MEKONG RIVER COMMISSION

THE COUNCIL STUDY

The Study on the Sustainable Management and Development of the Mekong River Basin including Impacts of Mainstream Hydropower Projects

Report for Navigation Thematic Area

Cambodia - Lao PDR - Thailand - Viet Nam

Mekong River Commission Secretariat

(Unedited Version)

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Disclaimer

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ABBREVIATIONS

AARG	Average Annual Rate of Growth
ADB	Asian Development Bank
AIS	Automatic Identification System
ASEAN	Association of Southeast Asian Nations
ATN	Aids to Navigation
DEMP	Dredging Environmental Management Plan
DG	Dangerous goods
DGMM	Dangerous Goods Management Manual
DWT	Dead Weight Ton
ECDIS	Electronic Chart Display Information System
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GMS	Greater Mekong Sub region
GPS	Global Positioning System
IEIA	Initial Environmental Impact Assessment
IMDG	International Maritime Dangerous Goods Code
IWT	Inland Waterway Transport
JCCCN	Joint Committee on Coordination of Commercial Navigation on the Lancang-Mekong River
KOICA	Korea International Cooperation Agency
MOE	Ministry of Environment (Cambodia)
MONRE	Ministry of Natural Resources and Environment (Thailand, Lao PDR, Vietnam)
MOT	Ministry of Transport (Thailand, Viet Nam)
MOWRAM	Ministry of Water Resources and Meteorology (Cambodia)
MPWT	Ministry of Public Works and Transport (Lao PDR, Cambodia)
navaids	Aids to Navigation instruments
pax	passengers, persons
PPAP	Phnom Penh Autonomous Port
PSHEMS	Port Safety, Health and Environmental Management System
RIS	River Information Services
SAR	Search and Rescue
SEIA	Strategic Environmental Impact assessment
SIA	Social Impact Assessment
TEU	Twenty-foot Equivalent Unit (container)
VTS	Vessel Traffic Services

DOCUMENT HISTORY

Version	Revision	Description	Issue date	Issued by
Final	0	**Interim report:** Problem definition Data collection Economic forecast: Development Scenarios Action Portfolio, General Socio-Economic and Environmental Assessments	Dec 2015	Lieven
	1	**Interim report:** Updated against MC comments	Jun 2016	Yen
1	0	**Assessment report:** Early Development Scenario 2007 Definite Future Scenario 2020 Planned Development Scenario 2040 Concerning the impact on and from navigation versus other sectors	March 2017	Freddy
	1	**Assessment report:** Annex: Matrix of the Scope and progress of the assessment	April 2017	Yen
	2	**Assessment report:** Updated the impacts on and from navigation versus other sectors	May 2017	Freddy
	3	**Assessment report:** Updated/revised the impacts on and from navigation versus other sectors	June 2017	Yen
	4	**Assessment report:** Updated assessment indicators	July 26	Yen
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Final	6	**Assessment report:** Finalisation with RTWG remarks	December 25	Yen & Freddy

EXECUTIVE SUMMARY

This report is a thematic report on the impacts and benefits of navigation infrastructure development in the Lower Mekong Basin, including recommendations for positive impact enhancement, negative impact avoidance and mitigation measures.

The report has many references to the recently completed Design of the Master Plan (MP) for Regional Waterborne Transportation in the Mekong River Basin. So, the planned navigation development scenarios M2 (2020) and M3 (2040) are based on the assumption of a sustainable 5% annual growth of the waterborne transport sector in the coming years.

Actions on waterway design, port development, navigation safety, social, regulatory and environmental protection measures were studied to achieve this goal. In this Council Study Navigation Assessment, impacts from and on these navigation development scenarios with the other areas and with the socio-economic and environmental disciplines were calculated and assessed.

For the economic and social assessment, unfortunately, there is sometimes a major lack of reliable data concerning the IWT freight and passenger transport on the Mekong River in all riparian countries. This means that some of the figures are indirectly calculated or even estimated values and should be treated with caution.

A. SENARIOS:

Early Development Scenario 2007

In 2007 and still today, inland waterway transport is seriously troubled by the seasonal lack of water depths during the low water season.

Almost 98% of all registered vessels in the lower Mekong Basin (about 100,000) are navigation in the Vietnamese Mekong Delta and about 78% of the annual cargo volume is transported there. In Thailand, the annual transported cargo volume is about 6% of the total transported volume in the Lower Mekong Basin, in the Lao PDR it is 4% and in Cambodia 12%.

Some 89% of the total passenger transport in the Lower Mekong Basin happens in the Vietnamese Mekong Delta, some 1% in Thailand, some 5% in the Lao PDR and some 5% in Cambodia.

2007	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Total IWT Cargo volume (ton)	893,000	491,000	1,818,000	11,615,000	14,817,000
Total IWT passengers (pax)	325,000	1,953,000	1,900,000	34,000,000	38,178,000

Except for Chiang Saen Port, Phnom Penh Port and Can Tho Port, all other ports are only small river ports or landing facilities and in Lao PDR and Cambodia, most of these ports are in their natural condition or consist of a laterite or reinforced concrete ramp, parallel to the river bank.

In most parts of the Lower Mekong Basin, fleet safety is in a very poor condition. Especially, awareness of the risks of the transport of dangerous goods is very limited in all MRC Member Countries. Localization and communication equipment is only available on a voluntary basis and Vessel Traffic Services are only available in a limited Vietnamese stretch. River Information Services are not available and Emergency Response with Search and Rescue is only available in Thailand and Vietnam.

Definite Future Scenario 2020

For the period 2007-2020, three hydropower dams have been considered: the Xayaburi dam, where commercial operation is scheduled to start in 2019 and the Pak Beng dam, where construction works are scheduled to start in 2017. Both dams (will) have two locks of 120 x 12 x 4 m for navigation and it is expected that 1 or 2 lock operations will be needed per day.

Third dam is the Don Sahong, blocking off one of more than ten channels that flow over the Khone falls, without any influence on navigation and with commercial operation expected to be in 2019.

During the period 2007-2020, high investments were and are made in port development: Chiang Saen Commercial Port in Thailand, the New PPAP Container Terminal in Cambodia and the expansion of Can Tho Port for ships up to 10,000 DWT.

From the Green Triangle to Huay Xay, vessels of 300 ton (instead of 100 ton in 2007) can now navigate the whole year. Moreover, special attention was given to the navigation in the Mekong Delta by upgrading the Cho Gao Canal between the Tien (Mekong) River and Ho Chi Minh City and the construction of the Quang Chanh Bo Canal at the mouth of the Hau (Bassac) River, to allow bigger ships to navigate to Can Tho and Phnom Penh.

Finally, several safety projects are proposed to create acceptable living conditions for passengers and tourists on passenger vessels. Another safety priority is the transport, handling and storage of dangerous goods, contingency planning, search and rescue and the upgrading of aids to navigation (buoys and beacons), to reduce accidents, oil spills and other pollution sources.

Aids to navigation was made available by China between the Green Triangle and Huay Xay. From Kompong Cham to the Cambodia – Vietnam border, buoys are installed by MRC and allow day and night navigation, but several of them disappeared. Also in the Vietnamese Mekong Delta, day and night navigation is possible, but the waterways are not fully fitted with navaids so that efficiency and safety are not yet optimal.

Total cost of executed, planned and proposed actions for the period 2007-2020 can be estimated at 913 million US$, including 293 million US$ for four locks at the Pak Beng Dam and the Xayaburi Dam and including 480 million US$ for the Quang Chanh Bo Canal.

Yearly IWT cargo volume and number of passengers in 2020 is forecasted as follows:

2020	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Total IWT Cargo volume (ton)	1,768,000	1,228,000	4,582,000	28,643,000	36,221,000
Total IWT passengers (pax)	497,000	4,094,000	2,909,000	92,200,000	99,700,000

Planned Development Scenario 2040

The navigation scenario 2040 considers eleven (ten) hydropower dams with locks, that should have some 12 lock operations per day. The scenario aims to allow 500-ton vessels during the whole year from the Green Triangle to Kratie (including a bypass canal with three locks at the Khone Falls). The river stretch between Kratie and Kompong Cham should be navigable for 2,000 DWT ships over the whole year, the stretch between Kompong Cham and Phnom Penh for 3,000 DWT ships, the stretch between Phnom Penh (New Container Terminal) and Can Tho for 7,000 DWT ships and the stretch from Can Tho to the sea for 10,000 DWT ships over the whole year. Finally, the Tonle Sap River and Lake between Phnom Penh and Chhong Kneas (Siem Reap) should be navigable for boats of 500 ton over the whole year.

Moreover, new passenger ports should be constructed in some 14 locations and new cargo ports should be constructed in some 7 locations in Laos and in Kratie, Kompong Cham, Phnom Penh (NCT LM17 Phase III) and Chong Kneas in Cambodia.

Finally, it is proposed to install River Information Services (RIS) over the total length of the Mekong river, to develop and install a GPS navigation guidance system, compulsory for all boats carrying cargo and passengers and to upgrade buoys and beacons, to reduce accidents, oil spills and other pollution sources.

The total cost of all planned and proposed activities in the period 2020-2040 (fleet modernization, waterway improvement, port development, fleet-, waterway- and port safety measures) can be estimated at 1,944 million US$, including 940 million US$ for the locks at the hydropower dams and 526 million US$ for the bypass canal with locks at the Khone Falls.

This scenario should lead to a total volume of yearly cargo transport by inland waterways of 168 million ton in 2040, compared to 23 million ton, measured in 2014 (AARG 8%), which also means that in 2040, almost 11% of cargo should be shifted from road to inland waterway transport.

The annual net economic value of the IWT cargo volume should rise from 12,010 million US$ in 2014 to 148,262 million US$ in 2040.

The number of domestic passengers should rise from 69 million per year in 2014 to 313 million per year in 2040 (AARG 6%) and the number of foreign tourists, making use of inland waterway transport should rise from 814,000 per year in 2014 to 6,078,000 per year in 2040 (AARG 8%).

2040	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Total IWT Cargo volume (ton)	7,372,000	6,390,000	20,581,000	133,504,000	167,847,000
Total IWT passengers (pax)	1,319,000	13,130,000	8,803,000	295,700,000	318,952,000

Without investments, it is assumed that the inland waterway transport sector will only grow (as well for cargo as for passengers) with an average annual rate of growth (AARG) of about 4%, certainly less than the growth rate of the GDP, and that most of the lost cargo and passengers will shift to road transport.

B. IMPACT ON AND FROM NAVIGATION VERSUS OTHER SECTORS:

1. ECONOMICAL:

The impact from lock operations at the hydropower dams

The greatest obstacle for the growth of inland waterway transport sector is the fact that waterway transport is slower than land transport. Therefore, the lock operations at the hydropower dams should not increase the transit times of waterway transport. Moreover, emergency dam operations with high release and flushing of water can be very harmful for the berthed and sailing ships downstream, with even accidents and damage if the boat operators are not informed in time.

To reduce the impact of the dam operations and the lock operations at the dams on the navigation, it should be of a high priority to establish a “Vessel Traffic Service Center” in the Lao PDR, covering the whole stretch of the Mekong River from the Green Triangle to Vientiane with compulsory AIS and VHF on board of selected ship sizes and types, so that important information can be exchanged between boats and shore.

The impact from Climate Change

In the Mekong Delta, climate change and sea level rise will increase the number of periods in the year when the full navigation air clearance of 37.5 m would not be available at the Cao Lanh and Vam

Cong bridges and many approach roads and interconnecting roads will be submerged. In the upper part of the Lower Mekong Basin, the flow increase during the flood season could influence the speed and fuel use of vessels, sailing upstream, but should be an advantage for vessels, sailing downstream.

Climate Change Adaptation Plans for sea level rise and increased flooding must be in place to protect IWT infrastructure and IWT vessels. This can be incorporated into contingency planning for flooding. Special attention must be given to the height of bridges, power lines and port wharves.

The impact from fisheries

In Cambodia, fishermen are (unreasonably) unwilling to come to an agreement with the Ministry of Public Works and Transport to allow floating aids to navigation to be installed and maintained. In Vietnam, several fixed fishing installations are deployed on the Tiền (Mekong) and Hậu (Bassac) River, sometimes reaching into the navigation channel.
The adverse influence of fisheries on inland waterway transport can only be reduced by a better cooperation between national ministries and provincial authorities to define river zones that are (exclusively) allocated to fishing or transport activities. Rules and regulations should be imposed to avoid mutual hindrance of both activities.

2. SOCIAL:

The impact on employment

Employment in the inland waterway transport sector (situation 2014) can be roughly estimated at 780,000 people. It can be assumed that employment will grow up to 975,000 people in 2020 and 1.95 million people in 2040.
The impacts of port development projects and the modification and maintenance of waterways for IWT must be incorporated into a Social Impact Assessment (SIA). It is important that new infrastructure projects are assessed with consideration for the social effects.

The impact on accessibility

More than 29.6 million people are estimated to live within 15 km of the Mekong mainstream, defined as the Mekong corridor. As a result of some 200 interviews with IWT domestic passengers (2014), it was found that about 30% make a daily use and about 30% make a weekly use of inland waterway transport. Some 25% make use of IWT to visit family or friends and another 25% use IWT to visit markets. Some 20% use IWT to transport goods and another 20% use IWT to go to their job.
Questioned on possible improvements, the participants reported that IWT could be improved by (amongst others) more safety equipment for passenger vessels, better passenger port facilities, strict enforcement of safety rules, an increase in boat capacity and safe, cheaper and more frequent ferry services. They also proposed to promote awareness for local people and ship owners to reduce pollution and solid wastes and to promote IWT and water-related tourism for international and local tourists, to consider financial incentives and to simplify procedures and regulations for cross-border transport.

This survey should be continued. Moreover, socio-economic risks and opportunities must be integrated into SIAs. Planning for linking local IWT with domestic and cross-border transport is required. The development of rural/domestic cargo and passenger transport should be fully integrated and IWT should be also integrated with hydropower, agricultural, mining, industrial and other sectors. Landing facilities should be installed at priority locations to link local transport and eco-tourism with national ports.

The impact from education and training opportunities

During a Training Needs Assessment for IWT related disciplines and topics, executed by the MRC NAP in 2014, all countries and their stakeholders expressed a high need for additional education and training actions on navigation techniques and equipment (crew certification); navigation safety, including carriage and handling of dangerous goods; hydrodynamics, hydrography and waterway

design and maintenance; IWT vessel design and construction; registration and inspection, and IWT Socio-Environmental Issues (EIAs, SIAs, Environmental Management Plans, sand mining, Dredging Environmental Management Plans (DEMP), etc.).

Based on this Training Needs Assessment, in 2014, MRCS prepared a MRC NAP Training Plan available in the "Formulation of a Training Plan to Implement the Activities under the Navigation Programme - Final Report", MRCS NAP, December 2014.

3. ENVIRONMENTAL

The impact from dredging activities on the river flow

The proposed channel improvement activities in Thailand and Lao PDR consist mainly of the clearing of rapids and rock removal while in Cambodia and Vietnam, some 28 million m^3 of dredging are proposed (of which some 12 million m^2 in the Great Lake).

Hydro-morphological changes can have far-reaching impacts upstream and downstream from dredging activities, significantly affecting river system dynamics and interfering with the exchange of water and sediments between the mainstream river and its tributaries and flood plains.

These impacts must be incorporated into an Environmental Impact Assessment (EIA). It is important that new projects are assessed with consideration for the main natural functions of river systems, including the morphological processes (e.g. erosion, sediment transport and sedimentation), the maintenance of the hydrological balance (e.g. flood pulse) and the maintenance of the sediment balance,

The impact on the river flow and sediment transport could be mitigated by:

- Repeated surveys of the river bathymetry, together with a morphological optimization study;
- Dumping the dredged material back in the river, to maintain the hydrological and sediment balance;
- Better coordination between navigation dredging and sand mining; and
- Study the opportunities to replace dredging works by river training works.

The impact from inland waterway transport on Climate Change

IWT vessels can carry larger volumes of cargo relative to the extra fuel needed, resulting in lower emissions per ton-km compared to road transport. However, to mitigate the impact of waterborne transport on the climate change causes, improvements must be made for vessels to use more energy efficient engines and cleaner fuels. In the ports and terminals, air emissions by vehicles, cargo handling equipment and cranes can be reduced using modern electrical engines.

Finally, awareness should be raised in the transport sector for the use of "Combined Transport", an environment-friendly multimodal door-to-door transport, involving as little road transport as possible.

The impact on water quality

Potential impacts on water quality are derived from the following activities:

- The construction of navigation infrastructure e.g. ports and landing facilities;
- The operational activities e.g. oil spills, solid and liquid wastes, navigation accidents; and
- The maintenance of the navigation channel and waterway conditions.

The construction of inland port and landing facilities development can cause significant direct and indirect impacts on the environment and socio-economic characteristics of a river basin. The environmental impacts need to be considered during planning and construction in an Environmental Impact Assessment (EIA) and during operations in an Environmental Management Plan (EMP).

During operations, oil spills in inland waters are highly likely to contaminate water supplies. A possible incident involving the transportation of dangerous goods can have severe consequences for

the environment and people, including risk of spillages and pollution from shipping accidents. Finally, the operations of ports, terminals and vessels have the potential to generate both domestic and hazardous wastes. Direct dumping of untreated wastes into rivers can alter the aquatic habitats and harm fisheries, other aquatic organisms and riparian vegetation.

To mitigate these impacts, pollution control and environmental monitoring are needed for a sustainable inland waterway navigation. Next to the Contingency Plans that should be developed, the MRC Environment Programme (EP) drafted a "Water Quality Emergency Response and Management" chapter, developed to ensure timely and effective cooperation between Mekong Countries in response to water quality emergencies and to minimise the extent and mitigate the negative effects on water quality in the Mekong River.

Dredging activities can pose a threat to the aquatic environment not only through the disposal of dredged material, but also through the dispersal of pollutants into surface waters during dredging.

To mitigate the impact of channel dredging activities on the environment, it is proposed to conduct an Optimization Study of dredging sand from the Mekong River at various places that are not creating a negative impact on the river behavior or ecological status and to adopt Dredging Environmental Management Procedures (DEMP).

The impact on river habitats, river banks and eco-regions

Limited research exists on the impacts of modifications of waterway channels on ecosystems, fisheries and livelihoods in the Mekong River Basin. Planned developments for port construction, dredging and reef removal in the upper and lower part of the Mekong Basin need to be assessed against the significance of the ecological areas.

The eco-regions are important to use as a first step in preliminary assessments (e.g. initial environmental impact assessment (IEIA) or examination) to determine the existing environmental degradation, biodiversity and protected areas in relation to the specific location of existing and planned IWT projects/activities in specific stretches. Further Environmental Impact Assessment (EIA) would be required to consider the critical ecosystems, fisheries conservation zones, water quality, ecological status and socio-economic conditions. The eco-regions could also be used to determine zones or restrictions for port/vessel activities, transport of dangerous goods and dredging/sand mining activities.

The impact on fishing activities

Also inland navigation could be a disturbing element for capture fisheries:

- By dredging millions of cubic meters of sand in possible fishing zones. Therefore, it is important that new dredging projects are assessed with consideration to protect fishing zones and wetlands, the provision of habitats (ecosystem connectivity) and the maintenance of the nutrient cycles (especially dredging works in the Tonle Sap Lake requires special consideration);
- By allowing bigger ships of which the stern waves can influence embankments and flood fish zones. Therefore, it should be studied in which river stretches a speed reduction or even restrictions for port/vessel activities should be introduced.

The impact from hydropower development

The changes in flow regime due to potential hydropower and climate change could result in higher flows in both wet and dry seasons, lower flow in the high-flow season and increased flow in the low-flow season (MRC 2011). Moreover, the Mekong Delta is vulnerable to projected reductions in sediment transport that could cause destabilisation of riverbanks from down cutting and bed erosion, potentially impacting port and waterway infrastructure. Therefore, dam operations should be duly adapted to these risks.
Concerning the lock operations, it has to be mentioned that the main disadvantage of waterborne transport is that it is slower than road or rail transport. In the near future, insufficient navigation will

generate only one or two lock operations per day at the hydropower dams and this will create additional delays. In the M3 (2040) scenario, it was calculated that about 12 lock operations per day should be necessary, so that the delays can be reduced to 30 at 45 minutes per simple or double lock-lift.

The impact from sand mining

Dredging and sand mining would usually be considered as two separate issues, as modern waterway dredging strategies prohibit commercial extraction and require refilling of dredged material in the system. To date, the issue of sediment mining in the Mekong River channel has been a politically sensitive issue. In-channel extractions are contributing to a reduced sediment load in the Mekong Delta, causing large-scale erosion. Therefore, rigorous Environmental Impact Assessment (EIA) studies should precede any new sand mining project.

From this overview, it can be seen that the navigation development scenario 2040 only can be sustainable if a lot of fleet, port and waterway safety measures are carried out and if all development projects are submitted to rigorous Environmental Impact Assessment and Social Impact Assessment studies.

The economic value of some parts of the scenario (e.g. Luang Prabang – Savannakhet, Savannakhet – Kratie, Tonle Sap Lake) could eventually be re-assessed.

NAVIGATION THEMATIC AREA

1. BACKGROUND

1.1. OVERVIEW

This report is a thematic report on the impacts and benefits of navigation infrastructure development in the Lower Mekong Basin, including recommendations for positive impact enhancement, negative impact avoidance and mitigation measures.

The report has many references to the recently completed Design of the Master Plan (MP) for Regional Waterborne Transportation in the Mekong River Basin, because the MP is dealing with all opportunities for trade and transportation.

"The goal of the Master Plan for Regional Waterborne Transport in the Mekong River Basin is to increase waterborne transport in the MRB to at least 125% of the actual waterborne transport volume in 2020 and to at least 250% of the actual waterborne transport volume in 2040 (corresponding to the estimated GDP growth in the MRC member countries) and to make navigation safer and more sustainable for the people and for the environment."

This goal should be achieved by:

- The use of larger ships used over the total length of the Mekong River and over the whole year, including the use of sea-river ships in the Mekong Delta;
- The creation of a safe navigation channel, able to accommodate the larger ships over the whole year;
- The development of safe and efficient passenger ports and multimodal nodal points in the main cargo ports and dry ports;
- The improvement of safety of all types of ships, including the use of more save passenger ships and ships carrying dangerous goods;
- The promotion of the concept of "clean" river transportation, focusing on strategic prevention of environmental damage from waterway infrastructures or from shipping or port accidents;

When no inland waterway transport investments should be made, inland waterway transport growth in the Lower Mekong river Basin will be very low and in some stretches of the river there will be even no growth or a decline, due to strong competition of faster (but more expensive and polluting) road transport. So, for example, very recently, passenger transport between Phnom Penh and Siem Reap almost fully collapsed (yearly decline of 18.3% during the last decade), caused by the seasonal navigation limitations, the lack of investments in Chong Kneas port and the fierce competition of low fare and faster air-conditioned buses.

For the economic and social assessment, unfortunately, there is sometimes a major lack of reliable data concerning the IWT freight and passenger transport on the Mekong River in all riparian countries. This means that some of the figures, given in chapter 4, are indirectly calculated or even estimated values and should be treated with caution.

In Chapter 2 of this report, the current situation is described.
In Chapter 3, the navigation development activities, plans and proposals for the period 2007-2020 and for the period 2020-2040 are described with a budget estimation for the planned and proposed investments.
In Chapter 4 of this report, some economic and social data are given.
In Chapter 5, the impacts on and from navigation versus other sectors are described.
And in chapter 6, some recommendations are made to avoid or mitigate negative impacts.

2. CURRENT SITUATION AND BASELINE CONDITIONS

2.1 FLEET

THAILAND

In 2014, there were 183 vessels registered in Thailand to sail on the Mekong River. Thailand does make significant use of the Mekong River and its associated waterways for domestic transport or passenger services. Attention should be paid to the state of the numerous local ferries and the different ferry sites.

Cargo fleet (ton)		Passenger fleet (pax)		Ferries	Total
50	100	50	100		
82	53	16	32	?	183

An increasing number of vessels under Chinese flag are sailing in this region.

LAO PDR

In 2009, the Lao MPWT gave following information on the Lao fleet:

Cargo fleet (ton)			Passenger fleet (pax)				Ferries	Total
0.5 - 5	5 – 50	>50	Speed	5 – 15	16 – 50	>50		
272	192	73	374	215	244	206	26	1,626
537			1,039				26	1,626

In 2014, there were 2,961 vessels registered in the Lao PDR to sail on the Mekong River:

Cargo vessels (max. 50 ton)	689
Passenger vessels (max. 50 pax)	1,809
Speedboats	121
Ferries	60
Fishing boats	282
Total	2,961

CAMBODIA

The Mekong River receives both kind of vessels up to Phnom Penh: inland vessels and seagoing (maritime) vessels up to 5,000 DWT. The main traffic is dedicated to inland shipping, for the domestic market and cross-border trade with Viet Nam.
In 2014, there were 246 vessels of >250 ton registered at the Cambodian Ministry of Public Works and Transport. Smaller vessels must register at the provincial authorities, but there are no data available.

	Number	Average capacity (ton)
Sand cargo vessels	69	1,690
Dry bulk cargo vessels	20	380
General cargo vessels	10	1,200

Oil tanker vessels	10	125
Container cargo vessels	3	560
Passenger vessels 100 pax	9	
Passenger vessels 50 pax	63	
Ferries	19	240
Dredging boats	43	260
Total	246	

In 2010, container services between Phnom Penh and the Vietnamese ports were conducted by 15 barges from 4 (non-Cambodian) shipping companies and with an average capacity of 72 to 104 TEUs (800 to 1,200 ton)

VIETNAM

In 2012, the number of inland waterway vessels, registered in the Mekong Delta was 253,090.

Vessel type	2005	2006	2009	2010	2011	2012
Dry bulk cargo	68,083	71,829	147,394	168,232	181,709	190,190
Average tonnage (ton)	68	76	71	68	66	64
Tankers	1,974	2,025	2,543	2,697	2,899	3,459
Passenger vessels	13,953	14,868	31,254	32,583	34,528	39,872
Average capacity (pax)	22	22	14	14	14	13
Other vessels	10,382	11,330	15,905	17,766	19,174	19,058
Total fleet (Mekong Delta)	94,597	100,279	197,499	221,764	238,827	253,090

2.2 WATERWAYS

Annual number of days the Mekong River is navigable along different reaches

Vessel tonnage (ton)	10	30	50	100	300	500	1,000	1,500	2,000	3,000	5,000	7,000	10,000
Channel Depth (m)	0.9	1.1	1.3	1.9	2.5	3.1	4.5	4.9	5.3	6.2	7.0	8.0	8.8
Min. Channel Width (m)	8	10	12	27	33	35	48	50	52	56	64	76	88
Stretch 1 Green Triangle – Huay Xay					365	180	0						
Stretch 2 Huay Xay – Luang Prabang			365	180	0								
Stretch 3 Luang Prabang – Sanakham Dam		365	180	0									
Stretch 4 Sanakham Dam – Vientiane		365	180	0									
Stretch 5 Vientiane – Savannakhet				365	180	0							
Stretch 6 Savannakhet – Khone Falls	365		180	0									
Stretch 7 Khone Falls													
Stretch 8 Khone Falls – Kratie		365	180	0									

Vessel tonnage (ton)	10	30	50	100	300	500	1,000	1,500	2,000	3,000	5,000	7,000	10,000
Channel Depth (m)	0.9	1.1	1.3	1.9	2.5	3.1	4.5	4.9	5.3	6.2	7.0	8.0	8.8
Min. Channel Width (m)	8	10	12	27	33	35	48	50	52	56	64	76	88
Stretch 9 Kratie – Kompong Cham				365		180	0						
Stretch 10 Kompong Cham – PHN NCT						365			365 150[1]	0			
Stretch 11 Phnom Penh – Kompong Chhnang					365			365 150[2]	0				
Stretch 12 Kompong Chhnang - Chhnok Trou		365			180	0							
Stretch 13 Chhnok Trou – Chong Kneas (104 km)		365			180	0							
Stretch 14 Phnom Penh – Cai Mep (Cho Gao)								365		tidal			
Stretch 15 Phnom Penh – Cai Mep (Bassac River)										365	tidal		

[1] Only barges of 2,000 ton can navigate the whole year. Seagoing vessels of 2,000 DWT can only navigate to Kompong Cham for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) during the highwater season.

[2] Only barges. Seagoing vessels of 1,500 DWT can only navigate to Kompong Chhnang for five months of the year as they are unable to pass under the Chrui Chanvar bridge (10 m) during the highwater season.

2.3 PORTS

THAILAND

Haciang Commercial Port is a private owned and operated port. Chiang Saen Port, Chiang Sean Commercial Port and Chiang Khong port are owned and operated by the Port Authority of Thailand (PAT).

Haciang Commercial Port

From 2004 to 2012 petroleum products (diesel and gasoline) where mainly exported through Keawalee terminal to PR China and Myanmar. Export increased from just over 4 million liters in 2004 up to almost 17 million liters in 2011. Operations would be phased out at the Keawalee terminal in 2012 and transferred to Chiang Sean Commercial Port (CSCP). However, the transfer of operations to CSCP was unable to commence due to the low water level at the navigation (entrance) channel. Beginning 2012, as intermediate solution, all operations were temporarily transferred to Haciang Commercial Port (HCCP). The export of fuel products through Haciang Commercial port reached 27 million liters (21,000 ton) in 2014.

The port has a sloped berth for trucks to reach the vessels for loading/discharging general cargoes. The berth is about 110 meters in length. Up to 5 Vessels can berth alongside each other for (manual) cargo operations.

The port also has one vertical berth where one vessel can berth for loading/discharging heavy loads and one dedicated berth for loading/discharging fuel (diesel and gasoline) from truck to vessel.

Chiang Saen Port

The terminal at Chiang Saen Port consists of two floating pontoons provided with bridges linking to the quayside (investment 2003: US$ 4.6 million). The pontoons are equipped with roofs providing shelter from sunshine and wind and this makes it possible to conduct cargo operations in all weather conditions. There are 2 berths of 12 by 50 meters and an area for container storage. The berths can accommodate ships less than 200 ton, 50 meters in length and 2 meters in depth. The port has one mobile crane with a capacity of 50 tons and a conveyor belt for loading/discharging cargo to and from ship's. The designed cargo handling capacity is about 540,000 tons per year and the port is currently mainly used as a tourist port with some 6,000 passengers in 2014.

Chiang Saen Commercial Port

The construction of Chiang Sean Commercial Port (CSCP) started in 2008 and the port was officially opened end of March 2012. The port has the ambition to become a center of investment, trade and transport in the Greater Mekong Sub region and a major gateway between Thailand and Southern China for the trade of goods. The port has two two-level sloped berths of 300 m long, which can accommodate each five 50 meters long ships simultaneously for loading and discharging general cargoes and a vertical berth of 200 m long which can accommodate three 50 meters long ships simultaneously for general cargo and container handling.

In the port the basin size is 200 x 800 m with two 30 x 30 m warehouses and marshalling yard.

	Chiang Saen Port + Chiang Saen Commercial Port Annual Cargo Volume (ton) and number of ships calling the port(s)							
	2007	2008	2009	2010	2011	2012	2013	AARG (%)
Throughput	696,390	569,980	568,220	496,010	567,510	624,790	777,690	6.5
Ships calling	1,764	2,023	2,088	3,052	4,980	7,688	12,734	

Most products imported through Chiang Sean Commercial port are fruit from China, such as pomegranates and apples, sunflower seeds, garlic, shiitake mushrooms and cassava, while exported products include mostly frozen chicken and red meat, palm oil and energy drinks.

Chiang Khong Port

The port is a small river port, primarily serving small ships and ferries from China and Lao PDR.

The port has a concrete quayside terminal with a width of 24 m and length of 108 m (investment 2003: US$ 1.6 million), which can accommodate 3 to 5 vessels of 80 to 150 ton simultaneously. The port has no cargo handling facilities and the top three imported products through this port are vegetables, fruit and fresh flowers from China. The top three exported products are petrol, gasoline and consumer products, mostly to China and Lao PDR.

LAO PDR

There are 29 river port facilities on the Lao PDR side of the river. All river ports and facilities are under the responsibility of the provincial governments. Most of these river ports are small and still in their natural condition or consists of a reinforced concrete ramp parallel to the river bank. These berthing facilities make it difficult for vessels to berth. Most ports have none or limited handling facilities and have no maintenance nor a management system in place.

Ban Sai Port

Ban Sai ports is a provincial-level checkpoint to undertake exit and entry inspections for border inhabitants and ferry boats. The port is located at the natural bank of the river and has no cargo handling facilities.

Xiengkok Port

Xiengkok Port is a national-level checkpoint, 107 km upstream of Chiang Sean port (Thailand). The port is an open port and still in its natural condition without any concrete berth. There is a well-organized joint inspection organization that inspects people, vessels and cargo passing the port from four countries (China, Myanmar, Lao PDR and Thailand). The port has a sloped laterite berth but no cargo handling facilities.

Muongmom Port

Muongmom Port is a national level checkpoint, located 18 km upstream of Chiang Sean Port (Thailand). The port handles almost no cargo, the port serving as a checkpoint where all vessels passing this port need to stop in order to sign the necessary documents.

The total area of the port is 4.3 hectares. The port has an open storage area and one office building but no cargo handling facilities. The concrete sloped ramp is 248 m long. During the wet season 5 vessels of 300 DWT can berth, during the dry season 3 vessels of 300 DWT can berth.

Huay Xay Port

Huay Xay Port is located 57 km downstream Chiang Sean port (Thailand). The port started commercial operations in 1990 and is used both as a passenger and cargo port at the same sloped wharf. The port is an embarking / disembarking point for boat trips, going to Pak Beng and after an overnight stay at Pak Beng, further to Luang Prabang. The port has no parking space available and all trucks, cars and taxis need to park on the crumbled concrete sloped wharf. The port has never been upgraded or rehabilitated to accommodate the current number of tourists calling at the port. Port handling and storing fuel (diesel and gasoline), passengers and cargo have no minimum safety, health and environmental management system in place.

Pak Beng Port

Pak Beng Port is used for import and export of agriculture products in bulk, there are no dangerous goods handled at the port. In 2014 the cargo throughput was 725 tons for import and 1,350 tons for export. In the same year 22 cargo vessels called at the port. The port has a 5-ton lifting truck but most cargo operations are done using manual labor. The maximum permissible draft at the port is 2.5 m during the wet season and 0.4 m during the dry season.

Pak Beng port is however mainly used as a passenger port. The port is an intermediate stopping place, as there is no navigation during night time, for tourist going from Huay Xay to Luang Prabang and vice versa. Passenger landing facilities have been improved by a cubic-module platform, the system has better comfort than the rocky embankment but is unstable for the number of people. This platform is not suited anymore for the number of passengers using the port. The port has no maintenance system in place and no system to assure the safety of the passengers.

Pak Beng	2010	2011	2012	2013	2014	AARG (%)
Passenger ships in	1,271	1,377	1,122	1,042	1,063	-4.5
Passenger ships out	1,217	1,325	1,173	1,045	1,258	0.8
Tourists in	18,174	58,134	28,766	29,321	28,063	11.5
Tourists out	17,878	56,341	28,765	29,315	28,065	12.0
Other passengers in	2,437	2,218	3,951	7,150	6,160	26.0
Other passengers out	2,032	2,943	4,249	7,457	6,680	34.6

Luang Prabang Port

Luang Prabang has two ports, one used for cargo and one for passengers. The port used for cargo is Chiang Keo port, in operation from 1973 with no infrastructure and no concrete berth (only compacted soil). Only in 2010, the sloped berth has been upgraded with concrete. The port has no maintenance system in place and almost no maintenance has been done since construction of the port. The main cargoes that are handled are cement (70% of the goods transported), construction material, wood, logging and consumer goods. The port has no parking space for trucks calling at the port.

