DSPC response to MRCS Initial Review of the DSHPP

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For Don Sahong Power Company
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Notes on the Initial Assessment of the Project Documents by the MRCS January 2014.

After receiving the submission from Lao PDR, the MRC Secretariat has been working on initial assessment of the documents submitted by LNMC to prepare for detailed technical review at a later stage.

Footnote 2 - The initial assessment by the MRCS Programmes will indicate **the finding on what environment issues have been addressed properly by the developer and what issues need further assessment.**

If the Joint Committee agrees that the MRC Secretariat needs to carry out the detailed technical review of the Don Sahong Hydropower Project, the MRC Secretariat will mobilise their resources and it is expected that some external expertise will be required.

Detailed Comments

The MRC review references the DSHPP Engineering Status Report and Environmental Impact Assessment Report. Review comments are generally related to requesting clarification or further information that is not presented in these documents.

MRCS Review comments are in italics, and the DSPC response is in red font.

Annex 1: Hydrology:

The main gap within the analysis of the submitted documents is the issue that the flow regime for environmental analysis needs to consider more than just the flow rate. It is important to consider other changes such as water velocity and channel morphology.

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The reasoning to choose an environmental flow of 800 m³/s was not clear and should be better explained.

The decision on minimum environmental flow should be targeted towards maintaining a sustainable balance between the purpose of the dam and the needs of the downstream ecosystems and resource users.

A flow of 800 m³/s satisfies the existing ecological and ecosystem demands, as the overall pool water volumes, deep-pool locations and depths, and water pathways in the affected reach are not significantly changed. Visual impact on the Khone Phapheng Falls is a primary consideration in establishing the minimum flow in Hou Phapheng.

Peak flood flow rates in the Hou Phapheng, which may change channel morphology through an increase or decrease in erosion, are essentially unchanged by the presence of DSHPP.

In other channels (Hou Sadam, Hou Xang Pheuak), the environmental flow regime will ensure natural flow rates are maintained or increased for a given existing flow condition, and local channel constrictions improved to aid fish migration.

The developer has surveyed a number of cross-sections and collected water level and flow data at the project sites. It would be useful to have access to such data for any future studies or detailed project assessment.

Data on cross-section, local surveys and water level monitoring and flow observation before and during project construction, and during operation should be shared with MRCS for consolidation.

The Developer is willing to share project data to improve understanding and encourage discussion of the project impacts.

The water level drawdown in the upstream section of the Hou Sahong inlet are based on modeling results as well as the evaluations of the rate of daily water level changes. The hydraulic model used should be explained in more detail (e.g. detailed modeling report and remarks on reliability and accuracy).

Subsequent to the studies presented to MRC and referenced in their review, further computational hydraulic modelling has been undertaken to further investigate upstream drawdown, and a modelling report is in preparation.

Flood analysis during construction was considered, but its management strategy was not proposed including the likelihood of cofferdams being overtopped and washed away creating potential impacts and pollution incident downstream.

The management of construction risks will be detailed by the construction contractor, when appointed. EPC contractual documents will include requirements for the temporary cofferdams to be designed by suitably qualified engineers, and meet the requirements of the Environmental Management and Monitoring Plan.

Hydrological monitoring programmes during construction and operation in the project area is currently missing in the submitted documents and a respective revision is needed.

The hydrological monitoring program should be considered during the project construction and operation. Furthermore, the location of the network and observation method should be reviewed, revised and improved.

Due to the change of flow and sediment regime a proposal for a separate hydrologic and sediment monitoring scheme should be included for the downstream section of the Hou Xang Pheuak and Hou Sahong (downstream of the DSHPP) which indicates the extent, the type and frequency of observations and the reporting periods.

Hydrological monitoring during construction and operation will include continuous monitoring of water levels on Hou Phapheng, Hou Sadam, and Hou Xang Pheuak to ensure compliance with the environmental flow regime, and upstream and downstream of the headpond for operational control and to ensure compliance with rate of change ('surge') requirements.
Sediment monitoring will include ongoing suspended sediment measurement during operation upstream and downstream of the station, and periodic bathymetric survey of the head pond to monitor sedimentation.

The actual turbine ramp rates should be studied and an appropriate warning system would also be implemented in the events of a flow rejection, controlled shut-down and start-up to minimise water level fluctuation.

Appropriate limits to water level rate of change, and requirements for appropriate warning systems have been considered in project design, and will be included in EPC contractual documents.

In the report it should be clearly stated that this fluctuation will not be used to practice hydro-peaking and hence the total instantaneous inflow to the system will always equal the total outflow.

It is confirmed that the headpond will not be used for peaking operation, and that inflow to the system will always equal the total outflow (neglecting changes to in-channel storage).

The presented flow duration curve for Hou Sahong and Khone Phapheng are put in perspective to the overall discharge of the Mekong but should also address the local changes in the flow durations of the other channels.

From the reports it is not clear how the flow characteristic of the Hou Sadam and Hou Xang Peuk channels will change. This needs to be more detailed since these channels will be developed as a new alternative fish passage.

Excavation works will be undertaken in Hou Sadam and Hou Xang Pheuak to ensure that flow rates and local flow conditions will match or improve over pre-development conditions for a given existing flow condition. Definition of this work is ongoing as trial fish migration pathways are being monitored.

MRCS in collaboration with Lao PDR and its Line Agencies should develop a hydraulic model to investigate possible negative impact of DSHPP on the transboundary Mekong mainstream.

If MRCS wish to pursue further modelling studies, the Developer is willing to share data collected for the project, and would anticipate that study results would be likewise shared, in the interests of mitigating possible negative impacts.

Annex 2: Sediment (IKMP)

MRCS Comments: *The calculation of the suspended sediment load on the Mekong River follows established approaches and is based on the available literature. The derived values and time series fits the current knowledge but could be extended with more recent data (e.g. up to 2012)*

It is difficult to fathom that for such a large project no actual suspended sediment samples were taken. Hence the estimation on the grain size distribution is based on estimates and most likely not representative samples from sand bars. More recent data with respect to the grain size distribution of the suspended sediments for Pakse are now available through the MRCS (e.g. up to 2012)

The bed load estimates follow a reasonable engineering approach, however as said above actual measurements should have been taken during the planning period to support the provided values.

It is not understandable why the petrographic analysis of the sand samples are not included in the report. It would be of great interest to notice the composition of the (settled) sediments. It is assumed that the quartz content may be rather high which will affect the turbines and other machinery parts. This information should be included in the report.

The Developer has carried out a campaign of sediment sampling at site, with six data collection visits having been completed over 2012-2013. Suspended sediment and bedload have been sampled across the range of flow conditions. Data have been analysed and a report is now available on the DSHPP website.

The Developer would welcome the sharing of more recent MRCS data (suspended sediment concentration and grain size distribution sampled at Pakse), which would be of value to supplement the Developer's own data collection.

Petrographic analysis of sandbar samples can be made available to MRCS if the data are of interest.

MRCS Comments: *The results with respect to sediment deposition in the headpond are based on a detailed hydraulic model and are consistent and can be considered conservative. However, as said above the deposition depends on the actual grain size distribution of the suspended sediments.*

The construction of a submerged sill at the entrance of the headrace to divert bed load material is common practice. However, since no samples of bed load were taken it is difficult to judge if this is also true for the proposed design. Also the river morphology of the mainstream at the point diversion (channel inlet) may have an effect on the transport and distribution of bed load material.

No details are presented on the calculation of headloss due to the increase in reservoir sedimentation. Although the principle is well understood the results should be included in the report.

The Developer has commissioned further, more detailed coupled hydraulic-sedimentation computational modelling. This has been carried out based on the sampled grain size of transported sediments at site. A sedimentation modelling report is available on the DSPC website.

The modelling shows smaller rates of deposition than predicted by the modelling reported in the ESR, as a significant amount of sediment predicted to settle in the peak of the wet season will be re-entrained and flushed through the head pond as the head pond flood level recedes

The effectiveness of the submerged sill at the headpond entrance in excluding bedload will depend upon its exact geometry, to be finalized during the detailed design phase. There is an incentive for the Developer to optimize this aspect of the design, being in his economic interests in minimizing the ingress of coarser grain sizes. This optimization is a refinement, and overall sediment transport estimates in the context of the total Mekong sediment budget will not be impacted by the outcomes as only a small fraction of the total sediment is affected by this refinement.

Headloss caused by sedimentation of the headpond is similarly of direct economic interest to the Developer, and thus design and operation of the headpond seeks to minimize sediment deposition. It is noted that without intervention a form of equilibrium will be approached, whereby increasing headloss reduces deposition rates and causes increased re-suspension of sediment. It is not clear why the optimization of headloss would be a question of relevance under the MRC PDG.

MRCS Comments: *It is not clear how the sediment management of the tailrace will be handled. Since a higher sediment load will pass through the Hou Sahong the river morphology in the downstream area will change. There is no mentioning of effects or possible measures with respect to the outlet and rejoining the Mekong branch.*

In the immediate tailrace area, water velocities will be significantly higher than within the headpond, and sediment deposition is not expected. Downstream of this the river morphology is largely influenced by wet season flows from the Hou Sahong and Hou Xang Pheuak, which remain generally the same as the pre-development case.

MRCS Comments: *No details are presented on the calculation of the optimal submerged skimming wall height. The principle of skimming walls is well understood but the results of the calculations/models should be included in the report. Also a comparison with the existing natural rock levee (height, length) should be considered.*

The lowering of the rock outcrop in the upstream vicinity of the Hou Sahong intake, the construction of a submerged skimming wall as well as the changed flow regime (1600 m^3/s throughout the year) will have some effect on the river morphology of the

main branch leading to the Khone Phapheng. An evaluation of the possible effects should be included in the report.

As above, the effectiveness of the submerged sill at the headpond entrance in excluding bedload will depend upon its exact geometry, which is a refinement to be finalized during the detailed design phase. There is an incentive for the Developer to optimize this aspect of the design, being in his economic interests.

The change in flow regime and local changes to riverbed geometry at the Hou Sahong inlet are expected to have no significant impact on river morphology of the main branch leading to the Khone Phapheng Falls. The vast majority of sediment transport (thus potential morphological change) occurs during the wet season, when flows in this channel will be similar to the pre-development case. Optimisation of the skimming wall therefore only influences a very small proportion of the overall sediment load, and will therefore have no significant influence on the Mekong sediment budget.

In general, channels (and islands) in the project area are constrained by the bedrock formed of meta-sediments which has a high degree of resistance to erosion and scour, and no significant changes to channel morphology are expected.

MRCS Comments: *It is not clear from the description how the additional discharge of up to 300 m^3/s will be possible through the turbines.*

It is mentioned that during flushing operations the downstream suspended sediment concentration should be monitored but no design of the monitoring programme as well as limits on concentration is found.

No criteria on the effectiveness of flushing are mentioned and under what conditions mechanical dredging will be considered.

The elimination of any emergency or low level outlet should be argued more clearly and conclusive.

Sediment flushing was presented in the ESR as a potential sediment management solution. The more recent modelling of sediment transport through the headpond (noted above) has identified that the headpond will achieve an annual equilibrium condition without the requirement for sediment flushing, i.e. with only the normal operation of the turbines up to their maximum normal discharge of 1600 m3/s. Thus it will not be necessary to operate the turbines beyond their normal discharge condition or to provide special additional gates for flushing. This equilibrium condition was shown by the modelling to be achieved after the first few years of operation, following which there would be no further accumulation of deposited sediments within the headpond.

Given the modest headpond area, targeted dredging is considered to most likely provide the most economical sediment management outcome if required for economic reasons to reduce headlosses, as identified in the ESR. In addition, manual sediment removal is the most adaptable management technique.

Sediment management will be dictated by economic decisions rather than by necessity to mitigate environmental effects, given the small volumes of trapped sediment in relation to the total Mekong sediment load. This said, water quality considerations are important if releasing sediment from storage back into the river, particularly at Don Sahong given the distinct change in water clarity observed from wet to dry season.

Appropriate guidelines for use of removed sediment (whether released back into the river downstream, or used productively on land), and for monitoring will be developed between the Developer and GoL. If returned to the river, sediments will be released at volumes and times of the year when the addition of sediment will make no discernible difference to the naturally occurring sediment concentrations.

MRCS Comments: *Since mechanical dredging is considered a feasible solution, it would be worth to evaluate the available systems in more detail and chose the most effective.*

The Developer is evaluating and developing the most effective dredging solution. It is only necessary to demonstrate the general feasibility of such systems at this stage. Final selection is better deferred under an adaptive management strategy once actual sediment transportation and deposition characteristics within the headpond can be monitored and assessed.

