MYANMAR TRANSPORT SECTOR POLICY NOTE

RIVER TRANSPORT

ASIAN DEVELOPMENT BANK

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Come you back to Mandalay,
Where the old Flotilla lay:
Can't you 'ear their paddles chunkin' from Rangoon to Mandalay?

Rudyard Kipling. 1892. *Mandalay*

Foreword

Myanmar is at a historic milestone in its transition into a market economy and democracy. After decades of isolation and stagnation, the country has, since 2011, been undergoing a fundamental political, economic, and social transformation at unprecedented speed and scope. Achieving the country's high growth potential will require continued reforms and structural transformation, especially in advancing major investments in infrastructure, developing relevant capacities and skills, and enhancing the business environment. This will enable Myanmar to reach the ranks of upper middle income economies by 2030.

Due to massive underinvestment and neglect in recent history, Myanmar's infrastructure lags behind its Association of Southeast Asian Nations neighbors, and hinders access to markets and social services. High transport costs and associated limited access to markets and services are among the main causes of poverty and regional inequality. Twenty million people still live in villages without access to all-season roads. The questions then are: how can basic transport services be provided to all? What does it take to improve the quality of the transport infrastructure and services for the private sector? How can Myanmar reduce the economic and social costs of transport?

The Government of the Republic of the Union of Myanmar is committed to addressing these questions, and the underlying issues. Towards this end, the Government has commissioned from the Asian Development Bank (ADB) the preparation of a *Transport Sector Policy Note*. The *Transport Sector Policy Note* takes stock of the transport sector challenges, provides a strategic framework for reforms that could assist Myanmar's policymaking, and identifies the areas where international financial and technical assistance could make the highest contribution to the development of Myanmar's transport sector.

The *Transport Sector Policy Note* is composed of nine reports, including this one, and a summary for decision-makers. The first two—*How to Reform Transport Institutions*, and *How to Reduce Transport Costs*—provide an overview and framework for policy reform, institutional restructuring, and investments. These are accompanied by separate reviews of key subsectors of transport: *Railways, River Transport, Rural Roads and Access, Trunk Roads*, and *Urban Transport*. These reports summarize and interpret trends on each transport sector to propose new initiatives to develop them. The thematic report *Road Safety* builds a first assessment of road safety in Myanmar. The thematic report *How to Improve Road User Charges* is a stand-alone study of cost-recovery in the road sector.

The research was organized by ADB and the then Ministry of Transport, with the active participation of the Ministry of Construction and the then Ministry of Railway Transportation. A working group comprising senior staff from these government ministries guided preparation. The work stretched over the period of 24 months, and was timed such that the final results could be presented to the new government that assumed office in April 2016, as a contribution to its policy making in the transport sector.

As the *Transport Sector Policy Note* demonstrates, Myanmar can, and should, develop a modern transport system that provides low-cost and safe services, is accessible to all including in rural areas and lagging regions, and connects Myanmar with its neighbors by 2030. The Government has the determination to doing so, and can tap the support from development partners, the private sector and other stakeholders. It can take inspiration from good practices in the region and globally.

The *Transport Sector Policy Note* provides a rich set of sector data, is meant to be thought-provoking, presents strategic directions, and makes concrete reform recommendations. It stresses the need to strengthen the role of planning and policy-making to make the best use of scarce resources in the transport sector. It highlights the need to reexamine the roles of the state—and particularly state enterprises—and the private sector in terms of regulation, management, and delivery of services in the sector. It identifies private sector investment, based on principles of cost-recovery and competitive bidding, as a driver for accelerated change. Finally, it aims at a safe, accessible, and environmentally friendly transport system, in which all modes of transport play the role for which they are the most suited.

We are confident that the *Transport Sector Policy Note* will provide value and a meaningful contribution to Myanmar's policymakers and other key stakeholders in the transport sector.

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and Communications

Acknowledgments

The Transport Sector Policy Note was prepared at the initiative of Hideaki Iwasaki, director of the Transport and Communications Division of the Southeast Asia Department of the Asian Development Bank (ADB). It was prepared by ADB staff and consultants. Adrien Véron-Okamoto (ADB) coordinated the study, prepared the notes *How to Reduce Transport Costs, How to Improve Road User Charges* and the overall *Summary for Decision-Makers,* drafted the executive summaries, and contributed substantially to the notes *How to Reform Transport Institutions, River Transport, Trunk Roads, and Urban Transport.* Gregory Wood prepared the note *How to Reform Transport Institutions.* The *Railways* note was prepared by Paul Power. It also benefited from analytical research and suggestions by Richard Bullock. Eric Howard prepared the Road Safety note. Kek Chung Choo prepared the *River Transport* note. Paul Starkey and Serge Cartier van Dissel prepared the *Rural Roads and Access note.* Serge Cartier van Dissel also prepared the *Trunk Roads* note. Colin Brader (of Integrated Transport Planning) prepared the *Urban Transport* note.

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Abbreviations

ADB	–	Asian Development Bank
DMA	–	Department of Marine Administration
DWIR	–	Directorate of Water Resources and Improvement of River Systems
FY	–	fiscal year
IWT	–	Inland Water Transport
JICA	–	Japan International Cooperation Agency
LAD	–	least available depth
MK	–	kyat
MOTC	–	Ministry of Transport and Communications
MPA	–	Myanma Port Authority
PRC	–	People's Republic of China
TA	–	technical assistance
UNDP	–	United Nations Development Programme
VTMS	–	Vessel Traffic Management System

Currency Equivalents

(as of December 2014)

Currency unit	–	kyat/s (MK)
MK1.00	=	$0.0001
$1.00	=	MK1,000

Weights and Measures

dwt - deadweight ton
km - kilometer
km^2 - square kilometer
m - meter
m^3 - cubic meter
mm - millimeter
t - ton

Executive Summary

Overview

The navigable river system is a major natural resource for the people of Myanmar. For centuries, it has provided Myanmar with fresh water, irrigation for one of the most extensive rice cultivation basins in the world, and over 9,600 kilometers (km) of navigable rivers. It is one of the great natural river systems in the world.

In the early 1990s, the Comprehensive Transport Study conducted by the United Nations Development Programme identified that the river transport sector had a largely unexploited potential. River channels were not engineered, ports were just landing beaches, and subsidies were heavily distortive. Because of lack of alternatives, river transport still accounted for more than 20% of national freight. With limited improvements, costs could be cut and the sector could be made sustainable. Twenty-five years on, this report updates these findings. By and large, it finds that the sector abandoned by the Government of Myanmar, left as it was, except that now it is no longer competitive with far more modern road operations. Is there still a role for river transport in Myanmar? What should be done?

This report summarizes the condition of the river and river ports, outlines the status and responsibility of the main public organizations with impact on the river, and suggests some areas of physical and policy change that would have a large beneficial impact on the river transport system.

River Transport System

Myanmar has an extensive river network that is well positioned to serve the country's main transport corridors, including the link between Yangon and Mandalay.

However, it is difficult to navigate the main rivers of Myanmar because of shallow waters during the dry season, shifting navigation channels, and lack of terminal facilities. Other factors strongly constrain transport efficiency. Larger vessels can navigate the segment between Yangon and Mandalay only about 70% of the year because of poor navigation conditions, and their operational speed is limited by the lack of a defined channel. Inadequate port facilities (i.e. often, there is only a beach landing with planks) results in very slow loading and unloading operations and creates long waiting times. As a result, river transport in Myanmar is low-cost, but not to level observed in other countries, where it is by far the cheapest mode of transportation.

The market share of river transport is now only 6% for inland long-distance freight and only 1.5% for passenger transport. The rapid decline of Inland Water Transport (IWT)—the state-owned transporter—in the last 5 years has been compensated by an equal rise in private sector operators for freight, but not for passengers.

However, even for freight, river transport has not emerged as a preferred option for any market, and is absent from bulk markets (e.g., sand, stone, ore) where it should hold a comparative advantage.

Restoring a Functioning River Transport System

Small investments are sufficient to enable the development of river transport in Myanmar. Efforts should concentrate on two objectives:

- **Improving the Ayeyarwaddy River channel and the navigation conditions between Yangon and Mandalay**. A minimum navigation depth of 1.5 m should be targeted. Channelization through river training, dredging, and bank stabilization should be followed by scaled-up efforts by the Directorate of Water Resources and Improvement of River Systems (DWIR) to maintain the channel and publicize its location. Modern navigation aids should be provided, which will enable night navigation in the long run. Larger investments, such as weirs and locks, are unnecessary and wasteful at this stage.
- **Developing basic river port terminals, gradually enabling mechanized operations**. The slow turnover of riverside operations raises costs and constrains the use of large vessels. Because of the nature of the river, mechanization can only be gradually introduced. Low cost options for river ports, such as floating docks, should be installed before considering costlier permanent structures.

These improvements have the potential to cut Myanmar's river transport costs by a factor three in the long run. They have a moderate cost—about $200 million—and the benefits may be up to seven times higher. By the end of this program, river transport could become the preferred transport alternative for low-value freight between Yangon and Mandalay.

This report proposes that the government should make improving the Yangon to Mandalay navigation channel and terminals a major initiative. The World Bank, in cooperation with the Government of the Netherlands, is already providing assistance and financing, but resources made available in the range of $35 million–$40 million are just a small share of the investments needed (about $200 million).

