EXECUTIVE SUMMARY

THE RAPID ASSESSMENT OF TRANSBOUNDARY IMPACTS CAUSED BY RAPID WATER FLUCTUATION DOWNSTREAM OF THE SANAKHAM HYDROPOWER PROJECT

An Addendum to the Technical Review Report on the Prior Consultation for the Proposed Sanakham Hydropower Project

29 October 2021

Mekong River Commission

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Prepared by
The MRC Secretariat
29 October 2021

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Mekong River Commission
Documentation and Learning Centre
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Telephone: +856-21 263 263 | E-mail: mrcs@mrcmekong.org | www.mrcmekong.org

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ABBREVIATIONS AND ACRONYMS

CS	Chiang Saen
CK	Chiang Khan
HPP	Hydropower Project
LMB	Lower Mekong River Basin
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
NK	Nong Khai
PNPCA	Procedures for Notification, Prior Consultation and Agreement
PLHPP	Pak Lay Hydropower Project
RoR	Run-of-river
SNHPP	Sanakham Hydropower Project
VTE	Vientiane

EXECUTIVE SUMMARY

1. Introduction

The Technical Review Report (TRR) for the Sanakham hydropower project (SNHPP) presents a number of concerns that require more detail on the potential adverse transboundary impacts. It specifically highlighted the following:

- The proposed SNHPP is located approximately 1.5 km upstream of the point where the Lao/Thai border joins the Mekong. Any transboundary impacts are therefore likely to be immediate, inevitable and potentially significant.
- While the developer has indicated that they will not practise hydropeaking, such operations at the Pak Lay HPP or Xayaburi may result in fluctuations in the discharge from the SNHPP.
- During low flow conditions, when the normal run-of-river (RoR) operations are insufficient to satisfy peak power demands, ramping up power production may be required, as has been noted with the Xayaburi HPP.
- The riparian zone along the downstream reach is heavily populated, with several large towns and cities on both sides of the river. Fisheries, tourism and sand mining along this stretch make up a significant part of the livelihoods on both the Lao and Thai banks. It is noted, however, that the Thai provinces of Loei, Nong Khai (NK) and Bueng Kan are generally wealthier and are probably less vulnerable to changes than some downstream provinces.

Rapid changes in water levels downstream of HPPs are generally known to result in a range of impacts downstream of the dam, including:

- repeated and rapid drying and wetting of critical riverine habitats, which makes them unsuitable for fish spawning and macro-invertebrate habitats, may lead to a decline in fisheries;
- increased riverbank erosion and potential losses of riverbank gardens;
- impaired and dangerous navigation, particularly where shipping may become stranded on shallow rapids;
- the stranding of moored tourist and fishing vessels as water levels rapidly drop;
- changes in erosion and deposition patterns for sediments.

The Mekong River Commission Secretariat (MRCS) was therefore tasked to undertake a quick assessment of the potential impacts of rapid changes in discharge from the SNHPP, which is presented in this report. This rapid assessment is an Addendum to the TRR. It assesses and investigates the impacts from the rapid water fluctuation of the SNHPP's operation to hydrology and hydraulics, sediment and geomorphology, aquatic ecology and fisheries, and socio-economic conditions of the riverine communities between the Sanakham damsite and Paksane, although its main focus is up to Chiang Khan (CK), and hydrological modelling extends further downstream to Pakse.

Available information from the MRC ISH0306 and the Council Study, additional information on the project design and operating rules of the SNHPP project from the submitted documents for Prior Consultation, and available information from operation of the Xayaburi HP and from the Joint Environmental Monitoring were used in the model.

The rapid assessment cannot provide details of possible changes in the riverbed morphology, nor can it *quantify* the impacts on ecology, fisheries, and socio-economic conditions, due to limitation of existing data and information. Therefore, these impacts are qualitatively assessed based on available data and experience in other systems and expert's assessment. The report is not a forecast of likely impacts, but rather highlights the impacts that may occur should the discharge from the SNHPP change rapidly. More detailed assessment as recommended by the TRR will need further time to be conducted during the JAP process.

2. The Mekong reach investigated

The mainstream reach between the proposed Sanakham damsite and Paksane[1] was included in the assessment, although the reach downstream to Pakse was included in the hydrological model (see Figure 1).

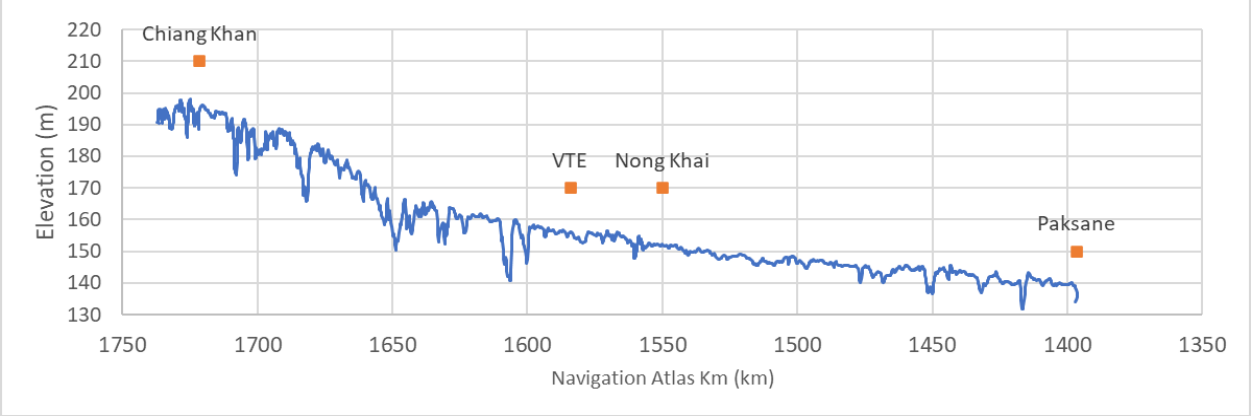

Figure 1. Long section of the Mekong riverbed between the proposed SNHPP damsite and Paksane

