AYEYARWADY INTEGRATED RIVER BASIN MANAGEMENT PROJECT (AIRBMP)

EXECUTIVE SUMMARY FOR ESIA OF SUBPROJECT 1

Prepared by: ICEM
Prepared for: DWIR and WB
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DISCLAIMER

This document was prepared for Directorate of Water Resources and Improvement of River Systems (DWIR) and the World Bank (WB) by a consultant team engaged to undertake the project “Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) for Subproject 1, Environmental and Social Assessment (ESA) for Stretch 1, and ESMP Monitoring and Reporting during Construction of Subproject 1”. The views, conclusions and recommendations in the document are not to be taken to represent the views of DWIR and the WB.

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More information www.icem.com.au | info@icem.com.au
ICEM - International Centre for Environmental Management
6A Lane 49, To Ngoc Van
Tay Ho, Hanoi
Viet Nam
Consultant team Michal Musil, Jens Grue Sjørslev, Kim Wium Olesen, Lwin Lwin Wai, Win Maung, Lina Sein Sein Myint, Mai Ky Vinh, Peter-John Meynell, Phyoe Thaw Thaw Tun, Richard Francis Di Bona, Rory Hunter, Thein Soe, Thinzar Oo, Vuong Thu Huong, Win Naing Tun and Yinn Mar Swe Hlaing
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>ADPA</td>
<td>Ayeyawady Dolphin Protected Area</td>
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<td>BOD</td>
<td>Biological Oxygen Demand</td>
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<tr>
<td>BTNMT</td>
<td>Ministry of Natural Resources and Environment of Vietnam</td>
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<tr>
<td>DALMS</td>
<td>Department of Agricultural Land Management and Statistics</td>
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<tr>
<td>DO</td>
<td>Dissolved Oxygen</td>
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<td>DWIR</td>
<td>Directorate of Water Resources and Improvement of River Systems</td>
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<tr>
<td>DWT</td>
<td>Dead Weight Tonne</td>
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<tr>
<td>E&amp;S</td>
<td>Environmental and Social</td>
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<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<td>ESIA</td>
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<td>ESMP</td>
<td>Environmental and Social Management Plan</td>
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<td>ICEM</td>
<td>International Centre for Environmental Management</td>
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<tr>
<td>LAD</td>
<td>Least Available Depth</td>
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<tr>
<td>MCA</td>
<td>Multi-Criteria Analysis</td>
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<td>MRC</td>
<td>Mekong River Commission</td>
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<td>OPIC</td>
<td>On-site Project Implementation Committee</td>
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<td>PMU</td>
<td>Project Management Unit</td>
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<td>QCVN</td>
<td>Vietnam National Technical Regulations</td>
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<td>RHDHV</td>
<td>Royal HaskoningDHV</td>
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<td>USD</td>
<td>United States dollar</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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EXECUTIVE SUMMARY

1 OVERVIEW

The 2,170km long Ayeyarwady River has a catchment area of 413,710 km\(^2\), of which 91% lies within Myanmar, around 21,400 km\(^2\) (5%) in People’s Republic of China (PRC) (mostly Yunnan), and 17,400 km\(^2\) (4%) in India (Manipur and Nagaland). With a total annual flow of around 400 km\(^3\), the Ayeyarwady ranks as the 22\(^{nd}\) largest river in the world in terms of discharge. It is a monsoonal flood-pulse river, with strong seasonal flow, peaking during the wet season between July - September and reducing by an order of magnitude during the dry season.

The main river is navigable for 1,280 km from the sea, opening a vast highway deep into the dry zone and interior of the basin. Enormous quantities of sediment are transported through the river during the annual floods leading to erosion and deposition of the navigation channel, bars, islands and riverbanks this means that some sections have insufficient water depth for inland waterway vessels to operate safely. In view of the importance of inland waterway transport (IWT) to the economic development of Myanmar, the World Bank (WB) funded Ayeyarwady Integrated River Basin Management Project (AIRBMP) aims at finding and implementing technical and operational schemes for making improvements of the navigability of the Ayeyarwady River Basin (ARB). The goal is:

"to improve IWT in priority stretches of the Ayeyarwady River and design a cost-effective and environmentally and socially acceptable strategy for managing the full length of the navigation channel".

2 PROJECT OBJECTIVES

The overall objectives of Subproject 1 are to achieve a Least Available Depth (LAD) of 2.0 m for a design of 1,000 dead weight tonne (DWT). The river training works and dredging will allow vessels to pass more heavily loaded during dry season, increasing the efficiency of passenger and cargo transport. The project will

- Contribute to the year-round and safe accessibility to the Mandalay Port Area;
- Contribute to the stabilization and deepening of the main navigation channel (Mandalay channel) in selected area (km 887 - 909) by natural bed erosion and capital dredging for most critical locations; and
- Reduce possible future scenarios that the navigation channel shifts to one of the side channels (e.g. Sagaing channel).

Subproject 1 comprises the following three components (Figure 1):

1. Bank protection- to commence construction in February 2017
2. Roughness measures (concrete porcupines and hedges)- to commence construction in October 2017
3. Dredging program- the location and extent/volume of dredging required in 2018/19 in the upstream and downstream areas is still to be specified.
The following section provides an outline of process to assess the project alternatives and an outline of the bank protection, roughness measures (porcupines) and dredging program.

3 ASSESSING PROJECT ALTERNATIVES

The PMU and DWIR were initially considering several alternative design options for Subproject 1 involving the combination of:

- the construction of a guidebund, series of rock pile groynes and/or porcupines/groynes in the upstream area;
- a series of groynes and riverbank protection in the downstream area; and
• dredging in both upstream and downstream within the main navigation channel.

The process to assess the project alternatives and select the river training measures for Subproject 1 has been an iterative process that has involved ongoing stakeholder engagement and collaboration between ICEM, RHDHV, PMU/DWIR and the World Bank. The following activities have informed the selection of subproject 1 and the preliminary and detailed design phases:

- Joint field trip to Subproject 1 area and Stretch 1: March 2017;
- ICEM social survey and baseline sampling to inform MCA criteria: April/May 2017;
- GIS field survey to map erosion risk, land use, pagodas and ports/boat landing facilities: May 2017;
- Joint MCA technical meeting: June 2017;
- Public consultation for the Scoping Report for ESIA/ESMP: 4 August 2017;
- MCA technical meeting and workshop: August 21-22 and 28 2017;
- ICEM wet season sampling and fishers survey: September 2017;
- Preliminary design workshop: 23 October 2017;
- Social survey near porcupine fields: 28 October to 1 November 2017;
- Joint Field Trip to Subproject 1 area: 28 November 2017.