Improving the Institutional and Policy Framework

The organizations involved in river transport management are all under the Ministry of Transport and Communications (MOTC), but they lack clear leadership. For far too long, river transport has been equated with to IWT. The Government of Myanmar has dedicated very little funds to the maintenance and improvement of the inland waterway channels by the DWIR. River ports lack a clear custodian since the Myanma Port Authority (MPA) is only in charge of seaports, and private sector regulation has been considered a side issue by the Department of Marine Administration (DMA), which also focuses on seagoing vessels. IWT traffic has collapsed after 2010, as the government reduced its financial support to the company. By 2015, the quick decline of IWT leaves a major gap in the sector, from which it may not recover. Institutional and policy improvements are necessary to develop the river transport sector in the long run.

Restructuring the IWT, which is preferable to having it declare bankruptcy, is necessary and will require government support. The Asian Development Bank (ADB) is providing technical assistance (TA) to MOTC to consider business restructuring strategies under the TA for Transport Sector Reform and Modernization.

Since IWT can no longer be the main government agency in the sector, an alternative leader is needed. This report identifies the following as possible directions:

- DMA could be transformed into a policy and planning body, in addition to being a regulator.
- DWIR could be turned into a river management authority over Myanmar's rivers, waterways, and river ports. Resources should then be earmarked for DWIR to be financially autonomous.
- Alternatively, DWIR and MPA could be merged into a port and waterways authority. This authority would manage and develop water transport infrastructure on behalf of the government. The advantage would be that such entity could be fully self-financing ensure some degree of cross-subsidization of insufficiently funded river transport by sea transport. Since the river approaches Yangon Port, the river and seaports should be managed by the same entity, as was the case until 1972.

The sector can only be sustainable if it mobilizes higher budgets. The historic level of maintenance and operations budget of DWIR ($2 million) would need to be doubled in the short term and possibly raised to $10 million in the medium term. At some point, earmarked sector resources (e.g., share of fuel levy, vessel registration fees) could replace government resources. In the short run, the sector will need government subsidies for capital investments of about $200 million. These would likely not be recovered, even though parallel revenue sources (e.g., water tax, land development revenues) may be mobilized.

Finally, a river port development model that associates with national and regional or state governments is needed. Meanwhile, one option may simply be to declare some of the river ports are of national importance, and to request MPA to lead in their development in cooperation with DMA and DWIR.

Myanmar Navigable Waterways

This map was produced by the cartography unit of the Asian Development Bank. The boundaries, colors, denominations, and any other information shown on this map do not imply, on the part of the Asian Development Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information.

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1 Introduction

The Situation in the 1990s

This note has the special advantage of being able to look back more than 20 years ago. Considerable analytical work on the sector has been done, in particular the Irrawaddy and Lower Chindwin Rivers Study by Haskoning (1988), and the Comprehensive Transport Study (1993) funded by United Nations Development Programme (UNDP) and managed by the World Bank. The general findings of these studies are summarized in the next paragraphs.

In the 1990s, Myanmar already had a large network of rivers that had not been exploited fully and effectively for transportation. Vast stretches of water were in their natural state which, if improved, could be used more extensively for the transport of goods and passengers. In their natural state, the rivers have large variations in depth between low and high water levels, and have frequent changes in the course of the river channels, especially in the delta region. Outside the delta, free movements of 300-ton vessels were possible up to Mandalay for 10 months of the year. For the remaining 2 months, only 100 tonners could navigate the river.

The river network had enabled small-scale and unreliable operations. Physical constraints and a limited number of local expert river pilots hampered the growth of the inland waterway shipping industry. Navigation was difficult when the riverbed was shallow and the course constantly changing. There was heavy reliance on local pilots whose knowledge of the river was acquired from years of sailing on the river. Such knowledge was hard to come by, and this discouraged the entry of new participants in the sector. Sailing time was never certain because it depended on pilot skills. The cost of effective routine marking, dredging, and surveying the river usually ended up three times the amount budgeted.

The fleet was old and small. It consisted of 491 government-owned vessels (average tonnage: 140 dwt, age: 31 years), and 1,760 vessels controlled by a large number of private operators (average tonnage: 75 dwt, age: 17 years). Most cargo barges were below 300 tons, and most passenger-cum-cargo barges were below 100 tons. Generally, the fleet was not adequately maintained and repaired; its service availability was poor; and its safety record was considered low by most standards. In the 1980s, an average of 10 boats sank every year.

The fleet was very inefficiently utilized (20% usage rate), which was linked to the need for frequent repairs (80%–85% availability rate), very long waiting times at terminals (10 days average), symptoms of overcapacity, macroeconomic restrictions (lack of fuel), and slow loading and unloading (partly due to difficult port access).

River port facilities were "only landing beaches, at which vessels temporarily moor and ground themselves to load and unload, using their own gangplank,"[1] with the exception of the port of Yangon (825,000 tons/year). All operations remained manual, except for a few specialized terminals for petroleum products (pipelines) and cement or fertilizers (conveyor belts); all operations remain manual. Most ports had no storage facilities, and land access was only via steep narrow unpaved tracks suitable for oxcarts.

Still, river navigation was a major mode of transport for Myanmar. In 1993, it accounted for 22% of long-distance movements of goods (both by volume and production)—2.6 million tons annually and 983 million ton-kilometer (ton-km).[2] Goods transported were mainly paddy and rice (25%), petroleum (18%), and cement (11%). It was the mode of choice for the long-distance movement of petroleum (58%), cement (50%), fertilizer (45%), and paddy and rice (35%). The Comprehensive Transport Study estimated transport of passengers to be about 1.5 million long-distance passenger trips (262 million passenger-km, 3% of all passenger trips).

The economics of river transport were deeply distorted, constraining future development. Freight fees (MK0.22/ton-km in 1993) charged by Inland Water Transport (IWT), the dominant carrier, were half their long-term financial costs, undermining private operators which had to charge their full costs (MK1–4/ton-km in 1993) and did not have access to subsidized fuel and foreign exchange. Tariffs bore little resemblance to actual economic costs (MK4/ton-km on a 250 km trip). Inefficiencies meant that waterway transport was not as competitive as road transport for distances less than 700 km if economic costs were considered. However, because of various subsidies and direct allocation of goods, most river transport was actually on short to medium distances. Future growth was dependent on sustained government capital injections in IWT to renew its fleet, which had been lagging behind.

Economic reforms, more than investments, were seen as key to reducing inland waterway transport costs. Relieving macroeconomic constraints on fuel and foreign exchange availability, and introducing equal treatment for IWT and private operators (by terminating the freight allocation system and raising IWT's prices to long-term costs) would have led to major gains in efficiency in fleet use and free the resources needed for a gradual modernization of the fleet. Fleet modernization itself would have cost about MK360 million per year over 15 years (total $77 million as of 1993). Limited improvements in infrastructure, particularly, (i) improving the marking system to introduce night navigation, (ii) river training and dredging the Ayeyarwaddy to increase the least available depth up to potentially 2.1 m between Pyay and Mandalay, (iii) extending port operating hours to 20 hours/day, and (iv) improving river terminals (simple pontoon with gangway) at low cost (not involving mechanization) would have yielded significant results.

Overall, it was potentially possible to reduce freight river transport costs by a factor of three, and fully restore competitiveness of river transport. Users of river transport would have faced tariff increases, the growing private sector would have enjoyed better quality services and the economy of Myanmar would have improved.

25 Years Later

These recommendations had not been fully implemented mainly due to shortage of funds, and past economic sanctions that isolated the country from external sources of investments. The few reforms that were implemented took time to yield results.

1 United Nations Development Programme. 1993. Comprehensive Transport Study.Yangon. Emphasis added.

2 This may be underestimated: in the same year, Inland Water Transport (IWT) recorded carrying 2.1 million tons at an average distance of 200 km, or 418 million ton-km.

Consequently, river transport is losing market share in the transport of goods and passengers. This is due to shortcomings in infrastructure and service delivery, and is compounded by institutional weaknesses.

This raises concern on the long-term viability of river transport in the country. More importantly, it poses the question, is there a role for river transport in Myanmar?

The Inland Waterway Transport Sector

This note summarizes the past and current state of Myanmar's water transport sector, its physical extent and condition, the traffic carried, barriers to its expanded role in the national transport system, and possible changes that could improve service through better logistics and institutional reform. Some of the note's data are drawn from the Survey Program for the National Transport Development Master Plan in the Republic of Myanmar, which was completed by the Japan International Cooperation Agency (JICA) in 2014.

This note starts with a diagnostic of the current situation and the limits to and potential for improvement. Most of the physical data have not changed much since the early 1990s; the river remains unimproved. But river traffic and service have changed, most significantly, the turnover of shipping service from the government to private operators. Overall, there has been a decline in the relative significance of river transport in the face of increased competition from road haulers, both trucks and buses. This decline is amplified by the creation of many new bridges across the Ayeyarwaddy River which has cut travel time and significantly improved door-to-door service for shippers and passengers.

This note reviews and assesses the role of river transport in the movement of goods and people, and recommends strategic options to maintain the relevance of the river transport sector in the growing Myanmar economy. The findings are based on the following information:

- river network navigability and management;
- current demand and outlook;
- river ports and cargo handling facilities;
- river transport fleet (public and private);
- operational efficiency of the principal service provider;
- pricing, cost recovery, and the competitiveness of river transport; and
- core policies and regulations affecting the provision of transport services and navigation on inland waters.

This note then reviews the institutional structure of the sector, its mandates and responsibilities, focusing on the four key agencies of the Ministry of Transport and Communications (MOTC): the Department of Marine Administration (DMA), the Directorate of Water Resources and Improvement of River Systems (DWIR), the Myanma Port Authority (MPA), and Inland Water Transport (IWT).

Finally, this note recommends reform options. They focus mainly on institutional and policy improvements, and on providing an effective management and operational framework to create a fully functioning and effective water transport system.