Because of steeper slopes of the riverbed upstream of Vientiane, the reach is characterized by a series of rapids, while the river further downstream is characterized by large sand bars. These provide a rich diversity of habitats, making this an important ecological and fisheries reach. The relative importance of this reach will increase if the full northern Lao cascade is completed, thus drowning most of the important habitats upstream of the SNHPP.

A number of rapids are found along the mainstream reach downstream of the SNHPP (see Figure 2).

[1] The hydrological modelling included scenarios extending further downstream to Pakse.

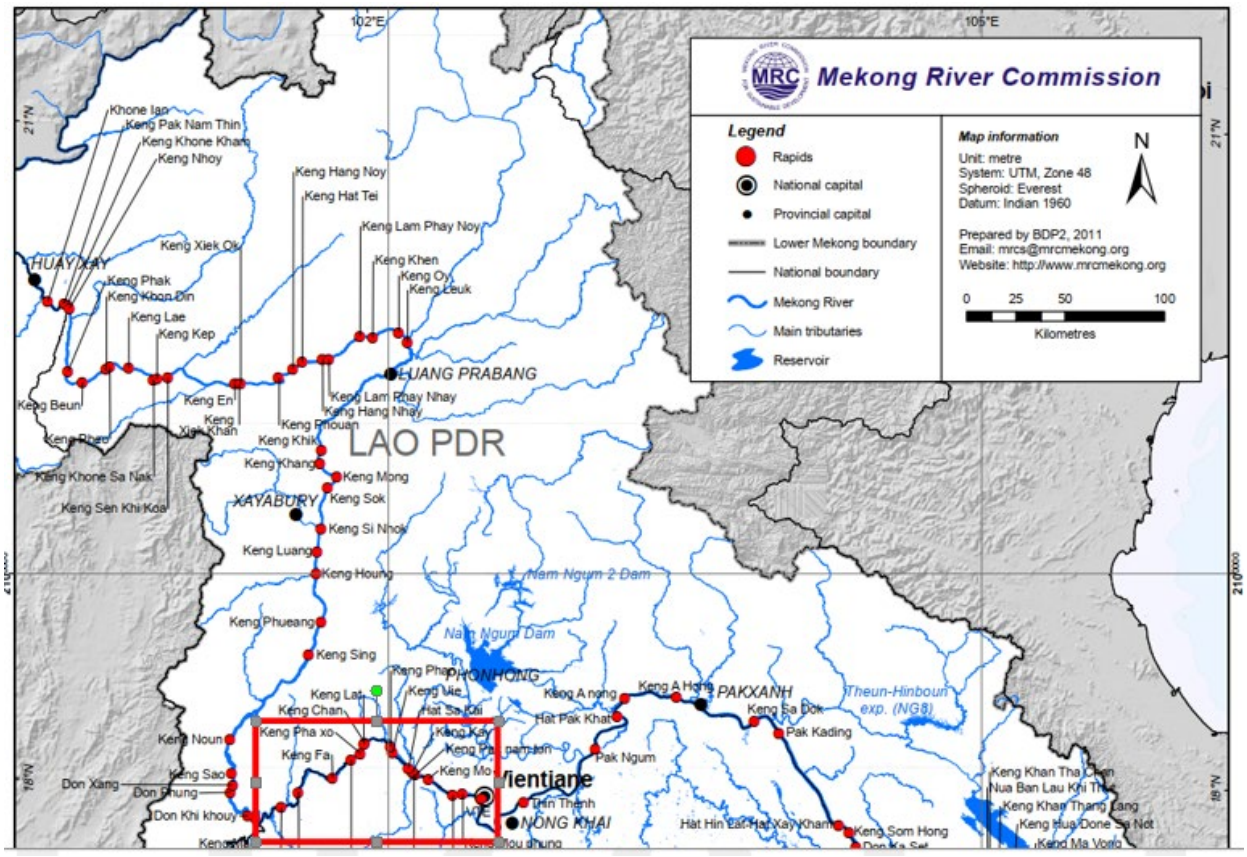

Figure 2. Map of northern LMB showing the location of rapids, with a high concentration of rapids between the Lao PDR – Thailand border and Vientiane

Source: MRC (2011)

3. Scenarios tested

The scenarios tested were based on the flow records from the recently installed Ban Pakhoung station, a few kilometres downstream of Xayaburi dam, as well as the capacity and number of turbines at the HPPs.

From February to March 2021 discharges from the Xayaburi HPP vary between 1,400 m^3/s (from 22.00 to 06.00) and 1,900 m^3/s (from 06.00 to 22.00). During September and October 2021, similar rapid changes in flows at Ban Pakhoung were noted at inflows around 4,000 m^3/s. This appears to be due to the Xayaburi HPP increasing power generation during the day to accommodate the larger demands.

