



Mekong River Commission

Cambodia • Lao PDR • Thailand • Viet Nam

For sustainable development

Summary note

Review of the Design Changes Made for the Xayaburi Hydropower Project

Final draft

In an effort to communicate openly with broader stakeholders of the Mekong River Commission (MRC) and to help them participate in MRC's regional stakeholder forums more meaningfully, the MRC Secretariat has prepared this summary report to present key and substantive points from selected on-going technical work of the MRC which is in the process of development and finalization in consultation with its member countries.

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1. Summary

The prior consultation process on the Xayaburi Hydropower Project was formally initiated on 22 October 2010, once the documentation submitted by the Lao National Mekong Committee (LNMC) was reviewed for completeness and submitted to the Member Countries.

Following the first meeting of the MRC Joint Committee Working Group on 26 October 2010 the MRC Secretariat (MRCS) was entrusted to prepare a technical review of the submitted documents (the Xayaburi Technical Review Report, XTRR), as well as request by Development Partners. The 6 months provided for prior consultation in the PNPCA came to an end on 22 April 2011. However, a special session of the Joint Committee on 19 April 2011 could not come to a decision on the conclusion of the prior consultation process under Article 5.4.3 of the PNPCA and elevated the issue to the Council for a decision. On 8 December 2011 the Council resolved to initiate the “Council Study” to provide a better basis for future processes but did not make any further decision on the Xayaburi HPP.

Following a review of the XTRR and project documents by consultants Pöyry Pty. Ltd., the developer (Xayaburi Power Company Ltd. (XPCL)) and Government of Lao PDR (GOL) undertook the re-design of certain aspects of the project to address the concerns raised during the prior consultation process. Documentation, including reports, PowerPoint presentations and design drawings have been made available to the MRCS from time to time during the re-design and construction process.

The Secretariat has now reviewed the revised design¹ based on all the documentation made available. This review has not replicated the detailed assessment made in the XTRR, but focusses on whether the documentation provided answers the following questions:

- a) Is sufficient detailed information provided to describe how the recommendations of the XTRR have been considered in the revised design of the project?
- b) Does the documentation provide sufficient evidence that the revised design addresses the recommendations of the XTRR, and allays the concerns raised by member countries during the prior consultation process?
- c) Is sufficient information provided to establish the record of the proposed use, and the record of the proposed use once commenced (PNPCA Article 5.4.3)?

The possible effectiveness of the mitigation measures in the revised design is assessed against both the recommendations in the XTRR and studies or research that have subsequently been undertaken to provide more evidence of the benefits of mitigation measures.

The major findings of this review are as follows:

- The review reinforced the importance of the 1995 Mekong Agreement, the prior consultation process, the Preliminary Design Guidance (PDG), and the mutual benefits

¹ Design in this context refers to both the changes in the infrastructure (some of which is already in place), as well as the changes in the operating rules.

of ongoing dialogue and actions towards resolving concerns regarding the impacts of the Xayaburi HPP;

- The information provided by the developer and GOL, along with field trips to the facilities, and ongoing discussions on the technical details have been important to reduce uncertainty and misunderstanding between stakeholders;
- A number of the recommendations included in the XTRR have been considered by the developer in the redesign of the Xayaburi HPP;
- The XPCL has made substantial investments in monitoring, research and re-engineering to further minimise potential impacts based on the XTRR and subsequent discussions.
- An in-depth assessment of the efficacy of the revised design to mitigate impacts would require additional detailed baseline information (e.g. on fisheries, water quality, aquatic ecology and sediment data and related operating rules) to be submitted with the redesign documentation.
- Due to the unique nature of this major infrastructure, it is not possible to fully assess the effectiveness of the design of fish passage and sediment flushing operations without access to the data and knowledge of the rationale used in the design and operations.
- The analyses undertaken in the MRC's Mitigation Guidelines² on the mainstream cascade indicate that major impacts can only be partially mitigated, and that the efficacy of the measures and any residual impacts may only be fully felt in two or three decades.
- Concerns regarding sediment transmission through the dam have been partially addressed by the inclusion of four large low-level gates to facilitate sediment flushing. The gates have the potential to improve sediment transmission, but as no operating rules have been provided the efficacy of these measures cannot be evaluated.
- Design or operational mitigation measures, to reduce potential impact of sediment flushing on downstream fish, fisheries, water quality and aquatic ecology have not been submitted for review.
- The MRC Mitigation Guidelines suggest that, the silt may be readily flushed through the impoundment, but gravels and coarse sands will not be effectively flushed until the sediment deposits reach the toe of the dam, which will require years to decades. During this period coarse sand and gravel will be trapped, accounting for trapping of up to ~80% of incoming sediment load.
- The MRC Mitigation Guidelines study has demonstrated that an erosional 'wave' will progress downstream of hydropower projects over the next few decades and the impact on sediment transport further downstream can only be assessed by looking at the entire mainstream cascade.
- Substantial work has been undertaken by the XPCL to understand the fisheries baseline characteristics and the implications for the revised upstream and downstream fish pass design. However, detailed documentation has not been supplied and the scientific rigour of the monitoring and evaluation processes cannot be evaluated.

² Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries, Volume 4 – Draft Final Case Study Report, Final Mainstream Dams Assessment Including Alternative Scheme Layouts (Version 2.0)

- The complex array of both upstream and downstream fishpass facilities has been modified extensively to improve *attraction* and *passage* of a wide variety of fish species and high biomass. However, these have not addressed all the recommendations of the XTRR, and monitoring will be needed to: i) assess the efficacy of the fish passage facilities *vis-à-vis* the guidance provided in the PDG, ii) optimise fishpass operation, and iii) assess whether modifications may be required.
- Target species for monitoring should be based on size (e.g. small, medium, large), life stage (e.g. larvae, juvenile adult) and behavioural guilds (surface, mid-water, benthic and migratory characteristics).
- The rationale behind the re-design of the fish passage is only partially described in the submitted documentation and it is not possible to assess the effectiveness of these facilities given the unique nature of the project, and the difficulty in describing the nature of the fishery accurately.
- Whilst considerable effort has been put into the assessment of the fish population dynamics, little information on the ecological characteristics of the species, biodiversity and conservation status or assessment of the transboundary impacts has been provided.
- The Joint Environmental Monitoring (JEM) scheme will be vital to enhance the technical understanding of the upstream and downstream impacts, and assess the effectiveness of the mitigation measures, and build confidence that the impacts of development can be addressed.
- Adaptive management will be necessary to modify operations and manage impacts once this detailed information is available.
- The cumulative impacts of infrastructure development in the Mekong, analysed by the MRC's Council Study, indicate major adverse effects on Mekong River System, and riparian communities if all proposed developments in the basin proceeds. This reinforces the need for joint monitoring, analysis and dialogue on regional strategies in the water, food and energy sectors to meet all the Member Countries development needs.

In conclusion, the developer has made significant efforts and investments towards addressing the concerns raised in the XTRR. However, insufficient information has been provided to fully review the likely efficacy of these measures. Due to the lack of detail on revised operating rules, there is insufficient information to establish the record of the proposed use once commenced for the purposes of the Procedures for Water Use Monitoring.

Monitoring, through the proposed joint environmental monitoring scheme (JEM), and adaptive management will be needed to further understand the efficacy of the mitigation measures and to further modify and adapt the design and operation as far as it is provided for in the Power Purchase and Concession Agreements.

2. Review of the Xayaburi Design Changes

The review considers all reports, drawings, presentations, and correspondence provided by GOL and the developer as well as their advisors, and any pertinent information that is available in the public domain. A list of the documentation provided by GOL is shown in Annex 1.

Recent work undertaken by the MRC has been used to assess the likely efficacy of the revised design (see list in Annex 1). It is recognised that some of this work has only recently been completed and may not therefore be available to support the re-design process.

Ultimately, this summary of the review is made available to stakeholders to understand how the XTRR, and more broadly the MRC and prior consultation process, may have contributed to a betterXHPP with fewer impacts.

This review covers six aspects related to the revised design including navigation, fisheries, hydrology, sediment, water quality and aquatic ecology, and dam safety. Information on the social aspects and cumulative impacts was not made available, but a brief reflection is provided.