A MCA process was implemented from June to August 2017 to select the most cost effective and sustainable design options for subproject 1. E&S criteria was designed to assess several combinations of river training structures and dredging in both the upstream and downstream areas/

Following the MCA workshop, the PMU and DWIR reviewed the suggestions and feedback from stakeholders and selected **Scenario A3. Roughness zone in secondary channels with zone of porcupines/groynes and dredging near Mandalay port area.** The main benefit of the zone of porcupines/groynes is that the interventions are a low cost, flexible approach with less environmental and social impacts than the guide bund and groynes initially proposed.

Following the preliminary design workshop and joint field trip, concrete porcupines (hydraulic roughness measures) in and along the secondary channels were then selected as intervention to prevent a shift of the main channel to the Sagaing channel, and to enhance navigation in the Ayeyarwady River upstream of Mandalay. The **Scenario A3 (permeable roughness zones with pile fields, porcupines, wooden pile groynes) and Scenario B4 (dynamic dredging) was selected by the PMU/DWIR as preferred solution following the MCA process. Porcupines are permeable structures designed to reduce flow and to trap sediment.**

RHDHV presented the Preliminary Design Report (in October 2017 prior to the workshop, the report assessed the project alternatives for A3 Scenario (hydraulic roughness) and Scenario B4 (dredging). From 28October to 1 November, the ICEM social team conduced additional KIIs and surveys with village tracts and villages near the proposed porcupine fields. The people consulted in Kyun Sin Village requested that the roughness field is moved to the north of the village. This had two advantages:

1. The channel between the stable banks is smaller, which reduces the wet area where the roughness structures has to be applied;
2. The roughness field is more effective (closer to the main channel). It is considered to be an effective change of the location of the roughness field with local support of the people in Kyin Sin Village.

Based on practical phasing considerations and the outcome of the field survey, RHDHV recommended constructing at least the three roughness fields in the wet area of the three secondary channels. The initial location and configuration of the porcupines (October 2017) and the updated location (November 2017) following the social surveys and joint field visits with RHDHV and
PMU/DWIR are shown below for comparison. The initial configuration of the roughness areas required a total area of about 800,000m$^2$ with approximately 150,000 porcupines or 200,000 piles that had to be installed in wet area and on the islands in the upcoming dry season. It is estimated that the total area is now restricted to about 180,000 m$^2$ in the updated locations.

3.1 Roughness measures (porcupines)

The PMU/DWIR selected concrete porcupines, which consist of six poles with equal lengths of commonly 2 or 3 meters. These poles are connected at the ends in a tetrahedron shape. The porcupines are constructed from 6 piles of concrete, with the dimension of the piles: $0.1mx0.1mx2.4m$. The concrete piles will be prefabricated at a concrete or cement factory in Mandalay and then transported to the construction areas designated on the sandbars adjacent or upstream of the planned concrete porcupines. The pre-fabrication of the concrete piles, and only the assembly of the porcupines on site greatly reduces the site-specific environmental impacts associated with dust, noise and vibrations.

The porcupines will be constructed in three locations:

1. Porcupine field planned in the Sagaing channel, upstream of Kyun Sin village;
2. Most eastern porcupine field in the middle channel; and
3. Most western field upstream of the Let Pan village.

The porcupines planned in the Sagaing channel were identified as a priority by PMU/DWIR for construction. To mitigate the potential impacts of riverbank erosion associated with the porcupines it was decided to first construct bank protection to align with the porcupine fields planned in the Sagaing and middle channels.

3.2 Bank protection

The requirement for bed and bank protection is detailed in the RHDHV Preliminary Design Report (v3) and Detailed Design Report (December 2017). The proposed roughness measures (porcupines) alter the flow velocity and sediment transport capacity in the side channels. Although the roughness measures reduce the discharge to the side channels and the flow velocity on the islands, both local flow acceleration and a downstream increase in sediment transport capacity may occur. Local flow acceleration near the banks might cause, or accelerate, local bank erosion, whereas a downstream increase in sediment transport capacity might cause bed erosion. The location of the prosed bank protection and roughness measure (porcupines) are shown below in Figure 2.
Local communities near the proposed bank protection works are supportive of addressing riverbank erosion which is impacting farmlands. Throughout the series of stakeholder consultations, the local communities in the Subproject 1 area emphasized riverbank as a significant issue affecting land and agriculture throughout the series of stakeholder consultations. The agricultural land on the island area is changing every year due to riverbank erosion and is classified as alluvial soil. The government cannot issue land use certificates for alluvial soil land so instead the farmers must pay tax for growing crops on the alluvial soils.

3.3 Dredging

Dredging has been proposed in the upstream and downstream areas of Subproject 1 (Figure 3). The dredging program is not likely to trigger an EIA under the Myanmar EIA procedures as dredging volumes are likely to be much less than threshold of 270,000m$^3$. For example, the 2017/18 dredging
program only recommended dredging in in the order of 70,000 m³ in the upstream area\(^1\) and no dredging is required in the downstream area as the navigation channel is sufficiently deep and wide for navigation. During the Detailed Design Workshop on 15 December 2017, RHDHV stated that there is no urgency for dredging at this stage. The dredging associated with AUDP in the downstream area and impacts of the roughness measures also needs to be considered as this is likely to reduce the need for dredging in the upstream and downstream area.

Figure 3: Identified dredging sites in upstream and downstream

\(^1\) RHDHV and the PMU/DWIR are evaluating the bathymetric surveys undertaken in November 2017 to clarify dredging volumes in upstream area
4 OBJECTIVES OF THE ESIA

The International Centre for Environmental Management (ICEM) has been engaged to prepare the Environmental and Social Impact Assessment (ESIA) for Subproject 1 and three separate Environmental and Social Management Plan (ESMPs) for 1) Bank protection, 2) Roughness measures (porcupines), and, 3) Dredging. This ESIA report is set out as follows:

- **Chapter 1 - Description of the proposed projects:** provides an overview of the project and the process for accessing project alternatives.
- **Chapter 2 - Legal and institutional framework:** outlines the relevant legal and institutional framework for environmental conservation in Myanmar and World Bank safeguards.
- **Chapter 3 - Scope and methodology of the assessment:** the approach and methodology used for the assessment and the key themes of the ESIA.
- **Chapter 4 - Description of the existing environment baseline:** describes the environmental and socio-economic baseline conditions in the Subproject 1 for hydrology, geomorphology, water quality and sampling, biodiversity and fisheries and social and livelihoods.
- **Chapter 5 - Assessment of environmental and social impacts:** identifies and assesses the impacts associated with the bank protection, roughness measures (porcupines) and dredging program.
- **Chapter 6 - Avoidance and mitigation:** outlines the mitigation measures (including cost, responsibility and timing) related to the development of porcupines and related bank protection measures.
- **Chapter 7 - Stakeholder consultation:** The consultation and communication plan outlines steps for disclosure of documents and the engagement with relevant stakeholders potentially affected by Subproject 1 and aims to meets the legal requirements for the Myanmar EIA Procedures (2015) and WB safeguard policies.

