

# ENVIRONMENTAL STUDY OF THE LANCANG-MEKONG DEVELOPMENT PLAN

## Impact Assessment

Photo: Petro Kotze (ICEM)

### 1. APPROACH

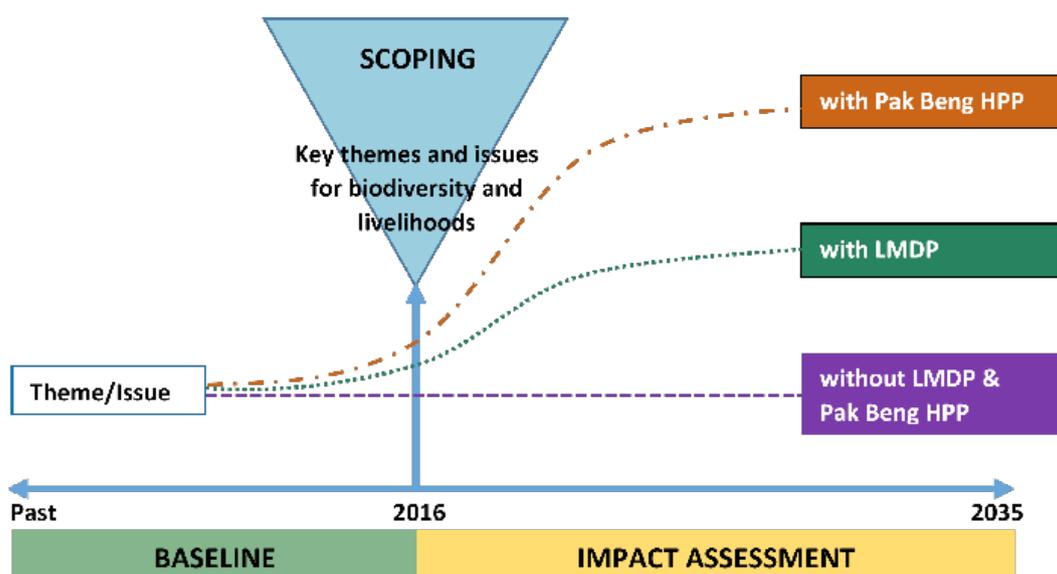
The impact assessment uses trend analysis to identify the cumulative effects of the LMDP and Pak Beng HPP reservoir on future trends and drivers relating to the key themes and environmental and socio-economics issues identified in the baseline phase. Three scenarios were generated (Figure 1):

- 1. Baseline:** Past, current and future trends without the LMDP and Pak Beng HPP reservoir.
- 2. LMDP:** Future trends with the LMDP
- 3. Pak Beng HPP reservoir:** Future trends to 2030 with the Pak Beng HPP reservoir

The assessed impacts of the **LMDP** and **Pak Beng HPP** scenarios were compared to a projected pathway to 2035 without the LMDP and Pak Beng HPP. This phase included assessing implications on the national/regional/global conservation value of Red List species and the impacts on hydromorphology and riparian communities.

Due to the differing impacts that can be expected from the proposed developments along the target river stretch, the study reach was divided into three assessment zones representing the areas of influence of the developments and distinctive biophysical features (Figure 2).

Figure 1: Trend analysis of scenarios with and without LMDP and Pak Beng HPP reservoir



**ZONE 1 - Golden Triangle to the Thai-Lao border (approx. 98 km):** This region has four MRC surveyed dangerous areas for navigation, where obstruction removal and channel dredging under the LMDP is likely. Construction of the Houay Xay and Chiang Khong ports as part of the LMDP will also occur in this zone.

**ZONE 2 - Thai-Lao border to Pak Beng dam site (approx. 94 km):** The impoundment reservoir of the Pak Beng HPP is expected to reach as far as the Thai-Lao border. This region has seven dangerous areas likely to be subject to obstruction removal and channel dredging under the LMDP. However, with construction of Pak Beng HPP, this whole section will become a reservoir and it is expected that the navigation improvement works under the LMDP would only be needed in the upper parts of the reservoir.