Various scenarios were tested using these flows as a basis, which included:

1. A reference condition under various inflows but with Sanakham operating in a RoR mode.
2. Four scenarios for the SNHPP with increasing numbers of turbines to accommodate increased power demand from 6:00 to 22:00, as follows:

a. *Extreme* – with energy production increasing from 1 turbine to 7 turbines (flow rate increasing 7-fold)
b. *Moderate* – with energy production increasing from 3 turbines to 5 turbines (flow rate increasing by 1.7-fold)
c. *Considerable* – with energy production increasing from 1 turbine to 4 turbines (flow rate increasing by 4-fold)
d. *Mild* – with energy production increasing from 3 to 4 turbines, and from 2 to 3 turbines.

3. Different ramping rates were also tested, with a 20-minute ramping as the base case then ramping over 1-hour and over 3-hours.
4. Operating the SNHPP as a RoR HPP, with rapid changes in inflows due to operations at Pak Lay or Xayaburi.
5. Operating the SNHPP specifically to dampen changes in flows, with the 1 m maximum daily change in the impounded section behind the dam.

These scenarios best illustrate the potential downstream impacts.

Based on flows at the CK station for the years 2015 to 2021, the discharge at the SNHPP will fluctuate from 1,200 m^3/s (in 2020) to around 4,000 m^3/s (in 2019). In these years extended periods of low discharge around 2,000 m^3/s occurred. The scenarios used these to guide the selection of the inflows for the different scenarios.

Water level fluctuations are recognized as having negative impacts on the aquatic ecosystem and the river channel. To minimize potential impacts The MRC Hydropower Guidelines for Environmental Impacts have adopted a target rate of 5 cm/hr as a good practice guide.

4. The effects of rapid changes in outflows from the SNHPP

Water level changes downstream

Rapid flow fluctuations due to maintain power outputs will propagate downstream, being dampened downstream over long distances. This is affected by the magnitude, duration, ramping rate and amplitude of the changes, as well as by the background average flow.

The following graphs plot the changes in water levels and discharge, at various points downstream of the SNHPP and under different peaking scenarios. These show that immediately downstream of the HPP, water levels can vary by as much as 4 m over a 24-hour cycle – for the more extreme peaking, to less than 1 m for mild peaking.

The amplitude of the water level changes decreases downstream to 3.5 m at CK, 0.7 m at Vientiane (VTE) and 0.5 m at NK over 24 hours, and for the extreme peaking scenario (Figure 3). The rate of change also decreases downstream, smoothing out further downstream.