Luang Prabang passenger port is located near the city center. The landing facility is concrete with a steep slope in earth and partly in concrete. This is all right in the highwater season but the steps are not always very safe in the low water season.

Pak Lay Port

Pak Lay is a passenger port with no cargo handling facilities. The port is in poor condition and has been abandoned after completion of the bridge over the Mekong.

KM4 State port - Vientiane

Km 4 State port is located in Vientiane Capital and is managed by the Ministry of Public Works and Transport (MPWT). Cargo exports have, however, decreased as transport companies have opted for improved roads as a more viable and reliable transport link. However, the Mekong River still provides an important transport link between rural provinces in Lao PDR and the capital.

The port has a concrete sloped ramp in poor condition due to the lack of maintenance. The port has also two 10,000 litre underground storage tanks in poor conditions for the storage of fuel and diesel.
Study and plans to relocate the port are ongoing, because the current port has no expansion possibilities and is close to the city centre.

Savannakhet Port

Savannakhet, with a friendship bridge between Thailand and the Lao PDR and a Special Economic Zone (SEZ) has an unsafe and outdated floating landing point where regular ferry services carry passengers and goods across the Mekong river to Mukhadan (Thailand) about 3 km downstream on the opposite side. Also, other passenger and cargo vessels berth at this landing point which has no maintenance or safety management plan.

Pakxe Port

Pakxe is located at the confluence of the Mekong River and the Se Don River. The town has grown quickly since the Lao-Japanese Bridge across the Mekong was opened in 2002, facilitating trade with Thailand. Its position on the way to Si Phan Don in the far south, the Bolaven Plateau to the east, and Thailand to the west attracts local and international tourists. Pakxe has no real port

infrastructure and goods are (un)loaded and passengers (dis)embarking along the river bank in its natural conditions.

CAMBODIA

Apart from Phnom Penh Port, all the inland waterway ports are mainly just ramps or simply river banks used by domestic boats for landing to discharge and load various kinds of food stuffs, groceries, construction materials and passengers. The ramps that local people tend to call "ports" are mainly used as the loading and discharging points for domestic boats sailing inter-provinces, intra-province or even city-province voyages.

Stung Treng Port

Stung Treng Port is located where the Sekong joins the Mekong and has road access both to Lao PDR (road 7) and Viet Nam (Road 78). A ferry brings the traffic along Road 7 across the Sekong, but is not much used in the present situation. The river port area just in front of the small city park is handling trade mostly between Cambodia and Laos.

There are no dedicated port or cargo handling facilities. The river banks must be used and during the low water season a temporary jetty is to be provided for the ferry. A floating pontoon for embarking / disembarking passengers is in a poor condition due to the lack of a proper maintenance system.

Kratie Port

Kratie port is 220 km upstream from Phnom Penh which is ideal for travel and bulk product transportation. As road 7 is very poor and indirect, most of the current traffic between Phnom Penh and Kratie is carried by river. Kratie is an important center for the rubber trade. The port has a 35 m long floating pontoon for embarking / disembarking passengers and one for fuel transfer operations.

Both pontoons are in poor condition due to the lack of a proper maintenance system and are only used in the rainy season. Since 2008, there is also a paved sloped ramp to serve as cargo landing and a 1,000 m2 warehouse said to have a capacity up to 5,000 tons. There are no cargo handling facilities available.

Kompong Cham – Tonle Bet Port

Kampong Cham Port (or Tonle Bet Port), 106 km upstream Phnom Penh, is situated on a cross road of two main trading routes: north-south along the Mekong from Laos to the sea, and east-west between Thailand and Viet Nam along the historic route via Siem Reap. It is growing quickly and is an important center for the rubber plantations.

The port has no special facilities for passengers disembarking at the city and the local travelers are only able to disembark at the present riverbank on the town side of the river. There is also a 13-year concession (counted from 2008) from the Ministry of Economy and Finance to a private company to build a tourist port at the current port site.

For cargo, there is a 10-m long pontoon for barges up to about 400-ton capacity. During the dry season the pontoon is grounded and the river bank is used. There is also a warehouse with a covered area of 550 m2, said to have a capacity of about 600 tons.

The present method of transferring loaded containers from Kampong Cham to Phnom Penh involves the use of flat platform barges (15 to 20 containers every three months) equipped with a derrick and towed by a tug to place empty containers at Kampong Cham for loading and transfer to Phnom Penh. This is an expensive operation, tying up a tug and a floating crane for about 3 days during movement to / from Kampong Cham, loading in Kampong Cham and transshipment in Phnom Penh.

Moreover, although there are no port facilities, in 2015 two 2,000 DWT ships berthed in Kompong Cham and loaded bulk cassava.

PPAP Phnom Penh Passenger Port (Tonle Sap)

In Phnom Penh, the Passenger and Tourist Terminal is situated at Sisowath Quay Boulevard. The port is located at walking distance from the town center, there is a wide parking across the road where buses, taxis and tuk-tuks can park their vehicles.

There are two floating pontoon of 15m x 45 m. There are regular departures with tourist boats to Siem Reap as well as to Ho Chi Minh City via Chau Doc in Vietnam.

	2010	2011	2012	2013	2014	AARG
Passengers outbound	4,738	6,982	10,004	11,479	11,988	
Passengers inbound	5,157	7,060	10,174	12,057	12,782	
Total	9,895	14,042	20,178	23,536	24,770	25.8%

PPAP Phnom Penh Old Cargo Port (Tonle Sap)

At km 6, a 184-m long pier, built in concrete could accommodate barges up to 2,000 ton but is since long completely abandoned.

The old main cargo port is situated at Sisowath Quay Boulevard and has an open concrete quay. The main wharf is built in 2002 and is still in good condition. The port converted to all-container operations in 2002 on completion of a JICA-funded project. It comprises a concrete decked structure some 300 m long by approximately 20 m wide, built out into the stream with two broad concrete connecting bridges. Due to the water level of the river the draft is limited to 5.5 meters in the rainy season and 4.5 meters in the dry season with depths alongside varying from 6 to 9 meters.

The first year when container traffic started in 2002, Phnom Penh port managed 746 TUE up to 95,333 TEUs in 2012. Seen the location of the port (in the city center between the river and the street) the area could not expand in any direction. The port had 2 (old) floating derricks owned by Sovereign, to load / discharge containers from / to the vessels.

Phnom Penh Oil Terminals (Tonle Sap)

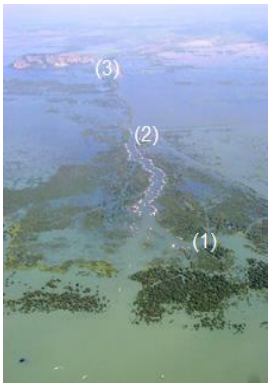
Between km 6 and km 10 on the Tonle Sap River, there are three Oil Terminals, all privately owned and operated. Condition depends on the owner/operator of the port. Some terminals are in excellent conditions, others are in very bad condition and should not continue to operate anymore.

Kompong Chhnang Port (Tonle Sap)

Kompong Chhnang port has a long-term concession granted by the Provincial Authority to private operators but this concession has not resulted in any improvements to the port. Cruise boats sailing from Phnom Penh to Siem Reap avoid stopping there because the existing infrastructure is not adequate to handle the luxurious cruise boats and their passengers. Because of the small

distance to Phnom Penh, almost all cargo is transported by road and next to local transport for the many floating villages, only fishermen unload their cargo in the port.

Chong Kneas Port (Tonle Sap Lake)



Chong Kneas Port is located within the seasonal flood plain of the Great Lake (Tonle Sap Lake), the shoreline of which migrates about 8 km at this location with the changing water level. The present landing at Chong Kneas moves with the water level in the Tonle Sap. During the low water period from mid-March and to the end of May, goods and passengers are loaded and discharged at the lake edge just east of the existing channel mouth (1). Access is via the existing embankment to Kanthey Kaom where there is a bridge crossing the Stung Siem Reap to a dirt track down to the lake edge. As the water level rises, the landing is moved, first to Kanthey Kaom (2) and then progressively up the embankment until at high water, it is located at the foot of Phnom Kraom (3). As the water level recedes, the landing moves progressively down towards the lake. During low water, the water depth at the entrance to the lake is only 0.5 m, and only very shallow draft passenger boats can cross the lake. The three main categories of traffic at Chong Kneas are fish, cargo and passengers. All three suffer from operational inefficiencies, because no proper landing or handling facilities are available.

PPAP Phnom Penh New Container Terminal NCT LM17

The new container terminal is located along the Mekong River in Kean Svay district, about 30 kilometers east from the old port on the Tonle Sap River in Phnom Penh. The construction of the terminal started in 2011 and the terminal officially started operations in the beginning of 2013. The construction of new container terminal comprises a container yard for a total capacity of 150,000 TEUs per year. NCT LM 17 has a total quay length of 300 m and is 22 m wide. The quay can accommodate 2 vessels simultaneously of about 5,000 DWT. The current port area is about 12 ha and can be extended to 30 ha in the future (the container yard is currently 32,852 m2). The port has currently 68 staff members and 33 workers. There are about 16 barges per week that call at the port. The total ground slot capacity is 896 TEU and the yard also has a parking slot for trucks an office building and a car parking. The port also has 3 single jib mobile cranes mostly used for transferring containers to and from the vessels. For stacking containers at the yard the port has 4 8-wheel Rubber-tire gantry (RTG) cranes, 6 reach stackers and 3 sky stackers. NCT LM 17 also has a warehouse of 40,000 square meters.

PPAP	Old PPAP Cargo Port						NCT LM17		
	2007	2008	2009	2010	2011	2012	2013	2014	AARG
TEU export	22,595	22,497	22,808	34,947	46,163	52,829	59,508	71,561	
TEU import	24,909	25,010	20,504	27,309	35,468	42,504	50,992	62,105	
Total	47,504	47,507	43,312	62,257	81,631	95,333	110,500	133,666	15.9%
Gen.cargo (ton)				28,715	17,333	20,295	34,669[1]	44,638[1]	11.7%
Ship calls				492	599	661	709	753	

[1] NCT LM17 + Old PPAP Cargo Port

VIETNAM

In the Mekong Delta, there are more than 100 small IWT ports, of which the condition depends on the owner/operator of the port. The main port in the Delta is Can Tho Port.

Can Tho Port

Through several stages of development investments, takeovers and mergers, Can Tho Port is the largest port in the Mekong Delta. The port has two branches: Hoang Dieu Port branch and Cai Cui Port branch. Cai Cui Port has a wharf length of 365 m and Hoang Dieu Port a wharf length of 204 m, both able to accommodate two vessels of up to 10,000 DWT.

The total port area is about 45 ha with 22,000 m³ of modern warehouses and up to date handling equipment.

	2010	2011	2012	2013	2014	2015	AARG
Import (ton)	196,181	60,620	80,078	104,021	113,150	123,093	
Export (ton)	102,802	111,310	68,256	124,111	114,052	94,748	
Domestic (ton)	977,505	584,186	625,346	1,303,794	2,136,930	2,716,107	
Total (ton)	1,276,488	756,116	773,116	1,531,926	2,364,132	2,933,948	18.1%
Container (TEU)	4,825	3,196	2,250	10,898	18,693	25,649	39.6%
Ship Calls	1,085	807	190	292	486	549	

2.4 FLEET SAFETY, WATERWAY SAFETY, PORT SAFETY

2.4.1. FLEET SAFETY

PASSENGER VESSELS

Especially in the Huay Xay – Luang Prabang stretch but also in the other parts of the Mekong River, accidents do occur frequently. Many of these accidents are due to a complete lack of on board safety (Poor ship design and construction, poor maintenance of ship's hull, steering gear and engine, no vessel checklist available, no communication and radio available, safety equipment is missing, life jackets and buoys are missing, not enough or bad quality, fire extinguishers are missing or faulty, no safety procedures or emergency plans and no insurance).

DANGEROUS GOODS VESSELS

The transport and storage of dangerous goods is extensive along the whole Mekong River. Awareness of dangerous goods risks, impacts of oils spills and safety requirements are currently limited in all the Member Countries. The continuous rise in inland waterway transport increases the risks of accidents such as fires, explosions and oil spillages that require efficient emergency response.

AUTOMATIC IDENTIFICATION SYSTEM (AIS)

In Thailand, Lao PDR and Cambodia, the Automatic Identification System (AIS) is in use on board inland waterway vessels on a voluntary base. There is no plan to impose the use of AIS equipment on board of inland waterway vessels. In Cambodia, MRC developed a strategy for the use of AIS in 2009 in PPAP, which called for implementing AIS coverage along the Mekong River between

Phnom Penh and the Viet Nam border. Presently about 21 inland waterway vessels, mainly containerships sailing between Phnom Penh and Viet Nam, are equipped with AIS transponders. In Vietnam, Automatic Identification System (AIS) equipment is compulsory on all passenger speedboats. For inland waterway vessels of 1,000 tons and more this will be made compulsory from 2017 – 2020 (according to the Master Plan for the Mekong Delta).

VESSEL GUIDANCE SYSTEM – GLOBAL POSITIONING SYSTEM (GPS)

In Thailand, Lao PDR and Cambodia, the installation and use of a Vessel Guidance System - Global Positioning System (GPS) on board of inland waterway vessels is voluntary. In Lao PDR, on the Huay Xay – Luang Prabang stretch, in 2014 MRC installed a GPS Navigation Guided System with navigation map on some 15 vessels and the system is fully functional here.

In Vietnam, the Vessel Guidance System - Global Positioning System (GPS) is compulsory for passenger transport with speedboats. This is not yet compulsory for other inland waterway vessels. For inland waterway vessels of 1,000 tons and more this will be made compulsory from 2017 – 2020 (according to the Master Plan for the Mekong Delta).

VESSEL TRAFFIC SERVICES (VTS)

In Thailand, Lao PDR and Cambodia, Vessel Traffic Services (VTS) are not available. In Vietnam, Vessel Traffic Services (VTS) is presently in use only for the river stretch between Saigon and Vung Tau (length ±100km). There is a program to introduce the VTS system from 2020 in the Cho Gao channel, from the Cambodia border to Chau Doc on the Tiền (Mekong) River and on the Hậu (Bassac) River.

RIVER INFORMATION SERVICES (RIS)

There are no River Information Services (RIS) available in the whole lower Mekong river basin.

EMERGENCY RESPONSE – SEARCH AND RESCUE

Emergency response stations along the Mekong River in Thailand are available in Chiang Saen, Chiang Kong, Nong Kai, Nakhon Phanom, Mukdaham and Ubon Rachathani.

In Lao PDR and Cambodia, there are no specialized emergency response stations along the Mekong River (in Cambodia, PPAP has limited emergency response equipment, often in bad state and no or insufficient trained personnel). Viet Nam is installing three emergency response centers for emergencies on the river, including collision, explosion, fire, oil spill and grounding. The centers will be located in Tien Giang Province, Can Tho City and Chau Doc City.

2.4.2. WATERWAY SAFETY

In 2001, ESCAP-MRC published “Guidelines for the Harmonisation of Navigation Rules and Regulations – Volume I Aids to Navigation” and in June 2002, ESCAP-MRC published “Recommended Aids to Navigation Systems on the Greater Mekong River”.

GREEN TRIANGLE TO HUAY XAY

In this more than 300 km long stretch of the Mekong River, the Chinese authorities have installed 57 aids to navigation, including large beacons on the shore and on some rocks. These beacons are very high and do not become submerged during high water levels. This stretch is only navigable during daytime (average 13 hrs. per day) but even though the river stretch is only navigable during daylight hours because it is too dangerous at night, many vessels are sailing at night using big floodlights that are installed on the navigation bridge.

Between 1910 and 1930, 600 concrete beacons were built by the French from Bokeo (Lao PDR) to Kratie (Cambodia). Some of them disappeared but there are still 541 unlighted concrete beacons left in the Lao PDR and Cambodia (upstream Kratie), although many of them are damaged.

HUAY XAY TO LUANG PRABANG

Old French markers are existing but form an additional danger when submerged.
In 2008 – 2009, after a condition survey of some dangerous areas and hotspots, MRC installed some 28 visual aids (plastic buoys and spring coiled beacons) between Huay Xay and Vientiane, but they failed due to heavy debris. There is only daytime navigation.

LUANG PRABANG TO KRATIE

Only daytime navigation. Navigation in this stretch remains an issue because there are only limited and old French markers available, forming an additional danger when submerged. Accidents occur because of this.

KRATIE TO KOMPONG CHAM

Only daytime navigation. Navigation in this stretch remains an issue because there are no buoys or markers available. Accidents occur because of this.

KOMPONG CHAM TO PHNOM PENH

Day and night navigation. Issues with the Fishing Community about the use of the waterway for navigation have high priority. For this stretch the fishermen are (unreasonably) unwilling to come to an agreement with the MPWT to allow floating aids to navigation to be installed and maintained.

In May 2009, 45 lighted buoys (23 green and 22 red) were inaugurated but today only 8 medium sized buoys are remaining. Many of the installed buoys have been swept away by debris or through theft.

PHNOM PENH TO CHHNOK TROU

Issues with the Fishing Community about the use of the waterway for navigation have high priority. For this stretch the fishermen are (unreasonably) unwilling to come to an agreement with the Ministry of Public Works and Transport to allow floating aids to navigation to be installed and maintained.

In 2012, 18 lighted buoys were installed between Phnom Penh and Chhnok Trou but today only 8 medium sized red and green buoys are remaining and some of the lanterns are dysfunctional.

PHNOM PENH TO CAMBODIA-VIET NAM BORDER

Day and night navigation. In April 2007, 56 lighted buoys and eight leading markers were inaugurated. Today, 17 medium green buoys, 11 medium red buoys, 3 large green buoys, 3 medium red buoys and 8 leading markers are still in place and the medium sized red and green buoys are installed with lantern and GSM locator modules to prevent theft.

CAMBODIA-VIET NAM BORDER TO SOUTH CHINA SEA (MEKONG MAINSTREAM)

Day and night navigation. From the Cambodia–Viet Nam border to the South China Sea, 24 red steel buoys and 30 green steel buoys are installed. The waterway is not fully fitted with navaids, so efficiency and safety are still not good. Problem of theft of buoys and lanterns and steel buoys too expensive for maintenance.

CHO GAO CANAL FROM MEKONG MAINSTREAM TO HO CHI MINH – CAI MEP

No Aids to Navigation available. Aids to Navigation to be installed under the World Bank Project.

VAM NAO PASS

Day and night navigation. Upstream the Vam Nao River (between the Mekong Mainstream and the Vam Nao Pass), 11 red and 13 green large plastic buoys are installed. In the Vam Nao Pass, 2 red and 2 green large plastic buoys are installed.

BASSAC RIVER FROM VAM NAO PASS TO CAN THO

Day and night navigation. From the Vam Nao Pass to Vàm Cái Săn, 15 red large plastic buoys and 15 green large plastic buoys have been installed. Moreover, from the Vam Nao Pass to Cần Thơ, 57 steel red buoys and 32 steel green buoys are still present.

BASSAC RIVER FROM CAN THO TO QUANG CHAN BO CANAL AND SOUTH CHINA SEA

Day and night navigation. Also, downstream Cần Thơ, a nearly full range of steel buoys is installed. The waterway is not fully fitted with navaids, so efficiency and safety are still not good. Problem of theft of buoys and lanterns and steel buoys too expensive for maintenance.

2.4.3. PORT SAFETY

PORT SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT SYSTEM (PSHEMS)
No ports in the Lower Mekong River Basin have a well-developed Port Safety, Health and Environmental Management System (PSHEMS) specific to each port in order to build a culture that promotes safety, health and environmental protection as well as reducing accidents and operating costs, improving community relations and for the ports and terminals handling dangerous goods to be recognized as safe and efficient.

PASSENGER PORTS

All studies show that a bright future lies ahead for international tourism in the Lower Mekong River basin. However, all experts point out that many of the port and landing facilities are unsafe for tourists and inadequate to accommodate that growth.

CARGO PORTS

Very few of the cargo ports and landing facilities have a minimum on safety measures for mooring of vessels and the handling, loading and unloading of cargo.
In the Lao PDR, safe landing sites for cargo vessels / barges will become even more important when the dams that are being built and planned will be operational. At certain times the dams and adjacent locks will generate strong currents that will affect all vessels in that particular stretch. Provisions for safe moorings are of utmost importance to avoid light craft being pushed away ending up adrift midstream.

In Cambodia, except for the PPAP operated terminals, due to previous long term arrangements in the provincial ports, not much has been done about the safety, development and maintenance of these ports, despite well-defined planning proposals for improvement described in the 2006 Master Plan for Waterborne Transport on the Mekong River System in Cambodia.
Viet Nam has many (often small) cargo ports, the conditions of these ports depend on the owner / operator. Substandard facilities should be identified and rehabilitated.

DANGEROUS GOODS

One of the main issues identified by the “Risk Analysis of the carriage, handling and storage of dangerous goods “, executed by MRC, was the limited awareness of the risks associated with handling and storage of dangerous goods. Especially in Lao PDR and Cambodia, but also in Vietnam there are several (not all) substandard port facilities that should be rehabilitated.

- Several inland ports and terminals have limited capacity in the area of management of dangerous goods and revealed insufficient emergency response planning.
- Several ports are not planned, designed and constructed in a sustainable manner, in order to provide the best achievable protection of public health, safety and the environment
- Most ports have no Maintenance, Inspection and Testing Program (MITP) for critical equipment to secure their functioning in a safe and efficient manner and reduce the downtime required for repair or replacement.

3. PAST, PRESENT AND FUTURE NAVIGATION DEVELOPMENT ACTIVITIES, PLANS AND PROPOSALS

3.1 PERIOD 2007-2020

SCENARIO 2020

For the period 2007-2020, three hydropower dams have been considered: the Xayaburi dam, where commercial operation is scheduled to start in 2019 and the Pak Beng dam, where construction works are scheduled to start in 2017. Both dams will have two locks of 120 x 12 x 4 m for navigation and it is expected that following number of vessels will need 1 or 2 lock operations per day.

Year	Cargo 50 ton L x B = 14 x 3 m	Cargo 100 ton L x B = 24 x 5 m	Pass. 50 pax L x B = 40 x 4 m	Number of lock operations / day
	Number / day	Number / day	Number / day	
2007	3	2	3	1
2014	5	3	3	1
2020	8	4	5	2

Third dam is the Don Sahong, blocking off one of more than ten channels that flow over the Khone falls, without any influence on navigation and with commercial operation expected to be in 2019.

During the period 2007-2020, high investments were and are made in port development: Chiang Saen Commercial Port in Thailand, the New PPAP Container Terminal in Cambodia and the expansion of Can Tho Port for ships up to 10,000 DWT.

From the Green Triangle to Huay Xay, vessels of 300 ton (instead of 100 ton in 2007) can now navigate the whole year. Moreover, special attention was given to the navigation in the Mekong Delta by upgrading the Cho Gao Canal between the Tien (Mekong) River and Ho Chi Minh City and the construction of the Quang Chanh Bo Canal at the mouth of the Hau (Bassac) River, to allow bigger ships to navigate to Can Tho and Phnom Penh.

Finally, several safety projects are proposed for the transport, handling and storage of dangerous goods, contingency planning and search and rescue and the upgrading of aids to navigation (buoys and beacons), in order to reduce accidents, oil spills and other pollution sources.

Ex = executed activities, Pl = planned activities, Pr = proposed activities

3.1.1 FLEET

CONDUCT FEASIBILITY STUDY ON REINFORCED SEA-RIVER BARGES

It is clear that regional waterborne transportation between Cambodia and Viet Nam and between the delta and overseas ports will gain in significance (according to the Master Plan with an AARG of 8 to 9%). However, strong competition with other transport modes require serious optimization of the cargo handling facilities, administrative waterway and port costs, but also and importantly improving the fleet.

in the IWT case, a cost assessment showed that the comparable costs for the Phnom Penh – Cai Mep trip with a 1,000 DWT and a 3,000 DWT container vessel were respectively 222 US$ and 68 US$ per TEU. The technical feasibility and economic viability of operating 3,000 DWT Sea-River barges between Cambodia and Viet Nam should be studied.

Estimated cost: 380,000 US$. (Pr)

3.1.2 WATERWAYS

River Stretch	Ton	Activities	Cost (US$)
Stretch 1 Green Triangle – Huay Xay (293 km)	HW 300 LW 150	11 rapids and 10 shoals cleared by the Chinese in 2007-2010 (Ex)	±30,000,000 (est.)
Stretch 2 Huay Xay – Luang Prabang	HW 100 LW 50	Lock(s) Pak Beng (Pl) Locks Xayaburi (Ex)	144,000,000 134,000,000
Stretch 10 Kompong Cham – Phnom Penh (NCT) (125 km)	HW 2,000 LW 1,500	Regular dredging in the Sdao Canal (2,171,000 m³) and in the Phnom Penh – Cambodia-Vietnam border stretch (7,306,000 m³) (Ex)	500,000 (est.)[1]
Stretch 14 Phnom Penh – Cai Mep (Cho Gao Canal) (372 km)	2,000	Upgrade Cho Gao Canal (World Bank project)[2] (Ex)	12,600,000
Stretch 15 Phnom Penh – Cai Mep (Bassac River) (433 km)	7,000 10,000[3]	Construction Quang Chanh Bo Canal (Ex)	450,000,000

[1] The dredged sand was sold and used for landfill / construction. Normal dredging cost is 0.85 US$/m³.

[2] The final objective of this World Bank project is to ensure a comfortable waterway between the Mekong mainstream and Ho Chi Minh City, but it also includes the connection from Phu My Port (along the Thi Vai) through the Cho Gao Canal, Cho Lach, Mang Tit and Hau River to Can Tho (total investment cost 300 million US$).

[3] 10,000 DWT vessels will be able to reach Can Tho through the Quang Chanh Bo Canal.

Annual number of days the Mekong river is navigable along different reaches (2020)

Vessel tonnage (ton)	10	30	50	100	300	500	1,000	1,500	2,000	3,000	5,000	7,000	10,000
Channel Depth (m)	0.9	1.1	1.3	1.9	2.5	3.1	4.5	4.9	5.3	6.2	7.0	8.0	8.8
Min. Channel Width (m)	8	10	12	27	33	35	48	50	52	56	64	76	88
Stretch 1 Green Triangle – Huay Xay					365								
Stretch 10 Kompong Cham – PHN NCT						365			365 150[1]	0			
Stretch 14 Phnom Penh – Cai Mep (Cho Gao)									365				

Stretch 15 Phnom Penh - Can Tho (Bassac River)												365	
Stretch 15 Can Tho – Quang Chanh Bo Canal													365

[1] Only barges of 2,000 ton can navigate the whole year. Seagoing vessels of 2,000 DWT can only navigate to Kompong Cham for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) during the highwater season.

3.1.3 PORTS

CHIANG SAEN COMMERCIAL PORT

The construction of Chiang Sean Commercial Port (CSCP) started in 2008 and the port was officially opened end of March 2012. The port has two two-level sloped berths of 300 m long and a vertical berth of 200 m long. In the port the basin size is 200 x 800 m with two 30 x 30 m warehouses and marshalling yard (Ex).

Cost: 15,000,000 US$ (est.)

PHNOM PENH NEW CONTAINER TERMINAL (PPAP NCT LM17)

The construction of the terminal started in 2011 and the terminal officially started operations in the beginning of 2013. The construction of new container terminal comprises a container yard for a total capacity of 150,000 TEUs per year. NCT LM 17 has a total quay length of 300 m and 22 m wide. The current port area is about 12 ha and can be extended to 30 ha in the future. NCT LM 17 also has a warehouse of 40,000 m² (Ex).

Cost: 28.2 million US$

CONSTRUCT 10 NEW PASSENGER PORTS AND LANDING FACILITIES

In order to connect the rural waterway transport network to the regional network, it is proposed to develop landing facilities for local passenger transport to improve safety and create further economic opportunities for rural IWT users

The objectives of this action are to install five landing facilities in Lao PDR and five landing facilities in Cambodia supported by operations and maintenance (O&M) manuals (Pr).

Estimated cost: 250,000 US$

EXPAND NEW PHNOM PENH CONTAINER TERMINAL – NCT LM 17

The objective of this action is to prepare PPAP for the growth in containers and additional logistic services for the next 5 years. Therefore, in phase II, the container yard must expand to a capacity of 300,000 TEU. Phase II will be executed in two steps: 5 ha extra container yard and equipment to have annual capacity of 230,000 TEUs in 2017-2018 and 5 ha extra container yard and equipment to have annual capacity of 300,000 TEUs in 2018-2019 (Pl).

Estimated cost: 35 million US$

DEVELOPMENT OF A CONTAINER TERMINAL AT CAI CUI PORT (THE MAIN BRANCH OF CAN THO PORT) TO SERVE ACTIVE CONTAINERIZED IMPORTS AND EXPORTS OF THE MAJOR PORTS IN THE COUNTRY, THE KINGDOM OF CAMBODIA AND THE MEKONG REGION COUNTRIES.

In the near future, the Can Tho port will be expanded to carry 650,000 tons of goods per year and receive 10,000-ton ships. The second phase of the Cai Cui port in Can Tho city will be carried out with the construction of four wharves able to accommodate 10,000-20,000 ton ships and handle a maximum of 2.5 million tons of goods annually (PI).

Estimated cost: 35 million US$ (est.)

REHABILITATE MORE THAN 50 EXISTING CARGO PORTS IN VIET NAM ACCORDING TO THE VIETNAMESE MASTER PLANS.

Viet Nam has many (often small) cargo ports. The conditions of these ports depend on the owner/operator. Substandard facilities should be identified and rehabilitated.

The objective is to make a detailed plan for some 50 cargo ports to meet the demand of loading and unloading cargoes and to rehabilitate 11 main ports in the Mekong Delta (PI).

Estimated cost: 2,700,000 US$

3.1.4 FLEET SAFETY, WATERWAY SAFETY, PORT SAFETY

Fleet Safety

The short term should focus on the transport conditions of passengers and the carriage and handling of dangerous goods that are presently very unsafe for various reasons. Therefore, priority should be to immediate increase safety and create acceptable living conditions for passengers and tourists on passenger vessels and safe carriage and handling of dangerous goods.

Furthermore, safety should be increased by the implementation of the Regional Action Plan on Dangerous Goods and the implementation of search and rescue units.

IMPLEMENT FLEET PROJECTS OF THE MRC REGIONAL ACTION PLAN FOR TRANSPORT OF DANGEROUS GOODS

The carriage, handling and storage of dangerous goods are significant in the Lower Mekong River basin. Next to domestic transport, gasoline, diesel, jet fuel and other petroleum products are imported or exported on inland barges from Thailand to China and Lao PDR and from Vietnam to Cambodia.

The ultimate objective of the implementation of the FLEET related projects of the MRC Regional Action Plan on the Sustainable Transport of Dangerous Goods along the Mekong River is to actively prevent and mitigate the environmental and safety risks associated with the carriage and handling of dangerous goods and to create a more sustainable transport of dangerous goods (Pr). The proposed actions are:

- The implementation of the International Maritime Dangerous Goods (IMDG) Code and Provision of Material Safety Data Sheets (MSDS) for Inland Waterway Vessels.
- The organization of Emergency Response on Board Vessels.
- The preparation of a Mekong Tanker Safety Management System.
- The establishment of Minimum Standards for Vessels Design, Construction and Equipment.
- The identification and training of qualified Safe Manning on Inland Waterway Vessels.

Estimated cost:

Project	Project type	Thailand	Lao PDR	Cambodia	Viet Nam	All countries
1. Implementation of the IMDG Code and provision of the MSDS	National	322,500	326,500	346,500	354,500	**1,350,000**
2. Emergency Response Onboard Vessels	National	279,500	271,500	279,500	294,500	**1,125,000**
3. Mekong Tanker Safety Management	National with Cross -Border Impacts	440,000	585,000	525,000	450,000	**2,000,000**
Project	**Project type**	**Thailand**	**Lao PDR**	**Cambodia**	**Viet Nam**	**All countries**
4. Minimum Standards for Vessel Design, Construction and Equipment	National with Cross-Border Impacts	385,000	459,000	411,000	336,000	**1,591,000**
5. Safe Manning on Inland Waterway Vessels	National with Cross-Border impacts	540,500	586,000	566,000	559,500	**2,252,000**
Total		**1,965,500**	**2,228,000**	**2,128,000**	**1,994,500**	**8,318,000**

DEVELOP A CONTINGENCY PLAN FOR EFFICIENT ACCIDENT RESPONSE.

Developing a contingency plan involves making decisions in advance about the management of human and financial resources, coordination and communications procedures, and being aware of a range of technical and logistical responses and restrictions.

This involves procedures for accident reporting, the establishment of a response team and defining the roles and responsibilities in the response system. This includes planning and coordinating responses, providing guidance to regional or local response teams, coordinating a national program of preparedness planning and response, and facilitating research to improve response activities (Pr).

Estimated cost:

US$	Thailand	Lao PDR	Cambodia	Vietnam
Assessment of existing standards	10,000	10,000	10,000	10,000
Design of harmonized contingency plan	15,000	20,000	15,000	20,000
Implementation	10,000	20,000	15,000	30,000
Total	**35,000**	**50,000**	**40,000**	**60,000**

SEARCH AND RESCUE UNITS ON THE MEKONG RIVER

River accidents to the crew and other waterway users occur and damage to the environment will increase if no action is taken. The overall objective of this action is to save the lives of the ship's crew and to protect the Mekong River environment from the damaging effects of accidents by providing coordinated Search and Rescue (SAR), prepared for vessel emergencies such as collision, grounding, sinking, fire and explosion and oil and chemical spills (Pr).

Estimated cost:

Thailand	Lao PDR	Cambodia	Vietnam
87,000 US$	208,000 US$	163,000 US$	237,000 US$

INTRODUCE THE OBLIGATION OF AIS AND VHF IN THE WHOLE MEKONG RIVER BASIN

The overall objective of this project is to improve safety/security and vessel/port efficiency through the development of AIS and VHF all along the Mekong River System, and by making it compulsory for selected ship sizes and types.
Therefore, the results of the technical feasibility and economic viability of developing the AIS and Radio Communication Systems conducted by Thailand should be reviewed and the implementation expanded to the Lao PDR, Cambodia and Viet Nam (Pr).

Total estimated cost:
For the Lao PDR and Thailand: 560,000 US$
For Cambodia: 305,000 US$
For Viet Nam: 350,000 US$

PASSENGER SAFETY BETWEEN HUAY XAY AND LUANG PRABANG

The boat route between Huay Xay and Luang Prabang is frequently used by tourists and is also one of the busiest passenger routes of local people living in the smaller villages along that route. Unfortunately, this stretch of the river is very difficult and dangerous to navigate.

This means the boats are constructed narrow and long which drastically decreases the stability and on top of this, the boats themselves lack all safety standards:

The Development Objective is to prevent loss of life from possible accidents on the Mekong River in the Huay Xay - Luang Prabang stretch by an increase of the safety on board of the passenger vessels and a better human capacity of both the waterway operators and the authorities (Pr).