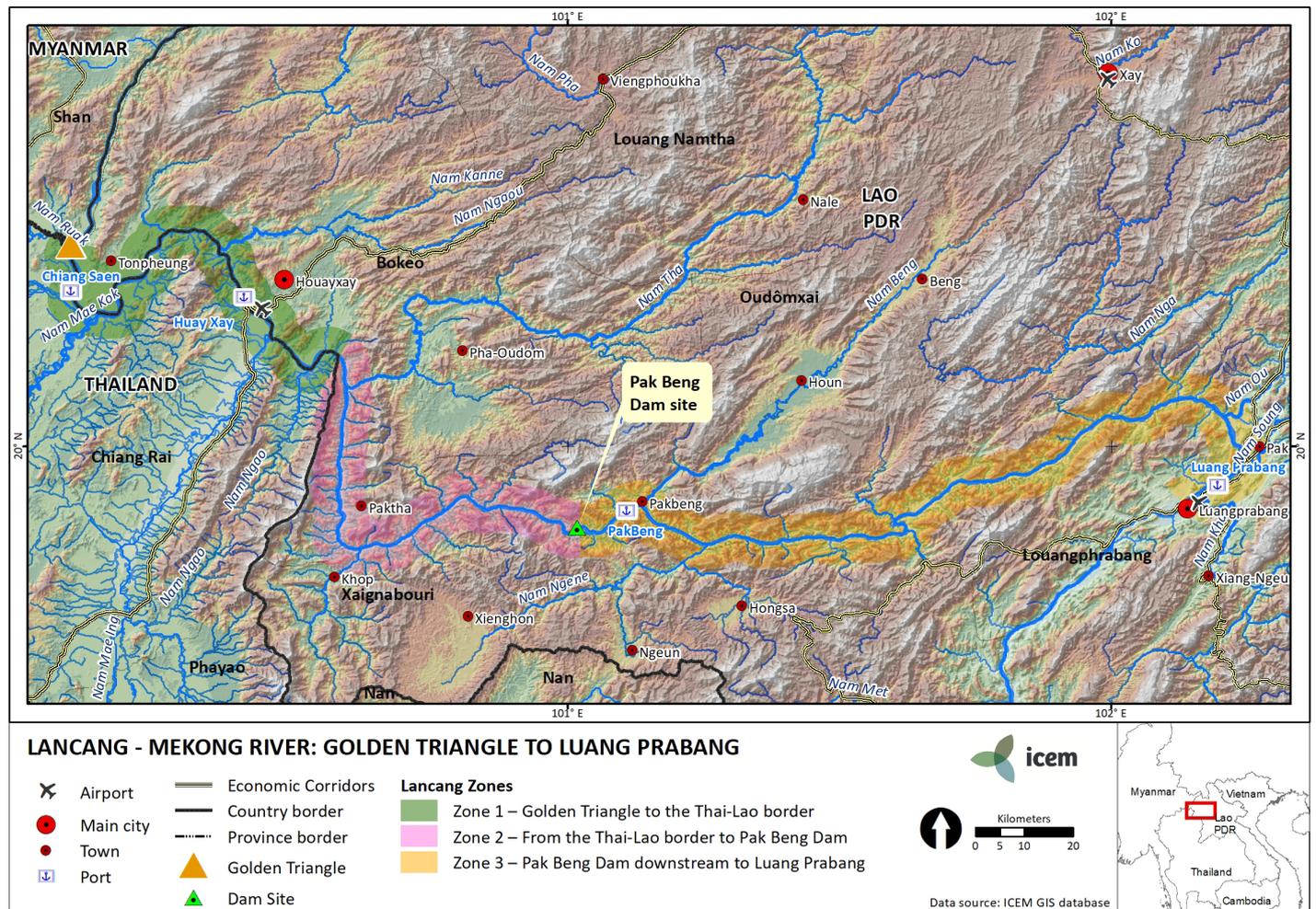
**ZONE 3 - Pak Beng dam site to Luang Prabang (approx. 176 km):** This stretch is located downstream of the proposed Pak Beng HPP

dam and has twelve surveys dangerous areas where river improvement works under the LMDP are expected. Impacts in this stretch of the river include: removal of obstructions, dredging and port construction (at Pak Beng and Luang Prabang) associated with river improvement works; and impacts from the upstream Pak Beng HPP dam, reservoir and operations.

