# Mekong River Commission

# Procedures for Notification, Prior Consultation and Agreement (PNPCA) Prior Consultation

# BRIEFING NOTE
# In support of Public Consultation regarding Prior Consultation for the Proposed Don Sahong Hydropower Project

**Prepared by:**

The Mekong River Commission Secretariat

November 2014

**For:**

PNPCA Joint Committee Working Group

**NOTE**

This document has been prepared by the Mekong River Commission (MRC) Secretariat. It provides an update on progress with the various specialist studies initiated in support of Prior Consultation on the Don Sahong Hydropower Project (DSHPP). Specifically this report summarises the findings and recommendations of the specialist studies thus far. It makes no inference as to the 'acceptability' of the impacts or reasonableness of the recommendations, that being the purview of the Joint Committee.

This report intended to support the national and regional public consultation process.

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# 1. Introduction

## 1.1 Background

On 30 September 2013, Lao PDR submitted the Don Sahong Hydropower Project (DSHPP), located in Champasak Province, Lao PDR, for "Notification" under the MRC Procedures for Notification, Prior Consultation and Agreement (PNPCA). In pursuance of the provisions of the PNPCA and its Technical Guidelines, the MRC Secretariat forwarded this submission, along with a number of supporting documents submitted by the Lao PDR, to the other three Member Countries; Cambodia, Thailand and Viet Nam on 3 October 2013.

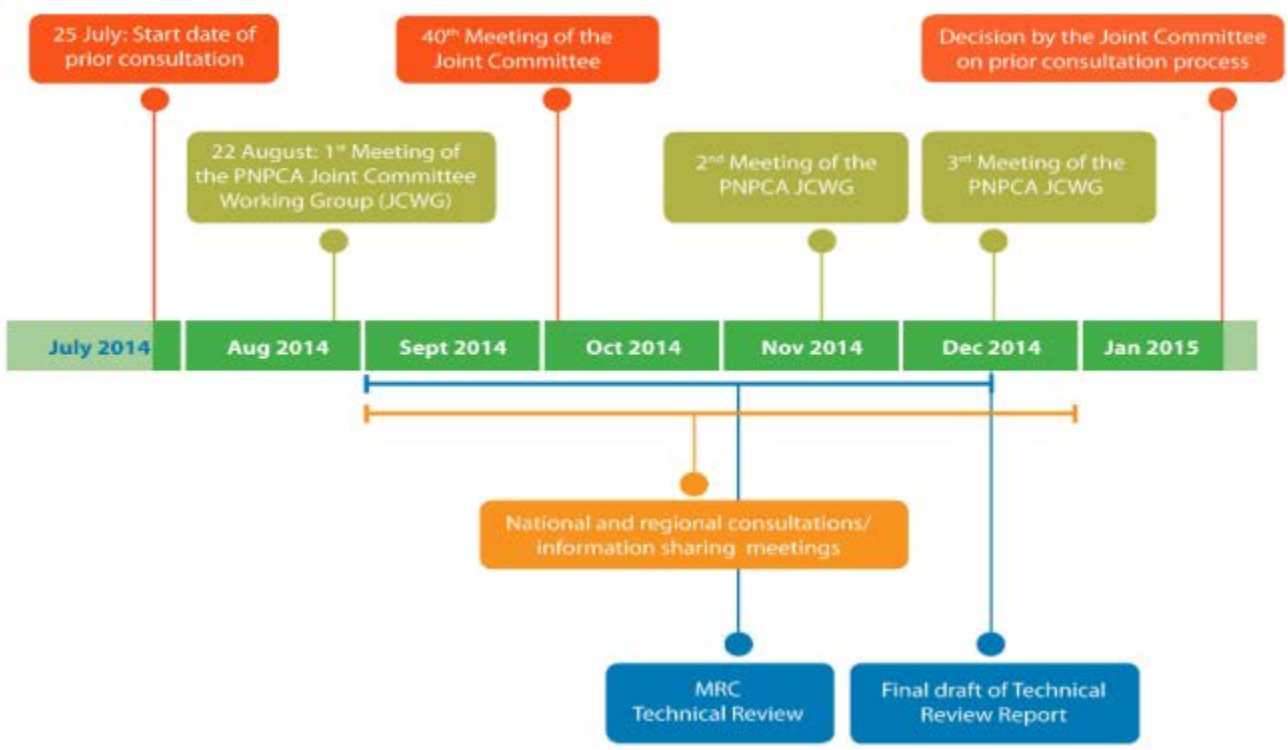
At this time the other Member Countries expressed the opinion that the DSHPP should be submitted for Prior Consultation. Between October and December 2013 the Secretariat was requested to conduct a preliminary review of the documentation submitted by the Lao National Mekong Committee (LNMC). This preliminary review was submitted to the Joint Committee (JC) in January 2014 at its Special Session to discuss the proposed Project. The preliminary review noted that further information on particular aspects of the DSHPP, its possible impacts, and potential mitigation options was necessary in order to fully support any possible discussions between the Member Countries.

On 7th March 2014 the LNMC hosted a technical consultation with the MRC Member Countries and other stakeholders, including Development Partners, to further discuss the potential Prior Consultation on the DSHPP. The developer, through the LNMC, provided the MRCS with a written response to the questions raised in the preliminary review. Two site visits were arranged by Lao PDR, the first on 11th -12th November 2013, and another on 11th March 2014 to allow interested parties to directly engage the project developers and their proposed impact mitigation approaches. Further site visits from Expert Teams appointed to investigate potential impacts in depth have been conducted.

At the 20th Council Meeting on 26 June 2014, Lao PDR stated that the DSHPP would be re-submitted for the Prior Consultation process under the PNPCA. A letter to this effect was received by the Secretariat from the LNMC on 30 June 2014, along with confirmation of the list of relevant documents originally submitted in September 2013. The Secretariat submitted the letter and list to the JC members from the other three Member Countries on 3 July 2014. It was subsequently decided by the JC that the formal start date for Prior Consultation would be 25 July 2014, the date that Lao PDR submitted additional information on Don Sahong Project.

The three notified Countries are reviewing all the documents submitted for prior consultation and will submit their replies to the JC via the Secretariat. In order to support the preparation of these replies, the JC has under Article 5.3.3 [c] of the PNPCA established the PNPCA Joint Committee Working Group (JCWG). Under guidance from the JCWG the MRC Secretariat has appointed several expert groups to provide independent specialist evaluations of the potential impacts associated with the DSHPP, and prepare a consolidated Technical Review Report to submit to the JC.

On receiving all the replies and reviews, the JC will aim to arrive at an agreement on the proposed use and issue a decision that contains agreed upon conditions under Article 5.4.3 of the PNPCA, within six months of the submission of the all the required documents (Article 5.5.1). The six-month timeframe may be extended by the decision of the JC (Article 5.5.2). The Technical Review Process must therefore be completed at least 3 weeks before 25 January 2015, in order for the Joint Committee to adequately prepare responses before the initial 6 month period is completed. The following roadmap outlines this process.




The proposed DSHPP is the second Prior Consultation process to be undertaken under the 1995 Mekong Agreement, after the first one which was triggered by the Xayaburi Hydropower project.