Recommendations for the next steps

a) *Detailed estimation of sediment transport (suspended and bed load) based on measured data;*
   The Developer has carried out a campaign of sediment sampling at site. The Developer would welcome the sharing of more recent MRCS data. These collected data will be used to refine estimates of sediment transport rates.
b) *Evaluation of the suspended sediment grain size distribution based on actually measured data;*
   As noted above, the Developer has carried out a campaign of sediment sampling at site. A report summarizing the collected data is available. These data have been used to update detailed computational models already developed to investigate sedimentation.
c) *Detailed planning of extraction of material from the river (from sediment extraction to excavation of bed rock) and evaluation of the environmental impact;*
   Excavation methodology will be decided by the EPC Contractor, which shall be in compliance with the project developer's requirements and specifications. The EPC contractor is required to develop a formal Contractor's Environmental Management Plan, which will be monitored by the project developer as well as by independent agencies.
   Appropriate guidelines for environmental impacts and monitoring of any sediment returned to the river will be developed between the Developer and GoL.
d) *Selection and detailing of the chosen reservoir sediment flushing approach;*

Sediment flushing was presented in the ESR as a potential sediment management solution. Subsequent sediment modeling indicates however that sediment flushing will not be required, and that an annual equilibrium of sediment deposition/transport through the headpond will be achieved after a few years of operation. Sediment management would therefore only be required for economic reasons (to reduce headloss). Given the modest headpond area, targeted dredging is considered to most likely provide the most economical sediment management outcome, if ongoing sediment management (beyond normal operation) is required. In addition, manual sediment removal is the most adaptable management technique.

e) *Development of sediment flushing operation rules;*
As above

f) *Evaluation of the impacts of the chosen flushing approach;*
As above

g) *Predictions of the river morphological changes at the inlet (widening of the inflow channel) and the dredged tailrace downstream of the HPP;*
The Developer has undertaken further, more detailed coupled hydraulic-sedimentation computational modeling which includes prediction of morphological changes at the inlet.
In general, channels in the project area are constrained by the bedrock formed of meta-sediments which has a high degree of resistance to erosion and scour. As such the existing river bathymetry was modelled as non-erodible in the sedimentation modelling. No changes in river morphology at the inlet due to sediment deposition were apparent in the modelling. This is because at the highest seasonal river conditions the developed Hou Sahong and Hou Phapheng flow rates are very similar to their respective existing flow rates.
In the tailrace immediately downstream of the station, velocities will be higher than within the headpond, and deposition is not expected.

h) *Concept for monitoring sediment transport (suspended and bed load), reservoir sedimentation and the change in river morphology;*
Monitoring will include periodic bathymetric survey to measure sedimentation, and ongoing sampling of suspended sediment upstream and downstream of the scheme. Appropriate guidelines for monitoring will be developed between the Developer and GoL, and the input from MRC experts is welcomed..

i) *Measures to extract floating wood and debris with a concept of disposal;*
Agreed that these measures should be further defined. Reference design for the station has already incorporated log booms at the Hou Sahong inlet to deflect debris down the Phapheng Channel. This is a technical operational requirement relating to protection of the power station turbines, and will not have an impact on the overall amount of debris transported by the river.

j) *The deposition or use of the reservoir sediments at the stage of decommissioning needs to be addressed.*

This project is developed on a Build-Operate-Transfer basis. The ultimate owner (GoL) may wish to consider the use of deposited sediments at decommissioning, however it is not a question that would typically be responded at this pre-construction phase of a hydropower project (in particular for DSH where the quantities of trapped sediment are relatively small compared to other hydropower facilities with large reservoirs). The development of sediment management plan for project decommissioning should logically occur at the time when decommissioning is being considered.

Annex 3: Fisheries (FP)

The MRCS review in this Annex (3), has misinterpreted the available hydrological information regarding flows in Hou Xang Pheuak and Hou Sadam –flows in these channels will NOT be substantially reduced. The Concession agreement between the GOL and the Developer requires flows in Hou Xang Pheuak and Hou Sadam to be retained at least as at present (especially at minimum flows) for a given existing flow condition. This can easily be achieved by targeted excavation and has already been trialled in Hou Sadam in 2013.

1. INTRODUCTION

This document presents an initial review of the Fisheries Annexes C and D to the Environmental Impact Assessment of the Don Sahong Hydropower Project 2013 (EIA). The EIA aims at providing more detailed information regarding the project's likely impacts on the fisheries of the Mekong River, and what actions the project would take to mitigate those impacts. To this end, the EIA provides a Fisheries Monitoring and Action Plan (FishMAP) that proposes a package of mitigation measures. The results of FishMAP generated during 2010-2012 and presented in the EIA are considered a "living document" aimed at "improving the models and mitigation efforts as understanding of how the system works evolves".

Hou Sahong channel is critically important for basin-wide fish migration and, thus, the long- term sustainability of migratory fish species in the Lower Mekong Basin. There is a direct interdependency between fish productivity in the Great Lake Tonle Sap and 3-S Rivers of Cambodia and fish migration through Khone Falls area, most prominently through Hou Sahong channel.

Is there any actual evidence that the number of fish migrating through H Sahong determines the productivity of these two great Cambodian fisheries (i.e. they are interdependent)?

If there is interdependency (unproven) then it is highly skewed. There is evidence that the productivity of the Khone Falls pa soi fishery is highly dependent on the productivity and management of the Cambodian fisheries (linkages in Dai fishery catch and Khone falls Household catch data). But is the Cambodian pa soi fishery really dependent on the success of pa soi passage thru H Sahong?

Also some commercially important aquatic species (including Pa Suay Hang Leung Pangasius kremfi, the anadromous species like Salmon) migrate from the Vietnamese Delta through the Khone Falls area up into Lao PDR.

The disappearance of the Mekong herring, *Tenualosa thibaudeaui*, from the Khone falls area which was recognised in the 1980's and effectively complete by 1994 (Roberts and Baird 1995) seems almost certainly due to the introduction of monofilament gill nets in the 1960s and resultant unmanaged overfishing.

Other factors like deterioration in the river ecosystem caused by deforestation and siltation and the building of irrigation and hydropower dams are also claimed to be causes (Blaber 2009). However, the report of Roberts and Baird (1995) that the immense schools of this fish which once migrated through the Khone Falls had effectively disappeared by the 1990's, suggest the herring was in serious decline in the 1980s before these other factors came into play.

The dwindling stock of *P. krempfi* may also be attributed to over harvesting of broodstock fish in Vietnam, where these fish accumulate in Mekong delta deep pools whilst acclimating from marine to freshwater before migrating upstream to spawn around Khone Falls.

What of the impact of the Ba Lai barrage on the Mekong mainstream in the delta on fish migration? What are the operating conditions used at that dam to ensure effective passage for *P. kremfi*. The MRC does not hold a notification document for this dam (LNMC pers. comm. 2014).

While the Khone Falls has a series of water channels that allow for fish migrations at certain periods of the year, depending mainly on the water level, it is only the Hou Sahong channel, which allows for year-round migration and is large enough to support migration of big groups of large fish, including the Mekong giant catfish Pangasianodon gigas, and small fish, including the mud carps Cirrhinus spp., all year round.

Considering the large number of assumptions and lack of resolution in data and analysis presented in the EIA report, the EIA is still at a preliminary stage as high risks remain due to the impact mitigation measures suggested in the EIA are unproven and untested in a fisheries environment such as the Mekong.

This statement misrepresents the mitigation measures.

Firstly they are not just 'suggestions'. MRCS representatives visited the site in November 2013, and inspected these measures *in situ*.... Two demonstration fish migration pathways are described in EIA Annex C and D. A third pathway (in Hou Sadam) was developed in March 2013 (and in 2014 a fourth pathway has been established in Xang Pheuak as a second bypass around the Khone Larn obstruction). Further developments are planned for the 2015 dry season and will be ongoing until the carrying capacity of the pathways is demonstrably adequate.

Secondly the statement that "migration pathways are unproven and untested in a fisheries environment such as the Mekong", is completely false. The designated migration pathways are existing natural channels, which already support upstream fish migration. These pathways were first described in the scientific literature as anecdotal evidence from fishermen in (Roberts and Baird 1995). But the studies conducted by the DSPC since 2010 confirm these pathways do allow fish migrations throughout the year.

The aim of the mitigation measures is to increase the carrying capacity of these pathways and the duration each year when they are most effective.

They might work, and they might not, but the stakes are very high, and if they don't work, everyone in the basin will pay.

This statement is unsubstantiated and hyperbolic.

It implies the entire Mekong Basin above the Khone Falls is completely open to migratory fishes, whereas large swathes of the basin are already blocked or soon will be blocked to fish migration. Prime examples are the Mun Chi system in Thailand, the Ba Lai distributary in Vietnam, and the lower Sesan dam now under construction in Cambodia. All these barriers have little or no provision for fish migration. The Don Sahong Project aims to actually improve the likelihood of upstream migrating fish crossing the Khone Falls barrier. The project will ensure the reduction in capacity in Hou Sahong to pass upstream migrating fish will be more than compensated by improvements to passage through other adjacent natural channels.

2. ISSUES THAT REQUIRE FURTHER CONSIDERATION

2.1 Monitoring Methods

1. *Fisheries monitoring methods are not clearly described and explained – rather folkloristic and not scientifically robust. It seems that the monitoring focused on traps (which are highly selective gear) albeit the fact that gillnet was mentioned to have widely been used. No dimensions of gears are reported; no detailed analysis of fish species composition is conducted and reported except for aggregated data on some selected fishers' daily catch.*
2. *The household fish catch monitoring methods does not consider any household-specific characteristics such as gender composition, age structure, decision-making processes, income generating and livelihoods portfolios, fishing dependency etc. and, thus, data are little representative and of little use as baselines - "household catches" is too imprecise.*

The extensive Household catch data base has been validated for all of the above concerns by detailed survey questionnaire and by internal review and assessment after compilation to Database

3. *The monitoring is only conducted at a limited number of local sites; not put into perspective of trans-boundary context.*

This issue is currently being addressed on receipt of the MRCS data sets on fish catches u/s and d/s of the project location.

4. *Though monitoring drift of fish larvae and juveniles is mentioned, neither the methods*

used nor the results are reported.

The project commenced a detailed daily multi-site survey of larval fish abundance and composition in June 2013. The study is ongoing. The methods used were designed for comparability with the MRCS own larval fish study at Phnom Penh and the results will be compared when the MRCS data for similar periods is available to the Project.

5. *Standard methods for monitoring capture fisheries in the Mekong basin are required to generate reliable baselines and strengthen robustness of scientific insights.*

Noted and is being addressed by our project team

2.2 Impact Analysis and Mitigation Measures

DSHPP EIA:

- ✓ *EIA responds to the recommendations by MRC on the 2008 initial impact analysis and mitigation measures (EIA 2013 Annex C: 10-11).*

MRCS Comments:

6. *Annex C offers little concrete action, at best; it lacks sufficient detail with adequate resolution and proper explanations – most of the proposed mitigation measures are unproven and not tested in fisheries environments similar to the Mekong and, thus, their effectiveness is only assumed.*

Channel modification trials have now been implemented at four different locations since Annex C was written.

7. *The proposed mitigation measures remain highly experimental and risk-prone.*

Adaptive management and risk assessment processes will be applied to accommodate and adapt to changes in the situation.

2.3 Fish migration

DSHPP EIA:

- ✓ *Fish migration and implications for fisheries are described in general terms in the immediate vicinity, i.e. the Hou Sahong channel, of the project site.*
- ✓ *Threats such as alteration of natural flow regime, altered sediment loads, and loss of critical habitat to migratory fishes are acknowledged, however, it is stated that the project will not increase these threats and, thus, no mitigation or management action is required.*

MRCS Comments:

8. *Trans-boundary fisheries impacts up-stream in Lao PDR and down-stream in Cambodia and Viet Nam are not assessed (the same applies for social impacts and economic*

impacts);

9. *Impacts from altered flow regime on fish migration during and after dam construction need to be assessed; this need to include impacts on river dolphin population in the Lao-Cambodia border area that may be impacted by blasting and dredging during the construction phase as well as 17-fold higher discharge of water during the operation phase in the dry season (Figure 8 in EIA Annex C).*

MRCS experts have misinterpreted information provided on post-development flows See Hydrology report for guidance.

2.4 Flow regime and fish migration

DSHPP EIA:

- ✓ *Threats such as alteration of natural flow regime, altered sediment loads, and loss of critical habitats to migratory fishes are acknowledged but it is stated that the project will not increase these threats and, thus, no mitigation or management action is required.*
- ✓ *Hou Sadam and Hou Xangpueak channels can absorb fish migrations disabled by the dam at Hou Sahong.*

MRCS Comments:

10. *Hou Sahong is a one of the most prominent migration corridors in the Mekong Basin as it is the only channel that allows for fish migration throughout the whole year and as such it is a key habitat to maintain connectivity between important lifecycle habitats of many migratory fish species;*

Repeat of statement in introduction - see response there.

11. *EIA report does not provide information on average monthly water flows of pre-dam and post-dam situation of Hou Sadam and Hou Xang Pueak and other channels that are supposed to absorb all the fish migration movements including those disabled by Hou Sahong dam.*

This information is available in the engineering reports (AECOM 2011, AECOM 2011, SMEC 2012, SMEC 2013). Daily actual and predicted post development flows for past 5 years are presented below.