The impact assessment is split into:

- 1 Assessing the impacts of the LMDP river improvement works, ports and operation of larger boats in Zones 1, 2 and 3; and
- 2 Assessing the impacts of Pak Beng in Zones 2 and 3. The impact assessment in Zone 2 focusses on changing the river to a reservoir. The impact assessment of Pak Beng in Zone 3 focusses on altered flow and sediment regimes from the dam construction and scheme operation.

Figure 2: Study assessment zones



## 2. RESULTS

### 1.2.1 Primary potential impacts from the LMDP

The immediate and longer-term changes resulting from the LMDP activities in all three zones are shown below. It is these changes that were used to assess the impacts on biodiversity and socio-economics.

**ZONES 1 to 3: Golden Triangle to Luang Prabang (whole study reach)** - approx. 368 km; 23 dangerous areas - focus on navigation improvement works under LMDP

#### Construction phase:

- ✓ Rocky materials may be released and distributed in the immediate area of obstruction removal (the team's case study of Kheng Pai Dai estimates removal of 20,500 m<sup>3</sup> of rock)
- ✓ Some rocky material is likely to be deposited in deep pools downstream of obstruction removal. The volume of materials deposited in deep pools cannot be estimated at this stage
- ✓ Sand from bed, banks and islands will be removed through dredging (the team's Hat Ngao case study estimates removal of 100,000m<sup>3</sup> of sand)
- ✓ Sand from sand banks and islands may be deposited downstream and on adjacent banks (the location for depositing large quantities of dredged materials is not identified in the LMDP)
- ✓ Port construction and annual dredging of channels will involve clearing and releasing materials into the river
- ✓ Waves from obstruction removal and related large boats may lead to increased bank and island erosion where not bedrock

#### Box 1: Note on impact assessment approach

The impact assessment adopted an approach to include all possible impacts. The study team recognises that many impacts could be avoided or reduced if best-practice approaches are followed in river improvement and hydropower management. Nonetheless, it is the role of this study to highlight all possible impacts, assess their risk and propose mitigation options. This approach highlights the consequences of not adopting best practice, and leads in the mitigation phase to identification of best practices that need to be adopted.

#### Long term impact:

- ✓ The main river channel will be wider and less obstructed (extent of change is not known at this stage, although the team's 2 case studies applying best practice indicate a minor change)
- ✓ The flow in the channel may be less restricted and consequently the flow may be slower (unless removed materials are placed within the vicinity of removal to replicate natural obstruction)
- ✓ Slower flows may reduce sediment generation due lower rates of bank erosion
- ✓ Sediment transport may be reduced – resulting in potential greater build up of sediment upstream and decreased sediment supply downstream
- ✓ Increased large boat traffic will cause bank erosion and pollution



## 1.2.2 Primary potential impacts from Pak Beng HPP

The immediate and longer-term changes resulting from Pak Beng Dam in Zone 2 and Zone 3 are shown below. The impact of Pak Beng HPP is expected to be less in Zone 1 although flow rate and sedimentation could be affected, in addition to overall aquatic ecology due to diminished migratory species and communities. The primary changes identified in Section 1.2.1 are used to assess the impacts on biodiversity and socio-economics in Zones 2 and 3.

**ZONE 2 From the Thai-Lao border to Pak Beng Dam** - approx. 94 km with 7 dangerous areas; dam = 62 m, reservoir = 90 km long - focus on impacts from creation of Pak Beng dam and reservoir

### Construction phase:

- ✓ Increasing water levels and decreasing flow velocity upstream of dam as the reservoir fills

### Long term impact:

- ✓ Change from lotic to lentic environment upstream of the dam
- ✓ Sediment transport will be reduced – resulting in sediment build up at the upstream end of the reservoir
- ✓ Existing riverine habitats will be flooded
- ✓ Anaerobic conditions in the reservoir, down to a certain depth (regardless of vegetation, because of reduced circulation)
- ✓ New delta's forming at the bottom of tributaries (likely located further upstream of tributary)
- ✓ Barrier to sediment and fish passage