The legal basis for conducting an ESIA in Myanmar is provided by the Environmental Conservation Law (2012) and subsequent provisions under the Environmental Conservation Rules (2014) and the EIA Procedures (2015). The combination of bank protection and roughness measures (porcupines) in the Sagaing and middle channels and the estimated volume of dredging in the upstream and downstream area in the next dry seasons (2017/17 & 2018/19) is expected to be less than 270,000m$^3$ and will not trigger an EIA under the Myanmar EIA procedures (2015).

The World Bank also screens all projects and classifies them into one of four categories (Category A, B, C, and FI), Subproject 1 has been classified as a Category B which is generally similar with IEE (Initial Environmental Examination) required under Myanmar EIA procedures (2015). The ESIA for the Subproject 1 and ESMPs will be prepared in compliance with the Myanmar Environmental Impact Assessment (EIA) Procedures (2015) and applicable WB safeguard policies. The WB has ten (plus one) environmental and social policies which are known as safeguard policies. The WB Group operational policies relevant to the project include:

- **OP/BP 4.01 on Environmental Assessment:** Applicable as project is considered a Category B so ESIA and ESMP required.
- **OP/BP 4.04 on Natural Habitats:** applicable, due to occurrence of important natural habitats near Subproject
- **OP/BP 4.11 on Physical Cultural Resources:** potentially applicable, the construction of the western porcupine fields is upstream of a pagoda but impacts are not anticipated

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2Environmental Conservation Rules, Notification No. 50/2014
• **OP/BP 4.12 on Involuntary Resettlement**: potentially applicable, however the construction of porcupines and bank protection under Subproject 1 will not lead to involuntary resettlement, however there may be temporary loss of access to agricultural land during construction which will be covered in the Abbreviated Resettlement Action Plan (ARAP).

## 5 BASELINE ASSESSMENT

The ESIA report provides comprehensive information on the environmental and social baseline conditions in the Subproject 1 area and outlines the assessment methodology and stakeholder consultation carried out during implementation. The baseline and impact assessment methodology was designed around the following key themes:

1. Water quality and baseline sampling;
2. Fisheries and Biodiversity;
3. Geomorphology and hydrology;
4. Social and livelihoods.

The following sections provide a brief overview of the key findings related to each theme.

### 5.1 Water quality and baseline sampling

Baseline sampling was undertaken during both the dry and monsoon seasons. From 28 April 2017 to 3rd May 2017 ICEM and local partner EMC conducted the following monitoring:

- **Air quality**: 2 samples
- **Groundwater**: 2 samples
- **Sediment**: 2 samples
- **Soil**: 2 samples
- **Surface water quality**: 5 samples

A number of parameters were monitored for groundwater, sediment, soil, surface water and groundwater which are described in the report. It was agreed during the scoping phase that wet season surface water quality sampling would also be conducted on 25 & 26 September 2017. In the absence of Myanmar water quality standards or guidelines, the World Health Organisation (WHO) and Vietnamese technical standards and Mekong River Commission (MRC) were used for comparison. The results are summarised below:

- **Air quality**: All the parameters for the air quality standards are within the WHO’s standards, for both 24 hour and 1 hour time frames.
- **Groundwater**: The following parameters do not meet the QCVN 08:2008 & 2015 / BTNMT standards: Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Hardness and Iron.
- **Sediment**: The second sample had a small concentration of arsenic, heavy metal (lead and chromium) was higher in upstream sample when compared to the downstream and mercury values in both samples high, but within the standards for Mekong Lowland Rivers.

From stakeholder consultations, it was found that the people who do use the Ayeyarwady River as a source for drinking water, only use it during the dry season. During the wet season rain water is harvested. Most of the communities use a dug well with sand filter as their main drinking water source. By comparing the monitored parameters to the standards no significant or worrying values were found that would do harm to the public or aquatic life for all parameters of the air, sediment, surface and groundwater parameters.

### 5.2 Biodiversity and fisheries

Two field visits have been made in dry and wet seasons during 2017. During the dry season field visit, fish species composition was examined at the proposed project area. The record and collection were made with the help of the local fishers. The fishes were collected using different fishing gear...
available at the proposed project sites like gill nets, cast nets, beach seine nets and various traps. The fish were photographed and basic characteristics were recorded for identification. The aquatic habitats in the study area can be defined in terms of the seasonality of inundation by the river flood waters:

1. Main channel - permanent flowing water with channel depth up to 20 m;
2. Side channels - permanent water, flowing in the wet season, with flows decreasing to nil in the dry season and becoming lakes. Depth of the lakes in the dry season may be up to 5 m deep; and
3. Seasonally inundated land on islands and river banks.
   - Inundation of low lying areas lasting for up to 6 months from May to October. These areas may have reeds and grasses surrounding them, e.g. in the northern end of the island, or may dry to form sandbanks, e.g. in the channels or at the southern end of the island
   - Inundation of higher lying areas for a few weeks in July/August, e.g. near the villages. These will generally be used or agriculture.

In most of the villages there are relatively few full-time fishing households, although most villagers will catch fish for subsistence purposes. Within the project area, there are 34 villages, with a total population of 46,599 and 289 fishermen. Nine of these villages are located on the islands with about 8,647 people, of which there are about 131 full-time fishermen. A total of 37 fish species were recorded during the dry season survey and an additional 17 species were recognised by fishermen part of their catches during the wet season field visit. These have been compared with the species list prepared from Nwe Nwe Thein’s PhD thesis, which includes the study area. These species lists have been consolidated giving a total of 70 fish species found in the area.

May and June are breeding seasons for fishes. September to November is the peak season of fish catches with average yield is 7-8 viss (11.5 - 13.1 kg) of fish per day. It is noted that yield of Cat fish and Striped catfish has declined over the last 10 years. From discussions with fishermen, it is generally perceived that the amount of fish being caught by fishermen each day has decreased.

The Ayeyawady Dolphin Protected Area (ADPA) is located just upstream of the proposed project area starting from Mingun area (downstream end) to Bahmo city (upstream end). Two Ayeyarwady dolphins *Orcaella brevirostris* (Owen in Gray, 1866) were observed at Mingun, which is upstream of the proposed project area. According to the interview survey of local villagers and fishermen, Ayeyarwady dolphins (or *Irrawaddy dolphin* - *Orcaella brevirostris*) visit the main channel of the river during monsoon season. The Mandalay Fisheries Department carry out dolphin counts in the ADPA two times per month. Recent counts indicate that there are between 61 - 70 dolphins in this area. During the wet season field visit, villagers in Ko Daung mentioned that the body of a pregnant female dolphin had been recovered in the study area at the end of the dry season 2017.

