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SUMMARY OF SCIENTIFIC REVIEWS FROM THREE INTERNATIONAL FISH PASSAGE EXPERTS ON THE DON SAHONG DAM EIA AND TECHNICAL REPORTS RELATED TO PROJECT DESIGN AND MITIGATION MEASURES

SUMMARY

The Environmental Impact Assessment (EIA) documents lack sufficient information to fully assess the potential impacts of the Don Sahong Dam on Mekong River fish runs. Because of this, and without further empirical evidence, the proponents' conclusions in the EIA that the project's "mitigation measures... recommended... will minimise the impact of this closure by enhancing migration pathways in two adjacent channels that will replicate the conditions in the Hou Sahong in both low and high flow seasons, so that the residual impact on upstream and downstream migrations will not be significant" are not credible.

A baseline is not presented for the fish communities or migration rates in order to properly address the impacts on the fish communities and allow the monitoring after the beginning of the interventions on the river. The requisite baseline should include information on the species' distribution in relation to the hydropower-plant, preferential habitats (pools or rapids), reproductive behaviour (migratory or not), and other relevant information. These baselines should include not only the most important species for fisheries, but also the small sized ones, especially those potentially endemic from the rapids areas.

The EIA's conclusion of no significant effects rests largely on a program designed to monitor fish fauna conditions and if they are found not to meet passage criteria, the proponents indicate that they will modify conditions to achieve desired goals. This strategy has the possibility of seriously impacting stocks and is largely "faith based". There is no evidence that their proposals to improve passage in adjacent channels will work to anywhere near the extent necessary to pass large volumes and variety of life-forms of fish, or that they could easily develop effective passage systems as presently envisioned.

Considering the technical features of the hydropower dam, and the magnitude of the local fish migration, it would be expected that fish are frequently killed.

It seems unlikely that the Don Sahong Dam will meet the MRC requirement in Article 61 of the MRC Preliminary Design Guide (Aug. 2009), which states, "that the developer should provide effective fish passage upstream and downstream. Effective fish passage is usually defined as providing safe passage for 95% of the target species under all flow conditions". While the proposed passage systems may attain this level for some stocks of fish and some life stages of fish, it appears unlikely that it would attain this for all stocks of fish and which species must be targeted for passage is not yet clear.

The EIA and associated documents consists of at best sloppy and incomplete research, and fails to address a large number of potential and probable effects on fisheries. The mitigation

measures are unproven and unlikely to offset the dam. The monitoring plans are vague and misdirected, with baselines to be established during and after-the-fact, and are unlikely to provide timely warning of problems. In the event that the proposed mitigation measures do not work, there is no alternative plan or failsafe. Overall, if in the likely event the passage systems proposed for the Don Sahong Dam fail, permanent harm to some Mekong River fish populations and the millions of livelihoods they support will likely occur.

GENERAL ISSUES WITH THE ENVIRONMENTAL IMPACT ASSESSMENT AND FISH

- Vagueness of the monitoring plan: specifically lack of information about amount of effort, frequency, and timing of monitoring. With such non-specific plans it is impossible to judge or justify the efficacy of the monitoring to inform mitigation measures, or to detect changes in fish passage rates or abundances
- Faith-based nature of the mitigation measures
- Unrealism of some expectations. For example; ability to control fish trap removal, ongoing catch and transport of rare enormous fish (it must also be noted that larger individual fish produce exponentially more larvae than smaller individuals; as larger fish may be heavily impacted this could have a disproportionately large effect on fish recruitment)
- Generally poor research methodology: lack of reference to many relevant studies, factual errors etc.
    - Lack of geographic knowledge and specific ecosystem services
    - Community and stakeholder engagement gaps
    - No disaggregated fisheries data. Only amalgamated fisheries data has been collected, which has very limited value.
    - The EIA does not indicate who would be responsible if plans to sustain fish populations don't function as expected indicating that the project holders do not plan to take any financial responsibility for the impacts of the dam.
- Description of which species to be included under MRC 95% passage rate target
- Mekong River capture fisheries is valued at US$1.4 billion–US$3.9 billion per year. Even in the unlikely event that a maximum 5% fish passage reduction is maintained; this will still amount significant annual losses to the Mekong economies that currently benefit from rich fisheries resources.
    - There is no mention of providing compensation to neighbouring countries, even though the fish that would be impacted are clearly a trans-national resource where communities and economies in Thailand, Cambodia and Vietnam would be impacted.
- Extremely poor site selection. The site of the Don Sahong is the worst location possible for fish and fisheries impacts in the Khone Falls area given how important the Hou Sahong channel is for fish migrations, even though in the main Don Sahong Dam EIA report (pg. 1-9), the authors reference the World Bank's acknowledgement that good site selection as the key for reducing impacts.