**ZONE 3 From Pak Beng Dam downstream to Luang Prabang** – approx. 176 km with 12 dangerous areas - focus on downstream impacts from construction and operation of Pak Beng HPP

### Construction phase:

- ✓ Rocky materials may be released and distributed in the immediate area of the dam construction
- ✓ Some rocky material is likely to be deposited in deep pools downstream of dam construction
- ✓ Increased vehicle traffic around dam construction site may increase sediment loads downstream
- ✓ Limited or no flow downstream as the reservoir fills

### Long term impact:

- ✓ Erosion of bed and banks is likely to occur in areas without bedrock due to reduced sediment supply from Pak Beng
- ✓ Increased temperature variability downstream
- ✓ Reduced water quality due to anaerobic conditions of lake
- ✓ Depending on operation mode, water level variability downstream may cause bank and island erosion
- ✓ Depending on operation mode, there may be small or large-scale changes in the flow regime - likely to be some flattening of the hydrograph resulting in reduced area of seasonally inundated habitat
- ✓ Change in the sediment size distribution of the channel bed

### 1.2.3 Understanding the nature of navigation improvement works

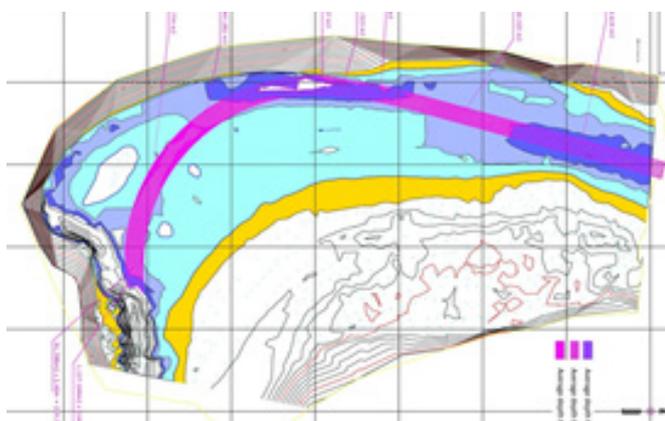
Navigation channel improvements are in most cases surgical excavations if best practice is applied, mainly consisting of chiseling rocky banks or removal of scattered rock outcrops in the middle of the channel, that generally impact on a small part of the entire surface of the outcrop. To better understand the likely scale and nature of navigation works to occur under the LMDP (if done according to typical international practice familiar to the ES navigation team), example channel designs were

conducted on two MRC surveyed dangerous areas for navigation both in Zone 1 of the study stretch:

- 1 DA-01 at Km 2,324, named Hat Ngao: shallow area over a distance of 1,100m; and
- 2 DA-04 at Km 2,289, named Keng Nhoy. The series of rapids, just at the border of Lao-Thailand, are commonly called "Keng Pha Dai" and stretch from Km 2,287 to Km 2,290. These are notorious rapids with bends, rock outcrops, narrow channel and strong currents

**The assessment revealed the following:**

Hat Ngao	Keng Nhoy
No rock removal necessary	20,501.499 m3 removal of rock - chiseling channel banks
Channel in sandy area to be dredged	Represents 6.97% of wet surface at low water level/ 1.88% of total rapid surface - 98.12% of rapid untouched
103,000 m3 sand to be dredged annually	Vessels up to 1,500-1,600t (3m water depth) gain access
Without river training works upstream, gully might silt up	



Yellow = Mekong floodplain  
 Pink = dredge depth 1.5-2.5m  
 Blue = water depth



Pink = areas to be removed



## 1.2.4 Summary of LMDP Impacts

### ✓ Hydrology and sediment

The LMDP dredging of sand from bed, banks and islands for navigation improvement will cause downstream bed and bank erosion. The clearing of sediment for port construction, and increased large boat traffic will also cause bank erosion through wave action. Both impacts will have moderate consequences but are nonetheless considered high risk due to their likelihood and need to be adequately managed.