As a seasonally flooded wetland area, with side channels and permanent bodies of open water, the study area is attractive to water birds and migratory and congregatory species, such as geese and ducks. Permanent resident water birds observed during the wet season survey include Pied kingfisher, Great and Little Egrets, Pond Heron, Grey heron, Purple Heron, Green Bee-eater, Ruddy Shelduck. They are usually found on the inlets and reed bed areas to the north of the island complex, on the sandbars and around the open bodies of water. Asiatic softshell turtles *Amyda cartilaginea* have been found in the study area.

### 5.3 Hydrology and geomorphology

#### 5.3.1 Hydrograph

Subproject 1 Area is located at Mandalay and Sagaing in the Ayeyarwady River. At Sagaing, the basin area is 120,193 km² and the annual mean flow is about 240 10⁵ m³. Variation between high and low water level is great. Because of the monsoonal character of the seasons, the highest point in
discharge is generally recorded in August and the lowest in February. An annual averaged flow of 7,630 m$^3$/s is measured at Sagaing gauging station, with an average base flow of around 2,000 m$^3$/s and an averaged high flow of 18,000 m$^3$/s. A hydrograph for Sagaing is shown in Figure 4.

Figure 4: Hydrograph of Sagaing based on daily discharge for the period 1980-2014

![Hydrograph of Sagaing](image)

5.3.2 Flow distribution

At the upstream end of Subproject Area 1 the Ayeyarwady bifurcates into three channels, viz. the Mandalay Channel (eastern channel), the Sagaing Channel (western channel) and the Mid Channel. From all available satellite images it appears that the Mandalay Channel exceeds the other channels in size, but there appears to be a significant variation over time in size of both the Sagaing and Mid Channels, see Figure 5. During high flows the islands separating the channels are flooded (Figure 6).

Figure 5: Dry-season (January) satellite images of Subproject 1 area. From left to right: 1990, 1998 and 2017
Referring to Figure 6 it appears that in the current (2017) condition the secondary (Sagaing and Mid) channels are less significant than earlier. Model simulations presented by RHDHV suggest that about 58.6 to 62.2% of the discharge flows through the Mandalay channel.

### 5.4 Geomorphology

The morphology of Subproject 1 Area is highly dynamic and complex. From inspection of satellite images, it seems however that certain features are remarkable stable, while other features seem to be more short-lived (see Figure 7).

- Upstream of Minkun, the right bank is made of hard non-erodible material. At part of this section, the deep channel is consistently attracted to the non-erodible bank whereas the deep channel fluctuate from the right to the left bank further upstream. The deep channel meanders within the river belt and contribute to making the Mandalay channel dominant.
- Further downstream at Sagaing, the river width seems to be confined by rocky outcrops at both right and left bank.
- In the middle reach of Subproject1 Area (opposite Mandalay) the channel along the right bank seems to have a lifecycle where it grows to an almost similar size as the channel at Mandalay followed by a decline.

It is difficult to determine the factors controlling the cyclic behaviour of this channel pattern. It is, however, important to understand that most of the braid belt is submerged during high flows (see Figure 4 above) and that enormous quantities of sediment are being transported through the river during the annual floods, with huge potential for erosion and deposition of the channels, bars, islands and riverbanks. After each flood season, the channels, bars, islands and riverbanks are thus left in a different location than they were before. To quantify this dynamic behaviour and analyses of recent LANDSAT 7/8 images from February 2014 through 2017 were made. From the images shapefiles representing the extent of the water bodies have been extracted. Combining the
shapefiles from each of the four years the dynamics of sand bars, bank lines and islands become visible. The shapefiles overlaid the February 2017 satellite images are shown below in Figure 7, where also areas subjected to bank erosion are indicated.

**Figure 7: Analysis of geomorphological changes from Feb 2014-17 (Landstat 7/8) in Subproject 1 Area**

The figure shows that large sand bars are migrating though the river and in particular through the Mandalay Channel. The migration speed is locally up to 500 m per year but generally of the order of magnitude 100 m per year. These sand bars are affecting navigability. The sand bars also may hamper access to the river for villagers, berths and landing facilities may not be accessible and it may render irrigation intakes inoperable during low flow.
The bank erosion (risk) indicated above is based on visual inspection of the river banks during a boat trip in the area. Generally, steep banks have been interpreted as a sign of bank erosion. Bank erosion is reported to be a key concern in the present situation. For instance, in the stakeholder consultations at township level river bank erosion surfaced as the major river related issue for all five of the townships consulted. The key issue related to bank erosion is loss of fertile agricultural land and erosion of pertinent infrastructure at the river banks. Two mechanisms seem to be responsible for bank erosion:

- The characteristic spiral (helical) flow in rivers bends causes the river to depend and attract flow along the outer bend. The higher flow velocities and larger depth cause the outer bend to erode.
- Where a sand bar is formed along one bank (or detached from the bank) the flow is deflected towards the other bank and give rise to bank erosion.

### 5.5 Social and livelihoods

The initial social field research revealed that there are nine village tracts in the Subproject 1 area on the west bank (Sagaing), on island and east bank (Mandalay) (Figure 8). The villages in this area use the river and the Sagaing and middle channels for domestic and agricultural uses, local boat transport, fishing and are experiencing loss of agricultural land from riverbank erosion.

![Figure 8: Village tracts in Subproject 1 area](image-url)
Field research for the social and livelihoods theme was carried out throughout implementation with two major missions taking place from May 2-8th 2017 prior to the MCA process and then again October 30th to November 2nd after the preliminary design workshop. The second fieldwork focussed on Kyun Sin village on the island and the area from Let Pan village North on the Sagaing side. These villages are nearer to the location of the proposed bank protection and roughness measures (porcupines). The main findings in relation to local communities living in the area are summarised below.

- **Livelihoods**: The income of most households in the study villages on the island is from agriculture and livestock. It was reported that in general incomes have decreased due to erosion and loss of farmland on the riverbanks. Other economic activities are handicrafts such as sewing, weaving and making traditional cigars, sand extraction, and small-scale trade. Some women work as vendors and sell the snacks at their village. Others are daily workers making traditional cigarettes, or are yellow-robe tailors.

- **Water use**: On the island, the villages Kyun Sin and Gyaint Gyi have tube-wells, but according to verbal information they use the river as drinking water source. In the dry season, Kyun Sin village use water from the secondary river channel for irrigating crops.

- **Land use**: Probably the most important land use category in the present context is the agricultural land on the floodplains on the riverbanks and on the island, so-called alluvial lands. The fertile sediment lands are dynamic and sensitive to changes in river flows. According to information from the villages, the study area has a total of 2,654 hectares of riverbank and island gardens and fields, of which 656 hectares are on the island.