2 River Transport System

Key Findings

Myanmar has an extensive river network that is well positioned to serve the country's main transport corridors, including the link between Yangon and Mandalay.

However, navigation is difficult along the main rivers because of shallow waters during the dry season, shifting navigation channels, and lack of terminal facilities. Several factors strongly constrain river transport efficiency. Navigation conditions constrain the use of most vessels (except the smaller ones) to about 70% of the year on the segment between Yangon and Mandalay, and the lack of a defined channel limit operational speed. The absence of port facilities (i.e., there is only beach landing with planks) makes loading and unloading operations very slow, and creates long waiting times in port.

As a result, river transport in Myanmar has low-cost, but not to the level observed in other countries, where it is by far the cheapest transport mode. The absence of port facilities and limited navigation opportunities lead to a low vessel utilization, and prevent the use of large vessels handicapped.

The market share of river transport is now only 6% for inland long-distance freight and only 1.5% for passenger transport. The rapid decline of Inland Water Transport (IWT) in the last 5 years has been compensated by an equal rise in private sector operators for freight, but not for passengers. However, even for freight, river transport has not emerged as a preferred option for any market, and is absent from bulk markets (e.g., sand, stone, ore), where it should hold a comparative advantage.

2.1 Inland Waterway Network

River Systems

Myanmar has an extensive network of rivers (Table 1 and Annex 1). Five relatively large rivers—Ayeyarwaddy, Chindwin, Thanlwin, Sittaung, and Kaladan—dissect the country and are easily accessible to a large part of the population of some 60 million. Some 6,650 km of these rivers are navigable.

The primary network is made up of the Ayeyarwaddy and Chindwin rivers and a network of streams and canals in the Ayeyarwaddy Delta. The Ayeyarwaddy is the spine of the system. It is navigable year round up to Bhamo, and up to Myitkyina during the dry season. During the wet season, rapids on the stretch of the channel between Bhamo, and Myitkyina render navigation hazardous. The Chindwin is navigable for some 730 km from its confluence with the Ayeyarwaddy. Many streams of the Ayeyarwaddy Delta are navigable and are interconnected by a web of canals. The Sittaung and the Thanlwin are used to a lesser extent for commercial navigation due to physical constraints. The Sittaung experiences heavy siltation, while rapids are prevalent on the Thanlwin. Small steamers and country boats also serve the coasts of the Rakhine and Tenasserim regions.

Table 1: Extent of Navigable Rivers (km)

Navigable Waterways	Length (km)
Ayeyarwaddy River	1,534
Chindwin River	730
Thanlwin River and rivers in Mon State	380
Rivers in Ayeyarwaddy Delta	2,404
Rivers in Rakhine State	1,602
Total	**6,650**

km = kilometer.
Source: Directorate of Water Resources and Improvement of River Systems.

Past studies have pointed to obstacles to improving the utilization of the channels. In particular, the 1993 Comprehensive Transport Study financed by UNDP and managed by the World Bank highlighted the following, which are still relevant in varying degrees.[3]

Navigation Channels

For many years, the rivers, a major mode of transportation, have essentially been used in their natural state. Development of navigation channels has been sporadic at best and mainly a response to heavy sedimentation and riverbank protection. Navigation channels are not well defined and sufficiently marked. Nautical charts providing crucial information for safe navigation are not available. Transport service providers using the rivers are left to fend for themselves as best as they can when navigating.

Geography and climate cause instability of river flows. Myanmar, with an area of about 676,000 km^2, is bordered by a series of mountains and the sea. It is bordered by mountains that are an extension of the Himalayas in the west, and by a continuation of the Yunnan Plateau in the east. The two mountain systems join in the north with elevations as high as 5,000 m. Between the mountain ranges and the sea are alluvial lowlands dissected by the five large rivers. Most of the lowland area is less than 100 m in elevation, but the elevation in the far north may be as high as 1,500 m.

Myanmar extends about 2,000 km north to south, and its eastern and western extremities are about 700 km apart. The topography and the wide expanse of land result in significant variations in climatic conditions, rainfall regime in particular (Table 2).

There are three distinct seasons: hot season during February–April, wet monsoon season during May–October, and dry and cold season during November–January. Annual average rainfall is 750 mm in the center

Table 2: Monthly Rainfall (mm)

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Yangon	5	2	7	15	303	547	559	602	368	206	60	7
Mandalay	4	3	1	40	138	116	83	136	150	125	38	6
National average	3	0	16	14	151	110	77	99	127	152	25	2

mm = millimeter.
Source: Haskoning. 1988. Irrawaddy and Lower Chindwin Rivers Study. Yangon.

[3] UNDP. 1993. *Myanmar Comprehensive Transport Study*. Yangon.

of the lowlands, 1,500 mm in the eastern and western hilly areas, and 4,000–5,000 mm in the coastal belt. About 90% of rainfall occurs during May–October, peaking during July–September. The central lowland is considerably drier than the rest.

Consequently, the water level of all rivers rises in May and June, peaking in September and October. Changes in water level in the Ayeyarwaddy Delta due to the influence of tides can complicate but is less disruptive of navigation, and vessels unable to sail due to insufficient depth may still have to wait for the water to rise.

Figure 1: Sedimentation Examples for Magway and Monywa

Magway

Monywa

Similar evidences of sedimentation can be found in many places on the Ayeyarwady

Source: Image 2016 DigitalGlobe, CNES - Astrium accessed through Google Earth.

The volume and intensity of water discharge has other physical effects. In particular, sedimentation is severe and rivers change course frequently. Sedimentation reduces the depth (free flow) of water and, in tandem with changes in the course of flow, destabilizes the channel. The severity of sedimentation is evident; in many places, accumulation of sand on the rivers is visible. The causes of river instability cannot be eliminated; they can only be mitigated.

To ensure that vessels can navigate safely, the minimum water level at the channels have to be established and maintained. Data available from the Comprehensive Transport Study show the following least available depth of the Ayeyarwaddy and Chindwin (Table 3).

Since the water level varies, appropriate depth restrictions applicable to navigation are established for various sections. Current restrictions on the draft of vessels are in Table 4.

Table 3: Least Available Depth of the Ayeyarwaddy and Lower Chindwin Rivers (m)

Stretch	Draught Limitation for Duration in Days							
	1	20	30	60	90	120	150	180
Ayeyarwaddy								
1. Yangon–Pyay	2.10	2.30	2.40	2.55	3.30	4.50	5.70	6.90
2. Pyay–Magway	1.05	1.20	1.30	1.50	2.05	2.85	3.70	4.50
3. Magway–Confluence	0.95	1.10	1.20	1.35	1.85	2.65	3.45	4.20
4. Confluence–Mandalay	0.95	1.25	1.35	1.50	2.10	2.95	3.85	4.75
5. Mandalay–Bhamo	0.75	0.95	1.10	1.25	1.80	2.65	3.50	4.40
Chindwin								
6. Confluence–Monywa	0.75	0.90	0.95	1.10	1.45	2.05	2.70	3.35
7. Monywa–Mawlaik	0.75	0.90	1.00	1.15	1.50	2.05	2.70	3.45
Ayeyarwaddy Delta								
8. Ayeyarwaddy Delta	1.40	1.90	2.20	2.65	2.95	3.30	3.60	3.80

m = meter.
Source: United Nations Development Programme. 1991. *Comprehensive Transport Study*. Yangon.

Table 4: Draft Restrictions by River Stretch

River Sections	Depth (m)	Distance (km)
Ayeyarwaddy		
Myitkyina–Sinbo	0.8	90
Bhamo–Katha	1.1	130
Katha–Mandalay	1.2	290
Mandalay–Pyay	1.5	522
Pyay–Hinthada	1.7	172
Delta	1.9	n/a
Chindwin		
Hkamti–Homalin	0.8	62
Homalin–Kalewa	0.9	64
Kalewa–Monywa	1.0	234
Monywa–Confluence	0.9	85

km = kilometer, m = meter, n/a = not applicable.
Source: Directorate of Water Resources and Improvement of River Systems.

The lowest depth available determines the size of the vessel that can use the channel. Based on the minimum depth available, the largest that can operate all year round on the Ayeyarwaddy is a 300-ton vessel.

Navigation

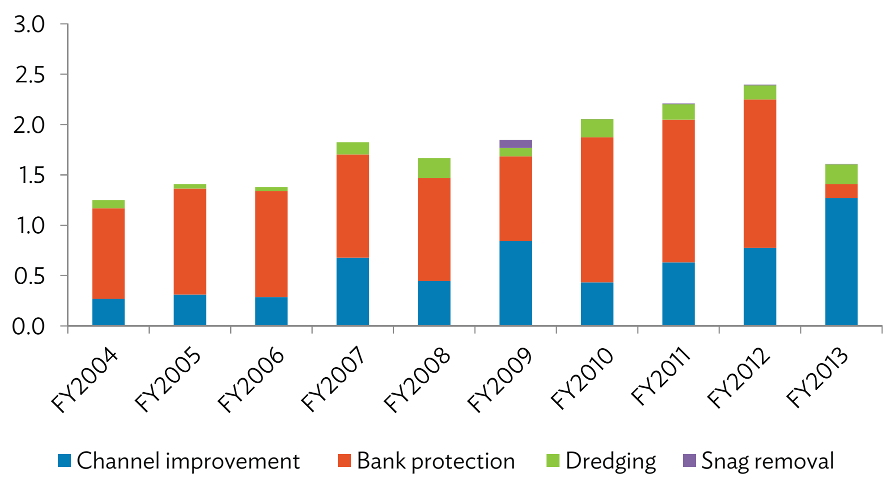
For safety reasons, navigation is confined to daylight hours. Water level is down during the dry season, and the channels are not well defined. Navigation channels are unstable due to the shallow water and the migration of sandbanks. Extensive knowledge of the waters is required to navigate the channel safely; as a rule, a pilot who knows the waters intimately should operate in restricted waters. A journey from Yangon to Mandalay will, in all cases, rely on several pilots for different sections of the river.