SPECIFIC INFORMATION RELATED TO UPSTREAM MIGRANTS

Background

The ability to design effective conditions and facilities that fish will use to pass obstructions in rivers successfully requires taking into account the general behaviour of migrant fish (both upstream and downstream migrants) in flowing water (e.g. Goodwin et al., 2007; Goodwin et al., 2006; Katopodis and Williams, 2012; Williams et al., 2012). Upstream migrants tend to use water velocity as cues to determining route selection. When encountering variable velocity conditions (two sources of water coming together at one

point), they tend to favour the route with higher velocity. Thus, when considering design for passage facilities associated with obstructions in rivers, designers need to provide two critical flow conditions: 1) a velocity of water higher than the ambient water velocity, and 2) a sufficient volume of water with the higher velocity that projects into the main body of water far enough to attract the migrant fish.

Present Mekong River conditions

Based on Table 4-10 (Engineering Status Report 2011), discharge through Hou Sahong and Hou XangPeuk between the minimum and 20% flow levels are quite similar, and somewhat higher in the later between the 30 and 50% flow levels. Flows in Hou Sadam are considerably lower at all levels. Based on Map 1 (EIA Final – Annex C), it appears that where they meet the width of the Hou Sahong is approximately 25% of that of the Hou XangPeuk. Thus, the water velocity through Hou Sahong would be approximately 4-times higher than through Hou XangPeuk. The Hou Sadam is so small that regardless of water velocities through it (undeterminable from the reports), in low flows it likely has little attraction ability compared to the main river. Thus, it is not surprising that the Hou Sahong is by far the most important for fish passage.

Mekong River conditions with proposed Don Sahong Dam

Based on Table 4-14 (Engineering Status Report 2011), discharge through Hou Sahong after construction of the dam will increase about 10-fold under all flow conditions between the minimum and 50% level, while the flow through Hou XangPeuk and Hou Sadam will remain the same as under pre-project conditions after modifications to the upstream and/or downstream ends of the channels. The Don Sahong Dam will have 2 effects on water velocity: 1) the increased flow through Hou Sahong will substantially increase water velocity downstream of the project in low flow conditions, and 2) because of the head of the dam (~13-20m under varying flow conditions), the water velocity in the vicinity of the tailrace of the dam will be even higher than in the main river downstream of it. Combined, this will result in water velocity cues that will attract upstream migrants to the base of Don Sahong Dam. While the Engineering Status Report 2011 (Figure 4-49) indicates that changes in flows downstream of the Hou Sahong/Hou XangPeuk convergence will be minor, Figure 4-53 indicates that with Don Sahong Dam operation compared to natural conditions, the flow increases 100-200% over flows in the lower one-half of the flow range (from minimum to 50% of the Pakse excedent flow). While the increased flow will somewhat increase the water height, it will also increase the water velocity (with unknown effects on timing of upstream migrants).

Potential problems for upstream fish passage

The most glaring issue is that the authors claim that since the Hou XangPeuk is similar in size to Hou Sahong, it can be modified to provide fish passage similar to what now passes through Hou Sahong (EIA Final Annex C). What is not identified is that the horizontal width of Hou XangPeuk is considerably greater than Hou Sahong (up to 4 times wider in many places), thus the depth and velocity profiles of water passing through the 2 channels are not the same under equivalent flow levels. Yet, no empirical evidence exists to substantiate the claim that fish will pass through both channels with equal success. The Annex contains Table 2 (A), (B), and (C) with some responses to previous concerns about upstream fish passage.

1. A successful bypass should attract and pass 95% of migrants (Baumgartner et al., 2012). The author's response only indicates that the bypass will attract fish away from the tailrace of Don Sahong Dam (No. 14, Table 2 (A) EIA Final, Annex C) but provide no evidence that they will provide the velocity and depth profiles in the bypass channels to attract and pass 95% of the upstream migrant fish. This is speculative and not compliant to Article 61 of the MRC Preliminary Design Guide (Aug. 2009).