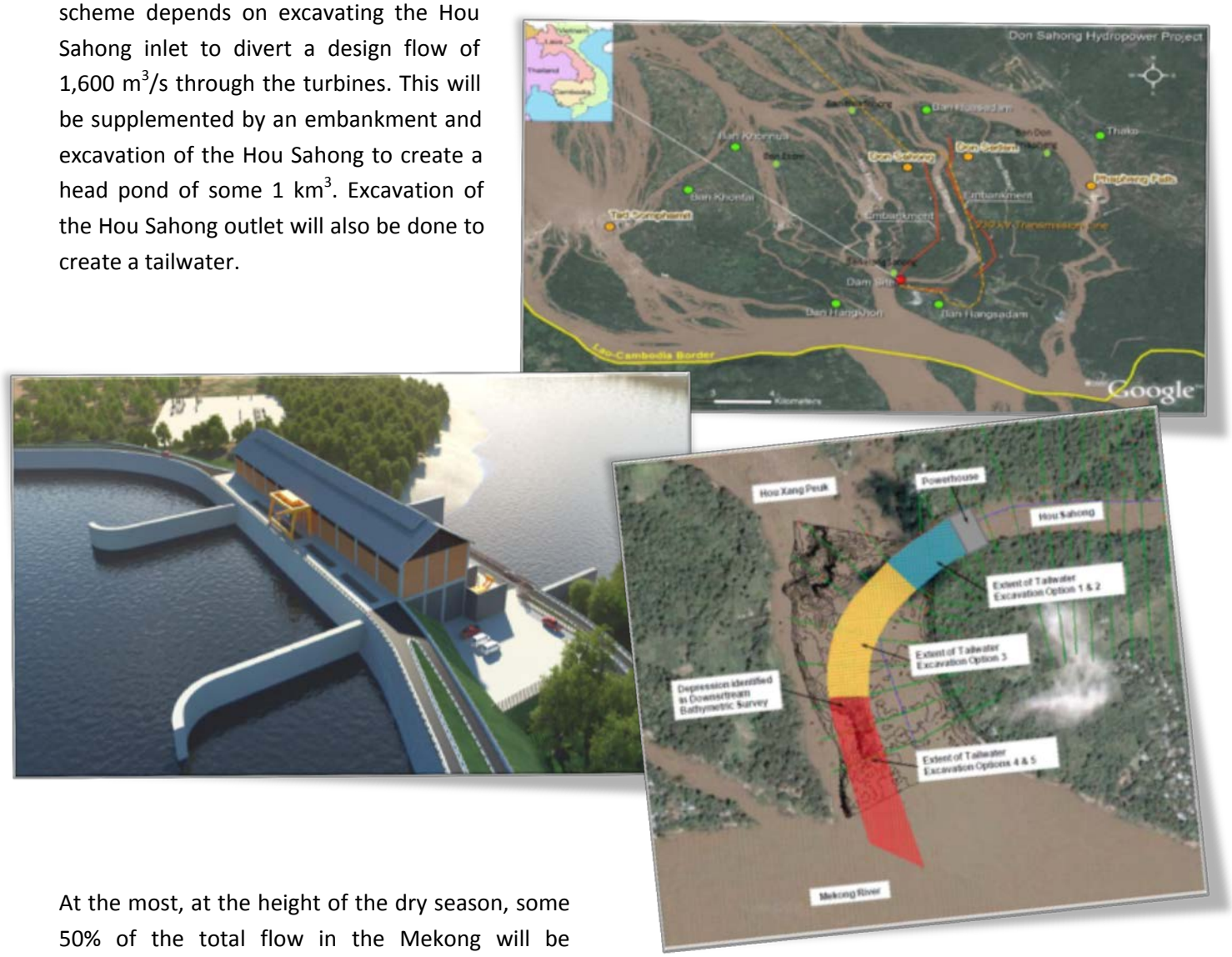
## 1.2 Purpose of this document

Public consultation is a critical component of the Prior Consultation process, and is undertaken by the Member Countries on a national, and MRC on a regional basis. It is important that this process is informed by scientifically sound independent reviews of the possible impacts of the DSHPP. The Expert Groups appointed by the MRC to support this process have collated an enormous volume of reports and data to support as rigorous a review as is viable in the limited timeframes. This is an ongoing task, and the Expert Groups have not yet finalised their reports for the Joint Committee.

Nonetheless, recognising the need for public consultations this Briefing Note was prepared to support the public consultation process, and more specifically the regional consultation planned for 12 December 2014. This Briefing Note is supplemented by a PowerPoint presentation.

## 2. The Don Sahong Hydropower Project (DSHPP)

The DSHPP is designed as a run of river plant on the Hou Sahong channel of the Mekong mainstream in southern Lao PDR. It consists of 4 x 65MW bulb turbines totalling 260 MW. The economic viability of the scheme depends on excavating the Hou Sahong inlet to divert a design flow of 1,600 $m^3/s$ through the turbines. This will be supplemented by an embankment and excavation of the Hou Sahong to create a head pond of some 1 $km^3$. Excavation of the Hou Sahong outlet will also be done to create a tailwater.




At the most, at the height of the dry season, some 50% of the total flow in the Mekong will be diverted through the DSHPP turbines – mostly at the expense of flows over the Khone Phapheng Falls. At the height of the wet season about 7% of the flow in the Mekong is expected to be diverted through the DSHPP. The developer has indicated that a minimum flow of 800 $m^3/s$ will be diverted over the Khone Phapheng Falls as a priority flow, through the operations of the turbines. There will be no peaking operations for the scheme, and hence rapid changes in flow would not occur.

Recognising the potential loss of fish passage through the Hou Sahong, the developer is undertaking the modification of the Hou Xang Pheuak and Hou Sadam channels to act as alternative fish passage routes. The developer has also undertaken to implement an adaptive management fish monitoring and action plan (FishMAP), which would monitor the impacts on fish and allow for adaptive measures to be put in place. In

addition the developer has indicated that no underwater blasting would be done as a measure to limit impacts on the local dolphin population, and that contributions would be made to dolphin conservation efforts.

Further details of the proposed DSHPP are available from the developer, and have been uploaded to the MRC website at: http://www.mrcmekong.org/news-and-events/consultations/don-sahong-hydropower-project/.

# 3. Preliminary findings of the Expert Groups

## 3.1 Introduction

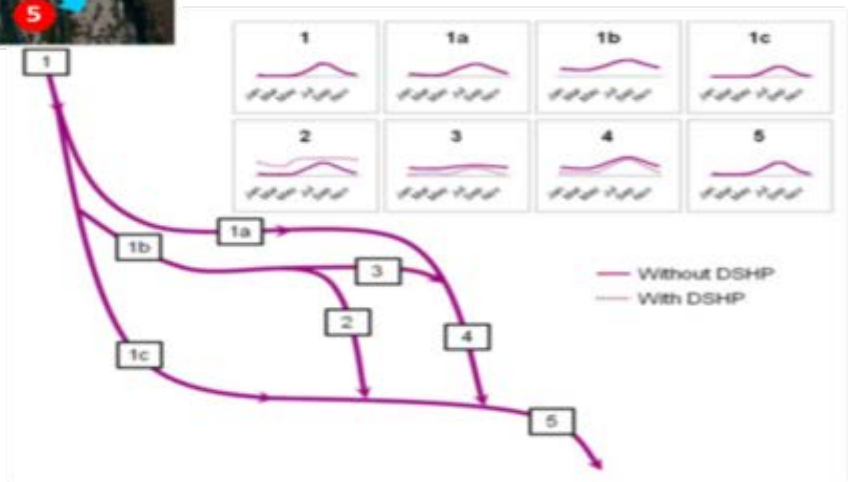
Under direction from the JCWG, the Secretariat has established 5 Expert Groups; A Fisheries and Fish Passage group; A Dolphin group; A Hydrology group; a Water Quality and Ecosystems group; and a Sediment group. These Expert Groups are comprised of internationally recognised experts working together with the experts from the relevant Programmes in the MRCS, and the Member Countries.

