Overview on Policy on Sustainable Hydropower Development(PSHD) in Lao PDR and Implementation.

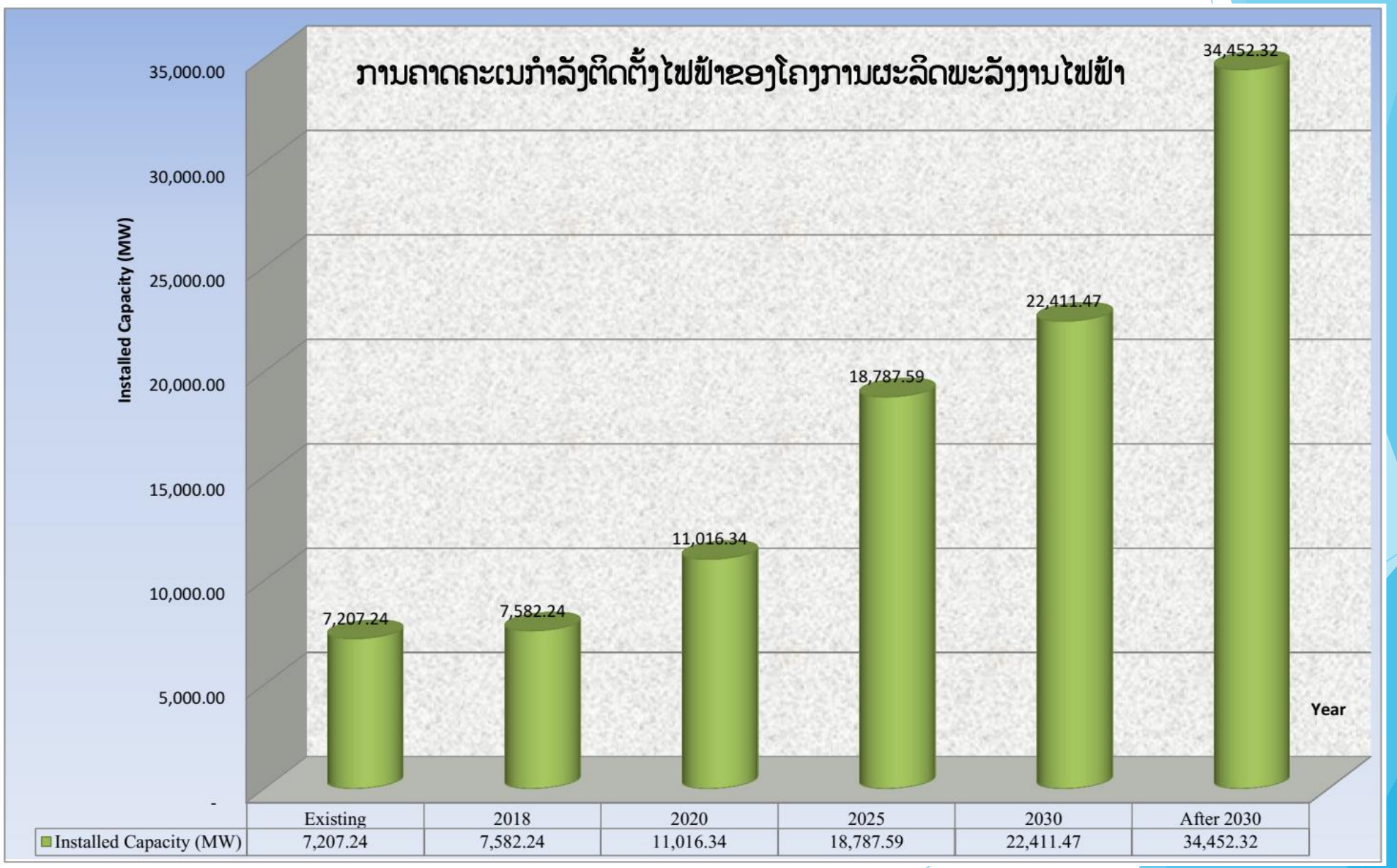
Vithounlabandish THOMMABOUT

Deputy Director General

Department of Energy Policy and Planning

Ministry of Energy and Mines Laos PDR.

Expected Hydropower Development

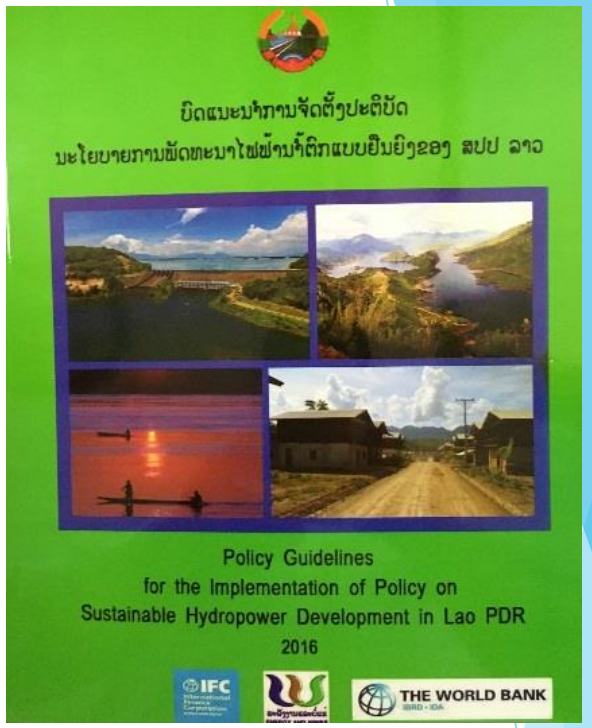


The major objectives behind the rapid growth is to provide:

- An affordable and reliable electricity supply for domestic consumers.
- Maximize the benefit for the Government through export revenue to promote socio-economic development of the country.

Key development goals of SDGs adopted by Lao PDR:

- End poverty in all its form everywhere,
- Ensure availability and sustainable management of water and sanitation for all,
- ***Ensure access to affordable, reliable, sustainable and modern energy for all,***
- Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all,
- Conserve and sustainably use marine resources for sustainable development,
- Protect, restore and promote sustainable use of terrestrial ecosystems,
- Sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss



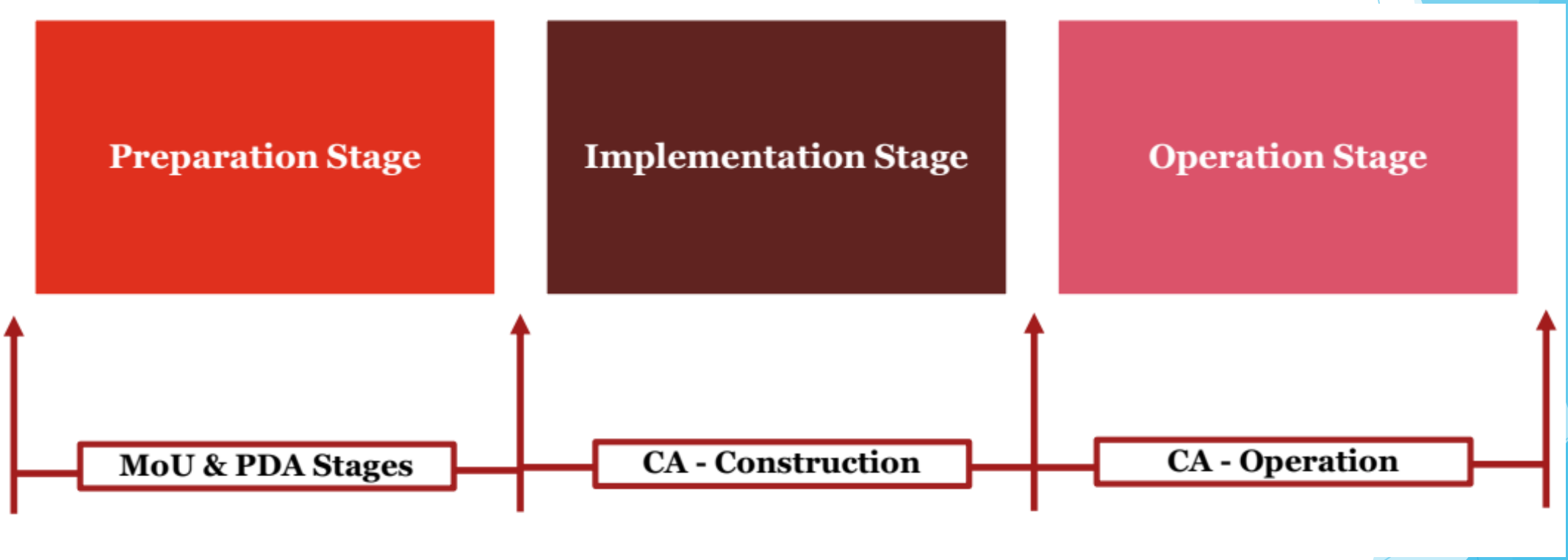
- National Policy on Environment and Social Sustainability of Hydropower (NPSH) was promulgated in 2005.
- Policy on Sustainable Hydropower Development (PSHD) was announced in 2015.
- Policy guidelines for implement PSHD was announced in 2016
- In 2017 by HMTA project supported by WB guideline for implement PSHD was updated and called Criteria On Evaluate PSHD and approved by MEM Dec 2018

