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Technical Review of Pak Beng Hydropower Project – (1) Hydrology & Hydraulics and (2) Sediment Transport & River Morphology

The 2nd Regional Stakeholder Forum
The Pak Beng Hydropower Project
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Overview

- Physical characteristics are the '**backbone**' of a river system.
- Hydrological and geomorphic **processes** control distribution, quality & availability of ecological habitats.
- Social **dependence** on river systems linked to flow regime and geomorphic processes. Rivers will '**adjust**' itself to any change in flow or sediment regimes.

Concerns and risks

- Proper **method** and **modelling** to quantify the physical behavior of the river, and its variability?
- Operation of Pak Beng dam contribute to **changes in seasonal** or **annual flow**/**sediment** and daily **fluctuations up**/**downstream**?
- Uncertainty about those aspects given **transboundary**/**cumulative impact** of dams?
- Ideal **hydraulic conditions** of different components of dam?

Overview of submitted documents

12 of 20 submitted documents cover:

- Engineering components and its drawings
- Hydrologic and sediment data sampling
- Automatic Hydrologic data collection
- Sediment management and monitoring
- Physical model
- Numerical simulation
- Hydrodynamic characteristics

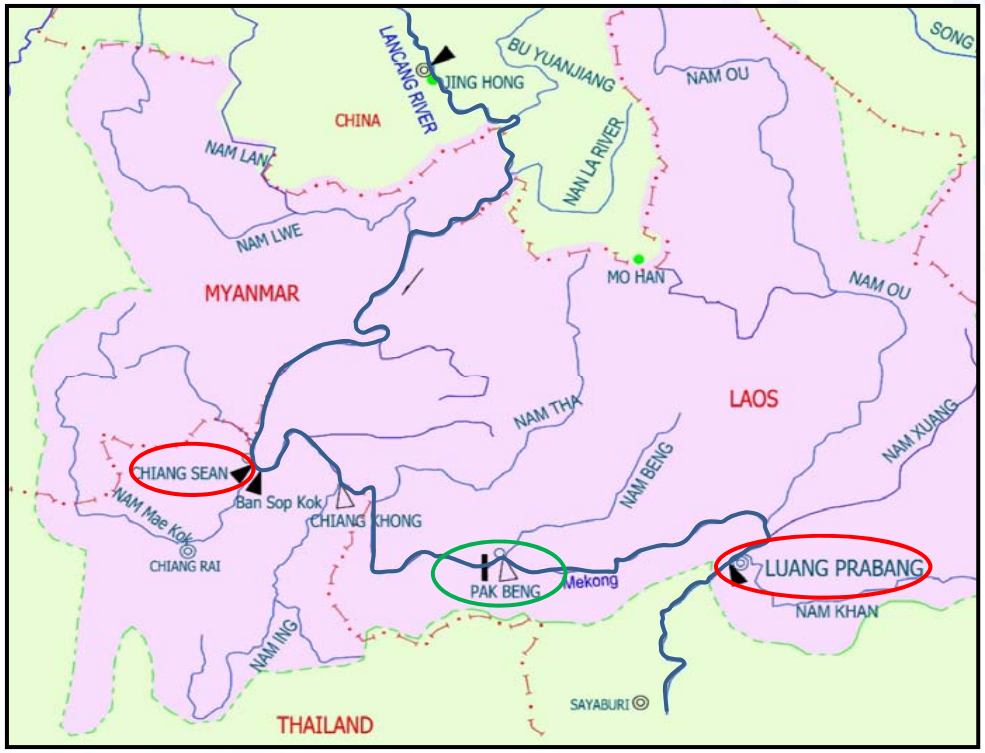
These documents contain **primary** and **secondary hydrologic/sediment data**, design **concept**, **methodology**, and **analysis/modelling results** in format of **photos**, **maps**, **tables** and **figures**.

Main findings of Technical Review

- ***Basic information underpinning the design and operations***
  - **Hydrological and sediment data** and **information** should be additionally collected and shared.
- ***Method and modelling***
  - **Methodology** should be additionally explored and verified.
  - Range of **sediment models** should be reviewed and updated with additional site specific sediment monitoring.
- ***Dam design and proposed operations and mitigation***
  - **Operation** and **management** was largely based on **pre-Lancang** scenarios.
  - Clarity of water level **fluctuations in reservoir** and **downstream** is needed.
  - Further studies of **backwater effect** should be conducted.
  - Further attention required with respect to **joint cascade operations**.
- ***Impact***
  - **Downstream impacts** on sediment transport and river geomorphology should be **properly addressed**.