Total estimated cost:
Safety equipment for 50 boats 100,000 US$
Emergency procedures 140,000 US$

Waterway Safety

AIDS TO NAVIGATION KOMPONG CHAM TO PHNOM PENH

Day and night navigation. Issues with the Fishing Community about the use of the waterway for navigation have high priority. For this stretch the fishermen are (unreasonably) unwilling to come to an agreement with the MPWT to allow floating aids to navigation to be installed and maintained.

In May 2009, 45 lighted buoys (23 green and 22 red) were inaugurated but today only 8 medium sized buoys are remaining. Many of the installed buoys have been swept away by debris or through theft (Ex).

Cost: 400,000 US$

AIDS TO NAVIGATION PHNOM PENH TO CHHNOK TROU

Issues with the Fishing Community about the use of the waterway for navigation have high priority. For this stretch the fishermen are (unreasonably) unwilling to come to an agreement with the Ministry of Public Works and Transport to allow floating aids to navigation to be installed and maintained.

In 2012, 18 lighted buoys were installed between Phnom Penh and Chhnok Trou but today only 8 medium sized red and green buoys are remaining and some of the lanterns are dysfunctional (Ex).

Cost: 150,000 US$

AIDS TO NAVIGATION PHNOM PENH TO CAMBODIA-VIET NAM BORDER

Day and night navigation. In April 2007, 56 lighted buoys and eight leading markers were inaugurated. Today, 17 medium green buoys, 11 medium red buoys, 3 large green buoys, 3 medium red buoys and 8 leading markers are still in place and the medium sized red and green buoys are installed with lantern and GSM locator modules to prevent theft (Ex).

Cost: 500,000 US$

IMPROVE THE EXISTING OLD CONCRETE FRENCH MARKERS (PRIORITY FROM HUAY XAY TO LUANG PRABANG)

Physical marking of the navigation channel of the Mekong River in the Upper sections in the Lao PDR, between the Lao PDR and Thailand or along the upper parts in Cambodia, has not been an easy or effective task. The immediate objectives of the project are:

- To investigate the best way to improve the design and structure of the French markers.
- To have an inventory and plan which French markers need to be improved or removed.
- To improve the most important French markers.
- To develop a maintenance plan (Pr).

Estimated cost:

	Thailand	Lao PDR	Cambodia
Design	10,000 US$	25,000 US$	15,000 US$
Inventory		20,000 US$	15,000 US$
Improvement	50,000 US$	100,000 US$	80,000 US$
Maintenance	15,000 US$	25,000 US$	25,000 US$
Total	**75,000 US$**	**170,000 US$**	**135,000 US$**

As a Priority Project the stretch Huay Xay – Luang Prabang could be done first and would cost 133,000 US$

DEVELOP AND INSTALL A GPS NAVIGATION GUIDANCE SYSTEM, COMPULSORY FOR ALL BOATS CARRYING CARGO AND PASSENGERS ALONG THE MEKONG RIVER BETWEEN THE GREEN TRIANGLE AND HUAY XAY

The objectives of the project are:

- To identify and record the deepest navigation route along the river thereby improving navigation safety through the establishment of an officially recommended course.
- To promote waterway use and improved safety using electronic mapping resources.
- To test the feasibility of GPS navigation devices as an aid to navigation on the Upper Mekong and build capacity in the use of this technology among waterway users (Pr).
- The costs are calculated at a total price of US$ 1,350 US$/km. Since the total distance here is 293 km, the estimated total cost is 395,000 US$.

IMPROVE THE EXISTING GPS NAVIGATION GUIDANCE SYSTEM AND MAKE IT COMPULSORY FOR ALL BOATS CARRYING CARGO AND PASSENGERS ALONG THE MEKONG RIVER BETWEEN HUAY XAY AND LUANG PRABANG

The objectives of the project are:

- To improve the GPS system including the maps based on the recommendations by the users and stakeholders.

- To make the GPS system more accessible and usable for the stakeholders (Pr).

Estimated cost: 180,000 US$

UPGRADE THE EXISTING AIDS TO NAVIGATION SYSTEM ALONG THE MEKONG RIVER BETWEEN KOMPONG CHAM AND THE ENTRANCE (ESTUARY) TO THE MEKONG RIVER

The Mekong River from Kompong Cham to the sea is used by sea going vessels as a transit route to transport the goods and passengers to Cambodia. The design buoys and beacons should be of the same specifications, type and material as used by MRC when the organization procured and installed the navaids along the Bassac and Mekong Rivers between 2007 and 2015 (Pr).

Estimated cost for the part in Cambodia: 970,000 US$

Estimated cost for the part in Viet Nam: 1,810,000 US$

UPGRADE THE EXISTING AIDS TO NAVIGATION SYSTEM ALONG THE VAM NAO PASS AND THE BASSAC RIVER BETWEEN THE EAST ENTRANCE OF THE VAM NAO PASS AND THE ENTRANCE TO THE QUAN CHANH BO CANAL.

This stretch of the Mekong River is part of the international shipping route that connects Phnom Penh Port with the sea passing through Viet Nam's territory. The design buoys and beacons should be of the same specifications, type and material as used by MRC when the organization procured and installed the navaids along the Bassac and Mekong Rivers between 2007 and 2015 (Pr).

Estimated cost: 1,390,000 US$

Port Safety

DEVELOP GENERAL ARRANGEMENTS ON A MINIMUM PORT HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT SYSTEM (PHSEMS) FOR ALL PASSENGER AND CARGO PORTS SPECIFIC FOR THE MEKONG RIVER PORTS

All ports and landing sites in the four MRC member countries should adhere to a minimum of safety, health and environmental regulations in accordance with the rules of the relevant international institutions, in order to:

- Provide safe practices in port operation and a safe working environment;
- Establish safeguards against all identified risks;
- Continuously improve safety management skills of personnel;
- Prevent operational pollution of the port's environment; and
- Provide quality, safe and environmentally-responsible services (Pr)

Estimated cost: Thailand 295,000 US$
Lao PDR 235,000 US$
Cambodia 300,000 US$
Viet Nam 335,000 US$

IMPLEMENT THE "REGIONAL ACTION PLAN FOR SUSTAINABLE TRANSPORT OF DANGEROUS GOODS ALONG THE MEKONG RIVER 2015-2020" FOR PORTS, HANDLING DANGEROUS GOODS.

The implementation of the Regional Action Plan has as its overall objective "to ensure efficient, safe and secure carriage, handling and storage of dangerous goods on the Mekong River in a sustainable manner". With regard to PORTS, there are 5 projects:

- Project 1: Standards for the planning, design and construction of ports and terminals
- Project 2: Maintenance, inspection and testing of critical equipment
- Project 4: National vessel and port waste management
- Project 5: Emergency and oil spill response in ports and terminals
- Project 6: Cross-border vessel and port waste management (Pr)

The estimated costs for technical assistance, training, capacity building and equipment are:

	Thailand	Lao PDR	Cambodia	Viet Nam	All countries
Project 1	411,000	400,000	404,000	399,000	1,614,000
Project 2	245,000	245,000	255,000	275,000	1,020,000
Project 4	454,000	387,000	357,000	596,000	1,794,000
Project 5	335,000	330,000	340,000	385,000	1,390,000
Project 6	38,750	38,750	38,750	38,750	155,000
Total	1,483,750	1,400,750	1,394,750	1,693,750	5,973,000

ESTABLISH STANDARDS ON PETROCHEMICAL TRANSFER PORTS (BOTH PUBLIC AND PRIVATE) IN LAO PDR, THAILAND AND CAMBODIA AND ORGANIZE AN INTERNATIONAL AUDIT FOR THE EXISTING PETROCHEMICAL TRANSFER PORTS IN ORDER TO CREATE SAFE PROCESSING AND STORAGE OF FUEL

From the "Risk Analysis of the Carriage, Handling and Storage of Dangerous Goods", it was determined that a number of inland ports and terminals have limited capacity in the areas of management of dangerous goods, waste management and environmental protection

A Dangerous Goods Management Manual (DGMM) has to be prepared in the national language of each country and an international audit for the existing petrochemical transfer ports has to be organised in order to create safe processing and storage of fuel. Training must be provided in the handling of dangerous goods and the use of personal protective equipment (Pr).

Estimated cost: Thailand 67,000 US$
Lao PDR 87,000 US$
Cambodia 127,000 US$

DETERMINE THE EXTENT OF OIL SPILL POLLUTION FROM EXISTING PORTS, PETROLEUM TERMINALS AND VESSEL OPERATIONS TO DETERMINE REGIONAL AND NATIONAL CONTINGENCY PLANNING AND DEVELOP SPECIFIC WATER QUALITY PARAMETERS TO MONITOR IWT OPERATIONS.

Review and analyse MRC data and information to develop relevant scenarios of oil spills and/or water quality incident model simulation. The water quality parameters would include surface water and sediment, and include ports, vessels and dredging operations.

- Provide parameters for procedures for water quality;
- Include transport and storage of other dangerous goods;
- Results would feed into contingency planning: Early warning and notification systems, Tier 1 (<20 tons), 2 (20-500 tons) or 3 (>500 tons) and local / national / trans-boundary response.

Estimated cost: 4 x 20,000 US$

REHABILITATE MORE THAN 40 EXISTING PETROCHEMICAL TRANSFER PORTS IN VIET NAM ACCORDING TO THE VIETNAMESE MASTER PLANS.

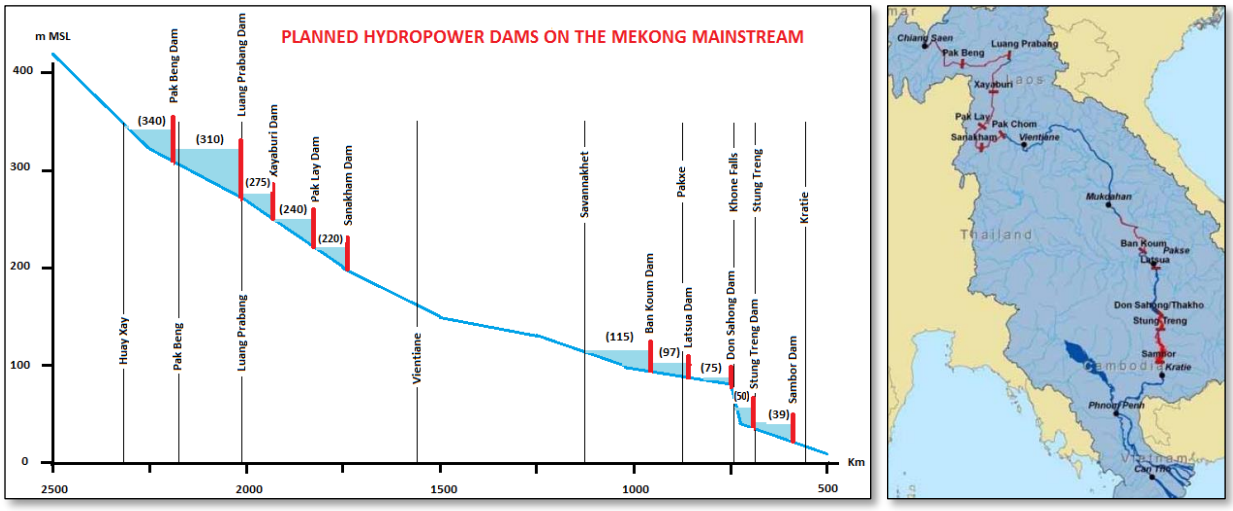
Viet Nam has many fuel transfer ports. The conditions of these ports depend on the owner/operator. Substandard facilities should be identified and rehabilitated.

The objective is to update the detailed plan for all the fuel ports and to meet the demand of current loading and unloading of fuel in the Mekong Delta (PI).

Estimated cost: 2,584,000 US$

3.2 PERIOD 2020-2040

SCENARIO 2040



For the period 2020-2040, eight (or seven)[1] more hydropower dams have been considered:

1. **The Luang Prabang dam** is the second dam in the cascade, located above Luang Prabang town.
2. **The Pak Lay dam** is the fourth dam in the cascade, located just above the town of Pak Lay.
3. **The Sanakham dam**, the final dam of the cascade, is situated just upstream of the Thai-Lao border, between Loei and Vientiane provinces.

With the Full Supply Levels, the air clearance of the Huay Xay Bridge, the Pak Beng Bridge and the Luang Prabang Bridge should be 20.0 m, of the Tcheua Pachon Bridge 12.0 m and of the Pak Lay Bridge only 7.3 m.

4. **The Ban Koum dam** is located about 10 km above the confluence of the Mun/Chi River with the Mekong
5. **The Lat Sua dam** has been relocated to a site 10 km downstream of Pakse.
6. **The Stung Treng dam** is the uppermost of the two Cambodian dams, and is located about 10 km upstream of Stung Treng town and the confluence with the Sekong/Sesan/Sre Pok Rivers. The dam site lies within the Stung Treng Ramsar Site which effectively obliges the Royal Cambodian Government to 'actively support the Ramsar Convention.
7. **The Sambor dam** is the lowest of the Mekong Mainstream dams and largest one in Cambodia. It is located near the village of Sambor, upstream of Kratie and would inundate the river channel to just south of Stung Treng town.

All dams should have two navigation locks of 120 x 12 x 4 m, except the Stung Treng dam, where one lock is sufficient and it is expected that following number of vessels will need up to 12 lock operations per day in 2040:

[1] The international hydropower consultants Pöyry have said that the **Pak Chom** dam would not be built. There are reports that this dam would be merged with the planned Sanakham dam in order to have the entire construction and reservoir on full Lao territory instead of building the dam and the reservoir on the shared river stretch with Thailand.

Year	Cargo 50 ton L x B = 14 x 3 m	Cargo 100 ton L x B = 24 x 5 m	Cargo 500 ton[1] L x B = 75 x 9 m	Pass. 50 pax L x B = 40 x 4 m	Number of lock operations / day
	Number / day	Number / day	Number / day	Number / day	
2020	8	4	0	5	2
2040	20	10	6	50	12

[1] According to the China class IV standard, a convoy of 2 x 500 ton is 109 m long and 10.8 m wide.

The aim of the 2040 scenario is to allow 500-ton vessels during the whole year from the Green Triangle to Kratie. The river stretch between Kratie and Kompong Cham should be navigable for 2,000 DWT ships over the whole year, the stretch between Kompong Cham and Phnom Penh for 3,000 DWT ships, the stretch between Phnom Penh (New Container Terminal) and Can Tho for 7,000 DWT ships and the stretch from Can Tho to the sea for 10,000 DWT ships over the whole year. Finally, the Tonle Sap River and Lake between Phnom Penh and Chhong Kneas (Siem Reap) should be navigable for boats of 500 ton over the whole year.

Moreover, new passenger ports should be constructed in some 14 locations and new cargo ports should be constructed in some 7 locations in Laos and in Kratie, Kompong Cham, Phnom Penh (NCT LM17 Phase III) and Chong Kneas in Cambodia.

Finally, it is proposed to install River Information Services (RIS) over the total length of the Mekong river, to develop and install a GPS navigation guidance system, compulsory for all boats carrying cargo and passengers and to upgrade buoys and beacons, in order to reduce accidents, oil spills and other pollution sources.

3.2.1 FLEET

DEVELOPMENT OF SHIP CONSTRUCTION AND SHIP YARD POLICY

With the exception of some river cruise ships that ply between HCMC and Siem Reap, the fleet on the Greater Mekong River, from house boats to passenger vessels, tug boats, ferries, container ships and tankers are substandard, inadequate, unsafe, not carbon-emission-friendly, slow and not fit to carry the amount of cargo or passengers that should normally be carried by river. The objective of the project is to promote investments and development in the Mekong Fleet by formulating a short and long term Ship Construction and Ship Yard policy focusing on the inland fleet, thus attracting more political attention and budgetary allocations to meet the demands and requirements that modern traders and transporters request (Pr).

Cost: US$ 160,000

IMPLEMENTATION OF STANDARDS FOR CONSTRUCTION OF NEW VESSELS

There are codes or guides to be used in order to comply with operational standards for inland waterway vessels. These are relevant for vessel designers, builders, surveyors and operators of inland waterway vessels. In addition, there should be technical requirements, merchant shipping notices and regulations. The objectives of the project are:

1) To introduce, improve and harmonize the standards on ship safety construction and equipment.
2) To formulate Guidebooks to support the process of conforming with ship safety construction and ship safety equipment and provide training.
3) To prepare the framework for Classification Societies to be established in the Mekong Region.
4) To propose a framework for Inland Port State Control or River State Control per country (Pr).

Estimated costs:

US$	Thailand	Lao PDR	Cambodia	Vietnam
Part 1)	47,500	47,500	47,500	42,500
Part 2)	22,500	22,500	22,500	22,500
Part 3)	12,500	12,500	12,500	12,500
Part 4)	97,500	97,500	97,500	97,500
Total	180,000	180,000	180,000	175,000

3.2.2 WATERWAY

To obtain "whole year" navigation, following channel dimensions were used:

Tonnage (ton)	Channel Depth (m)	Channel Width (m)
50	1.25	9 – 12
100	1.90	24 – 32
500	3.10	28 – 38
1,000	4.50	36 – 48
3,000	6.20	42 – 56
7,000	8.00	57 – 76

River Stretch	**Ton**	**Activities (Pl = planned, Pr = proposed)**	**Est. cost (US$)**
Stretch 1 Green Triangle – Huay Xay (293 km)	500	Clearing 53 rapids (Pl)	84,950,000
Stretch 2 Huay Xay – Luang Prabang (306 km)	500	Free flow upstr. Pak Beng Dam (22km) clearing 1 rapid and 2 shoals (Pl) Free flow upstr. Luang Prabang Dam (46 km) clearing 8 rapids and 2 shoals (Pl)	5,461,000 14,398,000
Locks Luang Prabang Dam	500	(Pr)	167,000,000[2]
Stretch 3 Luang Prabang – Sanakham Dam (279 km)	500	Free flow upstr. Xayaburi Dam (15 km) clearing 1 rapid (Pr) Free flow upstr. Paklay Dam (19 km) clearing 1 rapid Free flow upstr. Sanakham Dam (44 km) clearing 6 rapids (Pr)	1,607,500 1,609,500 9,622,000
Locks Pak Lay Dam Locks Sanakham Dam	500	(Pr)	145,000,000 145,000,000
Stretch 4 Sanakham Dam – Vientiane (148 km)	500	Clearing 17 rapids (Pr)	21,678,000
Stretch 5 Vientiane – Savannakhet (455 km)	500	Rock excavation at four rapids 144,045 m³ (Pr)	12,180,000
Stretch 6 Savannakhet – Khone Falls (390 km)	500	49 moderate rapids or reefs at 900,000 US$/rapid 7 big rapids or reefs at 1,600,000 US$/reef 10 medium rapids at 1,200,000 US$/rapid Estimated amount for constructing river training works	44,100,000 11,200,000 12,000,000 11,000,000
Locks Ban Khoum Dam Locks Latsua Dam	500		132,000,000 145,000,000
Stretch 7 Khone Falls	500	3 shiplocks of about 15 m lift 11 km bypass canal Road works and bridge over the canal	171,000,000 316,000,000 39,000,000

River Stretch	Ton	Activities	Est. cost (US$)
Stretch 8 Khone Falls – Kratie (174 km)	500	6 big rapids at 1,600,000 US$/rapid 13 scattered rocks to be removed at 400,000 $/rock Estimated amount for constructing river training works	9,600,000 5,200,000 2,880,000
Locks Stung Treng Dam Locks Sambor Dam	500		67,000,000 140,000,000
Stretch 9 Kratie – Kompong Cham (114 km)	2,000[1]	Capital dredging 8,810,000 m³ (Pr) Annual maintenance dredging 2,000,000 m³	29,430,000
Stretch 10 Kompong Cham – Phnom Penh (NCT) (125 km)	3,000[3]	Capital dredging 2,143,200 m³ (Pr) Bank protection 2,300 m Annual maintenance dredging 500,000 m³	12,870,000
Stretch 11 Phnom Penh – Kompong Chhnang (122 km)	500 1,500[4]		
Stretch 12 Kompong Chhnang - Chhnok Trou (18 km)	500	Capital dredging 2,820,000 m³ (Pr) Annual maintenance dredging 500,000 m³	8,460,000
Stretch 13 Chhnok Trou – Chong Kneas (104 km)	500	Capital dredging 12,348,300 m³ (Pr) Annual maintenance dredging 500,000 m³	37,045,000
Stretch 14 Phnom Penh – Cai Mep (Cho Gao Canal)	2,500		
Stretch 15 Phnom Penh – Cai Mep (Bassac River) (433 km)	7,000[5]	Capital dredging Cambodia 3,227,000 m³ (Pr) Capital dredging Vietnam 1,816,000 m³ (Pr) Annual maintenance dredging 800,000 m³	10,650,000 5,991,000

1 Only barges of 2,000 ton can navigate the whole year. Seagoing vessels of 2,000 DWT can only navigate to Kratie for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) and the Kizuna bridge (Kompong Cham - 15.5 m) during the highwater season.

2 The lock costs are according to the Mekong Mainstream Hydropower study – 2008 calculation method. For the dams upstream Vientiane, the lock costs represent about 10% of the total dam costs, for the dams downstream Vientiane, the lock costs represent about 6% of the total dam costs.

3 Only barges of 3,000 ton can navigate the whole year. Seagoing vessels of 3,000 DWT can only navigate to Kompong Cham for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) during the highwater season.

4 Only barges of 1,500 ton can navigate the whole year. Seagoing vessels of 1,500 DWT can only navigate to Kompong Chhnang for five months of the year as they are unable to pass under the Chrui Chanvar bridge (10 m) during the highwater season.

5 From Can Tho to the Sea, ships of 10,000 DWT can enter through the Quang Chanh Bo Canal.

These proposals for waterway development activities are made up by:

For stretch 1 and 2: The JCCCN Development plan on International Navigation on the Lancang-Mekong River (2015-2025), Department of Transport of Yunnan Province – Tianjin research Institute for Water Transport Engineering, Ministry of Transport, PR China.

For stretch 3 to 8: The MRC MP Master Plan for Regional Waterborne Transportation in the Mekong River Basin, December 2015

For stretch 9 and 10: The KOIKA Plan in the Feasibility Study on Waterway Improvement for Port Logistics Development in Cambodia, February 2015

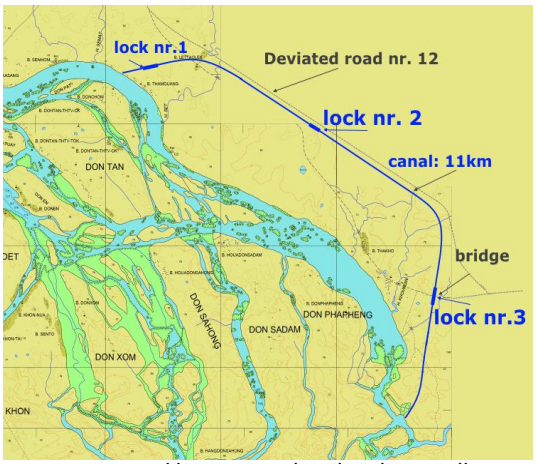
For stretch 12 and 13: The MRC MP Master Plan for Regional Waterborne Transportation in the Mekong River Basin, December 2015

For stretch 14 and 15 MRC MP Master Plan for Regional Waterborne Transportation in the Mekong River Basin, December 2015 and the Vietnam Delta Master Plan "Transportation Development Plan for the Mekong Delta in Viet Nam 2020-2030".

Annual number of days the Mekong river is navigable along different reaches

Vessel tonnage (ton)	10	30	50	100	300	500	1,000	1,500	2,000	3,000	5,000	7,000	10,000
Channel Depth (m)	0.9	1.1	1.3	1.9	2.5	3.1	4.5	4.9	5.3	6.2	7.0	8.0	8.8
Min. Channel Width (m)	8	10	12	27	33	35	48	50	52	56	64	76	88
Stretch 1 Green Triangle – Huay Xay						365							
Stretch 2 Huay Xay – Luang Prabang						365							
Stretch 3 Luang Prabang – Sanakham Dam						365							
Stretch 4 Sanakham Dam – Vientiane						365							
Stretch 5 Vientiane – Savannakhet						365							
Stretch 6 Savannakhet – Khone Falls						365							
Stretch 7 Khone Falls						365							
Stretch 8 Khone Falls – Kratie						365							
Stretch 9 Kratie – Kompong Cham									365 150[1]				
Stretch 10 Kompong Cham – PHN NCT										365 150[1]			
Stretch 11 Phnom Penh – Kompong Chhnang								365 150[1]					
Stretch 12 Kompong Chhnang - Chhnok Trou						365							
Stretch 13 Chhnok Trou – Chong Kneas (104 km)						365							
Stretch 14 Phnom Penh – Cai Mep (Cho Gao)									365	tidal			
Stretch 15 Phnom Penh – Can Tho (Bassac River)												365	
Stretch 15 Can Tho – Quang Chanh Bo Canal													365

[1] Seagoing vessels of 2,000 DWT can only navigate to Kratie for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) and the Kizuna bridge (Kompong Cham - 15.5 m) during the highwater season. Seagoing vessels of 3,000 DWT can only navigate to Kompong Cham for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) during the highwater season. Seagoing vessels of 1,500 DWT can only navigate to Kompong Chhnang for five months of the year as they are unable to pass under the Chrui Chanvar bridge (10 m) during the highwater season. Inland barges can navigate all these stretches over the whole year.



Proposal bypass canal at the Khone Falls

3.2.3 PORTS

CONSTRUCT NEW PASSENGER PORTS AND LANDING FACILITIES IN CHIANG SAEN (JCCCN PHASE 2), CHIANG KHONG (JCCCN PHASE 2), BAN SAI PORT (JCCCN PHASE 2), XIENGKOK (JCCN PHASE 2), MUONG MOM PORT (JCCCN PHASE 2), HUAY XAY (JCCCN PHASE 2), PAK BENG (JCCCN PHASE 2), LUANG PRABANG (JCCCN PHASE 2), VIENTIANE LAKSI PORT (MP), SAVANNAKHET (MP), PAKXE (MP), KRATIE (MP), KOMPONG CHAM (MP) AND KOMPONG CHHNANG (MP) SUITABLE TO HANDLE THE FORECASTED PASSENGER VOLUMES. THESE PORTS SHOULD BE CONSTRUCTED FOR EFFICIENT AND SAFE PROCESSING OF THE PASSENGERS.

The objective is to bring these landing sites to an acceptable level of efficiency and safety and decide on investments according to the needs and the number of passengers likely to use the site now and in the next 25 years.

According to the JCCCN Development Plan, the construction of passenger landing sites in in the Lao PDR that allow comfortable embarking and disembarking of passengers will cost approximately 3.8 million US$ per berth. That is the price for one berth in each (international) port selected in Phase I: Xiengkok, Huay Xay, Pak Beng and Luang Prabang (Pl).

For Ban Sai, Muong Mom, Vientiane, Savannakhet, Pakxe, Kratie, Kompong Cham and Kompong Chhnang, cheaper solutions could be applied, according to the site and the civil works needed to prepare the site. In these ports, a cost of 0.7 million US$ per port is estimated (4 ports Pl and 10 ports Pr).

Estimated costs:	Thailand (Pr)	2 x 25,000 US$
	Lao PDR (Pl)	4 x 3.4 million US$
	Lao PDR (Pr)	1 x 3.4 million US$
		4 x 0.7 million US$
	Cambodia (Pr)	3 x 0.7 million US$

CONSTRUCT NEW PORT INFRASTRUCTURE FOR CARGO PORTS WITH PROPER BERTHING AND CARGO HANDLING FACILITIES IN XIENGKOK (JCCCN PHASE 1), MUONG MOM (BAN MOM), HUAY XAY (JCCCN PHASE 1), PAK BENG (JCCCN PHASE 1), LUANG PRABANG (JCCCN PHASE 1), VIENTIANE (MP), SAVANNAKHET (MP). THE NEW CARGO PORTS SHOULD BE LOCATED IN ORDER TO ASSURE GOOD HINTERLAND CONNECTION (ROAD AND RAIL) - TWO FULLY EQUIPPED VERTICAL 500 DWT BERTHS AND ONE SLOPING RAMP BERTH.
The objective is to bring the ports in line with the new possibilities offered by the implementation of the dams and the improvement of the waterway from the Chinese border to Savannakhet (3 ports Pl and 4 ports Pr)

Estimated costs	Lao PDR (Pl)	3 x 3.6 million US$
	Lao PDR (Pr)	4 x 3.6 million US$

EXPAND THE EXISTING CONTAINER YARD AT THE NEW CONTAINER TERMINAL – NCT LM 17 IN ORDER TO ACCOMMODATE FORECASTED CONTAINER TRAFFIC.

The objective of this action is to prepare PPAP for the growth in containers and additional logistic services for the next 20 years. Therefore, in phase III, the container yard must be expanded to a capacity of 500,000 TEU which is planned by PPAP in the long-term period 2020-2028 (Pr).

Estimated cost: 35 million US$

DEVELOPMENT OF A CARGO PORT IN KRATIE ABLE TO ACCOMMODATE TWO SEAGOING BARGES UP TO 2,000 DWT (KOIKA) SUITABLE TO HANDLE THE FORECASTED CARGO VOLUMES IN AN EFFICIENT AND SAFE WAY

The objective is to find a cheaper way to export cassava to Viet Nam or China by seagoing vessels or alternatively via river transport to Phnom Penh port, either in big bags or containers.

If Kratie will be exporting its cassava in containers to be barged to Phnom Penh, then a vertical quay wall will have to be built backed up by a paved yard allowing the free movement of containers. These are expensive investments and could well run up to 15,000,000 US$ for a single berth.

Therefore, it is proposed to transport the cassava pellets from the shed to the vessel with a conveyor belt and to provide anchorage buoys, also called dolphins, anchored in the riverbed (Pr).

Estimated cost: 3,000,000 US$

DEVELOPMENT OF A CARGO PORT IN KOMPONG CHAM (TONLE BET) WITH VERTICAL QUAYS, ABLE TO ACCOMMODATE 2 SEAGOING VESSELS UP TO 3,000 DWT FOR CONTAINERS AND GENERAL CARGO (KOIKA), A DOMESTIC GENERAL CARGO PORT FOR INLAND BARGES (RAMP) AND AN OIL DISTRIBUTION FACILITY (JETTY) SUITABLE TO HANDLE THE FORECASTED CARGO VOLUMES IN AN EFFICIENT AND SAFE WAY.

In the short term (2020), PPAP is planning to install 4 conveyor belts and to install a 100 ton crawler crane at the Tonle Bet Terminal in Kompong Cham for a total budget of 200,000 US$. In the long term, the objective of the project is to provide facilities for efficient general cargo, container and oil handling, in order to develop direct import and export traffic to and from Kompong Cham. Another objective is to provide efficient handling of domestic general cargo.

For the KOICA project (two vertical berths for 3,000 DWT vessels) an infrastructure budget of 15 million US$ and an equipment budget of 5 million US$ is estimated. In case a conveyor belt with anchorage buoys for general cargo and a container terminal with a jetty and derrick crane, this budget can be reduced to 5,000,000 US$. A new berthing facility for domestic general cargo (ramp) can be estimated at 500,000 US$ and the provision of facilities for an oil distribution center (land, superstructure to be provided by oil companies) can be estimated at 250,000 US$. Preliminary study costs and training of staff can be estimated at 100,000 US$ (Pr).

Estimated cost: 5,850,000 US$

CONSTRUCTION OF A NEW PASSENGER AND CARGO TERMINAL, FISH MARKET AND BUNKERING JETTY IN CHHONG KNEAS

To create a modern, efficient, environmentally-friendly, multi-purpose port serving the cross-border and domestic waterborne transport needs of Siem Reap and the surrounding areas in order to reduce the transportation and handling costs for imported and local products distributed to the area and for products exported from the area, and to promote the growth of international tourism in Siem Reap and the Tonle Sap Lake (Pr).

Estimated cost: 21,800,000 US$

3.2.4 FLEET SAFETY, WATERWAY SAFETY, PORT SAFETY

The long term should focus on increased safety, efficiency and protection of the environment by improving vessel design and construction and by the installation of VTS and RIS over the total length of the Mekong river. Especially for the Mekong Delta (downstream Phnom Penh), it is

stated that an efficient waterway maintenance plan and the use of an AIS system, VTS, RIS and pilotage should increase safety of navigation.

Fleet Safety

IMPLEMENT RIVER INFORMATION SERVICES (RIS) OVER THE TOTAL LENGTH OF THE MEKONG RIVER

The immediate objective of the project is to establish an integrated Mekong River Information Service necessary for navigation development that covers operational data, traffic monitoring and information on navigation development and management throughout the lower Mekong Basin (Pr).

The outputs of the project are:
Output 1: RIS Implementation Plans.
Output 2: Standardization and harmonization of data.
Output 3: Mekong traffic monitoring: Cargo and passenger statistics.
Output 4: Operational services and fairway information.
Estimated costs:

US$	Thailand	Lao PDR	Cambodia	Vietnam
Output 1	21,000	65,000	50,000	74,000
Output 2	13,000	40,000	31,000	46,000
Output 3	38,000	118,000	91,000	133,000
Output 4	68,000	211,000	163,000	238,000
Maintenance (10 years)	300,000	900,000	700,000	1,000,000
Total	440,000	1,334,000	1,035,000	1,491,000

Waterway Safety

DEVELOP AND INSTALL A GPS NAVIGATION GUIDANCE SYSTEM, COMPULSORY FOR ALL BOATS CARRYING CARGO AND PASSENGERS ALONG THE MEKONG RIVER FROM LUANG PRABANG TO KRATIE

The objectives of the project are:

1) To identify and record the deepest navigation route along the river thereby improving navigation safety through the establishment of an officially recommended course.
1) To promote waterway use and improved safety using electronic mapping resources.
2) To test the feasibility of GPS navigation devices as an aid to navigation on the Upper Mekong and build capacity in the use of this technology among waterway users (Pr).

The costs are calculated at a total price of US$ 1,350 US$/km, based on the costs of the GPS project between Huay Xay and Luang Prabang. Since the total distance here is 1,446 km. The estimated total cost is 1,950,000 US$ (1,717,000 US$ for Laos and 233,000 US$ for Cambodia).

DEVELOP AND INSTALL A GPS NAVIGATION GUIDANCE SYSTEM, COMPULSORY FOR ALL BOATS CARRYING CARGO AND PASSENGERS ALONG THE TONLE SAP RIVER AND LAKE

The objectives of the project are:

1) To identify and record the deepest navigation route along the river thereby improving navigation safety through the establishment of an officially recommended course.
2) To promote waterway use and improved safety using electronic mapping resources.

3) To test the feasibility of GPS navigation devices as an aid to navigation on the Upper Mekong and build capacity in the use of this technology among waterway users (Pr).

The costs are calculated at a total price of US$ 1,350 US$/km. Since the total distance here is 244 km, the estimated cost is 330,000 US$. An additional amount of US$ 80,000 is required to make the system compulsory by law and prepare awareness and training campaigns.

Estimated cost: 410,000 US$

INSTALL BUOYS AND BEACONS FROM KRATIE TO KOMPONG CHAM FOR DAY AND NIGHT NAVIGATION

The **objective** of this project is to improve safety and quality of navigation along this shipping route of the Mekong River. The project activities are:

1) To design a detailed aids to navigation system on the selected stretches of the Mekong River;
2) To procure and install the required navaids;
3) To strengthen the capability of the related line agencies (Pr).