Amendments in the Electricity Law (2017) that support PSHD implementation:

- Provision for integrated power sector planning for project identification and prioritization,
- Competitive resource allocation aimed at value maximization of natural resources
- Defining boundaries and stipulations for resource allocation on the basis of Unsolicited Proposals
- Proposing a robust monitoring framework and well-defined institutional arrangement for efficient project monitoring during construction and operation.
- Provision for tariff regulation for determining domestic electricity prices

Elements of PSHD Policy Guideline:

These stages correspond to the different stages as provisioned by the Electricity Law viz. MoU, PDA and CA



Preparation Stage

Project Stage	Thematic areas for sustainability assessment	Sustainability Topics
Preparation (P)	Environmental	• Environmental Impact Assessment and Management • Biodiversity and invasive species • Erosion & sedimentation • Water quality • Reservoir planning • Downstream flow regimes
	Social	• Social Impact Assessment and Management • Project affected communities and livelihoods • Resettlement • Indigenous peoples • Labor and working conditions • Cultural heritage • Public health
	Economic/ Financial	• Financial viability • Project benefits • Economic viability
	Technical & engineering	• Siting & design • Hydrological resource • Infrastructure safety

Implementation Stage

Project Stage	Thematic areas for sustainability assessment	Sustainability Topics
Implementation (I)	Environmental	• Environmental Issues Assessment & Management • Biodiversity & Invasive Species • Erosion & Sedimentation • Water Quality • Waste, Noise & Air Quality • Reservoir Preparation & Filling • Downstream Flow Regimes
	Social	• Social Issues Assessment & Management • Project Affected Communities & Livelihoods • Resettlement • Indigenous Peoples • Labor & Working Conditions • Cultural Heritage • Public Health
	Economic/ Financial	• Project Benefits
	Technical & engineering	• Infrastructure Safety • Procurement

Operation Stage

Project Stage	Thematic areas for sustainability assessment	Sustainability Topics
Operation (O)	Environmental	• Environmental Issues Management • Hydrological Resource • Biodiversity and Invasive Species • Erosion and Sedimentation • Water Quality • Reservoir Management • Downstream Flow Regimes
	Social	• Social Issues Management • Project Affected Communities and Livelihoods • Resettlement • Indigenous Peoples • Labor and Working Conditions • Cultural Heritage • Public Health
	Economic/ Financial	• Financial Viability • Project Benefits
	Technical & engineering	• Asset Reliability and Efficiency • Infrastructure Safety

PNPCA, LUANG PRABANG HPP

Ministry of Energy & Mines, Lao PDR
November 2019

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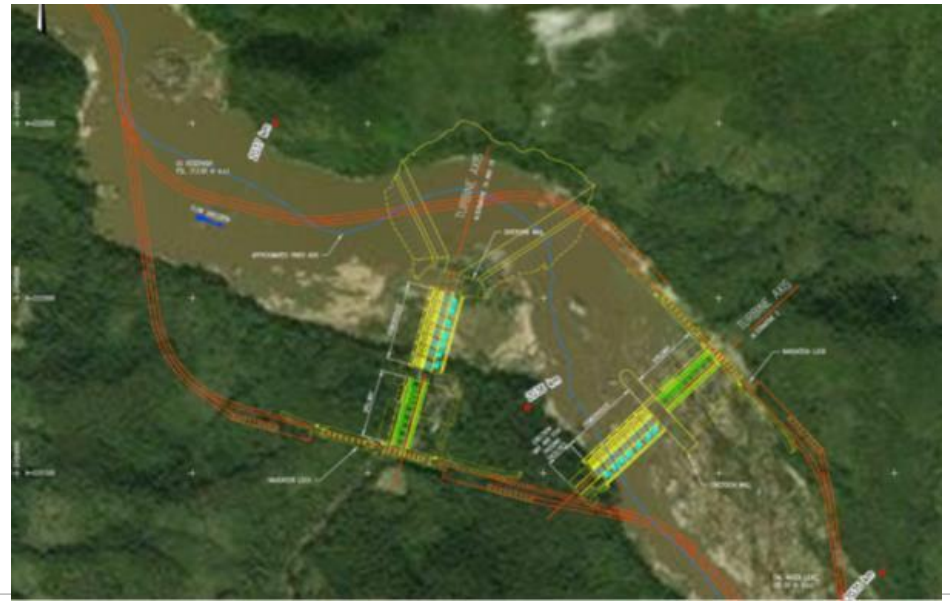
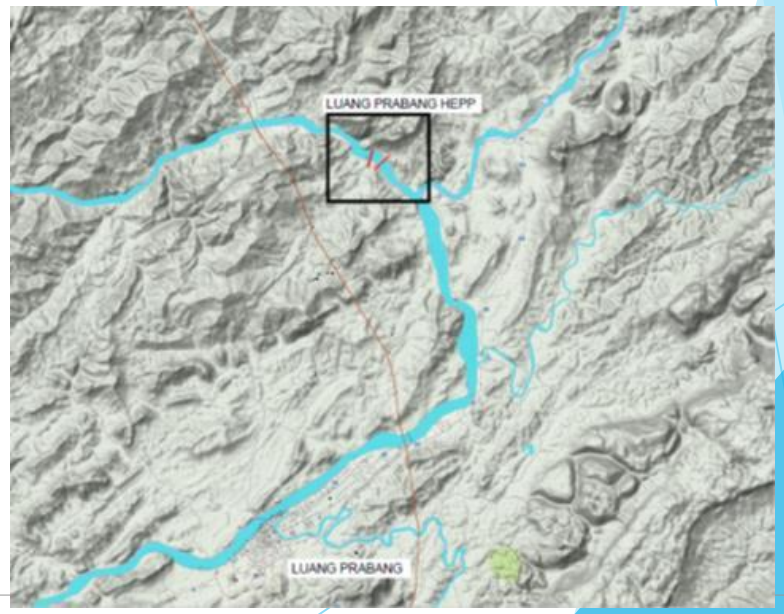
- Introduction
- General Overview
- Fish Migration
- Navigation
- Existing Infrastructure
- Sediment Management