2. Proponents are entirely speculative that they can meet target goals by modifying channels slightly even though they recognize that passage through the proposed channels presently is not good (No. 15, Table 2 (A) EIA Final, Annex C). This level of uncertainty in project design is not acceptable.

3. Improving fish passage conditions is not mitigation. One could double passage rates from 25 to 50% (100% improvement) and it would still represent a huge failure to meet passage goals (No. 17, Table 2 (A) EIA Final, Annex C)

4. The EIA authors state that "the alternative channel is adjacent, and its attraction flow will be improved this should not be an issue" since modifications to the channels will change attraction flows (No. 61, Table 2 (A), Annex C). This avoids the issue of attraction to, and subsequent passage up, the channels, which needs to be specifically measured and compared to passage success rates that presently occur through Hou Sahong. While fish bypasses at river obstructions, whether technical or nature-like, have generally substantially lower flow volumes than in the river at the obstruction, successful ones have entrances sited close to the obstruction and with sufficient velocity (and flow) to attract fish away from the main body of water. The alternative bypass channels (Hou XangPeuk and Hou Sadam) will not have entrances next to the Don Sahong Dam. This is not a trivial issue that one can easily ignore.

   The proponents need to outline what specific changes to the bypass channels are feasible in order to make them attractive to fish. For instance, how they will modify the channels (with modifications that will withstand all flood conditions) that will increase water velocities enough to attract fish away from the velocities created in downstream reaches of Hou Sahong by the Don Sahong Dam?

5. The Don Sahong Dam may alter long-term fish abundance. (No.1, Table 2 (B) EIA Final, Annex C). Without effective passage routes, this dam operates as essentially a bank-to-bank mainstream dam through much of the low-flow season. If bypass channels cannot attract and pass 95% of the fish successfully, and do so without changing the migratory timing of fish compared to the migration timing in an undammed river, then the Don Sahong Dam may alter long-term fish abundance.

6. The authors propose a 'trap-and-transport' system (No.3, Table 2 (B) EIA Final, Annex C). However, if large fish do not effectively pass through bypass channels or are not effectively trapped, carefully handled, and transported to a release site above the dam, substantial impacts to species populations may occur before monitoring can determine the extent of changes or alternative passage means are found. In essence, monitoring is not mitigation.

7. Success is dependent on trap efficiency and the means to successfully remove, handle, and transport large fish to release sites above the dam. It is not clear that this issue was adequately considered (No.60, Table 2 (C) EIA Final, Annex C). It is also not clear how such a labour-intense system of fish passage would be maintained for the life of the dam.

   Information on such measures for tropical regions are restricted to the Santa Clara power plant, Mucuri River, Brazil (Pompeu & Martinez, 2006). In this mechanism, mortality rates along the transportation route is a key factor. In the case of the Santa Clara, although the mortality rate for the group of passed species was kept extremely low, marine species, and Siluriforms and larger sized individuals were particularly more sensitive (Pompeu & Martinez, 2007).

8. The authors presume that fish will use bypass channels (No.64, Table 2 (C) EIA Final, Annex C). This should be empirically proven before construction of the Don Sahong

Dam. If assumptions about the ability to attain high passage are correct, then after modifications to the channel, it should pass more than 95% of the upstream migrants presently in the system. And the modifications to the channel need to have attraction flows and velocities that will work once the increased flow and velocity occurs after construction of the dam.

9. The authors do not adequately address the velocity component of the flow that will occur after modifications (No.73, Table 2 (C) EIA Final, Annex C). Here, the proponents for the first time appear to admit that the Don Sahong dam will likely attract fish, and that this attraction may cause migratory delay. For example, Salmonids in other river systems sometimes delay for weeks when attraction flows/velocities from dams override those from bypass systems (Rivinoja et al., 2001; Thorstad et al., 2003). Delays of similar duration here could substantially affect migratory timing as flood flows increased and/or change times and places of spawning that would be less than optimal.