Estimated cost:

Consultancies, data collection and survey	80,000 US$
Procurement of navaids and installation	450,000 US$
Training material and consultancy	60,000 US$
Total:	590,000 US$

MAINTAIN THE AIDS TO NAVIGATION (ATN) FROM KOMPONG CHAM TO CAI MEP INCLUDING THE CHO GAO CANAL

The objectives of the project are:

1) To prepare a monitoring and management plan for Cambodia and for Viet Nam.
2) To implement the monitoring and management plan in Cambodia and Viet Nam.
3) To strengthen the capability of the related line agencies in monitoring and management (Pr).

The estimated costs for 10 years of maintenance are estimated at:

Cambodia: 1,040,000 US$
Vietnam 1,880,000 US$

MAINTAIN THE AIDS TO NAVIGATION (ATN) ON THE VAM NAO PASS AND THE BASSAC RIVER

The objectives of the project are:

1) To prepare a monitoring and management plan for Cambodia and for Viet Nam.
2) To implement the monitoring and management plan in Cambodia and Viet Nam.
3) To strengthen the capability of the related line agencies in monitoring and management (Pr).

The estimated costs for 10 years of maintenance are estimated at 1,680,000 US$

3.3 CAPITAL AND ANNUAL OPERATIONS AND MAINTENANCE (O&M) COSTS FOR DIFFERENT TYPES OF NAVIGATION INFRASTRUCTURE, INCLUDING CANALS AND LOCKS (IN US$)

Ex = executed activities, Pl = planned activities, Pr = proposed activities

2007-2020		Thailand	Lao PDR	Cambodia	Vietnam
Fleet	Ex	-	-	-	-
	Pl	-	-	-	-
	Pr	-	-	190,000	190,000
Waterways	Ex	15,000,000	149,000,000	500,000	462,600,000
	Pl	-	144,000,000	-	-
	Pr	-	-	-	-
Ports	Ex	15,000,000	-	28,200,000	17,500,000
	Pl	-	-	35,000,000	20,200,000
	Pr	-	125,000	125,000	-
Fleet safety	Ex	-	-	-	-
	Pl	-	-	-	-
	Pr	2,287,000	3,086,000	2,636,000	2,642,000
Waterway safety	Ex	-	-	1,150,000	-
	Pl	-	-	-	-
	Pr	275,000	545,000	1,105,000	3,200,000
Port safety	Ex	-	-	-	-
	Pl	-	-	-	2,584,000
	Pr	1,866,000	1,743,000	1,842,000	2,049,000
Total	Ex	30,000,000	149,000,000	28,700,000	480,100,000
	Pl	-	144,000,000	35,000,000	22,784,000
	Pr	4,428,000	5,499,000	5,898,000	8,081,000
General total		34,428,000	298,499,000[1]	69,598,000	510,965,000[2]
Average investment costs/year (2007-2020)		2,459,000	21,321,000	4,971,000	36,498,000

[1] Including 293,000,000 US$ for four locks at the Pak Beng Dam and the Xayaburi Dam.
[2] Including 480,000,000 US$ for the Quang Chanh Bo Canal.

2020-2040		Thailand	Lao PDR	Cambodia	Vietnam
Fleet	Pl				
	Pr	220,000	220,000	220,000	215,000
Waterways	Pl	84,950,000	19,859,000	-	-
	Pr	-	1,121,997,000	586,135,000	5,991,000

2020-2040		Thailand	Lao PDR	Cambodia	Vietnam
Ports	Pl	-	24,400,000	-	-
	Pr	50,000	20,600,000	67,750,000	-
Fleet safety	Pl	-	-	-	-
	Pr	440,000	1,334,000	1,035,000	1,491,000
Waterway safety	Pl	-	-	-	-
	Pr	-	1,717,000	1,683,000	3,560,000
Port safety	Pl	-	-	-	-
	Pr	-	-	-	-
Total	Pl	84,950,000	44,259,000	-	-
	Pr	710,000	1,145,868,000	656,823,000	11,257,000
General total		85,660,000[1]	1,190,127,000[2]	656,823,000[3]	11,257,000
Average investment costs/year (2020-2040)		4,283,000	59,506,000	32,841,000	563,000

[1] The costs for waterway improvement between the Green Triangle and Huay Xay should be shared between China, Myanmar, Thailand and Laos.

[2] Including 10 locks at the Luang Prabang Dam, the Pak Lay Dam, the Sanakham Dam, the Ban Khoum Dam and the Latsua Dam for 734,000,000 US$ and 263,000,000 US$ for the bypass canal with locks at the Khone Falls.

[3] Including 207,000,000 US$ for three locks at the Stung Treng and the Sambor Dam and 263,000,000 US$ for the bypass canal with locks at the Khone Falls.

The general total of all planned and proposed activities as from today is as follows:

2017-2040	Thailand	Lao PDR	Cambodia	Vietnam
Planned	84,950,000	188,259,000	35,000,000	22,784,000
Proposed	5,138,000	1,151,367,000	662,721,000	19,338,000
General Total	90,088,000	1,339,626,000	697,721,000	42,122,000
Average investment costs/year (2007-2040)	3,754,000	55,818,000[1]	29,072,000[2]	1,755,000

[1] of which 47,541,000 US$ for the locks at the hydropower dams and for the bypass canal at the Khone Falls (50%).

[2] of which 19,583,000 US$ for the locks at the hydropower dams and for the bypass canal at the Khone Falls (50%).

Excluding the costs of the hydropower dam locks, according to the Master Plan:

- Each country should contribute 3 to 4 percent of this amount from its own public and private budgets;
- About 81 percent of these costs should be funded by international or regional loans;
- About 5 percent of these costs should be funded by international or regional grants.

4. ECONOMIC AND SOCIAL DATA AND INFORMATION

4.1 ECONOMIC COSTS AND BENEFITS OF THE IWT INVESTMENTS (MASTER PLAN FINAL REPORT VOLUME II)

Green Triangle - Vientiane

Provision of a navigation channel for operation of 500 DWT vessels will reduce the operating costs and improve the competitive position of IWT versus road transport for the transport of cargo between the Green Triangle and Luang Prabang. The economic benefits of this project may be measured in terms of the reduced operating costs of 500 DWT vessels versus those of existing 100 DWT vessels and of semi-trailer trucks with a 25-ton payload capacity. These benefits were measured only between Simao and Luang Prabang, *since it was concluded that there would be very little potential for IWT traffic between Luang Prabang and Vientiane*.

Vientiane - Savannakhet

Potential demand for IWT on this stretch has been estimated as very limited and therefore the economic benefits of this project will be close to zero. Both Vientiane and Savannakhet are served by high quality roads from Thailand and the costs of transferring cargo between road vehicles and barges would negate any benefits associated with linehaul movement of cargo by IWT between these two ports.

Savannakhet- Kratie

There is unlikely to be any significant demand for IWT in the stretch between Savannakhet and Kratie, other than for local and very limited tourist transport. While it is close to the large mineral reserves of the Bolovens Plateau, these if ever deemed suitable for commercial exploitation are likely to be transported by heavy haul railway to ports in Viet Nam (or possibly in Cambodia). Given the very limited outlook for cargo traffic in this stretch, coupled with the high capital cost of the project, it is unlikely that the by-pass canal can be economically justified.

Downstream the Khone Falls, the project is unlikely to be justified in economic terms, although it can be expected to have major safety benefits – the community benefits of which are practically difficult to measure.

Kratie-Kompong Cham

Improvement of the navigation channel to allow passage of 2,000 DWT vessels would have to be justified by the potential for export of agricultural commodities from Kratie. *The volumes of agricultural commodities produced around Kratie are unlikely to be sufficient to generate a high-volume export trade and therefore it is unlikely that the channel improvement project can be justified in economic terms.*

Moreover, seagoing vessels of 2,000 DWT can only navigate for five months of the year as they are unable to pass under the Prek Tameak bridge (14 m) and the Kizuna bridge (Kompong Cham (15.5 m) during the high-water season.

Kompong Cham- Phnom Penh (NCT LM17)

The proposed project should permit year-round navigation of vessels of up to 3,000 DWT. Currently, sea going vessels of more than 2,000 DWT navigate as far Tonle Bet to the south of Kompong Cham, but can only navigate for five months of the year as they are unable to pass

under the Prek Tameak bridge during the high-water season. Kompong Cham Province produces much of Cambodia's high quality cassava crop and direct exports to China commenced from Tonle Bet in 2015. The improvement of the channel for navigation of vessels of up to 3,000 DWT would result in economic benefits associated with this cassava trade, which is forecasted to grow to 225,000 tons by 2040. These benefits would include savings in the operating costs of transporting agricultural commodities from Kompong Cham by direct barge/ship movement as compared with movement by road to Phnom Penh and from there by barge.

Phnom Penh – Chong Kneas

The proposed project to dredge a navigation channel for 500 DWT vessels in the Tonle Sap can only be justified by demand for barge transport of cargo between Phnom Penh and Chong Kneas, but forecasts prepared for this Master Plan indicate only demand for passenger tour vessels between these two ports. The potential for cargo transport by barge is very limited owing to:

- The much shorter travel times of trucks as compared with barges between Phnom Penh and Siem Reap (approximately 7 hours by truck vs. at least 17 hours by barge);
- The need to transfer cargo between barges and trucks at Chong Kneas to complete the journey between Phnom Penh and Siem Reap, causing additional costs for cargo owners, when trucks can deliver cargo to where it is consumed;
- The need to invest in additional cargo storage facilities at Chong Kneas, which may add to distribution facilities in Siem Reap.

Moreover, because of their unavoidable and unmitigable environmental impacts, all dredging activities in any of the three zones of the Tonle Sap Biosphere Reserve are in contravention of Articles 3, 4 and 5 of the Royal Decree on the establishment and management of the Tonle Sap Biosphere Reserve, and may be illegal.

Phnom Penh -Cai Mep (Mekong mainstream and Cho Gao Canal)

Improvement of the navigation channel will allow the gradual replacement of current 1500 DWT (100 TEU) barges with 2,500 DWT (166 TEU) barges. The economic benefits associated with this project are a saving in barge operating costs of 44.84 US$ (20%) per TEU.

Phnom Penh – Cai Mep (Bassac and Quang Chanh Bo Canal)

This project will permit operation of:

- Reinforced sea/river barges with capacity of 3,000 DWT (300 TEU) between the Phnom Penh New Container Port and Cai Mep, via the Bassac River and the Quan Chanh Bo canal;
- Sea going vessels with capacity of 7,000 DWT (550 TEU) between the Phnom Penh New Container Terminal and Singapore, Hong Kong or Kaoshiung, via the Bassac River and the Quan Chanh Bo canal;
- Sea going vessels with capacity of 10,000 DWT (650 TEU) between Can Tho and Singapore, Hong Kong or Kaoshiung, via the Bassac River and the Quan Chanh Bo canal.

New services based on the operation of high capacity container carrying vessels would gradually replace existing services via the Mekong River and the Cho Gao canal utilizing barges with a typical capacity of only 100 TEU. The economic benefits arising from these new services would translate into savings in vessel operating costs, calculated by comparing the operating costs of:

1) reinforced sea/river barges with those of existing low capacity river barges;
2) sea going vessels (operating directly between Phnom Penh and Singapore) with those of existing low capacity river barges; and
3) sea going vessels, operating directly between Phnom Penh and Singapore, with those of combined feeder shipping plus road services between Phnom Penh and Singapore, via Sihanoukville Port.

With long term GDP growth settling at around 5% per annum, IWT transport volumes forecast for 2020 are at least 125% of their baseline levels while those forecast for 2040 are at least 250% of their baseline levels.
Relatively strong IWT cargo growth has been achieved in all riverine countries, except for Lao PDR, where IWT growth is restricted by the poor condition of boats and port infrastructure, as well as by increasing competition from road transport which has benefitted from improved highway infrastructure. However, the progressive increase in cargo boat capacity from about 100 DWT now to 500 DWT in the future will reduce IWT operating cost and increase IWT competitiveness and modal share against road transport in Lao PDR, thereby boosting its growth prospects.
In Lao PDR, the tourist potential of the Mekong has yet to be fully realized owing to the poor safety record and poor comfort of passenger boat operations on scenic stretches of the river, particularly that between Huay Xay and Luang Prabang. Significant improvements to on-board safety and to landing facilities are expected to allow IWT tourist traffic to grow at rates approaching the growth in overall tourist arrivals into Lao PDR (recently about 16% per annum).
The growth of IWT tourist traffic between Viet Nam and Cambodia has been very robust over the past decade and its future rapid growth will be assured by investments in upgraded passenger terminal facilities in Ho Chi Minh City, Chau Doc (Viet Nam), Phnom Penh and Chong Kneas (Siem Reap).

4.2. ANNUAL VOLUME OF IWT CROSS-BORDER CARGO TRADE IN PAST, PRESENT AND FUTURE (TON)

Data from the Master Plan – Economic Assessment Report

	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Cross-border Lao-China-Thai – total road + IWT	312,000	518,000	7.5	1,009,000	3,004,000	7.0
Cross-border Lao-China-Thai - no IWT Investments (100 ton)	136,000	216,000	6.7	207,000	202,000	-0.3
Vessel movements		2,158		2,070	2,020	
Cross-border Lao-China-Thai – with IWT Investments (500 ton)	136,000	216,000	6.7	296,000	1,759,000	8.4
Vessel movements		2,158		1,346	4,628	
Cross-border Lao-Thai no IWT investments	68,000	108,000	6.7	103,000	101,000	-0.3
Cross-border Lao-Thai With IWT investments	68,000	108,000	6.7	148,000	880,000	8.4
Cross-border China-Thai (Chiang Saen-Chiang Khong) no IWT investments (300 ton)	218,000	532,000	8.0	687,000	1,921,000	5.1
Vessel movements		1,775		2,197	6,141	
Cross-border China-Thai (Chiang Saen-Chiang Khong) with IWT investments (500 ton)	218,000	532,000	8.0	808,000	3,577,000	7.4
Vessel movements		1,775		2,245	8,942	
Cross-border China-Thai Petrol (Chiang Saen – Haciang)	4,459	21,761	20.1	26,877	130,368	7.1

	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Cross-border Vietnam – Cambodia Containers no IWT investments (100 TEU)	374,000	1,025,000	15.5	1,103,000	3,621,000	5.1
Vessel movements		1,337		1,367	3,442	
Cross-border Vietnam – Cambodia Containers with IWT investments (166 – 500 TEU)	374,000	1,025,000	15.5	1,259,000	5,279,000	6.9
Vessel movements		1,337		1,199	2,360	
Cross-border Vietnam – Cambodia Petrol no IWT investments (1,000 DWT)	780,000	605,000	-3.5	1,657,000	7,226,000	8.8
Vessel movements		966		1,657	7,226	
Cross-border Vietnam – Cambodia Petrol with IWT investments (3,000 DWT)	780,000	605,000	-3.5	1,657,000	7,869,000	9.1
Vessel movements		966		1,036	2,623	
Cross-border Vietnam – Cambodia General Cargo	166,000	267,000	7.0	410,000	1,346,000	6.4
Cross-border Vietnam – Cambodia TOTAL[1] no IWT investments	1,180,000	1,898,000	7.0	3,233,000	12,419,000	6.9
Cross-border Vietnam – Cambodia TOTAL with IWT investments	1,180,000	1,898,000	7.0	3,388,000	14,720,000	7.8
Agric. ex Kompong Cham	0	0	0	62,000	225,000	6.7

[1] Including containers, petroleum and general cargo

4.3 ANNUAL TOTAL VOLUME OF IWT CARGO TRADE ON THE LMB IN PAST, PRESENT AND FUTURE (TON)

Data from Master Plan (MP) Economic Assessment Report

Thailand

	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Overall IWT cargo transport	31,312,000	37,081,000	4.1	53,869,000	238,456,000	7.4
LMB IWT cargo transport no IWT investments	898,000	1,152,140	3.7	1,552,820	4,199,290	5.1
Share of overall IWT cargo transport Thailand	2.9%	3.1%		2.9%	1.8%	
LMB IWT cargo transport with IWT investments				1,768,200	7,372,530	7.4
Share of overall IWT cargo transport Thailand				3.3%	3.1%	

In Thailand, IWT is estimated to transport about 40 million tons of cargo annually, representing 10% of the total inland cargo volume. This is better than rail, which has a share of only 3%, but well below road, which has a commanding share of 87%.

THAILAND	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Crossborder cargo IWT	515,000	664,000[1]	3.7	1,020,000	4,249,000	7.4
Domestic cargo IWT	378,000	488,000[2]		748,000	3,123,000	
Total cargo IWT	893,000	1,152,000[3]		1,768,000	7,372,000	

[1] China -Thai + Thai - Lao + Petrol (Haciang)

[2] Cross-border cargo transport is 58% and domestic cargo transport is 42% of the total cargo transport

[3] Throughput Haciang Port + Chiang Saen Port + Chiang Khong Port

Lao PDR

	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Overall cargo transport	4,089,000	7,053,000	8.1	10,119,000	33,700,000	6.2
Road cargo transport No IWT investments	3,566,000	6,305,000	8.5	9,148,000	31,634,000	6.4
% road cargo	87.2	89.4		90.4	93,9	
IW cargo transport No IWT investments	523,000	748,000	6.2	971,000	2,066,000	4.0
% IW cargo	12.8	10.6		9.6	6.1	
Road cargo transport with IWT investments				8,892,000	25,366,000	5.8
% road cargo				87.9	81,0	
IW cargo transport with IWT investments				1,227,000	8,334,000	8.6
% IW cargo				12.1	19,0	

The IWT modal share for freight transport is about 17% and for passenger transport about 6% of the total yearly carried capacity among all modes. The main commodities or goods are timber, wood products, construction material, rice, fuel, sand, rock, wood products, foods grains, steel product and logs.

LAO PDR	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Crossborder cargo IWT	213,000	324,000[1]	6.2	532,000	2,768,000	8.6
Domestic cargo IWT	278,000	424,000[2]		696,000	3,622,000	
Total cargo IWT	491,000	748,000		1,228,000	6,390,000	

[1] Lao - China + Lao - Thai

[2] Cross-border cargo transport is 43% and domestic cargo transport is 57% of the total cargo transport

Cambodia

CAMBODIA	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Crossborder cargo IWT	1,182,000	1,898,000	7%	2,977,000	13,378,000	7.8%
Domestic cargo IWT	636,000	1,022,000[1]		1,605,000	7,203,000	
Total cargo IWT	1,818,000	2,920,000		4,582,000	20,581,000	

[1] Because of lack of data, it is estimated that Cross-border cargo transport is 65% and domestic cargo transport is 35% of the total cargo transport

Vietnam

In 2014, the total cargo transport volume of Vietnam was 545,500,000 tons. Of this volume, 16% or 90,270,000 ton was transported by water (AARG 6.5%) of which 30% by maritime transport overseas, 10% by coastal transport and 60% by inland waterway transport (54,152,000 ton).

It is estimated that 50% of the Vietnamese import-export is passing the southern seaports and that 80% of this volume is transported inland by IWT (7,963,000 ton).

It is also estimated that the total cargo inland waterway transport in the Mekong Delta is about one third of the total cargo volume by IWT (18,050,000 ton). This means that 10,087,000 ton is domestic cargo IWT in the Mekong Delta.

The inland waterways system is relatively well-developed and provides an efficient network to transport throughout the country. It facilitates 25-30% of domestic cargo transport. Barging is a very competitive sector in Vietnam providing a cheap mode of transport for especially bulk goods.

With the mentioned volumes, cross-border cargo transport is 44% and domestic cargo transport is 56% of the total cargo transport.

VIETNAM	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Crossborder cargo IWT	5,124,000	7,963,000	6.5%	12,636,000	58,897,000	8.0%
Domestic cargo IWT	6,491,000	10,087,000		16,007,000	74,607,000	
Total cargo IWT	11,615,000	18,050,000		28,643,000	133,504,000	

Data for the cost-benefit assessment on the annual IWT Cargo Volume in the Lower Mekong Basin (ton)

a) Baseline condition (2014)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	576,000	374,000	584,000	4,512,500	6,046,500
Small barges 100 ton	576,000	374,000	584,000	4,512,500	6,046,500
Medium barges 500 ton	0	0	292,000	4,512,500	4,804,500
Large barges 1,000 ton	0	0	1,460,000	4,512,500	5,972,500
Large barges 3,000 ton	0	0	0	0	0
Total IWT Cargo volume	1,152,000	748,000	2,920,000	18,050,000	22,870,000

b) Early Development Scenario (Existing 2007)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	446,500	245,500	363,600	2,903,750	3,959,350
Small barges 100 ton	446,500	245,500	363,600	2,903,750	3,959,350
Medium barges 500 ton	0	0	181,800	2,903,750	3,085,550
Large barges 1,000 ton	0	0	909,000	2,903,750	3,812,750
Large barges 3,000 ton	0	0	0	0	0
Total IWT Cargo volume	893,000	491,000	1,818,000	11,615,000	14,817,000

c) Definite Future (including 2020 plans)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	884,000	614,000	916,400	5,728,600	8,143,000
Small barges 100 ton	884,000	614,000	916,400	5,728,600	8,143,000
Medium barges 500 ton	0	0	458,200	5,728,600	6,186,800
Large barges 1,000 ton	0	0	2,291,000	5,728,600	8,019,600
Large barges 3,000 ton	0	0	0	5,728,600	5,728,600
Total IWT Cargo volume	1,768,000	1,228,000	4,582,000	28,643,000	36,221,000

d) Planned Development Scenario (including 2040 plans)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	1,474,400	1,278,000	2,058,100	13,350,400	18,160,900
Small barges 100 ton	1,474,400	1,278,000	2,058,100	13,350,400	18,160,900
Medium barges 500 ton	4,423,200	3,834,000	6,174,300	26,700,800	41,132,300
Large barges 1,000 ton	0	0	4,116,200	40,051,200	44,167,400
Large barges 3,000 ton	0	0	6,174,300	40,051,200	46,225,500
Total IWT Cargo volume	7,372,000	6,390,000	20,581,000	133,504,000	167,847,000

4.4 GROSS ECONOMIC VALUE, HAULAGE COSTS AND NET ECONOMIC VALUE OF INLAND WATERWAY CARGO TRANSPORT (US$/TON)

Gross economic value (US$/ton)

2014	Thailand	Lao PDR	Cambodia	Vietnam
https://www.cia.gov/library/publications/the-world-factbook/fields/2090.html				
GDP (billion US$) (CIA)	390.0	13.5	19.4	191.0
Export (billion US$) (CIA)	190.0	2.8	8.1	155,1
Import (billion US$) (CIA)	170.0	4.0	11.5	148,9
Import + Export (billion US$)	360.0	6.8	19.6	304.0
Master Plan Economic Assessment				
Mekong IWT Share	0.15%	4.0%	6.0%	20.0%
Mekong IWT Import + Export (billion US$)	0.54	0.27	1.18	60.80
Mekong IWT Import + Export (ton)	664,000	324,000	1,198,000	7,963,000
Gross economic value 2014 (US$/ton)	813	833	985	764

Taking into account an average annual inflation rate of 2%, this leads to following data:

Gross economic value (US$/ton)	Thailand	Lao PDR	Cambodia	Vietnam
2007	708	725	858	665
2014	813	833	985	764
2020	916	938	1,109	860
2040	1,360	1,394	1,648	1,278

Taking into account that domestic transport has a lower value than import-export transport (more sand, construction material, etc.), it is estimated that the gross economic value here is only 50% of the import-export goods economic value

Gross economic value (US$/ton)	Thailand	Lao PDR	Cambodia	Vietnam
2007	354	363	429	333
2014	407	417	493	382
2020	458	469	555	430
2040	680	697	824	639

Gross economic value (US$/ton)

a) Baseline condition (2014)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	407	417	493	382
Small barges 100 ton	813	833	493	382
Medium barges 500 ton	0	0	493	764
Large barges 1,000 ton	0	0	985	764
Large barges 3,000 ton	0	0	0	0

b) Early Development Scenario (Existing 2007)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton (domestic)	354	363	429	333
Small barges 100 ton	708	725	429	333
Medium barges 500 ton	0	0	429	665
Large barges 1,000 ton	0	0	858	665
Large barges 3,000 ton	0	0	0	0

c) Definite Future (including 2020 plans)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	458	469	555	430
Small barges 100 ton	916	938	555	430
Medium barges 500 ton	0	0	555	645
Large barges 1,000 ton	0	0	1,109	860
Large barges 3,000 ton	0	0	0	860

d) Planned Development Scenario (including 2040 plans)

Vessel Class	Lao PDR	Thailand	Cambodia	Viet Nam
Small barges <50 ton	680	697	824	639
Small barges 100 ton	680	697	824	639
Medium barges 500 ton	1,247	1,394	824	639
Large barges 1,000 ton	0	0	1,648	1,065
Large barges 3,000 ton	0	0	1,648	1,278

IW Transport costs (US$/ton) (Master Plan Economic Assessment – situation 2014)

Green triangle – Chiang Saen

The economic benefits generated by the project include reduced operating costs of 500 DWT vessels as compared with 100 DWT vessels (a saving of 9.28 per ton of cargo, or 40%) and with road semi-trailers (a saving of 15.00 US$ per ton of cargo, or 52%)

Option	Item	Route	Cost US$ / ton	Fuel cons. Lit. / ton
1	Existing river barges (100 DWT)	Simao-Chiang Saen via Mekong (590 km)	23,22	8,60
2	Future river barges (500 DWT)	Simao-Chiang Saen via Mekong (590 km)	13,94	5,17
3	Road transport	Simao-Chiang Saen via Route 13N (460 km)	28,61	11,83

Green triangle – Luang Prabang

The economic benefits generated by the project include reduced operating costs of 500 DWT vessels as compared with 100 DWT vessels (a saving of 12.23 US$ per ton of cargo, or 44%) and with road semi-trailers (a saving of 16.33 US$ per ton of cargo, or 51%)

Option	Item	Route	Cost US$ / ton	Fuel cons. Lit. / ton
1	Existing river barges (100 DWT)	Simao-Luang Prabang via Mekong (890 km)	27.62	12.97
2	Future river barges (500 DWT)	Simao-Luang Prabang via Mekong (890 km)	15,39	7.80
3	Road transport	Simao-Luang Prabang via Route 13N (510 km)	31.72	13.12

CONTAINERS Phnom Penh – Cai Mep via Mekong mainstream and Cho Gao Canal (1 and 2) and via Bassac and Quang Chanh Bo Canal (3, 4 and 5)

Improvement of the navigation channel will allow the gradual replacement of current 1,000 DWT (96 TEU) barges with 2,000 DWT (192 TEU) barges or 3,000 DWT sea-river barges (288 TEU). The economic benefits associated with this project are respectively a saving in barge operating costs of 15.18 US$ (17%) and 22.71 US$ (25%) per TEU. So, of the new services, those involving the operation of reinforced sea river barges can be expected to deliver the highest economic benefits, with a 25% saving in vessel operating costs per TEU.

Option	Item	Route	Cost US$/TEU	Fuel cons. Lit. / TEU
1	Existing river barges to Cai Mep (1,000 DWT= 96 TEU)	PNH-CAI via Mekong and Cho Gao canal (371 km)	90.84	36
2	Future river barges to Cai Mep (2,000 DWT = 192 TEU)	PNH-CAI via Mekong and Cho Gao canal (371 km)	75,66	30
3	Sea-river barges to Cai Mep (3,000 DWT= 288 TEU)	PNH-CAI via Bassac and Quang Chanh Bo Canal (433 km)	68.13	27
4	Seagoing vessel PHN - Cai Mep to Singapore (7,000 DWT= 672 TEU)	PNH-CM-SIN via Bassac and Quang Chanh Bo Canal (1,443 km)	129.12	54
5	Seagoing vessel Sihanoukville to Singapore (12,000 DWT= 1,152 TEU + truck PNH-SHV)	PNH-SHV-SIN (sea voyage = 1,028 km; road haul = 226 km)	286.72	76

PETROLEUM Phnom Penh – Nha Be
Improvement of the navigation channel will allow the gradual replacement of current 1,000 DWT tankers with 3,000 DWT sea-river tankers. The economic benefits associated with this project are a saving in barge operating costs of 2,42 US$ (24%) per TEU.

Option	Item	Route	Cost US$ / TEU	Fuel cons. Lit. / TEU
1	Existing river tankers 1,000 DWT	Mekong – Cho Gao canal (350 km)	10,08	36
2	Future sea-river tankers 2,000 DWT	Mekong – Cho Gao canal (350 km)	7,66	30

According to the World Bank World Development Indicators database, May 2016, the costs to export or import containers (US$ / TEU), including costs for documents, administrative fees for customs, clearance and technical control, customs broker fees, and trade taxes are given below:

US$/TEU	2007	2008	2009	2010	2011	2012	2013	2014
Costs to Export per container								
Thailand	615	625	625	625	625	585	595	595
Lao PDR	1,750	1,860	1,860	1,860	1,880	2,140	1,950	1,950
Cambodia	722	732	732	732	732	755	795	795
Vietnam	468	533	555	555	580	610	610	610

Costs to Import per container								
Thailand	786	795	795	795	750	750	760	760
Lao PDR	1,930	2,040	2,040	2,040	2,035	2,125	1,910	1,910
Cambodia	852	872	872	872	872	900	930	930
Vietnam	586	606	645	645	670	600	600	600

Port handling costs (berthing, loading, unloading) can be estimated at an average of 12 US$/ton per port and import /export costs can be estimated at an average of 75 US$/ton (on average one TEU is 10 to 11 ton).

Data for the cost-benefit assessment on the annual IWT Cargo Volume in the Lower Mekong Basin (US$/ton)

The transport costs are calculated as follows:

For domestic IW transport (± 50% of total IW transport) with smaller barges: Barge transport costs for an average distance of 200 km + two times port costs (berthing, loading, unloading) (2 x 12 US$/ton)

For cross-border IW transport (± 50% of total IW transport) with larger barges: Barge transport costs + two times port costs (berthing, loading, unloading) + import/export taxes (80 US$/ton).

Inflation rate is estimated at 2% per year.

a) Baseline condition (2014)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	36	36	36	36
Small barges 100 ton	122	126	35	35
Medium barges 500 ton	0	0	31	110
Large barges 1,000 ton	0	0	109	107
Large barges 3,000 ton	0	0	0	0

b) Early Development Scenario (Existing 2007)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton (domestic)	31	31	31	31
Small barges 100 ton	106	110	30	30
Medium barges 500 ton	0	0	27	96
Large barges 1,000 ton	0	0	95	94
Large barges 3,000 ton	0	0	0	0

c) Definite Future (including 2020 plans)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	41	41	41	41
Small barges 100 ton	137	142	39	39
Medium barges 500 ton	0	0	35	35
Large barges 1,000 ton	0	0	125	123
Large barges 3,000 ton	0	0	0	120

d) Planned Development Scenario (including 2040 plans)

Vessel Class	Lao PDR	Thailand	Cambodia	Viet Nam
Small barges <50 ton	60	60	60	60
Small barges 100 ton	58	58	58	58
Medium barges 500 ton	178	166	52	52
Large barges 1,000 ton	0	0	182	139
Large barges 3,000 ton	0	0	179	177

4.5 ANNUAL NET ECONOMIC VALUE OF IWT CARGO VOLUME (MILLION US$)

= (Gross economic value - transport costs)[1] (US$/ton) x annual total volume (ton)
([1] = Net economic value US$/ton)

a) Baseline condition (2014)

Vessel Class	Lao PDR	Thailand	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	214	142	267	1,561	2,184
Small barges 100 ton	398	264	267	1,566	2,496
Medium barges 500 ton	0	0	135	2,951	3,086
Large barges 1,000 ton	0	0	1,279	2,965	4,244
Large barges 3,000 ton	0	0	0	0	0
Total IWT Cargo volume	612	407	1,948	9,043	12,010

b) Early Development Scenario (Existing 2007)

Vessel Class	Lao PDR	Thailand	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	144	82	145	877	1,247
Small barges 100 ton	269	151	145	880	1445
Medium barges 500 ton	0	0	73	1,652	1,725
Large barges 1,000 ton	0	0	694	1,658	2,352
Large barges 3,000 ton	0	0	0	0	0
Total IWT Cargo volume	413	232	1,056	5,067	6,769

c) Definite Future (including 2020 plans)

Vessel Class	Lao PDR	Thailand	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	369	263	471	2,228	3,331
Small barges 100 ton	689	489	473	2,240	3,890
Medium barges 500 ton	0	0	238	3,494	3,733
Large barges 1,000 ton	0	0	2,254	4,222	6,476
Large barges 3,000 ton	0	0	0	4,239	4,239
Total IWT Cargo volume	1,057	752	3,437	16,424	21,669

d) Planned Development Scenario (including 2040 plans)

Vessel Class	Lao PDR	Thailand	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	914	814	1,572	7,730	11,030
Small barges 100 ton	917	817	1,577	7,757	11,067
Medium barges 500 ton	4,728	4,708	4,767	15,673	29,876
Large barges 1,000 ton	0	0	6,034	37,087	43,122
Large barges 3,000 ton	0	0	9,070	44,096	53,166
Total IWT Cargo volume	6,560	6,339	23,020	112,344	148,262

In conclusion, this leads to the following Annual Net Economic Value in billion US$, providing a more than twenty-fold increase of the sector's NPV in 2040 (M3), compared to 2007 (M1):

	M1(2007)	M2(2020)	M3(2040)	M2-M1 Diff		M3-M1 Diff	
	B$	B$	B$	B$	%	B$	%
Cambodia	$1.1	$3.4	$23.0	$2.4	225%	$22.0	2080%
Lao PDR	$0.4	$1.1	$6.6	$0.6	156%	$6.1	1488%
Thailand	$0.2	$0.8	$6.3	$0.5	224%	$6.1	2632%
Vietnam	$5.1	$16.4	$112.3	$11.4	224%	$107.3	2117%
LMB	$6.8	$21.7	$148.3	$14.9	220%	$141.5	2090%

In the "Macro-Economic Assessment Report", following Annual Net Present Economic Value in billion US$ is given, providing only a ten-fold increase of the sector's NPV in 2040 (M3), compared to 2007 (M1):

	M1(2007)	M2(2020)	M3(2040)	M2-M1 Diff		M3-M1 Diff	
	B$	B$	B$	B$	%	B$	%
Cambodia	$0.9	$2.2	$9.5	$1.3	132%	$8.5	898%
Lao PDR	$0.3	$0.4	$2.2	$0.1	46%	$1.9	665%
Thailand	$0.5	$0.9	$3.4	$0.4	83%	$2.9	632%
Vietnam	$5.6	$13.8	$61.2	$8.2	146%	$55.5	990%
LMB	$7.3	$17.2	$76.2	$9.9	136%	$68.9	942%

The difference with the higher mentioned values is due to the fact that in this Report for the Navigation Thematic Area, the Net Economic Value was not discounted to define the so-called *net present values*, translating future benefits into today's values.

In the Macro-Economic Assessment report, on the contrary, a social discount rate[2] was applied, converting future benefits into net present value because people have a strong preference for present consumption (see Macro-Economic Assessment Report page 17 and 18).