## 3.2 Changes in flows between the distributary channels

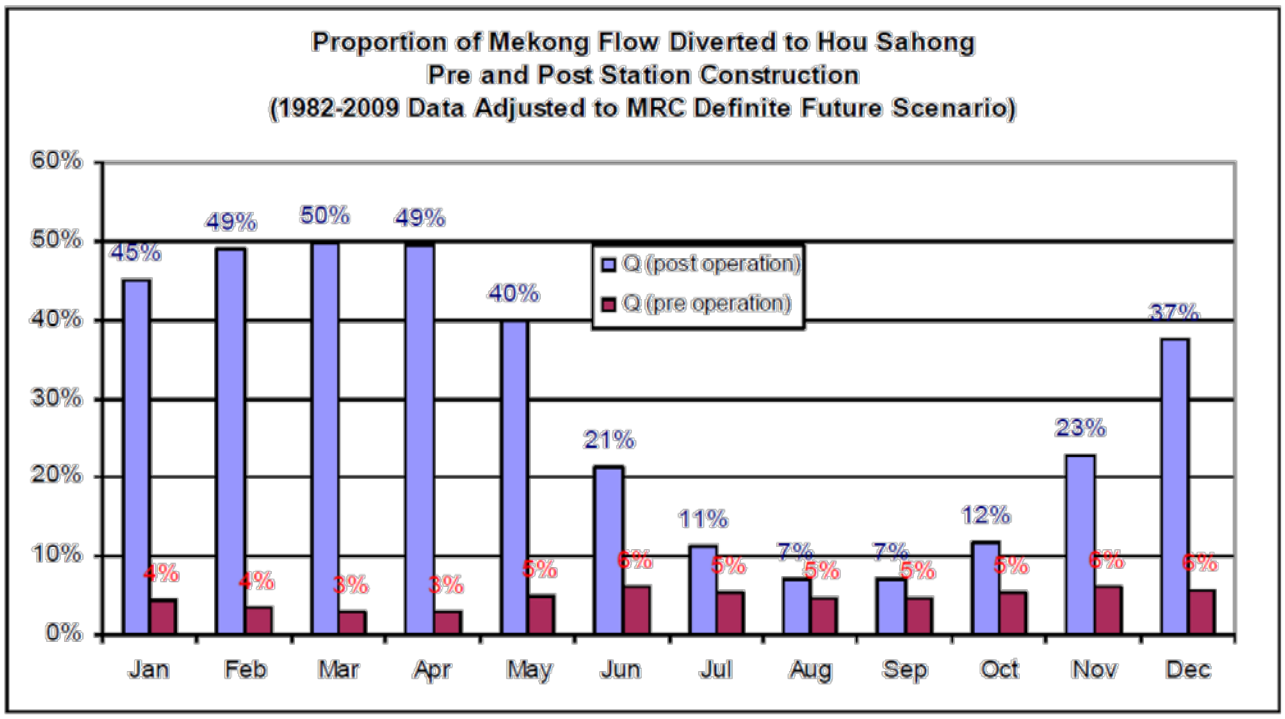
The Mekong mainstream divides into a number of distributary channels at the site of the proposed DSHPP. The DSHPP will be built in one of these channels – the Hou Sahong. However, the expected changes in flow between these channels is considered to be central to understanding the total impacts of the hydropower plant on the Mekong mainstream, and are consequently summarised here.

Prior to the DSHPP the Hou Sahong channel carried some 4% of the total flows in the Mekong mainstream. This will be higher after construction in order to maintain the minimum design flow of 1,600 $m^3/s$. Flows to the west of the Hou Sahong (and DSHPP) are not expected to change throughout the year, but the excavation of the Hou Sahong inlet will divert flows away from the Hou Phapheng. Flows into the Hou Sahong will be higher throughout the year, while those in the Hou Phapheng will be noticeably lower in the dry season.


*Blue lines = no expected changes, pink lines expected changes in flows*




At most, and if the system is operated as designed, some 50% of the flow in the Mekong will be diverted through the Hou Sahong, while a minimum flow of 800$m^3/s$ will be maintained over the Khone Phapheng Falls.




## 3.3 Fisheries and Fish Passage Expert Group

### *3.3.1 Preliminary screening assessment*

The primary impact of the DSHPP on fisheries and fish passage would be the loss of the important Hou Sahong fish migration route. The option proposed by the developer to mitigate this is to re-engineer the Hou Sadam and Hou Xang Pheuak channels to serve as alternative migration routes. While inventive, the information currently available does not yet fully explore the best possible design for this option.

In particular, the following is noted;

- Only the Hou Sahong, Hou Sadam and Hou Xang Pheuak channels were investigated. However, the other channels are also important migratory pathways and could be included in the mitigation proposals.
- Modifications to the channel morphology in the three targeted channels may alter conditions in the other channels. This may affect fisheries and ecosystem functioning. (Estimates of altered flows in the other channels have been made, and it is only proposed to change flows in the Hou Sadam and Khone Phapheng channels).
- The channel morphology is important to allow for fish passage, and so the key morphological components of the Hou Sahong that allow for year round migration must be studied so that they can be mimicked in the other channels. However, this may require diverting some flows away from the blocked Hou Sahong into these other channels.
- There is limited information about fish migration for specific species in the Hou Sahong channel along with the other channels in the Khone Falls area. Additional analyses on the extent to which the other

channels are used for upstream passage, and the times of the year this occurs would enable a better assessment of the total impact of the DSHPP.

- Few independent studies, which have been published by third party authors, on fish ecology or migration are reported. Specific issues include, but are not exclusive to:
  - The data of the project relies on catches from fishers, which is not necessarily a rigorous scientific method of sampling migrating fish.
  - A large fish passage project needs a biological baseline, including the species and sizes of fish: a) approaching the site, b) their behaviour at the site (e.g. division between channels; do they search multiple channels or remain in one), and c) passage through the site, including hydraulic conditions, at different times and flows. It is believed that some data has been collected since 2006 but this is not readily available.
  - Apart from species and weight, which is partly reported, it is important to monitor gonad condition, which would provide an insight into migration and the potential species with larval drift at the site.
  - No methods or experimental design are presented to assess how the data were collected. Similarly, the Fisheries Monitoring and Action Plan (FishMAP) suggests that monitoring of fisher catches will continue "combined with direct sampling of accumulation zones" but provides no detail on how this will be done.
  - No process is suggested for independent review of the monitoring data.