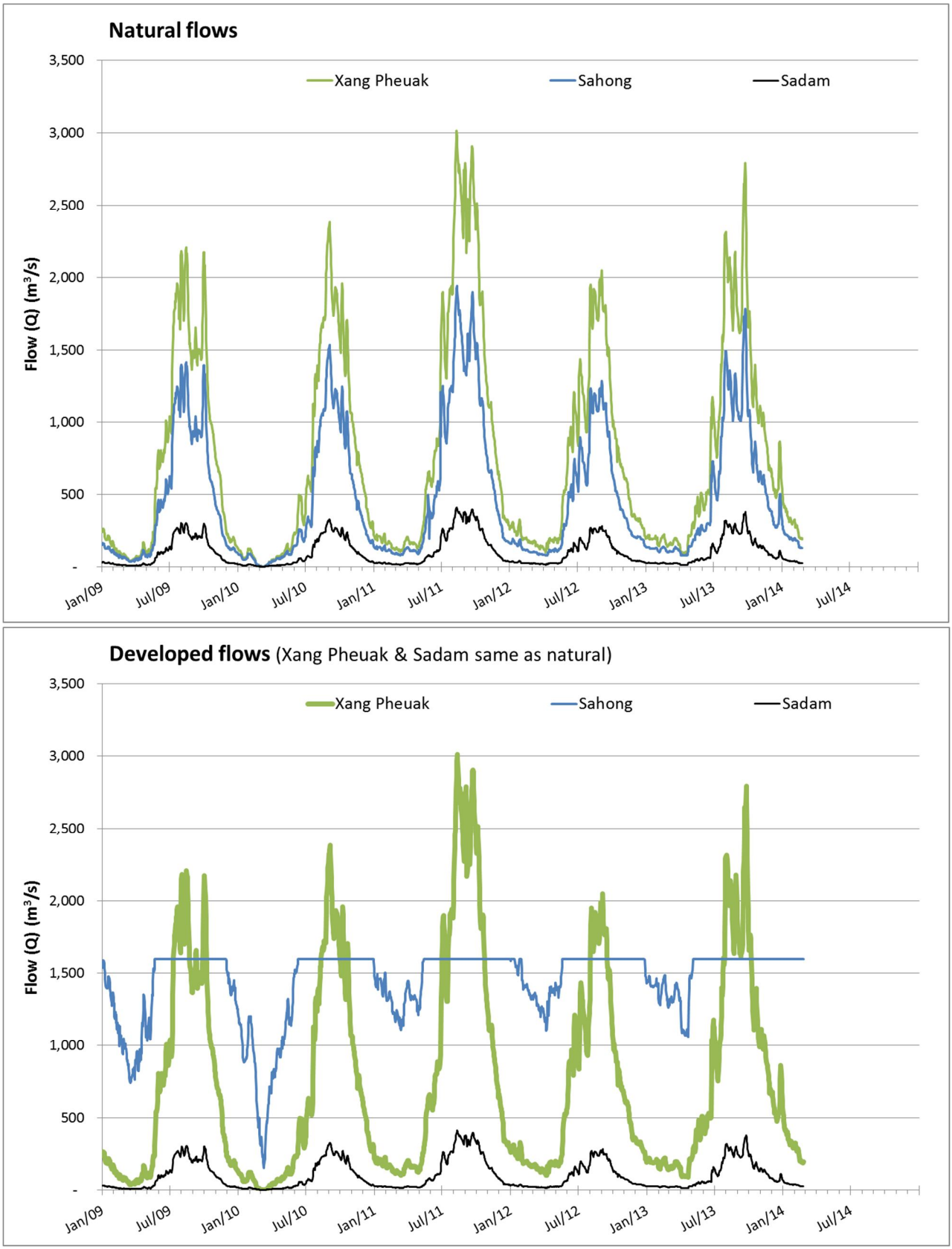


Figure 1. Natural and developed flows in channels modified to improve migration pathway

12. *Reduction of fish up-stream migration would adversely affect brood stock populations downstream. The severity of the impacts will not be known until after DSHPP is built, unless exhaustive research, testing of mitigation measures and adequate (well calibrated) modelling is conducted.*

Exhaustive research and testing of the mitigation measures is now underway and has built on and continued the studies reported in the EIA

13. *Hydrological changes downstream of DSHPP most likely have impacts on "hydrological triggers" that affect fish migrations and may cause interruption of lifecycle completion of certain fish; this aspect remains unaddressed in the EIA;*

MRCS has misunderstood the flow changes - these will be extremely localised. In terms of the behaviour of migrating fish, most existing evidence suggests fish attempt a series of different routes to pass the Khone falls, probably determined by the relative attraction flows. Example in the dry season H Phapheng has greatest attraction flow and in wet season this is from the Somphamit Falls area. Both these channels are virtually 'dead ends' so fish cannot pass upstream and so most fish have to backtrack to find a more suitable passage.

14. *It is an unproven and untested assumption that Hou Sadam and Hou Xangpueak can absorb all fish migrations from Hou Sahong; the different physiographic conditions of these channels and strongly altered water flow conditions, after dam construction, in these two channels are not put into context of migratory requirements of the actual migration guilds, let alone of single fish species. According to the PDG (2009), "… of particular importance are size at time of migration; swimming capabilities (prolonged and burst swimming speeds); depth and horizontal positioning in the river channel downstream or the impoundment upstream of the dam wall; diurnal movements; and cover, substrate and light preferences…..";*

Note the flow conditions in Sadam and Xang Pheuak will not be "strongly altered' but will either be unchanged or slightly increased after project development. MRCS presupposes "different physiographic conditions" but Sadam has very similar gradient and rapid development as Sahong. Whilst the constriction points in Xang Pheuak will be modified to be similar in gradient, pool length and depths.

All the species recorded in H Sahong have also been caught in the two adjacent channels (see EIA Annex C). Cover, substrate and light are all very similar in all three channels.

15. *Hou Sadam and Hou Xangpueak channels will experience a much reduced dry season water flow, which will contrast to the extremely increased water flow (6 to 17 higher) in dry season through the Hou Sahong dam*

MRCS has misunderstood the flow changes

– with potentially high impact on the attraction flow that could trigger fish migration through the proposed alternative migration routes. Fish will be attracted to the flow from the turbines and will approach the flow from surface, mid-water, along the river bottom, and along the thalweg; hence, fishway entrances need to accommodate these behaviours.

The volume of flow down the alternative migration pathway channels will be greater than found in any fishway, and the channels will be further modified to optimise their attraction to fish. The area below the dam and the adjacent main alternative pathway will be intensively monitored and modified as required to ensure passage delays in this area are minimised.

No attempt has been made to prove the acceptance of other channels for alternative fish migration once migration through Hou Sahong would be disabled;

This statement is incorrect

DSPC has modified the Hou Sadam and Hou Xang Pheuak channels in 2011, 2012 and 2013, and is currently modifying a section of Xang Pheuak below Khone Larn (March 2014) and will continue this programme in 2015, 16, 17 etc. The aim is to provide flow conditions conducive to fish migration.

Dry season flows in these channels will not be reduced below the existing case. Channel modifications will be designed to ensure sufficient flow rates in these channels.

Meanwhile measurement of fish distribution and abundance in all three channels by recording local fishers catches and by scientifically controlled catch survey are all being done with the explicit aim "to prove the acceptance of other channels for alternative fish migration".

16. *Adequate flows must be directed through the fishways to ensure they function effectively in both the high and low flow seasons, and at all times are sufficient to ensure optimal effectiveness for fish passage targets (PDG,2009). "To provide sufficient attraction for migrating fish, effective upstream fish passage on the mainstream Mekong River would need to pass 10% (100 m3/s) of low flows and 1% (230 m3/s) of the maximum design flow" (Xayaburi Prior Consultation Review Report, MRC 2011).*

Agreed that adequate flows must be provided through the adjacent channels. This will be achieved with targeted channel improvement and excavation.

It is noted that in the existing case in the Khone Falls area, the vast majority of dry season flow passes over the Phapheng Falls, which are virtually impassable to upstream migrating fish. The concept of a given percentage of the total river flow as an attraction flow for upstream migration is simplistic in the multi-channel situation that occurs at the Khone

falls.

Note that the existing daily flow through Hou Sahong, which MRCS regards as "the only year round pathway for upstream migrating fish" is typically around 5% of the total Mekong flow, whatever the season, although MRCS cite 10% as a minimum requirement for effective fish passage.

Targeted clearing, shaping and excavation works are being carried out within the Hou Xang Pheuak to encourage fish migration. These works will be extended to ensure that dry season flows through Hou Xang Pheuak will not be reduced by scheme operation. The modelled daily flows through Hou Xang Pheuak (and adjoining Edtout channel) as a percentage of Hou Sahong discharge are shown in Figure 2.

The attraction flow in Xang Pheuak at the Sahong confluence (Q Xang Pheuak + Q Ee Doot) will almost always be more than 10% of the Sahong flow. The Developer plans channel modification (illustrated in Pakse meeting March 2014) to focus and improve this attraction flow near the Sahong confluence.

The figure is based on reported daily Mekong flows of 2009-2013. It is noted that 2010 dry season represented an extreme case (lowest river levels on record), and the observed flows of 2011 onward are more representative of expected future flows.

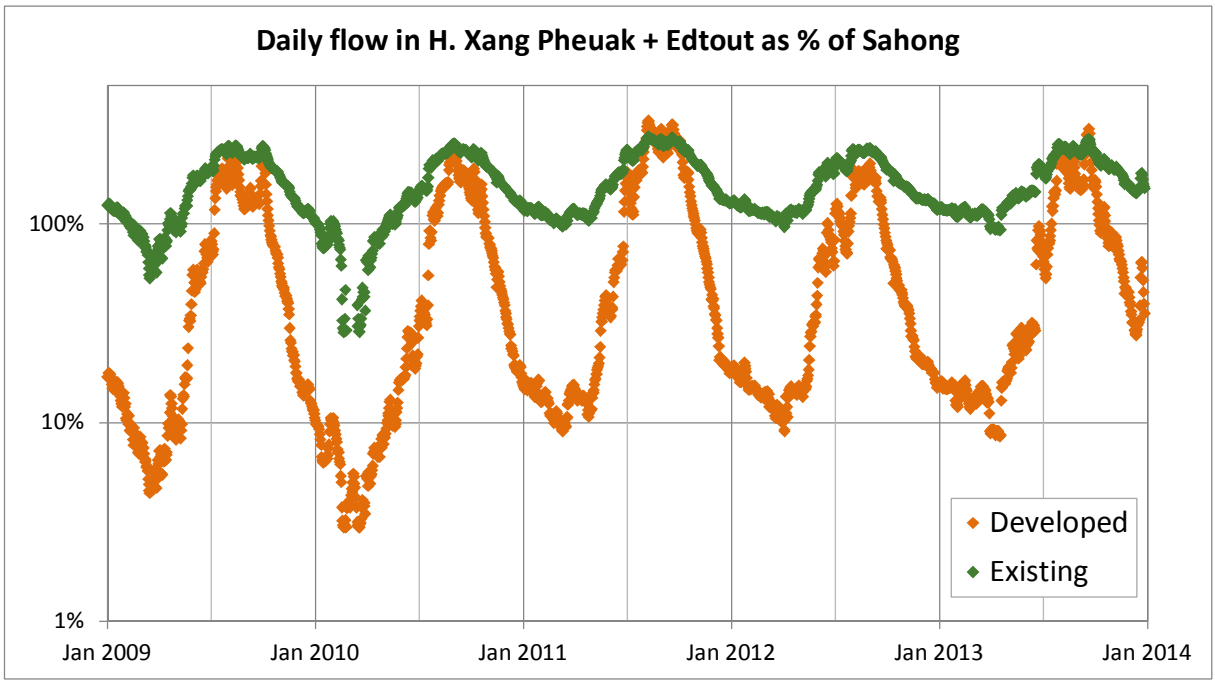


Figure 2. Attraction flow from Hou Xang Pheuak at Sahong Junction (2009-2013)

17. *Von Raben blade strike model (of the fish-friendly turbine solution proposed) has never been proved in Mekong River. Calculations are based on experience outside Mekong with much less biodiversity.*

The model shows that the probability of blade strike is related to fish body length. There is

no reason to believe this will not also be true for Mekong fish.

18. *Numeric and physical models of the dam and adjacent river are necessary to accurately predict flow patterns, and hence dam and fish passage design (PDG, 2009).*

Detailed 3D numerical models of the channels system have been developed to understand the complex flow patterns which exist now and how these will be affected by the project operations

19. *"Fishways should be fully operational from minimum low season flow of up to the 1:20 year flood level" (PDG, 2009).*

The Don Sahong Project has not built and will not build any constructed 'fishways'.
The operation of the dam related systems will be monitored and modified as required to ensure they meet these requirements.
The flows in Xang Pheuak and Sadam channels will continue to behave as they have done in the past unless flows are increased by excavation at the upstream entrances.
In the pre dam case, Xang Pheuak plus Sadam exceed 10% of total flow during the main spawning migration periods each year.

MRCS Report Table 1: Type of fish migrations and alteration of Mekong flow through Hou Sahong

Season / Month	Decem	Januar	Februa	March	April	May	June	July	August	Septem	Octobe	Novem	Decem	Januar
% of normal pre- construction Mekong flow through Hou Sahong channel	6	4	4	3	3	5	6	5	5	5	5	6	6	6
% of Mekong mainstream flow diverted through Hou Sahong dam	37	45	49	50	49	40	21	11	7	7	12	23	37	45
Type of fish migration														
Medium-sized cyprinid carps	■	■	■											
Small cyprinid fish (minnows)		■	■	■										
Large carps, nearly exclusively through Hou Sahong					■									
Catfishes (*Pangasius macronema* from Cambodia to Laos through Hou Sahong)					■	■								
Catfishes (*Pangasius krempfi* from Vietnamese Delta up into Laos through Hou Sahong) *P. krempfi* represents 5% of lee trap fishery. *P. conchophilus* represents 40% of lee trap catch						■	■							
Large fish (MGC)								■	■	■				
Endangered *Probarbus jullieni*											■	■	■	■

Sources: EIA DSHPP 2013, Annex C; Baird 2011

20. *Table 1 shows that 37% to 50% of the Mekong water flow passes through Hou Sahong channel after potential dam construction during the six month dry season, representing a 6 to 17-fold increase of water discharge as compared to normal (without dam) situation. As a consequence, the water discharge through Hou Phapeng, Hou Sadam and Hou Xangpueak and other minor channels is significantly reduced during dry season. These hydrological changes potentially severely impair and impact on the capacity of fish to migrate up-stream, especially medium-sized cyprinid carps and small cyprinid fishes (minnows) representing important trans-boundary fisheries resources may be impacted.*

As noted above, MRCS misunderstands the extent of the flow changes – Hou Sadam and Hou Xang Pheuak channels will be altered to provide flow conditions conducive to fish migration. Dry season water flows will not be reduced at all but will remain the same as or potentially increased compared to the existing case.
The Phapheng channel is not relevant or applicable to upstream fish migration.