Project overview - location

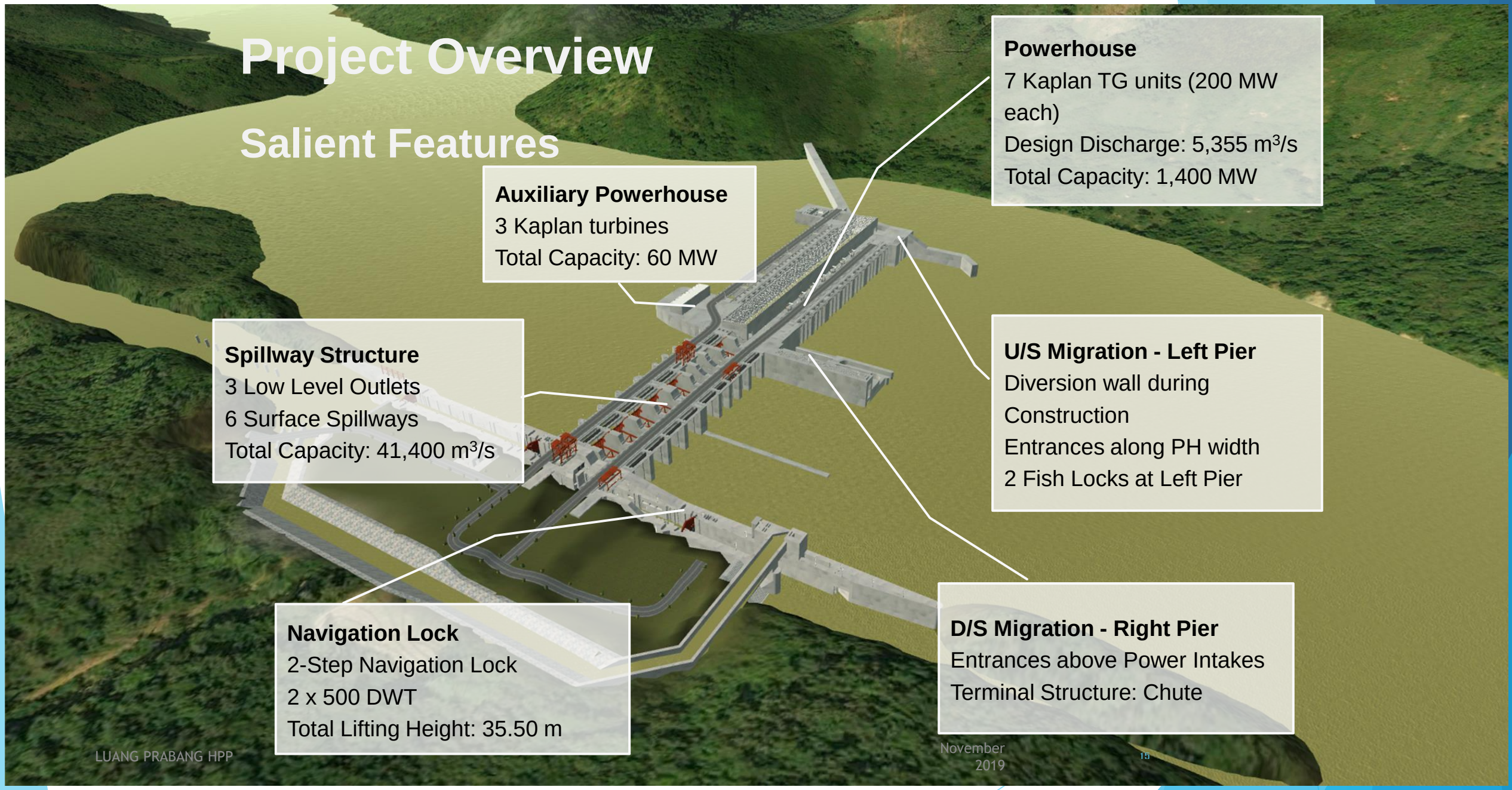
- Located at Mekong km 2036 in Luang Prabang province, Lao PDR
- About 25 km upstream of the city of Luang Prabang
- Between Pak Beng HPP (upstream) and Xayaburi HEPP (downstream)





Project Overview

Salient Features



Powerhouse
7 Kaplan TG units (200 MW each)
Design Discharge: 5,355 m^3/s
Total Capacity: 1,400 MW

Auxiliary Powerhouse
3 Kaplan turbines
Total Capacity: 60 MW

Spillway Structure
3 Low Level Outlets
6 Surface Spillways
Total Capacity: 41,400 m^3/s

U/S Migration - Left Pier
Diversion wall during Construction
Entrances along PH width
2 Fish Locks at Left Pier

Navigation Lock
2-Step Navigation Lock
2 x 500 DWT
Total Lifting Height: 35.50 m

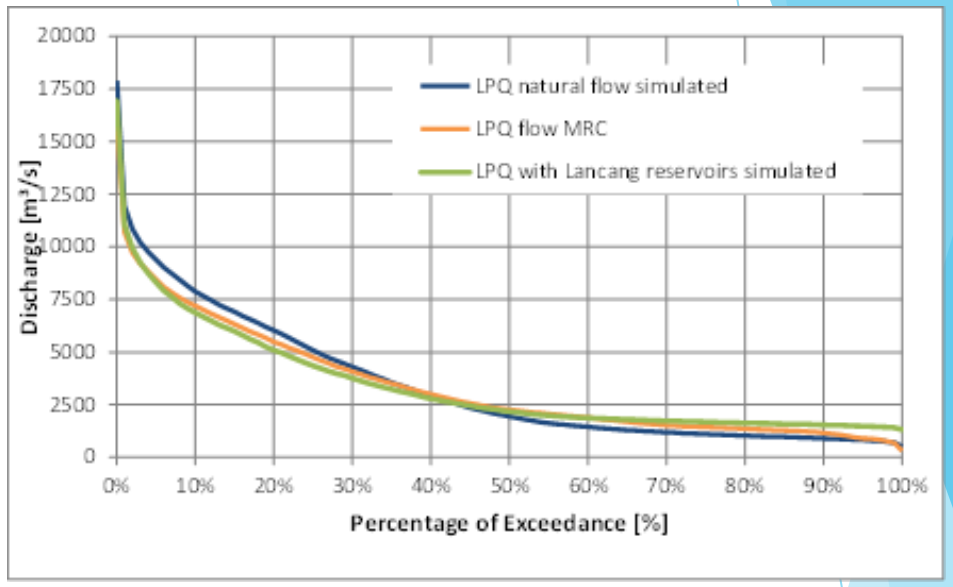
D/S Migration - Right Pier
Entrances above Power Intakes
Terminal Structure: Chute

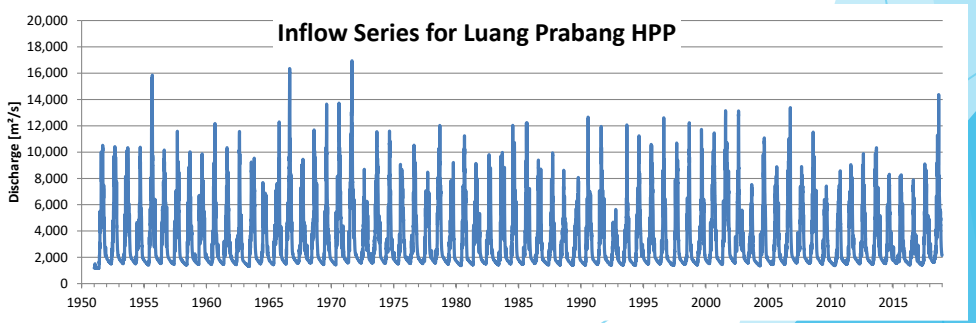
Hydrology

In general good data basis
Main focus was in impact of Lancang Cascade

- Hydrological Rainfall-Runoff Model with 60 years of data, calibrated using first 4 years of full operation of Lancang Cascade

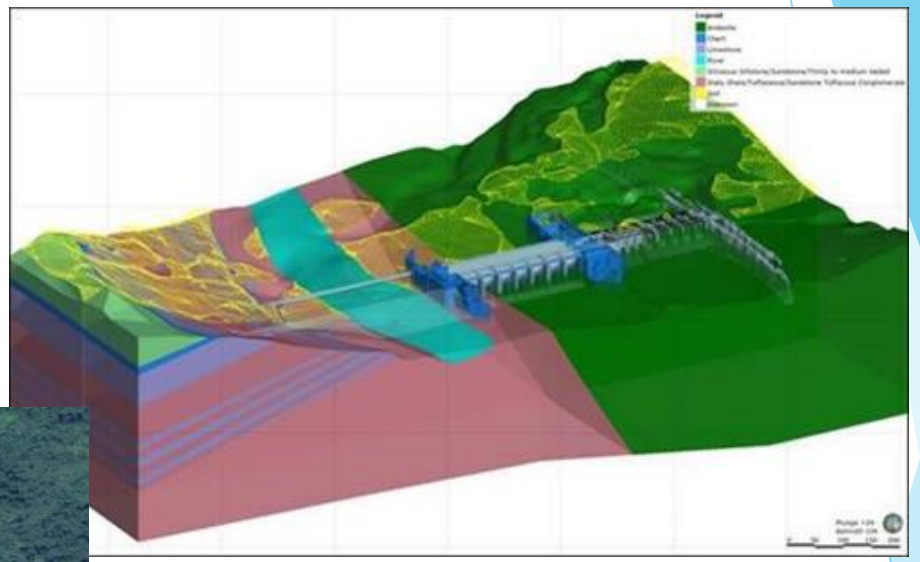
- Impact of Lancang Cascade
  - Significant higher than anticipated
  - Positive effects due to higher dry season floods
  - Sedimentation: Lancang cascade heavily impacts sediment regime in Lower Mekong