Similarly larval fish surveys which appear to have been done by the developer would need to be reported in full to inform the technical review, specifically:

- Changes in the species of larvae drifting, temporally (seasonal) and spatially (distribution in each of the channels).
- Whether larvae have inflated swim bladders, which is critical to assess impacts on pressure through turbines.
- Position of larvae in the water column to determine the risk of mortality from pressure in turbines.
- Whether larvae with a swim bladder connected to the gut have a functioning opening, which can occur in early life stages, and whether the cyprinid species have larvae with swim bladders that have developed separate chambers, which helps the larvae cope with pressure changes induced by passage through the turbines.
- The details and scope of the larval drift monitoring proposed in FishMAP needs to be specified to determine if the budget is sufficient.
- The budget provided for monitoring of fish survival through turbines may prove inadequate.

### *3.2.2 Hydrological alteration and channel modifications*

The extent to which the Hou Xang Pheuak and Hou Sadam channels can replace the lost fish passage in the Hou Sahong is one of the key factors associated with mitigating the potential impacts of the DSHPP. If the two channels cannot replace the fish passage in Hou Sahong it may reduce the loss of prey species for the dolphin, reduce the impacts on upstream, downstream and local fisheries, and also reduce sediment trapping. The key issues to be considered in this respect are:

- Deepening of the Hou Sahong Channel at the upstream end is proposed by the developer to increase flow to maintain power generation, but this may divert more larvae into this channel.

However, the deepening of the inlets of the neighboring Hou Xang Pheuak and Hou Sadam channels to mitigate the loss of flow may alleviate this impact – but will divert flows away from the hydropower plant. Moreover, the maximum flow diverted through the Hou Sahong at the peak of the dry season would be 50%.

- Modification of Hou Xang Pheuak and Hou Sadam channels at "choke" points is proposed to improve passage of fish, but the effect of this on the hydrological, hydraulic or other morphological features necessary for migration needs further investigation and clarity.
- Other options to improve fish passage in the channels, including increasing discharge by deepening the inlets and channels, or reducing the power output for parts of the day at critical migration periods could be investigated.
- The present hydrological / hydraulic modelling of flows between the channels is not detailed enough to support fish migration studies.
- The studies done to date focus on the 4 eastern most channels, but the effects of bed and bank modifications in these channels on flows in the other channels is not well understood.
- The extent to which the morphology of the modified Hou Sadam and Hou Xang Pheuak would be able to accommodate fish of all sizes needs to be further investigated and / or reported on a basis of fish species with similar migration behaviours and needs (fish guilds[1]).
- No information on entrance designs of the alternative fish pathways in the Hou Sadam and Hou Xang Pheuak is available, and studies of the flows required to attract fish, access to proposed bypass channels and fish behavior are required to fully assess the extent to which fish would use the alternative channels. (At present the alternative channels have a very poor attraction flow compared with Hou Sahong).
- Potential compensation to the villages that have fish traps in the three main affected channels has not been discussed. However, the extent to which these fish traps were legal in the first place needs to be investigated.
- The proposed trap and transport measures for large-sized fishes are not described in detail, to determine if best practices will be applied. However, unless water to water transport is viable, this option is not recommended. In any event it would only be able to transport a limited number of fish.

### *3.3.3 Downstream fish passage*

The evaluation of downstream passage (adults and larvae/juvenile life stages) and the likely impacts on fisheries could be could be enhanced with focused studies including;

- Bulb turbines, rather than Kaplan turbines, have been chosen because of greater power efficiency and lower cost. Bulb turbines may have less mortality due to less pressure change, but specific investigation on the survival of Mekong fish in these turbines would enhance this assessment, particularly if the impacts of the proposed trash rack on trapping of the fish are considered.

[1] Fish Guilds = groups of fish with similar behaviour patterns.

- The impacts of the pressure, shear and blade strike on all sizes of fish passing through the turbines needs to be assessed in order to assess its potential risk for downstream fish passage.
- As death of large fish attracted into the upstream end of Hou Sahong is expected, the option of fish screening should be explored at the outset, and not on an as needed basis.
- Water velocities drop from 1m/s to 0.3 m/s within 2 km of the power station in the Hou Sahong channel, which is may cause larvae and fry to settle out (fall to the bottom). Further investigation is therefore proposed and it is proposed that a mitigation strategy is developed. This is particularly pertinent during the dry season (in March) when up to 50% of the total the flow will be diverted through the Don Sahong channel. This would have to offset against the relative importance of larval drift in that period.

#### *3.3.4 Preliminary prognosis*

The positioning of the DSHPP on one of the distributaries of the Mekong Mainstream offers some interesting opportunities to mitigate impacts on fisheries and fish passage. In any event, the loss of fish passage would only be partial, but possibly substantial.

However, there are options to further minimise this impact. The developers have offered some solutions to replace lost fish passage in the Hou Sahong with other channels. Much of this depends on the extent to which the alternative fish pass channels can replace or mimic the morphology and flow attraction of the Don Sahong channel as it now exists, and the time of the year the different fish species spawn and migrate. At present there is insufficient information to assess whether this is viable, and hence the extent to which the partial loss of fish passage can be mitigated. Nonetheless, the expert team does note that the Hou Sahong offers an ideal passage, and that it would be difficult to replace it's fish passage function entirely.

It is also noted that an alternative hydropower plant in the Hou Phabheng would maintain the critical Hou Sahong migration route.

### 3.4 Socio-Economic Impacts

#### *3.4.1 Project Implementation Area*

The developer has undertaken a socio-economic impact assessment of the Lao project areas. It covers the built-up area of the infrastructure and the wider project area where people live whose livelihood will be affected by the Project's construction and operation. As very little land would be inundated by the head pond, this primarily focusses on the potential loss of fisheries, and the potential increase in tourism for the local area. The developer has proposed an alternative livelihoods programme in this respect. A more rigorous assessment of the potential increases in tourism due to increased access to the area as part of a sub-regional development scheme would also enhance the findings.

The Socio-economic and livelihoods analyses could be enhanced to support the design of alternative livelihoods options. In particular the following issues should be addressed;

- Tourism might have a potential for a new and/or additional income source at minor or major scale for concerning local cash income and a possible alternative livelihood for displaced fishers. Tourism in the Champassak Province has been increasing over the last few years, and improved access to the area may further boost this. However, this assumes that tourism at the Khone Phapheng Falls will increase even if there is less water flowing over the falls for much of the year. This needs a more rigorous analysis with respect to possible changes in tourism to the falls as a result of the changes in flows, and improved access. However, positive spin offs associated with the DSHPP could be explored.
- To bring clarity on the potential social impacts of the project there is a need for a fisheries impact assessment related to the changed fisheries potential which would then be used to identify not only the likelihood and consequence, but also the ease and cost of mitigation.

### *3.4.2 Transboundary aspects*

Some of the topics covered by the different expert groups are or relevance concerning potential transboundary social impacts (TSI). They concern mainly the use of water and fisheries.