10. The suggestion that electric fences could potentially keep fish from the area seems not well thought out (No.73, Table 2 (C) EIA Final, Annex C). Differences in amperage, amplitude, and frequency of electrical currents in water are needed to guide, attract or repel fish of different sizes. What works for fish of one size is likely lethal to others, or will not work at all (e.g., Snyder 2003).

11. In reference to No.75, Table 2 (C) EIA Final, Annex C, no information is readily available on how the tailrace area of the dam can be modified, either through flow manipulation, construction of exclusion barriers, or other means to alter migration timing if fish are attracted to the area and are delayed. Delay of fish here could have considerable negative consequences to fish if it substantially alters migration timing.

12. In reference to No.81, Table 2 (C) EIA Final, Annex C, definition of 'very large fish' is needed. What constitutes a 'very large fish? How would they arrive upstream at traps if an electric barrier were in place?

13. No.84, Table 2 (C) EIA Final, Annex C, states that entrance slot velocities are not applicable. This is not true. Suitable entrance velocities to the bypass channels are critical to attract fish into the channels from the main river.

14. It is not clear from this figure whether the higher catch (in kg) of fish from the Hou Sahong channel results from catching more fish, larger fish, or a combination of both (EIA Final, Fig.6). If it represents larger fish, then this suggests problems with attracting larger fish to the bypass channels may occur.

15. Page 37 of the main EIA report claims that it plans to monitor the channels during construction and after operations begin from the Don Sahong Dam. If successful fish passage does not occur (target 95% of migratory fish), then it is proposes to modify the channels to improve migration. However, this monitoring scheme after the fact places fish stocks at potentially serious risk if problems are not identified immediately and solutions not found and implemented immediately.

16. On page 37-1, map 1 in the main EIA report appears to show that Hou XangPeuk is considerably wider than Hou Sahong. Thus, with similar flows, the former would have much shallower water than the latter. This may affect the success of passage in the channel. Further, it is not the width of the channel that attracts fish, but the flow and velocity characteristics. Authors of the report recognize that the powerhouse will likely attract most fish.

17. Page 38-3 of the main EIA report fails to define 'improved passage'. Will passage improvements increase enough to meet the 95% success target?

18. On page 38-4 and in section 5.5 of the main EIA report, the control rock wall needs more detail. Will this wall have sufficient bulk and strength to withstand years of peak flood flows? What velocity of water will it create entering the river and how will this compare to the velocity of water exiting the Hou Sahong? What delays in fish passage might occur? This is an area of particular concern. Modification to this area should occur before the DSHPP is constructed to determine if increased attraction velocities and flow alignment/configuration exiting from Hou XangPeuk will successfully attract and pass 95% of migrant fish. It is important that the configuration of the mouth of the Hou XangPeuk channel where it meets the water from Hou Sahong does not do so perpendicularly. If it does, it will unlikely attract fish away from the main river regardless of the velocity and flow it contains.

19. In reference to page 38-6 of the main EIA report. Again, velocity of the flow exiting Hou Sadam is critical to success, not just the volume of water. What velocity of water will exit the channel and how does this compare to the velocity of water in the main river?

20. In reference to page 38-7 of the main EIA report. If alternative migration pathways do not work as hoped and passage success is much less than 95%, what will happen to fish populations while efforts are expended to solve the problems?

21. Page 38-8 and section 5.5 of the main EIA report indicates that a trap and transport system will be used for large fish. This presents more concerns in project design.

    How effective are large fish traps? Can they exist in high velocity water that will occur below the dam? If not and they are moved downstream to an area where velocities are not as high, will they intercept fish? If traps are not effective, what are the contingencies for collecting large fish attracted to the base of the dam? Has consideration been made to putting in a junction pool at the base of the dam (as found in conventional technical fish ladders) with sufficient flow and velocity to attract fish and provide a place to capture them? Or a fish lift? It is simple to state, "we will collect fish and transport them to above the dam", but it would help to see the details of exactly how this will occur to ensure handling and transportation does not impair survivability. [As an aside, trap and haul was what was offered in 1945 when a dam was completed on the Kemi River in Finland to move salmon above it after their passage was blocked by construction. The annual run of 200,000 fish in the river went extinct within a decade because the way of capturing the fish and moving them above the dam was with a dipnet. Fish did not survive. That is not proposed here, but the details are also not sufficient to judge how capture and haul might impair fish viability.]