2.5 Up-stream fish migration

DSHPP EIA:

- ✓ *Fish caught in Cambodia first, Tonle Sap is blocked all the time now … (Page8- Table 1 of the Annex C)*
- ✓ *It is proposed to reduce fishing efforts immediately below dam as well as further downstream.*
- ✓ *Xang Phueak and Sadam channels will "imitate the conditions the same as previously existed in the Hou Sahong Channel" to allow up-stream migration.*
- ✓ *Channel modification in Hou Wai and Xang Phueak channels to improve fish migration pathways has been trialled*

MRCS Comments:

21. *This statement (on page 8-Table 1) is a misleading as the migration route to and from Tonle Sap is open all year round;*

Although it does suffer from very high fishing pressure

22. *Dai fishery operates between late Oct and Feb or early March – these fishing operations do not completely block off the river but are limited to specified anchoring positions; sufficient space is* ***always available for navigation during this period****. More than 100 fish species are, including small mud carps up to Mekong giant catfish, recorded to migrate upstream to access vital dry season and* ***spawning habitats in the Mekong River of Kratie and Stung Treng provinces*** *in Cambodia and Champasack province in Lao PDR to sustain fisheries production;*

23. *All fishing lots in Cambodia including in Tonle Sap flood plain lots have been cancelled;*

24. *Fish breeders are believed to freely migrate upstream the Mekong. In recent years evidence suggests that increased downstream drift of fish larvae and juveniles have been observed (MRC FP larvae drift monitoring programmes).*

Is this relevant? It is a long and dangerous survival path from larvae to breeding adult

MRCS Comments:

25. *Up-stream migration will be blocked by dam. Increased concentration of migrating fish is expected downstream, including in the border area with Cambodia. How this will be managed remains unaddressed.*

EIA (FishMAP) describes an adaptive management approach to manage the increased concentration of migrating fish downstream, with activities such as:

- ✓ monitoring of fish in accumulation zones;

- ✓ management of fishing pressures in those zones by closures; and
- ✓ monitoring of time of passage and time of delay

MRCS Comments:

26. *The attraction flow from Hou Sahong will be multi-fold higher (up to 17 times) in dry season than under natural conditions (before construction) – how can fish migrate through alternative channels given that their water flow are significantly reduced as compared to national flow conditions and will have a much inferior attraction flow as a consequence of the potential Hou Sahong dam.*

As above, the flow through channels offering alternative migration pathways will be maintained at or above existing levels (NB the combined Sadam and Xang Pheuak flow is nearly double the existing Sahong flow).

The increase in flow rate of the Hou Sahong channel will be balanced by a decreased flow in the Hou Phapheng channel which is impassable to upstream migrating fish.

Discharges will be modified to focus attractant flows and guide fish into Sadam and Xang Pheuak.

MRCS Comments:

27. *Channel modification in Hou Wai and Xang Phueak channels to improve fish migration pathways have been trialled. However, preliminary results based on anecdotal records of fishers do not give evidence that the modifications in fact can absorb those fish migrations blocked by the Hou Sahong dam, especially those in the dry season. This requires further detailed study proving the effectiveness of the modified channels for year round fish migration prior to dam construction.*

The DSPC recognises the limitations of using local fishers catch data (although these data have been widely used by MRCS and others throughout the basin in the past). As DSPC has already reduced the obstruction effects of barriers in the alternative pathways (which can limit the effectiveness of local fishing success) and as DSPC intends to assist GoL to reduce fishing pressure, it is quite likely that local catches will diminish as more fish move through the area unimpeded. Therefore DSPC has established a rigorous CPUE based monitoring program to provide a more accurate guide to success of the mitigation measures for upstream passage.

MRCS Comments:

2.6 Downstream migration

DSHPP EIA:

- ✓ *Threat is acknowledged;*

- ✓ *"Trap- and transport systems, alternative fishways and turbine bypass screening and fish-friendly turbines" are proposed including further studies on their functionality and efficiency;*
- ✓ *Further studies proposed "which can then be imputed into the process for determining further development of water infrastructure related project in the wider basin";*
- ✓ *Downstream mortality (Page12 in Annex C): DSHPP proposes a testing programme to be undertaken by the turbine supplier to provide more definitive information about expected fish survival through actual turbine type to be installed.*

MRCS Comments:

28. ***No proven solution are provided**; the proposed mitigation measures do not have any previous track record of success in the Mekong, the solutions are not further detailed and, thus, remain highly experimental and extremely risk-prone.*

Project has 5 year construction period in which to trial the diversion devices before the Sahong channel is opened. Hou Sadam can be used as a field site to pilot experimental for trials. Some sound deterrent based behavioural methods to guide fish that are effective on Mekong fish and used by riparian fishers are described in "Fishing Gears of Cambodian Mekong" (Chapter 16).

29. *As all the measures suggested in the EIA are unproven and untested. They might work, and they might not, but the stakes are very high, and if they don't work, everyone in the basin will pay;*

Results of larval abundance surveys in 2013 and 2014 already show the majority of larval fish will bypass the project as this drift occurs during the high flow season when the fraction of the total flow passing the turbines is lowest. The conceptual model of downstream migration provided in MRCS Table 1 shows that the downstream migration of adult fish also occur during higher flow periods. The mitigation measures for diverting or deterring larger downstream migrating fish like physical or behavioural deterrents have all been applied elsewhere to fish of similar sizes or biologically related families, so it is incorrect to state they are "unproven or untested".
The combination of a high bypass volume during the main migration period coupled with an effective deterrent system can prevent significant numbers of fish from passing through the turbines.

30. *Impacts from river blasting, dredging and other earth movements and construction activities on river dolphin population in the immediate vicinity of the project site are not addressed; neither is the impact of increased discharge from dam operation.*

Refer to Dolphin discussion attached below (Appendix 1).

31. *It would be better to do these studies at a dam with less impact on fish migration (e.g. upstream from Xayaburi).*

May not have same species composition; head and flow arrangements etc.

32. *Recommendation: this testing programme should be conducted prior to dam construction to prove that the turbine is practically effective as theoretically stated.*

This is an unrealistic expectation at an EIA stage. But is possible in the construction period and will be considered. Initially based on larval drift data results from 2013/14.

MRCS Comments:

2.7 Fish production and value

DSHPP EIA:

- ✓ *Method to measure fish production is "household fish catch";*
- ✓ *"Anecdotal evidence of household fish catch yield" and trends is provided;*
- ✓ *An average of 2,871 USD/household is recorded for 2009;*

MRCS Comments:

33. *The overall economic value of fish migrating through the three main channels Hou Sahong, Hou Sadam and Hou Xang Pheuak needs to be assessed with particular emphasis on trans-boundary species (see Table 1);*

- ✓ *giant freshwater shrimp (Macrobrachium resenbergi), Pangasius krempfi and others migrate up-river from Mekong Delta into Laos;*
- ✓ *Small minnow or mud carps represents more than 21% of whole inland fisheries catch in Cambodia; this species depends on long distance migrations from Tonle Sap in Cambodia and would potentially be highly affected by Hou Sahong dam.*

The overall economic value of the fish migrating through these channels cannot be determined, because it is impossible to reliably monitor the wet season passage rate. Nonetheless this passage rate will not be affected by the Don Sahong project as in the wet season the major obstructions in Hou Xang Pheuak are flooded to allow fish passage.

The MRCS has used household fisher catch in one channel Hou Som Yai for many years and the evidence from those data are that there are large fluctuations in the quantity of fish caught from year to year. However, over time there has been a progressive decline in the proportion of large and valuable fish being caught. This is consistent with the increasing CPUE in the system.

MRCS paper by So Nam et al [1] reports on the Dai fishery in Tonle Sap and concluded that

- approximately 83 % of all fish arriving at the dai fishery are caught
- the migratory range of the main species is unknown and needs to be established; and
- although there are correlations between catches in the dai fishery and elsewhere, these may simply reflect environmental responses of separate stocks."

[1] SO NAM, PENGBUN, N., LIENG, S., N, P., HORTLE, K., HALLS, A. S., PAXTON, B. R. & HALL, N. 2011. Spatial and Temporal Variation in Bag-Net Fish Catch Rate along Tonle Sap River, Cambodia

Taken together these published statements from MRCS in 2011, repudiate the contention in item 33 above that the success of 21% of Cambodia's inland fisheries is directly linked to success of dry season fish passage through Hou Sahong.

The Tonle Sap Dai fishery catch over past 5 years has ranged from 12,00 to 45,000 tonne (MRCS reports) and artisanal fishers also undoubtedly catch many fish. DSPC has estimated household catches in the Khone Falls area during the dry season migration period are only 50 -150 tonne over past 5 years.
Therefore the sustainability of Cambodian fisheries would seem much more sensitive to fishing pressure than success of small cyprinid passage across the Khone Falls.

MRCS Comments:

- ✓ *Labeo erythropterus, Bangana behri* and others migrating to and from the 3-S rivers basin;

NB The lower Sesan 2 dam now under construction on the 3S system, has much more direct implication than Don Sahong to these migrations especially as it may not have fish passage facilities.

MRCS Comments:

- ✓ *The endangered Mekong giant catfish and Probarbus jullieni, Pangasius concophilus and others migrating from Tonle Sap.*

Large endangered spp have iconic status and are a valued contribution to biodiversity but the economic value of the catch of these species is minor as they are rare (e.g. one Giant catfish has been caught each year in the Khone falls area during the project monitoring period). The economic value of *Pangasius conchophilus* is high but it migrates in the early wet season when the alternate channels definitely do provide fish passage.

MRCS Comments:

34. *Impacts for Tonle Sap fisheries in terms of fish species, yield and value needs to be assessed and subsequent economic and social impacts including on food security and nutrition security; this also applies for impacts along the Mekong river and its tributaries in Lao PDR;*

See notes on 33 above re Ton Sap Dai fisheries

MRCS Comments:

35. *Not enough is known about the migratory requirements of the various fish species to predict the results of mitigation measures – knowledge gap to be filled;*

Issue only applies to dry season migration - not all seasons

36. Fish loss up-stream of DSHPP in Lao PDR is not assessed;

See notes on 33 above re Ton Sap Dai fisheries

37. *Accumulative and synergistic impacts in aquatic communities, e.g. in biodiversity not addressed.*
    - ✓ *Cumulative and synergistic impacts on food web not assessed; including focus on how perturbations at lower trophic levels ripple up through the food web to affect valuable prey and predator fish dynamics;*
    - ✓ *Loss of migratory species would lead to negative changes in all aquatic communities, both up-stream and down-stream. However, cumulative and synergistic impacts will not be known until the dam is built – unless comprehensive monitoring, modelling and calibration of models precede and informs about effective mitigation measures of the project;*

See notes on 33 above re Ton Sap Dai fisheries

38. *Footprint on food security and nutrition is not assessed;*

See notes on 33 above re Ton Sap Dai fisheries

39. *Trans-boundary impacts including Lao PDR up-stream of DSHPP, Cambodia and Viet Nam not assessed – in terms of income generation, livelihoods, food security and nutrition security as well as replacement costs from loss of fisheries;*

See notes on 33 above re Ton Sap Dai fisheries

40. *Value of income from eco-tourism and dependence of eco-tourism on landscape panorama and existence of river dolphins not assessed.*

Dam and head pond has very small geographic footprint so no significant impact on 'landscape panorama'. NB Hou Sahong has never been passable by conventional boats.
Other project impacts on eco-tourism not measured but new bridges and roads will open up the islands of Sahong and Sadam to tourists where before they were isolated due to difficulty of boat access.
The impact of the project on river dolphins is discussed below –this small group of animals is currently at risk from several hazards. The Don Sahong project will help not hinder the sustainability of this dolphin population.

2.8 Excavation and water quality:

DSHPP EIA:

- ✓ *There was concern on the various forms of excavation including underwater blasting.*

DSHPP responded that 'no underwater blasting at the downstream end will be permitted (Page10 of Annex C)'.

MRCS Comment:

41. *This is inconsistent with EIA report 2013, points out that 'To improve flow through the Hou Sahong the river bed will be excavated to an average of 3 m and 1.5 m at the upstream and downstream ends of the channel, respectively' (PageVIII in EIA report).*
42. *Impacts of blasting and dredging during construction on river dolphin population in immediate vicinity of project site in cross-border area with Cambodia;*

The statements are not inconsistent. Excavation works at the downstream end of Hou Sahong will be conducted with alternative methods to underwater blasting. All excavation at the downstream end will be carried out in dry conditions behind a temporary dam (cofferdam).

MRCS Comments:

3. SUMMARY of CONCLUSIONS and RECOMMENDATIONS

3.1 The EIA report makes an attempt to assess the negative impacts of the Don Sahong hydropower construction and proposes a series of mitigation measures to respond to identified threats; some of the issues identified and mitigation measures proposed do point into the right direction proposing additional studies to increase the knowledge base. At this stage, the present EIA would not allow for scientifically sound decision-making about the design of the dam construction as the data/information and analysis provided is still incomplete. To improve the proposed mitigation measures clear identification and scientifically sound assessment of the local, trans-boundary and cumulative impacts are required.