- **Land tenure**: According to Department of Agricultural Land Management and Statistics (DALMS), Patheingyi Township, the agricultural land in the villages Than Bo Gyun, Hin Ywet Su, Gyaint Gyi, Po Hla Gone and Kyun Sin are alluvial flood plains. This type of land is not stable due to bank erosion and because it is recurrently submerged under water, which alters soil texture and structure. Hence, according to Farmland Law (2012) legal ownership cannot be given and farmland certificate (form-7) cannot be issued for such areas. However, the Township Administrative Department issues land use receipts to each farmer who are charged a land use fee. In both Kyun Sin and Let Pan village farmers have tax receipts for their cultivated land. The tax amount is 2 Kyat 70 Pyar per acre.

- **Local boat transport**: The study collected details about the present means of transport on the river and on land, with a view to assess potential impacts from the proposed navigation enhancements, on access to services, markets, work places and education. Information on the number of households that owns boats and the existing ferry services in terms of license holders, passengers and cargo was collected. The village profiles report on the importance of boats for river transport especially in the monsoon season. On the island and in the study villages on the Mandalay side, nearly all households have a boat, which is used during the monsoon, while on the Sagaing side only few households have boats.

- **Kyae Yar Taung Stupa**: On the Sagaing side in Ta Laing Zin village north of Let Pan there is the Kyae Yar Taung Stupa and Kyae Yar Taung Shwe Thein Taw (Ordination Hall). It is situated on the river bank above the proposed site of the western-most narrow porcupine field. The stupa is a holy place for community worship. The ordination hall (Sima) is a special religious building for ordination into monkhood and it is an exalted place for Buddhists.

- **River bank erosion and flooding**: Over the years many people along the Ayeyarwady have lost their livelihood due to flooding and river bank erosion. The study area is equally prone to erosion and flooding. People in Kyun Sin and Gyaint Gyi are worried about riverbank erosion. They have experienced river bank collapse many times over the past 30 years and the two villages were seriously damaged between 2013 and 2016. Kyun Sin lost one fourth...
of its total land between 2006-2016 and Gyaint Gyi village has been moved to a new location four times over the years.

5.6 Abbreviated Resettlement Action Plan (ARAP)

Following the detailed design workshop on 15 December 2017 it was decided that the bank protection works would commence construction in February 2018. Prior to construction the social survey team visited the locations of the proposed bank protection structures to determine the number of project affected persons (PAPs). The survey team visited the proposed location of bank protection works, construction area and access roads (Figure 9).
In the Sagaing channel, it was determined that there are 17 PAPs near the Kyun Sin village. All of the affected area from the construction of the bank protection works is farmland and it is currently peanut growing season which are due to be harvested in mid-February 2018. The average area of farmland belonging to PAPs is 0.50 acres and owners are both from the Kyun Sin and Talazin villages. According to interviews with PAPs and observations on sites the area of farmlands along the bank are decreasing gradually every year due to river bank erosion (Figure 10). The construction area is proposed to the sandbar adjacent to the bank protection works to limit the amount of agricultural land impacted.
During further consultation with the local community including the PAPs, the Kyun Sin village wish to start the construction of bank protection as quickly as possible and most of attendees in the meeting agree to lease their lands without receiving any compensation for loss of land. The team are going to the Subproject 1 area on 10-11 January to discuss the Land Donation forms with the PAPs. The team will also consult with the PAPs related to the bank protection works planned on the middle channel. There is also a fish farm that is located at the entrance to the middle channel (see Figure 9 above) and owner will be consulted. This updated information on land donation and compensation for loss of livelihoods (if required) will be reflected in the ARAP.

6 ENVIRONMENTAL AND SOCIAL IMPACTS

6.1 Impacts of roughness measures (porcupines and hedges) and bank protection measures.

6.1.1 Preparatory and construction phase

Preparation/modification of river bank/bed for installing porcupines and related bank protection will involve limited earth/sand moving, and levelling without significantly altering existing morphology. Most pronounced impact will be associated with the bank-protection measures on left banks of central and eastern side-channels in area where porcupine fields align with the islands (see Figure 9 above).

6.1.1.1 Loss of agricultural land

Small permanent loss of agriculture land on the river banks will be associated with bank modification in some areas with existing steep erosion-affected banks (e.g. some bank sections north of the Kyun Sin village). Such modification might represent an encroachment to the existing plain surface of the islands up to circa 30 meters from wet area of the channel. In most of the area however, a comparatively smaller modification will be required to obtain the desired slope, i.e. thanks to the naturally developed favorable mild slope or previous bank-protection works (e.g. along the bank in the vicinity of the Kyun Sin village).
Further agriculture land uptake will be required for planting vegetation hedges (additional roughness-increasing measures) in several stripes perpendicular to the channels. Given the proposed density of the hedge pattern and length extending across the islands, this might constitute considerable total area of cultivated soil uptake (although in this case it can be considered reversible impact), and potentially also concerns related to diminished comfort of access for individual farmers to their fields.

6.1.1.2 Risk of conflict and social issues

Potential risk of social conflicts and disturbance will be associated with setting and operation of construction camps including temporary accommodation for workers (located on sand bars in distance from local villages). Conflict prevention measures shall be implemented to prevent such negative impact.

6.1.1.3 Employment and business opportunities

Potentially positive effects are linked to Project implementation-related employment opportunities for the local people. Even if the porcupine production is located off-site, part of the workforce required for preparation of river bank and bed, bank protection works, transport of materials, and in porcupine assembly can be supplied by the local communities. Since the construction does not coincide with harvest period, the local people will be free to take part in the works. Additional opportunity represents increased demand for tea and beer stalls from workers during construction and business for ferry service operators for transport of materials.

6.1.1.4 Impacts on water quality

Earth-moving and levelling has the potential to increase sediment mobilization temporarily in the two channels, especially in the western channel where the bulk of the works lies within the wet part of the channel. Flows down both channels decrease progressively through the dry season, and it is probable that most of the in-channel works will occur towards the end of the dry season, when water levels and flows are lowest, and when suspended solids in the water is lowest. The combination of low flows and increased sediment release in these channels increases the risks of localized and temporary changes in water quality (turbidity and suspended solids). This effect is unlikely to extend for further than few kilometers downstream, as the sediment will settle out quite quickly.

Further, potential impacts on water quality are connected namely with the risk of contamination of surface water with the domestic waste originating from temporary construction camps hosting up to circa 600 people, and accidental spillage of fuel, oil and grease, as well as water pollution from construction materials and wastes (heavy materials, plastics). These impacts are to large extent avoidable, and will be prevented/minimized through implementations of dedicated site management measures.

6.1.1.5 Impacts on ecosystems

Project-related traffic and construction operations will cause some localised disturbance of wildlife during the day, and water birds will tend to avoid this area. For the works along the eastern channel, the construction materials will be transferred by boat to a location on the northern bank of the island, and transported by access track to the construction camp, on the sand banks along the eastern creek. This area is probably the least disturbed location on these islands which are fringed along the northern edge with reeds and grasses. The risk of disturbance of water birds such as ruddy shelduck and bar-tailed geese, which are known to frequent this part of the island, is higher than on the other construction sites.