22. In reference to page 55 of the main EIA report (PC11/12) - In addition to monitoring during the wet season, it seems important to monitor passage during the dry season when any migratory fish will have the most difficult time passing and when the Hou Sahong is at its most important for fish migration. Figure 1 indicates that the dry season is the peak passage time for some fish species.

23. In reference to section 7.3 (O1) of the main EIA report - How will information gained from monitoring fish passage determine if 95% passage rate success is attained?

24. The first item in the monitoring plan is to "develop ... a regular program for monitoring of fisheries", Environmental Monitoring and Management Plan (EMMP) Annex A, p. 30.

Monitoring focuses mostly on catches in villages and landings in markets, with a small budget for direct sampling of fish. Net fish catches do not directly represent the passage rates or abundances of fishes and larvae, and catch-per-unit-effort methods are notoriously unreliable indicators of abundance. The focus of these monitoring methods is several steps removed from actual passage rates and population abundances, and will therefore be slow to indicate changes due to the dam construction. This time lag between monitoring foci and impact will make it even more difficult to mitigate any effect of the dam. This concern applies equally to downstream migrants as upstream.

25. The zone of interconnectivity between the lower and middle Mekong, where the hydropower is located, have substantial waterfalls or rapid sections forming barriers to fish movement. This system of falls is a zoogeographic barrier for many fish species.

    The Don Sahong Hydropower Project, especially due to the proposed interventions on the lateral rivers channels to improve upstream passage, has a great potential to change the role of the local area as a biogeography barrier, and the invasion of some species previously limited by the natural barrier should be raised as a feasible impact of the project.

SPECIFIC INFORMATION RELATED TO DOWNSTREAM MIGRANTS

Background

Similar to upstream migrants, downstream migrants also utilize water flow and water velocity to determine migration pathways (Coutant and Whitney, 2000; Haefner and Bowen, 2002; Irvine, 1986; Kemp et al., 2003; Stalnaker et al., 1996; Calles et al., 2010; Piper et al., 2013; Russon et al., 2010; Travade, 2005; Williams et al., 2012). Much less is known about the behaviour of downstream migrants when encountering river obstructions, although much recent research has been directed at trying to determine better means of intercepting and/or guiding downstream migrants away from deleterious passage routes. In general, it appears that downstream migrants tend to move in areas with higher velocity water.

Present Mekong River conditions

No dams exist on the lower or middle mainstream Mekong River. For the Don Sahong Dam, so-called 'fish-friendly' bulb turbines are proposed and if target passage survival through the turbines is not met, a screening system is proposed for the upstream end of the channel to divert fish to another channel or passage route to avoid turbine passage. Without detailed information available, it is not clear if the distribution of downstream "migrants" (eggs, larvae, juvenile fish, and adult fish after spawning) will distribute randomly within the total downstream flow, and thus pass through Hou Sahong similar to the proportion of the flow passing into Hou Sahong. This lack of information is acknowledged when viewing results in Table 6 in the EIA – Annex C. However, Table 6 stands out as indicating a fairly high survival rate from turbine passage even though the text following the table provides a lot of caveats about what was not tested and how this knowledge of additional factors could change the results.

Further, it seems most plausible that not all species will incur turbine mortality at the same rate (as different species have different sizes, and the same sizes of different species will respond differently to being flushed through turbines). Given the absence of more complete analyses of potential affects from turbine passage, the Conclusion on page 31 "However the important conclusion of the above analysis is that the results indicate a reasonable

likelihood that the Don Sahong Dam turbine facility is capable of safely passing downstream migrating fish to a level that would meet the target fish survival criteria for a wide range of fish sizes, possibly without the need for exclusion screening upstream"[bolded text in report] is misleading, at best. It is scientifically and ethically not defensible to make such a strong, certain statement.

Potential problems for downstream fish passage

The EIA Final - Annex C contains Table 2 (A), (B), and (C) with some responses to previous concerns about downstream fish passage, particularly related to turbines at the Don Sahong Dam.

1. No.62, Table 2 (A), EIA Final, Annex C - Mortality to migrant fish passing through turbines includes more than just blade strike: it is also caused by shear stresses and cavitation — the formation and disappearance of vapour pockets in water due to pressure changes — in the turbine structure and disorientation upon exit, as recognised in the engineering status report (2011). This rapid decompression can lead to barotrauma injury and death.