- Water resources with focus on their use during the pre-construction, construction and operation phases of the DSHPP Project.
- Concerning water flow, no potential adverse TSIs for water users are expected, as there is:
  - No change in the overall flow between Laos and Cambodia;
  - Minor change between western (increase) and eastern channels (decrease) in the immediate vicinity of the Lao-Cambodia border;
  - A redistribution of flow which concerns channels with the Lao Siphandone Section of the Mekong only.
- Concerning water quality, no potential adverse TSIs for water users are expected, as there is
  - Unlikely a change in water quality during operation phase;
  - Temporary increase of sedimentation during certain periods of the construction phase in dry season, but unlikely to significantly impair the use or the Mekong River. This risk is to be minimized through good construction supervision and environmental management practice.
- Fisheries receive a high attention because of its importance for food and income activities, among many reasons. As the DSHPP Project is located in Laos but adjacent to the Cambodian border fisheries become automatically by nature a transboundary issue. There are potential adverse TSIs, as there will be a:
  - Change on local fish migration by (i) loss of Hou Sahong fish migration route, and (ii) re-engineering Hou Sadam and Hou Xang Pheuak channels as alternative migration routes;
  - Possible change on wider fish migration in the Lower Mekong Basin (LMB) upstream and downstream of the Project site depending on modified local fish migration. In this context is should be noted that insufficient attention has been paid to potential cross border impacts on fisher communities in Cambodia;
  - Risk on socio-economic conditions of fisheries in the LMB, if fish passages are not implemented successfully. This would have different impacts on the different hydro-geographic and social zones of the LMB. Depending on the fisheries impact assessment the transboundary social impact assessment could indicatively quantify the impacts on people and their livelihoods.

In addition to these above listed topics, some other items require also a transboundary attention, mainly because of the location of the DSHPP Project and the features of the Siphandone Area. This concerns mainly tourism and regional planning aspects.

- As the Champassak Province with its Siphandone Area is a well-known, famous and popular destination of Lao citizens but also international travelers, tourism should also be regarded as a transboundary matter. There can be potential adverse and negative TSI on tourist activities, as there will be:
  - No change of the Champassak Province as a major tourist region in Lao PDR;
  - No change of the overall attraction of the Siphandone area;
  - Increased accessibility to and in the Siphandone area through bridge and dam by the DSHPP Project, in addition to the new Mekong bridge to Khone island opened through the Gov. of Laos in Nov. 2014 might lead to more tourists visiting these islands;

  However,

  - The appearance of the Khone Water Falls will change towards a longer "low upstream water level scenario" and, therefore, losing its spectacular attraction at higher flows during some months of the year;
  - The dolphin watching site is located in the downstream vicinity of the dam construction site, and might be impacted through construction related noise and activities, but probably not through noise from turbine operation.
- The DSHPP Project probably requires a regional perspective towards a transboundary approach concerning:
  - Project related social safeguard monitoring;
  - Project related impact and compliance monitoring and evaluation;
  - Project related mitigating planning and implementation;
  - Consultations through project owners with project stakeholders (in addition to others, i.e. MRC);
  - Regional development in the context of the Greater Mekong sub-region as a natural economic area bound together by the Mekong River, where local governments should consider the Project's infrastructure in a sub-regional development scheme;
  - Others.

### *3.4.3 Preliminary prognosis*

The preliminary prognosis refers to aspects related to the Project implementation area and aspects related to potential transboundary impacts. The DSHPP developer includes in the Project's implementation area in Laos both the built-up area of the infrastructure and the wider project area where people live whose livelihood will be affected by the Project's construction and operation.

Concerning the Project implementation area, the potential loss of fisheries on the livelihoods of the local fishers can be balanced by reducing fishing pressure from local communities through the alternative livelihoods programme and sustainable fisheries management practices. The 'DSHPP Fisheries Monitoring Action Plan' (FishMAP) aims to address this through direct mitigation and by developing improved fisheries management systems supported by the introduction of alternative non-fisheries dependent livelihood systems to reduce fishing pressure on the improved alternative channels.

However, the extent to which this is viable or effective, and whether sufficient alternative livelihoods can be identified needs to be investigated. In order to be able to determine if such actions are effective a baseline reference condition should be established, and this should ideally engage fisher communities in the Cambodian border area. A review of existing knowledge of the migratory pathways of the 100 + migratory species of commercial value is recommended to enable a better assessment of the risks on fisher livelihoods both upstream and downstream.

From national and transboundary perspective with regard to fisheries impacts technical and monitoring issues are to be taken into consideration. For example the impacts of the following on the fisheries potential of both the Siphandone area and the LMB need to be addressed:

- What are the risks of a low proportion of fish locating the entrance of the improved Hou Sadam and Hou Xang Pheuak channels?
- What are the risks of not passing a fish guild upstream?
- What are the risks of turbines impacting adult fish? This risk is recognized and the intent of the developer is to monitor and install screens if needed. However, assessment and monitoring methods have no detail, and the costs of the preferred screening solution could be larger that budget provided.
- What are the risks of turbines impacting juvenile fish and larvae, which cannot be screened?

Concerning FishMAP, however, there is a need to cover not only the immediate upstream and downstream Lao impact areas of the Project site to define the compensation measures, but shall also cover the Mekong River further upstream and downstream (transboundary) to at least establish an ideally jointly implemented fisheries baseline. This will be of importance for several purposes including (i) FishMAP planning and implementation, but also (ii) for reacting on international complaints on fisheries to be expected. The latter should be part of a Consultation Plan including national and international grievance procedures, among other topics.

The Transboundary Social Impact Assessment (T-SIA) would aim at using a fisheries impact assessment, which the Fisheries Expert Group would provide, as basis for an assessment of potential impacts mainly on fisheries related livelihood and nutrition. In general, the approach would use selected sources of data and information, including but not limited to (i) MRC in-house general environmental and socio-economic information (socio-economic database), (ii) specific socio-economic information collected through the MRC Social Impact Monitoring and Vulnerability Assessment concerning a corridor of 15 km either side of the Mekong and its dependent islands, (iii) relevant specific fisheries related economic and socio-economic data (MRC, NMCs, national statistic offices, others), and (iv) complementary relevant information and data as required and/or available. In the context of this Technical Review the T-SIA could only provide indicative findings and potential impacts.

Tourism and regional planning should not only focus on the districts of the Champassak Province of Lao PDR, but elaborate in more detail from a transboundary approach. This will require new and/or complementary studies covering both details for specific livelihood restoration measures proposed for the Siphandone islanders affected by the Project, and shall be embedded in the available and/or future regional (GMS-sub-regional) tourism and economic development concepts.

## 3.5 Dolphin Expert Group

### *3.5.1 Summary of possible impacts*

The Irrawaddy dolphin (*Orcaella brevirostris*) sub-population in the Mekong River is classified as critically endangered by the IUCN. This indicates that without adequate protection the sub-population is at high risk of local extinction. The dolphin population historically ranged throughout much of the lower Mekong Basin south of Khone Falls (including Tonle Sap Great Lake and major tributaries such as the Sekong sub-basin). However, the population is now restricted to a 190km river stretch, between Kratie (Cambodia) north to just below Khone Falls on the Laos/Cambodia border.