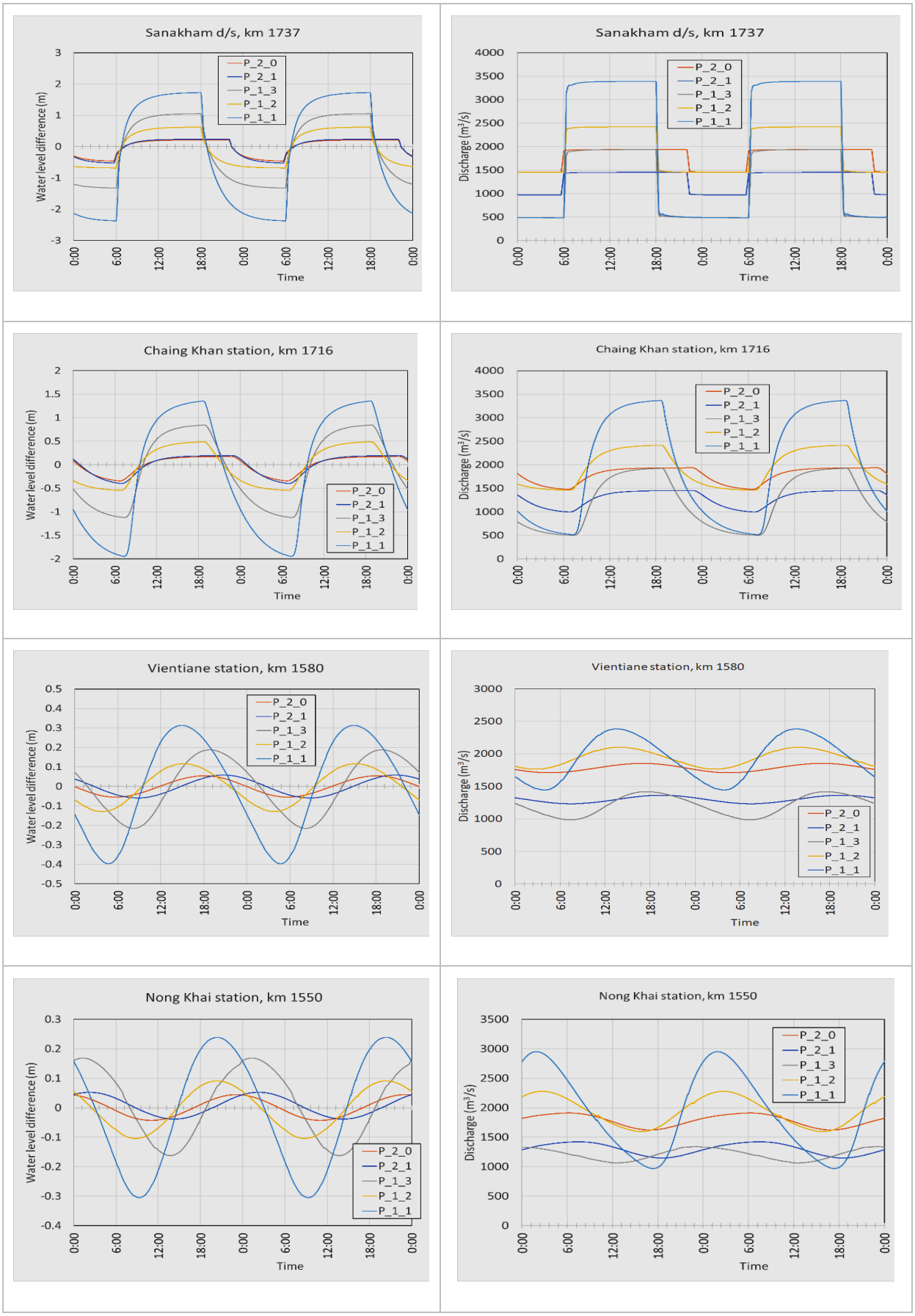

Figure 3. Simulated time variation in discharge (right) and water level (left) downstream under the mild peaking scenario under different inflow conditions

Table 1 highlights the scenarios and positions on the river down to Paksane where the water level changes (m/hour) would exceed the MRC's guidelines (0.5 m/hr).

Table 1. Summary of rates of water level change for different turbine operating patterns

		km in Navigation Atlas							
Scenario	Rate of WL change m/hr	1,736 d/s SNHPP	1,723	1716 Chiang Khan	1,661	1,599 u/s VTE	1,544 d/s NK	1,470	1,425 Paksane
Mild 3–4 units	Max inc	0.745*	0.235	0.129	0.228	0.016	0.013	0.005	0.003
	Max dec	-0.705	-0.185	-0.135	-0.222	-0.019	-0.016	-0.005	-0.004
Moderate 3–5 units	Max inc	1.55	0.76	0.52	0.70	0.19	0.32	0.03	0.01
	Max dec	-1.44	-0.38	-0.27	-0.76	-0.16	-0.27	-0.03	-0.01
Strong 1–4 units	Max inc	1.02	0.88	0.84	0.56	0.22	0.14	0.06	0.03
	Max dec	-1.28	-1.11	-1.12	-0.10	-0.26	-0.19	-0.07	-0.03
Extreme 1–7 units	Max inc	5.27	1.65	1.34	0.66	0.39	0.25	0.10	0.06
	Max dec	-3.68	-1.05	-0.59	-0.32	-0.49	-0.31	-0.11	-0.07

Note:

*Highlighted cells indicate the increase or decrease of water level that exceeds the updated Design Guidance 2020 for water level change of 0.05 m/hr (5 cm/hr).

WL=water level; inc.=increase; dec=decrease; VTE= Vientiane; NK=Nong Khai.

The rates of change are consequently higher than the guideline, even for the mild scenario, to downstream of CK. Under the extreme scenario this extends as far downstream as Paksane.

The effects of ramping

Ramping the changes in outflows over a longer period (for example 1 or 3 hours) decreases the amplitude of the changes in water levels downstream (Figure 4). However, even bringing the additional turbines online over a period of three hours still exceeds the MRC guidelines (5 cm/hr).

In addition to the amplitude of the changes in water levels, the timing of the changes also changes downstream. Thus, the higher flows can pass any point downstream during the night. This influences the impacts of the flow wave on navigation, mooring and fish.