Careful adherence to channel markers and warning signs is necessary. However, the shortage of funds has prevented the installation of proper markers and signs as well as system maintenance. To some extent, the difficulty in maintaining a proper navigational aid system is due to the frequent changes in the course of the river and the frequent relocation of markers and signs. As a result, many markers have remained traditional, in many instances consisting of bamboo poles sticking out of the water. Navigational aids have also been supplemented by signs placed by local pilots.

Maps to mark out the routes are not available. Similarly, no navigation bulletins are issued regarding changes in river conditions or warnings about dredging and river training works and other navigational hazards.

A major issue is the lack of resources for river improvements. The annual capital expenditures on the waterways have been less than $2 million a year, most of which has gone for riverbank protection (Figure 2).

Figure 2: Annual Spending on River Infrastructure ($ million)



Source: Directorate of Water Resources and Improvement of River Systems.

2.2. River Ports

There are more than 50 designated ports along the Ayeyarwaddy, the Chindwin, and the Ayeyarwaddy Delta. River ports are often little more than landing beaches. Areas for mooring of vessels are not defined. Approach channels are not provided. The inadequacy of navigation infrastructure is accompanied by a lack of facilities for the handling of passengers and cargo at terminals.

The main river ports are Yangon (0.7–1.0 million tons just for river transport annually), and Mandalay (0.5–0.6 million tons annually). Insufficient data are available to determine the volumes of traffic at other ports. Except for these two large ports, IWT mainly operates in the upper Ayeyarwaddy—Bhamo (70,000 tons in 2012–2013), Katha (about 32,000 tons), and Ayeyarwaddy Delta (Pathein, Pyapon, Myaungmya, all generating about 20,000 tons of annual turnover for IWT). The private sector accounts for about 85% of traffic in Mandalay, but this is expected to vary much from port to port.[4]

Changes in water level make the construction of port facilities difficult and prohibitive. The water level on the rivers rises and falls as much as 11 m in some places, but this variation is magnified in the dry season, which lasts for three months (Table 5). The river network is characterized by a water regime that is highly seasonal. During the dry season, the water line recedes and a wide expanse of the riverbed is exposed.

Table 5: Annual Changes in Water Level

River	Gauge Station	Location (km)	Water Level Variation (m)
Ayeyarwaddy	Bhamo	1,332	8.27
	Katha	1,202	9.09
	Thabeikkyin	1,032	11.50
	Mandalay	912	7.95
	Sagaing	897	9.28
	Nyaung Oo	721	9.76
	Chauk	674	10.79
	Nyaung Hla	606	10.66
	Minbu	576	12.80
	Aunglan	461	13.03
	Pyay	390	11.62
	Hinthada	218	10.94
Chindwin	Mawlaik	383	12.56
	Kalewa	319	15.15
	Monywa	87	8.73

km = kilometer, m = meter.

Source: Directorate of Water Resources and Improvement of River Systems.

[4] In 1991, the following ports generated more than 100,000 tons of annual traffic: Yangon (825,000 tons), Mandalay (292,000 tons), Kyangin (189,000 tons, a cement factory), Pakokku (167,000 tons), and Pathein (131,000 tons). Other ports with 50,000–100,000 tons throughput included Bogalay, Monywa, Kyawzwa (fertilizer factory), Thayet (cement factory), Myaungmya, Chauk, Hinthada, Kyaiklat, Mawlamyine, and Labutta. Source: UNDP. 1991. *Comprehensive Transport Study*. Yangon.

Construction of a jetty requires a site some distance away from the shoreline where there is sufficient depth most of the time to ensure that the jetty is useable throughout the year.

Apart from a few jetties at Yangon, there are no proper facilities available for the handling of cargo and passengers. Access from land to vessel is generally via a gangplank. In the absence of a platform upon which equipment can be positioned to load and unload cargo, mechanical handling of cargo hardly exists. Consignees experience long delays in the loading and unloading of cargo.

Yangon Port

Yangon Port is a river port, but mostly operating for seaborne cargo. It handles about 90% of Myanmar cargo by volume. The Yangon main port is located 32 km from the mouth of the Yangon River. It includes six main terminals and is connected to the Ayeyarwaddy River through the 35 km long Twante Canal. Further downstream is the Thilawa Area Port, located 16 km from the mouth of the Yangon River.

River and coastal shipping operations occur at 35 jetties owned by Myanma Port Authority (MPA) and operated by private operators (20), IWT (9), and MPA (6). These jetties are permanent but not mechanized, contrary to the nearby sea terminals.

Mandalay Port

Mandalay has small floating jetties for passengers and no handling facilities. Vessels and barges are anchored along the riverbank and unloaded through gangplanks. Freight is then placed on the riverside. Small trucks move goods on the beach to larger trucks waiting nearby. The entire riverside of Mandalay—about 6 km—are used for port operations. Loading and unloading at the Mandalay Port have essentially remained unchanged since the 1880s (Figure 3).

Figure 3: Typical Loading and Unloading Operations at Mandalay Port

Source: Asian Development Bank.

Manual loading or unloading limits the size of the vessels that can be used, since larger ones take longer to service. It also means that a very long beachfront is required—several kilometers in the case of Mandalay.

2.3 River Transport Services

River Fleet

As of 2014, some 4,590 vessels are registered with the Department of Marine Administration (DMA) for inland water operations. The fleet has a load carriage capacity of about 93,400 passengers and 68,600 tons of cargo. The fleet has been increasing steadily over the years although the ownership structure has changed significantly. Private ownership of vessels increased from 1,760 vessels of various sizes in 1991 to 4,131 in 2014, while IWT's fleet has seen a marginal decrease of 495 vessels to 429.

In 2013, there were 3,638 self-propelled vessels with more than 20 horsepower, of which 987 were registered for passenger operations and 2,651 for freight operations. With the exception of cross-river ferries, most passenger vessels were also used for carrying freight (passenger-cum-cargo vessels). It was estimated that about 60% of the freight reaching Mandalay was carried through barges (mainly private), and 24% by private passenger-cum-cargo vessels, and 16% by IWT passenger-cum-cargo vessels.

Smaller vessels and dumb barges are registered at the local level. They numbered about 38,000 in 2013.

Most vessels in use are small and low-cost. They are typically made of wood, with the exception of IWT's vessels, of which many are made of steel. Table 6 summarizes the costs and types of vessels in use. Figure 4 and Figure 5 show typical vessels. Utilization rates are strikingly low at less than 20,000 km a year.

Table 6: River Vessel Cost Data—2013 Survey

Vessel	Capacity (ton/ passengers)	Purchase Price ($)	Fuel Consumption (l/km)	Utilization (km/year)	Crew Number
Barge	90	18,000	2.3	18,300	1.6
Regular cargo vessel	<100 >100	15,000 25,000	1.6 n/a	9,700 n/a	2.8 n/a
Passenger-cum-cargo vessel	150	24,500	1.8	17,600	3.4
Passenger boat	50 200	4,200 55,900	1.1 n/a	13,900 13,900	1 2.7

km = kilometer, l/km = liter per kilometer, n/a = not available.

Source: Asian Development Bank estimates based on Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

Figure 4: Passenger-cum-Cargo Vessel

This passenger-cum-cargo vessel is of a type commonly seen in Myanmar. Manual loading and unloading is the norm at Mandalay port, where the picture was taken in 2014.

Source: Asian Development Bank.

Figure 5: Freight Barge

This freight barge is of a type commonly seen in Myanmar. Unloading operations are labor intensive. The barges in the back can be accessed through the one closest to the beach.

Source: Asian Development Bank.

Services

The public carrier IWT and private operators service the river's various markets:

- Transport in the Ayeyarwaddy Delta, which runs all year round, is often shorter than trips by road when there is connectivity and a good integration between long-distance and short-distance river transport.
- Transport on the Ayeyarwaddy itself up to Mandalay, subdivided between the section from the Delta area to Pakokku, which is navigable 80%–90% of the year for any kind of vessel, and between Pakokku and Mandalay, which is only navigable 70% of the year because of the sandbanks.
- Transport on the upper reaches of the Ayeyarwaddy is up to Katha and Bhamo, and transport on the Chindwin up to Monywa and Kalewa, where small vessels provide essential services during the wet season.

IWT, which used to account for most of the river transport market, has all but stopped its long-distance passenger transport services after 2012. The average fare charged by private carriers was $1.2 cents per ton/km (waterway distance usually differs from road or rail distance) for an average speed of 15 km per hour. In the ranges of the Ayeyarwaddy north of Pakokku, services are restricted and often take longer during the dry season. IWT's revenues were on average $1.1 per passenger/km, but this included both long-distance and short-distance passengers (river crossings).