Although turtles are increasingly rarely found in this area, the sand banks on this eastern channel, are a potential nesting location. Nesting occurs during the dry season, at a similar time as construction activities, so there is a greater risk of disturbance and failed nesting. Similarly, sand
bank nesting birds such as pratincoles, river tern and river lapwing, may also be disturbed by transport of materials along the access track to this eastern channel location.

Construction camp and facilities have several impacts upon the aquatic ecology. The presence of up to 600 workers living and working on the construction camp sites will cause considerable disturbance to the water birds which will tend to avoid the area.

The areas of the construction sites are currently relatively clear of solid wastes, so the added pressure from the construction sites could significantly increase solid waste pollution throughout the area.

No significant impacts are expected in connection with storage of materials and equipment, provided that precautions are taken to prevent spillage and escapes, with equipment for clean up to be accessible in the event of spillage.

Operation of electricity generators can also cause noise disturbance of wildlife within the vicinity of the construction sites, especially at night.

Preparation/modification of river bank/bed for installing porcupines and for installation of rip-rap bank protection will involve some river bank vegetation removal. The river bank vegetation to be removed consists mainly of reeds and grasses, and perhaps some shrubs, but no trees - as annual plants that grow up in the wet season, these will recover naturally during the next wet season.

Construction-related sediment mobilisation will temporarily affect the aquatic ecosystem in the side-channels due to localised and temporary changes in water quality (turbidity and suspended solids) which could reduce light penetration and productivity of the water bodies. The channel bed in these bodies of permanent water is mostly soft sediment which will be renewed every year in the wet season, so the increased sediment deposition during construction in the dry season is unlikely to cover sensitive aquatic habitat, and will be replaced during the next wet season.

6.1.1.6 Impacts on fisheries

The construction period is likely to occur for three months in the late dry season. There is a distinct period for catching fish in the late dry season from February to April, and a second period in September/October/November. Thus construction is likely to coincide with one of the best fishing seasons.

There could be a temporary impact upon the fish catches in these permanent bodies of water in side channels due to increased sediment load and turbidity, a) because some fish may move away from these bodies of permanent water to avoid the high turbidity, b) migratory fish moving upstream in February to April may avoid the channels altogether and c) slightly lowered primary productivity and availability food for fish in these channels. This impact is difficult to quantify.

6.1.1.7 Local ambient air quality

Air quality is likely to be negatively impacted by emissions from both road (truck) and boat transport of the construction materials and other supplies in combination with emissions from the construction machinery, electricity generators, and fireplaces and boilers used in the construction sites and camps. However, given to favourable baseline conditions in the area (open area, far from other significant emission sources) and limited time of the construction, the temporary impacts on the air quality is likely to be more of a nuisance issue than of a public health concern, i.e. the impact on the ambient air quality is not regarded as significant.

6.1.2 Operational phase (roughness measures in effect)

6.1.2.1 Geomorphology and erosion

In short term, the bank protection will have a stabilizing effect, diminishing existing severe erosion problems in the sections of side channels where porcupine fields are located (due to reduction of
flow and reduced flow velocity), and therefore its impact can be regarded as net positive and long term. Outside these areas the effects on the side channels are uncertain and will depend also on application of additional bank protection measures not included in the scope of Sub-project 1.

Long term effects are very uncertain. The simulation results presented in the section 3.4 *Hydraulic effects of optimized roughness measures* of the RHDHV Detailed Design Report show that the planned measures are most effective at reducing the flows down the side channels at lower flows, and at very low flows they may reduce the flow down the side channels by up to 30 – 40%. At higher flows (above 6,000 m³/sec) they reduce the flows down the side channels by under 10%. The morphology of the permanent bodies of water is likely to be defined by the higher flow rates. In effect, the area and depth of permanent water bodies can change in either direction depending on e.g. the future sequence of large and small floods. Some reduction of the size of the inns is considered as more likely scenario, although an opposite trend cannot be ruled out.

The reduction in discharge in side channels will likely continue in response to morphological changes (sedimentation) induced by the porcupines. After few years of sedimentation the discharge will reduce further. On the other hand, the sedimentation at the porcupine fields may introduce sediment starvation/deficit further downstream of the porcupines fields in the secondary channels thus increase their flow capacity and thereby attract flow through new channel developments (thus erosion of islands) and overland flows. However, such risk of growth of the new flow channels along the islands and the Sagaing channel, i.e. locations and likelihood are impossible to predict. Exacerbation of the erosion risk can be expected at the confluence with the Mandalay channel, in front of Amarapura Project.
In Mandalay (main) channel the desired effect of increased flow is likely to be further exacerbated by the envisaged massive dredging for the Amarapura project. The increased flow, however, will also increase the bank erosion risk. The occurrence of bank erosion hotspots will likely follow the already existing patterns, viz. along outer bends and at locations where the river cross-sections are constricted by sand bars.

6.1.2.2 Impacts on fisheries

Due to large uncertainty related to the effects of roughness-increasing measures on morphology of the side channels the impacts upon the fishery are equally difficult to predict, though if the bodies of permanent water at the end of the dry season will become smaller and shallower, it is likely that fish production will decrease. If however, the bodies of permanent water become more extensive and deeper, it is possible that fish production may increase; this is considered to be less likely.

The combined annual value of the catch is estimated at about 666,000 USD. If worse scenario applies, and the status of the bodies of permanent water is reduced by 10%, there would be a 66,000 USD loss per year, and reduction by 25 %, would mean estimated 166,500 USD reduction in the value of the catch each year.

Should the reduction of the catch actually occur, it will affect livelihood of local fishermen. There are approximately 289 artisanal fisherfolk living and working in the area likely to be affected by the
installation of porcupines in the side channels. Whilst many of these fish principally in the main channel, 137 fisher folk live on these islands, and about 26 on the Sagaing bank, some of whom are seasonal fishermen. The two fishing leaseholds each employ up to 20 fishermen, and artisanal fishermen can pay a rental for fishing in the leasehold areas.

The key driver of change - alteration of the morphology and flow patterns in the side channels affecting the size and productivity of permanent water bodies (inns) – is highly uncertain. Therefore the above indicated reduction of fisheries productivity downstream of the porcupines and consequently of the income of full-time fishers and food security of subsistence fishers shall be understood as a risk to be monitored and managed, rather than an impact to be mitigated or compensated.