[2] For the calculations following assumption was made to approximate hyperbolic discounting:
- *for the first 5 years: 6.5% discount rate*
- *for the ten years thereafter, an annual drop of the discount rate by 0.65%*
- *for the ten years thereafter, no further discounting is applied*

4.6 ANNUAL NUMBER OF IWT PASSENGERS IN PAST, PRESENT AND FUTURE (PAX)

Data from Master Plan (MP) Economic Assessment Report

	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (pax)	2014 (pax)	2007-2014	2020 (pax)	2040(pax)	2014-2040
Cross-border Lao-China-Thai	17,561	39,702	12.4	68,081	218,225	6.8
Huay Xay – Luang Prabang no IWT investments	49,361	47,996	-0.4	55,146	114,418	3.4
Number of tour boats		736		848	1,760	
Huay Xay – Luang Prabang with IWT investments	49,361	47,996	-0.4	95,251	1,961,450	15.4
Number of tour boats		736		953	19,615	
Cross-border China-Thai (Chiang Saen)	4,459	5,987	4.3	8,108	22,668	5.3
Cross-border Vietnam-Cambodia speedboat		22,338	-2.3	32,047	106,729	6.2
Cross-border Vietnam-Cambodia tourboat		24,341	1.2	35,718	128,241	6.6
Cross-border Vietnam-Cambodia total	76,216	46,679	-7.4	67,765	234,970	6.4
Number of speedboats		1,823		2,802	9,198	
Number of tour boats		543		835	2,740	
Total number of boats		2,722		3,637	11,938	

The Pak Beng Port Association recorded a total of 75,645 passengers in 2014 (47,996 tourists and 27,649 Laotians). In Pakse, 26,333 foreigners and 5,475 local passengers were transported in 2014.

Tourist arrivals via the Mekong at Huay Xay								
Year	2007	2008	2009	2010	2011	2012	2013	2014
Total inbound tourists	1,623,900	1,716,800	2,008,400	2,513,000	2,723,600	3,330,100	3,779,000	4,335,900
Arrivals via the Mekong River	49,299	53,448	51,477	45,712	47,112	39,583	49,682	47,824

Chau Doc passenger port statistics						
Year	2009	2010	2011	2012	2013	2014
No. passengers	16,436	20,216	12,086	20,450	12,471	14,352

Phnom Penh Passenger and Tourist Terminal recorded following numbers of passengers:

Phnom Penh passenger port statistics							
Year	2010	2011	2012	2013	2014	2015	2016
No. ship calls	2,118	2,033	2,171	2,093	2,701	2,674	1,666
No. passengers	84,259	39,774	48,428	48,883	62,788	47,714	33,117

Tourist data from "Development Potential for International Shipping on the Lancang-Mekong river", Mekong Institute, 2016

Immigration Report at Chiang Saen Port (number of persons)

Year	Disembarkation at Chiang Saen				Embarkation from Chiang Saen			
	Thailand	Lao PDR	Others	Total	Thailand	Lao PDR	Others	Total
2005	85,881	24,149	5,288	116,472	103,294	22,990	2,609	130,055
2006	86,246	29,592	5,743	121,581	101,063	12,578	2,528	116,169
2007	79,902	27,259	3,162	110,323	84,938	15,247	1,212	101,397
2008	61,676	30,470	3,689	95,835	63,879	22,196	1,590	87,665
2009	40,423	34,040	2,112	76,585	45,433	28,687	1,169	75,289
2010	17,688	31,787	2,457	51,932	24,216	30,051	1,155	55,422

Immigration Report at Chiang Khong Port

Year	Disembarkation at Chiang Khong				Embarkation from Chiang Khong			
	Thailand	Lao PDR	Others	Total	Thailand	Lao PDR	Others	Total
2005	22,708	27,126	17,879	67,713	26,621	25,632	45,552	97,805
2006	29,780	23,830	20,401	74,011	32,230	23,346	54,296	109,872
2007	42,295	29,366	29,020	100,681	46,772	27,644	51,431	145,847
2008	43,354	20,631	28,159	92,144	47,237	18,187	52,584	118,008

With these data, the statistics data from Lao PDR and Vietnam and some estimations, following table on the number of passengers, making use of inland waterway transport, was made up:

Total number of passengers (tourists, domestic, ferries, …)

	2007	2014	AARG 2007-2014	2020	2040	AARG 2014-2020
	1,000 pax	1,000 pax	%	1,000 pax	1,000 pax	%
THAILAND						
Total passengers transport (estimation)[1]	3,002,000	4,645,000	6.4	6,589,000	21,132,000	6.0
Total passengers IWT (4%)	120,000	184,000	6.3	247,000	654,000	5.0
Total passengers Mekong IWT (0,008%)	325	371	2.0	497	1,319	5.0

LAO PDR						
Total passengers transport	40,964[2]	52,356[2]	3.6	70,162	186,160	5.0
Total passengers IWT no IWT investments	1,953[2]	2,886[2]	5.7	3,652	8,001	4.0
Total passengers IWT with IWT investments				4,094	13,130	6.0
CAMBODIA						
Total passengers transport (estimation)[1]	64,372	96,792	6.0	137,301	440,344	6.0
Total passengers IWT no IWT investments	1,900	1,935	0.3	2,448	5,365	4.0
Total passengers IWT with IWT investments				2,909	8,803	6.0
VIETNAM						
Total passengers transport	1,638,000[2]	3,054,000[2]	9.3	5,122,000	28,705,000	9.0
Total passengers IWT	132,000[2]	244,000[2]	9.2	409,000	2,293,000	9.0
Total passengers Mekong Delta	479,000	695,000	5.5	985,000	3,162,000	6.0
Total passengers Mekong Delta IWT	34,000	65,000	9.7	92,200	295,700	6.0

[1] The total number of passengers, travelling each year by a particular mode of transport such as water, rail, air, or road in a given area or region, and other statistical data of transport activities are currently not recorded officially by a governmental organisation.

[2] Government statistics

Total number of international tourists, making use of IWT

	2007	2010	AARG 2007-2010	2014	AARG 2010-2014	2020	2040	AARG 2014-2040
	1,000pax	1,000pax	%	1,000pax	%	1,000pax	1,000pax	%
THAILAND								
Total tourists	11,700	15,920	10.8	24,780	11.7	43,900	295,330	10.0
Total tourists Mekong area	1,070	1,460	11.0	2,300	12.0	4,075	27,410	10.0
Total tourists using Mekong IWT	208	219	1.9	237	1.9	318	843	5.0
LAO PDR								
Total tourists	1,433	1,913	10.1	3,164	13.4	5,605	37,709	10.0
Tourists using Mekong IWT no investments	115	135	5.6	169	5.6	226	601	5.0
Tourists using Mekong IWT with investments						268	1,250	8.0

CAMBODIA								
Total tourists	1,831	2,504	11.0	4,503	15.8	8,888	85,737	12.0
Tourists using Mekong IWT no investments	128	124	-1.0	119	-1.0	134	199	2.0
Tourists using Mekong IWT with investments						169	541	6.0
VIETNAM								
Total tourists	4,044	5,094	8.0	7,874	11.5	13,949	93,843	10.0
Total tourists Mekong Delta	1,097	1,307	6.0	1,928	10.2	3,059	14,260	8.0
Total tourists using Mekong IWT	109	163	14.1	289	15.4	512	3,444	10.0

4.7 CONCLUSIONS

2007	THAILAND		LAO PDR		CAMBODIA		VIETNAM	
	Pax	%	Pax	%	Pax	%	Pax	%
Domestic IWT passengers	117,000	36.0	1,838,000	94.1	1,772,000	93.3	33,891,000	99.7
Tourist IWT passengers	208,000	64.0	115,000	5.9	128,000	6.7	109,000	0.3
Total IWT passengers	325,000		1,953,000		1,900,000		34,000,000	
Average IWT pass. per day	890		5,350		5,205		93,150	

2014	THAILAND		LAO PDR		CAMBODIA		VIETNAM	
	Pax	%	Pax	%	Pax	%	Pax	%
Domestic IWT passengers	134,000	36.1	2,717,000	94.1	1,816,000	93.8	64,711,000	99.5
Tourist IWT passengers	237,000	63.9	169,000	5.9	119,000	6.2	289,000	0.5
Total IWT passengers	371,000		2,886,000		1,935,000		65,000,000	
Average IWT pass. per day	1,016		7,907		5,301		178,082	

2020	THAILAND		LAO PDR		CAMBODIA		VIETNAM	
	Pax	%	Pax	%	Pax	%	Pax	%
Domestic IWT passengers	179,000	36.0	3,826,000	93.5	2,740,000	94.2	91,688,000	99.4
Tourist IWT passengers	318,000	64.0	268,000	6.5	169,000	5.8	512,000	0.6
Total IWT passengers	497,000		4,094,000		2,909,000		92,200,000	
Average IWT pass. per day	1,362		11,216		7,970		252,603	

2040	THAILAND		LAO PDR		CAMBODIA		VIETNAM	
	Pax	%	Pax	%	Pax	%	Pax	%
Domestic IWT passengers	476,000	36.1	11,880,000	90.5	8,262,000	93.8	292,256,000	98,8
Tourist IWT passengers	843,000	63.9	1,250,000	9.5	541,000	6.2	3,444,000	1.2
Total IWT passengers	1,319,000		13,130,000		8,803,000		295,700,000	
Average IWT pass. per day	3,614		35,973		24,118		810,137	

4.8 FORECASTS MODAL SHARE WITH ALTERNATIVE MODES OF TRANSPORT

The data for Lao PDR and Vietnam are found in the statistical yearbooks. The data for Thailand and Cambodia are mainly from publicly available online sources and should therefore be treated as estimations. Moreover, for Thailand and Vietnam, these values are for the whole country, which can differ from the values in northeastern Thailand and in the Mekong Delta.

Cargo (ton)	Thailand	Lao PDR		Cambodia	Vietnam	
Year	2007	2007	2014	2007	2007	2014
Road	82.5%	81.5%	74.4%	75.2%	71.1%	78.9%
Rail	2.5%	0.0%	0.0%	5.0%	1.6%	0.7%
Inl. Waterway	9.2%	18.5%	25.6%	19.8%	23.9%	17.9%
Coastal	5.8%	0.0%	0.0%	0.0%	3.3%	2.5%
Air	0.0%	0.0%	0.0%	0.0%	0.1%	0.02%

Passengers	Thailand	Lao PDR		Cambodia	Vietnam	
Year	2007	2007	2014	2007	2007	2014
Road	94.4%	94.1%	93.2%	92.0%	89.9%	94.2%
Rail	1.6%	0.0%	0.0%	0.0%	0.7%	0.4%
Inl. Waterway	3.0%	5.0%	5.9%	6.5%	8.9%	4.8%
Air	1.0%	0.9%	0.9%	1.5%	0.5%	0.6%

See paragraph 4.2.:

Thailand Cargo	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
LMB IWT cargo transport no IWT investments	898,000	1,152,000	3.7	1,553,000	4,199,000	5.1
LMB IWT cargo transport with IWT investments				1,768,000	7,372,000	7.4

With IWT investments, in 2020, 215,000 ton is shifted from road to IW and in 2040, 3,173,000 ton is shifted from road to IW

Lao PDR Cargo	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
IW cargo transport no IWT investments	523,000	748,000	6.2	971,000	2,066,000	4.0
IW cargo transport with IWT investments				1,227,000	8,334,000	8.6

With IWT investments, in 2020, 256,000 ton is shifted from road to IW and in 2040, 6,268,000 ton is shifted from road to IW

Cambodia Cargo	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
IW cargo transport no IWT investments	1,818,000	2,920,000	7.0	3,695,000	8,096,000	4.0
IW cargo transport with IWT investments				4,582,000	20,581,000	7.8

With IWT investments, in 2020, 887,000 ton is shifted from road to IW and in 2040, 12,485,000 ton is shifted from road to IW

Vietnam Cargo	Base CS	Base MP	AARG (%)	Forecast MP		AARG (%)
	2007 (ton)	2014 (ton)	2007-2014	2020 (ton)	2040(ton)	2014-2040
Mekong Delta IW cargo transport no IWT investments	11,615,000	18,050,000	6.5	24,189,000	64,180,000	5.0
Mekong Delta IW cargo transport with IWT investments				28,643,000	133,504,000	8.0

With IWT investments, in 2020, 4,454,000 ton is shifted from road to IW and in 2040, 69,324,000 ton is shifted from road to IW

On average, starting from a modal split 80% road, 17% IW and 5% rail, without IWT investments, IWT will lose 1% in 2020 and 4% in 2040 of the modal share and with IWT investments, IWT will shift 2% from road to IWT in 2020 and almost 11% in 2040.

Cargo modal share	2014 (%)	AARG 2014-2040	2020 (%)	2040 (%)
Total	100.0	5.0%	100.0	100.0
Rail	3.0	5.0%	3.0	3.0
Inland Waterway no IWT investments	17.0	4.0%	16.1	13.3
Road no IWT investments	80.0	5.2%	80.9	83.7
Inland Waterway with IWT investments	**17.0**	7.0%	19.0	**27.8**
Road with IWT investments	**80.0**	4.4%	78.0	**69.2**

Finally, according to the Master Plan Economic Assessment, taking into account the cost and the transit time of road and inland waterway cross-border transport, for some commodities, IWT share could even raise to 50 or 70% if enough promotion should be made for this mode of transport.

Cargo transport China – Thailand - Laos

	Costs		Transit time		Estimated modal share 2040	
	US$/1000 tkm		Hours		%	
	IWT	Road	IWT	Road	IWT	Road
With IWT 100 ton vessels	31.03	62.20	89	19	44.8	55.2
With IWT 500 ton vessels	14.11	62.20	89	19	61.7	38.3

Container transport Cambodia – Vietnam

	Costs		Transit time		Estimated modal share 2040	
	US$/1000 TEUkm		Hours		%	
	IWT	Road	IWT	Road	IWT	Road
With 2,500 DWT barges	300.00	750.00	28	9	69.3	30.7

Petroleum import Cambodia

	Costs		Transit time		Estimated modal share 2040	
	US$/1000 tkm		Hours		%	
	IWT[1]	Road + feeder[2]	IWT	Road + feeder	IWT	Road + feeder
With IWT 1,000 DWT vessels	51.71	25.99	89	101	47.9	52.1
With IWT 3,000 DWT vessels	25.59	25.99	89	101	52.2	47.8

[1] Over Mekong to Phnom Penh

[2] Feeder ship 7,000 DWT to Sihanoukville + truck Sihanoukville – Phnom Penh

4.9 IWT SPECIFIC URBAN AND RURAL EMPLOYMENT (CREW, PORTS, WATERWAYS, BROKERS, PLANNING)

Due to a complete lack of data, only a rough estimation can be made of the specific employment in the inland waterway transport sector.

Situation 2014	Thailand	Lao PDR	Cambodia	Vietnam	Total
Estimated number of vessels	(200)	(3,000)	(3,000)	(250,000)	
Estimated Crew (3/vessel)	600	9,000	9,000	750,000	768,600
Number of big ports (200 staff)	(2)		(1)	(3)	
Number of small ports (40 staff)	(2)	(25)	(10)	(>100)	
Estimated port staff	480	1,000	600	4,600	6,680
Waterway surveyors/workers	100	300	300	1,000	1,700
Logistics, brokers and customs	300	300	400	1,000	2,000
Planning and policy[1]	200	1,000	1,000	2,000	4,200
Total	1,680	11,600	11,300	758,600	783,180

[1] government, provincial and city departments

This rough estimation leads to a total employment of ± 780,000 person (of which 96% is Vietnamese crew), making that with their families, more than 3 million people are depending on the inland waterway transport sector.

In the "Social and Economic Assessment Report", using the SIMVA 2011 navigation full time equivalents (FTE), the total navigation employment figure for 2007 is only 64,909 FTEs.

Compared to the higher mentioned figure of 780,000 FTEs in 2014 (or with an average growth of 5%/year some 528,000 FTEs in 2007), the SIMVA figure is 8 times lower than the figure in this report. This is probably due to the fact that the SIMVA survey focused on rural communities and not on urban populations, while a substantial number of navigation employment occurs in the cities, especially in the delta (96% of all FTEs in the MRB are Vietnamese crew).

5. ASSESSMENT INDICATORS

5.1 ENVIRONMENT

Navigation has impact on:

- Climate change
- Water quality
- River habitats, river banks and eco-regions
- Fishing activities

Navigation has impact from:

- Dredging
- Hydropower development
- Sand mining

5.2 SOCIAL:

Navigation has impact on:

- Employment
- Accessibility

Navigation has impact from:

- Education and training opportunities

5.3 ECONOMIC:

Navigation has impact on:

- Economic value of transported volumes
- Expenditure on tourism
- Agricultural, commercialand industrial trade
- Export and import

Navigation has impact from:

- Growth demand for transport
- Navigation infrastructure
- Lock operations at the hydropower dams
- Climate Change
- Fisheries

6. ASSESSMENT METHODOLOGY AND APPROACH

The report has many references to the recently completed Design of the "Master Plan (MP) for Regional Waterborne Transportation in the Mekong River Basin", because the MP is dealing with all opportunities for trade and transportation (positive impacts).

The planned navigation development scenarios M2 (2020) and M3 (2040) are based on the assumption of a sustainable 5% annual growth of the waterborne transport sector in the coming years. Actions on waterway design, port development, navigation safety, social, regulatory and environmental protection measures were studied to achieve this goal. In this Council Study Navigation Assessment, impacts from and on these navigation development scenarios with the other areas and with the socio-economic and environmental disciplines were calculated and assessed.

In the 2015-2040 Master Plan, navigation development projects for some 2 billion US$ are recommended "*to increase waterborne transport in the MRB to at least 125% of the actual (2014) waterborne transport volume in 2020 and to at least 250% of the actual waterborne transport volume in 2040 and to make navigation safer and more sustainable for the people and for the environment.*"

Therefore, it is planned to allow 500-ton vessels during the whole year from the Green Triangle to Kratie (including a bypass canal with three locks at the Khone Falls). The river stretch between Kratie and Kompong Cham should be navigable for 2,000 DWT ships over the whole year (1), the stretch between Kompong Cham and Phnom Penh for 3,000 DWT ships (1), the stretch between Phnom Penh (New Container Terminal) and Can Tho for 7,000 DWT ships and the stretch from Can Tho to the sea for 10,000 DWT ships over the whole year. Finally, the Tonle Sap River and Lake between Phnom Penh and Chhong Kneas (Siem Reap) should be navigable for boats of 500 ton over the whole year.

Especially the "Master Plan Economic Assessment Report", prepared by Mr. Peter Hodgkinson in July 2015 and containing the regional transport demand forecasts for passenger and cargo transport flows along the Mekong in the four MRC riverine member countries (Lao PDR, Thailand, Cambodia and Viet Nam) and covering the 25-year forecasting timeframe adopted for the Master Plan, was of great use for the assessment.

For the economic and social assessment, unfortunately, there is sometimes a major lack of reliable data concerning the IWT freight and passenger transport on the Mekong River in all riparian countries. This means that some of the figures are indirectly calculated or even estimated values and should be treated with caution.

It is a basic assumption of the assessment that only the Climate (Climate Change) and HPP (Hydropower) scenarios will have influence on navigation development, while the ALU (Agriculture and Land Use), FPF (Flood Protection Infrastructure), IRR (Irrigation) and DIW (Domestic and Industrial Water Use) development scenarios will have no significant influence on navigation development.

For this assessment, following data were needed:

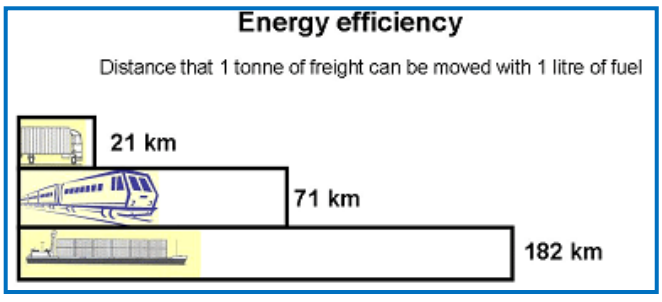
Type of data	Available
Economic	
Condition survey of dangerous areas for navigation	Limited
Agricultural and industrial trade statistics	Yes
Cargo transport volume statistics	Yes
Passenger transport statistics	Yes
Tourist use of inland waterway transport	Yes
Port throughput statistics	Limited
Transport modal share statistics	Limited
Accident statistics	No
Hydropower dam and lock operations	Limited
Social	
Employment in the IWT sector	No
Frequency of rural IWT use	Very limited
Reason of domestic IWT trips	Very limited
Environmental (BioRa)	
Statistics of dredging activities	Limited
Eco-regions, protected areas, important wetlands, critical habitat sites	Yes
Fuel and oil spillage	No
Disposal of waste and wastewater	No
Dangerous goods storage and handling	Limited
Fishing activities	Limited
Sand mining activities	No
River Flow (modelling discipline)	
Water levels	Yes
Discharges	Yes
Sediment balance	No
Modelling results	Limited

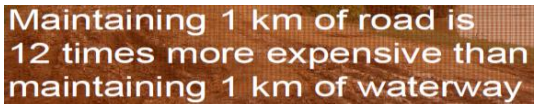
7. IMPACTS ON AND FROM NAVIGATION VERSUS OTHER SECTORS

7.1. QUALITATIVE ASSESSMENT

7.1.1. ECONOMIC

Dimension	Composite Strategic Indicators	Disciplinary assessment Indicators	Navigation has impact on	Navigation has impact from
Economic	Net economic value of MRC sectors	Economic value of irrigated agriculture, recession agriculture, rain fed agriculture, hydropower production, flood damage, drought damage, capture fisheries, etc. Economic expenditure on tourism and recreation	E1 Economic value of transported volumes E2 Expenditure on tourism	E5 Growth demand for transport E6 Navigation infrastructure (ports, vessels, …) E7 Lock operations at hydropower dams E8 Information, promotion and marketing E9 Climate change E10 Fisheries
	Contribution to national economy	Proportion of MRC sectors to overall GDP	E3 Agricultural, commercial, industrial trade E4 Export-Import	





E2 Tourism: With necessary safety and comfort investments (replacement of the old, run-down, unsafe boats and polluting outboard motors with a newly designed more cost-effective and safer modern type boat fitted with an environmentally friendly, less noisy, more reliable and powerful motor and upgrade of the unsafe passenger landing facilities) and with the estimation that river tourists are spending some 20 US$ extra on river tourism (excluding the cruises on the more luxurious cruise vessels), this can generate following income:

	Thailand	Lao PDR	Cambodia	Vietnam	Total
Number of river tourists 2014	237,000	169,000	119,000	289,000	814,000
Generated income 2014 (US$)	4,740,000	3,380,000	2,380,000	5,780,000	16,280,000
Number of river tourists 2040	843,000	1,250,000	541,000	3,444,000	6,078,000
Generated income 2040 (US$)	16,860,000	25,000,000	10,820,000	68,880,000	121,560,000

This means that in 2040, some 120 million US$ income can be generated from river tourism in the Mekong Countries, compared to some 20 million US$ today.
Moreover, river tourism will revive and generate income for the cottage industry at the landing sites with food, handicraft and souvenir stalls, mostly run by the female population.

E3 Trade: On average, the contribution of the transport sector, as part of the service sector, to the GDP can be estimated at 3 to 4%. Growth of the inland waterway transport sector will not change the GDP in a significant way. Only indirectly, a cheaper inland waterway transport can enhance export and make import cheaper so that agricultural and industrial commerce can rise.
Especially for bulk transport with no need for high speed transit times (construction materials, agricultural products such as cassava, wheat, rice and others), inland waterway transport is the most cost effective and environmentally friendly transport mode.

E7 Lock operations: The greatest obstacle for the growth of inland waterway transport sector is the fact that waterway transport is slower than land transport. Therefore, the lock operations at the hydropower dams should not increase the transit times of waterway transport. During a visit to the Xayaburi dam in January 2015 (then under full construction), it was stated that the locks should be operational only once a day. This could seriously disturb the growth of IWT in the concerned river stretches.
Moreover, emergency dam operations with high release and flushing of water, due to high water levels or high sedimentation in the upstream basins, can lead to daily and even hourly flow changes that can be very harmful for the berthed and sailing ships downstream, with even accidents and damage if the boat operators are not informed in time.

E9 Climate change: The ADB undertook a climate change threat and vulnerability assessment of existing and future transport projects in Viet Nam due to concerns about the impacts of climate change on project bridges, approach roads and interconnecting roads. ADB (2014) reported that if mean sea level rises by one meter in the Mekong Delta, it is estimated that 11,000 km of roads could be submerged and that up to 695 km of national highways would be at risk of inundation.

To allow the future passage of 7,000 DWT vessels upstream to Phnom Penh port, the water levels for the navigation channel and floodplain will provide navigational clearance of 37.5 m. However, climate change would increase the number of periods in the year when the full navigation clearance of 37.5 m would not be available at the Cao Lanh and Vam Cong bridges.

For the upper part of the LMB, analysis of daily data for historical and future climate data at six mainstream stations in the Mekong Basin indicates that the nature of change is consistent along the Mekong and can be summarized by four key changes:

1) Increase in flood magnitude and volume: Climate change will increase the flow during the flood season and the size of the flood peak. In terms of the percentage change in volume, a 25% increase in flow in Chiang Saen, approximately 20% between Vientiane and Pakxe, and 15% from Pakxe to Kratie;

2) Increase in flood duration: Across all stations, climate change will increase the duration of the flood season;
3) Shortening of transition seasons and onset of flooding: Climate change will shorten the transition seasons at all stations and increase the rate of increase of discharge; and
4) Increase in dry season water levels: Climate change will increase dry season flows in response to increases in dry season rainfall for most areas of the Mekong catchment.

For the inland waterway sector, the flow increase during the flood season could influence the speed and fuel use of vessels, sailing upstream, but should be an advantage for vessels, sailing downstream.

E10 Fisheries: On the Kompong Cham – Phnom Penh stretch and the Phnom Penh – Chhnok Trou stretch of the river, issues with the Fishing Community about the use of the waterway for navigation have high priority. For this stretch the fishermen are (unreasonably) unwilling to come to an agreement with the Ministry of Public Works and Transport to allow floating aids to navigation to be installed and maintained. In Vietnam, several fixed fishing installations are deployed on the Tiền (Mekong) and Hậu (Bassac) River, sometimes reaching into the navigation channel.

7.1.2 SOCIAL

Dimension	Composite Strategic Indicators	Disciplinary assessment Indicators	Navigation has impact on	Navigation has impact from
Social	Wellbeing	Water security Food security Income security Health security		
	Employment	Employment in MRC sectors Employment satisfaction	S1 Employment in IWT sector Ship wharfs, ports, tourism ……	S3 Education opportunities
	Social cohesion	Public participation Trust and public acceptance Social capital	S2 Access to education, health, cultural and social services	
	Equality	Gender inequality Income equality		
	Resilience	Total flood protected area Total water storage Total irrigated area		

S1 Employment: As mentioned under paragraph 4.6., employment in the inland waterway transport sector (situation 2014) can be roughly estimated at 780,000 people. With a growth of the sector between 2014 and 2020 of 25%, it can be assumed that employment will grow at the same pace up to 975,000 people in 2020.
With an expected growth of the sector between 2014 and 2040 of 150%, it can be assumed that employment will grow up to 1.95 million people in 2040.

Finally:

- with planned and proposed investments in the IWT sector for approximately 90 million US$ per year in the coming 25 years;
- with the estimation that approximately 2/3 of this budget is needed for technicians, workers and administrative staff;
- with the estimation that the average cost of one staff is about 4,000 US$ per year;

this leads to 15,000 additional jobs for the coming 25 years.

In the "Social and Economic Assessment Report", total employment in the navigation sector is calculated as follows:

	FTEs SEA Report	Change to M1	FTEs Master Plan	Change to MP
M1 (2007)	64,909			
MP (2015)			780,000	
M2 (2020)	83,726	+ 30% (2.3%/year)	975,000	+ 25% (5%/year)
+24 (2030)	104,316	+ 61% (2.7%/year)		
M3 (2040)	144,432	+123% (3.7%/year)	1,950,000	+125% (5%/year)

The lower growth figures in the SEA Report are due to a comparison with the manufacturing and services sectors and the finite number of employed population. Higher growth in the navigation sector means that the FTEs for the manufacturing and services sectors will decrease.

S2 Accessibility: In the Social Impact Monitoring and Vulnerability Assessment (SIMVA), data are provided on the number of people who rely on the Mekong's natural resources for livelihoods and their vulnerability to changes. More than 29.6 million people are estimated to live within 15 km of the Mekong mainstream, defined as the Mekong corridor. The table below shows the number of people living in the Mekong corridor:

Country	Corridor population	% living in the corridor	% of corridor population
Thailand	2,499,395	4	8
Lao PDR	3,430,040	53	12
Cambodia	9,895,525	70	33
Viet Nam	13,851,600	16	47
All Countries	29,676,560		100

In the Socio-Environmental Report of the Master Plan for Regional Waterborne Transport in the Mekong River Basin, the results of some 200 interviews with IWT passengers are given concerning the frequency of IWT use, the duration of the IWT trips and the reason of the IWT trip. The results are summarized here:

	Thailand	Lao PDR	Cambodia	Vietnam	Total
Number of pax interviewed	42	54	56	52	204
Frequency of IWT use?					
Daily	26.2%	18.5%	37.5%	30.9%	28.4%
3-4 times per week	11.9%	16.7%	23.2%	17.6%	17.6%
Weekly	42.8%	20.4%	10.7%	50.0%	29.9%
Every two weeks	4.8%	14.8%	3.6%	-	5.9%
monthly	2.4%	20.4%	12.5%	1.5%	9.8%
Less than monthly	11.9%	9.2%	12.5%	-	8.4%
Duration of IWT trip?					
Long trips (more than 3 hours	57.1%	54.1%	17.9%	10.3%	33.3%
Medium trips (0.5 to 3 hours)	19.8%	29.7%	71.4%	41.2%	42.2%
Short trips (less than 0.5 hours)	23.1%	16.2%	10.7%	48.5%	24.5%
What is IWT used for?					
To family, friends (Social)	19.4%	32.6%	14.2%	25.6%	23.1%
To transport goods	28.0%	24.2%	23.9%	11.7%	21.6%
To visit market	22.6%	17.9%	38.0%	20.9%	25.5%
To go to school / healthcare	4.3%	14.7%	5.6%	13.9%	9.8%
To go to employment	25.7%	10.6%	18.3%	27.9%	20.0%

S3 Education and training: During a Training Needs Assessment for IWT related disciplines and topics, executed by the MRC NAP in 2014, all countries and their stakeholders expressed a high need for additional training on:

- Master Planning, Waterway Transport Logistics and Multimodal Transport;
- Collection and analysis of economic and technical data;
- International, Regional and Bilateral Conventions, Agreements and Legal Framework on Cross Border Navigation;
- Regulations on ship construction, inspection and registration (especially for tankers and dangerous goods vessels);
- Design, construction and inspection of dangerous goods ports and terminals;
- PSHEMS development, set up and implementation, maintenance and testing of critical equipment;
- Emergency and oil spill response on board of DG vessels and in DG ports and terminals;
- International and national IWT safety regulations and Aids to Navigation;
- Automatic Identification System (AIS), Vessel Traffic System (VTS), Global Positioning System (GPS), River Information Service (RIS), Electronic Chart Display Information System (ECDIS);
- Oil and Chemical Spill Contingency planning" + Vessel and Port Waste Management;
- Climate Change mitigation and adaptation measures;
- Port and lock design, construction and operation;
- Bathymetric Survey and Monitoring, River Works;
- Inland Waterway Transport Promotion, Advantages of IWT and Port and Fleet Associations;
- Harmonized training standards for crew certification; and
- Gender participation and capacity building in the IWT sector.

7.1.3 ENVIRONMENTAL

Dimension	Composite Strategic Indicators	Disciplinary assessment Indicators	Navigation has impact on	Navigation has impact from
Environment	Water flow conditions in mainstream	Dry season flows – PMFM compliance Flood season peak flows – PMFM compliance Tonle Sap reverse flows – PMFM compliance Timing of onset of wet season flows Annual flooding	H1 River flow by dredging activities and rock removal H2 Climate change	H8 Dry and wet season flows H9 Hydropower projects H10 Dredging (sand mining)
	Water quality and sediment conditions in mainstream	Mainstream water quality – PWQ compliance Sediment transport in the mainstream Salinity intrusion in the delta	H3 Construction of navigation infrastructure H4 Operational pollution H5 Dredging activities	
	Status of environmental assets	Wetland area River channel conditions and habitats River bank erosion risk Aquatic biodiversity Ecologically significant areas	H6 River habitats, river banks and eco-regions H7 Fishing activities	

H1 Dredging activities versus river flow: The proposed channel improvement activities in Thailand and Lao PDR consist mainly of the clearing of rapids and rock removal while in Cambodia and

Vietnam, some 28 million m^3 of dredging are proposed (of which some 12 million m^2 in the Great Lake).

Hydro-morphological changes can have far-reaching impacts upstream and downstream from dredging activities, significantly affecting river system dynamics and interfering with the exchange of water and sediments between the mainstream river and its tributaries and flood plains (ECMT 2006). Maintaining the waterway can result in a stabilized uniform channel, lacking both natural in-stream structures and connectivity with floodplains, leading to ecosystem degradation and loss of species (ICDPR 2010). In-stream structures include shoals, deep pools, reefs, rocks, rapids and sandbars. These provide critical habitats for fish and other aquatic organisms (WWF 2013).

H*2* Climate Change: IWT vessels can carry larger volumes of cargo relative to the extra fuel needed, resulting in lower emissions per ton-km compared to road transport. The environmental benefits generated using larger vessels as compared with smaller vessels and road semi-trailers, include reduced greenhouse gas emissions calculated respectively as 0.0141 tons (40% saving) and 0.0212 tons (60% saving) per ton of cargo carried.

However, improvements must be made for vessels to use more energy efficient engines and cleaner fuels. Otherwise, air emissions may be even higher than land transport with old technology and limited regulations or public awareness to reduce Sulphur content of marine fuels. An inventory of air emissions in the IWT sector must consider a wide range of sources, including:

- IWT vessels (cargo, tankers, passenger, ferries, cruise ships, fishing vessels, tugboats);
- Ports and terminals (vehicles, cargo handling equipment, cranes, and infrastructure)
- Dredging (vessels, trucks); and
- Vehicles (on-road trucks or other port vehicles).

IWT is promoted as a safe and sustainable mode of transport, mainly due to lower fuel consumption and CO_2 emissions per ton-km compared to road transport. To take advantage of more energy efficient transport, the environmental impacts of IWT must be effectively managed. Potential impacts are derived from the following activities:

H3 Construction of navigation infrastructure e.g. ports and landing facilities;
H4 Operational e.g. water pollution from oil spills, solid and liquid wastes, navigation accidents; and
H5 Maintenance of the navigation channel and waterway conditions (e.g. dredging) and commercial extraction of sediment (e.g. sand mining).

H3 Construction of Infrastructure: The construction of inland port and landing facilities development can cause significant direct and indirect impacts on the environment and socio-economic characteristics of a river basin. The social and environmental impacts need to be considered during siting, planning construction and operational phases of the port. The baseline report will determine the legal framework for Environmental Impact Assessment (EIA) for new ports and waterway developments and whether Environmental Management Plans (EMP) need to be developed by port operators to manage impacts during operations.

H4 Operational pollution:

Water pollution: In 2011 MRC conducted a Multi-Media Monitoring and Assessment Program (MMMAP) to assess the levels of persistent micro-pollutants in water, sediment and biota in the Mekong Basin. A total of 28 stations were included in the field survey. The findings relevant to navigation include the detection of phenol, oil and grease and heavy metals (lead and mercury).

Phenol: Most phenol values in water were low, but levels at the Chiang Saen Pier, Chiang Khong, Vientiane, Pakxe and Phnom Penh Port exceeded the MRC Water Quality Criteria for the Protection of Aquatic Life.

Oil and grease (O&G): Elevated levels of O&G were detected in Luang Prabang, Vientiane and Phnom Penh Port.

Heavy metals: Urban areas such as Luang Prabang, Vientiane and Phnom Penh show trends of increasing levels of lead and mercury.