Geology

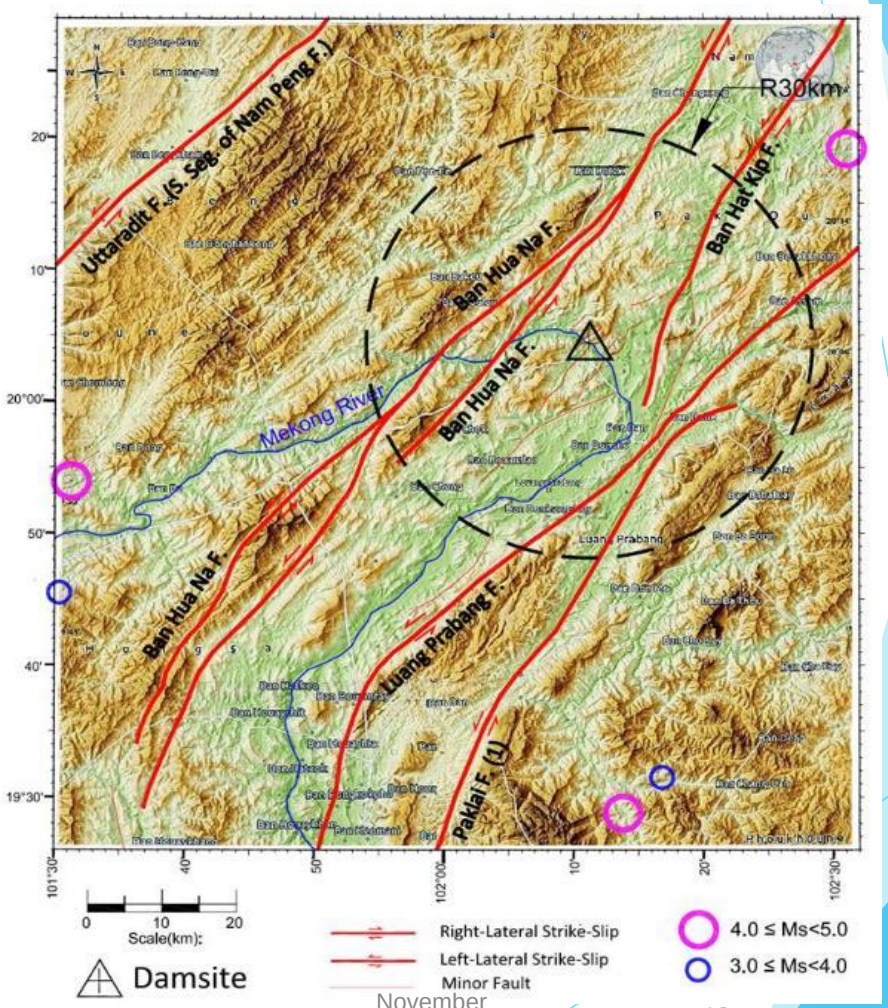
- Site investigation and laboratory testing carried out
- Geology:
  - Volcanic rocks and
  - Limestone
- Additional investigations ongoing



Seismicity

The Seismic conditions have been checked and the following conclusions have been made:

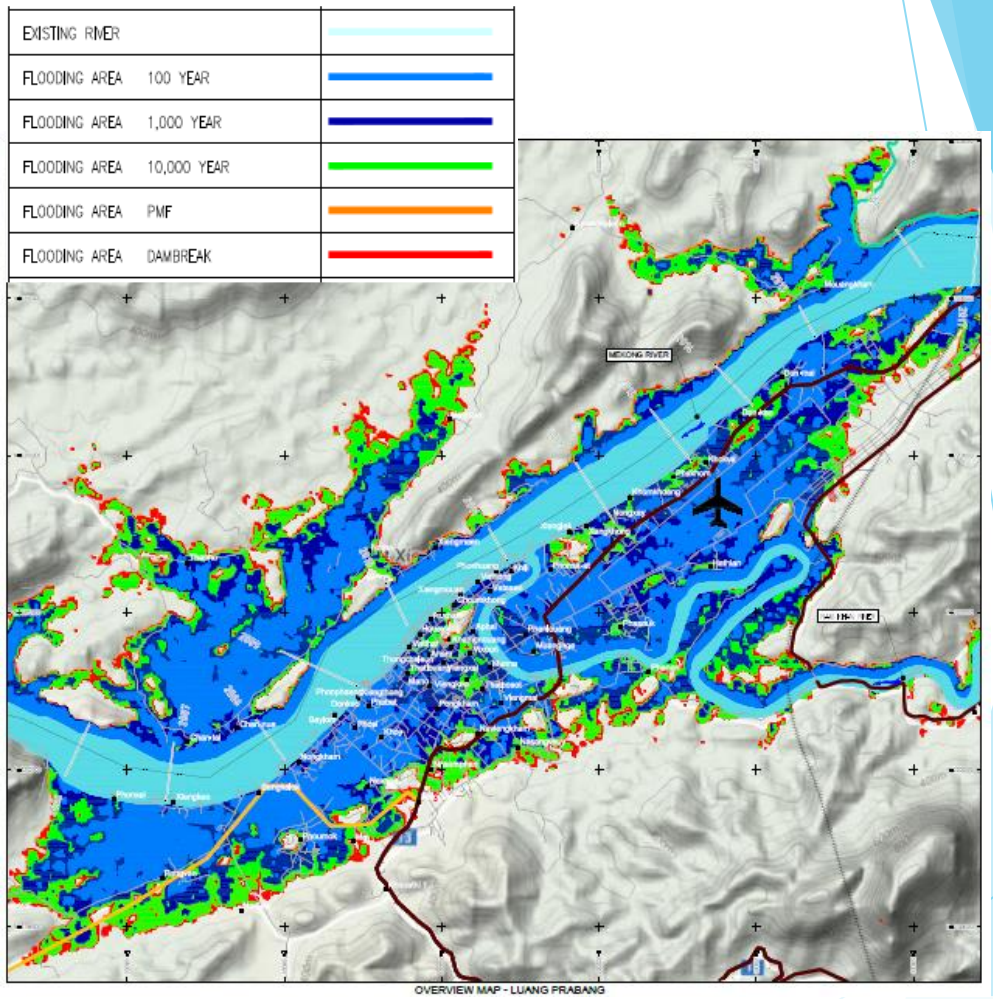
- Active faults about 10-20 km away from dam site
- Medium seismicity
- Probabilistic and Deterministic Seismic Hazard Assessment carried out
- No risk of reservoir triggered seismicity



Dam Safety

The dam break analysis are based on the following scenarios:

- The failure modes for Concrete Gravity Dams are given in ICOLD Bulletin 99 and 111
- Dam break based on a 100-year flood
- The peak of the dam break flood will be in range the PMF flood.