### ✓ Aquatic ecology and biodiversity

The assessments of impacts on the aquatic ecology show that generally the navigation improvement works have a low impact, especially when the works have been completed and the river ecology has been given time to recover and stabilise after the localised and short time period of the works. However, there are certain features which may be more sensitive to these works, especially the more labile sand and pebble flats. On the operational side, the increase in large boat traffic will contribute to the gradually declining water quality in this stretch of the river and the risks of accidents and spillages will also increase. Also, the need for annual dredging of some stretches and dumping of dredge spoils could lead to diminished habitat diversity if not carefully managed.

The LMDP is likely to impact fish, amphibians and reptiles and bird populations through some habitat loss or alteration, reducing food sources and availability, facilitating increased hunting, reducing water quality and direct mortality through blasting and wave action. The operational phase impacts on water quality and water disturbance are likely to be more significant than the construction phase impacts. However, if adequately managed, none of the LMDP impacts are considered likely to cause

permanent reductions in population or loss of species in these groups. Nevertheless, more detailed studies of the specific habitat requirements of species using the rapids is required. In particular, the dependency of fish species on flows and sediment types, either for spawning or via foraging on benthos – and the expected changes in these parameters from the improvement works.

### ✓ Socio-economics

The assessment used the biophysical impacts from other sections of the environmental study as a base, and also made projections about potential socio-economic impacts based on projected alterations in the river use as well as changes because of major developments such as port facilities. The LMDP is likely to cause some direct negative impacts, particularly on poor or near poor rural people who depend on river bank gardens, fishing or harvesting of kai for income or sustenance through erosion of river banks and sediment pollution. Increases in water pollution raise the likelihood of health impacts. There are also several indirect impacts associated with the increase in passengers, workers, trade and construction following and surrounding port development including increases in social and health problems.

Undoubtedly, there will be positive socio-economic changes associated with the implementation of the LMDP. Improved navigation is likely to enhance tourism potential in the area, and so there will be employment for tour operators, guides, transport operators (both on and off the river), as well as potential for increased accommodation facilities along the river. However, in the study area, it is generally the more affluent who will be able to take advantage of tourism opportunities to become tour operators and hoteliers, and even guides will need to be able to speak foreign languages such as Chinese, Thai, Vietnamese or English in order to communicate with foreign tourists.

## 1.2.5 Summary of Pak Beng HPP Impacts

### ✓ Hydrology and sediment

The Pak Beng HPP reservoir will cause increased water levels and flooding of existing habitats; decreased flow velocities; changes in water chemistry; blocking of sediment by the dam wall; reduction in sediment transport due to lower velocities; and new deltas forming at the bottom of tributaries. The downstream impacts of Pak Beng HPP are the alteration of the flow regime; reduced water quality of water released from the reservoir; change in the sediment size distribution of the channel bed due to change in velocities; reduced sediment load and increased water level variability causing bed and bank erosion.

### ✓ Aquatic ecology and biodiversity

The long term impacts over the whole reservoir area are Very High and reflect a complete change in the aquatic ecology in the reservoir – inundating habitats for invertebrates, birds, fish and amphibians and reptiles. There are also expected impacts on the aquatic ecology downstream in Zone 3, but the intensity of these impacts depend upon the way in which the Pak Beng dam is operated. The blockage of fish migration by the dam wall will have a major impact on migratory fish species even with the proposed fish passage. If the fish corridor role of the study section is confirmed by

additional analyses, altering the section and making it harder for fish to pass may have a disproportionately important negative impact on fish diversity in adjacent sub-basins. This impact would result from the interruption or perturbation of migration routes not only among white fish migrating over 100-1000 km between the Lower and the Upper Mekong, but also on grey fish migrating over 10-100 km between habitats located in neighbouring watersheds. The influx of construction workers and long term increased accessibility of habitats from Pak Beng HPP are likely to have significant impacts on hunting pressure, particularly for amphibians and reptiles and to a lesser extent on birds, which already have

### ✓ Socio-economics

Improved roads and ports are likely to put poor subsistence farming households in a wide area at risk of being pressured to give up their customary lands and subsistence activities. Other likely impacts are related to the increased size and number of boats that will be on the river, and which have the potential to cause bank erosion, and the loss of farmland and food security. In the towns near the dam site, population growth will create some positive changes, such as opportunities to establish restaurant and accommodation facilities. However, population growth is also likely to be associated with negative effects such as increased alcoholism, gambling, violence and prostitution.