Details of the 2011 TRR recommendation may be found on the MRC website.

2.1 Navigation

Adequacy of Information Provided

The reports on “Improvement of the Lock Design” (mainly on the filling and emptying system) and on “Design Adaptation”, indicate that most of the concerns raised in the XTRR have been dealt with by the XPCL.

A modelling report has been provided covering some of the approach and exit conditions during spillway gate operation. The operations have been described in some detail, as has the hydraulic design.

Limited information has been provided on the design characteristics of using the fish lock for passage other than a boat with a ‘crowder’ screen over the full width of the lock that is used to drive fish through the lock structure. The system will also only be operational during the rainy season, which may not be sufficient as the peak fish migration period is at the onset of the increased flows (i.e. in May, see Figure 1).

The highest and lowest Operating levels have been reported as providing for a 20m head difference (HOL=275 masl, LOL=255 masl). This does not appear to be feasible.

Evidence the revised will address the intent of the XTRR

It appears that the PDG performance standards have been adequately included in the revised design and operations. However, some details have not yet been provided, but could still be addressed. These include:

- The design could be adjusted to include a suitable work platform for unusual heavy-duty maintenance (e.g. damage to hydraulics and doors from ship impact, replacement of valves or seals and hydraulics from culvert valves, etc.) in the immediate neighbourhood of the ship locks;

- Provision can be made for an overhead rolling bridge over the entire ship lock chamber[s] to lift objects/obstacles from the lock chambers (e.g. barrels getting stuck behind the pintle doors, etc.);
- An RIS system (VTS radio) with up and downstream stations could be developed to facilitate efficient locking for approaching shipping, and inform pilots of the up- and down-stream water levels;
- A control cabin overlooking operations in both of the tandem locks can be included; and
- Provisions could be included for night mooring facilities with access to the shore provided (eg floating pontoons connected to the shore).

General

The XPCL has addressed the concerns raised in the XTRR. However, the subsequent prior consultation process for the Pak Beng HPP has highlighted some additional measures that could still be considered.

2.2 Fisheries



Figure 1: Vertical slot component of upstream fish pass (Source: Coe 2015 Xayabury HPP: Fish Migration Facilities”, Pöry and Fishtek [V1])

Adequacy of the Information Provided

The Design Adaptations Implemented in the Xayaburi Hydropower Project (November 2017) provides a summary of the work done to study baseline conditions and re-design the fish passage. The report demonstrates that the developer has clearly applied considerable effort

and resources to the re-design of the fish pass facilities, and to address the knowledge gaps identified in the XTRR.

There were additional studies on (1) Fish Biomass & Migration, (2) fish sampling, and (3) Mekong fish species and fisheries, including swimming speed/ability. However, there is little detailed information and data on fish abundance (including fish biomass) and diversity, and migration and swimming ability provided, and most information is only in PowerPoint presentations. The additional documents and presentations submitted by Pöyry are consequently not detailed enough to allow for a review of the rigour of the scientific methodologies. Details of the experiments, monitoring and assessments of the ecological characteristics should be included in reports for evaluation. There are also concerns over the frequency of the surveys, which were undertaken only 3-4 times per year, which could miss key migration periods, and whether the overall programme has provided an adequate baseline on which to base the redesign of the mitigation measures. In addition, there appear to be no surveys explicitly examining the biodiversity and conservation species endemic to the Mekong and the Xayaburi region.

Comment on the revised upstream/downstream fish passage design

Many of the recommendations and key design criteria from the XTRR have been adopted, but there are also key omissions and design aspects that have not been adequately addressed. These may entail a high-risk to effective fish passage, and these have been highlighted as high-priority areas for monitoring during operations.

For **downstream migration**, larval behaviour and thresholds to maintain drift in the impoundment remain unknown. The trash screens at the turbine intakes have been modified with narrower gaps but the screen angle remains steep and there are only surface entrances, so there is a major risk of impingement of large fish. Much work has been done on the turbine design to reduce risk to fish passing downstream, but without specific data for Mekong fish species, only blade strike can be assessed and not the impacts of shear or barotrauma (pressure impacts). Turbine passage remains an important unknown to assess in monitoring.