Hydrological data

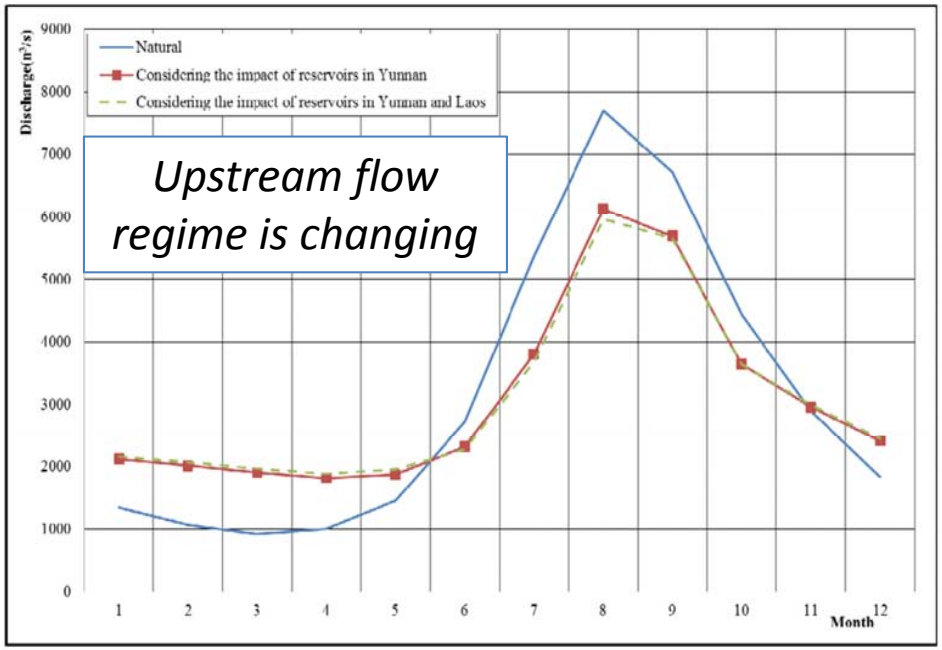
- **1960-2007**: MRC hydrological data at Chiang Saen and Luang Prabang extrapolated using a simple basin scaling method.
- **2008-2014**: Actual measurement at Pak Beng site.



→ ***Quality and consistency of constructed time series should be improved and verified.***

Method of flow determination

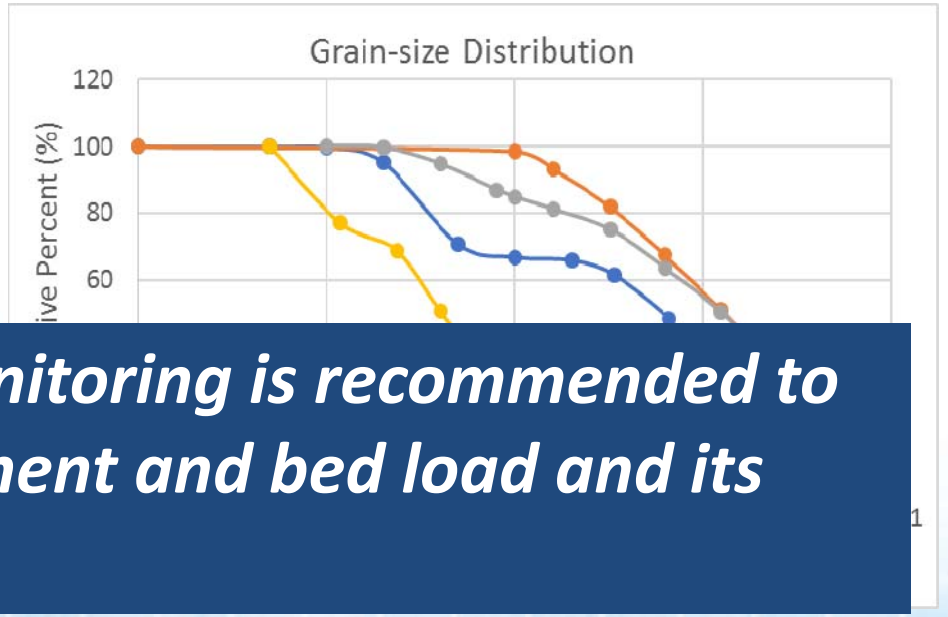
- Upstream dams in China are likely to affect the **flood peak determinations** for Pak Beng dam design.
- **Higher flows** may occur less frequently while **base flows** in the dry season may be higher