Table 7: Average Long-Distance River Passenger Fares as of 2014

Transport	River Distance (km)	Fare ($)	Time (h)	Fare ($/km)	Speed (km/h)
Yangon–Pathein	275	2.5	12.0	0.91	22.9
Yangon–Myaungmya	216	2.3	14.2	1.06	15.2
Yangon–Labutta	274	3.0	14.2	1.09	19.3
Yangon–Maubin	72	0.9	5.0	1.25	14.4
Yangon–Pyapon	85	1.6	10.0	1.88	8.5
Mandalay–Bhamo	420	3.9	40.0	0.93	10.5
Mandalay–Pakokku	164	1.5	11.4	0.91	14.3
Mandalay–Katha	290	2.0	40.0	0.69	7.2
Mandalay–Bagan	191	2.5	15.0	1.31	12.7
Monywa–Kale	234	6.1	13.8	2.61	16.9
Pakokku–Magway	176	1.3	6.6	0.74	26.6
Average				**1.22**	**15.3**

h = hour, km = kilometer.

Source: Asian Development Bank estimates based on Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

River transport is not a dominant transport mode on any corridors. For long-distance travel, river transport is only significant for

- passenger transport within the Ayeyarwaddy Delta, between the delta and Yangon, and between Mandalay and Bhamo in the upper Ayeyarwaddy where road connections are poor; and
- freight transport mainly between Yangon and Mandalay (76% of long-distance river transport), and to a lesser extent between Yangon and the Ayeyarwaddy Delta (11%), the upper Ayeyarwaddy (9%), and the Chindwin (4%).

Private operators handle almost exclusively cargo rather than passengers, but about a third of their vessels are passenger-cum-cargo, enabling occasional passenger transport. At the Mandalay Port, it is estimated that private operators account for 85% of cargo transport, and IWT, 15%.[5]

2.4 River Transport Markets

Long-Distance Transport

In 1990, the Comprehensive Transport Study estimated that long-distance river transport (more than 100 km) moved 1.3 million people and 2.6 million tons of goods. In 2013, a national transport survey found that 1.5 million people and 3.9 million tons was moved on the waterways (Table 8 and Table 9). During the 23 years in between studies, river transport of passengers grew by 15% and freight by 45%. The total transport market also increased by 200% for passengers and 550% for freight. The market share of long-distance river transport has fallen from 3.5% to 1.5% for passengers and from 22% to 3.5% for freight (6% if excluding coastal shipping).

Table 8: Passenger Transport Volumes by Distance (million passengers/year)

	Length of Trip (km)									
Transport	100–200	200–400	400–600	600–800	800–1,000	1,000–1,200	Total	Modal Share by Volume	Total Billion Pass-km	Modal Share by Pass-km
Car	15.0	7.4	1.9	1.8	0.0	0.0	26.1	25%	6.4	17%
Bus	17.3	18.1	12.5	9.1	2.2	1.5	60.7	58%	24.4	67%
Rail	3.5	4.0	1.8	1.1	0.5	0.0	11.0	11%	4.2	11%
River	0.4	0.6	1.1	0.4	0.2	0.0	3.5	3%	0.6	2%
Air	0.0	0.0	1.5	0.5	0.4	0.2	2.6	2%	1.0	3%
Total	**36.1**	**31.0**	**18.7**	**13.0**	**3.3**	**1.6**	**103.8**	**100%**	**36.6**	**100%**

km = kilometer, Pass km = passenger kilometers.

Note: Totals may not add up due to rounding.

Source: Asian Development Bank estimates based on Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

[5] M. Nakanishi, T. Muroi, and K. Kishida. 2014. Mandalay Port Development Project in Myanmar. Paper presented for the 33rd PIANC World Congress. San Francisco. 1–5 June.

Table 9: Freight Transport Volumes by Distance (million tons/year)

Transport	Length of Trip (km) 100–200	200–400	400–600	600–800	800–1,000	1,000–1,200	Total	Modal Share by Volume	Total Billion Ton-km	Modal Share by Ton-km
Truck	14.8	15.5	14.6	14.1	1.0	1.1	61.1	89%	25.8	88%
Rail	0.7	0.7	0.7	1.5	0.0	0.0	3.7	5%	1.7	6%
River	0.9	0.5	1.1	1.3	0.0	0.0	3.9	6%	1.8	6%
Total	**16.4**	**16.8**	**16.4**	**16.8**	**1.1**	**1.1**	**68.6**	**100%**	**29.3**	**100%**

km = kilometer.

Note: Totals may not add up due to rounding.

Source: Asian Development Bank estimates based on Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

Freight Markets

As indicated in Table 10, river transport freight mainly comprises liquids (31.6%), construction materials (14.8%), food (13.8%), grain (12.8%), and household items (12.8%). By international comparisons, Myanmar's river transport market for coal, metal, chemicals, ore, sand, or wood is small. Most of the goods transported are general cargo, e.g., those carried in bags, boxes, drums, and barrels, with few transported in bulk and none in containers. River transport does not hold a dominant market share on any segment. Its highest share is for the transport of liquids (petroleum, oil, and gas), where it reaches 15% (Table 11).

River transport's main customer base consists of commodity items that are essentially related to the farming community (foodstuffs and grain products, animal feed, fertilizer) and bulk cargo (oil, cement, sand, construction materials, and wood products). The affinity to the agricultural sector may be explained by the proximity of farms to the rivers, and hence better connectivity and access to the vessels.

Despite the inherent advantage in the transport of bulk cargo by river transport, substantial quantities of bulk cargo are carried by road. It would appear that river transport is not able to compete with road transport, even though river transport has inherent cost advantages over road transport.

Table 10: Composition of River Transport Freight (thousand ton/day)

Commodity	Volume	%
Cement, construction material	547	14.8
Coal, ore	73	2.0
Fertilizer	37	1.0
Foodstuff, beverage, animal feed	511	13.8
Grain and agricultural products	475	12.8
Household items, appliances	474	12.8
Machinery and parts	73	2.0
Petroleum, oil, and gas	1,168	31.6
Others	342	9.2

Source: Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

Table 11: Freight Volumes by Mode and Commodity (thousand ton/day)

Commodity	Truck	River	Railway	Coastal	Total
Live animal & animal products	1.6	0.0	0.0	0.0	1.6
Fish and aquatic products	2.6	0.0	0.0	0.0	2.7
Vegetable and fruits	6.0	0.0	0.0	0.0	6.0
Grain and grain products	31.9	0.7	0.4	1.3	34.3
Other agricultural products (e.g., plantation product)	14.2	0.6	0.1	0.0	15.0
Foodstuff, beverage, and animal food	17.6	1.4	2.5	4.1	25.6
Petroleum, oil, and gas	4.8	3.2	0.3	13.4	21.8
Coal, ore, stone, and sand	7.9	0.2	0.3	0.0	8.4
Cement, construction material (including steel frame)	22.7	1.5	2.7	1.2	28.0
Fertilizer (including urea)	14.0	0.1	0.1	0.0	14.2
Garment, textiles, and fabric	3.3	0.1	0.0	0.0	3.5
Wood and wood products	3.6	0.5	1.7	0.0	5.8
Paper and printed matter	1.4	0.0	0.1	0.0	1.5
Metal and metal products (excluding construction material)	1.9	0.1	0.3	0.0	2.3
Industrial material, chemicals	6.5	0.1	0.5	0.3	7.4
Household articles, miscellaneous	20.3	1.3	0.6	0.3	22.5
Machinery and parts, transportation	8.1	0.2	0.1	0.0	8.4
Total	**168.4**	**10.2**	**9.6**	**20.6**	**208.9**
Share	81%	5%	5%	10%	100%

Note: Percentage does not total 100% because of rounding.

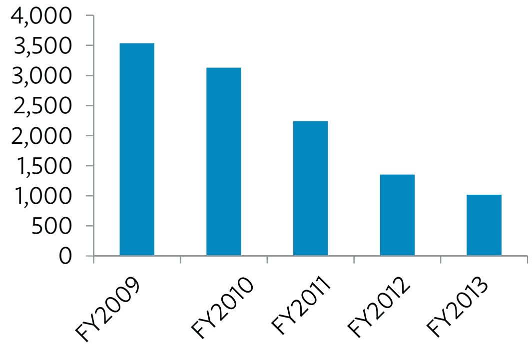
Source: Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

Local Passenger Transport

Currently, some 13–15 million passengers depend on river transport. Of these, some 12 million cross the river using ferries, mainly in the Yangon urban area (most passengers commute to and from Dalla on the opposite side of Yangon on the Yangon River).

Long-distance river transport is slow, and getting on and off vessels is difficult due to the lack of proper passenger handling facilities. Passenger services have been on the decline, as more roads and bridges are constructed. The decline of the river passenger market has been accelerated after 2009 by the downfall of IWT, which used to lead this market (Figure 6 and Figure 7).

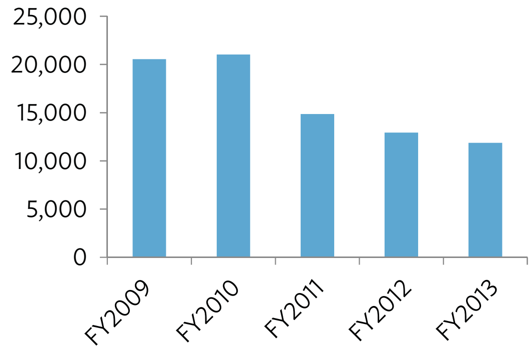
Figure 6: Inland Water Transport Long-Distance Passengers (1,000 passengers/year)



FY = fiscal year.

Source: Inland Water Transport.

Figure 7: Inland Water Transport Ferry Passengers (1,000 passengers/year)



FY = fiscal year.

Source: Inland Water Transport.