A detailed description on alternative downstream migration possibilities has been given. However, there are no details on the maximum amount of fish that the rest area can hold, and how 'a significant number of fish' is defined.

For **upstream passage**, assessment of fishway entrance location and design at varying spillway flows has been overlooked; only very high flows were assessed (12,000 and 15,000 m³/s) and only on one spillway abutment. The design philosophy of Pöyry, suggested by PowerPoint drawings, indicates they do not expect fish to migrate onto the stilling basin at any spillway flow.

The XTRR recommendation to use the **navigation lock for fish passage** was adopted. The redesign of the navigation lock has been outlined, however, further details such as attraction flow and cycle times would aid evaluation, as would information on the crowding mechanism in relation to the capacity to move fish in the system. The frequency and timing of the use of

the lock for passage requires in-depth evaluation, as does the mechanism for use of the tandem lock system.

Extensive work and re-design have been done on the **fish collection gallery** above the draft tubes but the recommendation for benthic entrances was not adopted. An assessment of benthic fish migration will determine if these should be installed for future projects.

The main pool-type pass is a new variation of a vertical-slot design. It utilises criteria from the XTRR which are conservative and provide a low-risk. However, the baffle design is untested and significantly, all fish that reach the top of the vertical-slot fishpass then need to use one of two fish locks. The **fish locks** have small chambers and may be a bottleneck during periods of high migratory biomass; this will require assessment to optimise cycle times and assess whether the additional fish lift is required. The proposed larger pool of the fishpass would allow catfish reaching a size of up to 300 cm, but no additional data (monitoring or sampling) or information were provided to confirm this statement.

Comment on Fisheries Monitoring and Management

Although a presentation from Fishtek in 2015 has been provided, the complete results on monitoring and sampling were not shared in detail in the reports, hence, they cannot be evaluated.

Furthermore, a detailed and robust fish monitoring programme, including budget, to monitor the status of fish and fisheries at project site (downstream and upstream, including the impoundment) and the effectiveness of fish passages (for both up and downstream fish migration) continuing in the future should have been provided. This would enable better integration into the Joint Environment Monitoring (JEM) scheme and strengthen the understanding of the impact of the development on fisheries and make adaptive changes to the mitigation measures as was suggested in the PNPCA documents provided by XPCL.

Evidence that the revised design will allay concerns

The XPCL has made commendable efforts to address the recommendations outlined in the XTRR and has invested considerably in studies to support the redesign process, and in constructing the revised fishpass facilities. In many cases the revised designs directly reflect the recommendations in the XTRR, and the fishpass facilities at Xayaburi are now likely to be the largest fishpass facilities on a tropical river system anywhere in the world. However, without ongoing monitoring the efficacy of these facilities cannot be assessed, and some concerns remain regarding the potential impacts on fish migration.

There are several critical recommendations in the XTRR that were not taken up. Most notably the suggestion in the XTRR that a workshop be convened to bring the developer's and MRC experts together was not taken up. This may have provided the opportunity to optimise the facilities before construction, and to build confidence in the revised design in all the Member Countries.

2.3 Hydrology

Adequacy of Information Provided

The lack of data and information in the documentation provided makes it difficult to assess the extent to which the revised design accommodates the recommendations in the XTRR.

The operational rules for:

- Addressing backwater effects to Luang Prabang;
- The expected ramping operation, and consequently the magnitude of the additional discharge on top of the ongoing flood; and
- Limiting the impacts of drawdown on the downstream reach.

... have still not been provided. These are critical to this review.

Evidence the revised design will allay the concerns

- Both the Council Study and MRC Mitigation Case Study confirmed that theXHPP will not affect the seasonal patterns downstream. These seasonal flows are mainly impacted by Lancang cascade and the tributary dams.
- However, flow velocities in the impoundment are significantly reduced. This will have considerable impact on fisheries and disrupt the downstream movement of migratory fishes. As no operating rules or analyses have been provided in the documentation it is not known whether the revised design accommodates this.
- However, the work by the MRC on Hydropower Mitigation Guidelines (ISH0306) suggests that for a large part of the year (for discharges less than about 4000 m³/s) the velocities drop below 0.3m/s for the lower 30 to 40km of the impoundment.
- The MRC's subsequent work has also highlighted the need for coordinated operations along the full cascade to minimise the potential impacts on fish migration and sediment transport. The extent to which this adaptive management can be accommodated by the XPCL is not known.
- Environmental flows are not detailed in the documents. However, the inclusion of functional flows that serve a range of environmental and socio-economic purposes (not just restrictions to minimal flows, but also pulses needed for maintaining functions of the river), should be included in the operating rules.