→ ***It is important to cross-check, improve and verify flood peak determination.***

Sediment data

- Sediment loads based on **pre-Lancang Cascade** measurements in China & extrapolated to Pak Beng.
- Limited **actual sampling** of bed load.
- Grain-size distribution of suspended & bedload based on **limited measurements** in June 2008 and 2015 at Pak Beng or Luang Prabang.
- No '**ground truthing**' with present conditions at Pak Beng.



→ ***Additional sediment monitoring is recommended to confirm suspended sediment and bed load and its characteristics.***

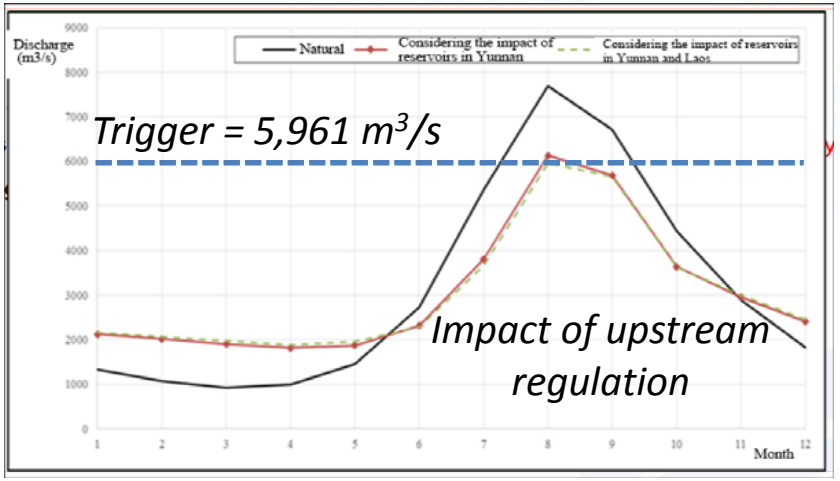
Sediment modelling

- Range of models have been applied and run at different time with **limited calibration** to **site-specific data**.
- **Detailed sediment** modelling only applied to area near project infrastructure
  - Lack of detail about sediment accumulation in reservoir
  - Lack of detail about seasonality or grain-sizes discharged downstream
- Lack of **geomorphic mapping** or modelling of downstream channel

→ ***The range of sediment models should be reviewed, cross-checked and updated once additional data is collected through monitoring.***

Sediment management

- 80% sediment passing through **power house** and another 20% will be flushed episodically via **flood sluice gate**.
- 'Sediment flushing' through **sluice gate** if Q > 5,961 m^3/s



- **Several mitigation options** were proposed. But, these measures are primarily aimed at **protection of the infrastructure** rather than passing **seasonal** and **annual fine**/**coarse sediment regime**.

→ Management targets require revision due to recent upstream regulation.

→ Provision for seasonal/annual flushing should be considered by incorporating large low level gates.

Sediment management

- Flushing is likely to have a **limited effect** due to the **high sill level** at the sluice gates.
- **Low level outlets** only remove sediment in front of the power house inlets.