3 Restoring a Functioning River Transport Sector

Key Findings and Suggestions

Small investments are sufficient to enable the development of river transport in Myanmar. Efforts should concentrate on two objectives:

- **Improving the Ayeyarwaddy River Channel and the navigation conditions between Yangon and Mandalay**. A minimum navigation depth of 1.5 m should be targeted. Channelization through river training, dredging, and bank stabilization should be followed by scale-up efforts by the Directorate of Water Resources and Improvement of River Systems (DWIR) to maintain the channel and publicize its location. Modern navigation aids should be provided for direct and short navigation in the long run.
- **Developing basic river port terminals, gradually enabling mechanized operations**. The slow turnover of riverside operations raises costs and constrains the use of large vessels. Because of the nature of the river, mechanization can only be gradually introduced. Low-cost options for river ports, such as floating docks, should be installed before considering more costly permanent structures.

These improvements have the potential to reduce Myanmar's river transport costs by up to 65% in the long run. They have a limited cost—about $200 million—and the benefits may be up to seven times higher. By the end of this program, river transport could become the preferred transport alternative for low-value freight between Yangon and Mandalay.

River transport in Myanmar is relatively underdeveloped. Despite its wide network of rivers, only 6,650 km is used for navigation and only 5% of the total volume of cargo is moved by river transport. By comparison, the People's Republic of China's inland waterway systems account for 16% of the total freight moving in the country. In Viet Nam, which has some 6,000 km of waters (about 30% is navigable), inland water transport accounts for 45% of 20 million tons of freight.

There is room to expand the use of river transport in Myanmar. The river systems have an outreach to a great part of the country. More than 70% of the population has access to a river which provides a right of way at minimum cost. Development of the country's rivers for commercial navigation is a viable option.

The overriding objective is to have a river transport system with the capacity to carry as much traffic as possible at a competitive price in relation to other transport modes. This can be achieved by ensuring that the capacity of the existing networks is utilized fully by

- removing and overcoming physical constraints to navigation,
- providing proper terminal facilities at river ports, and
- replacing old and obsolete vessels with a tug and barge operation.

Operational improvements can include the following:

- increase channel depth to enable the use of vessels with deeper draughts throughout the year;
- facilitate navigation to enable higher vessel speeds and navigable hours (such as night navigation), raising vessel throughput and utilization; and
- improve river port efficiency to enable faster throughput of cargoes, again raising vessel utilization.

3.1 Options for Navigation Improvements

Requirements for Navigation Improvements

DWIR has been unable to guarantee a minimum level of navigation conditions on the waterways. DWIR spends much effort to survey, mark, and dredge critical points, but the natural condition of the river means that from one day to another the location of the thalweg can shift. This makes river travel slow, as the vessel risks being stranded on a river sandbank; it happens often on the Ayeyarwaddy.

As a rule, the larger the vessel, the lower the unit cost of freight. However, the application of this principle is contingent on the availability of cargo. If the vessel has to wait for cargo to be fully loaded, the higher turnaround time at port nullifies the cost savings that can be achieved through carrying a bigger load. There is a fine balance between the size of payload and the frequency of sailing, and the aim of a shipping company is to provide frequent service demanded by the client. Given the present state of development in the country, it is unlikely that shipments exceeding 300 tons per trip can be assembled at one time. So there is little merit in having a vessel that carries more than 300 tons. In the medium term, vessels up to 500 tons may eventually cruise up to Mandalay.

The capacity of the channel is a function of the size of the load and the travel frequency of the payload. The frequency of shipments is dependent on the speed of travel and the turnaround time at terminal. Turnaround time at terminal is determined by the rate of loading and unloading and, in the case of a passenger vessel, by the rate of passenger embarkation and disembarkation. Assuming that each payload is 300 tons, the vessel travels at 6 knots, and sailing is possible throughout the day, the river systems are capable of handling some 250 million tons a year. The volume of freight on the river systems is currently about 3.7 million tons and can increase to about 20 million tons by 2030. The present network has the capacity to absorb all expected demand for river transport provided that the channels are maintained for all day sailing year round and terminal facilities exist for the proper loading and unloading of cargo and embarkation and disembarkation of passengers.

River Classifications and Objectives

The current minimum levels of water on the main river sections are only just below what is needed to enable navigation for 300- to 500-ton ships throughout the year. Taking the People's Republic of China's (PRC's) standard river classification (Table 12 and Table 13) as a base, DWIR would have to ensure

- a minimum level of water of 1.3–1.6 meters to enable 300-ton ships,
- a minimum level of water of 1.6–1.9 meters to enable 500-ton ships, and
- a minimum level of water of 2.0–2.4 meters to enable 1,000-ton ships.

Table 12: People's Republic of China's National Standard of Inland Waterway

Classification	I	II	III	IV	V	VI	VII
Vessel tonnage (dwt)	3,000	2,000	1,000	500	300	100	50
Water depth (m)	3.5–4.0	2.6–3.0	2.0–2.4	1.6–1.9	1.3–1.6	1.0–1.2	0.7–0.9

dwt = deadweight ton, m = meter.
Source: People's Republic of China's National Standard of Inland Waterway.

Table 13: River Network Navigability

Segment	Distance (km)	Conditions 95% of Year (20 days low water)		Conditions 85% of Year (60 days low water)		Annual Variations (m)
		Minimum depth (m)	PRC standard / vessel ton	Minimum Depth (m)	Eq. PRC standard / vessel ton	
Delta	600 km (network)	1.90	IV / 500	2.65	II / 2,000	
Yangon–Pyay	390	2.30	III / 1,000	2.55	II / 2,000	10–11
Pyay–Confluence (Pakokku)	358	1.10	VI / 100	1.35	V / 300	12–13
Confluence–Mandalay	164	1.25	VI / 100	1.50	V / 300	8–10
Mandalay–Bhamo	420	0.95	VII / 50	1.25	VI / 100	8–11
Confluence–Mawlaik (Chindwin)	383	0.90	VII / 50	1.10	VI / 100	9–15

km = kilometer, m = meter, PRC = People's Republic of China.
Sources: Minimum depth data are obtained from the Comprehensive Transport Study. Asian Development Bank computations of navigability are based on PRC's National Standard of Inland Waterway.

Currently, DWIR can guarantee the circulation to Mandalay of 100-ton vessels all year round, and 300-ton vessels up to 85% of the time.

To enable 500-ton vessels up to Mandalay, a minimum depth of 1.3–1.6 meters would be required. The 1991 Comprehensive Transport Study found that through low-cost least available depth (LAD) improvements, a minimum depth of up to 2.1 meters could be achieved up to Mandalay. Improvements of the stretch between Bhamo and Mandalay were prohibitively expensive, while the lower Chindwin could be marginally improved only up to 1.2 meters. The situation is unlikely to have changed significantly in the last 20 years.

Based on this review, it is proposed that DWIR should standardize the stretches of the river system into three categories, linking navigability to draught limitation (and channel characteristics):

- Class 1 waterways for vessels up to 1,000 tons—draught limitation of 2 meters
- Class 2 waterways for vessels up to 300 tons—draught limitation of 1.5 meters
- Class 3 waterways for vessels up to 100 tons—draught limitation of 1 meter
- Unclassified—below 1 meter

Table 14 illustrates possible objectives based on the above classification.

Table 14: Possible Channel Depth Objectives

Segment	Current Situation		Medium-Term Objective		Long-Term Objective	
	Minimum depth (m)	Class	Minimum depth (m)	Class	Minimum depth (m)	Class
Delta	1.90	2	1.90	2	2.10	1
Yangon-Pyay	2.30	1	2.30	1	2.30	1
Pyay-Confluence (Pakkoku)	1.10	3	1.50	2	2.10	1
Confluence-Mandalay	1.25	3	1.50	2	2.10	1
Mandalay-Bhamo	0.95	U	0.95	U	1.00	3
Confluence-Mawlaik (Chindwin)	0.90	U	0.90	U	1.20	3

m = meter, U = unclassified.

Note: Minimum depth here refers to 95% of the year, not year-round minimum depth, which can be 15–30 centimeters lower.

Source: Asian Development Bank estimates.

Channelization

The preferred way to make small-scale LAD improvements is through river channelization. By fixing the thalweg in one location through dredging, using riverbank training structures (i.e., groins), and stabilizing banks, the main flow of the water becomes concentrated and maintains an increased depth through natural erosion.

DWIR has identified 35 critical points requiring improvements on the Ayeyarwaddy, and 13 on the Chindwin. According to a 1988 Irrawaddy and Lower Chindwin Rivers study, there may be up to 46 spots that constrain navigation on the Ayeyarwaddy and 37 spots on the Chindwin. In 2014, the World Bank, in partnership with the government of the Netherlands, initiated a program to model sedimentation, and design and implement river channel improvement works between Nyaung Oo and Mandalay.[6] Informal discussions with the design team at an early stage indicated that a 1.8 m LAD may be considered in that section. Altogether, a program of LAD improvements for the Ayeyarwaddy is estimated by DWIR to cost about $110 million, of which the World Bank project will finance about $30 million, leaving $80 million unfinanced.

Once the channel is improved, DWIR would then need to maintain the standards assiduously. This will require higher resources than currently available to DWIR. DWIR would also need to widely publicize the standards so that new entrants to the sector know what vessels to deploy in their area of interest. Inconsistency in the standard of navigation channels is a deterrent to entry of new river transport operators. Physical measures to improve navigational conditions can be supplemented by nautical maps and a shipping advisory service.

If properly maintained, a system based on these standards will have the capacity to meet all foreseeable demand for years to come.

Water Level Regulation Works

DWIR and the Ministry of Transport and Communications (MOTC) have also been considering larger-scale improvements that would allow the use of vessels with deeper draught. MOTC has prepared a plan to improve

[6] World Bank. 2014. *Myanmar – Ayeyarwady Integrated River Basin Management Project.* Washington, DC.

river navigation on the Ayeyarwaddy, involving the construction of 12 weirs between Myitkyina and Hinthada. The cost for such a development is prohibitive—at least $500 million for each weir—and since the width of the Ayeyarwaddy ordinarily is more than 1 km including floodplains, this may be a large underestimate.