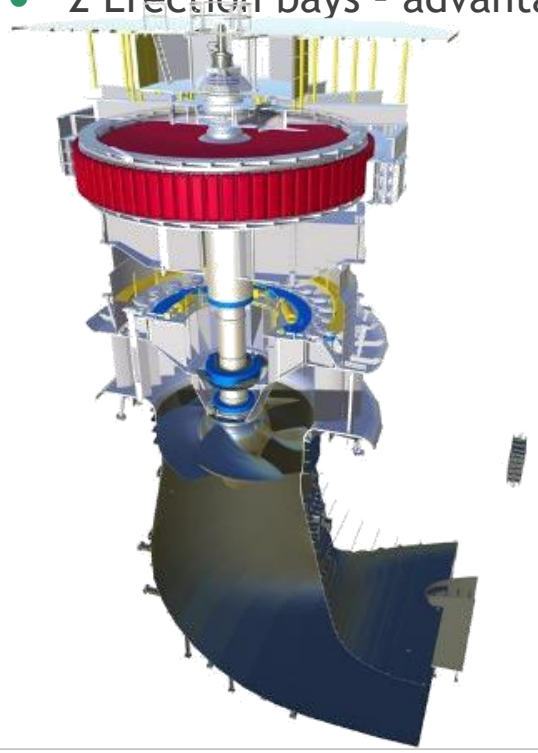


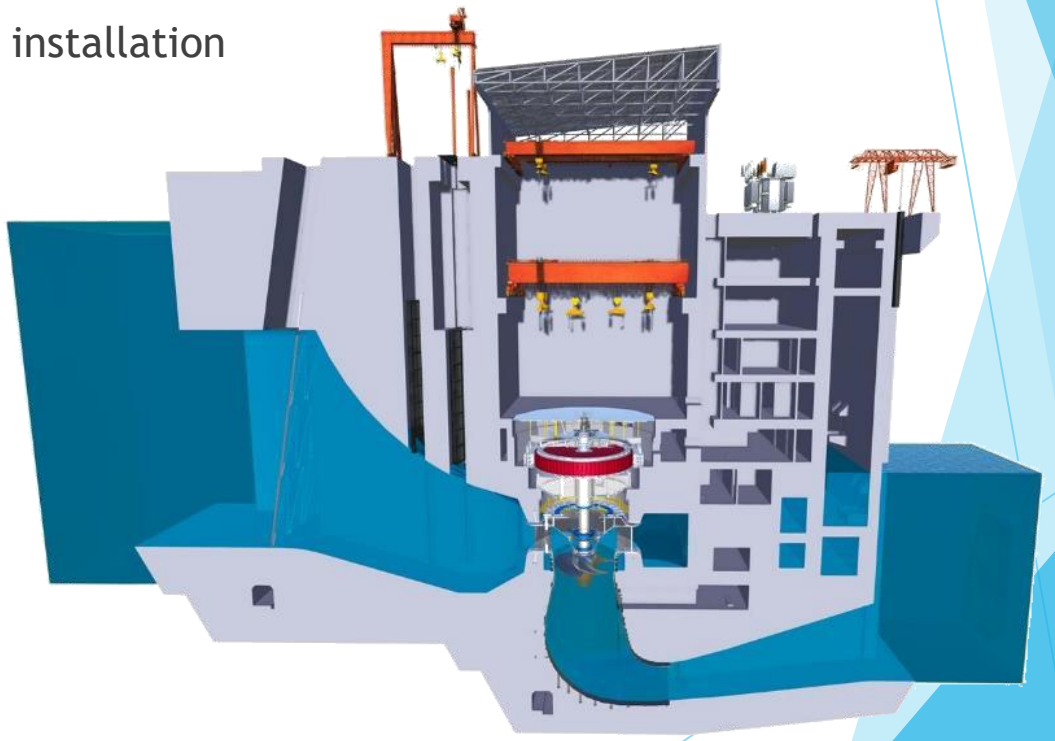
Natural Flood Map of Luang Prabang

Main powerhouse

Barrage Type Powerhouse

- 7 main units a 200 MW
- Total Installed Capacity: 1400 MW (main Units only)
- 2 Erection bays – advantages for installation

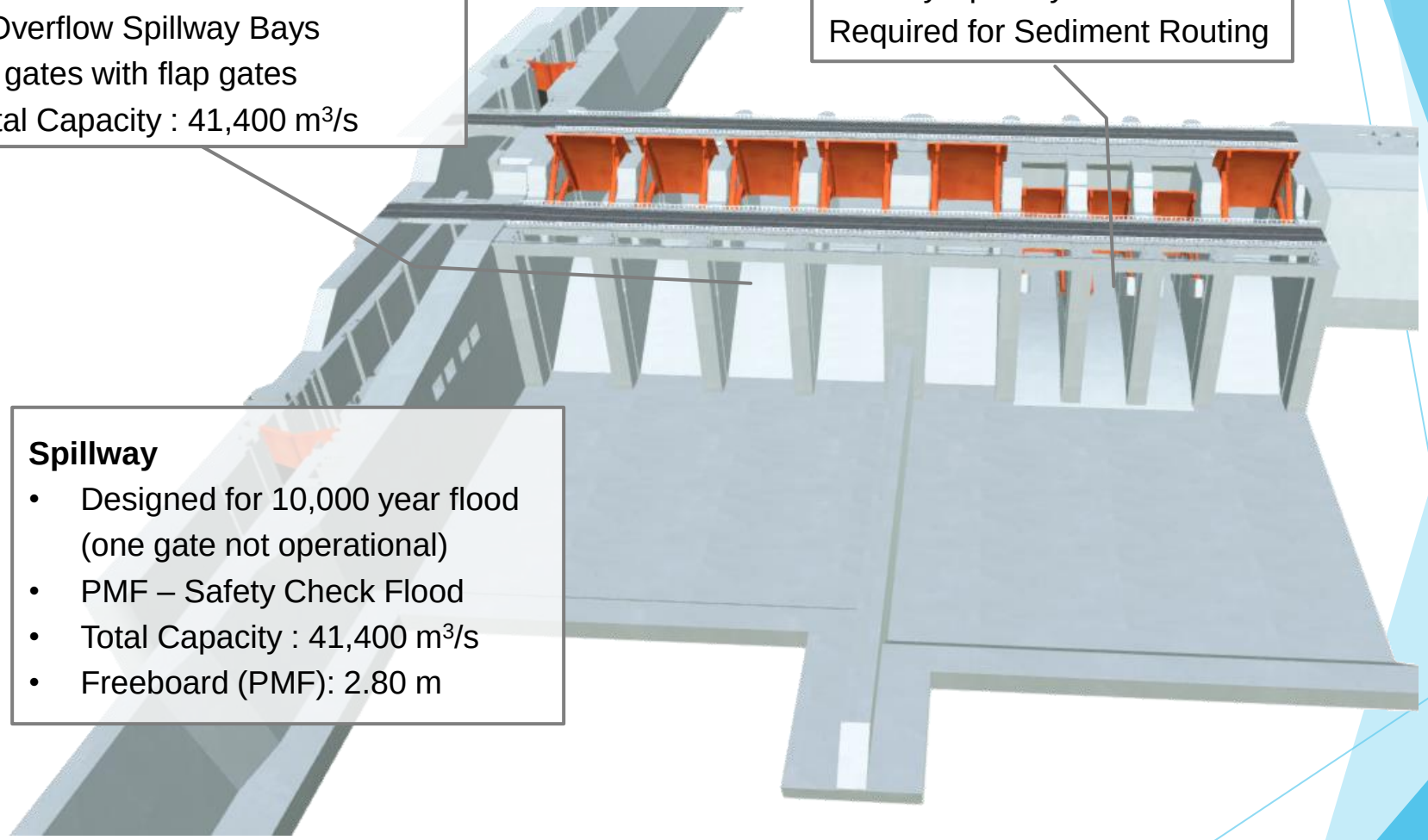




Spillway

Surface Spillway
6 Overflow Spillway Bays
All gates with flap gates
Total Capacity : 41,400 m^3/s