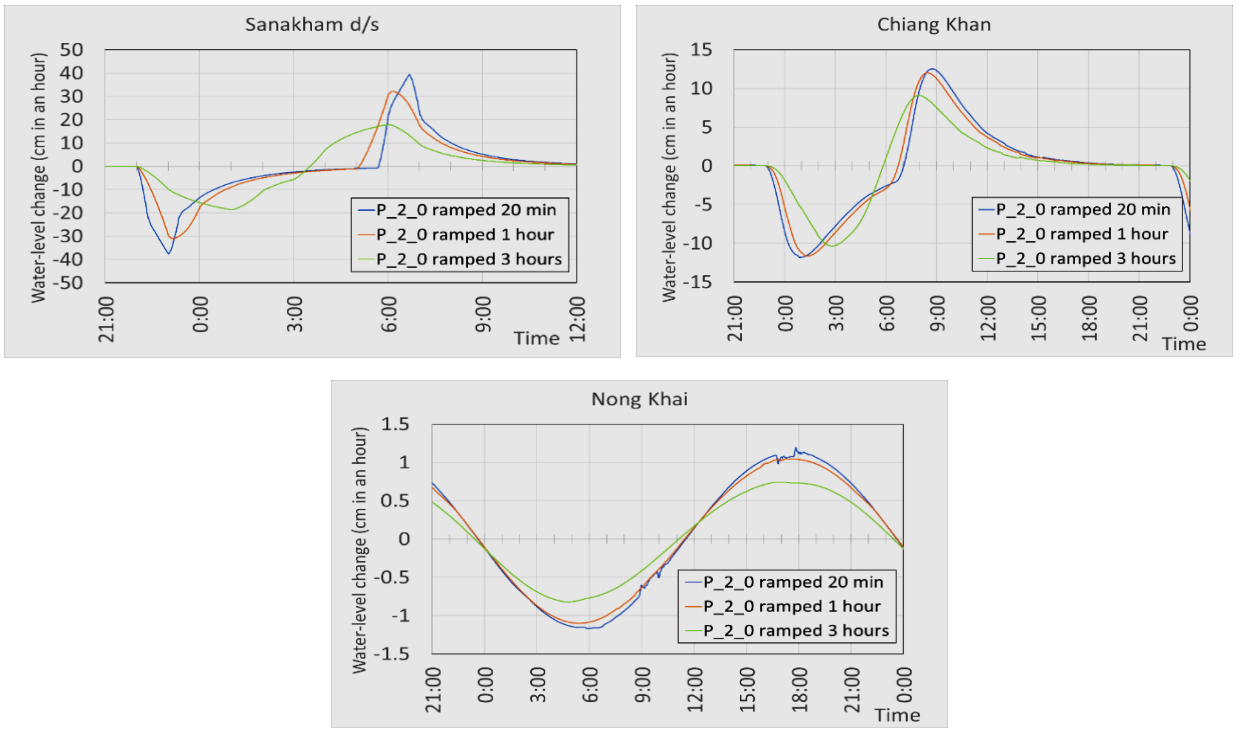

Figure 4. Rate of water-level change over a period of one hour for scenario P_2_0, with and without mitigation by ramping

Note: Ramping over 20 min has been included to reflect a standard practice of bringing turbines online).

However, operations at the Sanakham impoundment can minimize rapid fluctuations in water levels if optimized to regulate flow rather than maximize energy production, and turn on and off turbines at rates that maintain water level fluctuations below 5 cm/hr. If the Pak Lay HPP practises peaking, changes in water levels of about 0.6 m per day (just downstream of the PLHPP) decrease to about 0.25 m (just upstream of the SNHPP in the impoundment) may occur. This effect is even more marked if the SNHPP is actively managed to reduce any changes in water levels. Under normal RoR operations at the SNHPP, with peaking at Pak Lay, water levels just downstream fluctuate by about 0.3m per day. If the SNHPP is operated to release close to a constant discharge, these fluctuations disappear completely. The flow fluctuations originating from the Xayaburi HPP are dampened significantly before the SNHPP even without any operations to regulate them. Under this scenario, water level fluctuations of around 4 cm/day will remain at the end of the cascade.

Sediment

Sediment monitoring shows that by 2009 there was already a large reduction in sediment entering the LMB from China, with loads of about 10–15 Mt/yr compared to historic estimates of about 60 Mt/yr. In 2019, loads at CK and NK showed a substantial decrease relative to the previous years, with the calculated loads at CK and NK similar to, or lower than, those calculated for Chiang Saen (CS) (Figure 5).

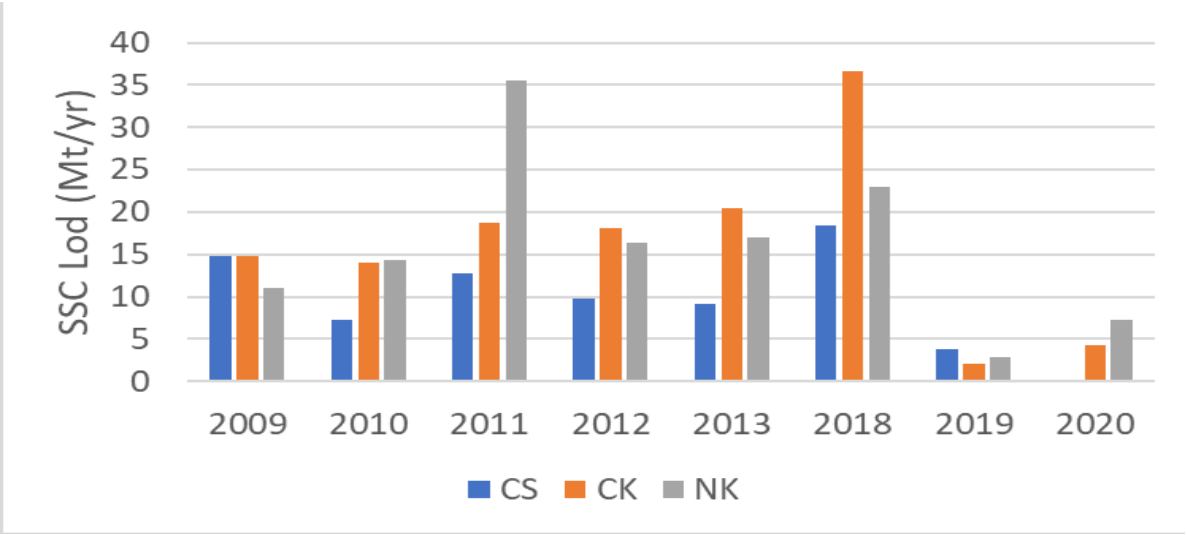

Figure 5. Suspended Sediment load at Chiang Saen (CS), Chiang Khan (CK), Nong Khai (NK) 2009–2020

Note:

Data based on DSM results are collected by Thailand. Estimated loads are based on interpolation of measured monitoring results. Analysis completed as part of the Joint Environmental Monitoring Programme.