2.4 Sediment

Sediment budget and sediment trapping

The details of the sediment monitoring methodologies and sediment trapping model are not provided. The results presented in the documentation also differ markedly from that held by the MRC both in terms of the total incoming sediment load and loss of sediment in the impounded reach. The documentation provided suggests input sediment loads of **82.5 Mt/yr, with 34% sand, and only 10% trapped**. Whereas the MRC's studies (based on MRC sediment monitoring) suggest an incoming load of **13.5 Mt/yr, with 72% sand, and some 80% trapped**. In

both cases the modelling results show that the fine clay and silt, and hence the nutrient fraction, is passed through the impoundment.

Resolving these differences is critical to assessing the likely transboundary impacts of Xayaburi, and other mainstream dams, and hence to assessing the extent to which the concerns raised in the XTRR have been addressed.

Low Level Outlets

The following comments are provided and supported by the outcomes of Council Study and the MRC Mitigation Guidelines:

- The Low-Level Outlet (LLO) provides an increased capacity to flush sediments, but information is lacking as to how the system will be operated to maximise sediment passage and minimize transboundary impacts. A provisional operating curve is provided for flows greater than 10,000 m³/s but no other operational information has been provided;
- The lower sill level (238 m asl) reduces the height between the river bed and the sill by 14 m, which will allow the passage of bedload earlier than with the initial design. However, even with the revised design, substantial sediment deposition is required before bedload can be transmitted through the 80km long impoundment;
- Given the length of the impoundment and the reduced sediment input, it is likely to be years to decades before sufficient sediment accumulates near the dam wall for a new equilibrium to establish and hence for incoming sediment to be able to be routed through the impoundment;
- No target suspended sediment concentrations have been identified for adoption during sediment flushing to minimise downstream impacts; and
- Sediment outlets in the power house have been omitted, but no reason or justification for this is provided.

Evidence the revised design will allay the concerns

- While the documentation suggests that the revised design will facilitate flushing with different grain sizes for both operating condition and flood release. No evidence supporting this claim was presented.
- The sediment load and grading assumed in the CNR analysis differ to that used in the MRC Mitigation Guidelines study, where the effect of the Lancang cascade on sediment yields is taken into account. The most recent MRC Discharge and Sediment Monitoring Program (DSMP) data reflects a lower percentage of silt and more fine and coarse sand. If this sediment grain-size distribution is valid for Xayaburi then a higher percentage of sediment would be expected to be trapped than shown in the CNR presentation.
- The submitted documents conclude that 97% of the sediment will be transmitted through the impoundment and suggest that with this level of sediment passage the trapping of nutrients will not be an issue. The MRC Mitigation Guidelines study found that only 10-15% of incoming sediments is passed; finer sediments, which transport the majority of sediment-bound nutrients, are likely to be effectively passed, but courser

sediments are trapped, and that it would take years to decades for a new sediment transport equilibrium to be established.

In conclusion it is likely that the revised sediment transport measures included at Xayaburi will improve the capacity to transport sediment through the impoundment. However, some residual impacts will be felt downstream due to the deposition of the courser sediments in the impounded reach.

2.5 Water Quality and Aquatic Ecology

Adequacy of information provided

No information has been provided regarding water quality monitoring of the river, waste water streams, site run-off or mitigation actions, as recommended by the XTRR. An inventory of pollution/water quality issues arising during the construction phase has not been provided as part of the monitoring recommended in the XTRR.

Similarly, no information on aquatic biodiversity and conservation species has been provided.