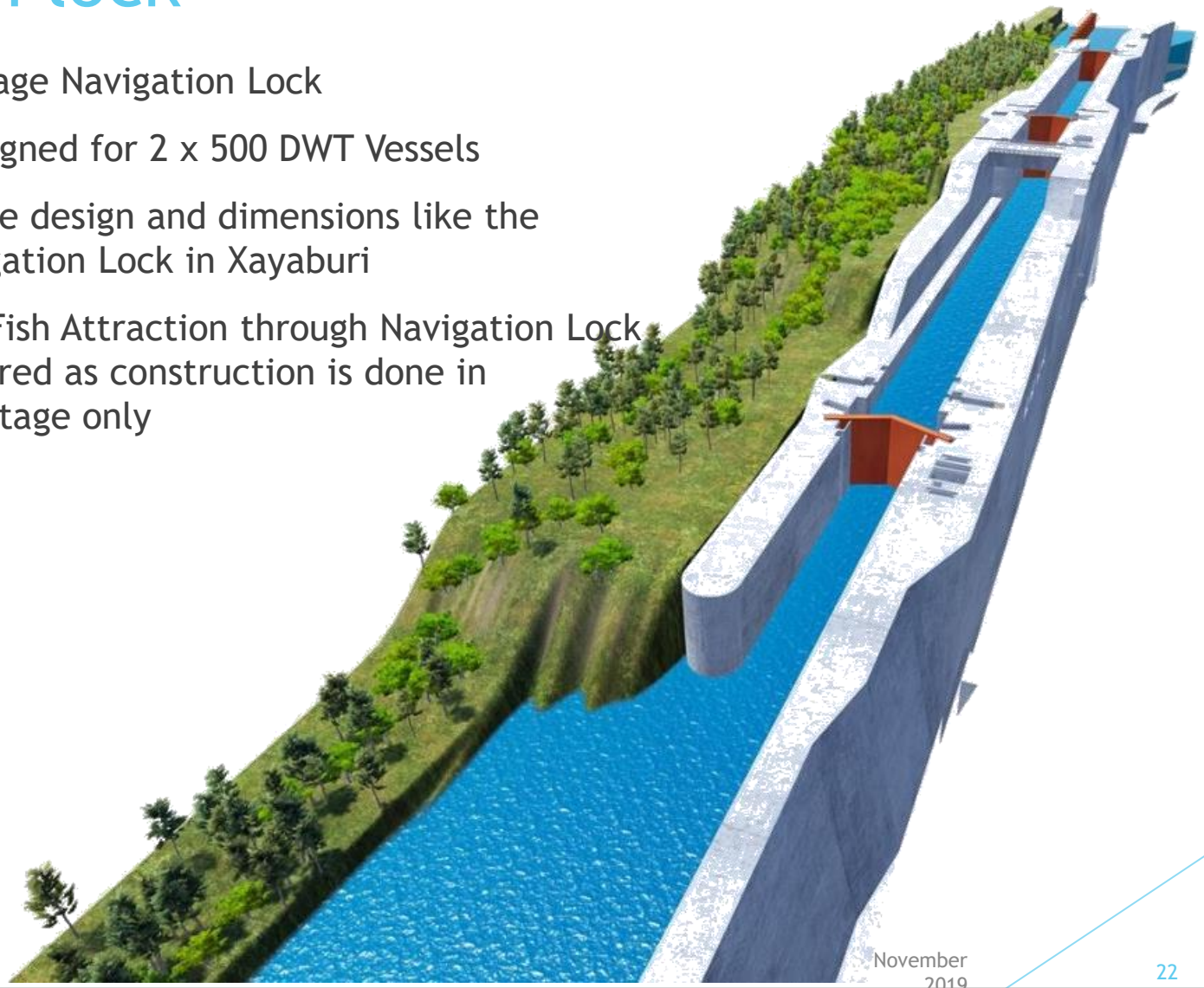
Low Level Outlets
3 Bays
Primary Spillway Devices
Required for Sediment Routing



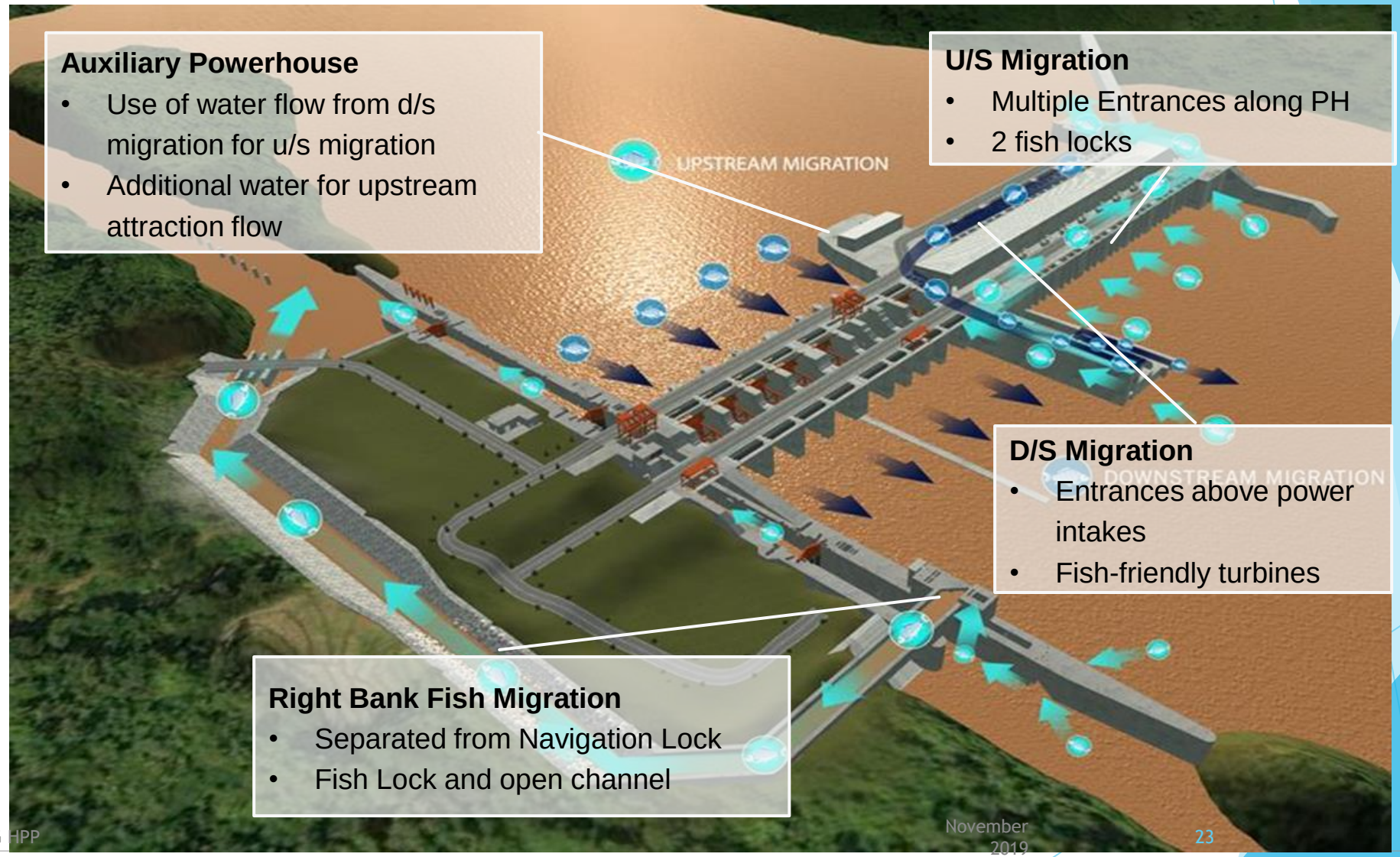
Spillway
- Designed for 10,000 year flood (one gate not operational)
- PMF – Safety Check Flood
- Total Capacity : 41,400 m^3/s
- Freeboard (PMF): 2.80 m

Navigation lock

- 2 stage Navigation Lock
- Designed for 2 x 500 DWT Vessels
- Same design and dimensions like the Navigation Lock in Xayaburi
- No Fish Attraction through Navigation Lock required as construction is done in one stage only



Fish Migration - Overview



Auxiliary Powerhouse

- Use of water flow from d/s migration for u/s migration
- Additional water for upstream attraction flow

U/S Migration

- Multiple Entrances along PH
- 2 fish locks

D/S Migration

- Entrances above power intakes
- Fish-friendly turbines

Right Bank Fish Migration

- Separated from Navigation Lock
- Fish Lock and open channel

Fish Migration System - General

- **Compliant with MRC Design Guidance**
  - Upstream Migration with entrances over entire length of Powerhouse
  - Downstream Migration with entrances above Powerhouse
  - Upstream Migration at right bank – Spillway Operation, Navigation Lock
  - Fish Friendly Turbine Technology with survival rates between 92% to 97%
- **Same Functionality like Xayaburi**
  - Simplified and optimized design
  - One (1) Auxiliary Powerhouse (3x20MW) instead of two Pumping Stations (not required)
  - No Fish Ladder needed due to reduced tailwater level fluctuations
- **Experience with Fish Migration System in Xayaburi**
  - Already in operation since several months
  - System works as expected from the very first day