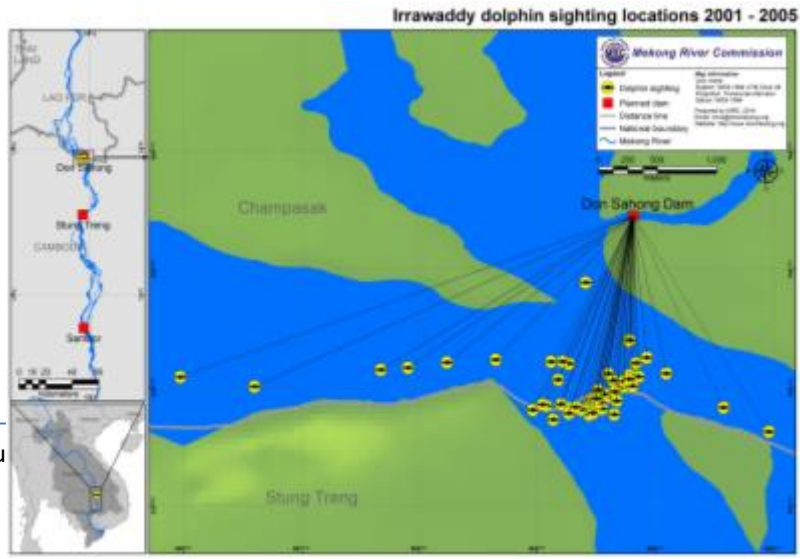
The total population size was estimated as 200 individuals in 1997, but has declined to 85 individuals as of 2011. Accidental entanglement in gillnets, low calf survival and daily harassment by dolphin-watching tour vessels at two locations are noted as the primary causes of population decline. The extent to which Cambodia and Lao PDR recognise their general commitments under Articles 3 and 7 of the 1995 Mekong Agreement in this regard is therefore directly relevant to the survival of the Mekong sub-population, and is to some extent pertinent to the DSHPP prior consultation process. Notably, in 2006 the vice governors of Champassak and Stung Treng provinces agreed to cooperate in Dolphin pool management.

The small population inhabiting the area close to the proposed DSHPP (see the sightings map) is the only dolphin population in Laos. This group of has declined from 20-30 individuals in 1991, to 6 individuals as of 2013. The viability of such a small population is unknown, but it is possible that this small group could form the nucleus of a growing population. The proximity of this local population to the proposed DSHPP, and the small number of individuals, makes this group particularly vulnerable.

The potential threats to this population due to the construction and operation of the DSHPP are;

- excavation and construction impacts primarily due to noise;
- noise related to the operations of the turbines;
- altered local water flow regimes and potential changes in sedimentation;
- increased boat traffic as a result of increased human presence in the area; and
- reduced prey abundance and diversity through degradation and blocking of fish migration pathways.

The threats posed by the proposed project to the wider Mekong dolphin population primarily arise from reduced prey abundance and diversity due to the reduced fish migration in the Hou Sahong. The issue of reduced prey abundance is being dealt with by the fisheries and fish passage team, and this summary focusses primarily on impacts on the local population of six animals due to construction noise and increased boat traffic. The potential loss of this local



population would reduce the Mekong dolphin population by 34%.

Given the proximity of the dolphin pool to the proposed hydropower plant, and the fact that dolphin have been sighted within or close to the area that will be excavated for the tailwater, it is likely that the local population will be affected in some way during construction and excavation. The proximity of the dolphin pool to the site means that construction sound (even on dry land) may be heard well into the dolphin pool in Cambodia. Similarly, during operations, noise from the turbines may be sufficiently alien to the normal noise of the cascade of water to affect the dolphin. While little is known about, or reported in the EIA, on the methods of the eventual decommissioning of the hydropower plant, the potential noise associated with this process is also relevant.

It is known that dolphins have extremely sensitive hearing and a complex sonar system used for foraging, navigating and communicating. The impact of human-made sounds may therefore result in physical and/or behavioural changes for these animals. The nature and degree of any impacts vary with the animal's distance from the source, the propagation qualities of the source, and the levels and characteristics of the sound, and may range from death and physical damage at close range to intense sounds, through to; permanent hearing loss; temporary hearing loss; avoidance of the sound; masking of biologically relevant sounds; and interruption of feeding, breeding, and nursing behaviour.

Few studies have been conducted on the effects of marine mammals and turbines, although one source noted that the impact zone for a 2 MW turbine was small. No studies have yet been conducted on the noise levels emitted from a 260MW dam and the potential impact of marine mammals. Nonetheless, it seems that noise and increased activities in the area during construction is likely to have some impact on the dolphin population, while noise from the turbines during operations may have some effect. The developers' commitment to avoid underwater blasting is therefore welcomed. However, construction noises will also include excavation (even if done behind the coffer dam), potentially pile-driving and general construction noise. To this end, it is recommended that standard procedures adopted internationally for seismic and other sound-based construction activities (such as piling) are adopted. These include precautionary zones, where construction work will not commence if a marine mammal is sighted within the zone. (As an example, for seismic surveys in Australia, standard precaution zones are: Observation zones, 3+km radius from the sound source; Low power zone, 2km radius from the sound source; Shut-down zone, 500m radius from the sound source.) Other international guidelines that may be considered are trained marine mammal observers on-watch, soft-starts, and exclusion zones.

The commitment of the developer to contribute to dolphin conservation efforts is also welcomed. This, if adequately planned and budgeted, could prevent or slow the decline in the Mekong dolphin population.

### *3.5.2 Preliminary prognosis*

The dolphin expert group has offered the following summary;

- The implementation of internationally accepted guidelines for future seismic surveys conducted as part of the design phase of the DSHPP would reduce the impacts on the dolphin population.

- A monitoring plan would be required prior to seismic surveys being undertaken, to outline precaution zones and precautions taken to mitigate impacts to the transboundary dolphin subpopulation.
- Assessments on the frequency, duration, sound pressure levels and propagation of sound from various construction activities need to be made in order to determine the potential impacts to dolphins, and develop appropriate exclusion/precaution zones.
- The EMMP should ideally include provisions for monitoring impacts on the local dolphin population. Preferably, the monitoring strategy should be developed by qualified experts, and peer reviewed.
- The contributions to dolphin conservation efforts are welcomed, but need to be adequately budgeted and aligned with the existing efforts, and planned in consultation with these experts in order to maximise the potential benefits offered.

## 3.6 Hydrology Expert Group

### *3.6.1 Methodology hydrology and hydraulics*

The hydrology at the site was derived from the long term records at Pakse some 100km upstream, as well as several years of on-site measurements. This enabled the calculation of "synthetic" daily discharge time-series at the scheme. These estimates were used to prepare daily flow duration curves at ten sites within the various distributary channels associated with the Project. The selection of Pakse, is sound, since the incremental catchment is less than 2% greater. The hydrology baseline for the Project is 1982 to 2009. This is comparable to the long term record (1923 – 2013).

Computational hydraulic modeling was undertaken to;

1. Understand the natural water levels and flows in the various distributary channels;
2. Determine the effects of channel excavation and hydropower operations on water levels, velocities and flow rates.

The evaluation was based on 15 discrete points on the flow duration curves that were estimated for each of the channels. Two models were used, the 2 dimensional Mike 21 was used for the headwater model, using a 5m x 5m grid. The tailrace model was the 1 dimensional HECRAS model. While the 2D headwater model is considered adequate, further modelling studies are recommended to confirm extent of headwater excavation needed.