Sediment loads will decrease further with the completion of the northern Lao cascade. This will increase the erosion of sediments downstream of the SNHPP. Already, riverbed profiles have been found to change rapidly at CK. While there is little change in the overall planiform of the river over longer periods, there have been changes in the distribution of sand within the channel or on the rocky platform bordering the main channel. This has also brought about changes to vegetation on the islands and sand bars.

There are ongoing sediment extraction works occurring upstream of CK and near VTE and NK. A reduction in sand supply due to trapping in the impoundment would be expected to increase the rate of channel incision and/or bank erosion, leading to a decrease in bank stability. Over time, the channel would likely scour down to bedrock, with sand deposits only remaining in hydraulically protected areas. This process will be faster with rapid changes in water levels, which increase the ability of the river to pick up and transport sediment. The wetting and drying of the riverbanks (in unprotected areas) will also cause slumping. This will remove some of the riparian vegetation.

Aquatic ecosystems and fisheries

Aquatic ecosystems and fisheries are affected by the frequency, magnitude and timing of rapid changes in flows, as summarized in Table 2.

Table 2. Summary of the main changes in the environment and responses of organisms resulting from rapid daily fluctuations in flow regimes

Flow features and changes	Changes to environment and responses of organisms
Frequency	
Increased within-day number of rapid flow increases and reversals	Fish behavioural changes including non-migratory short movements (e.g. constant change from resting on substrate to swimming in the water column, and search for suitable habitats). This implies higher fish energy consumption and reduced fitness.
	Increased scouring, which damages or removes sessile organisms or life stages, such as fish eggs, aquatic macroinvertebrates, and aquatic and riparian plants.
	Increased erosion and riverbed incision causing transient shelters and altered food resource, and reduced food uptake.
	Increased turbidity, which adversely effects fish movement and health by clogging gills, and hampers photosynthesis of aquatic and riparian plants.
	Increased drifting or displacement of aquatic organisms, which can result in more food for fish until sources depleted.
	Frequent inundation of riparian areas causing regular partial or total submergence that affects aquatic and riparian plants, and loss or change in vegetation and associated habitat, which lessens the role of vegetation as ecosystem engineers in river channels. Note the extent of inundation dissipates with distance downstream.
Magnitude	
Increased within-day magnitude of periods of higher flows. (Note: the extent of displacement dissipates with distance downstream)	Increased erosion and riverbed incision causes habitat degradation or improvement. Deterioration through substrate mobilization and supersaturation of water; improvement of habitat quality through flushing of fine sediment from gravels maximizing oxygen exchange.
	Downstream displacement and high drifting rate of fish and macroinvertebrates, loss of food sources, offset of migration triggers, stress for aquatic organisms. The extent of displacement dissipates with distance downstream.
	Increased scouring under high flows, which damages or removes sessile organisms or life stages, such as fish eggs, macroinvertebrates and plants directly or indirectly through sediment erosion and changes in channel morphology.
Decreased within-day magnitude of periods of minimum flows	Reduction of suitable habitats available for fish due to lower volume of water in the river and reduction in average depth and width of the river channel, which result in oxygen stress and cause problems with fish refuge and feeding.
	Habitat deterioration following siltation of gravel and reduced oxygen, which affects fish spawning. Likelihood of death of riparian or aquatic plants increases when they remain under water or exposed for long periods.

Flow features and changes	Changes to environment and responses of organisms
	Fish migration issues both upstream and downstream due to too little water that impedes fish movement.
	Elevated fish density due to inability to redistribute themselves. Fish restricted to wetted ponds, which may lead to cannibalism, limited feeding, and higher transmission of pathogens.
	Stranding/ loss of fish and macroinvertebrates along the changing channel margins, stress for aquatic organisms.
Thermopeaking	Unnatural (fast changing) temperature regime, stress for aquatic organisms, offset of migration triggers.
Rapid within-day flow decrease	Stranding/loss of fish and macroinvertebrates, stress for aquatic organisms.
Rapid within-day flow increase	High drifting rate of fish and macroinvertebrates (catastrophic drift), loss of food sources, offset of migration triggers, stress for aquatic organisms.
Short within-day periods of rapid flow rise and fall	Shorter duration of flow changes implies less time for key activities of fish such as feeding in the water column or resting on substrate, which ultimately results in less food uptake and higher fish energy consumption.
Short duration releases from hydropower stations	Alter water quality in the downstream river system by discharge 'pulses' of water modified during storage resulting in fluctuating temperature, electrical conductivity or other water quality characteristics in the downstream environment.
Timing	
Seasonality of short-term flow changes	Increased fish drift and stranding risk during juvenile growth period.
	Increased fish migratory and non-migratory behavioural changes during normal low flow period.
	Occurrence of different life stages of aquatic insects and aquatic and riparian plants determines how they are affected by short-term flow changes. For example, short-term flow alterations coinciding with adult egg-laying behaviour coinciding with river-edge layers, such as mayflies, or with seed germination will cause severe impact.

The impacts on aquatic ecosystems, and the consequent likely reduction in fisheries potential, are therefore likely to be considerable and varied.

The reach of the Mekong River downstream of the SNHPP is extremely important for the ecological functioning of the LMB. It provides faster flowing conditions that are important habitats for endemic species of aquatic organisms, including macroinvertebrates and fish. Fish species migrate upstream to spawn in this reach and then disperse downstream to grow

and become mature. The rapids are known to be important spawning areas and habitat for the species that are a major component of the fish community in this reach.