Moreover, the 'MRC Risk Analysis of the Carriage Handling and Storage of Dangerous Goods' identified pollution downstream due to high levels of petroleum and cargo transport.

There are limited emergency response mechanisms along the waterways to respond to accidents or oil spills. In addition, solid and liquid waste management facilities along the Mekong River are limited. Emergency response plans do not involve consultation with local communities and several terminals are in densely populated areas.

Concerns of IWT operations include risks of water pollution from fuel and oil spillage, from accidents and from disposal of waste and wastewater from vessels, from activities such as vessel maintenance and from dangerous goods storage and handling in inland ports, terminals and landing facilities.

Oil Spills and Operational Discharges: Oil spills in inland waters are highly likely to contaminate water supplies, impacting aquatic ecosystems and riparian populations. Fixed facilities and vessels are the major sources of oil spills in inland waters. The impacts of oils spills are highest for heavy fuels, followed by crude oil, and lower for light oils and gasoline.

Another threat to the environment is caused by the operational discharges of bilge oil, heavy oils and lubricants, as well as organic substances, mainly polycyclic aromatic hydrocarbons (PAH) and wastes.

Transport of Dangerous Goods (DG): A possible incident involving the transportation of DG can have severe consequences for the environment and people, including, but not limited to, the following:

- Increased pollution from transportation of petroleum products (e.g. cargo residues, spills and leakages, solid and liquid wastes);
- Risk of spillages and pollution from shipping accidents as well as ports and terminal operations;
- Loss or damage to habitats and species due to reduced water quality and pollution; and
- Impacts on human health because of pollution, fire and explosion

Waste Management: The operations of ports, terminals and vessels have the potential to generate both domestic and hazardous wastes. Direct dumping of untreated wastes into rivers can alter the aquatic habitats and harm fisheries, other aquatic organisms and riparian vegetation. Uncontrolled disposal of wastes can cause contamination to groundwater, while direct dumping to rivers can impact both surface and groundwater aquifers.

However, the impact of spills in the Lower Mekong Basin is slight as some oil spills do occur in the Mekong Delta area where there is busy shipping traffic. Otherwise, the situation is currently insignificant in the basin. No chemical spills have been recorded (Petersen 2003, Fedra et al. 2004). The risks of spills may increase if improvements to the navigation routes in the mainstream of the Mekong River, particularly along its upper reaches, lead to increased shipping traffic.

H5 Dredging versus environment: Capital and maintenance dredging of navigation channels can have significant impacts on the environment including: biodiversity loss, conflict with other uses (e.g. drainage, flood protection, water supply), hydrological changes (e.g. alteration of surface flows and drainage), destruction of floodplains, increased erosion, flooding risk and drainage of wetlands.

Dredging Activities can pose a threat to the aquatic environment not only through the disposal of dredged material, but also through the dispersal of pollutants into surface waters during dredging. If the sediments are contaminated with industrial discharges, there can be severe impacts on the water quality.

H6 Habitats, Species, Aquatic Life, Sensitive Areas: The Mekong Basin is one of the most productive and diverse river systems in the world and is particularly rich in migratory fish species. Ecosystem connectivity and natural flood pulses drive both its productivity and basin-wide fish migrations. The Mekong River aquatic and wetland ecosystems provide unique habitats for both aquatic and terrestrial plants and animals. Natural habitats provide distinct services to society. The connectivity that the river and its tributaries bring to the wetlands of the Mekong through the seasonal flooding caused by the flood pulse is critical for the productivity and diversity of the Mekong Basin fisheries.
Limited research exists on the impacts of modifications of waterway channels on ecosystems, fisheries and livelihoods in the Mekong River Basin. Planned developments for port construction, dredging and reef removal in the upper and lower part of the Mekong Basin need to be assessed against the significance of the ecological areas. There are more than 114 officially designated protected areas in the Mekong Basin and more than 100 important wetland sites; other sites including fish conservation zones, community managed forests and biosphere reserves.

The specific eco-regions, protected areas, important wetlands and critical habitats sites need to be incorporated into EIAs and planning. In addition, it will be important to determine further ecologically sensitive areas, protected areas and ecotourism sites along the Mekong River.

H7 Fisheries: Maintaining and improving the natural productivity of the river basin is essential to both the food security of the local population and the national economies of the countries within the basin. The people of the Mekong have the highest per capita consumption of fish in the world. Of the Mekong's fish species, nearly 200 are migratory "white" fish, some of them travelling long distances from the Tonle Sap or the Delta up the Khone Falls and further up the Mekong in Lao PDR and Thailand.

The rural poor are heavily dependent upon ecosystem services, as livelihoods are derived from activities relating to agriculture, fisheries, livestock and non-timber forest products. Threats to the provision of these ecosystem services, such as climate change and major infrastructure projects, can have large development impacts.

H8 Dry and wet season flows and water Levels: The Procedures for the Maintenance of Flows on the Mainstream (PMFM) were adopted by the MRC Council in June 2006. The objectives of the Procedures for the PMFM are to provide a framework for technical guidelines, institutional arrangements, directions and information to enable the MRC and its Member Countries to maintain and manage the flows of the Mekong River mainstream as required by Article 6 of the 1995 Mekong Agreement. This article defines three hydrological criteria that set-up the fundamentals of the PMFM. According to this Article, the mainstream flows should be maintained at levels such that:

- They are not less than the acceptable minimum monthly natural flow during each month of the dry season**;**

- They enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season; and
- The average daily peak flows are not greater than what naturally occur on the average during the flood season**.**

One of the main reasons of the limited growth of inland waterway transport on the Mekong river is the seasonal unavailability of enough water depth for navigation transport. Hydropower development is expected to modify the hydrology of the Mekong River and many of its tributaries by reducing and delaying wet season flows, and increasing dry season flows. **Increased dry season flows downstream of dams will provide more opportunities for navigation.** Conversely, many ecosystems and livelihoods adapted to natural flow extremes may be affected. Increased dry season flows will also limit opportunities for riverbank gardening. While hydropower reservoir storage is expected to reduce wet season flows, its effects on flood peaks are less certain partly because it is difficult to predict the effects of the emergency operating rules that dam managers use to prevent flood damage to dams.

H9 Hydropower Development: The changes in flow regime due to potential hydropower and climate change could result in higher flows in both wet and dry seasons, lower flow in the high-flow season and increased flow in the low-flow season (MRC 2011).

Moreover, the Mekong Delta is vulnerable to projected reductions in sediment transport (of up to 75%) that could cause destabilisation of riverbanks from down cutting and bed erosion, potentially impacting port and waterway infrastructure.

Studies predict that dams with reservoirs in the Lancang Cascade and Lower Mekong Basin tributaries will reduce the magnitude of wet season flows and increase the magnitude of dry season flows substantially. Lower Mekong mainstream dams are less likely to alter the distribution of flow between the wet and dry seasons than the dams in China and on Lower Mekong tributaries because they are largely run-of-river dams and only retain a very small proportion of the water that flows to them. They are expected, however, to create substantial changes in flow and water level at an hourly to daily time scale.

H10 Sand mining: Dredging and sand mining would usually be considered as two separate issues, as modern waterway dredging strategies prohibit commercial extraction and require refilling of dredged material in the system. To date, the issue of sediment mining in the Mekong River channel has been a politically sensitive issue. In-channel extractions are contributing to a reduced sediment load in the Mekong Delta causing large-scale erosion.

7.2 QUANTITATIVE ASSESSMENT

The Indicators with quantitative assessment are:

	Economic	Social	Environmental	River flow (quantity, timing and content)
Impact of navigation development on other sectors	Navigation development has impact on: **E1** The Economic value of transported volumes **E2** Expenditure on tourism	Navigation development has impact on: **S1** Employment in IWT sector (Crew, ship wharfs, ports, tourism ……) **S2** Accessibility to education, health,	Navigation development has impact on: **H1** Climate change (air emissions) **H2** Water quality by the construction of navigation	Navigation development has impact on: **F1** Water and sediment balance by dredging activities and rock removal

	E3 Agricultural, commercial, industrial trade **E4** Export-Import	cultural and social services	infrastructure **H3** Water quality by operational pollution	
	Economic	Social	Environmental	River flow (quantity, timing and content)
Impact of other sectors on navigation development	Navigation development has impact from: **E5** Growth demand for transport **E6** Navigation infrastructure (ports, waterways, vessels) **E7** Lock operations at the hydropower dams			Navigation development has impact from: **F2** Hydropower development **F3** Climate change

E1 The Economic value of transported volumes

In the M1 Early development scenario 2007, the total IWT Cargo volume in the Mekong River Basin was 14,817,000 ton with a net economic value of 6,769 million US$ (average 450 US$/ton).

In the M2 Definite future scenario 2020, the estimated forecast of total IWT Cargo volume in the Mekong River Basin is 36,221,000 ton with a net economic value of 21,669 million US$ (average 600 US$/ton).

In the M3 Planned development scenario 2040, the estimated forecast of total IWT Cargo volume in the Mekong River Basin is 167,847,000 ton with a net economic value of 148,262 million US$ (average 880 US$/ton).

E2 Expenditure on tourism

In the M1 Early development scenario 2007, the total number of tourists, making use of IWT on the Mekong River was 560,000 pax (average 1,500 tourists/day).

In the M2 Definite future scenario 2020, the estimated forecast of total number of tourists, making use of IWT on the Mekong River is 1,267,000 pax (average 3,470 tourists/day).

In the M3 Planned development scenario 2040, the estimated forecast of total number of tourists, making use of IWT on the Mekong River is 6,078,000 pax (average 16,650 tourists/day).

With the estimation that river tourists are spending some 20 US$ extra on river tourism (excluding the cruises on the more luxurious cruise vessels), this can generate following income:

	Thailand	Lao PDR	Cambodia	Vietnam	Total
Number of river tourists 2007	208,000	115,000	128,000	109,000	560,000
Generated income 2007 (US$)	4,160,000	2,300,000	2,560,000	2,180,000	11,200,000
Number of river tourists 2040	843,000	1,250,000	541,000	3,444,000	6,078,000
Generated income 2040 (US$)	16,860,000	25,000,000	10,820,000	68,880,000	121,560,000

This means that in 2040, some 120 million US$ income can be generated from river tourism in the Mekong Countries, compared to some 11 million US$ in 2007.
Moreover, river tourism will revive and generate income for the cottage industry at the landing sites with food, handicraft and souvenir stalls, mostly run by the female population.

E3 Agricultural, commercial, industrial trade

The GDP growth in the MRC member countries for the coming 25 years is estimated to be around 5% per annum.

On average, the contribution of the transport sector, as part of the service sector, to the GDP can be estimated at 3 to 4%. *Growth of the inland waterway transport sector will not change the GDP in a significant way.* Only indirectly, a cheaper inland waterway transport can enhance export and make import cheaper so that agricultural and industrial commerce can rise.
Especially for bulk transport with no need for high speed transit times (construction materials, agricultural products such as cassava, wheat, rice and others), inland waterway transport is the most cost effective and environmentally friendly transport mode.

Waterborne Cargo Transport in the Mekong River Basin is forecasted to grow at approximately 8% per year on the condition that investments in waterway improvements, port development and navigation safety should be made for about 2 billion US$ in the period from now to 2040. Without these investments, inland waterway cargo transport in the Mekong river Basin is estimated to grow with only 3 to 4% per year.

E4 Export-Import

In Thailand, cross-border cargo transport is 58% and domestic cargo transport is 42% of the total inland waterway cargo transport. In the Lao PDR, cross-border cargo transport is 43% and domestic cargo transport is 57% of the total inland waterway cargo transport.

In Cambodia, because of lack of data, it is estimated that cross-border cargo transport is 65% and domestic cargo transport is 35% of the total cargo transport.

In Viet Nam, it is estimated that 50% of the Vietnamese import-export is passing the southern seaports and that 80% of this volume is transported inland by IWT (7,963,000 ton).

It is also estimated that the total cargo inland waterway transport in the Mekong Delta is about one third of the total Vietnamese cargo volume by IWT (18,050,000 ton). This means that 10,087,000 ton is domestic cargo IWT in the Mekong Delta (56% versus 44% for cross-border cargo transport).

On average, it can be stated that import-export by inland waterway transport counts for about 50% of the total inland waterway cargo transport.

E5 Growth demand for transport

In Thailand, IWT is estimated to transport about 40 million tons of cargo annually, representing 10% of the total inland cargo volume. This is better than rail, which has a share of only 3%, but well below road, which has a commanding share of 83%. With IWT investments, in 2020, 215,000 ton is shifted from road to IW and in 2040, 3,173,000 ton is shifted from road to IW

The modal share for IWT freight transport in the Lao PDR is about 20% of the total yearly carried capacity among all modes versus 75% for road transport. The main commodities or goods are timber, wood products, construction material, rice, fuel, sand, rock, wood products, foods grains, steel product and logs. With IWT investments, in 2020, 256,000 ton is shifted from road to IW and in 2040, 6,268,000 ton is shifted from road to IW

Also in Cambodia, the modal share for IWT freight transport is about 20% of the total yearly carried capacity among all modes versus 75% for road transport. With IWT investments, in 2020, 887,000 ton is shifted from road to IW and in 2040, 12,485,000 ton is shifted from road to IW

For Viet Nam, in 2014 the total cargo transport volume was 545,500,000 tons. Of this volume, 16% or 90,270,000 ton was transported by water of which 30% by maritime transport overseas, 10% by coastal transport and 60% by inland waterway transport (54,152,000 ton or 10% of the total cargo transport volume). With IWT investments, in 2020, 4,454,000 ton is shifted from road to IW and in 2040, 69,324,000 ton is shifted from road to IW

On average, starting from a modal split 80% road, 15% IW and 5% rail, without IWT investments, IWT will lose 1% in 2020 and 4% in 2040 of the modal share and with IWT investments, IWT will shift 2% from road to IWT in 2020 and almost 11% (90 million tons) in 2040.

E6 Navigation infrastructure (ports, waterways, vessels, …)

For the period 2007-2020, investments on waterway improvement, port development and navigation safety have been made and/or are planned or proposed for a total amount of 913 million US$ (on average some 65 million US$ per year). This figure includes 293,000,000 US$ for four locks at the Pak Beng Dam and the Xayaburi Dam and 480,000,000 US$ for the Quang Chanh Bo Canal in Viet Nam at the mouth of the Bassac River.

For the period 2020-2040, Planned and proposed actions on fleet upgrade, waterway improvement, port development and navigation safety are planned and proposed for a total cost of 1,946 million US$ (on average some 97 million US$ per year). This figure includes 13 locks at the Luang Prabang Dam, the Pak Lay Dam, the Sanakham Dam, the Ban Khoum Dam and the Latsua Dam, the Stung Treng Dam and the Sambor Dam for 841,000,000 US$ and 526,000,000 US$ for the bypass canal with locks at the Khone Falls.

Allowing bigger ships over the whole year has large economic benefits. So, for example on the Green Triangle – Chiang Saen trajectory, the economic benefits generated by the project include reduced operating costs of 500 DWT vessels as compared with 100 DWT vessels with a saving of 9.28 US$ per ton of cargo, or 40% and with road semi-trailers with a saving of 15.00 US$ per ton of cargo, or 52%.

On the Green Triangle – Luang Prabang trajectory, the economic benefits generated by the project include reduced operating costs of 500 DWT vessels as compared with 100 DWT vessels with a saving of 12.23 US$ per ton of cargo, or 44% and with road semi-trailers with a saving of 16.33 US$ per ton of cargo, or 51%.

And finally, improvement of the navigation channel on the Phnom Penh – Cai Mep trajectory will allow the gradual replacement of current 1,000 DWT (96 TEU) barges with 2,000 DWT (192 TEU) barges or 3,000 DWT sea-river barges (288 TEU). The economic benefits associated with this project are respectively a saving in barge operating costs of 15.18 US$ (17%) and 22.71 US$ (25%) per TEU.

E7 Lock operations at the hydropower dams

Although more than 1 billion US$ should be invested in the navigation locks at 9 of the planned dams, the greatest obstacle for the growth of inland waterway transport sector is the fact that waterway transport is slower than land transport. Therefore, the lock operations at the hydropower dams should not increase the transit times of waterway transport because this could seriously disturb the growth of Inland Waterway Transport in the concerned river stretches. It is predicted that in 2020, two lock operations per day and in 2040, twelve lock operations per day will be needed at each dam.

S1 Employment in IWT sector (Crew, ship wharfs, ports, tourism ……)

Employment in the inland waterway transport sector (situation 2014) can be roughly estimated at 780,000 people (of which 96% is Vietnamese crew), making that with their families, more than 3 million people are depending on the inland waterway transport sector.

With the predicted growth of the sector, it can be assumed that employment will grow at the same pace up to 975,000 people in 2020 and up to 1.95 million people in 2040.

Moreover, with planned and proposed investments in the IWT sector for approximately 97 million US$ per year in the coming 25 years, with the estimation that approximately 2/3 of this budget is needed for technicians, workers and administrative staff and with the estimation that the average cost of one staff is about 4,000 US$ per year, this leads to 16,000 additional jobs for the coming 25 years.

In the "Social and Economic Assessment Report", total employment in the navigation sector is calculated as follows:

	FTEs SEA Report	Change to M1	FTEs Master Plan	Change to MP
M1	64,909			
MP			780,000	
M2	83,726	+ 30% (2.3%/year)	975,000	+ 25% (5%/year)
+24	104,316	+ 61% (2.7%/year)		
M3	144,432	+123% (3.7%/year)	1,950,000	+125% (5%/year)

The lower growth figures in the SEA Report are due to a comparison with the manufacturing and services sectors and the finite number of employed population. Higher growth in the navigation sector means that the FTEs for the manufacturing and services sectors will decrease.

S2 Accessibility to education, health, cultural and social services

In the Socio-Environmental Report of the Master Plan for Regional Waterborne Transport, the results of some 200 interviews with IWT passengers are given concerning the frequency of IWT use, the duration of the IWT trips and the reason of the IWT trip. The results are summarized here:

	Thailand	Lao PDR	Cambodia	Vietnam	Total
No. of passengers interviewed	42	54	56	52	204
Frequency of IWT use?					
Daily	26.2%	18.5%	37.5%	30.9%	28.4%
3-4 times per week	11.9%	16.7%	23.2%	17.6%	17.6%
Weekly	42.8%	20.4%	10.7%	50.0%	29.9%
Every two weeks	4.8%	14.8%	3.6%	-	5.9%
monthly	2.4%	20.4%	12.5%	1.5%	9.8%
Less than monthly	11.9%	9.2%	12.5%	-	8.4%
Duration of IWT trip?					
Long trips (more than 3 hours	57.1%	54.1%	17.9%	10.3%	33.3%
Medium trips (0.5 to 3 hours)	19.8%	29.7%	71.4%	41.2%	42.2%
Short trips (less than 0.5 hours)	23.1%	16.2%	10.7%	48.5%	24.5%
What is IWT used for?					
To family, friends (Social)	19.4%	32.6%	14.2%	25.6%	23.1%
To transport goods	28.0%	24.2%	23.9%	11.7%	21.6%
To visit market	22.6%	17.9%	38.0%	20.9%	25.5%
To go to school / healthcare	4.3%	14.7%	5.6%	13.9%	9.8%
To go to employment	25.7%	10.6%	18.3%	27.9%	20.0%

In the M1 Early development scenario 2007, the total number of domestic passengers, making use of IWT on the Mekong River was 37,618,000 pax (average 100,000 passengers/day).

In the M2 Definite future scenario 2020, the estimated forecast of total number of domestic passengers, making use of IWT on the Mekong River is 98,433,000 pax (average 270,000 passengers/day).

In the M3 Planned development scenario 2040, the estimated forecast of total number of domestic passengers, making use of IWT on the Mekong River is 316,874,000 pax (average 870,000 passengers/day).

H1 Climate change (air emissions)

IWT vessels can carry larger volumes of cargo relative to the extra fuel needed, resulting in lower emissions per ton-km compared to road transport. The environmental benefits generated using larger vessels as compared with smaller vessels and road semi-trailers, include reduced greenhouse gas emissions calculated respectively as 0.0141 tons (40% saving) and 0.0212 tons (60% saving) per ton-km of cargo carried.

So, although greenhouse gas emissions will rise with the transport growth, a shift of 90 million ton of cargo from road to inland waterway would mean an emission reduction of 380 million ton of greenhouse gases (at an average transport distance of 200 km).

H2 Water quality by the construction of navigation infrastructure

The proposed channel improvement activities in Thailand and Lao PDR consist mainly of the clearing of some 200 rapids with rock removal (total estimated cost ca. 275 million US$) while in Cambodia and Vietnam, some 28 million m^3 of dredging are proposed of which some 12 million m^2 in the Great Lake (total estimated cost ca. 100 million US$).

See "Draft Development Plan on International Navigation on the Lancang-Mekong River", JCCCN, 2015

"Impacts on aquatic life: During the construction, reef blasting may influence fishes within a certain "range. However, because the shock waves will be mitigated by water flow, the short-term impact of "reef blasting on fishes is limited to maximum 100 meters. Measures should be taken to chase the fish "away before blasting and moreover, every rapid removal project should avoid migrating and spawning "seasons.

"The long-term impact of dredging and reef removal is mainly on the normal behavior of fishes caused "by the change of ecological environment in the River. After some reefs being removed, fishes will lose "some habitat but macroscopically speaking, the navigation scenarios will not cause significant change "to the ecological system of the Mekong River and it will have minor negative impacts on the long-term "behaviors of the fishes in the River.

"Impacts on Wild Animals: All the construction areas are under the flood level of the River, which "indicates that the project will not have impact on plants and animals on the banks. For the wild "animals living near construction sites, the preparation work of blasting will scare them away. The "planned ports will be built in densely-populated areas. Therefore, the construction of ports won't have "impacts on wild animals.

"Impacts on Residents, Villages, Towns and Scenic Spots: Reef blasting sound and shock wave may

"have temporary impacts on residents within 100 meters from the blasting sites. However, because "most reefs to be improved are far from residential areas and borehole-blasting method

will be applied, “there will be no impact on residential areas, villages, towns and scenic spots along the River.

H3 Water quality by operational pollution

See “Draft Development Plan on International Navigation on the Lancang-Mekong River”, JCCCN, 2015

“Because it is predicted that in 2040 waterborne transported cargo volumes will be 7 to 8 times higher “than today and waterborne passenger transport will be 8 to 9 times higher than today, also water “pollution from vessels will increase.

“Oil pollution: However, navigation of vessels on the River will not have serious impacts on water “quality. It is predicted that larger vessels, equipped with an oily water separator, will cause limited “pollution to the water near the discharging place, but the water quality of the whole River won’t be “influenced. The oil discharged from vessels will account for only 0.0085% of the environmental “capacity of the River.

“Vessel sewage: Compared with oily water, vessel sewage causes less pollution and will have minor “impacts on water quality of the River. Even if vessels on the River will increase with development of “waterway transport in the future, the Mekong River will still have a large environmental capacity, and “the water quality will basically remain at the current level.

“Solid Waste Pollution: If solid waste of vessels is discarded into the River, water will be polluted. “When floating garbage gathers on banks, they will not only have serious impacts on the cleanness of “environment and worsen water quality, but also influence aquatic life in the River. Consequently, the “daily garbage from vessels has to be collected and transported to the destination ports for receiving “and treatment.

F1 Water and sediment balance by dredging activities and rock removal

The navigation scenarios will have a neglectable impact on water flow quantity, timing and content assuming that the cleared rapids’ material is staying under water and that the dredged material is dumped in the river again to maintain the hydrological and sediment balance.

Eventually, a faster flow could be generated by the new cross-sections, and this could be calculated by the modelling team with following information on channel dimensions, needed for “whole year” navigation:

Tonnage (ton)	Channel Depth (m)	Channel Width (m)
50	1.25	9 – 12
100	1.90	24 – 32
500	3.10	28 – 38
1,000	4.50	36 – 48
3,000	6.20	42 – 56
7,000	8.00	57 – 76
10,000	8.80	66 – 88

F2 Hydropower development

In the upstream reservoirs, created by the hydropower dams, sufficient water depth over the whole year will be created to allow bigger ships to sail in the related stretches of the river. Without these reservoirs, the cost-benefit of necessary river design works (dredging, rapid and reef removal) to allow bigger ships to sail during the whole year would certainly be negative.

In a second scenario of the Master Plan, where not all the downstream dams (between Savannakhet and Kratie) should be built, the activities on channel improvement between

Savannakhet and Kratie and on the construction of the bypass canal on the Khone Falls are cancelled (total estimated cost of 625 million US$).

F3 Climate change

From the ISIS modelling for the scenarios M1, M2, M3 and M3CC, considering the hydropower and irrigation scenarios, it can be seen that (only) with the climate change impact, the minimum available water depth in Chiang Saen, Luang Prabang and Vientiane is raising with several meters, which has a positive impact on the navigation scenarios. Almost 100 rapids and reefs should not be removed to obtain a water depth of 3.10 m, allowing 500-ton vessels to sail in this stretch of the river over the whole year, with a total cost reduction of approximately 170 million US$.

In Kratie, there is no impact on the available water depth, while in Kompong Cham and Phnom Penh, the impact is limited to 0.25 to 0.55 m.

On the Tonle Sap Lake, the minimum water depth is raising with 0.15 m in scenario M3 and with 0.20 m in scenario M3CC which should reduce the needed capital dredging to allow 500-ton vessels to sail over the whole year in the Tonle Sap Lake from 12,348,000 m^3 to 10,037,000 m^3 leading to a cost reduction of approximately 7 million US$.

Moreover, In the "Technical Feasibility Study of Dredging the Tonle Sap Lake for Navigation", MRC, July 2007, the main conclusions were:

- that only little or no channel maintenance dredging is needed – the average sedimentation in the navigational channel is less than 5 mm/year;
- that it is worth investigating the possibility to deposit the dredged sediment on the lake bed and examine distance from where no significant amounts of deposits are moved by flows and waves back to the channel; and
- that checking of the channel filling up rate and the behaviour of the deposited sediments in-situ by experimental dredging and deposition tests is recommended due to the complex set of factors affecting the bottom processes.

In the Mekong Delta, ADB (2014) reported that if mean sea level rises by one meter in the Mekong Delta, it is estimated that 11,000 km of roads could be submerged and that up to 695 km of national highways would be at risk of inundation.

To allow the future passage of 7,000 DWT vessels upstream to Phnom Penh Port, the water levels for the navigation channel and floodplain will provide navigational air clearance of 37.5 m. However, climate change would increase the number of periods in the year when the full navigation air clearance of 37.5 m would not be available at the Cao Lanh and Vam Cong bridges.

ISIS modelling results:

Mekong Mainstream									
Scenario	Water depth (m)	Chiang Saen	Luang Prabang	Vientiane	Pakse	Kratie	Kompong Cham	Phnom Penh	Can Tho
2007	Max	14.84	21.21	14.99	27.44	23.69	48.08	22.96	26.68
	Min	1.99	4.83	0.45	13.55	5.95	34.25	13.72	24.15
2020	Max	14.84	21.21	14.99	27.44	23.69	47.96	22.81	26.67
	Min	1.99	4.83	0.45	13.55	5.95	34.73	13.93	24.16
2040	Max	14.84	21.21	14.99	27.44	23.69	47.96	22.81	26.67
	Min	1.99	4.83	0.45	8.78	5.95	34.73	13.93	24.16
2040CC	Max	19.21	23.62	17.96	22.50	23.69	48.55	23.11	26.67
	Min	6.27	6.28	4.59	8.68	5.95	34.81	13.99	24.17
Tonle Sap Lake									
		G4000	G12000	G20000	G60000	G120000	G132000		
2007	Max	10.12	10.12	12.47	3.28	10.23	10.18		
	Min	1.11	0.95	3.48	2.50	1.23	1.22		
2020	Max	9.94	9.94	12.29	3.30	10.04	10.00		
	Min	1.05	1.20	3.56	2.69	1.31	1.31		
2040	Max	9.94	9.94	12.29	3.30	10.04	10.00		
	Min	1.08	1.26	3.61	2.71	1.36	1.34		
2040CC	Max	10.08	10.08	12.43	3.31	10.18	10.14		
	Min	1.17	1.28	3.65	2.79	1.40	1.38		

8. RECOMMENDATIONS FOR IMPACT AVOIDANCE AND MITIGATION MEASURES

8.1 ECONOMIC

The most important topics that could enhance the growth of inland waterway transport are that:

- Inland Waterway Transport needs to be fully integrated in the transport and supply chain.
- Transport infrastructure budgets should be divided more equally between road, rail and inland waterway.
- IWT should receive incentives as most cost-efficient and environmental friendliest transport mode.
- Documentation, customs procedures and data exchange need to be simplified and harmonized.
- Human resources development in freight forwarding, multi modal transport and logistics management should be encouraged.

E2 Expenditure on tourism:

Next to the more luxurious cruise vessels on the Mekong River, river tourism will only grow when **investments are made in safe and comfortable vessels and landing facilities.** Old, unsafe long tail boats with polluting outboard engines must be replaced by new designed more cost-effective and safer modern types, fitted with an environmentally friendly, less noisy, more reliable and more powerful motor that can withstand strong water flow. Also, most of the landing facilities to board and land the passengers need a serious upgrade and it is proposed to replace the sloped ramps (which are mostly also used for cargo loading and unloading) by floating pontoons.
Finally, it is proposed to create independent **"promotion agencies"** in the four MRC Member Countries with participation of the public sector and the private sector that will be recognised by all stakeholders as intermediate entities and that will actively pursue promotional and marketing activities together with the tourist sector to bring as much tourists and passengers as possible to IWT (see also E8).

E3 Agricultural, commercial, industrial trade:

Improvement in the regional situation of industrial and agricultural trade is expected to come from the Cross-Border Trade Agreement (CBTA) which is an agreement among the GMS-countries for **the facilitation of cross-border transport of goods and people.** It covers various aspects like customs inspection, movement of persons, transit traffic and a single stop cross-border system. It is supposed to end the need to reload vessels and reprocess documents for clearance when crossing the borders. When fully in place, the CBTA is expected to greatly promote cross-border and third country trade. Implementation of the CBTA however is slow; Thailand has not yet ratified the annexes because of conflicting national laws, facilities are not in place and there is a lack of institutional capacity. The institutional aspects of the GMS

integration will nevertheless slowly improve by aligning regulations. More extensive application of bilateral exchange of traffic rights is expected in the short run and implementation of the CBTA in the long run. Single Window Inspections can become reality relatively soon. Single Stop Inspection on the other hand is a long-term project. ASEAN is also pushing ambitious institutional integration measures such as the implementation of the ASEAN Single Window and ICT for customs and duties. Border issues are nevertheless expected to continue to hinder regional transport for the next 5- 10 years.

A full implementation of the harmonized rules and regulations made under the "Quadripartite Agreement on Commercial Navigation on the Lancang-Mekong River", signed in 2000 and the "Cambodian-Vietnamese Agreement on Waterway Transportation", signed in 2009, will significantly facilitate international and cross-border waterborne transportation of cargo and passengers, increase the competitiveness of the national economies and enhance safety and sustainability of navigation and port operations.

And finally, a fully free-trade ASEAN Community should reduce the transport costs significantly, but it is not expected that such measures will be implemented very soon.

E7 Lock operations at hydropower dams: To reduce the impact of the dam operations and the lock operations at the dams on the navigation, it should be of a high priority to establish a **"Vessel Traffic Service Center"** in the Lao PDR, covering the whole stretch of the Mekong River from the Green Triangle to Vientiane **with compulsory AIS and VHF on board** of selected ship sizes and types.

Vessel Traffic Service: A Vessel Traffic Service (VTS) is a marine traffic monitoring system, similar to air traffic control for aircrafts. Typical VTS systems use radar, VHF radiotelephony and Automatic Identification Systems to keep track of vessel movements and provide navigational safety in a limited geographical area. The VTS guidelines require that the VTS authority should be provided with sufficient staff, appropriately qualified, suitably trained and capable of performing the tasks required, taking into consideration the type and level of services to be provided.

This means that at the same time, AIS (Automatic Identification System) and VHF (Very High Frequency) radio equipment should be made compulsory on board of selected ship sizes and types.

Automatic Identification System: The AIS is an automatic tracking system used on ships and by Vessel Traffic Services for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations and satellites.

Information provided by AIS equipment, such as unique identification, position, course and speed can be displayed on a screen. AIS is intended to allow river-controlling authorities to track and monitor vessel movements.

The advantages are obvious:

- Able to monitor the movement of incoming vessels to prepare the port of call for discharging operations or the locks to prepare for locking operations;
- In case of oil spills, the ships in question can be easily tracked so that contingency plans can be started and the cause can be mitigated;
- Presence and movement of shipping traffic (real-time and historic) can be recorded to provide improved "black box" tracking;
- Finally, but critically, the Mekong River system is very environmentally sensitive. The vessels must remain clear of dangerous obstacles, and should be able to be contacted if they are seen to be on a dangerous course.

VHF Radio Communication Systems: Currently, there is limited communication available between the boats and the shore. A system with Very High Frequency (VHF) radiotelephony needs to be installed on all boats and in one or two central stations to allow for open lines between boats and the Vessel Traffic Service Center. Improved communication methods will

also be useful to exchange information regarding water depths, flow conditions and possible obstructions.
The urgent and dynamic information to be communicated by voice radio could concern, for example:

1) Temporary obstructions in the fairway, malfunctions of aids to navigation;
2) Restrictions in navigation caused by floods or dam operations; and
3) Present and future water levels at gauges.
4) Urgent reports on special events (e.g. traffic regulations after accidents).

The objectives of this project are:

1) To review the results of the technical feasibility and economic viability of developing the VTS, AIS and Radio Communication Systems conducted by Thailand, and expand the area of investigation and implementation to the Lao PDR. (In a later phase, this project can also be extended to Cambodia and Viet Nam).
2) To prepare a draft detailed procurement and implementation plan.
3) To develop and install the VTS Center, AIS and Radio Communication Systems where and when as determined in Objective 1.
4) To make the system compulsory (equipment must be on board, functional and operators should be trained to use it) for selected ship sizes and types, incorporated in the law, and consequently enforced.

The actual costs for Outputs 1 and 2 are estimated at 80,000 US$ for the stretch between the Green Triangle and Vientiane. The actual costs for Output 3 will become available when the results of the feasibility study are known. A preliminary estimate for the stretch between the Green Triangle and Vientiane is 480,000 US$.
River Information Service: In a later phase, the system can be transformed into a full River Information Service (RIS), supporting the planning and management of traffic and transport operations. It can contribute significantly to a more efficient and safer use of waterways, locks, ports and terminals by enhancing and optimizing electronic data interchange and logistic operations. RIS will lead to increased competitiveness of Mekong inland navigation and improved safety, and needs to be implemented and further developed in a coordinated way between the Mekong counties.
But this need a lot of preparatory work such as:

- The design of a RIS Implementation Plans;
- The standardization and harmonization of data;
- A Mekong traffic monitoring to establish cargo and passenger statistics; and
- The preparation of operational services and fairway information.

The costs for this work can be estimated at 1,400,000 US$ while the yearly costs for a VTS Center can be estimated at 60,000 US$ and for a full RIS Center at 90,000 US$.

E8 Management, information, promotion and marketing:

The need and scope of bilateral and/or regional cooperation on IWT data management and river information services, of bilateral and/or regional cooperation on IWT promotion and marketing should be studied.