The development of the whole system would take years; and because the benefit of shipping using larger vessels over a network accrues only when the whole system is completed, it would be a long time before the development bears fruit. From a financial point of view, the plan to construct a series of weirs to increase water depth is rational only if it is taken with the purpose of generating power. However, power generation would remain limited because of the low slope (the height difference between Myitkina and Hinthada is only 130 m, while the distance between them is 1,200 km). Upstream dams would certainly bring much more power per unit of investment. Each development would have negative environmental impacts, and even more if cumulated. Finally, the transport traffic does not warrant such capital development. At present, there is no need to increase the system capacity by deepening and widening the channels to accommodate bigger vessels.

Navigation Aids

As noted above, the channel from Yangon to Mandalay and beyond is marked by only the most basic of markers, consisting of a bamboo stake with a colored cloth on the top to indicate right and left hand channel limits. The markers are not fixed and are flushed away in high volume flow. No permanent mid-channel targets are provided. Because the river changes course often, permanent markers are not useful.

Once the channel is improved, permanent channel targets and limits should be placed by river maintenance ships and be moved as the channel moves. In the long run, enabling night navigation could double the time available for travel. This would require the following:

- installation of lighted buoys, gradually increasing their density (the Comprehensive Transport Study indicates the need for one buoy per kilometer);
- regular updating of maps and provision of bulletins;
- preparation of regulations; and
- training and certification of pilots and crew.

This can only be achieved in the long run through an incremental approach where the stretches are lighted, and the density of the buoys and the number of certified pilots are increased over time. The risk of losing buoys through pilferage needs to be mitigated. For example, the Red River in Viet Nam has 24-hour navigation capability from Ha Long Bay to Ha Noi through solar-powered, lighted buoys.

DWIR has a navigation aids plan for all sections of the river from Thilawa to Mandalay. The sustainability of those navigation aids will rely on annual river surveys of plan (channel) and cross section (draft) to identify the correct channel. The World Bank (under the same project) plans to provide navigation aids for the whole section of Yangon–Mandalay, with night navigation aids for the Mandalay up to Nyaung Oo.

Modern technology in monitoring and managing the river system—such as depth sounding devices, automatic cross section profile development, modeling, annual river location monitoring, and dredging requirements identification—is unavailable due to lack of funds, even though costs would remain modest.

The World Bank project plans to provide $3.4 million for navigation aids. This may cover only part of the total costs for channel marking and navigation aids, which have been estimated by DWIR to be between $10 million and $15 million.

Dredging

Once a full annual survey of the cross sections of the river has been carried out, usually at 200 m intervals, the plan of the river and its channels and the main channel cross section can be used to develop a three-dimensional picture of the complete river. Over that picture, a channel template can be laid that exactly locates the areas where dredging is needed and the full volume of dredged material that needs to be moved. This can then be used either for planning the dredging program of DWIR or as a basis for developing an annual dredging works plan for privately-contracted dredging companies operating on concessions.

Dredging can either be for capital or maintenance purposes. Capital dredging will be used for large areas of heavy siltation or where the LAD is to be permanently deepened. For instance, if the current LAD is 1.2 m and needs to be 1.5 m, then the requirement for deepening a full stretch of the river would be classified as capital dredging. If the river is already at the specified LAD but seasonal siltation has encroached on that LAD, then the dredging would be for maintenance purposes.

Dredged material has many uses. Existing riverside port areas can be upgraded significantly through the use of dredged material for staging areas and stable access to the river transport. As Myanmar's economy is expected to grow up to 10% per year over the next 2 decades, significant construction will take place all over the country and, notably, in many areas that are near the river system. In those areas, dredged sand and gravel can be a reliable source of building materials and can be sold commercially. They can also be used to fill land near the river for industrial development or to reclaim low-lying land for industrial, commercial, or residential use.

One option is to issue concessions for dredging to private companies that will pay for the right to use the dredged material commercially.

As of 2014, DWIR has about 25 dredgers with a further 40 or so nonmotorized dredge barges. No other dredging vessels are available on the river system. Any use of commercial dredgers will then require either leasing of the DWIR vessels to the private sector or provision by DWIR of concessions that allow private companies to both import vessels and use the proceeds of the dredging operations. Commercial dredging concession is used by other countries to reduce the channel maintenance costs. DWIR could replicate this model.

DWIR has estimated its dredging costs to be the following:

- Channel annual maintenance dredging—approximately $5 million (concessions may reduce this total and turn dredging into a revenue source)
- Channel capital dredging—approximately $20 million
- Additional river training works—approximately $5 million

3.2. River Port Improvements

Productivity Improvements

Improving river port productivity can be done by the following:

- **Mechanization of ports.** This includes the use of cranes, conveyor belts, and/or forklifts for palletized goods. This increases the productivity of loading and unloading, enabling vessels to spend less time docked, and thus increasing the throughput of both the vessel (which can do more cycles during the year) and the quay (which can serve more ships within the same time). It also reduces the labor cost of loading and unloading, however this cost is much smaller in Myanmar than the additional cost of equipment.

- **Mechanization of vessels.** This can incorporate cranes as long as the height difference between the vessel and the quay is not too large.
- **Night port operation.** This increases the time available for loading and unloading. This requires better lighting, which can only be provided over limited stretches.

Operational Challenges

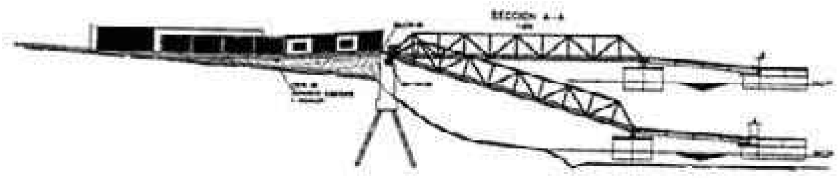
Proper port facilities are essential for efficient terminal operations. The basic facilities are a safe approach channel, a secure clearly defined area for working of vessels (jetties, storage areas, areas for staging cargo, warehousing, and other services), an anchorage, a turning basin, and a turning basin. All ports should be equipped with the basic cargo handling equipment of quayside cranes, forklift trucks, stackers, and mobile cranes. Cargo should be loaded and unloaded using quayside cranes and transferred from jetty to warehouse or open storage area using a tractor-trailer combination. Where cargo in bulk is handled, specialized cargo handling equipment and systems have to be provided. Two constraints exist in Myanmar:

- Mechanization through cranes is not possible for passenger-cum-cargo ships, which have a rooftop. This reduces the number of vessels that can benefit from port improvements. However, the number of such ships would be expected to reduce over 10 years if mechanized ports gave a competitive advantage to different barges.
- Changes in water level make the construction of fixed jetty or quay facilities prohibitive. The water level on the rivers rises and falls as much as 13 m in some places. Also, during the dry season, the waterline recedes, and a wide expanse of the riverbed is exposed. Large height differences between the vessel and the port can also lead to long cargo transfer cycles.

Figure 8: Mandalay Port Jetty Options

Source: M. Nakanishi, T. Muroi, and K. Kishida. 2014. Mandalay Port Development Project in Myanmar. Paper presented for the 33rd PIANC World Congress. San Francisco. 1–5 June.

Figure 9: Typical Cross Section of Floating Dock



Floating pontoon dock commonly used in Myanmar and in other countries.
Source: United Nations Development Programme. 1991. *Comprehensive Transport Study*. Yangon.

Quays. Except in Yangon where a quay already exists, installing fixed quays would be prohibitively expensive. Stepped quays, however, were considered in the Comprehensive Transport Study. In Yangon, nothing prevents current vessels from using the quays, where a crane could be installed.

Floating jetties. Construction of a jetty requires a site some distance away from the shoreline where there is sufficient depth all year to ensure that the jetty is useable throughout the year. This concept has been proposed for the port of Mandalay during the preparation of the transport master plan (Figure 8). It enables both manual and mechanized operations for $35 million–$40 million as estimated at feasibility stage. However, without mechanization, the benefits of the jetty above current facilities may be limited.

Simple pontoons. River docks installed with high seasonal river level fluctuation are common in Myanmar as in other countries. (Figure 9). In Yangon, the pontoons are located approximately 80 m from the high waterline; but in port areas where the water variation is up to 12 m annually, extension docks will need to be installed as the water level drops and the initial pontoons become a base for access to the second dock in deeper water. Such simple pontoons could be designed to accept forklifts (Figure 10).

Figure 10: Floating Pontoon Dock and Access Bridges in Yangon

Pontoon dock in Yangon at the pier near Botahtaung Pagoda. This pontoon is the berth of a large seagoing vessel that has been converted to a floating hotel. The tidal range at the pontoon dock is 5.5 meters.
Source: Photos by Greg Wood.

The Myanma Port Authority (MPA) fabrication company constructed the complex in Figure 10 including the pontoon dock, two 40 m access bridges, and two 50 m jetties from the parking area to the bridge for about $400,000. This design is modular. It can be expanded by adding more pontoons. The current dock is comprised of three 20 m pontoons chained together and is only 5 m wide. These can be installed along the river at various points; and the cost of fabrication, maintenance, and operation can be recovered from the users.

Altogether, port operations productivity can be improved by

- providing permanent structures at low cost, particularly if they enable forklifts;
- lighting them to enable night operations;
- encouraging the use of conveyor belts (possibly outside of designated port areas); and
- introducing crane operations in Yangon first, and then maybe in Mandalay.