Evidence the revised design will allay the concerns

As no new information has been provided it is not possible to assess whether the concerns expressed in the XTRR will be addressed. Nonetheless, these aspects have been investigated in the MRC Mitigation Guidelines, from which the following assessments are made:

Water quality risks associated with Xayaburi

The cumulative water quality risks of mainstream hydropower include:

- Increased water clarity due to the reduction in suspended sediment concentrations from sediment trapping in the Lancang Cascade and tributary dams;
- Changes to water temperature due to storage;
- A reduction in river flow velocity will decrease mixing and promote algal growth, especially when associated with increased nutrient loading. (An algal bloom was observed in the backwater created by the Xayaburi project in March 2016.)
- Increased run-off of nutrients from the catchment, pesticides and herbicides may affect water quality in the impoundment;
- Changes in water quality resulting from immediate land use change and population growth around the impoundment will potentially lead to



Figure 2: Algal bloom in the Xayaburi backwater during construction, March 2016 (Photo: Lois Koehnken)

nutrient enrichment, although the run-of-river operating regime would mean retention time in the impoundment is short, limiting algal build up.

The Council Study has also considered WQ issues, specifically the potential effects on downstream biology and ecological processes. These effects are likely limited to immediate downstream area or dams constructed below Xayaburi, e.g. Pak Beng.

Applicability of LLO to water quality issues

The inclusion of additional low-level gates in the project increases operational flexibility with respect to water quality. Water can be released from variable depths within the impoundment if required to manage a water quality issue, such as an extreme algal bloom or oil spills. Although the downstream effects must also be taken into consideration.

2.6 Dam Safety

Adequacy of Information Provided

The documents related to Dam safety were requested by MRC, but as yet not all the documents have been provided. The documents that were not received are following;

- Flood risk and dam break analysis
- Spillway gate operations and backup power arrangements
- Dam safety management plans
- Flood warning and emergency response plans.

As such, this review is unable to fully evaluate the extent to which the concerns in the XTRR have been addressed. Nonetheless it is noted that the seismic hazards have been addressed in detail, and Asian Institute of Technology study demonstrates a commitment to observing international standards for dam safety including consideration of a Maximum Credible Earthquake.

Evidence the revised design will allay the concerns

An Independent Dam Safety Review Panel (DSRP) for the Xayaburi dam project and assignment of the task to review the Design Report was not established. Instead Pöyry engineers have been engaged as “Owners Engineer” to review designs and dam safety matters.

The seismic design has been reviewed by the MRC in 2015. This review recommended that due to uncertainties over the size of the Safety Evaluation Earthquake (SEE), the design of the dam should be checked for a higher peak ground acceleration. The review also recommended that there should be further investigations of the foundations during the construction period to identify any risk of fault rupture through the foundation. It is unclear if these recommendations were carried out.

A Plant Safety Concept for the structural safety was implemented based on international standards to ensure an earthquake resistance design based on the ground motion parameters. All dam and safety-relevant elements have been designed for the Safety evaluation earthquake (10,000-year return period). Earthquake resistance design of Xayaburi HPP for each structure was summarized in the Plant safety concept document, Oct 2012. It is unclear if this plant safety concept was reviewed and the calculations revised to take account of the recommendations to increase the SEE.

The process for consultation and engagement of local stakeholders, especially for the Emergency Preparedness Plan (EPP) needs to be implemented during the construction as well as the operation phases.

2.7 Socio-Economics

These aspects were not dealt with in documentation provided. It is recommended that mechanisms for achieving sustainable livelihoods and equitable distribution of benefits should be developed (if these have not already been developed), and shared.

The MRC Member Countries have undertaken studies on National-to-Local benefit sharing, and their priorities have been documented. In addition, the MRC is considering regional benefit sharing projects. There are examples of international best practice being adopted in Lao PDR including the increasing trend towards project-based benefit-sharing mechanisms for affected communities.

These should be considered as a basis for mitigation measures at Xayaburi. For the cascade of 6 dams upstream from Vientiane excluding proposed tributary dams, incremental effects regarding fish losses due to reduced capture fisheries are estimated at about 66,000 tons per year. The livelihoods of about 450,000 people would be at risk to some extent. The distribution of the number of affected people among countries would need to be further analysed based on more extensive social information.