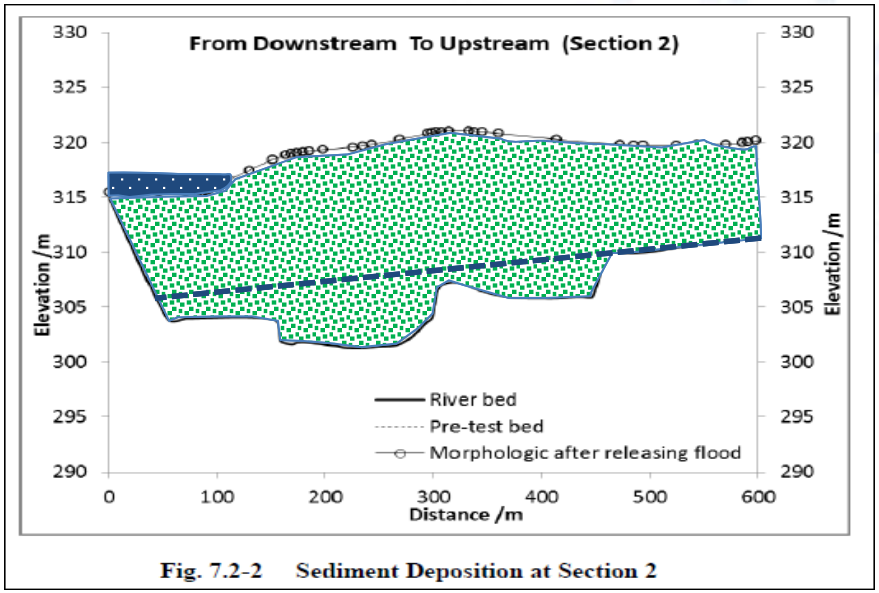


Fig. 7.2-2 Sediment Deposition at Section 2

- **Bedload** effectively trapped upstream of dam and

→ ***Lower sill level increases water surface slope & depth of sediment flushing.***

Operation & fluctuation mitigation

- **Run-of-the-river** scheme with **small storage**: reservoir operated between **335 m ↔ 340 m** at different inflows to address inundation of **Keng Pha Dai** and downstream **sediment flushing**.
  → ***Temporary impacts on both immediately up/downstream.***
- Developer proposes a maximum water level change in the reservoir of **1 m/day**, which will limit these immediate impacts.
  → ***A public information network about expected fluctuations.***
- Water levels immediately downstream are largely dependent on whether Luang Prabang Hydropower will be developed.
  → ***Reduced hydropower potential and limited operational***

→ ***Operational rule should be written in a simple format.***
→ ***Operational rule should consider above mentioned conditions and explore coordinated operations.***

Transboundary/Cumulative impact: Hydrology

- Proposed operating rules of the Pak Beng Hydropower to minimise impacts on Thailand was considered. However, it is suggested that the **potential for increased flooding upstream** of the dam needs to be more comprehensively addressed.
- Pak Beng Hydropower will **not** potentially have **substantial impacts on the seasonal flow regime** on the mainstream over and above those due to the operation of the dams in China and upstream tributaries.

Transboundary impact: Sediment

- With or without the development of Pak Beng, the sand supply in the Mekong will **decrease over the long term**.
- **Transboundary impact of Pak Beng**
  - **Disruption** to the transport of sand will reduce the quantity entering and potentially exiting Xayaburi.
  - Increase in **sedimentation** in reservoir may increase water levels relative to pre-dam conditions.
  - Water level **fluctuations** in the reservoir have the potential to increase bank erosion through scour and seepage erosion processes and could increase erosion at the mouths of Thai tributaries.

Cumulative impact: Sediment

- The project has **not undertaken** a rigorous analysis of these aspects.
- **MRC Studies** (ISH0306)
  - Very large decrease in sediment supply associated with the **Lancang cascade**.
  - Sediment trapping in **tributary dams** was projected to remove an additional 10 million tonnes, resulting in a sediment load of 21 million tonnes.
  - The **northern Lao PDR cascade** was projected to trap about 70% of that 21 million tonnes.
  - **Coordinated sediment flushing** and routing increased sediment discharge by about 30%.

Compliance with the PDG

- Minimization of rapid water level **fluctuation** in the reservoir and downstream.
- Consideration of **environmental flow**:
  → ***PMFM.***
- Inclusion of **large low level gate** and its operation to maintain **annual** and **seasonal coarse sediment** routing.
- Guidance for a formal **external engineering review**.

Recommendations

- Further studies of the inundation at the **Keng Pha Dai** reefs, and into Thailand, including the tributaries.
- Additional investigations into the incorporation of **large low level sediment** flushing gates in the flood sluicing part of the project.
- Review of sediment management strategy to ensure **seasonal** or **annual sediment** flow regimes.
- **Coordination** of sediment management and operations with other hydropower projects.
- **External engineering review** of the infrastructure associated with the sediment management aspects.

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Thank you!