### *3.6.2 Overall assessment*

The expert group notes that all of the pertinent hydrological variables relevant to the evaluation of the scheme, its design and operation have been considered, and the "at site" estimation of hydrology from the upstream Pakse MRC PMFM site is described in detail. Similarly, the on-site measurements of flows are more comprehensive than is typical for hydropower schemes. The 28-year baseline series adopted for the hydrological analysis is considered to be of sufficient length to represent the natural variability in Mekong

flows, although additional verification may lend further weight to the assessment.

The long term mean flows at Pakse are compared to those obtained for the baseline, however, the inter-annual and seasonal variance of the hydrological data should be evaluated using an appropriate statistical measure such as the standard deviation or, better still, a non-parametric measure of "data spread" such as the median absolute deviation about the mean. This is important because average discharge values do not provide a sufficient indication of flow reliability and the potential for decreased flows to limit power generation, or for the maintenance of sufficient flows in the alternative fish passage channels.

Currently some 4% of the annual Mekong mainstream flow enters the Hou Sahong. The viability of the DSHPP requires that this is increased substantially. The hydraulic modelling shows that at most some 50% of the flow (in the dry season) will be diverted though the turbines, while some 7% of the wet season flows will be diverted. There are no changes to transboundary flow regimes, and the cross border delivery of flow to Cambodia remains the same in volumetric terms, with no seasonal modification of the flow regime. There may be diurnal changes, but these would be inconsequential given that that the head pond is just 1 $km^3$.

The modelling of the distribution of flows between the channels showed that increased flows in the Hou Sahong channel would lead to a corresponding reduction in the flows in the other channels, particularly the Hou Sadam and Hou Xang Peuak. This issue will be addressed through excavation works to improve the situation for fish passage. The effects of this on flows was simulated by changing through the bathymetry in the model to allow for accurate modelling of flow volumes in the various channels[2]. Nonetheless, the sensitivity of headwater levels to the depth of excavation was found to be greatest when river levels are relatively low and the power station is operating at full discharge capacity. This may make it difficult to assess the extent to which flows can be maintained in the other channels during low flow periods.

As significant contractual penalties will be enforced if insufficient excavation work has been carried out to provide guaranteed water levels at the powerhouse, the Contractor will carry out further model studies during detailed design of the civil works. However, there is a risk that the Contractor would err on the safe side, perhaps to the detriment of flows in the alternative fish passage channels.

### *3.6.3 Preliminary prognosis*

The hydrological components of the documentation provided is done to an adequate level of accuracy and diligence, although a better statistical analysis would provide better assessments of the risks of low flows either reducing the flows through the powerhouse or through the fish passage channels.

The fact that the Contractor will need to undertake further more detailed modelling studies provides an

[2] A finer resolution modelling is required to assess the viability for fish passage,

opportunity to address many of the issues raised in the fisheries and fish passage section above, and hence to optimise the mitigation of any potential impacts.

Nonetheless the following is noted;

- It is doubtful whether the flows in the Hou Phapheng or other channels can be actively managed by changing the head-pond levels through turbine operations.
- This could be addressed through a gated control structure at the entrance to the Hou Sahong, which would have benefits for both fisheries and sediment control.
- The hydropower operator will have economic incentives during dry years to minimize the flows to the Khone Phapheng waterfall and in the alternative channels for fish migration.
- The submerged weir to arrest bed load ingress into the head pond may function in the short term but not in the long term.
- The depth of excavation required to assure the design diversion of 1,600 $m^3/s$ into the Hou Sahong should prescribed and modelled before construction starts.
- The trans-boundary impact studies undertaken thus far, based on 1D modeling, should be viewed as exploratory and the conclusions preliminary.

## 3.7 Water Quality and Ecosystems Expert Group

### *3.7.1 Water quality*

Given the small storage and run-of-river nature of the DSHPP no significant water quality problems are expected during the normal operation of the scheme.

However there may be some impacts during construction, mostly related to:

- Increased sediment in the water due to excavation in the river bed[3], earth moving e.g. construction of coffer dams and preparation of embankments etc.
- Increased organic pollution from worker camps, canteens etc.
- Accidental spillage of construction materials, including washing of concrete
- Accidental spillage of oils and grease, releases from vehicle and plant maintenance

These impacts can largely be managed through good construction practice, treatment of waste waters, and storage of construction materials and chemicals, including fuel and oils, in appropriate compounds that contain accidental spillages. These measures are all provided for in the relevant documentation provided.

There may be occasional incidents of impaired water quality passing downstream into Cambodia, most

[3] It is noted that excavation is mostly planned to occur behind the coffer dam, thus limiting the introduction of sediments to the water.

likely due to increased sediment loads. This may have a greater impact during the low flow seasons when the water is clearer, but are unlikely to significantly impair the use or enjoyment of the Mekong River in Cambodia. Spillages and accidents and malfunction of waste water treatment plants may also occur, and may have a temporary impact upon the water quality downstream in the Stung Treng Ramsar site. The MRC Human Impact Water Index for Stung Treng indicates that the water quality has been impacted by human activity, but not severely so[4]. The construction activities in Don Sahong are unlikely to change that rating, though the scores may decrease within that range.

It is probable that, with the measures that will be put in place for managing water pollution during construction, and the nature of the reservoir and its residence time during operation the DSHPP will be able to comply with the PDG guidance on water quality.

### *3.7.2 Impacts on aquatic habitats*

The documentation provided includes considerable information on the flows and some on the changes to the morphology in the Hou Sahong, the Hou Sadam and Hou Xang Peuak channels or around the Khone Phapheng Falls. However, this only relates to the impacts on fish passage and no information is provided about the riverine habitats, aquatic plants and other fauna. Generally, it is assumed that all the channels have equally important or unimportant riverine habitats, but this is obviously not the case, as illustrated by the importance of sand bars that are exposed in the low flow season in some channels, and used for bird and turtle nesting.

It would, therefore, be useful to have a morphological and habitat comparison of the different channels to assess the significance of the loss of habitat in Hou Sahong, and whether the Hou Sadam and Hou Xeng Peuak channels provide some of these habitats. Similarly, the potential impacts of changes in flows in the Khone Phapheng and other channels could be assessed.

Terrestrial habitats are covered, and the EIA suggests that the area of "island, rock and water" in the Hou Sahong channel and affected downstream areas totals 92.6 ha. However, there is no analysis of these aquatic habitats or an assessment of their ecological significance. The proposed mitigation measures are standard precautionary measures (for management of land affected by construction), which are likely to be effective provided that:

- Contractors follow best practice soil erosion and disposal management measures during construction
- Compliance monitoring of both the DSHPP and its contractors is effective
- Water quality monitoring specified in the EMMP is carried out, and incidents of failure to comply with water quality standards are investigated and remedial measures followed up if necessary

[4] An explanation of the scoring system and impact ranges is available at: http://portal.mrcmekong.org/cms/water-quality-monitoring-map

- Adequate emergency response measures are in place with staff trained to respond. All accidents involving spillage and water pollution are investigated and remedial measures put in place.