   While shear exists in only a small percentage of a turbine scroll case (1-2%), fish passing through turbines suffer mortality from shear, and it is not clear to what extent (Cada et al., 2006). They may also suffer mortality due to disorientation when exiting the turbines that makes them susceptible to increased predation (Ferguson et al., 2008). These two latter factors were not assessed in determining survival probabilities. Further, the size of migrants varies by species. Since smaller fish generally have lower probability of blade strike than larger fish, they also will have lower mortality resulting from blade strike than larger fish. Thus, species of fish with generally larger migrants will likely have lower survival than species with smaller migrants. Averaging survival of all fish over all species may make it appear survival targets are met (although in the reports survival only linked to blade strike). But, additional estimates are needed to account for shear and disorientation losses – even if small. For some species, turbine passage will likely lead to much lower survival than target levels as defined by the MRC "...effective fish passage is usually defined as providing safe passage for 95% of the target species under all flow conditions".

2. The so-called "fish friendly" low-head bulb turbines discussed in the EIA (pg. 37, Annex C) are unproven in the Mekong, as acknowledged in the EIA. Studies have only been completed in North America (pg. 31, Annex C). Therefore, it is uncertain how effective they might be in the Mekong. This is a very risky proposition.

3. No.2, Table 2 (B), EIA Final, Annex C needs to take into account mortality due to shear and disorientation from passing through turbines. Please refer to previous comments in point 1.

4. There are similar concerns about larvae being damaged after passing through the turbines. The impacts are uncertain due to a lack of studies (see pg. 32, Annex C). The MRC apparently claims that not more than 30% of larvae should be lost when passing through the turbines (pg. 41, Annex C). But a 30% loss would still be quite a heavy impact.

5. No.61, Table 2 (C), EIA Final, Annex C please refer to previous comments in point 1.

6. No.80, Table 2 (C), EIA Final, Annex C. Unlikely to meet a 95% passage success rate for all species of fish, particularly those with larger migrants.

7. Page 31 of the final EIA, Annex C – Blade strike modelling by Deng (2005). Fish do not move through turbines as inanimate objects, but actively swim (Coutant and

Whitney, 2000). Scale models using plastic beads or dye do not predict where fish will travel when passing into turbines. For example, fish behaviour of salmon smolts entering turbine intakes at Bonneville Dam, Columbia River, dye traces were observed in a turbine intake model to develop a configuration for a large screen which could be placed into a turbine intake and intercept juveniles passing into the turbines. Based on the modelling results, a configuration was selected where nearly 100% of the dye moved above the screen. On testing the prototype in the field, however, less than 40% of the juveniles migrated above the screen. Inanimate objects do not adequately represent fish with behaviour. For further details on behavioural testing at Bonneville Dam, see Gessel et al. (1991).

8. Page 39 of the final EIA, Annex C – Here the report repeats the results from the blade strike modelling and presents biased conclusions from section 3.2. Further, it does not provide all the caveats relating to factors not considered and recognized in the earlier text as potentially causing additional mortality. This section needs all of the caveats added in **BOLD** text. There is no mention of losses from cavitation and shear stress or losses from passing through turbines that occurs downstream of a dam, likely due to predation on disoriented fish.

9. Page 149 of the Engineering Status Report 2011 - The head at McNary Dam is approximately 22m, not the 60m indicated in the text, and thus, does not have much higher pressure differentials. Therefore, asserting that the high rate of fish mortality passing through the turbines at McNary is not comparable to Don Sahong is wrong.

10. Page 153, No.3 of the Engineering Status Report 2011 - The range in head for all of the mainstream dams on the Columbia River through which migrant fish pass and the places at which turbine survival measurements have occurred ranges from 12-28m. These are similar to those expected at DSHPP. The suggestion that turbine passage estimates made at Columbia River dams may be higher than at DSHPP because of differences in head is not valid.