Review of the impacts not credible because 1) basic misunderstanding of flow changes (Xang Pheuak not affected at all; flow in Sadam will be adjusted to exceed pre project levels by deepening of inlet (stage 1 already completed in 2013); 2) no consideration of the channel modifications that have already been made by the Project.

3.2 Scientifically robust methods for capture fisheries monitoring are required;

Existing methods used in Mekong by MRC have been used to date (e.g. Household catch) not all data reported to date but it has been collected. Currently 2013-14 scientifically rigorous methods also implemented. These will be described at workshop and the results of 2013 wet season and 2014 dry season migration monitoring will be presented by midyear.

3.3 Comprehensive trans-boundary fish and fisheries impact assessment, including fish species diversity, fish production and their economic, ecological and welfare

values, food security and nutrition security, and ecological impacts in terms of food web alterations;

DSPC believes the mitigation measures will be effective because of the number of natural channels available and the company's commitment to modify these successfully.

MRC has done several trans-boundary analyses for multiple dam scenarios[2] and demonstrated there will be significant impacts - we note that all assume the DSH would be an impassable barrier to fish.

NB the MRC scenarios all failed to include the barrage on the Ba Lai distributary in Delta (similar case as DSH).

Baran (2010) reviewed fish pass design of 11 proposed Mekong mainstream dams and concluded that "DSH is the only case possible" [where passage may be effective]

3.4 Mitigation measures need to be proven;

The mitigation methods are not all "untested" and all spawning grounds in the Mekong River are not immediately upstream of Khone falls, so the statement "everyone will pay" is not correct and inappropriate for a scientific review.

Based on results of larval abundance survey in 2013, most larval fish will bypass the project as the highest concentrations of larval fish occur during the high flow season when the fraction of the total flow passing through the turbines is lowest.

3.5 Information gaps as identified in the above Sections need to be filled allowing for well-calibrated modelling and scientifically sound decision making including concerning project design, operation and impact monitoring.

The gaps identified, either have already been filled; are being filled; or will be filled before the project commences operation.

[2] MRCS 2011. Proposed Xayaburi Dam Project: MRCS Prior Consultation Project Review Report MRC.
HALLS, A. & KSHATRIYA, M. 2009. Modelling the cumulative barrier and passage effects of mainstream hydropower dams on migratory fish populations in the Lower Mekong Basin. Vientiane, Lao PDR: Mekong River Commission.
BARAN, E. 2010. Mekong fisheries and mainstream dams. In: ICEM (ed.) Mekong River Commission Strategic Environmental Assessment of hydropower on the Mekong mainstream. Hanoi, Viet Nam.

Annex 4: Water Quality and Aquatic Ecosystem Health (EP)

Criteria for review: Completeness, consistency and adequacy of information provided. In particular, potential transboundary impacts are considered.
Adherence to MRC PDG, where relevant.

Scoping of potential impacts

The scoping of potential environmental impacts (EIA report, Figure 2-8) seems questionable, e.g. impacts on species and populations due to presence of the dam are assessed as "potential minor negative impact", although one of the important impacts listed in the Executive Summary (p. viii) is on fish, and p. 5-18 says "The potential impacts of the proposed DSHPP on the fisheries are by far the most important aspects of the Project". Furthermore, there is no methodology (impact criteria) described for the scoping process.

Environmental issues of potential relevance for this review

It is assessed that some of the relevant issues related to environment for the review of the EIA of the DSHPP would be the following:

1. *Impacts on environmental flows?*
2. *Water quality during construction?*
3. *Water quality in the head pond/impoundment?*
4. *Water quality during flushing?*
5. *Water quality during decommission?*
6. *Impacts on sediment balance?*
7. *Impacts on nutrient balance?*
8. *Impacts on fish migration, both upstream and downstream passage?*
9. *Impacts on habitat continuity (fragmentation)?*
10. *Impacts on wildlife?*
11. *Impacts on tourism?*
12. *Impacts on health and livelihoods?*

[1] A general comment to the EIA report: In Annex A it seems that all MRC comments to the 2007 EIA report have been addressed. However, it is very difficult to check because there are no references to the relevant sections in the updated EIA report.

1. Impacts on environmental flows (EIA report p. 5-28 – 5-33)

Environmental flows (EF) over Khone Phapheng is chosen as 800 m3/s – the lowest flow recorded in the extreme dry season of 2010. This will not be an exceptional situation with the project but rather the norm: In at least 40% of the time the flow over Khone Phapheng will be confined to 800 m3/s (Table 5-8). What will this mean for tourism at Khone Falls? Perhaps a higher EF should be considered? For example, the natural 99% exceedance flow at Khone Phapheng is 1,410 m3/s (Tab. 5-7). It would be prudent to analyse the impact on the project economy of selecting this (or another) flow as the minimum (ref. comment #58 in MRC's EIA review of 2007). There is no analysis of this and no photos of less than 1,450 m3/s (p. 3-7) – however, this level visually seems OK for tourism purposes. It would also have been interesting to see an assessment of the impact of climate change on the EF over Khone Falls.

No EF impacts of the DSHPP are anticipated elsewhere than the Khone Phapheng branch as the HP flow is diverted solely at the expense of this branch (Table 5-8).

Derivation of 800 m^3/s as a minimum environmental flow rate considered the following points:

- ✓ Decision on minimum environmental flow should be targeted towards maintaining a sustainable balance between the purpose of the dam and the needs of the downstream ecosystems and resource users.
- ✓ Visual impact on the Falls is a primary consideration in establishing the minimum flow
- ✓ A flow of 800 m^3/s satisfies the existing ecological and ecosystem demands, as the overall pool water volumes, deep-pool locations and depths, and water pathways in the affected reach are not significantly changed
- ✓ Economic effect of 600-800-1000 m^3/s environmental flow has been assessed
- ✓ A flow of 800 m^3/s is 28% of the mean and 32% of the median flow over the Falls, which is substantially higher than the "rule of thumb" of 10% that has traditionally been applied to other projects internationally.

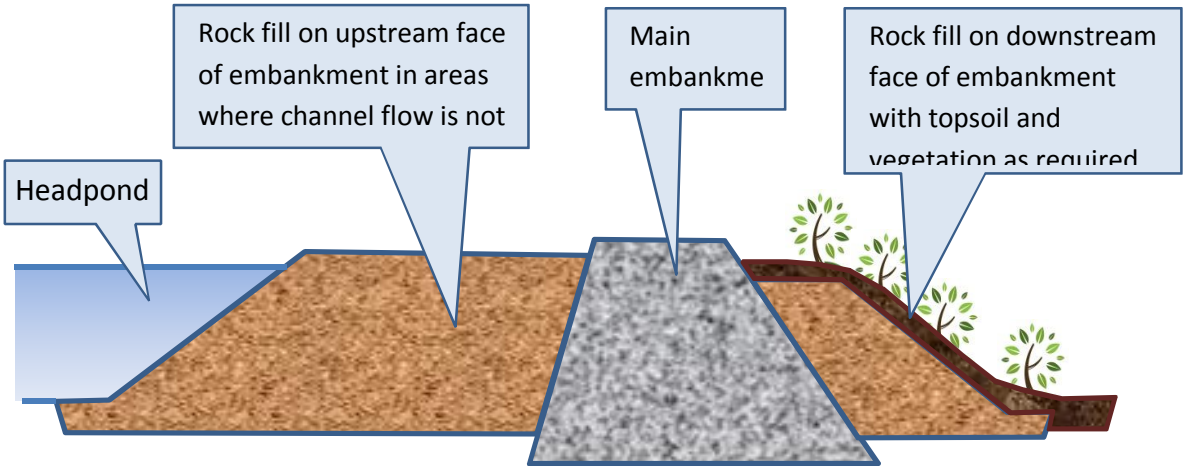
It is relevant to note that the 2010 feasibility studies for the neighbouring Thakho project similarly adopted a minimum environmental flow of 800 m^3/s over the Phapheng Falls. Documentation produced by the Thakho project does include a photograph of a reported flow of 980 m^3/s over the falls (taken 5/3/10) – as below.

Source: CNR Presentation to DOE 21 Apr 2011

2. Water quality during construction -

Water quality impacts during construction are addressed and mitigation plans anticipated for collection of waste and waste water. However, potential impacts on water quality from excavation of bedrock for channel modification purposes are not analysed in detail. The EIA report (p. 5-11) refers to approx. 1 million cubic meter of sediment/rock that needs to be disposed of. Impacts from loss of sediments during excavation or from deposition have not been addressed (other than measures for protection of dolphins from sediments, see below) and deposit site has not yet been decided. Therefore, the conclusion that "impacts from cofferdam construction will not be significant" seems premature. Just for comparison, the 1 million cubic meter of excavated sediment/rock corresponds to the amount of sediment transported during 3 days by the Mekong mainstream at Pakse (assuming 123 Mt/yr (ESR p. 96) and bulk density of 1 t/m3 (ESR p. 106)).

Excess excavation from construction will be disposed of as controlled fill against parts of the embankment where the headpond is wider and flows will not be affected. This is already provided for and shown on the drawings provided with the ESR. The diagram below shows how and where the excess material is placed. This material will be engineered so that it does not erode in the flow, noting that it will be placed in areas where the velocity is very low (~0.5 m/s).



95% the excavated material will be excavated in the dry, i.e. behind a temporary dam (cofferdam), so will not be exposed to the river flow. A small amount of excavation (130,000 m³) will be carried out in the river immediately up-stream of the Hou Sahong inlet. The specification requires excavation to be controlled so as to minimise turbidity in the river. As explained above, there will be no excavation of material from the river at the Hou Sahong outlet downstream of the scheme.

3. *Water quality in the head pond/impoundment (EIA report 5.4.4)*

Water quality impacts during operation are not addressed in the EIA. Given the short water residence time (max. 4 hrs, EIA report p. 5-22), it seems reasonable to expect no significant water quality impacts from the impoundment. Sedimentation of coarse material may occur in a zone of approx. 1 km in front of the impoundment (ESR Fig. 4-39). The impact of this reduction has not been addressed but is expected to be minimal.

Agree that given short residence time and given the occurrence of deep pools of similar depth, it seems reasonable to expect no significant water quality impacts from the impoundment.

4. *Water quality during flushing (ESR p. 111-5)*

The EIA report only briefly mentions flushing (p. 5-23) but the ESR (p. 111-5) mentions two options for sediment management: periodic flushing and mechanical removal. Flushing would have the greatest impact on water quality and the ESR suggests to apply this methodology and monitor the results. Impacts are not addressed further by the EIA. However, it is appropriate and in line with the MRC Preliminary Design Guidance that the EIA report suggests flushing sediment during high flow periods in order to mimic the natural sediment dynamics. Approx. 2 million cu m of sediment needs to be removed from the head pond every year (ESR p. 114), corresponding to less than 2% of the annual total sediment transport in the Mekong mainstream at Pakse. Potential short-term water quality impacts, e.g. on dolphins or other aquatic organisms living immediately downstream of the dam, could potentially be expected during flushing periods. The EIA report (p. 5-23) argues without further documentation that the hydraulic conditions of the area are such that the discharge from the DSHPP will bypass the deep pool dolphin habitat, especially at low water levels. This should preferably be investigated using 2-D or 3-D hydraulic models of the

near- field area. ***Also other aquatic organisms could potentially be impacted by short-term high concentrations of sediment during flushing which has not been analysed in the EIA report.***

Recent sedimentation computational modelling has demonstrated that periodic flushing is not required to sustain the headpond. Without intervention, equilibrium will be reached whereby normal operational discharge will sluice sediment through once deposition reaches certain levels. Flushing is no longer envisaged as a part of operation, and the economic impacts of deposited sediment (additional headloss) will be addressed by targeted mechanical removal if necessary. The avoidance of a flushing requirement means that the discharges from the power station will occur with normal flows and sediment concentrations will therefore closely mimic the natural river system.

5. Water quality during decommission

To the extent blasting to remove dam and concrete infrastructures will take place during the decommissioning phase (p. 5-17), it may affect dolphins and other aquatic animals. The details of blasting (if and how) are not highlighted in the EIA report. Neither are the consequences for the water quality (short-term increases in sediment concentrations) from blasting the concrete structures. Given the size of the structures and the magnitude of the natural sediment transport in the Mekong the impact may be small – but it has not been assessed.

A decommissioning plan has not been developed at this stage. This project is developed on a Build-Operate-Transfer basis, and plans for decommissioning would be best considered by the ultimate owner (GoL). It is noted that the anticipated normal service life of this (and any other) hydro scheme is in excess of 100 years.

6. Impacts on sediment balance (Engineering Status Report p. 95-115)

This issue seems not to be addressed by the EIA. However, the ESR addresses it in Section 4.8-4.9. According to this, long term impacts on sediment balance are not possible. Without any sediment management, up to 3 Mt/yr in the first years and up to 10 Mt in total could theoretically be retained in the head pond (ESR p. 107-108). Natural sediment load in the Mekong is estimated at 123 Mt/yr. With sediment management scheme implemented (for which there is a strong economic incentive) there will be no accumulation of sediment in the head pond other than an initial approx. 2 Mt.

[It is expected that IKMP will provide a more in-depth analysis of the sediment transport issue]

Due to the relatively small size of the headpond, there is very little capacity to trap sediment and affect the sediment balance of the Mekong. As identified, a maximum of around 10 Mt could be retained (deposited over a number of years), compared to the annual sediment load of the Mekong at Pakse of around 123 Mt.

Updated modelling based on sediment data collected at site estimates that after the first few years of operation, the mass of sediment trapped in the head pond will fluctuate between around 2 and 4 Mt.