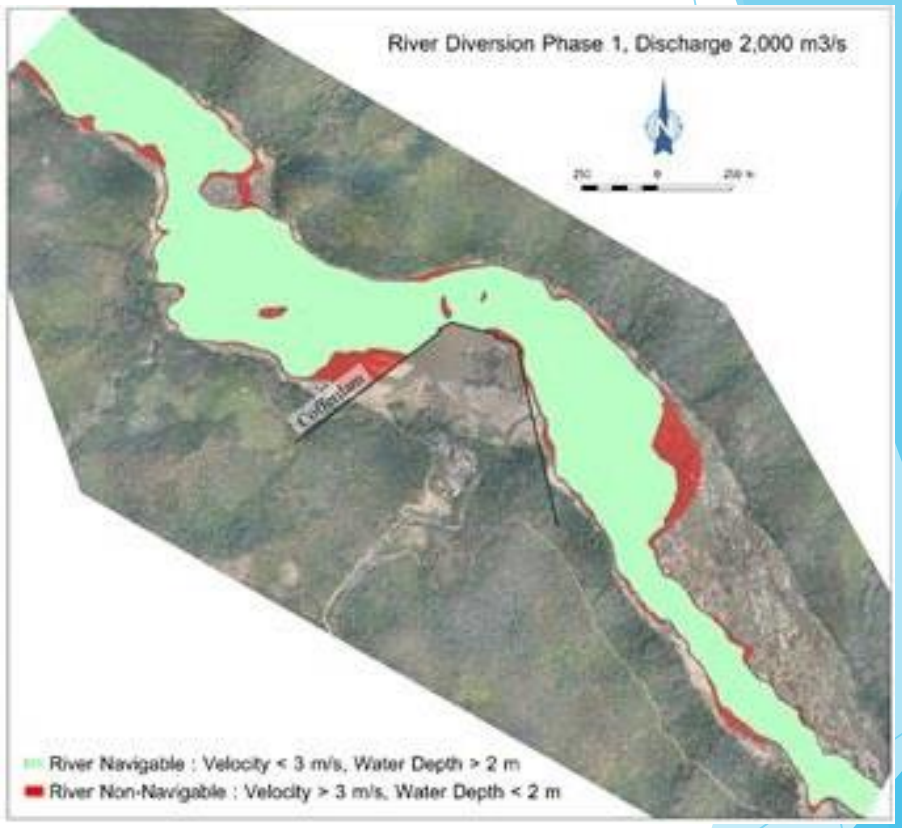
Navigation Lock Design and Operations

- Design and layout of the Navigation Lock follows the recommendations of the MRC Design Guidance. Same design as in Xayaburi which operates since more than 4 years safely
- All requirements have been addressed adequately in the Design.
- An additional second Navigation Lock is indicated in the design

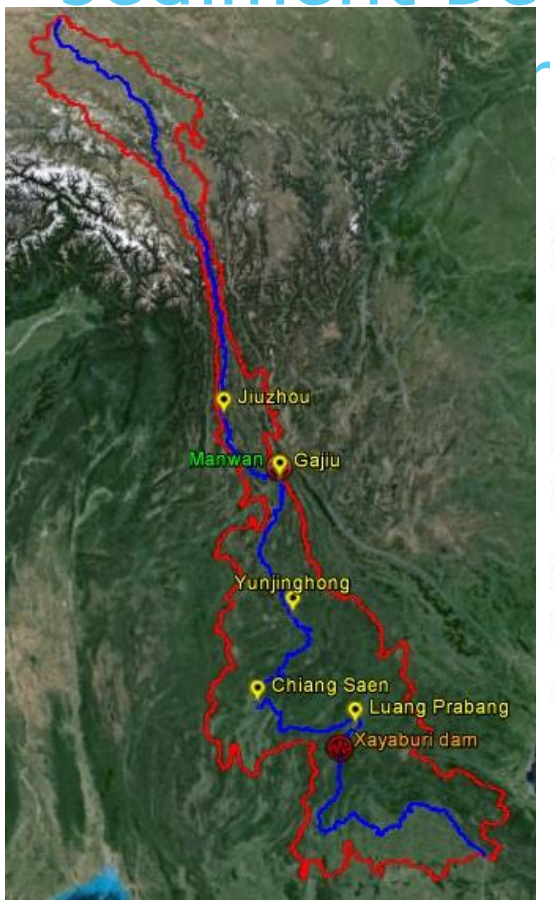
Salient Features	
Type of Lock	2-step Navigation Lock
Design Vessel	2 x 500 DWT
Max. Passage Time	50 Minutes
Max. Lifting Height	35.50 m
Length / Width (chamber)	120 m / 12 m
Min. water depth	5 m
Standards used:	MRC Design Guidance PIANC report n.o. 106

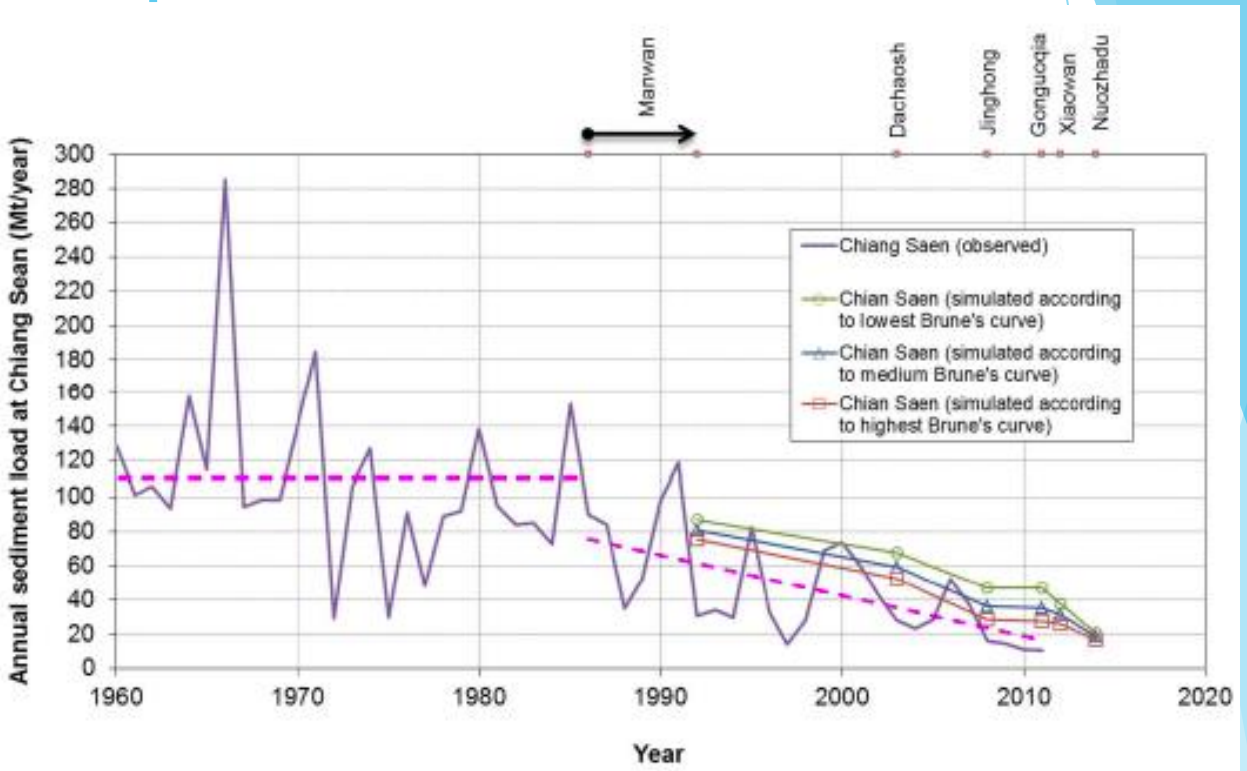
Navigation During Construction

- Navigation Requirements
  - Up to 8000 m^3/s safe navigation in the main channel is possible
- Numerical Model
  - 2D numerical model to check the navigability and proved
- Conclusions
  - Outcrop removal to improve navigability
  - Support during construction
    - Tugging boat support will be provided (for smaller vessels or higher discharges)
    - Small boat transfer with overland trailer