6.1.2.3 Impact on accessibility and ferry services

The installation of porcupines can result in blockage of the waterways from Kyun Sin and Let Pan villages to Mandalay and the villages East of Kyun Sin when the water level is too low for boats to pass over the porcupines. The restriction of boat access (ferry service and villagers’ boats) due to porcupine structure can be avoided through including a safe boat passage in the porcupine field design, and installing measures indicating the safe navigation depth. The effectiveness of such measures can be however compromised by a gradual siltation (in long perspective) of the water way. Siltation in channel can improve access by motorbike and truck/motorized vehicle from and to the island from Sagaing side at times outside the height of the rainy season. This can have positive effects with regard to reduced time to travel to school for high school students in Sagaing, access to markets, work places and services.

6.1.2.4 Loss of agriculture land to bank erosion

There can be a risk of increased erosion of agricultural land in Kyun Sin village if river banks along the porcupine fields remained unprotected. Since the bank protection measures have been included as part of the project design preparation (also in response to the concerns registered during field consultations with the local community), the above indicated construction phase-related loss of agriculture soil in some river bank sections will contribute to the prevention of further intrusions in the cultivated areas adjacent to the porcupine fields.

The net positive effect shall be ensured by ongoing monitoring and planning for additional river bank protection measures to be applied if new erosion hot-spots develop in connection with unpredicted long-term effects of the roughness-increasing measures implemented within the Sub-project 1.

6.1.3 Other impacts

6.1.3.1 Visual impacts

Aesthetically displeasing porcupines spoils the natural beauty, namely if accumulation of floating wastes and debris is allowed. This visual impact will be limited to the community in the close vicinity of the porcupine field (Kyun Sin). The visual impact from the direction of main Mandalay channel (e.g. from tourist boats) will be limited as the porcupines are located somewhat downstream from the side-channels entrances. Of concern can be the risk of lowering the serenity of the Kyae Yar Taung Stupa and consequently visiting people’s well-being, by the visual impact of the Sagaing porcupine field located nearby. Risk of discouraging tourists from visiting the areas cultural and archaeological sites cannot be entirely ruled out, but due to the location of the porcupines in visually not prominent locations, negative impact on tourism is not expected.

6.1.3.2 Employment in maintenance

If a regular maintenance of porcupine structures is envisaged, including clean up from the accumulated debris and waste after the high flow season, a positive impact on local peoples employment and livelihood can be expected.
6.2 Impacts of dredging

Dredging quantities will be small compared to the sediment transport in the river. Provided the dredged material will be disposed in the river, no significant disturbance to the natural sediment transport regime in the river is envisaged, hence no significant impact on the morphology.

If the dredged materials are returned to the river downstream, as it is understood is the current practice, there are two concerns for the aquatic ecology. (1) is the spillage of dredged materials at the dredging site and the (2) is the increased suspended sediments at the dispersal site. The local suspended sediment levels can be many times higher than the normal levels during the early dry season. Most of the sediments will quickly fall out of suspension, but there will be an impact zone of up to 10km downstream of where the dredged materials are dumped. At this time, fish would tend to avoid such a zone, but biota in the river bed would be covered by the settlement of the solids. Some of these may be killed whilst others will redistribute themselves in new sediment layers.

If the dredged materials are found to be contaminated with toxic materials - heavy metals or persistent organic chemicals, e.g. originated from the waste waters of Mandalay, then returning the dredged materials to the river, may have adverse impacts. At present, the sediment analysis indicates moderate levels of mercury, lead and chromium (all three parameters are higher in the sediment samples taken upstream compared to those downstream) but these are not considered to be dangerously high. Nevertheless, regular monitoring of toxic materials in sediments being dredged is recommended.

If the sediments are disposed of on land, disposal on the banks and sand bars on the islands should be avoided, as these may be important breeding sites for birds and possibly turtles. Toxic material content may also be an issue to be monitored. The use of the dredged material as for construction or fill materials shall be the preferred option.

With the envisaged dredging activities only minimal impacts on the socio-economic and cultural environment is expected.

If all the dredged material will be disposed into the river there will not be any disposal that can affect agricultural land. If temporary disposal on land is required, only government owned land should be used or material should directly be sold to the sand buyers. For any on-land disposal, there will be written agreement with individuals/communities affected.

If fish stocks decline due to dredging it will have negative impacts on fishermen and communities that depend on fish for their livelihoods. Dredging activities could have temporary impacts on the livelihood of a few individuals, mostly fishers. However, fishers would have several fishing location options that are available during the period of dredging.

Public health safety issues due to dredging activities could occur due to release of toxic material into river water used for drinking water and/or irrigation. Increased turbidity could affect the use of river water for drinking water. This would be in addition to potential impacts through the food chain mentioned above.

Changes in river flows due to dredging could have impact on transportation in smaller boats, for example by making normally used passages over shallow water inaccessible or creating currents that smaller boats would have to avoid for safe passage.

Impacts from dredging activities on the cultural environment are not foreseen.

7 MITIGATION AND AVOIDANCE

Mitigation measures put forth by this ESIA to prevent, minimize and mitigate identified potentially negative impacts as well as to enhance potential positive effects, can be divided in the following categories:
7.1 Project design optimization

Process of Sub-project 1 design preparation including alternative selection and adjustment allowed for addressing several environmental and social concerns such as:

- Bank erosion and loss of agriculture land
- The additional bank protection component was included in the design in response to local community concern
- Reduced access of the ferry boat to the side channels
- Adjusting the porcupine pattern to allow for a safe passage

7.2 Environmental and Social Management

For each of the Sub-project 1 components a dedicated Environmental and Social Management Plan (ESMP) has been elaborated. Considering the project complexity and phasing of individual interventions three ESMPs are prepared: ESMP for the Bank protection, ESMP for the Hydraulic roughness-increasing measures (i.e. Porcupines and vegetation hedges), and the ESMP for Dredging.

Each of the ESMPs consists of array of measures and mitigation actions to be implemented during the preparatory, construction or post-construction phases, with assigned responsibilities and provisions for reporting and monitoring. The key focus is on ensuring sound management of the construction operations and adopting responsible environmental and social practices. Environmental Code of Practices and Social, Health and Safety Code of Practices are included to provide guidance during the execution of the project-related works, as well as a Dredging protocol to ensure minimization of negative impacts connected to dredging operations.

7.3 Abbreviated Resettlement Action Plan (ARAP)

The project is not expected to have any severe impacts on living standards; no physical relocation and less than 10% of Potentially Affected Peoples (PAP) livelihood assets affected. However, in some cases unavoidable loss of livelihoods will occur, which will be compensated through the ARAP. This is envisaged for compensation of:

- Loss of agriculture land in connection with the Bank protection component

And potentially also:

- Loss of income for ferry operators due to decreased access during low-water season
- Loss of income of fishermen temporarily affected by the impact on water quality during the construction of Bank protection and Porcupines
- Loss of agriculture land in connection with introduction of vegetation hedges on the islands

Long-term effects on fisheries and related livelihoods are considered highly uncertain and therefore not suitable to be addressed through ARAP.