7. Impact on nutrient balance

This issue has not been addressed – but could easily have been. Nutrients are transported either as soluble (with the water) or as suspended (with the sediment). Since the issue is not a local but a regional one (nutrient transport from upstream reaches to downstream Ton Le Sap and delta areas), and given the fact that no regional-scale flow or sediment changes occur with the DSHPP it is to be expected that no impacts on the nutrient balance will occur from the project.

As identified, this issue can be addressed by consideration of the negligible (at regional scale) flow and sediment changes.

8. Impacts on fish migration (upstream and downstream)

Fish migration appears to be by far the most important environmental issue related to the DSHPP. The EIA report (p. 3-15) argues that household catch data from the project shows that upstream fish migration also occurs in other channels than Hou Sahong. Irrespective of this, it is widely agreed that Hou Sahong is by far the most important channel for fish migrating up the Mekong river. Therefore, the introduction of an insurmountable barrier like the proposed dam is a potentially serious environmental impact. Although the suggested mitigation (deepening of the Hou Xang Pheuak) appears conceptually sound there is still no certainty that the proposed modifications to the channel will actually work in terms of providing a full substitution for the lost fish passage. It has not been tested before; it is a large-scale experiment and this seems to be a key risk of the project. The deepening of alternative channels should be tested before implementation of the project.

If the suggested channel excavations are implemented, we assume underwater rock blasting will be necessary. How does this comply with the assurance that such practices will not be allowed (EIA report p. 5-22)?

Downstream fish passage is less critical as there are more available channels than Hou Sahong for downstream migration. However, the suggested mitigation measures (monitoring of mortality, use of 'fish-friendly' turbines, screen and bypass structure at Hou Sahong inlet, EIA p. 5-21) seem relevant and appropriate – although the effect of 'fish-friendly' turbines may not be fully documented yet.
[It is expected that Fisheries Programme will provide a more in-depth analysis of the fish passage issue]

See responses to Annex 3: Fisheries

9. Impacts on habitat continuity

Because the DSHPP is a project that spans only one channel and not the entire Mekong

mainstream, the risk of destroying habitat continuity is less than for other mainstream dams. Except, maybe, for fish (as described above) the dam does not create any insurmountable barrier for movement of species between habitats. It is therefore not expected that this issue will be of great importance – and it is not addressed in the EIA.

10. Impacts on wildlife

Other than the Irrawaddy dolphins there is no information about other wildlife species, including terrestrial species, of regional importance depending on the resources altered by the DSHPP. The EIA report (p. 3-13) describes the project area as being of poor status as a wildlife habitat. However, the EIA also notes that this assessment may hinge on the efforts put into the survey. Also, the survey found that 5 out of 48 bird species reported are classified as endangered species. This suggests that wildlife assets in the project area may not be properly inventoried and assessed. The project does not seem to have used the data suggested by MRCS in the 2007 review (comment #48).

There is a small population of the rare and critically endangered Irrawaddy dolphin living immediately downstream of the project area, using the Chiteal deep pool as habitat. Particularly the changed sediment patterns, but also the changed flow regimes, in the vicinity of the project area might alter the conditions of the dolphins' most important habitat. The dolphins might also potentially be impacted by noise and high sediment concentrations during construction and decommission, and by high sediment concentrations during operation of the dam (especially during flushing).

The EIA mentions that underwater rock blasting will not be permitted as an excavation method. Furthermore, the EIA refers to two important aspects for the dolphins, the reliance on i) the deep water pool during the dry season and ii) the annual migration of fish as feeding stock. The EIA report argues that since both aspects are insignificantly affected by the project, the dolphins are not threatened by the project. The EIA report (p. 5-23) argues without further documentation that the hydraulic conditions of the area are such that the discharge from the DSHPP will bypass the deep pool dolphin habitat, especially at low water levels. This should preferably be investigated using 2-D or 3-D hydraulic models of the near- field area.

See Appendix 1 – DSPC comments on impacts on dolphin

11. Impacts on tourism

Tourism in the Si Phan Don area is of regional importance due to the proximity and accessibility of tourists particularly from Cambodia and Thailand. A great deal of the tourism centers on the Khone Falls and the dolphin population. The EIA seems to have a quite superficial assessment of the potential impacts from the DSHPP. It assumes with little argument (p. 5-16) that no or little negative will occur. However, the visual impacts and the impacts on tourism of flows over Khone Falls of max. 800 m3/s for 50 % of the time has not been assessed. Neither has the scenario where Dolphins are no longer present in the area due to the DSHPP. Both would be relevant to analyse.

Information on tourist arrivals is generally outdated in the EIA report with typical figures from 2005-06 (p.3-23)

The eventual disappearance of the six dolphins in the downstream pool without the Project development is highly likely, based on scientific reports[3] of the rate of population decline and ongoing threats from human activities. Comment on the impact of the Project on these dolphins is provided in Appendix 1.

12. Impacts on health and livelihoods

The issue at stake for this review is not the local impacts on livelihoods – that may also be an important issue but it is a national one. The issue is whether there are transboundary impacts of the project on livelihoods for people living in other Member Countries. Consultations have been conducted with some communities in Cambodia (in Ton Le Sap and the area between Phnom Penh and Stung Treng).

The fish passage issue has a clear potential to impact livelihoods for people depending on fish catches upstream as well as downstream of the DSHPP. According to the Social Impact Assessment Report, sale of fish is one of the major sources of income (ranked first among income-generating activities) by households (SIA report, Table 14 & 15, p. 30-31). If the migration of fish should be impeded by the DSHPP and the amount of fish decline, contrary to the assessments of the EIA, then there is a risk of deterioration of the livelihoods of many people, also in other Member Countries. Also the nutrition and health of the population at large might be impacted if the source of protein and nutrition that fish from the Mekong constitute would be reduced. These aspects have not been analysed and assessed by the EIA report because it is assumed that with the proper mitigation measures these risks are not relevant. The consequence is that currently we have no assessment and mitigation plans for a "worst case scenario", i.e. if the fish migration gets blocked. It would be relevant with a mitigation plan for handling such a scenario.

See responses to Annex 3: Fisheries

Due to the limited size of the project (no change in flow, sediment transport and water quality except in a limited near-field area) it is not anticipated that the project will have other regional impacts than on fish catch.

Alternative options

There is some mentioning of the Thakho project (an alternative that diverts water from just above the Khone Falls to just below the falls) in the EIA report (sections 4.3.1 and 4.3.6). However, the information and discussion of this alternative seem to be based on a report from 2004 (p. 4-4) and not the much newer ESIA report from 2010.

<u>MRCS Comments</u>:

What is the reason for this? It would be interesting to have a more detailed comparison of the two alternative projects.

[3] WWF (2011) and WWF (2012)

Summary of conclusions and recommendations

#1: Assess the impacts on the project economy of selecting a minimum flow over Khone Phapheng higher than 800 m3/s and assess the impact of climate change on the flow over Khone Phapheng.

See above

#2: Assess impacts on water quality from loss of sediments during excavation and deposition.

See above

#3: It seems justified not to anticipate any water quality deterioration in the head pond.

Agreed

#4: Investigate potential impacts from sediment flushing on the dolphin deep pool immediately downstream of the dam using 2-D or 3-D hydraulic models of the near-field area.

See above. Sediment flushing will not be required for project operations. Normal sediment concentration conditions will apply as far as the dolphin pool is concerned

#5: Assess short-term consequences of increased sediment concentrations if blasting of structures during decommission take place.

See above

#6: Due to the physical characteristics of the head pond, long-term impacts on the regional sediment balance are not possible.

Agreed

#7: It is unlikely that impacts on the nutrient balance (although not addressed by the EIA) will occur.

Agreed

#8a: Fish migration over the Great Fault Line (particularly in the upstream direction) is by far the most important environmental issue of the DSHPP. Although the suggested mitigation measures proposed for provision of alternative upstream migration routes seem reasonable and sound, they remain to be tested and this issue seems to be a key risk of the project. The deepening of alternative channels should be tested before implementation of the project.

The developer agrees with this comment. The monitoring of the effectiveness of the channel modifications started in 2011 and is continuing.

#8b: Describe how deepening of channels will take place without underwater rock blasting in order to protect the dolphins and other aquatic animals.

Deepening of the channels at the downstream end of H. Sahong will be carried out entirely on dry land as the Sahong channel will be blocked by temporary cofferdams and drained.

#9: Due to the physical characteristics of the project it is not expected that discontinuity of habitats will be an issue (other than fish migration as already mentioned)

Noted and agreed

#10: Assess the data suggested by the 2007 MRC Review regarding status of wildlife.

Impact on terrestrial wildlife is minor as Project will only inundate 200 hectares of land, half of which has already been converted to farmland.

#11: Assess impacts on visual appearance and tourism of flow over Khone Phapheng of 800 m3/s. Up-to-date data on tourist arrivals should be used.

See above

#12: Assess the impacts of reduced fisheries on nutrition and livelihoods under the assumption that the fish migration mitigation measures fail.

The mitigation will not 'fail' as the Hou Sahong is not the only year round pathway for upstream migrating fish and there are multiple downstream pathways through the Khone falls that avoid the project.

A request for a basin wide environmental impact assessment of the impact of the Don Sahong Project is not sensible without including all the other water resource developments in the Mekong basin which could impact fisheries productivity (e.g. other dams, flood plain reclamation and land use change).

One recent study of the impact of planned dams alone reported that new tributary dams planned or currently under construction are a greater risk to fisheries production than mainstream dams (Ziv, Baran et al. 2012). In addition the MRCS commissioned SEA on the impacts of 11 dams proposed for the Mekong mainstream found "Don Sahong is the only case possible" where passage may be effective (Baran, 2010).

These studies of multiple dam impacts did not consider the impacts of the land use changes which are accelerating in the basin. Fragmentation of flood plain habitat by drainage, by dyking or by reclamation, are all activities which reduce connectivity between the river and wetlands and inevitably lower the aquatic productivity of a flood pulse driven aquatic system.

The Don Sahong Project cannot be responsible for the number of fish or larvae that arrive in the Khone Falls area from upstream or downstream, but will employ best practice measures to promote successful passage of all those fish through the area.

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#13: Compare the DSHPP project with the Thakho project alternative, using up-to-date information for the Thakho project.

Addressed in Annex 5 response

Annex 5: Dam Design and Operation (ISH)

MRCS REVIEW REPORT For Don Sahong Hydropower Project On Dam Design and Operation

1. Summary of Comments

The content of the DSHPP Engineering Status Report 2011 has given a best estimate of impacts resulting from the construction and operation of the power plant and the mitigation measures. However, in some places the description of mitigation measures is still limited and requires further elaboration to ensure smooth coordination and that shared responsibilities are well understood by all stakeholders to maximise safety and reduce impacts to the environment.

Overall impression is that the transboundary impacts need to be more clearly assessed and mitigation measures more clearly laid out including the adaptive management approach.

It is understood that the areas where additional mitigation measures are considered warranted are those specifically outlined in the subsequent MRC detailed comments. These are addressed point by point below.

2. Comments Related to Design, Construction and Operation of DSHPP

1. Project Siting and Options Economic Analysis: For sustainable hydropower design, it is important for this project to be seen in the context of the other power options available to the purchasers of the power and alternative siting options. As this report is clearly undertaken by the developer under the existing PDA, it would not be expected to discuss these points. However, from the MRCS perspective (basin planning), and as per common practice in the PDP process, it would be important for the economic assessment of these alternatives to be fully assessed to ensure the best outcomes for the Lao PDR, the power purchaser, and other MRC member countries. This economic analysis should show the relative benefits of the DSHPP over other fuel options and other HPP locations (e.g. Takho).

The DSHPP Final Feasibility Study (2009) referenced previous studies on power generation in the region, including the original Feasibility Study Report by PEC Konsult/APW (2007). While the 2007 report was not specifically provided to MRC, it does cover off the reasons for selecting DSH as the preferred power generation option for this reach of the Mekong basin. The background reports of relevance, and which were identified in the 2007 Report, include:

- ✓ Mekong Mainstream Run-of-River Hydropower Projects prepared for the Mekong Secretariat in 1994; by CNR in association with Acres International. This report considered 12 projects of which Don Sahong was ranked a "First Category Project", with major positives being its minimal displacement of population, minimal land flooding, and economic attractiveness. The project at that time was designated as a 240MW project, and concluded there would be no negative impacts if large storages were subsequently built upstream.
- ✓ Power Sector Strategy Study prepared for ADB in February 2001 by Electrowatt and Hagler-Bailey. This report considered power generation in the Phapheng Falls area and concluded that diversion of a significant proportion of flow would not affect the visual appreciation of the Falls.
- ✓ Power System Development Plan for Lao PDR in August 2004 by Maunsell/Lahmeyer International. This report considered (among many other projects) 3 development of similar size in the Siphandone Region – Don Sahong, Phapheng Falls, Thakho, and Tad

Somphamit (west of DSH), only one of these could be viably developed as they compete for the same component of the available water resource.

- ✓ The Thakho Project was separately investigated by CNR under their own PDA with GOL. This occurred in parallel with the DSH final feasibility studies during 2010/2011. The Thakho project developer considered a project size up to 172MW using 1300 cumecs to generate 1107 GWh/yr. As above, Thakho competes for the same water resource as DSH. Following completion of the Thakho feasibility studies in 2011, it was clearly apparent in comparison of the 2 projects that DSH was more economically attractive than Thakho, made more efficient use of the available water resource, and could be developed with acceptable and manageable environmental and social impacts. Accordingly the Thakho project developer declined to carry the Thakho opportunity project further, and DSH became the single preferred development in the region.