Sediment Development in the Lower



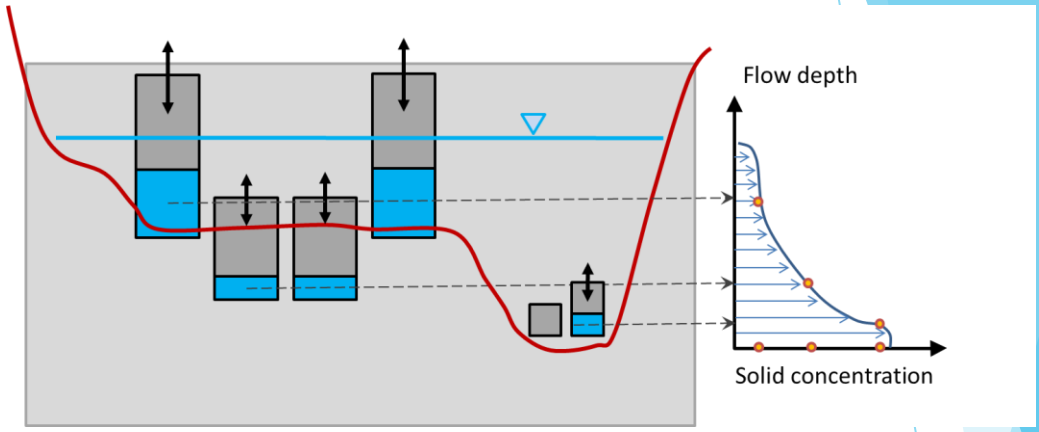


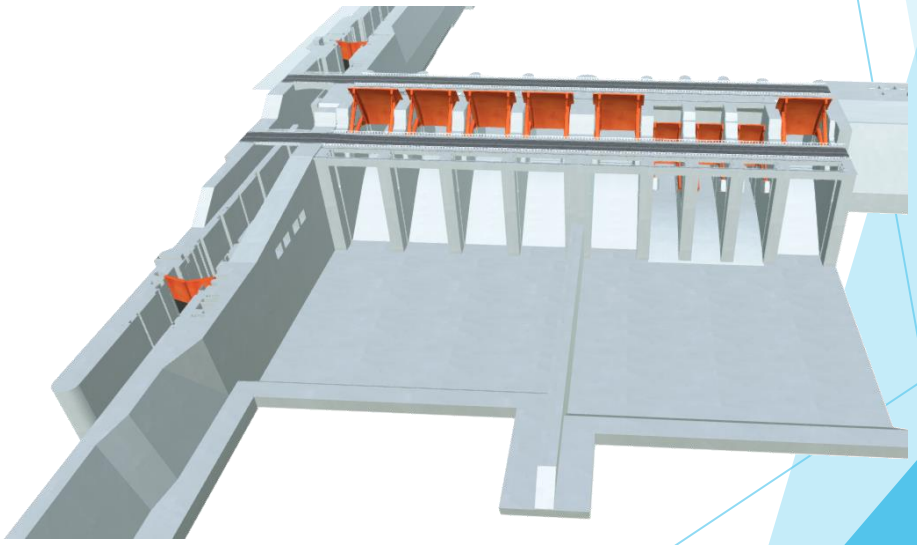
Source: Compagnie Nationale du Rhône

- Sediment Data, all available data collected
- Impact of u/s Lancang Cascade,
  Reduction from about 110 million ton per year to about 20 to 24 million ton per year

Sediment Management

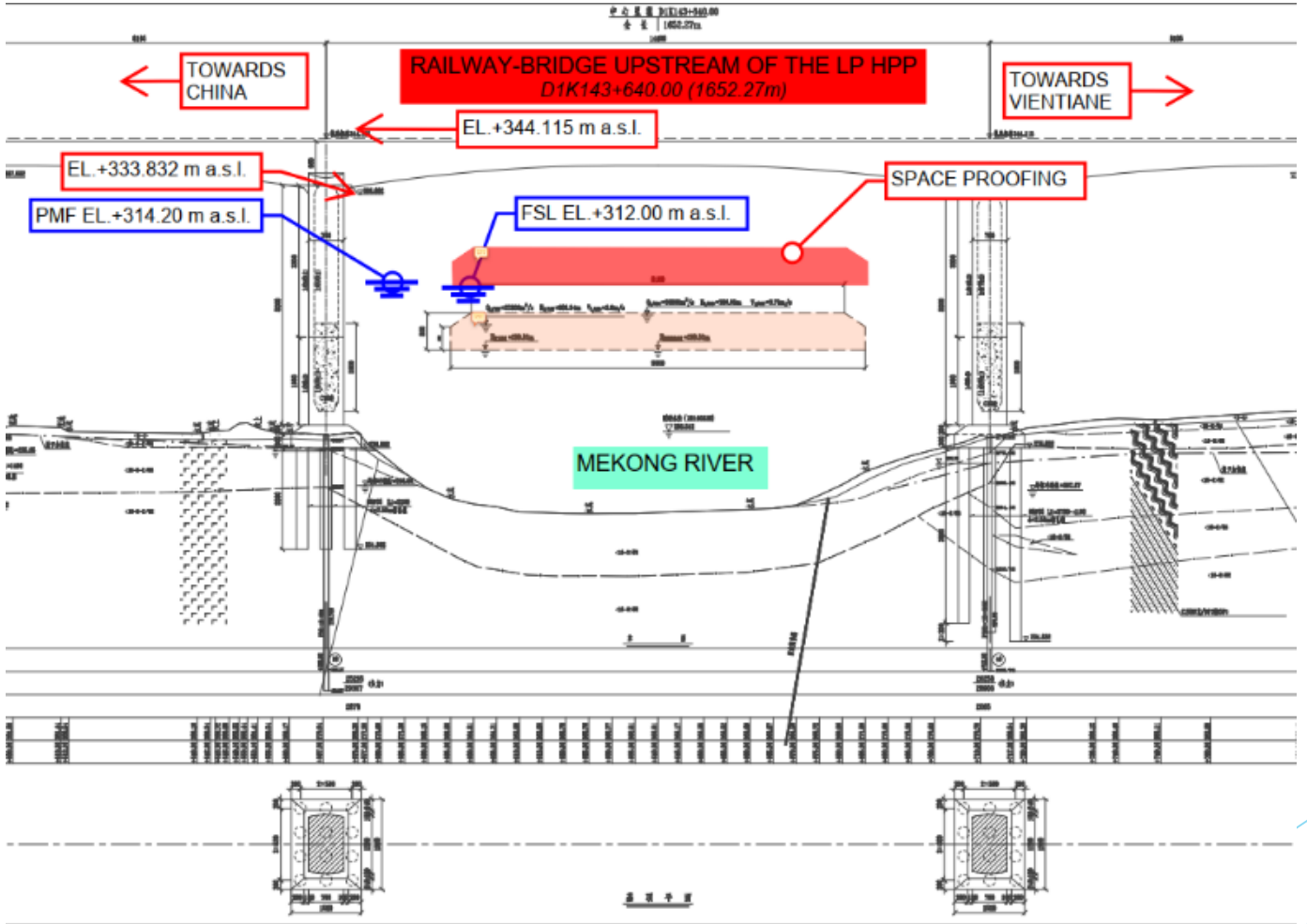
- The Sediment management is envisaged to route as much sediment (fine and suspension fractions) through the Low Level Outlets and the turbines.
- The Low Level Outlets are the first gates to open beyond Mekong flow of 5,355 m3/s
- This will avoid large sediment concentration flows downstream and negative environmental impacts
- Maintain similar sediment concentration as in natural conditions
- The exact geometry of the approach channel will be evaluated in the hydraulic model test currently ongoing





Existing Infrastructure

The existing infrastructure has been checked, e.g. railway bridge



Thank you for your attention

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