7.4 Monitoring and Adaptive management

In order to allow for effective application of both mitigation and compensatory measures, monitoring of key environmental and social issues is necessary both throughout the Subproject 1 implementation and afterwards. This monitoring is proposed with two components:

A. ESMP-related monitoring focusing on detecting any significant construction related impacts and verification of effectiveness of the preventive and mitigation actions implemented within the ESMP (and ARAP). This component includes number of qualitative and quantitative indicators and its results will be reported throughout the Subproject 1 implementation and final evaluation.

B. Long-term monitoring focusing on change in key selected indicators to check development of preliminary identified risks and to capture unforeseen impacts. In this context the
development of morphology of the side channels will be a primary issue of interest and linked risks of negative impacts such as decrease value of fisheries, limited access for ferry, and decrease of water resources for the adjacent communities. Monitoring of the development of new erosion hot-spots shall be another aspect of the long-term monitoring.

The ESIA argues that because these long-term risk and potential negative impacts is difficult to attribute to the effects of the Sub-project 1, the concerns of local communities shall be addressed through Adaptive management including actions beyond the scope of the Sub-project 1. Among these shall be e.g. continuation of the Bank protection program in response to any shift of erosion patterns in the territory of the Subproject 1, and improvement of fisheries policy and management to support its sustainability regardless of actual contribution of the Subproject 1 to ongoing change. Table 1 provides an overview of the key mitigation measures proposed for Subproject 1.

Table 1: Key mitigation measures for Subproject 1

<table>
<thead>
<tr>
<th>Issue</th>
<th>Significance</th>
<th>Mitigation</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture land loss</td>
<td>Minor to Moderate</td>
<td>Compensation for loss of crops to the affected farmers.</td>
<td>ARAP</td>
</tr>
<tr>
<td>Short term (alluvial land)</td>
<td></td>
<td></td>
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<tr>
<td>Bank erosion on islands</td>
<td>Uncertain</td>
<td>Additional bank protection aligned with the porcupine field-related</td>
<td>Project design</td>
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<td></td>
<td></td>
<td>bank protection in the exposed areas upstream and downstream of</td>
<td>Monitoring</td>
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<td></td>
<td></td>
<td>porcupine fields</td>
<td>Adaptive management</td>
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<tr>
<td>Bank erosion in Mandalay channel</td>
<td>Uncertain</td>
<td>Additional bank protection might be needed in the long run</td>
<td>Monitoring</td>
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<tr>
<td>Alteration of morphology of the permanent water bodies downstream in</td>
<td>Moderate to Significant</td>
<td>No mitigation available. Monitoring and corrective management or</td>
<td>Monitoring</td>
</tr>
<tr>
<td>side channels</td>
<td>Uncertain</td>
<td>compensation measures to address social and environmental consequences</td>
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<td></td>
<td>Long term</td>
<td></td>
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<tr>
<td>Impact on fisheries from change of side-channels morphology</td>
<td>Moderate to Significant</td>
<td>No mitigation available. Long term monitoring and non-financial</td>
<td>Monitoring</td>
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<tr>
<td></td>
<td>Uncertain</td>
<td>compensation measures shall be</td>
<td>Adaptive management</td>
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<td></td>
<td>Long term</td>
<td>considered when negative effects detected</td>
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<td></td>
<td></td>
<td>(e.g. addressing illegal fishing practices)</td>
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<tr>
<td>Secondary impacts from materials extraction (hard rock)</td>
<td>Uncertain</td>
<td>Compliance with E&amp;S standards included in the procurement conditions</td>
<td>ESMP</td>
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<tr>
<td>Impacts on water quality</td>
<td>Moderate</td>
<td>Measures to minimise the mobilisation of sediments and release into the</td>
<td>ESMP</td>
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<tr>
<td></td>
<td>Short term</td>
<td>channels</td>
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<td></td>
<td></td>
<td>Temporary sanitation and washing facilities should be provided for the</td>
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<td>workforce, with appropriate pits and soakaways to minimise risk of direct</td>
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<td></td>
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<td>water pollution.</td>
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<td>Sound site waste management and proper management and storage of fuels and</td>
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<tr>
<td>Issue</td>
<td>Significance</td>
<td>Mitigation</td>
<td>Mechanism</td>
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<tr>
<td>other hazardous substances</td>
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<td>A full cleanup of the site should be undertaken, including rehabilitation of contaminated sand from fuel and oil spillage around stores and vehicle maintenance areas.</td>
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<tr>
<td>Temporary impacts of construction on fisheries</td>
<td>Moderate</td>
<td>Measures to minimize the mobilization of sediments and release into the channels e.g. choice of timing when to carry out the works in areas within the channels. Regular monitoring of turbidity and Total Suspended Solids in the channels Monitoring of fish catches during the construction period</td>
<td>ESMP</td>
</tr>
<tr>
<td>Risk of social conflicts</td>
<td>Minor</td>
<td>On-site Project Implementation Committee (OPIC) with Village Leaders, local representatives, Department of Labour, Police, work crew managers and foremen, to meet weekly to address any issues. Employment - preference to be given to local workers from Kyun Sin and Let Pan for construction - aim is at least 30% of workforce</td>
<td>ESMP</td>
</tr>
<tr>
<td>Accessibility and ferry services</td>
<td>Moderate</td>
<td>Including boat passage corridor in the porcupine field design and water level signalization for the safe passage</td>
<td>Project design Adaptive management</td>
</tr>
<tr>
<td>Compaction of soils along transport tracks and loss of vegetation</td>
<td>Minor</td>
<td>Transporting of materials (e.g. hard rock) preferably on boats instead of trucks Rehabilitation of soils and riparian vegetation after construction</td>
<td>ESMP</td>
</tr>
<tr>
<td>Local ambient air quality and noise impacts</td>
<td>Minor</td>
<td>Transporting of materials (e.g. hard rock) preferably on boats instead of trucks Low emissions electricity generators Location of the emission sources (e.g. engines) in sufficient distance from settlements Limiting operation/working hours respecting local communities daily regime</td>
<td>ESMP</td>
</tr>
<tr>
<td>Wildlife disturbance</td>
<td>Minor to Moderate</td>
<td>Location of the camp/facilities/landing site where there are few reeds and grasses to be disturbed, and make provision for rehabilitation of the landing site after use Confining use of vehicles to the narrow corridor of the access track Awareness raising in the workforce that if nesting turtles and birds are observed, they should be left undisturbed and protected Penalties for workforce found capturing</td>
<td>ESMP</td>
</tr>
</tbody>
</table>
Further information on mitigation and avoidance will be provided in the three ESMPs that will be developed for Subproject 1: 1) Bank protection, 2) Roughness measures (porcupines), and, 3) Dredging program.

The results and findings for the ESIA and ESMP for Bank Protection will be presented during a public consultation meeting on 19th January 2017.