With respect to alternative fuel options, it has been well recognised as a result of numerous studies extending back through the last 20 years or more (some mentioned above) that the private development of the country's hydropower resource for export earnings (as well as national development) is a major policy of the Lao PDR Government. Apart from some exceptions such as the Hongsa Lignite Development, hydropower is widely accepted as the most economically attractive form of generation development for Lao PDR, which is well known to have a very large hydropower resource - of which only a small percentage has so far been developed. The numerous previous studies (the key ones having been sponsored by the ADB) have already covered the comparison with other non-hydro options, which in the case of Lao PDR is very limited in any case given the lack of other reliable base resources (wind or thermal), the large extent of their hydropower resource, the preponderance of thermal stations in neighbouring Thailand, and general lack of generating capacity in Cambodia. Accordingly further economic evaluation comparing DSH with other fuel options was not considered by the Project Developer or by the GOL to add value or otherwise to be warranted.

Considering all of the above, it is submitted that further economic analysis to demonstrate the relative benefits of DSH over other hydro projects in the region and with other fuel options is not necessary, as the required assessments have all been duly completed in the past, and remain valid.

2. *Project Scale and Location: The above review could also be supplemented by further explanation of the project scale relative to the demand in the southern region of Laos PDR. This would include the assessment of how the DSHPP production would feed into the Southern Grid and ensure that this project will work in coordinated operation with other power stations to maximise system production and minimise effects on environment and affected parties. Aspects of the connection to the grid and related operations are yet to be resolved. This needs to include network modelling to ensure production is maximised and outages minimised.*

In terms of project scale, the optimisation studies have demonstrated the optimal installed capacity to be in the region of 260MW, being the capacity that makes the most efficient use of the available water resource considering all factors such as; available generating head, topography, minimum flow requirements to other affected branches or channels in the

immediate location and thus the available flow for generation, and management to acceptable levels of environmental and social impacts. A smaller project would be wasteful of the available resource in this context, and would accordingly not be in the best long-term interests of the Lao PDR government or its riparian neighbours. This explanation satisfies the supply side of the equation.

In terms of the demand side (for electricity), the project is ideally located to maximise the potential of 3 electricity market areas, as follows:

- ✓ To supplement energy demand in the Southern region of Lao PDR, including to bolster and support the ongoing implementation of grid strengthening and network inter-connection within Lao PDR.
- ✓ Export of energy to Cambodia, which has been indicated in a number of studies (mostly sponsored by ADB) to have a serious shortfall of a reliable and stable energy supply – particularly in the Northern part of Cambodia. This is noted in particular in Section 1.5 of the AECOM 2009 (Final Feasibility Study). Development of a 230kV network from Laos to Stung Treng and onto Phnom Penh is now in progress.
- ✓ Export of energy to Thailand, noting that a new 500kV Mekong crossing near Pakse is now in the process of development.

Between the above 3 market areas there would clearly be demand well in excess of the optimised supply capacity of DSHPP, and further detailed analysis is not considered warranted for the purpose of demonstrating viability.

3. *During construction: the estimated quantities of materials to be excavated in many areas particularly in the channel area are huge but disposal areas are not final and still subject to detailed negotiation with local village officials. It is important that the plan contain an adequate erosion and sediment control plan to prevent environmental degradation of lands and streams during construction. The erosion and sediment control plan is required and the approved plan should include a Quality Control Inspection Plan to ensure that adequate inspection and reporting is in place to minimize pollution to the Mekong River. The plan should address the protection of existing vegetation, grading of slopes, control of surface drainage, sediment containment measures, temporary topsoil stockpiling, storage and disposal of excess excavation and debris, construction and upgrading of access roads, and clearing and construction of the transmission line rights-of-way. Approved disposal sites should be indicated.*

Specified as a requirement of EPC Contractor - to comply with EMMP and prepare their own CEMMP

4. *Effects of unexpected and possibly rapid changes in water surface level and flow rates downstream due to DSHPP operation: These effects have been addressed in the content of the DSHPP Engineering Status Report in connection mainly to station flow and surge effects which may cause serious impacts to people. Result from simulations appear to give small raise in water level for different scenarios .Therefore, for preventive measures the selected equipment suppliers must manufacture, supply and install their turbines with similar or better sluicing flow rate capability results as shown in the DSHPP Engineering Status Report.*

Specified as a requirement of EPC Contractor - Contractor to comply with relevant specifications

5. *Operation requires a pro-active approach to risk management, in part due to the run-of-river operation concept and relatively limited storage in relation to the high river flows that DSHPP must accommodate. Rates of change of water surface elevations in the reservoirs would sometimes be fast. Reaction times of dam operation staff in emergencies will equally need to be rapid and fail-safe. Mechanical and electrical control equipment must be well conceived and designed, and thoroughly backed-up to ensure the operation flexibility can be maintained during emergency situations, where different failure modes can arise with critical equipment, such as controls for spillway gates or stop logs. Therefore, to prevent accidents and hazards resulting from rapid rises in water surface level, DSHPP must implement adequate risk mitigation measures including public safety information and operational guidelines. .*

Noted and agreed that proactive risk management will be an integral part of station operation, in particular relating to the management of unforeseen grid outage events as noted above.

While station flows are relatively high, hazards from rising water level, and in particular natural flood events, are naturally mitigated given that the mainstream part of the river above the DSH inlet operates as a natural spillway capable of withstanding any and all natural flow changes, and that the DSH embankment crest level is higher than the design natural water level that will occur at the Hou Sahong inlet, thus allowing the "natural spillway" effect of the rest of the river to fully protect the scheme and its associated structures.

Comments related to Dam Safety for DSHPP:

The reports make a detailed assessment of the project against the PDG in both the Engineering Status Report and the EIA. This is a good feature of the report and will need more detailed review at some point. Proposals for improvement will be in the detail.

1. *The report calls out the ICOLD and Lao regulations on dam safety risks. Given the location of the project, the use of an expert panel would be most important to review seismic, flood risk management and the detailed design parameter selection. These will be further considered during any agreed PNPCA process.*

Dam safety review panel would be operative during construction phase, not during the PNPCA process.

2. *Beyond clarity on the institutional arrangements, it is also important to confirm that the five main sub-plans prescribed in the PDG would be prepared and implemented. These plans include (i) a construction supervision plan (ii) a quality assurance plan (iii) an instrumentation plan (iv) an operation and maintenance (O&M) plan, and (v) an emergency preparedness plan (EPP).*

Noted and has been considered as per Appendix A of the AECOM ESR.

3. *In the Mekong transboundary context, this means mechanisms to ensure the four MRC countries have information access throughout the project development stages, in the manner that may be agreed, including monitoring and compliance activities.*

Noted and has been considered as per Appendix A of the AECOM ESR.

4. *All four Member countries have a stake in the safe design and operation of mainstream dams due to potential transboundary impacts of dam failure and the need to assure the public that mainstream dams are well managed. As a consequence, all MRC countries need to be appropriately involved in various safety aspects from the design stage to monitoring and review processes.*

The principle is acknowledged. However it is noted that in terms of direct potential impacts of dam failure, only Cambodia is potentially impacted. As identified in the existing reports, the volume of water impounded by DSHPP is comparatively small, and the river reach immediately downstream of DSHPP is very wide with a substantially higher storage capacity than the DSH headpond. Accordingly it can reasonably be assessed that in principle the potential impacts of dam failure will be minor, if any. Nevertheless, the MRC Guidelines in relation to dam safety, including appropriate dam break analysis, will be followed as identified in the AECOM ESR.

5. *The Mekong is also projected to see a significant increase in the frequency of extreme flood peaks over the longer-term, due to climate change. Given the permanent nature of dam structures, an assessment of integrity of hydraulic structures against the range of projected flood extremes that MRC had developed is important to satisfy concerns and perceptions of hydrological risk.*

With reference to MRC Technical Paper No. 29 (June 2010) "Impacts of Climate Change and Development on Mekong Flow Regimes First Assessment-2009";

- ✓ Scenarios S1-S3 (no climate change) and scenarios S4-S6 (with climate change) were developed. Scenario S4 – baseline with no development, and S5-S6 include development.
- ✓ The development scenarios identified are now already under implementation, including the large Chinese storage dams assumed along with NT2 and others in Lao PDR. These can therefore reasonably be considered the most likely (i.e. S5 or S6). Scenario S4 is useful for baseline comparison, but has been shown to not represent the actual situation.
- ✓ For the development + climate change scenarios, MRC (2010) indicates that high (wet) season flows at Pakse and Stung Treng will reduce by 3.5% and 2.9% respectively (refer Table 6-11 of MRC 2010).

The effects of climate change have been considered along with reasonable development scenarios for DSH. In terms of dam safety and extreme event management, the studies carried out by MRC (which are the most definitive available) indicate that the combined effects of climate change and development will lead to reduced flood sizes in the long term. Scenarios that do not include "development" can realistically be considered as baseline scenarios only, which are not reflected in practice.

6. *The PDG notes that broadly, a consistent approach to the safe passage of extreme floods is required for critical structures during construction and operation of the mainstream dams, also taking into account the potential development of other dams in the mainstream cascade proposed in northern Lao PDR.*

Noted and has been considered as per Appendix A of the AECOM ESR.

7. *The PDG states (paragraph 182) that "Developers and owner / operators will need to demonstrate how they will apply the entire OP/BP 4.37 (which is embodied in the PDG). Consideration should also be given to ensuring that relevant dam safety measures provided in this guidance is appropriately reflected in Concession Agreements*

Noted and has been considered as per Appendix A of the AECOM ESR.

Comments on the other Aspects of the reports:

***Environmental flows and incentives**:*

The incentives for the developer to maintain environmental flows across Khone Phapeng falls and into the fish passage channels in Hou Xieng Peuk and Hou Sadam needs to be considered. Approximate trade -off is shown in the optimisation section of the report.

E-Flow	*Generation*	*Lost revenue (%)*
1000m3/s	*1676 GWh*	*-5%*
800m3/s	*1757 GWh*	*Selected case*
600m3/s	*1774 GWh*	*+1%*

The incentive for the developer to maintain agreed minimum flows resides principally with its compliance obligations under the Concession Agreement with Lao PDR. This is a contractual agreement and the developer is liable in law.

The Lao PDR government itself is strongly incentivized to ensure the developer complies with the agreed minimum flow regime, given (among other things) the economic importance of the Khone Phapheng Falls as a tourist attraction, and the importance to the people of Lao PDR (as well as other riparian nations) in maintaining suitable fish passage conditions from a livelihood perspective.

Annex 6: Navigation (NAP)

MRCS REVIEW REPORT For Don Sahong Hydropower Project On Navigation

At present the Hou Sahong is not navigable. The author(s) of Annex 6 suggests that consideration should be given to incorporating navigation facilities off the back of the Don Sahong development, i.e. by utilising the hydro development to provide an additional enhancement that does not at present exist. While this may be a potentially worthwhile pursuit for the Lao government (exclusive of the hydro developer) in terms of cross-boundary trade opportunities, navigation across the "Great Fault Line" is impractical and will remain so into the foreseeable future, with or without DSHPP.

This is mainly because the channels of the Mekong upstream of the Hou Sahong are for a number of kilometres heavily braided and are hydraulically "steep", with numerous and consistent rapids sections crossing every channel at some point.

In the 1994 CNR/Acres Report prepared for the MRC Secretariat ("Mekong Mainstream Run-of-River Hydropower Projects"), locks were included in all mainstream projects **except** Don Sahong, with the comment that *"At Khone Falls practical navigation could not be established past the falls with the addition of facilities only at the power development project"*. This is because considerable work would be necessary to improve the river between the top of Hou Sahong and Don Det or Khinak, the most downstream navigable parts of the Mekong in Laos. Even now, those parts are only navigable for 50 DWT vessels in high flow and 20 DWT vessels at low flow periods, which is far short of the 5,000 tonne barges that locks were considered for the other projects upstream and downstream of the Great Fault Line.

Accordingly, if at some time in the future navigation across the Great Fault Line were to be seriously considered, the only potential location would be to construct something in the western arm of the river, such that its headwaters were well upstream of Don Det. Such a construction (even if in some way feasible) would therefore be completely separate from and unaffected by DSHPP, and therefore does not need to be considered in parallel with DSHPP.

Annex 7: –Social Issues (BDP)

General comment from Developer

The Advice and suggestions from the MRCS provided by the BDP in Annex 7 are appreciated. The project team will take account of these where appropriate, most specifically in relation to the transboundary scale.

The issues identified at the project and local to sub-regional scales are internal to the Laos PDR and are being addressed as present by representatives of the GoL and the Developer in preparing the Concession Agreement (discussions ongoing in Feb 2014).

The concept of independent audits by an independent expert panel is one approach being considered. An alternative would be for a 'hands on' active involvement by fisheries agencies in Laos and Cambodian in a collaborative oversight of the Projects fisheries monitoring program.

1. GENERAL OUTLINE

The following preliminary review of the social issues[4] related to the project is based on the following project preparation documents provided by Lao PDR:

- ✓ *Social Impact Assessment (SIA);*
- ✓ *Cumulative Impact Assessment (CIA);*
- ✓ *Resettlement Action Plan (RAP); and*
- ✓ *Social Management and Monitoring Plan (SMMP).*

These documents have been prepared in according with laws and regulations from the Lao government, including guidelines and standards from ministries such as MONRE and MEM. In general, the guidelines and standards used by the project developer to prepare the above documents are similar to the ones used by international organizations, such as the World Bank.