Other components of aquatic ecosystems will also be affected by rapid changes in water levels. Riparian vegetation along the rocky shoreline of this area is dominated by shrubs tolerant to swift currents. They have fibrous, flexible stems, narrow, short-petioled blades, sympodial growth habits, and root and rhizome systems that anchor the plants deeply in rocky substrates. They germinate during low-water cycles and grow primarily as mature plants during this time. Rapid fluctuations in water levels may reduce the habitats formed by these plants, which will change the quality of habitat available to aquatic biota and ultimately shift the community structure and ecosystem functioning.

Many macroinvertebrates are well adapted to fast flowing environments with substrates not coated with fine sediments. Aquatic insect species that live on sand and coarse sediments, such as gravel, usually in moderate current, such as mayflies from the family Caenidae and dragonflies from the family Gomphidae, are also found throughout the reach. They will be unable to survive if the sand is buried under finer sediment or eroded, leaving only cobbles or bedrock. There is an abundance of aquatic snails (Gastropoda) that live and feed primarily on solid surfaces. They are important because there is an extremely high diversity and are also an important food for people living along the river.

Many of endangered species, several of which are endemic to the region, will be depleted by rapid changes in outflows the SNHPP, potentially as far downstream as Vientiane. Most of these species are known to live and or breed in the upper migration zone, upstream of Vientiane. Access to their breeding areas will be compromised by the northern Lao cascade. Consequently, these species will likely seek sub-optimal reproductive habitat downstream of the SNHPP to spawn.

Rapid fluctuations in water levels may also prevent fishers using their traditional gill netting and trapping gears, hence causing considerable operational and safety problems. This is already seen in the reach downstream of Xayaburi where fishers are complaining about difficulties fishing and a collapse in catches. Moored fishing vessels may also be stranded above the water line when water levels decrease rapidly.

Socio-economic impacts

Socio-economic conditions across the north-east of Thailand are quite diverse. The provinces of Loei, NK and Bueng Kan are generally wealthier and are probably less vulnerable to changes than some downstream provinces. Similarly, in comparison with other provinces in Lao PDR, the population along this river reach enjoys a relatively high level of human development.

Nonetheless, the ecosystem services provided by the Mekong River maintain several livelihoods benefits, including direct and indirect employment as well as subsistence opportunities. The degree of dependence differs between the different river zones and depends on factors such as local ecosystem services (e.g. abundance of fish) and the economic alternatives that people have. The river also has additional impacts on people's lives, such as safety on and near the water.

Although primary sector employment, which includes fisheries, has been declining, all four countries still each have more than a million people employed in fishing. However, the **number of families that primarily depend on fishing in the target reach is small**, with fishing more of an additional or part-time activity. **Riverbank farming as well as other river-related livelihoods are also activities of minor importance**. However, fishing is important because it is a source of income and protein for the community, and provides opportunities for the very poorest people.

Riverbank gardens appear to play a minor role in livelihoods along this reach, although satellite imagery shows significant areas of farming along the river. Floods can have significant impacts, but they are not always be related directly to the Mekong mainstream. Many villages have bank protection measures along the Mekong. Thailand has 17% of its riverbanks along the Mekong River protected. Lao PDF has only with 6% of its Mekong Riverbanks strengthened.

Upstream of Vientiane, the river is a single bedrock channel with relatively few sediment deposits. Making it suited to navigation. Downstream of VTE it is alluvial-braided with sediment bars. Sand extraction is therefore an important activity along this reach. In 2011, Thailand extracted about 13% (4.5 million m3) and Lao PDR 4% (1.4 million m3) of the total sand and gravel extraction by LMB countries. Google Earth shows a large sand mining operation less than 10 km downstream of the SNHPP. Rapid changes in water levels will result in scouring and remobilization of sandy sediments in this area, potentially depriving the mining operations of sand.

Several areas along the banks downstream had aquaculture cages, especially in the area between Nam Heung River mouth and CK. These cages are used to farm Tilapia. Surveys have found a total of 220 baskets, 180 in CK and 40 in Pak Chom, with a total production of 250,000 kg/year.

Tourism attractions in this river reach are primarily found in CK and the Kang Kout Koo rapids (approximately 5 km downstream of the town, or 25 km from SNHPP). More than 50,000 tourists per year visited Kang Kout Koo, and 50–60 households (150–200 people) were involved in the tourism business.

The following conceptual diagram shows how rapid changes in flows filter down through changes in the geomorphology of the river and aquatic ecosystems, and eventually to riparian communities