### *3.7.3 Flow modification and the impact on the Khone Falls*

The natural flows down the Hou Sahong have an annual average of 510 $m^3$/sec, with high flows of about 1,500 $m^3$/sec and low flows of under 50 $m^3$/sec. The economic viability of the DSHPP requires an increase in flows entering the Hou Sahong channel to maintain a design flow of 1,600 $m^3$/sec. This is to be achieved using excavations and channel modifications as described in the previous sections. However, this will have impacts on the flows in the other channels. The following paragraphs summarise those changes;

- In an average year, the flows down the Hou Sahong will be significantly increased in the dry season, with flows only falling below 1,500 $m^3$/sec between February and May, whilst in the Khone Phapheng and Hou Sadam (combined) the flows are maintained below 1,000 $m^3$/sec from December through to May, and only when the high flows start in the wet season (June to November) do the flows over the Falls increase, though always below the pre-DSHPP levels.
- The flows over the Falls are maintained below 1,000 $m^3$/sec for November through to June, and the wet season flows are reduced from over 3,000 $m^3$/sec in August and September to under 2,000 $m^3$/sec in a dry year.
- In a wet year, flows in the Hou Sahong are maintained above 1,500 $m^3$/sec throughout the year, while the flows over the Falls are lower than 1,000 $m^3$/sec for February, March and April. In the wet season of a wet year there is little difference in the flows with or without the DSHPP.

It is difficult to accurately assess the impacts of this on the tourism amenity value at the Khone Phapheng Falls. While tourism associated with other large Water Fall attractions has been shown to increase at higher flows, this is primarily a function of tourists timing their visits to coincide with high flows, rather than staying away during low flows. Conversely, improved access to the area because of the DSHPP could increase tourism, while the project could also include the construction of viewing areas and other amenities.

### *3.7.4 Preliminary prognosis*

The water quality and ecosystems expert group concludes that;

- The water quality issues during the construction period can be largely managed through good practice and attention to compliance and enforcement of construction.
- However, emergency measures and plans are necessary to deal with accidental spillages, with staff trained to manage such events.
- There may be periods such as construction of the coffer dams and when working in the Hou Sadam and Hou Xang Pheuak channels, when sediment will be temporarily released, and considerations need to be given to managing erosion and high sediment releases into the river.
- The short residence time in the DSHPP means that poor quality water is unlikely to cause problems downstream, while the removal of vegetation from the reservoir area will further reduce this problem.

- The operation of the DSHPP is therefore unlikely to change the water quality of the Mekong mainstream substantially.
- However, better descriptions of the aquatic habitats within the overall area, including the morphology of the channels likely to be affected, habitats and their ecological significance will allow for better assessments of the possible impacts of the DSHPP.
- Areas of uncertainty exist in terms of the temporary increase in flows through the other channels during the construction period in the Hou Sahong.
- In order to determine such impacts integrated monitoring of water quality, flows and habitats and ecosystem health is recommended to be included in the EMMP.
- The transboundary flow regime in the immediate vicinity of the Lao-Cambodia border shows moderate to minor changes in flow, with a slight increase in the western channels, especially the Chheuteal Pool, and a corresponding decrease in flows in the eastern channels.
- This modelling will have to be verified through hydrological and water level monitoring and the ecological impacts upon the habitats in these southern channels also monitored regularly.

## 3.8 Sediment and morphology

### *3.8.1 Potential impacts*

The impacts of sedimentation on the DSHPP are primarily related to the fourfold increase in sediment discharge through the Hou Sahong, as a result of the increased flows. This will increase the rate of sedimentation, and preliminary calculations suggest that the head pond may fill with sediment within six years. This could reduce the flows through the turbines from 1,600 $m^3/s$ to less than 340 $m^3/s$. The developer has nonetheless suggested that a sediment inflow / outflow equilibrium would be quickly established. Nonetheless, sedimentation of the excavated inlet to the Hou Sahong is likely to have some effects.

This will require continual reservoir sediment management, either through flushing or dredging. This would affect downstream sediment concentrations. There is limited land available for disposal on land, and disposal to the river would result in occasional sediment and turbidity pulses. This may affect the dolphin pool and dolphin behavior. However, these impacts would be limited to the immediate downstream area, and there would be very little cumulative impact on the Mekong Delta or Cambodia.

### *3.8.2 Preliminary prognosis*

It will be important to develop an effective headpond sedimentation management approach. This should include sediment disposal mechanisms, either on land or to the river. In the latter case the impacts on sedimentation in and turbidity in the Dolphin Pool should be considered.

Similarly, the sedimentation management approach should pay particular cognizance of the need to maintain design flows. While the proposed 'skimming wall' has been proposed, a gated inlet structure could be considered, as outlined elsewhere.

## 3.9 Dam Safety

### *3.9.1 Assessment*

While the volume of the head pond is small, the proximity to the Cambodian border makes dam safety a concern. However, in this regard the analysis of peak flood flows is adequate, and sufficiently rigorous. Hydraulic modelling of the headwater and tailrace systems is considered adequate for the purposes of designing and operating the hydropower plant. The Dam Safety issues are covered are generally in compliance with the PDG.

## 3.10 Navigation

### *3.10.1 Assessment*

The configuration of the Mekong Mainstream in the Don Sahong area forms a natural barrier to navigation, and the DSHPP will not change the freedom of navigation. The matter is therefore not addressed in the developer's reports or in this assessment.

It is noted that there are long term plans to develop a series of navigation locks around the area.

## 4. Preliminary Conclusions

While the analysis of the documentation provided to support prior consultation on the DSHPP is an ongoing process, certain general conclusions are emerging.

It seems unlikely that the construction, operation and decommissioning of the DSHPP will have no impacts on the Mekong mainstream. Generally these impacts are associated with;

- The effect of noise especially during construction, and to a lesser extent operations of the hydropower plant on the local resident dolphin population.
- The extent to which the modified (flow and morphology) Hou Sadam and Hou Xang Pheuk channels compensate for the lost fish passage in the Hou Sahong. This may affect local, upstream and downstream fisheries as well as the availability of prey for the dolphin population.
- The loss of important (and locally unique) aquatic habitat in the channels that will be affected by increased or decreased flows.
- The reduced flow over the Khone Phapheng Falls, particularly in the dry season and the possible loss of tourism amenity value. Conversely, the potential for increased tourism due to improved access to the area.
- The extent to which flows in the other channels can be regulated by turbine operations.

These impacts are limited by the fact that the DSHPP is on only one of several distributaries. While the flow regimes in the other distributary channels will change, they will serve to pass sediments and fish, particularly in the wet season. While the Hou Sahong has served as a vital dry season fish migration route, this may be to some extent replaced by measures taken in the other channels. The fisheries Expert Group is working on a number of specific recommendations in this regard.

The impacts of the DSHPP on the Mekong mainstream and the other Member Countries may therefore be described as partial, but potentially significant. The exact extent of the impacts can only be fully assessed with more information. The broad consensus of opinion from the Expert Groups is consequently that more information is required to optimise the design of mitigating options, and to more accurately determine the extent of (or to exclude) any other possible impacts.

The Expert Groups are currently investigating in more detail the studies that could be initiated to address this need. Ongoing work with the Expert Groups will be aimed at better defining these proposed studies.