It is BDP's assessment that – in general - the SIA, CIA, RAP and SMMP are fit-for- purpose, i.e. they are mostly complete, consistent and provide the required information with adequate quality. However, some of the proposed mitigating measures need to be further prepared and planned together with the affected population, such as the livelihood development measures to maximize employment opportunities.

In BDP's evaluation, the main challenge has to do with (independent) oversight and compliance assurance of the implementation of the proposed mitigation measures and with adaptive management based on good monitoring of a range of parameters.

[4] This review is part of a broader review prepared by the BDP in December 2013 after reviewing the project preparation report and participating in a study visit to the project area.

There is scope for further improvement of the above assessments and plans (SIA, CIA, RAP and SMMP). BDP's specific recommendations are provided below.

2. RECOMMENDATIONS FOR IMPROVEMENT OF THE SOCIAL ASSESSMENTS AND PLANS

In order to place our recommendations for improvement of the social assessments and plans in context, first a short summary is provided of the social impacts assessed and the mitigating measures proposed by the project developer. This information and our recommendations is presented are the structured according to the project scale, the local to sub-regional scale, ***and the transboundary scale****.*

2.1 The project scale

The project scale refers to the built up area of the project infrastructure, such as the dam and the reservoir. The people living in this area have to be resettled. The RAP demonstrates that resettlement issues are relatively small (11 households of Ban Hang Sadam). The main reason for this is that the project will be a run-of-river scheme with only 'buffer' storage in the head pond (volume less than 0.1 km, surface area less than 2 km2).

However there are a few issues that need further consideration in the RAP. These are summarized below:

- ✓ *The RAP implementation schedule is planned for 24 months which may be too short to really ensure successful resettlement (RAP, page 18 on Figure 7).*
- ✓ *Resettlement location: From the map on page 12 showing the original hamlet and the resettlement site which is deep inside the island away from the river bank while Conceptual Layout of Hang Sahong Resettlement Village on page C 15 of Appendix C of RAP showing the resettlement will be near Hou Xang Pheuak so which is the actual resettlement site?*
- ✓ *The RAP states that DSHPP will provide adequate clean water for HH consumption but it is not clear about the water for farming in which the original location is closer to water source at the Hou Sahong, the construction site of the Hydropower dam.*
- ✓ *The report of 2007 survey did not take into account the amount of increased in-migration workers and some may bring families with them to stay on Don Sahong for the construction period of the dam. This large amount of workers may lead to high demand for shelters, food, water, etc., and a need for proper waste disposal (garbage, human waste) that should include the island communities.*

2.2 The local to sub-regional scale

The local to sub-regional scale refers to the wider project area where people live whose livelihoods will be directly or indirectly affected by the project construction and operation.
In this area, the project related social impacts according to the SIA include 50-100 fishermen whose livelihoods depend on traditional fishing in Hou Sahong due to the

permanent removal of fish traps in the Hou Sahong and the reduction of fishing pressure in nearby channels. Another category of social impacts is related to nuisance (noise, dust etc.) from construction and excavation activities.

A range of mitigation measures is being proposed by the developer in the SIA and the SMMP, including 'livelihood development' in other sectors than fisheries such as agriculture, forestry, transport and security, and 'livelihood betterment' measures such as education, water supply and sanitation, electrification etc. Wealth creation advisors and revolving micro-credit funds would help local people to generate benefits from the project.

The Don Sahong Hydropower Project, which includes the construction of roads and a 350m long bride across the Hou Phapheng, will change the socio-economic future of sub-region beyond the impact of the hydropower plant. Strong independent oversight and compliance of the implementation of the project and the proposed mitigation measures would be important to maximize the potential development and poverty reduction benefits for the population in the sub-region.

Several issues need further consideration in the SIA, CIA and SMMP. These are summarized below:

- ✓ *Livelihood restoration and development strategy is well prepared guideline and mentioned that livelihood restoration activities will be continued over a period of about six years (SIA, page 48). However, social development action plan of SMMP shows Table 4 budgets for SMMP planned only 2-4 years (SMMP, page 34).*
- ✓ *Employment opportunity of local people during the construction period of DSHPP (SIA: page 67) should be ensured such as the recruitment of the best fishermen for catch and transfer (and other fisheries related tasks) would be full-time or part-time; what type of employment for skilled boatmen for logistics and transportation would be after the 350 m long bridge between mainland and island is available.*
- ✓ *Under point 6.3.2 Medical Care Support - Waste disposal management such as garbage and human waste disposal was not described (SMMP: on page18).*
- ✓ *Proposed public health mitigation found in SIA particular education and treatment programs for Schistosoma mekogi which is risk in life style and daily dietary of local people. An observation is whether the education and treatment is emphasizes and incorporated in the SMMP on primary health education or not. (SMMP, page 18 and SIA, page 68).*
- ✓ *The Education Promotion Programme of SMMP is incorporated with Section 5.5.9 Support for Education and Training of SIA in particular formal education on primary and secondary school levels. However, adult education mentioned in the Section 5.5.9 is not incorporated in SMMP.*
- ✓ *The community base aquaculture is not clearly defined that this will be a community based entity or cooperative or association to facilitate aquaculture sector as alternative sector to develop community economies (SIA, page 55: fisheries). This concept was not referred to in the SMMP on the Section 7: institution arrangement to*

be function in strengthening livelihood development (SMMP, page 25-26).

- ✓ *There is main gap between concept of fishery resources in livelihood system (SIA page 52: 5.3.2) and genuine practice. It is not easy to change perception of users on fisheries resources from common resources to be communal resources. In addition, this conceptual strategy was not fully adopted and applied into SMMP for enhancing and sustaining wild fisheries resources.*
- ✓ *Section 5.5.10 of SIA: Credit and Credit Training is not as a topic listed in Section 6.3.10 Livelihood Training and Awareness Raising of SMMP to support Section 6.3.12 Livelihood Development on e) Establishment of village development and revolving micro-credit funds (SIA, page 63 and SMMP, page 24-25).*
- ✓ *The implementation schedule of SMMP (Figure 2, page 31) has no details on task of organization of training related to fisheries sector as remarked in Section 6.3.12 Livelihood Development, in addition, training on fisheries sector is not listed in the Table 4 budgets of SMMP (SMMP, page 34).*

2.3 The transboundary scale

The transboundary scale (arguably the most important for MRC purposes) refers to the impact that the project may have on nearby Cambodia and the other countries in the Mekong Basin.

According to the project preparation documents, the project, including the proposed mitigating measures, will not have a significant transboundary impact in terms of changes in hydrology, fisheries, environment etc. (that would lead to social impacts). As a consequence, the SIA does not assess social impacts in Cambodia and the other countries. Therefore, the project developer does not propose mitigating measures (or benefit sharing options).

The project preparation reports show that theoretically the negative transboundary impacts of the project can be mitigated and can make the Khone Falls fault less of an obstacle to the migrating fish (and the potential adverse impacts this would bring upstream and downstream)[5].

However, the challenge has to do with oversight and compliance assurance of the proposed mitigating measures and with adaptive management based on good monitoring of a range of parameters. This is potentially important as the design, construction and management of some of the proposed mitigating measures will pose some technical and managerial challenges.

In this context, the following recommendations are made:

- ✓ *The project preparation reports would benefit from a more comprehensive discussion of the best ways and means for compliance assurance of the large range and variety of mitigating actions that are being proposed. There* ***would be a role to play for MONRE (incl. LNMC) as well as for periodic independent audits during the construction and operational phases of the project.***

The Developer is working with GoL (MONRE) to develop practical and realistic methods of monitoring the Project impacts on migrating fish stocks. This program will be included in the Concession Agreement.

Similarly, a joint Lao-Cambodia technical monitoring programme could be established with support from the MRC (this would become a transboundary cooperation

[5] **It should be recalled that in the 'without project' situation, fish migration over the Khone Falls is also at risk**. The developer's reports (as well as MRC reports and other papers) suggest that the Hou Sahong and other channels are heavily fished and increasingly so. Population increases, and so do fish traps. Also the deep (dolphin) pool is heavily fished. As a result, papers on fisheries in the Khone Falls region describe decreasing numbers and proportions of big (late maturing) fish, and decreasing catch per unit effort.

project). The programme would monitor fisheries and improve fisheries management in the wider Khone Falls area. Given the decreasing numbers and proportions of big fish, and decreasing catch per unit effort, such a transboundary project should be a priority even if there is no hydropower project. To prevent misperception about the impact of the project, the Government must ensure that monitoring data are made available to the public.

Noted

"Improved fisheries management in the Khone Falls area" is a central aim of the project's Fisheries Monitoring and Action Plan. This objective is described in the EIA 2013 - Annex C (Phonekhampheng 2010) and has since been repeated at the Site visit briefing in Pakse and in wider forums like the Challenge Program Workshop in Hanoi both held in November last year.

The diminishing returns from the Khone Falls fishery and need for better management were identified as long ago as 1995 (Roberts and Baird 1995). Ian Baird reported on the urgent need for co-ordinated transboundary management of the aquatic resources of the Khone Falls in several papers (Baird and Beasley 2005) (Baird and FLAHERTY 2004) but to little effect.

Appendix 1 – DSPC comment on Impacts on Dolphin

The attached is DSPC comment on WWF report on the impact of the Don Sahong Project on the Irrawaddy dolphin population in a deep pool downstream

WWF (Mr Gerard Ryan) published an update on the Don Sahong Project risk to the Irrawaddy dolphin on 19th Feb 2014. That report made several unsubstantiated or false claims about the potential impacts of the Don Sahong Project on the Irrawaddy dolphin living downstream in the Mekong River.
These false claims have subsequently been widely reported in the regional press. So Don Sahong Project has prepared this brief note in response to the Key Messages in the WWF report (Ryan, 2014) (*WWF points in black italic*)

- ✓ *Don Sahong Project one kilometer upstream of the **core habitat for Irrawaddy dolphins in the Mekong River**.*

The WWF estimated there were around 85 Irrawaddy dolphins in the Mekong River in 2010 (Ryan et al, (2011). Figure 1 of that report showed the "core habitats" of more than 90% of these dolphins are deep pools in Stung Treng and Kratie Provinces (Cambodia). These locations are more than one hundred kilometres downstream of Don Sahong Project.
The project is a little more than one kilometre upstream of the edge of the Cheuteal pool, which is inhabited by a group of only six dolphins. These animals are "reproductively isolated" by distance, from all other dolphin in the Mekong River.

- ✓ *The Don Sahong Dam will almost certainly cause the disappearance of dolphins in the transboundary pool downstream of the dam site due to excavation activities and increased boat traffic.*

The WWF diagram of tailrace excavation below coffer dam provided in Ryan (2014) is a redrawn version of a Don Sahong Project document. At best it can be regarded as a misunderstood (at worst it is a fabrication). The WWF chose to display one of several tailrace excavation options that were considered at the design stage. They fail to report that the EIA clearly states "excavation will only occur within the bounds of the cofferdam" and the comment in the ESR that "No underwater blasting will be permitted, in order to protect a nearby sensitive dolphin population."

WWF provide no evidence for increased boat activity due to project (and ignore the fact that Don Sahong Project will build a road and bridge from mainland (EIA executive summary) so most access to the site will be overland and existing boat activity will be reduced when island residents have the option of a bridge to the mainland).

However, Ryan et al, (2011) report the dolphin population was at risk from "frequent disturbance from tourism activities". Tourist activity has increased since then.

WWF fails to mention another reason for boat activity across the dolphin pool - local trade between the Cambodian shore and the Lao islands. This is also linked to tourism - is not controlled - and is increasing.

- ✓ *The dam will also increase the extinction risk of the entire Mekong dolphin population due to the probable extirpation of the dolphin group in the transboundary pool,* ***changes in water and sediment flow****, and interrupted migration of dolphin prey.*

WWF previously described the six dolphins in the Cheuteal pool as isolated "The evidence now is very clear that this trans-boundary sub-population is [reproductively] isolated (Ryan 2012, Ryan 2013)." So the extinction risk of the larger group is not linked to the fate of the smaller one.

An MRCS review of the Project documents in Jan 2014, found that project operations will not significantly alter water quality or sediment flow downstream. So the Don Sahong Project cannot "increase the extinction risk of the entire Mekong dolphin population".

The Project has designed mitigation measures to allow passage of all fish that arrive at Khone falls BUT we also note that the management of the Mekong Fishery is poor and human catches of important migratory fishes at Khone falls have been declining for several decades. Indeed the project aims to reverse this trend and improve the fisheries sustainability of the area by improving fish migration through increasing fish migration pathways.

Not to forget that the range of the variation in flow and turbidity in the transboundary pool during the annual hydrographic cycle is extreme for the Mekong. The dolphins live there year round and must be adapted to these natural phenomena.

- ✓ *Not building a dam at Don Sahong will not stop Lao PDR producing electricity, but building it* ***will almost certainly cause the loss of dolphins from Lao PDR*** *and it could precipitate the extinction of the species from the Mekong River.*

Don Sahong Project disagrees with the statement that the project will almost certainly cause the demise of the dolphin in Cheuteal pool, as the causes proposed to hasten their demise: underwater blasting, increased boat traffic and changes in flow, sediment and water quality have no basis in fact. The potential impact on fish as dolphin prey is hypothetical.

We also note that although WWF has been an advocate of better protection for the Mekong dolphin since at least 2011, the proposed management actions, like coordinated management by Laos and Cambodia to eliminate dangerous fishing gears and manage boat traffic, have been unsuccessful to date.

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