11. Page 149-154 of the Engineering Status Report 2011 - Turbine blade strike and direct mortality of fish passing through turbines does not present a complete picture of mortality to fish that pass through turbines. Direct survival rates after blade strike and shear stress from passing through low-head Kaplan turbines tend to range 93-98% (optimistic values similar to ones used in most of the analyses for the DSHPP) as measured with recoveries of tagged fish immediately after they passed through the turbines (Skalski et al., 2002). But, these studies did not take into account how stress from passage or non-lethal injuries might subsequently affect survival. Fewer studies have attempted to evaluate these effects, but where conducted relative survival of fish passing through turbines has ranged from only 72-93% compared to the best passage routes, and the best passage routes do not have 100% survival (Muir et al., 2001; Ledgerwood et al., 1990; Ledgerwood et al., 1994).

12. Fish kills can occur during stop-start events of turbines. During hydropower dam turbine stop-start ups, fish in the tailrace have free access to the draft tube when the turbine is stopped. After the turbine has been started up, fish with lesions caused by decompression and/or mechanical impact are commonly observed in the tailrace. In turbine dewatering, fish that enter the draft tube can become trapped after stop logs are deployed, which isolate the draft tube from the tailrace. At Três Marias Dam (São Francisco River, Brazil), up to 2.5 tonne of fishes have been removed from the draft tube in a single dewatering (Andrade et al., 2012).

13. According to the Engineering Status Report (2011, pg. 109) for the Don Sahong dam, sedimentation of the reservoir area would be rapid if management measures are not taken. Therefore, the periodic “sediment flushing” is proposed. This could have

serious impacts on fish and fisheries downstream, as unusually high amounts of silt would be released downstream during flushing for short periods of time, and this could have adverse impacts on fish and dolphins downriver in Cambodia. Mechanical removal of silt is also proposed as a possibility, but sediment flushing is the main measure being proposed. Monitoring of sediment releases is proposed (2011, pg. 113) to keep sediment levels downstream within "allowable limits", but it is unclear what those limits would be, and if those limited levels would still lead to downstream impacts or not. Research on this aspect has not been completed so there are a lot of unknowns.

LACK OF GEOGRAPHIC KNOWLEDGE AND SPECIFIC ECOSYSTEM SERVICES

1. In the main EIA report, pg. 1-15, the authors claim that the Don Sahong dam would be "several kilometers upstream of the Lao-Cambodia border," but it would actually be less than one kilometer from the border. The authors of the report don't appear to know the local geography well. The report thus lacks credibility.

2. On page 3-18 of the main EIA report, the authors claim that the number of households at Hang Sadam village increased from 20 in 1990 to 96 in 2009. This is certainly incorrect. In 1993, there were at least 80 households in Hang Sadam. Again, the quality of information included in the report is low. The authors do not appear to know the area very well.

3. The Don Sahong dam will significantly detract from the natural beauty and tourism potential of the Khone Falls area. It was due to the desire to build the Don Sahong dam that the Siphandone area was dropped as a Ramsar Site, despite being initially considered by the Lao government to be the first Ramsar Site, although the EIA does not acknowledge that.

4. In the main EIA report, pg. 1-3, "Don Sakoun" is mentioned as a place that would benefit from electricity. But there is no island in the Khone Falls area with this name. The EIA authors do not appear to know the area well, as this sort of big mistake indicates.

5. The research carried out by the project proponents with villagers in the Khone Falls area in relation to fish catches (6 villages) only recorded the weight of all species of fish combined. No consideration of species differences was recorded (pg. 21, Annex C; pg. 3, Annex D). The rich biodiversity and the diverse migratory behaviours of the many species in the area have been ignored. Prices of different fish species in different seasons also varies greatly, so even for economic purposes this methodology is unacceptable. Compensation cannot be accurately determined using this methodology.

6. The authors of the EIA claim that *Trichogaster pectoralis, Oreochromis niloticus*, and *Trichogaster trichopterus* were found in the Hou Xang Pheuak. This is a strange report and one that lacks credibility. *Oreochromis niloticus* (tilapia) is a non-native species that likes relatively still water and has never been recorded from the Khone Falls area (see Daconto 2001). The other two species are native species, but they are mainly found in relatively still waters. They would not be expected to be found in the Hou Xang Pheuak in significant numbers, as Annex C (pg. 23) would suggest. This information suggests that the authors of the report know very little about the fish species found in the Khone Falls area, and that the species found have been misidentified. This work is not credible.