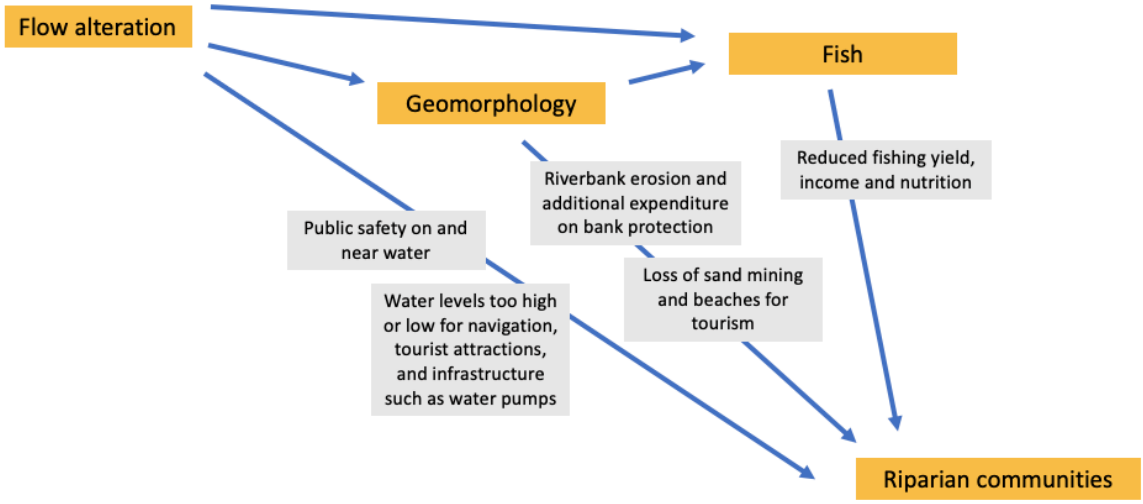

Figure 6. Conceptual impact pathways

The potential impact of rapid changes in flows on socio-economic conditions in the downstream reach on both sides of the river are therefore varied, and include reduced fisheries potential loss of other aquatic organisms for food, impacts of tourism, riverbank erosion, and reduced sand mining potential. Rapid changes in water levels also pose a safety risk. There is only anecdotal information on current safety risks and accident rates on the Mekong River. Because water level changes attenuate with distance, the impacts will be strongest for the communities closer to the SNHPP. However, population densities and community exposure appear to increase further downstream.

5. Border demarcation

A Lao/Thai Joint Border Commission was established in 1997 to agree on the alignment of the border between the two countries. In 2018, the Commission followed up on the demarcation of the land and river boundary between Lao PDR and Thailand, and noted the progress with a jointly prepared new map of the Mekong River between Thailand and Lao PDR. Negotiations on the Terms of Reference for the survey and demarcation were held in 2018.[2] There is no other readily available information on further progress with discussions.

The MRC recognizes that the border demarcation is a separate bilateral arrangement between Lao PDR and Thailand. It is also unknown what mechanisms are being or may be used to define the common border. However, as outlined in Chapter 4, while the overall planiform (including islands) of the mainstream appears to be stable, the riverbed and sand banks will continually change with the changing sediment transport characteristics.

6. Conclusions

[2] See Thailand's Ministry of Foreign Affairs for detail:
www.mfa.go.th/en/content/5d5bd0e815e39c3060022073?cate=5d5bcb4e15e39c306000683e

1. Rapid changes in water levels will only be a concern if the SNHPP also adopts rapid changes in discharge. This can result, in extreme cases, in changes in water levels in the order of meters per day immediately downstream of the HPP, reducing to decimetres at VTE and NK, and to a few centimetres at Paksane. The impacts are negligible further downstream.

   Extreme changes in water levels, if they occur will have a variety of adverse effects, including:
   - a loss of important habitats for key fish and invertebrate species;
   - a decline in the populations of critically endangered species;
   - reduced fisheries potential with the consequent socio-economic impacts;
   - difficulties with navigation and mooring upstream of Vientiane;
   - a potential loss of sand for sand mining operations;
   - disruptions to cage fish farming in the area;
   - a loss of livelihoods, particularly for the poorer riparian villagers;
   - reduced public safety and on the amenity value of beaches in the dry season, with consequent economic impacts.

   However, the **number of families that primarily depend on fishing in the target reach is small**, with fishing more of an additional or part-time activity. **Riverbank farming as well as other river-related livelihoods are also activities of minor importance.**

2. The impacts of rapid fluctuations in water levels are reduced at flows higher than 2,000 m^3/s but are still evident and problematic at higher flows. The extent to which discharges below 2,000 m^3/s will occur in the future is an important consideration going forward as dry season flows are likely to increase, and extremely low flows may be manageable with greater storage in the Basin.

3. Active operations to limit water level fluctuations, or even passive RoR operations at the SNHPP markedly reduce the water level changes just downstream.

4. There is an ongoing trajectory of change affecting the livelihoods of people along the river, including those induced by the development of hydropower, climate change, demographic change and growing economies.

7. Recommendations

Rapid changes in outflows from the SNHPP should be avoided. The Statement agreed at the conclusion of the Prior Consultation should include the following conditions (as per clause 5.4.3 of the PNPCA):

Lao PDR is urged to make every effort to avoid rapid changes in the outflows from the SNHPP by, *inter alia*:

- including relevant articles in the Concession Agreement and the Power Purchase Agreement. These Agreements should include provisions to avoid financial incentives for operators to adjust discharges to accommodate rapid changes in power demands;
- providing opportunities to cross subsidize measures to mitigate harmful effects on the Mekong River System between all the hydropower projects;
- developing cascade operating rules that facilitate the transport of all sediment fractions through the cascade, and which eliminate rapid changes in flows discharged from the upstream HPP.

All the Member Countries should work with their electricity providers to urge them to conclude power purchase agreements that avoid or minimize the impacts on the Mekong River.

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Mekong River Commission Secretariat

P. O. Box 6101, 184 Fa Ngoum Road, Unit 18 Ban Sithane Neua,
Sikhottabong District, Vientiane 01000, Lao PDR
Tel: +856 21 263 263. Fax: +856 21 263 264
ww.mrcmekong.org