Social issues are not dealt with in the PDG and this has been considered in the updated PDG 2018.

2.8. Cumulative Impacts

The Council Study and other initiatives in the MRC since 2011, initiated in large part because of the Xayaburi prior consultation process, have made an invaluable contribution to the understanding the impacts of development on both the tributaries and mainstream. These studies have indicated that:

- While the overall flow regimes in the LMB will not be substantially affected by run-of-river hydropower projects in the mainstream, increased storage in the tributaries and the Lancang cascade will reduce the volume of the return flow into the Tonle Sap;
- Even run-of-river developments on the mainstream and developments on tributaries will result in substantial and irreversible impacts associated mostly with reduced fish migration and sediment transport;

- Measures to avoid, minimize or mitigate impacts at each of these projects (as provided for in Article 7 of the 1995 Mekong Agreement) may limit possible transboundary impacts;
- Conjunctive operation of the hydropower projects can further reduce the possible impacts; and
- If the required infrastructural changes are in place, it may be possible to retrospectively adjust the operating rules at each project to accommodate the growing understanding of the Basin and the impacts of hydropower development, as well as monitoring through the JEM scheme, provided that these can be accommodated by the concession and power purchase agreements.

However, key Water Diplomacy aspects of the prior consultation process still must be clarified through the PNPCA Commentaries. Whether the residual impacts of *all* developments in the Mekong River Basin constitute a reasonable and equitable use of the shared watercourse. This includes the potential impacts of developments outside of the energy sector, as well as population pressures, over fishing, sand mining, increased nutrient loads, and increased use of herbicides and pesticides and other pollutants.

3. Conclusions and Recommendations

In Article 7 of the 1995 Mekong Agreement, the Member Countries agree to make every effort to avoid, minimize and mitigate any harmful effects of development and use of the Mekong River System.

In this regard:

- The XPCL has made commendable *efforts* to further reduce the potential harmful effects of the XHPP, but it is not possible to assess whether *every* effort has been made without the inclusion of the operating rules;
- The documentation provided primarily outlines the infrastructural changes, but the efficacy of these changes will be realized through the operational rules which have mostly not been provided;
- The details of the monitoring, data and analyses that have led to the design changes have not yet been shared, which limits any assessment of the scientific rigour of the methodologies. Of concern are the differences between the XPCL and MRC sediment analyses.
- The potential constraints to design and operational changes have not been shared, to assess the extent to which the *all reasonable measures* have been considered.

It is therefore not possible to completely review the extent to which the revised design addresses the concerns raised in the XTRR, or the extent to which transboundary impacts may be reduced. However, given that some of the infrastructural measures have been constructed, the operational measures could be retrospectively included, provided that the CA and PPA allow. It is understood that the Lao PDR Standard Environmental and Social Obligations (SESO) have domesticated the provisions of the 1995 Mekong Agreement, but it is not known how these have been taken up in the CA and PPA.

However, the efficacy of the revised fish passage infrastructure, irrespective of any operating rules is unknown at this stage. This highlights the importance of ongoing interaction between the developer and MRC throughout the re-design process. The Joint Action Plan for the Pak Beng Statement should help address this need.

Nonetheless, the admission by the XPCL in their Compliance Report, highlights that the XTRR and the prior consultation process have been instrumental in identifying additional measures to avoid, minimize and mitigate harmful effects. Similarly, the studies that have emerged because of the Xayaburi PC process have been invaluable and can still contribute to optimizing the operating rules to further minimize impacts.

However, it would be necessary for additional information to be provided– particularly the revised operational rules, to establish the record of the use once commenced as outlined in Article 5.4.3 of the PNPCA, and as stipulated in the PWUM.

Appendix 1: List of information provided by GOL

MRCS Request for information on revised design

In May 2013 the MRCS sent a request for information on the re-design proposals to the GOL, detailing the kind of information that would be necessary to undertake this review. To date only the information outlined in the following sections has been provided.

Revised design reports received February 2014

- Improvement of Lock Design (125 pages);
- Physical Hydraulic Model Study of Xayaburi HPP (197 pages);
- Plant Safety Concept (7 pages); and
- Seismic Hazard Study (101 pages).