7. In the main EIA report, pg. 3-13 reports that there were only 48 bird species found in the project area. There are clearly more birds there than indicated, as stated in Daconto (2001), Siphandone Wetlands. Again, a poor piece of research has been carried out on another aspect of the EIA. Overall, the quality of studies completed on this project is quite low.

8. The authors of the EIA claim that they will develop FCZs, but they incorrectly refer to them as "Fish Control Zones"; FCZ actually refers to "Fish Conservation Zones" (see Baird and Flaherty 2005; Baird 2006). This misunderstanding indicates that the authors of the EIA have very little understanding of this sort of work. Their plans are not credible. The idea to protect areas where "unusual fish accumulations are found" (pg. 29, Cumulative Impact Assess.) in the project area does not make sense. This idea clearly has not been well thought out. The idea also seems to be to enforce this on villagers, and while rhetoric about villager participation is included, the reality is that conflict with villagers seems likely to occur. This needs to be more realistically considered.

9. The Social Impact Assessment (SIA) did not consider some important villages that would be impacted by the project, such as Don Phapheng, Don Esom and Ban Khone (SIA, pg. 9). These are major oversights. These villages would certainly be impacted by the project (either directly on fisheries due to the project – i.e. Don Phapheng, or in relation to fishers whose fishing would be impacted by plans related to supporting migratory passage – Don Esom and Ban Khone), especially in relation to plans related to fisheries, so it is unclear why they have not been investigated or considered in the plan. They certainly should be, according to the Lao PDR government's compensation policy (Decree 192) (refer SIA, pg. 13).

10. The SIA (pg. 56) claims that irrigation for dry season rice will be introduced. This is not realistic for island communities, as water will not stay in fields during the dry season due to geological conditions. This is well-known to local people. Past attempts to introduce irrigation have failed terribly. Water will also not stay in the community fish ponds planned (SIA, pg. 57), so this activity is unrealistic as well. Overall, the plan for restoring the livelihoods of villagers impacted by the project in the Khone Falls area is very vague and unacceptable.

11. The SIA fails totally to understand that some of the trap fisheries on the Hou Sahong (particularly the one for *Pangasius macronema* in the dry season) is not individually owned but communally-owned by the whole village of Hang Sadam (see Baird et al. 2001, Asian Fisheries Science peer-reviewed article). The people who conducted the study do not seem to recognize the unique circumstances of communities in the Khone Falls area.

12. Page 5-7 of the main EIA report claims that aquatic habitat impacted would be restored, but there is no indication how that would actually be done. This claim is not credible. There does not appear to even be a reasonable plan to really restore lost habitat. Important habitat will definitely be lost, without restoration really being possible, especially in the reservoir area.

13. The authors of the EIA want to increase fish migration success above pre-project levels (pg. 15, Annex C), but how will they know what pre-project levels are without having carried out any studies to determine this benchmark, and with no plans to do so? This is one of many examples of unsubstantiated claims.

COMMUNITY AND STAKEHOLDER ENGAGEMENT GAPS

1. The Environmental Management and Monitoring Plan (2013, pg. 24) states that the proposed management measures for the project have so far not been discussed in any stakeholder meetings. This should have been completed before including the measures in the plan.

2. The Environment Management and Monitoring Plan (2013, pg. 31) states that the project will "negotiate" with villagers to rent their fixed fish traps so that they are not used. However, it is unclear what would happen if fishers decided not to cooperate. The reality is that they would likely be focused to accept the terms and amounts of compensation, whether they would be fair or not. The power dynamics associated with the government of Laos and "negotiations" needs to be recognized.

3. On page 4-10 of the main EIA report, the authors claim that villagers in southern Laos would be deprived of electricity if the Don Sahong dam was not built. There is no evidence to support such a claim. The electricity from the project would be exported, according to the authors. This is yet another sloppy and inappropriate comment, reducing the credibility of the report.

4. The SIA (pg. 15) states that compensation will be provided for the lost harvests of crops and trees. However, it is unclear if people would receive compensation for a single year or multiple years. For tree crops, compensation for a single year would represent unfairly low compensation. The same is true for fish traps. Full net loss would be compensated, but for how many years? Also, compensation would be temporary, based on successes for livelihood replacement activities. It is unclear what would happen if the livelihood replacement activities never reached expected success rates. Would compensation continue forever? This option is not discussed.

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