In the long term, a regional **"Mekong River Navigation Commission"**, bilateral or a regional **"Mekong River IWT Information Management Centre"** and **"River Information Services"**, and bilateral or a regional **"Mekong River IWT Promotion and Marketing Agency"** could be established.

Mekong River Navigation Commission: As already existing for all major cross-bordering rivers in the world, the establishment of a "Mekong River Navigation Commission" should be studied.

River Rhine Commission

River Nile Commission

River Scheldt Commission

River Congo Commission

River Danube Commission

Transport, Infrastructure and Communications Commission (CETICAM)

River Amazon Commission

This commission could have following tasks:

- Under the present organisational structure of MRC, the National Mekong Committees should support the planning and implementation of the cross-bordering planned and proposed IWT investment projects. To centralise efforts for the implementation of these projects, a regional "Mekong River Navigation Commission" should be established, that is directly connected to the National Mekong Committees and the Waterborne Transport related Ministries and Authorities. This commission could coordinate and prepare the planned and proposed cross-border projects (inception notes, project files, terms of reference, etc.) with regards to fleet, waterway design, port development, legal amendments, safety and security, socio-environment and the accompanying capacity building.
- The commission should outline the regional policy on the use of modes of transport, promote multi-modal principles and act as intermediary between the MRCS, the NMCs, the MPWTs and MoTs, the private sector and its professional associations.
- In the (likely) event of a stronger integration between the economies of the riparian countries, it would be a logical step to also integrate the current institutional mechanisms and further harmonize the legal framework for the management of the waterway over its entire navigable length. Such an integrated commission should have as its task the gradual elaboration of a fully harmonized legal framework for navigation for all the countries concerned.
- The commission should be instrumental in facilitating new and additional investments in the sector, will help draft new regulations and will lead international promotional campaigns to develop new commercial opportunities.

This way, this commission could ensure integration of the decision-making mechanisms across the riparian countries, increase efficiency of the governance structure, of competitiveness of waterborne transportation and ports and the overall sustainability of the system.

Ideally, the envisaged commission should replace the JCCCN and the Mekong Navigation Facilitation Committee.

The study of such a “Mekong River Navigation Commission” should comprise an analysis of the current structure, an assessment of new needs arising from better navigational conditions and interconnection of river stretches, international benchmarks, political and economic feasibility, alternative solutions and final recommendations.

The estimated costs for this study are 96,000 US$ for 4 national experts at US$ 1,000 / month during 2 years and 36,000 US$ for an international expert at US$ 12,000 / month during 3 months.

The estimated costs for a “Mekong River Navigation Commission” per year are estimated at 120,000 US$ (Steering Committee, Office Director, full time Local Experts and Administrative Staff, part time International Consultants, Office Costs).

Mekong Navigation Data and Information Management Systems: It is of great concern that there is a lack of data with respect to trade and traffic production and attraction, intra- and inter-regional trade and traffic flows, modal split, as well as the physical aspects of the river and the ports.

Moreover, information and data collection and management on waterway characteristics, obstacles, IWT fleet, port infrastructure and throughput, cargo and passenger transport, dangerous goods transport and storage, accidents and so on, is organised by many different organisations and authorities.

Without vital time-series of trade, port and transport statistics and modal split, master planning and cost benefit analyses of proposed infrastructure developments is an ineffective exercise.

Although MRC does have a comprehensive overview of all studies and projects carried out by agencies such as the World Bank, ADB, ESCAP and ASEAN, among others, the impression nevertheless is that waterborne transport sector data, lacks overall coordination and focus, and is fragmented and far from complete.

Also data on water quality and pollution incidents should be integrated into a data system to monitor environmental impacts of IWT.

Therefore, it is proposed to study the creation of “Mekong Navigation Data and Information Management Systems” in the four MRC Member Countries to support planning and policy formulation and to provide daily services for safe and efficient passage by inland and sea-going vessels on the Mekong River System.

The investment budget to set up and provide substantial technical assistance to the Systems cannot be defined until some detailed policy objectives have been established. An initial estimate for such study can be estimated at 10,000 US$ per country and an operational Mekong Navigation Data and Information Management System should cost some 40,000 US$ per year and per country.

Depending on the results of this short-term study, to harmonize data and information sets and to reduce costs, it can be proposed to establish two bilateral (Thailand-Lao PDR and Cambodia-Vietnam) “Mekong Navigation Data and Information Management Systems” and “River Information Services”. The investment budget to set up such unit can be estimated at US$ 10,000 US$ (IT hardware and software). To provide substantial technical assistance in order support the bilateral Mekong Data Management Systems, yearly costs can be estimated at 60,000 US$ per system.

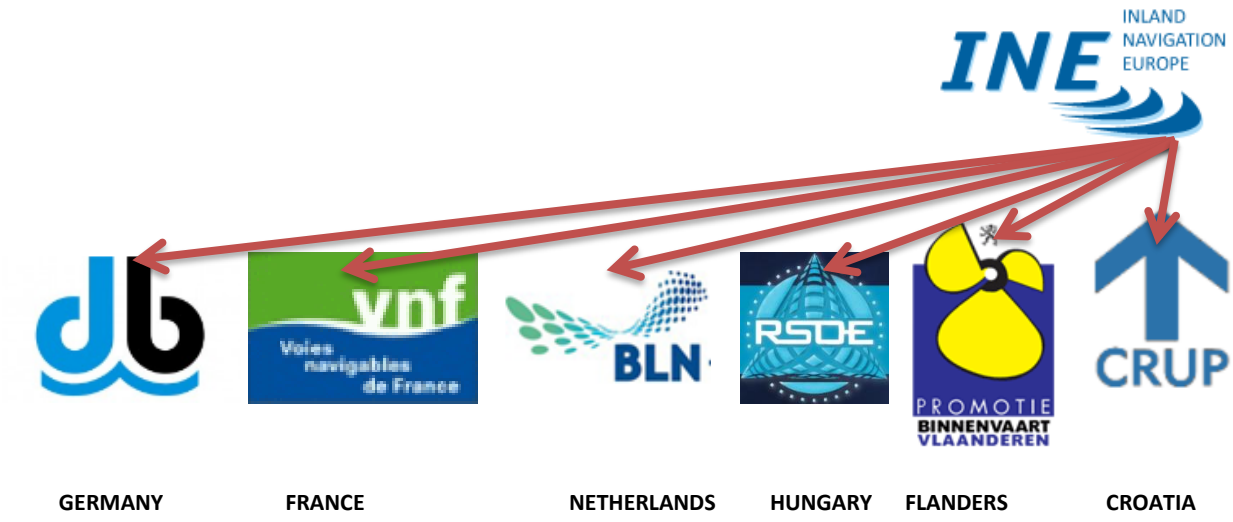
Mekong Navigation Promotion and Marketing Agencies: Inland waterway transport suffers from a negative perception on its performance. There is a need to improve the image of IWT. Governments have not taken the initiative to promote IWT. An independent agency that could lobby policy makers, act as interface between policy makers, users and other partners sharing

the same goals is required to maximise the use of one of the Mekong Basin's major assets: its rivers.

Therefore, it is proposed to study the creation of independent agencies in the four MRC Member Countries that will actively pursue promotional and marketing activities to bring as much cargo and passengers as possible to IWT, thus contributing to a better competitive position of IWT.

These independent agencies with participation of the public sector and the private sector that will be recognised by all stakeholders as intermediate entities in promoting IWT, should be composed of a manager plus 2 or 3 employees, all computer literate. The budget per year and per country can be estimated at 50,000 US$.

As established in the European Union, it could also be proposed to establish a regional "Mekong River Inland Waterway Transport Promotion and Marketing Agency", coordinating the national activities. Here, the budget per year can also be estimated at 50,000 US$ or 12,500 US$ per country.



E9 Climate change adaptation: **Climate Change Adaptation Plans** for sea level rise and increased flooding must be in place to protect IWT infrastructure and IWT vessels. This can be incorporated into contingency planning for flooding. Special attention must be given to the height of bridges, power lines and port wharves.

E10 Fisheries: The adverse influence of fisheries on inland waterway transport can only be reduced by a better cooperation between national ministries and provincial authorities to define **river zones that are (exclusively) allocated to fishing or transport activities**. Rules and regulations should be imposed to avoid mutual hindrance of both activities.

8.2 SOCIAL

Assessment and Planning: The impacts discussed above must be incorporated into a **Social Impact Assessment (SIA)** for port development projects and the modification and maintenance of waterways for IWT. It is important that new infrastructure projects are assessed with consideration for the social effects. Eventually, non-experts and local people should participate in the design and implementation of proposed developments or programs, because a rigorous SIA report, showing real consequences of the projects and suggesting ways to mitigate adverse impacts, gives credibility and provides evidence to take these campaigns to the planning officers.

S2 Accessibility: During the social survey of the Master Plan, the passenger and boat owners/operators were asked to provide further details on why they use inland waterway transport and how IWT can be improved. The participants reported that the main reasons they use Inland Waterway Transport are:

- Inland Waterway Transport is cheaper and more comfortable than transport by car;
- Passengers enjoy travelling by boat due to the environment and the scenery on the river;
- Safer and less accidents than road transport;
- Close to farming, markets and employment opportunities along the river;
- No access to roads and bridges, especially during the wet season;
- Convenient to visit tourist attractions and entertainment;

The participants reported that IWT could be improved by:

FLEET, WATERWAY, PORTS

- Providing more safety equipment (life jackets, fire extinguishers, etc.), emergency response and communications equipment for passenger vessels;
- Establishing better passenger port facilities;
- Building capacity of boat owners, captains, crew members and port workers to maintain, control and inspect engines and equipment for safety;
- Strict enforcement of safety rules for passengers; Conducting safety inspections of boats, monitor the vessel conditions and enforce the restrictions on number of passengers;
- Improving the navigation channel, installing more aids to navigation and providing more waterway information for boats and port operators to reduce accidents;
- Larger boats and an increase in boat capacity are required for passengers to respond to the increase of the demand;
- Develop safe, cheaper and more efficient ferry services and increase the number of ferries and passenger services operating to reduce waiting times.;

ENVIRONMENT

- Promoting awareness for local people and ship owners to reduce pollution and solid wastes;

PROMOTION

- Promoting of IWT and water-related tourism for international and local tourists;
- Considering financial incentives and reducing tax to promote IWT to transport operators;
- Identify more economic opportunities for local people;

INSTITUTIONAL

- Improving coordination between National and Provincial Departments of Public Works and Transport, Boat Associations and Port Authorities;
- Simplifying procedures and regulations for cross-border transport; reduce the burden of administrative procedures for cross-border transport;
- Increasing participation from the private sector by raising awareness of IWT.

This survey should be continued. Moreover, socio-economic risks and opportunities must be integrated into SIAs. Planning for linking local IWT with domestic and cross-border transport is required. The development of rural/domestic cargo and passenger transport should be fully integrated and IWT should be also integrated with hydropower, agricultural, mining, industrial and other sectors.

Landing facilities should be installed at priority locations to link local transport and eco-tourism with national ports.

S3 Education and training: **Plan and implement national, bilateral and regional IWT education and training actions** on navigation techniques and equipment (crew certification); navigation safety, including carriage and handling of dangerous goods; hydrodynamics, hydrography and waterway design and maintenance; IWT vessel design and construction; registration and inspection, and IWT Socio-Environmental Issues (EIAs, SIAs, Environmental Management Plans, sand mining, Dredging Environmental Management Plans, etc.).

Based on a Training Needs Assessment in the four MRC Member Countries, in 2014 MRCS prepared a "MRC NAP Training Plan" with some 24 national seminars/workshops and 24 national short courses (6 per country), some 5 bilateral seminars/workshops and 5 bilateral short courses, some 5 regional seminars/workshops and some 5 training of trainer's courses abroad.

Elaborated project files for each of these Training Actions are available in the *"Formulation of a Training Plan to Implement the Activities under the Navigation Programme - Final Report"*, MRCS NAP, December 2014.

The costs for the mentioned Training Actions were estimated as follows:

- International ± 400,000 US$
- Regional ± 600,000 US$
- National (Public + Private Sector) 4 x ± 100,000 US$ = ± 400,000 US$

It is worth noting that these budget estimations are absolute maxima and can be strongly reduced, for example by saving on the logistic costs.

8.3 ENVIRONMENTAL

Assessment and Planning: The impacts discussed above must be incorporated into an **Environmental Impact Assessment (EIA)** and **Environmental Management Planning (EMP)** for port development projects and the modification and maintenance of waterways for IWT. It is important that new projects are assessed with consideration for the main natural functions of river systems, including the morphological processes (e.g. erosion, sediment transport and sedimentation), the maintenance of the hydrological balance (e.g. flood pulse), the maintenance of the sediment balance, the provision of habitat (ecosystem connectivity) and the maintenance of biological and chemical processes (nutrient cycles).

A **Strategic Environment Impact Assessment (SEIA)** ensures integrated planning by assessing environmental and sustainability opportunities and risks of strategic options (e.g. master plan or policy). A SEIA or integrated planning process for the IWT sector should also incorporate:

- Environmental aspects such as water quality, environmental flow, sediment management, hydro morphology, biodiversity and climate change;
- Economic assessment of multi-modal transport i.e. road, rail and maritime shipping;
- Competing uses of the waterway (e.g. hydropower, flood protection, agriculture, industrial use, recreation, water supply); and
- Transboundary management for IWT sector (e.g. shared maintenance of waterways, accident prevention, and emergency response).

H1 Dredging activities versus river flow: Concerning dredging works, the (limited) influence on the river flow and sediment transport could be mitigated by:

- **Repeated surveys** of the river bathymetry, together with a morphological optimization study (see H4), indicating the places and the rate at which navigation maintenance dredging is required and should be executed on a sustainable way;

- **Dumping the dredged material back in the river**, on places where it doesn't block any navigation to maintain the hydrological and sediment balance of the river;
- **Better coordination between navigation dredging and sand mining**, leading to a solution where everyone benefits from eventual combined actions of navigation dredging and sand mining;
- **Study the opportunities to replace dredging works by river training works.** For example, the Sdao channel is an artificial dredged gully in the middle of a huge sand deposit at Km 387 between Kompong Cham and Phnom Penh. All past projects for improving this situation were based on dredging and bank protection but none has proven sustainable so far. It looks like river training works may be the long term sustainable solution even though the groynes to be constructed may have lengths of several kilometers. These low-cost groynes should be overflow dikes during the flood season, but sufficiently high to direct and concentrate the flood current into scouring a specific channel to substantially reduce, if not totally omit the yearly maintenance dredging.

H2 Climate Change mitigation:

To mitigate the impact of waterborne transport on the climate change causes (greenhouse gases), improvements must be made for **vessels to use more energy efficient engines and cleaner fuels**. Otherwise, air emissions may be even higher than land transport with old technology and limited regulations or public awareness to reduce Sulphur content of marine fuels.

In the ports and terminals, air emissions by vehicles, cargo handling equipment and cranes can be reduced **using modern electrical engines**.

Finally, awareness should be raised in the transport sector for the use of **"Combined Transport"**.

This term is used by the United Nations Economic Commission for Europe (ECE) and the European Conference of Ministers of Transport (ECMT) to cover environment-friendly multimodal door-to-door transport, **involving as little road transport as possible**: *"Combined Transport means the transport of goods where the lorry, trailer, semi-trailer with or without tractor unit or container of 20 feet or more uses the road on the shortest possible initial and final leg of the journey and uses rail or inland waterway on the longest leg of the journey."*

H3 Construction of Infrastructure: **EIAs are needed** for specific port and terminal constructions and waterway improvement projects. Standards and guidelines, if not existing, should be drafted for environmental assessment to achieve sustainable infrastructure investments.

H4 Operational pollution: The increased environmental impact from inland waterway transport requires urgent attention to reduce water pollution. **Meanwhile, energy efficient vessels, pollution control and environmental monitoring are needed for sustainable inland waterway navigation.**

The MRC Environment Programme (EP) drafted a **"Water Quality Emergency Response and Management"** chapter, developed to ensure timely and effective cooperation between Mekong Countries in response to water quality emergencies and to minimise the extent and mitigate the negative effects on water quality in the Mekong River.

Finally, **Contingency Plans** should be developed, involving decisions in advance about the management of human and financial resources, coordination and communications procedures and awareness of a range of technical and logistical responses and restrictions.

This involves procedures for accident reporting, the establishment of a response team and defining the roles and responsibilities in the response system. This includes planning and coordinating responses, providing guidance to regional or local response teams, coordinating a national program of preparedness planning and response, and facilitating research to improve response activities.

H5 Dredging versus environment:

To mitigate the impact of channel dredging activities on the environment, it is proposed to conduct an **Optimization study of dredging sand from the Mekong River** at various places that are not creating a negative impact on the river behavior or ecological status and to adopt **Dredging Environmental Management Procedure (DEMP)**.

Dredging optimization study: A morphological feasibility study should indicate the places where sand dredging or excavation has limited or reduced impact on the river behavior or ecological status. Dredging includes impacts to aquatic ecosystems and habitat (especially fish spawning areas) from dredging operations, impacts to terrestrial flora/fauna and natural habitats, as sites of on-land disposal of dredged material poses a threat to the aquatic environment not only through the disposal of dredged material, but also the dispersal of pollutants into surface waters during dredging.

It is important that new dredging projects are assessed with consideration for the main natural functions of river systems, including:

1) Morphological processes (e.g. erosion, sediment transport and sedimentation);
2) Maintenance of the hydrological balance (e.g. flood pulse);
3) Maintenance of the sediment balance;
4) Provision of habitat (ecosystem connectivity); and
5) Maintenance of biological and chemical processes (nutrient cycles).

This study of sustainable waterway maintenance in the Mekong Basin, including a regional workshop should take 9 months and cost ± 200,000 US$.

Dredging Environmental Management Procedure (DEMP): The volumes of dredging works required to deepen the MRS navigation channel to permit operation of larger vessels, and then to maintain that depth, are substantial. But at present, there are no adequate procedures for planning of dredging works on this scale, nor for proper and cost-efficient disposal of dredged material. The need is for the adoption of a Dredging Environmental Management Procedure (DEMP) and enabling regulations in order to ensure that:

1) the planning and implementation of dredging works is technically and environmentally sound;
2) opportunities for cost-recovery from sale of dredged material are exploited; and
3) other dredged materials are disposed of safely and without damage to the environment or local livelihoods.

This DEMP, and its decision-making processes, will provide a practical tool for the responsible authorities to manage dredging of the MRS in an efficient and sustainable manner.
The deliverables will be:

- An agreed DEMP that conforms to accepted international practices.
- Staff of the responsible authorities trained in the DEMP and its decision-making processes

and the estimated costs are 60,000 US$.

H6 Habitats, Species, Aquatic Life, Sensitive Areas:

Ecoregions, protected areas, fisheries conservation zones, socio-economic conditions and important wetlands should be included in assessments for specific stretches.

The specific eco-regions, protected areas, important wetlands and critical habitats sites need to be incorporated into EIA and planning. In addition, it will be important to determine further ecologically sensitive areas, protected areas and ecotourism sites along the Mekong River.

It is important that proposed IWT projects are assessed with consideration of the main natural functions of river systems in specific waterway sections as the environmental and socio-economic characteristics are unique throughout the Mekong Basin. The eco-regions are important to use as a first step in preliminary assessments (e.g. initial environmental impact assessment or examination) to determine the existing environmental degradation, biodiversity and protected areas in relation to the specific location of existing and planned IWT projects/activities in specific stretches. Further assessment would be required to consider the critical ecosystems, fisheries conservation zones, water quality, ecological status and socio-economic conditions. **The eco-regions could also be used to determine zones or restrictions for port/vessel activities, transport of dangerous goods and dredging/sand mining activities.**

H7 Fisheries:

In the MRC report "Fisheries Habitat and Yield in the Lower Mekong Basin", it is stated that the main threats to fisheries production are the planned hydroelectric dams (preventing fish migration, altering the flow regime, retaining vital nutrient-rich sediments and changing water quality) and intensified agriculture in the rain fed habitats (creation of shallower water depths and use of pesticides).

However, although limited, also inland navigation could be a third disturbing element for capture fisheries:

1) By dredging millions of cubic meters of sand in possible fishing zones. Therefore, it is important that **new dredging projects are assessed** with consideration to protect fishing zones and wetlands, the provision of habitats (ecosystem connectivity) and the maintenance of the nutrient cycles (especially dredging works in the Tonle Sap Lake requires special consideration).
2) By allowing bigger ships of which the stern waves can influence embankment and flood fish zones. Therefore, it should be studied in which river stretches **a speed reduction or even restrictions for port/vessel activities should be introduced.**

Finally, technical know-how on fisheries management should be shared and awareness on the sector's significance for the Mekong's environment and its people should be raised in the inland waterway transport sector.

H8 Dry and wet season flows and water Levels: The **hydrological criteria** of article 6 of the 1995 Mekong Agreement **should be rigorously followed.** According to this Article, the mainstream flows should be maintained at levels such that they are not less than the acceptable minimum monthly natural flow during each month of the dry season, they enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season, and the average daily peak flows are not greater than what naturally occur on the average during the flood season.

The Procedures for the Maintenance of Flow on the Mainstream (PMFM) of the Mekong River with its flow framework for planning is to be used to assess the navigation development plan to inform national and transboundary planning. The potential impacts of the development plans should be assessed using the simulation models of the Decision Support Framework (DSF) and evaluated with respect to the agreed flows framework for planning purposes.
Finally, VHF radiocommunication and River Information Services should be developed over the whole length of the river to **inform boat operators about the water flows and levels**.

H9 Hydropower Development: Due to hydropower development, the lower Mekong River is vulnerable to projected reductions in sediment transport (of up to 75%) that could cause destabilisation of riverbanks from down cutting and bed erosion, potentially impacting port and waterway infrastructure. **Dam operations should be duly adapted to these risks.**

H10 Sand mining: While the impacts of navigation dredging can be mitigated by dumping the sand back in the river to maintain the hydrological and sediment balance of the river, channel extractions by sand mining are contributing to a reduced sediment load that could cause large-scale erosion and destabilization of riverbanks, potentially impacting port and waterway infrastructure.

Rigorous EIA studies should precede any new sand mining project.

9. SUMMARY

In the 2007 situation, inland waterway transport was (and still is) seriously troubled by the seasonal lack of water depths during the low water season.

Almost 98% of all registered vessels in the lower Mekong Basin are navigation in the Vietnamese Mekong Delta and about 78% of the annual cargo volume is transported there. In Thailand, the annual transported cargo volume is about 6% of the total transported volume in the Lower Mekong Basin, in the Lao PDR it is 4% and in Cambodia 12%.

Some 89% of the total passenger transport in the Lower Mekong Delta happens in the Vietnamese Mekong Delta, some 1% in Thailand, some 5% in the Lao PDR and some 5% in Cambodia.

Except for Chiang Saen Port, Phnom Penh Port and Can Tho Port, all other ports are only small river ports or landing facilities and in Lao PDR and Cambodia, most of these ports are in their natural condition or consist of a laterite or reinforced concrete ramp, parallel to the river bank.

In most parts of the Lower Mekong Basin, fleet safety is in a very poor condition. Especially, awareness of the risks of the transport of dangerous goods is very limited in all MRC Member Countries. Localization and communication equipment is only available on a voluntary basis and Vessel Traffic Services are only available in a limited Vietnamese stretch. River Information Services are not available and Emergency Response with Search and Rescue is only available in Thailand and Vietnam.

Concerning Aids to navigation, only some 540 old French beacons are left between Bokeo and Kratie, many of them damaged. In the ports of the Lower Mekong Basin, there are no Ports Safety, Health and Environmental Management Systems (PSHEMS) and also here, the awareness of the risks, associated with handling and storage of dangerous goods is very limited.

The navigation scenario 2020, three hydropower dams have been considered: the Xayaburi dam, where commercial operation is scheduled to start in 2019, the Pak Beng dam, where construction works are scheduled to start in 2017 and the Don Sahong dam, blocking off one of the channels that flow over the Khone falls, with commercial operation expected to be in 2019.
During the period 2007-2020, high investments were and are made in port development: Chiang Saen Commercial Port in Thailand, the New PPAP Container Terminal in Cambodia and the expansion of Can Tho Port for ships up to 10,000 DWT.

From the Green Triangle to Huay Xay, vessels of 300 ton (instead of 100 ton in 2007) can now navigate the whole year. Moreover, special attention was given to the navigation in the Mekong Delta by upgrading the Cho Gao Canal between the Tien (Mekong) River and Ho Chi Minh City and the construction of the Quang Chanh Bo Canal at the mouth of the Hau (Bassac) River, to allow bigger ships to navigate to Can Tho and Phnom Penh.

Finally, a number of safety projects are proposed to create acceptable living conditions for passengers and tourists on passenger. Another safety priority is the transport, handling and storage of dangerous goods, contingency planning and search and rescue and the upgrading of aids to navigation (buoys and beacons), in order to reduce accidents, oil spills and other pollution sources.

Aids to navigation was made available by China between the Green Triangle and Huay Xay. From Kompong Cham to the Cambodia – Vietnam border, buoys are installed by MRC and allow day and night navigation, but several of them disappeared. Also in the Vietnamese Mekong Delta, day and

night navigation is possible, but the waterways are not fully fitted with navaids so that efficiency and safety are not yet optimal.

Total cost of executed, planned and proposed actions for the period 2007-2020 can be estimated at 913 million US$, including 293 million US$ for four locks at the Pak Beng Dam and the Xayaburi Dam and including 480 million US$ for the Quang Chanh Bo Canal.

The navigation scenario 2040 considers eleven (ten) hydropower dams with locks, that should have some 12 lock operations per day. The scenario aims to allow 500-ton vessels during the whole year from the Green Triangle to Kratie (including a bypass canal with three locks at the Khone Falls). The river stretch between Kratie and Kompong Cham should be navigable for 2,000 DWT ships over the whole year, the stretch between Kompong Cham and Phnom Penh for 3,000 DWT ships, the stretch between Phnom Penh (New Container Terminal) and Can Tho for 7,000 DWT ships and the stretch from Can Tho to the sea for 10,000 DWT ships over the whole year. Finally, the Tonle Sap River and Lake between Phnom Penh and Chhong Kneas (Siem Reap) should be navigable for boats of 500 ton over the whole year.

Moreover, new passenger ports should be constructed in some 14 locations and new cargo ports should be constructed in some 7 locations in Laos and in Kratie, Kompong Cham, Phnom Penh (NCT LM17 Phase III) and Chong Kneas in Cambodia.

Finally, it is proposed to install River Information Services (RIS) over the total length of the Mekong river, to develop and install a GPS navigation guidance system, compulsory for all boats carrying cargo and passengers and to upgrade buoys and beacons, in order to reduce accidents, oil spills and other pollution sources.

The total cost of all planned and proposed activities in the period 2020-2040 (fleet modernization, waterway improvement, port renovation, fleet-, waterway- and port safety measures) can be estimated at 1,944 million US$, including 940 million US$ for the locks at the hydropower dams and 526 million US$ for the bypass canal with locks at the Khone Falls.

This scenario should lead to a total volume of yearly cargo transport by inland waterways of 168 million ton in 2040, compared to 23 million ton, measured in 2014 (AARG 8%), which also means that in 2040, almost 11% of cargo should be shifted from road to inland waterway transport.

The annual net economic value of the IWT cargo volume should rise from 12,010 million US$ in 2014 to 148,262 million US$ in 2040.

The number of domestic passengers should rise from 69 million per year in 2014 to 312 million per year in 2040 (AARG 6%) and the number of foreign tourists, making use of inland waterway transport should rise from 814,000 per year in 2014 to 6,078,000 per year in 2040 (AARG 8%).

Without investments, it is assumed that the inland waterway transport sector will only grow (as well for cargo as for passengers) with an average annual rate of growth (AARG) of about 4%, certainly less than the growth rate of the GDP, and that most of the lost cargo and passengers will shift to road transport.

Concerning the impact on and from navigation versus other sectors, the most important are:

ECONOMICAL

- The impact from lock operations at the hydropower dams
  The greatest obstacle for the growth of inland waterway transport sector is the fact that waterway transport is slower than land transport. Therefore, the lock operations at the hydropower dams should not increase the transit times of waterway transport. Moreover, emergency dam operations with high release and flushing of water can be very harmful for the berthed and sailing ships downstream, with even accidents and damage if the boat operators are not informed in time.

To reduce the impact of the dam operations and the lock operations at the dams on the navigation, it should be of a high priority to establish a "Vessel Traffic Service Center" in the Lao PDR, covering the whole stretch of the Mekong River from the Green Triangle to Vientiane with compulsory AIS and VHF on board of selected ship sizes and types, so that important information can be exchanged between boats and shore.

- The impact from Climate Change

  In the Mekong Delta, climate change and sea level rise will increase the number of periods in the year when the full navigation clearance of 37.5 m would not be available at the Cao Lanh and Vam Cong bridges and many approach roads and interconnecting roads will be submerged. In the upper part of the Lower Mekong Basin, the flow increase during the flood season could influence the speed and fuel use of vessels, sailing upstream, but should be an advantage for vessels, sailing downstream.

  Climate Change Adaptation Plans for sea level rise and increased flooding must be in place to protect IWT infrastructure and IWT vessels. This can be incorporated into the contingency planning for flooding. Special attention must be given to the height of bridges, power lines and port wharves.

- The impact from fisheries

  In Cambodia, fishermen are (unreasonably) unwilling to come to an agreement with the Ministry of Public Works and Transport to allow floating aids to navigation to be installed and maintained. In Vietnam, several fixed fishing installations are deployed on the Tiền (Mekong) and Hậu (Bassac) River, sometimes reaching into the navigation channel.

  The adverse influence of fisheries on inland waterway transport can only be reduced by a better cooperation between national ministries and provincial authorities to define river zones that are (exclusively) allocated to fishing or transport activities. Rules and regulations should be imposed to avoid mutual hindrance of both activities.

SOCIAL

- The impact on employment

  Employment in the inland waterway transport sector (situation 2014) can be roughly estimated at 780,000 people. It can be assumed that employment will grow up to 975,000 people in 2020 and 1.95 million people in 2040.

  The impacts of port development projects and the modification and maintenance of waterways for IWT must be incorporated into a Social Impact Assessment (SIA). It is important that new infrastructure projects are assessed with consideration for the social effects.

  In the "Social and Economic Assessment Report", total employment in the navigation sector is calculated as follows:

	FTEs SEA Report	Change to M1	FTEs Master Plan	Change to MP
M1 (2007)	64,909			
MP (2015)			780,000	
M2 (2020)	83,726	+ 30% (2.3%/year)	975,000	+ 25% (5%/year)
+24 (2030)	104,316	+ 61% (2.7%/year)		
M3 (2040)	144,432	+123% (3.7%/year)	1,950,000	+125% (5%/year)

The lower growth figures in the SEA Report are due to a comparison with the manufacturing and services sectors and the finite number of employed population. Higher growth in the navigation sector means that the FTEs for the manufacturing and services sectors will decrease.

- The impact on accessibility

  More than 29.6 million people are estimated to live within 15 km of the Mekong mainstream, defined as the Mekong corridor. As a result of some 200 interviews with IWT domestic passengers (2014), it was found that about 30% make a daily use and about 30% make a weekly use of inland waterway transport. Some 25% make use of IWT to visit family or friends and another 25% use IWT to visit markets. Some 20% use IWT to transport goods and another 20% use IWT to go to their job.

  Questioned on possible improvements, the participants reported that IWT could be improved by (amongst others) more safety equipment for passenger vessels, better passenger port facilities, strict enforcement of safety rules, an increase in boat capacity and safe, cheaper and more frequent ferry services. They also proposed to promote awareness for local people and ship owners to reduce pollution and solid wastes and to promote IWT and water-related tourism for international and local tourists, to consider financial incentives and to simplify procedures and regulations for cross-border transport.

  This survey should be continued. Moreover, socio-economic risks and opportunities must be integrated into SIAs. Planning for linking local IWT with domestic and cross-border transport is required. The development of rural/domestic cargo and passenger transport should be fully integrated and IWT should be also integrated with hydropower, agricultural, mining, industrial and other sectors. Landing facilities should be installed at priority locations to link local transport and eco-tourism with national ports.

- The impact from education and training opportunities

  During a Training Needs Assessment for IWT related disciplines and topics, executed by the MRC NAP in 2014, all countries and their stakeholders expressed a high need for additional education and training actions on navigation techniques and equipment (crew certification); navigation safety, including carriage and handling of dangerous goods; hydrodynamics, hydrography and waterway design and maintenance; IWT vessel design and construction; registration and inspection, and IWT Socio-Environmental Issues (EIAs, SIAs, Environmental Management Plans, sand mining, Dredging Environmental Management Plans (DEMP), etc.). Based on this Training Needs Assessment, in 2014, MRCS prepared a MRC NAP Training Plan available in the "Formulation of a Training Plan to Implement the Activities under the Navigation Programme - Final Report", MRCS NAP, December 2014.

ENVIRONMENTAL

- The impact from dredging activities on the river flow

  The proposed channel improvement activities in Thailand and Lao PDR consist mainly of the clearing of rapids and rock removal while in Cambodia and Vietnam, some 28 million m^3 of dredging are proposed (of which some 12 million m^2 in the Great Lake).

Stretch	Max. tonnage whole year (ton)			Min. channel dimensions(m)		Actions	Estimated cost (US$)
	2007	2020	2040	depth	width		
1 Green Triangle – Huay Xay	150	300	500	3.1	35	'20 Clearing 11 rapids / 4 shoals '40 Clearing 53 rapids	30,000,000 84,950,000
2 Huay Xay – Luang Prabang	50	50	500	3.1	35	Clearing 9 rapids / 4 shoals	19,859,000
3 Luang Prabang – Sanakham Dam	30	30	500	3.1	35	Clearing 8 rapids	12,839,000
4 Sanakham Dam – Vientiane	30	30	500	3.1	35	Clearing 17 rapids	21,678,000
5 Vientiane – Savannakhet	100	100	500	3.1	35	Clearing 4 rapids	12,180,000
6 Savannakhet –	10	10	500	3.1	35	Clearing 66 rapids or reefs	78,300,000

Khone Falls							
7 Khone Falls			500	3.1	35	Bypass canal with 3 ship locks	526,000,000
8 Khone Falls – Kratie	30	30	500	3.1	35	Clearing 6 rapids and 13 scattered rocks	17,680,000
9 Kratie – Kompong Cham	100	100	2000	5.3	52	Dredging 8,810,000 m³	29,430,000
10 Kompong Cham – PHN NCT	2000	2000	3000	6.2	56	Dredging 2,143,200 m³	12,870,000
11 Phnom Penh – Kompong Chhnang	1500	1500	1500	4.9	50		
12 Komp. Chhnang – Chhnok Trou	30	30	500	3.1	35	Dredging 2,820,000 m³	8,460,000
13 Chhnok Trou – Chong Kneas	30	30	500	3.1	35	Dredging 12,348,300 m³	37,045,000
14 Phnom Penh – Cai Mep (Cho Gao)	1500	2000	2000	5.3	52	Upgrade Cho Gao Canal	12,600,000
15 PHN – Can Tho (Bassac River)	3000	5000	7000	8.0	76	Dredging 5,043,000 m³	16,641,000
15 Can Tho – Cai Mep (Bassac River)	3000	10000	10000	8.8	88	Construction Quang Chanh Bo Canal	450,000,000

Hydro-morphological changes can have far-reaching impacts upstream and downstream from dredging activities, significantly affecting river system dynamics and interfering with the exchange of water and sediments between the mainstream river and its tributaries and flood plains.
These impacts must be incorporated into an Environmental Impact Assessment (EIA). It is important that new projects are assessed with consideration for the main natural functions of river systems, including the morphological processes (e.g. erosion, sediment transport and sedimentation), the maintenance of the hydrological balance (e.g. flood pulse) and the maintenance of the sediment balance,

The impact on the river flow and sediment transport could be mitigated by:

- Repeated surveys of the river bathymetry, together with a morphological optimization study;
- Dumping the dredged material back in the river, to maintain the hydrological and sediment balance;
- Better coordination between navigation dredging and sand mining; and
- Study the opportunities to replace dredging works by river training works.