Presentations received July 2015

The government of Lao PDR held a stakeholder consultation meeting in July 2015 called “Open Forum on Xayaburi” and several presentations covering aspects of the redesign of Xayaburi were provided. These contained some information on the redesign of the fish passage, the sediment flushing facilities and other design details. The following is a list of these presentations:

- “Lao PDR Power Policy and Development plan” – Dr Daovong, DG Dept Energy Planning, Ministry of Energy and Mines, LAO PDR
- “Requisites for Concession Agreement: *Requirements of MRC-1995 Agreement*”, Xaypaseuth Phomsoupha, DG Dept of Energy Business, Ministry of Energy and Mines
- “Development and Status of Xayaburi HPP”, Knut Sierotski, Pöyry Engineering
- “Xayaburi HPP: Fish Migration Facilities”, Pöyry and Fishtek (V1)
- “Xayaburi HPP: Fish Migration Facilities”, Pöyry and Fishtek (V2)
- “Follow-up of recommendations made by CNR during the peer review regarding navigation and sediments issues”, Benjamin Graff, CNR

Drawings received August 2016

In August 2016, the MRCS received further details of the revised designs. The drawings are A3 scanned copies of sections of the construction drawings, marked up with comments and text. The complete drawing set was not received, although several requests have been made for these to be provided.

No reports of the detailed analyses behind the re-design of the fish passage and the sediment transmission have been provided. These would be valuable to make a more thorough assessment of the likely efficacy of the proposed mitigation options in the revised design. Importantly, the proposed operating rules for the infrastructure have not been provided.

Further to a request from MRCS in April 2017, GOL shared a report on design adaptation of the Xayaburi HPP in November 2017³. The draft report provides information on the design changes related to four main aspects including (1) navigation lock, (2) fish passage, (3) sediment

³Design adaptations implemented in the Xayaburi Hydropower Scheme based on the Preliminary Design Guidelines; Progress on Xayaburi Hydroelectric Power Project Construction; Pöyry, 2017.

transport and morphology, and (4) dam safety, but no drawings are provided. Information on water quality and aquatic ecology was not shown in the submitted documents.

The construction of the project is now more than 82% complete (as of November 2017), and opportunities to make any alterations to the design are very limited at this stage. However, changes in the operating rules are still feasible, to the extent allowed by the Power Purchase and Concession Agreements (PPA &CA).

Follow-up work by the MRCS

As part of the MRC Strategic Plan (SP) 2011-2015 and SP 2016-2020, investigations of global best practices for Sustainable Hydropower, and specifically for mitigating the risks and impacts of HPP, have been undertaken. This work has included several studies important for the Xayaburi case. These include:

- Review of Existing Knowledge on the Effectiveness and Economics of Fish-Friendly Turbines; Niels M. Nielsen, Richard S. Brown, Z. Daniel Deng², July 2014
- Review of Existing Research on Fish Passage through Large Dams and its Applicability to Mekong Mainstream Dams; S Schmutz, Boku University, Austria, June 2014
- Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries; MRC 2017. (MRC Mitigation Guidelines)
- A detailed case study on the mitigation recommendations contained in the above studies applied to the mainstream Mekong cascade upstream of Vientiane, including the Xayaburi project. MRC December 2017, (Volume 4 of the MRC Mitigation Guidelines)
- Study on the Sustainable Management and Development of the Mekong River, including impacts of Mainstream Hydropower Projects (MRC Council Study); MRC, December 2017.
- MRC Joint Environment Monitoring for Mekong Hydropower Projects (In Progress); and
- MRC Guidelines for Transboundary Environment Impact Assessment, including the EMP implementation and monitoring (In Progress).
- Discharge and Sediment Monitoring Programme Review, Discharge Sediment Monitoring Project (DSMP) 2009-2013 Summary & Analysis of Results (Koehnken, 2014).
- The MRC fisheries programme has conducted studies on larvae drift in the reaches near the Xayaburi project.

These investigations will provide further information on the likely efficacy of various mitigation options. Therefore, they extend and support the analyses undertaken in for the XTRR and the CNR/Pöyry analyses.



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