- <u>The impact from inland waterway transport on Climate Change</u>
  IWT vessels can carry larger volumes of cargo relative to the extra fuel needed, resulting in lower emissions per ton-km compared to road transport. However, to mitigate the impact of waterborne transport on the climate change causes, improvements must be made for vessels to use more energy efficient engines and cleaner fuels. In the ports and terminals, air emissions by vehicles, cargo handling equipment and cranes can be reduced using modern electrical engines.

  Finally, awareness should be raised in the transport sector for the use of "Combined Transport", an environment-friendly multimodal door-to-door transport, involving as little road transport as possible.

- <u>The impact on water quality</u>
  Potential impacts on water quality are derived from the following activities:

  - The construction of navigation infrastructure e.g. ports and landing facilities;
  - The operational activities e.g. oil spills, solid and liquid wastes, navigation accidents; and
  - The maintenance of the navigation channel and waterway conditions.

The construction of inland port and landing facilities development can cause significant direct and indirect impacts on the environment and socio-economic characteristics of a river basin. The environmental impacts need to be considered during planning and construction in an Environmental Impact Assessment (EIA) and during operations in an Environmental Management Plan (EMP).

During operations, oil spills in inland waters are highly likely to contaminate water supplies. A possible incident involving the transportation of dangerous goods can have severe consequences for the environment and people, including risk of spillages and pollution from shipping accidents. Finally, the operations of ports, terminals and vessels have the potential to generate both domestic and hazardous wastes. Direct dumping of untreated wastes into rivers can alter the aquatic habitats and harm fisheries, other aquatic organisms and riparian vegetation.

To mitigate these impacts, pollution control and environmental monitoring are needed for a sustainable inland waterway navigation. Next to the Contingency plans that should be developed, the MRC Environment Programme (EP) drafted a "Water Quality Emergency Response and Management" chapter, developed to ensure timely and effective cooperation between Mekong Countries in response to water quality emergencies and to minimise the extent and mitigate the negative effects on water quality in the Mekong River.

Dredging activities can pose a threat to the aquatic environment not only through the disposal of dredged material, but also through the dispersal of pollutants into surface waters during dredging.
To mitigate the impact of channel dredging activities on the environment, it is proposed to conduct an Optimization study of dredging sand from the Mekong River at various places that are not creating a negative impact on the river behavior or ecological status and to adopt Dredging Environmental Management Procedures (DEMP).

- <u>The impact on river habitats, river banks and eco-regions</u>
  Limited research exists on the impacts of modifications of waterway channels on ecosystems, fisheries and livelihoods in the Mekong River Basin. Planned developments for port construction, dredging and reef removal in the upper and lower part of the Mekong Basin need to be assessed against the significance of the ecological areas.

  The eco-regions are important to use as a first step in preliminary assessments (e.g. initial environmental impact assessment (IEIA) or examination) to determine the existing environmental degradation, biodiversity and protected areas in relation to the specific location of existing and planned IWT projects/activities in specific stretches. Further Environmental Impact Assessment (EIA) would be required to consider the critical ecosystems, fisheries conservation zones, water quality, ecological status and socio-economic conditions. The eco-regions could also be used to determine zones or restrictions for port/vessel activities, transport of dangerous goods and dredging/sand mining activities.

- <u>The impact on fishing activities</u>
  Also inland navigation could be a disturbing element for capture fisheries:

  - By dredging millions of cubic meters of sand in possible fishing zones. Therefore, it is important that new dredging projects are assessed with consideration to protect fishing zones and wetlands, the provision of habitats (ecosystem connectivity) and the maintenance of the nutrient cycles (especially dredging works in the Tonle Sap Lake requires special consideration);

- By allowing bigger ships of which the stern waves can influence embankments and flood fish zones. Therefore, it should be studied in which river stretches a speed reduction or even restrictions for port/vessel activities should be introduced.

- The impact from hydropower development
  The changes in flow regime due to potential hydropower and climate change could result in higher flows in both wet and dry seasons, lower flow in the high-flow season and increased flow in the low-flow season (MRC 2011). Moreover, the Mekong Delta is vulnerable to projected reductions in sediment transport that could cause destabilisation of riverbanks from down cutting and bed erosion, potentially impacting port and waterway infrastructure. Therefore, dam operations should be duly adapted to these risks.
- The impact from sand mining
  Dredging and sand mining would usually be considered as two separate issues, as modern waterway dredging strategies prohibit commercial extraction and require refilling of dredged material in the system. To date, the issue of sediment mining in the Mekong River channel has been a politically sensitive issue. In-channel extractions are contributing to a reduced sediment load in the Mekong Delta, causing large-scale erosion. Therefore, rigorous Environmental Impact Assessment (EIA) studies should precede any new sand mining project.

From this overview, it can be seen that the navigation development scenario 2040 only can be sustainable if a lot of fleet, port and waterway safety measures are carried out and if all development projects are submitted to rigorous Environmental Impact Assessment and Social Impact Assessment studies.

The economic value of some parts of the scenario (e.g. Luang Prabang – Savannakhet, Savannakhet – Kratie, Tonle Sap Lake) could eventually be re-assessed.

10. CONCLUSIONS

The scope of the Council Study Navigation Thematic Area is the assessment of transboundary positive and negative impacts on environmental, social and economic parameters based on the existing and planned navigation infrastructure on river flow (quantity, quality, timing and content) including the assessment of the positive and negative impacts of water resources development in other thematic areas on navigation with mitigation measures

The navigation scenarios aim to have a growth of waterborne transport in the Mekong River basin of at least 5% per year during the coming 25 years. Therefore, it is planned to allow 500-ton vessels during the whole year from the Green Triangle to Kratie (including a bypass canal with three locks at the Khone Falls). The river stretch between Kratie and Kompong Cham should be navigable for 2,000 DWT ships over the whole year (1), the stretch between Kompong Cham and Phnom Penh for 3,000 DWT ships (1), the stretch between Phnom Penh (New Container Terminal) and Can Tho for 7,000 DWT ships and the stretch from Can Tho to the sea for 10,000 DWT ships over the whole year. Finally, the Tonle Sap River and Lake between Phnom Penh and Chhong Kneas (Siem Reap) should be navigable for boats of 500 ton over the whole year.

(1) The navigability in these stretches of the river will be limited by the insufficient air clearance under the Kizuna and Prek Tamaek bridges at high water.

As main transboundary impact assessment conclusions, it can be stated that:

1. There will be a **positive economic impact** of navigation development scenarios:
   M1 Early development scenario 2007
   Total IWT Cargo volume 14,817,000 ton and total IWT passengers 38,178,000 pax. (of which 550,000 tourists).
   2007-2020
   Executed, planned and proposed projects on waterway improvement, port development and navigation safety for a total cost of 913 million US$ (including Quang Chanh Bo Canal and Xayaburi dam locks).
   M2 Definite future scenario 2020
   Estimated forecast of total IWT Cargo volume 36,221,000 US$ and total IWT passengers 99,700,000 pax. (of which 1,250,000 tourists).
   2020-2040
   Planned and proposed projects on fleet upgrade, waterway improvement, port development and navigation safety for a total cost of 1,946 million US$ (including locks at 7 hydropower dams and bypass canal at the Khone Falls).
   M3 Planned development scenario 2040
   Estimated forecast of total IWT Cargo volume 167,847,000 ton and total IWT passengers 318,952,000 pax. (of which 6,080,000 tourists).

   Without IWT investments, the total IWT cargo volume 2040 is estimated to be 78,541,000 ton, meaning that with IWT investments, about 89 million ton of cargo can be shifted from road to IWT.

2. There will be a **positive social impact** of navigation development scenarios
   - Employment in IWT sector (Ship wharfs, ports, tourism ……): employment in the inland waterway transport sector (situation 2014) can be roughly estimated at 780,000 people. With the predicted growth of the sector, it can be assumed that employment will grow at the same pace up to 975,000 people in 2020 and up to 1.95 million people in 2040.

- Accessibility to education, health, cultural and social services (see number of passengers)
- Education and training opportunities

3. There will be a **neglectable impact** of navigation development scenarios **on water quantity, timing and (sediment) content**.
The navigation scenarios will have a neglectable impact on water flow quantity, timing and content assuming that the dredged material is dumped in the river again to maintain the hydrological and sediment balance.

In the "Technical Feasibility Study of Dredging the Tonle Sap Lake for Navigation", MRC, July 2007, the main conclusions were:

- that only little or no channel maintenance dredging is needed – the average sedimentation in the navigational channel is less than 5 mm/year;
- that it is worth investigating the possibility to deposit the dredged sediment on the lake bed and examine distance from where no significant amounts of deposits are moved by flows and waves back to the channel; and
- that checking of the channel filling up rate and the behaviour of the deposited sediments in-situ by experimental dredging and deposition tests is recommended due to the complex set of factors affecting the bottom processes.

4. There will be a **limited (negative) impact** of navigation development scenarios **on aquatic life, animals, residents, villages and towns** during construction
   - **See "Draft Development Plan on International Navigation on the Lancang-Mekong River", JCCCN, 2015**
     "Impacts on aquatic life: During the construction, reef blasting may influence fishes within a certain "range. However, because the shock waves will be mitigated by water flow, the short-term impact of "reef blasting on fishes is limited to maximum 100 meters. Measures should be taken to chase the fish "away before blasting and moreover, every rapid removal project should avoid migrating and spawning "seasons.

     "The long-term impact of dredging and reef removal is mainly on the normal behavior of fishes caused "by the change of ecological environment in the River. After some reefs being removed, fishes will lose "some habitat but macroscopically speaking, the navigation scenarios will not cause significant change "to the ecological system of the Mekong River and it will have minor negative impacts on the long-term "behaviors of the fishes in the River.

     "Impacts on Wild Animals: All the construction areas are under the flood level of the River, which "indicates that the project will not have impact on plants and animals on the banks. For the wild "animals living near construction sites, the preparation work of blasting will scare them away. The "planned ports will be built in densely-populated areas. Therefore, the construction of ports won't have "impacts on wild animals.

     "Impacts on Residents, Villages, Towns and Scenic Spots: Reef blasting sound and shock wave may "have temporary impacts on residents within 100 meters from the blasting sites. However, because "most reefs to be improved are far from residential areas and borehole-blasting method will be applied, "there will be no impact on residential areas, villages, towns and scenic spots along the River.

   Mitigation Measures

   - Dredging activities are executed following the "Dredging Environmental Management Procedures (DEMP)";
   - EIAs should be carried out for every port development activity, every dredging activity (habitats, protected zones, …) and rapid or reef removal (blasting, chiseling, …). These EIAs

should be done by an independent organization/institute and approved by the competent authority(ies) before the start of the works.

5. There will be a **limited (negative) impact** of navigation development scenarios **on water quality** during operations
   - **See "Draft Development Plan on International Navigation on the Lancang-Mekong River", JCCCN, 2015**
     "Because it is predicted that in 2040 waterborne transported cargo volumes will be 5 to 6 times higher "than today and waterborne passenger transport will be 3 to 4 times higher than today, also water "pollution from vessels will increase.
     "Oil pollution: However, navigation of vessels on the River will not have serious impacts on water "quality. It is predicted that larger vessels, equipped with an oily water separator, will cause limited "pollution to the water near the discharging place, but the water quality of the whole River won't be "influenced. The oil discharged from vessels will account for only 0.0085% of the environmental "capacity of the River.
     "Vessel sewage: Compared with oily water, vessel sewage causes less pollution and will have minor "impacts on water quality of the River. Even if vessels on the River will increase with development of "waterway transport in the future, the Mekong River will still have a large environmental capacity, and "the water quality will basically remain at the current level.
     "Solid Waste Pollution: If solid waste of vessels is discarded into the River, water will be polluted. "When floating garbage gathers on banks, they will not only have serious impacts on the cleanness of "environment and worsen water quality, but also influence aquatic life in the River. Consequently, the "daily garbage from vessels has to be collected and transported to the destination ports for receiving "and treatment.

   Mitigation Measures

   - Vessels shall be installed with oil-water separator, in order to prevent oily water from polluting the River.
   - Small vessels not equipped with oil-water separator shall be installed with temporary slop tanks, and these pollution prevention facilities shall be gradually improved.
   - Ports shall be planned with facilities for receiving and treating oily water in order to receive and treat oily water from small vessels.
   - A strict management system on discharge of vessels' residual and oily water shall be established. Vessels discharging oily water not treated or not meeting standards will be educated and fined, in order to enhance the crewmembers' consciousness of protecting water quality.
   - A collection system of solid waste shall be established on passenger and cargo vessels. All the garbage on board shall be collected with dustbins or bags, and shall not be thrown into the River. After arrival at the destination ports, the garbage shall be received and treated by the port treatment stations.

6. There will be a **positive impact from the hydropower development** on navigation development scenarios
   - In the upstream reservoirs, created by the hydropower dams, sufficient water depth over the whole year will be created to allow bigger ships to sail in the related stretches of the river. Without these reservoirs, the cost-benefit of necessary river design works (dredging, rapid and reef removal) to allow bigger ships to sail during the whole year would certainly be negative.
   - Due to the projected reductions in sediment transport, less maintenance dredging in the Lower Mekong River will be needed.

7. There will be a **negative impact from the hydropower development** on the navigation development scenarios
   - The greatest obstacle for the growth of inland waterway transport sector is the fact that waterway transport is slower than land transport. Therefore, the lock operations at the hydropower dams should not increase the transit times of waterway transport because this could seriously disturb the growth of Inland Waterway Transport in the concerned river stretches. It is predicted that in 2020, two lock operations per day and in 2040, twelve lock operations per day will be needed at each dam.
   - Emergency dam operations with high release and flushing of water, due to high water levels or high sedimentation in the upstream basins, can lead to daily and even hourly flow changes that can be harmful for the berthed and sailing ships downstream, even with accidents and damage if the boat operators are not informed in time.
   - Due to hydropower development, the Mekong River is vulnerable to projected reductions in sediment transport that could cause destabilisation of riverbanks from down cutting and bed erosion, potentially impacting port and waterway infrastructure.

   Mitigation Measures

   - To reduce the impact of the dam operations and the lock operations at the dams on the navigation, it should be of a high priority to establish a "Vessel Traffic Service Center" with compulsory AIS and VHF on board of selected ship sizes and types to inform the skippers of lock and dam operations.
   - Regular inspections of the foundations of ports and waterway infrastructures.

8. There will be a **limited positive impact of Climate Change** on the navigation development scenarios
   - **See "First Draft of main scenario report: Modelling the impacts of climate change and development infrastructure on Mekong flow, sediment regimes and water quality", MRC, April 2017**
   - The increase of the dry season flow (+ 25 to +30%) and decrease of wet season flow (- 5 to -10%) between Chiang Saen and the Cambodia-Viet Nam border, due to the hydropower development will slightly be reduced by climate change.
   - From the ISIS modelling for the scenarios M1, M2, M3 and M3CC, considering the hydropower and irrigation scenarios, it can be seen that (only) with the climate change impact, the minimum available water depth in Chiang Saen, Luang Prabang and Vientiane is raising with several meters, which has a positive impact on the navigation scenarios. Less rapid and reef removal is needed to obtain a water depth of 3.10 m, allowing 500 ton vessels to sail in this stretch of the river over the whole year.
   - On the Tonle Sap Lake, the minimum water depth is raising with 0.15 m in scenario M3 and with 0.20 m in scenario M3CC which should reduce the needed capital dredging to allow 500 ton vessels to sail over the whole year in the Tonle Sap Lake from 12,348,000 m^3 to 10,037,000 m^3.
   - The big increase in the high flood events due to climate change could be a disadvantage for upstream sailing vessels but should be an advantage for downstream sailing vessels.

9. There will be no significant impact from/on the ALU (Agriculture and Land Use), FPF (Flood Protection Infrastructure), IRR (Irrigation) and DIW (Domestic and Industrial Water Use) development and sub-development scenarios on/from the navigation development scenario.

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ANNEX 1 ECONOMIC VALUE OF INLAND WATERWAY TRANSPORT CARGO VOLUME

Baseline condition (2014)

Annual total volume of IWT cargo trade on the LMB (ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	576 000	374 000	584 000	4 512 500	6 046 500
Small barges 100 ton	576 000	374 000	584 000	4 512 500	6 046 500
Medium barges 500 ton			292 000	4 512 500	4 804 500
Large barges 1,000 ton			1 460 000	4 512 500	5 972 500
Large barges 3,000 ton					
Total IWT Cargo volume	1 152 000	748 000	2 920 000	18 050 000	22 870 000

Gross Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	407	417	493	382
Small barges 100 ton	813	833	493	382
Medium barges 500 ton	0	0	493	764
Large barges 1,000 ton	0	0	985	764
Large barges 3,000 ton	0	0	0	0

Transport costs (US$/ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	36	36	36	36
Small barges 100 ton	122	126	35	35
Medium barges 500 ton	0	0	31	110
Large barges 1,000 ton	0	0	109	107
Large barges 3,000 ton	0	0	0	0

Net Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	371	381	457	346
Small barges 100 ton	691	707	458	347
Medium barges 500 ton	0	0	462	654
Large barges 1,000 ton	0	0	876	657
Large barges 3,000 ton	0	0	0	0

Annual Net Economic Value of IWT Cargo Volume (US$ Million)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	214	142	267	1561	2184
Small barges 100 ton	398	264	267	1566	2496
Medium barges 500 ton	0	0	135	2951	3086
Large barges 1,000 ton	0	0	1279	2965	4244
Large barges 3,000 ton	0	0	0	0	0
Total IWT Cargo volume	612	407	1948	9043	12010

Early Development Scenario (Existing 2007)

Annual total volume of IWT cargo trade on the LMB (ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	446500	245500	363600	2903750	3959350
Small barges 100 ton	446500	245500	363600	2903750	3959350
Medium barges 500 ton			181800	2903750	3085550
Large barges 1,000 ton			909000	2903750	3812750
Large barges 3,000 ton					
Total IWT Cargo volume	893000	491000	1818000	11615000	14817000

Gross Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	354	363	429	333
Small barges 100 ton	708	725	429	333
Medium barges 500 ton	0	0	429	665
Large barges 1,000 ton	0	0	858	665
Large barges 3,000 ton	0	0	0	0

Transport costs (US$/ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	31	31	31	31
Small barges 100 ton	106	110	30	30
Medium barges 500 ton	0	0	27	96
Large barges 1,000 ton	0	0	95	94
Large barges 3,000 ton	0	0	0	0

Net Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	323	332	398	302
Small barges 100 ton	602	615	399	303
Medium barges 500 ton	0	0	402	569
Large barges 1,000 ton	0	0	763	571
Large barges 3,000 ton	0	0	0	0

Annual Net Economic Value of IWT Cargo Volume (US$ Million)

Vessel class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	144	82	145	877	1247
Small barges 100 ton	269	151	145	880	1445
Medium barges 500 ton	0	0	73	1652	1725
Large barges 1,000 ton	0	0	694	1658	2352
Large barges 3,000 ton	0	0	0	0	0
Total IWT Cargo volume	413	232	1056	5067	6769

Definite Future (including 2020 plans)

Annual total volume of IWT cargo trade on the LMB (ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	884000	614000	916400	5728600	8143000
Small barges 100 ton	884000	614000	916400	5728600	8143000
Medium barges 500 ton			458200	5728600	6186800
Large barges 1,000 ton			2291000	5728600	8019600
Large barges 3,000 ton				5728600	5728600
Total IWT Cargo volume	1768000	1228000	4582000	28643000	36221000

Gross Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	458	469	555	430
Small barges 100 ton	916	938	555	430
Medium barges 500 ton	0	0	555	645
Large barges 1,000 ton	0	0	1109	860
Large barges 3,000 ton	0	0	0	860

Transport costs (US$/ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	41	41	41	41
Small barges 100 ton	137	142	39	39
Medium barges 500 ton	0	0	35	35
Large barges 1,000 ton	0	0	125	123
Large barges 3,000 ton	0	0	0	120

Net Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	417	428	514	389
Small barges 100 ton	779	796	516	391
Medium barges 500 ton	0	0	520	610
Large barges 1,000 ton	0	0	984	737
Large barges 3,000 ton	0	0	0	740

Annual Net Economic Value of IWT Cargo Volume (US$ Million)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	369	263	471	2228	3331
Small barges 100 ton	689	489	473	2240	3890
Medium barges 500 ton	0	0	238	3494	3733
Large barges 1,000 ton	0	0	2254	4222	6476
Large barges 3,000 ton	0	0	0	4239	4239
Total IWT Cargo volume	1057	752	3437	16424	21669

Planned Development Scenario (including 2040 plans)

Annual total volume of IWT cargo trade on the LMB (ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	1474400	1278000	2058100	13350400	18160900
Small barges 100 ton	1474400	1278000	2058100	13350400	18160900
Medium barges 500 ton	4423200	3834000	6174300	26700800	41132300
Large barges 1,000 ton			4116200	40051200	44167400
Large barges 3,000 ton			6174300	40051200	46225500
Total IWT Cargo volume	7372000	6390000	20581000	133504000	167847000

Gross Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	680	697	824	639
Small barges 100 ton	680	697	824	639
Medium barges 500 ton	1247	1394	824	639
Large barges 1,000 ton	0	0	1648	1065
Large barges 3,000 ton	0	0	1648	1278

Transport costs (US$/ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	60	60	60	60
Small barges 100 ton	58	58	58	58
Medium barges 500 ton	178	166	52	52
Large barges 1,000 ton	0	0	182	139
Large barges 3,000 ton	0	0	179	177

Net Economic Value of IWT Cargo Volume (US$ per ton)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam
Small barges <50 ton	620	637	764	579
Small barges 100 ton	622	639	766	581
Medium barges 500 ton	1069	1228	772	587
Large barges 1,000 ton	0	0	1466	926
Large barges 3,000 ton	0	0	1469	1101

Annual Net Economic Value of IWT Cargo Volume (US$ Million)

Vessel Class	Thailand	Lao PDR	Cambodia	Viet Nam	Total LMB
Small barges <50 ton	914	814	1572	7730	11030
Small barges 100 ton	917	817	1577	7757	11067
Medium barges 500 ton	4728	4708	4767	15673	29876
Large barges 1,000 ton	0	0	6034	37087	43122
Large barges 3,000 ton	0	0	9070	44096	53166
Total IWT Cargo volume	6560	6339	23020	112344	148262

ANNEX II WATERWAY TRANSPORT RELATED ENVIRONMENTAL LEGISLATION

Environmental Protection and Environmental Impact Assessment

In Thailand, the National Environmental Quality Act (NEQA) 1992 outlines requirements to prepare an EIA report for different project types and sizes. For the IWT and shipping sectors EIAs are required and must be prepared for the construction of new ports and navigation infrastructure along the Mekong River. Ports/terminals, shipping companies and dredging/sand mining operators are required to develop EMPs.

In the Lao PDR, the Environmental Protection Law 2013 defines the principles, regulations and measures related to environmental management, including the monitoring protection, control, preservation and rehabilitation of the natural environment. This law includes two articles on the assessment procedures for Initial Environment Examination (IEE), Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA).

In Cambodia, an EIA study and report is required for the construction of new ports and landing facilities, channel dredging and bank protection works. All public and private investment/development projects must submit a full EIA report to the MoE. Specific legislation, sub-decrees or prakas (guidelines) for the IWT sector have not been developed. The principles of a new draft law promote public participation and integrating social impacts into the EIA process, including a health impact assessment for people living in or surrounding the project area.

In Vietnam, the decision on SEA, EIA and environmental protection commitment (*Decree No. 29/2011/ND-CP*) outlines the projects that are subject to EIA:

- Inland ports that can receive ships of more than 1000 DWT need to prepare EIA; and
- Inland ports that can receive ships of less than 1000 DWT need to register an environmental protection commitment (EPC).

MONRE reported that EIA legislation requires private transport enterprises and port/terminal operators to develop EMPs, however, the inspection and supervision of environmental functions is not implemented or enforced.

Finally, MRC, in consultation with Member Countries, has been preparing "Technical Guidance for Conducting and Considering Transboundary Environmental Impact Assessment (TbEIA)" process for proposed development projects/activities in connection with the national EIA process. The TbEIA guides when and how two or more Member Countries should conduct a joint TbEIA study in order reach a common understanding of any potential impacts of a development project/activity.

Water Quality Monitoring

In Thailand, under the NEQA, the National Environment Board prescribes the following environmental quality standards:

- Water quality standards for river, canal, swamp, marsh, lake, reservoir and other public inland water sources according to their use and classifications in each river basin or water catchment;
- Water quality standards for coastal and estuarine water areas;
- Groundwater quality standards;
- Atmospheric ambient air standards;

- Ambient standards for noise and vibration; and
- Environmental quality standards for other matters.

The Pollution Control Department (PCD) under MONRE is responsible for water quality and management, hazardous materials and pollution control.

In the Lao PDR, chapter 2 of the Environment Protection Law 2013 relates to pollution control, air, soil, water and disturbance such as noise, light, odour, vibration and heat. Article 17 includes environmental prevention against chemical leakages due to accidents and limitation of impacts caused by construction. This can be applied to the construction of ports/landing facilities and also the operational impacts of IWT. The water quality parameters and guidelines are outlined in the National Environmental Quality Standard No: 2734/PMO-WREA, December 2009, which includes drinking water quality, groundwater quality and surface water quality standards. In Lao PDR, monitoring of water quality is not undertaken for specific locations in relation to navigation activities and ports.

In Cambodia, water quality monitoring is undertaken in surrounding ports/terminals and IWT operations. The water sampling stations include: Phnom Penh Port, Bak Prea, Kompong Luong, Neak Luong and Phnom Krom. A specific water quality standard has not been developed to measure the potential impacts from IWT. However, several national standards from the Sub-Decree on Water Pollution Control 1999 can be applied. MOWRAM and MOE do not specifically monitor or report water quality in the navigation sector.

In Vietnam, the Department of Water Resource Management (DWR) under MONRE is responsible for water quantity (flow) and does not undertake water quality monitoring for ports/terminals. The Environmental Management Agency do this. Water quality issues can be discussed with the Environmental Management Agency and the National Hydrometeorology Service. The implementation of environmental monitoring responsibilities and data management is detailed under the 'Law on Environmental Protection 2014'. Port/ship operators must also comply with standards for environment and water quality.

Pollution Control and Waste Management

In Thailand, the Pollution Control Department (PCD) under MONRE is responsible for water quality and management, hazardous materials and pollution control. Section 78 of the NEQA 1992 relates to water pollution from the collection, transport and disposal of garbage/solid wastes and the discharge of oil and the dumping of wastes from sea-going vessels, tankers and other types of vessels. The main issue with establishing systems to monitor and respond to water pollution incidents is the implementation of water quality emergency plans at the regional and national level.

In the Lao PDR, chapter 3 (toxic, chemical control and waste disposal) and chapter 4 (environmental certification and permission) of the Environment Protection Law 2013 will ensure that investments comply with the national environmental quality standards and the national pollution control standards. There is currently limited pollution control and contingency planning for the existing ports and IWT activities in Lao PDR.

In Cambodia, the MOE is responsible for monitoring the existing IWT operations for pollution control and the management of solid and liquid wastes, including ballast water discharge. There are no adequate waste reception facilities or systems to monitor and respond to water pollution incidents along the Mekong River.

It is the responsibility of the port and terminal operator to arrange for the collection of wastes.

In Vietnam, small oil spills during IWT activities are reportedly common, but only a few ports have adequate equipment for collecting oil, diesel and other liquid wastes. The handling of oil spills is difficult as there is limited funding and investment, limited training, out of date technology and low

effectiveness of treating oil spills in fast flowing rivers. There are no facilities to receive vessel wastes on shore and ships are not equipped with adequate waste collection systems.

According to 2009 statistics from a survey of 24 port companies operating in the southern region of Viet Nam, 66 per cent reported managing solid and hazardous waste in accordance with national regulations. However, only 30 per cent of those surveyed had invested in environmental protection and wastewater treatment systems.

Article 16 of 'Decision 02/2013/ND-CP dated Jan 14th 2013' requires all port operators (maritime, military and inland) to develop emergency and oil spill response plans. Port authorities are responsible for coordinating local monitoring and evaluating the effectiveness of the response plans.

The 'Law on Environmental Protection 2014' outlines actions against causing serious environmental pollution from activities such as discharges of wastewater, exhaust gases, dust, solid wastes, noise, vibration, and other pollutants. MONRE is responsible for enforcing these laws.

The same law requires ministries/departments to report environmental aspects to MONRE, including condition reports, environmental complaints, compliance with regulations, list of entities causing pollution, investigations and environmental protection plans and solutions.

Dredging and Sand Mining Operations

In Thailand, under the NEQA, activities that involve dredging of more than 100,000 m^3 are considered as serious impacts to the environment. It was reported that MONRE is responsible for monitoring dredging and sand mining operations in Thailand. The Thailand Marine Department (MD) is responsible for maintaining the navigation channel; there are no specific licensing or environmental requirements for dredging and sand mining in the Mekong River.

In the Lao PDR, the responsibility for dredging the navigation channel and licensing sand mining operators requires further investigation. It could not be determined from laws or guidelines if private and public operators are required to prepare an EIA or EMP for dredging or sand mining activities (Decree No 7737/MPWT, dated 8/08/2010 and 467/MPWT.WD, dated 15/01/2013 on the responsibility for the dredging of the navigation channel and licensing for sand mining operators only in Lao language).

In Cambodia, the process for licensing and managing the environmental impacts of dredging the navigation channel and sand mining operations is complex. The MPWT is responsible for dredging the navigation channel and waterway conditions and the Ministry of Industry, Mines and Energy (MIME) for sand mining.

The MPWT is preparing a technical guideline on managing the environmental impacts of navigation dredging that will require private-sector dredging of more than 5,000 m^3 to submit an EIA to MOE and develop an EMP. Due to concerns around sand mining, the government recently established the Committee on Sand Resources Management with relevant ministries and institutions (dated 20th March 2015) and issued an Inter-Ministries Prakas (MIME-MOE) on EIAs for all kind of sand mining activities (dated 24th March 2015).

In Vietnam, the dredging extraction of sand and gravel is widespread along the waterways and is becoming increasingly complex, affecting the navigation channel and also the safety of IWT operations. The government requires dredging and sand mining operators to comply with an EIA (Decree No. 29/2011/ND-CP dated 18 April 2011) if the volume is higher than 50,000 m^3 or the area is higher than 10,000 m^2. If the volume is below 50,000 m^3 and the dredging area is less than 10,000 m^2, then an EPC is required. To strengthen the management of sand mining, the government has issued specific instructions for the survey, transportation and extraction of gravel and sand from the riverbed (Directive No.29/2008/CT-TTg). Under this directive, the Provincial People's Committee consult with other ministries to restrict illegal sand mining activities. Meanwhile MONRE coordinates

with provincial People's Committees to raise local awareness on the relevant laws, and MOT reviews and approves the dredging plans and ensures that the operator registers the volume of sand and gravel to be extracted. VIWA or the Department of Transportation (DOT) evaluate the maintenance of inland waterway plans for dredging, and then submit them to MOT for approval (Circular No. 17/2013 /TT-BGTVt dated 05 Aug. 2013 of MOT).

Climate Change

In Thailand, the Climate Change Master Plan is a framework of integrated policies and action plans. Its purpose is to support climate change preparedness initiatives so that they are in line with Thailand's economic and socio-cultural contexts as well as economic development.

The Safety and Planning Bureau of the Transport and Traffic Policy and Planning Office has developed the "Master Plan for Sustainable Transport and Climate Change Mitigation". The master plans enable the integration of information among stakeholders, build up capacity and develop infrastructure. It could not be determined whether any IWT projects are under the Master Plan for Sustainable Transport and Climate Mitigation.

In the Lao PDR, in 2010 the National Strategy on Climate Change was adopted. In June 2011, the Department of Disaster Management and Climate Change (DDMCC) under the MONRE was formed. The main duties of the DDMCC are:

- To research, disseminate, and implement directions, policies, resolutions, orders, strategies, laws and legislations of the government on national disaster and climate change; and
- To research and apply directions, policies, strategy plans, orders, agreements, notifications, and other legislation of MONRE to become work plans, detailed projects and implement these in an effective way.

In the meantime, the '*National Climate Change Adaptation Action Plan for 2013-2020*' is being implemented with the followings priority activities:

- Strengthening institutional and human resource capacity on climate change;
- Enhancement of adaptive capacity for coping with climate change;
- Climate change mitigation through reduction of GHG emissions; and
- Strengthening education and public awareness on climate change.

Cambodia has developed and documented action plans to respond to climate change, including:

- Cambodia Climate Change Strategic Plan 2014-2023;
- National Adaptation Programme of Action to Climate Change (NAPA);
- Sectoral action plans (e.g. MOWRAM, Ministry of Agriculture, Forestry and Fisheries, MPWT, National Committee of Disaster Management and other line agencies); and
- National Strategic Development Plan (NSDP) 2014 – 2018.

The climate change strategic and sector plans are being developed for transport infrastructure including roads, bridges, and maritime and inland ports.

In Vietnam, inland ports and navigation infrastructure in the Mekong Delta are extremely vulnerable to climate change. According to the National Climate Change Scenarios 2012 the following is predicted for the low, medium and high emissions scenarios in Viet Nam: A sea level rise of 54 to 72 cm in the low emission scenario (B1), a rise of 62 to 82 cm in the medium emissions scenario (B2), and a sea level rise of 85 to 105 cm in the high emission scenario (A1).

Climate change is predicted to adversely affect transportation infrastructure in the Mekong Delta. Rising sea levels may impact on low lying inland ports and sea ports and, combined with increased water levels, affect navigation clearance under bridges and power lines crossing over the river.

Predicted heavy rains and flooding may lead to increased erosion, damage to port infrastructure, road works and railway.

The government has implemented the National Program to Respond to Climate Change (Decision No. 158/2008/QD-TTg dated 12/02/2008) and MOT has developed specific adaptation and mitigation plans (Decision No 199/QĐ-BGTVT dated 26 Jan 2011) for transport infrastructure including roads, bridges, and maritime and inland ports.

Coordination

In Thailand, coordination mechanisms exist between MD, MOT and ONEP to manage the environmental and social impacts of IWT.

In the Lao PDR, further analysis is required to determine the coordination mechanisms between MONRE and the Department of Waterways to ensure that the social and environmental impacts of future IWT development is effectively managed.

In Cambodia, the Department of Planning in the MPWT is responsible for managing social and environmental impacts and for coordinating with MOE. The MPWT reported that environmental and social issues are addressed in project planning and implementation through education/awareness programs and by establishing authority and teams for monitoring and assessing potential impacts.

In Vietnam, MOT is required to coordinate with MONRE and relevant ministries to implement and monitor laws on environmental protection for construction of traffic infrastructure and transport activities (Decree No. 107/2012/ND-CP). The MOT reported that good coordination exists between MONRE and the Ministry of Labor, Invalids and Social Affairs (MOLISA).

VIWA does not have any inspectors and relies on MONRE to inspect ports and terminals. More coordination between VIWA, MONRE and port authorities would improve this process.