3.3 Benefits

The background analysis for this note includes modeling possible changes in costs that would arise from the following operational improvements:

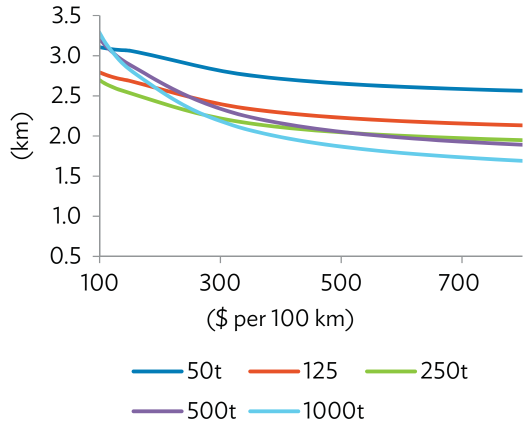
- Increased productivity in port loading and unloading from 7.5 to 12 tons/hour/gang
- Reduced waiting time in ports from 24 hours to 18 hours
- Introduction of night navigation 50% of the time
- Channelization and increased navigability from 70%–75% to 100% for up to 500 ton vessels
- Increased availability of vessels from 80% to 90% (through fleet renewal)

The results are shown in Figure 12 and Figure 13. Under these assumptions, the cost of freight transport for any ship could be halved. Faster loading times would particularly benefit larger ships, which would become more competitive than smaller ones. Assuming that the shipping market also evolves and that larger vessels are preferred (500 and 1,000 tons), the cost of freight transport by river is estimated to reduce by 65%.

This cost structure would make river transport a preferable option to road or rail for distances over 250 km for low-cost goods, and over 400 km for higher value commodities. The river would be the mode of choice for freight transport between Yangon and Mandalay, even factoring in the longer distance by river than by road. The benefit-cost ratio of these improvements would be high, at 11 for basic river improvements and 2.5 for port improvements.[7]

[7] The parameters of the model are explained in the ADB. 2016. *Myanmar Transport Sector Policy Note: How to Reduce Transport Costs.* Manila.

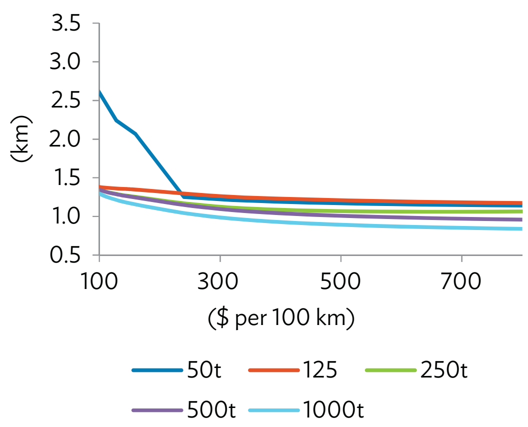
Figure 11: Current Freight Transport Cost ($/100 km)



km = kilometer, t = ton.

Source: Asian Development Bank estimates.

Figure 12: Possible Freight Transport Cost ($/100 km)



km = kilometer, t = ton.

Source: Asian Development Bank estimates.

4 Organization of the Water Transport Sector

Key Findings and Suggestions

The organizations involved in river transport management are all under the Ministry of Transport and Communications (MOTC), but they lack clear leadership. For far too long, river transport has been equated with Inland Water Transport (IWT). The government has dedicated very little funds to the maintenance and improvement of the inland waterway channels by the Directorate of Water Resources and Improvement of River Systems (DWIR). River ports lack a clear custodian since the Myanma Port Authority (MPA) is only in charge of seaports, and private sector regulation has been considered a side issue by the Department of Marine Administration (DMA), which also focuses on seagoing vessels. By 2015, the quick decline of IWT leaves a major gap in the sector, from which it may not recover. Institutional and policy improvements are necessary to develop river navigation in the long run.

Restructuring the IWT, which is preferable to having it declare bankruptcy, is necessary and will require government support. ADB is providing technical assistance (TA) to MOTC to consider business restructuring strategy under the TA for Transport Sector Reform and Modernization.

Since IWT can no longer be the main government agent in the sector, an alternative leader is needed. This report identifies the following as possible directions:

- DMA could be transformed into a policy and planning body, in addition to being a regulator.
- DWIR could be turned into a river management authority, which will be in charge of Myanmar's rivers, waterways, and river ports. Resources should then be earmarked for DWIR to be financially autonomous.
- Alternatively, DWIR and MPA could be merged into a port and waterways authority. This authority would manage and develop water transport infrastructure on behalf of the government. The advantage would be that such entity could be fully self-financing, ensure some degree of cross-subsidization from sea transport into river transport (insufficiently funded). Since the river approaches Yangon Port, the river and seaports should be managed by the same entity, as was the case until 1972.

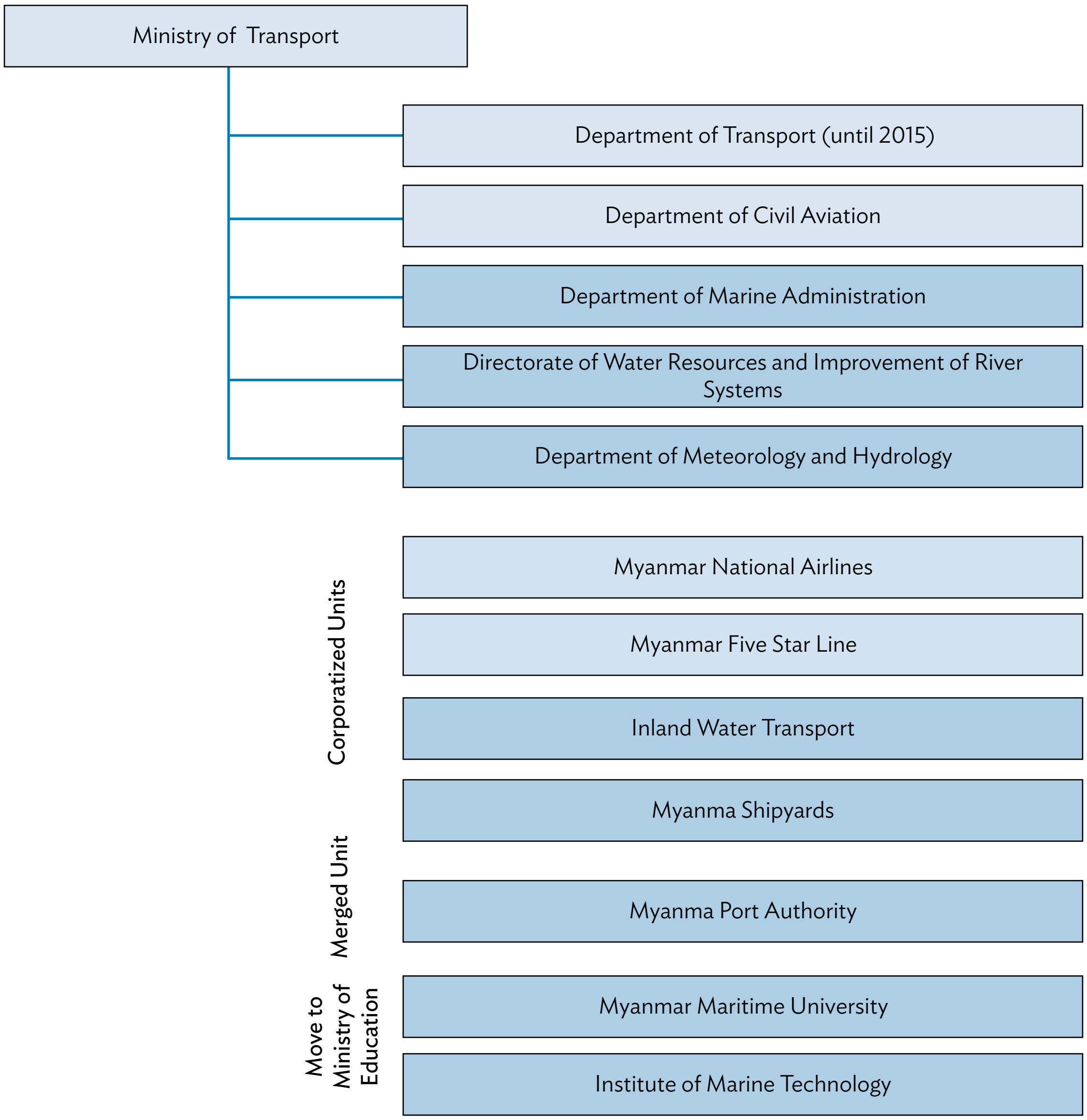
The sector can only be sustainable if it mobilizes higher budgets. The historic level of maintenance and operations budget of DWIR ($2 million only) would need to be doubled in the short term, and possibly raised to $10 million in the medium term. At some point, earmarked sector resources (e.g., share of fuel levy, vessel registration fee) could replace government resources. In the short run, the sector will need government subsidies for capital investments of about $200 million. These would likely not be recovered, even though parallel revenue sources (water tax, land development revenues) may be mobilized.

Finally, a model of development of the river ports that associates national and regional or state governments is needed. Meanwhile, an option may simply to declare that some of the river ports are of national importance, and to request MPA to lead in their development in cooperation with DMA and DWIR.

4.1 Union Government Organizations

The water transport sector is under the direct management of the Ministry of Transport and Communications (MOTC). The MOTC was created in April 2016, through the merger of the former Ministry of Transport, Ministry of Rail Transportation and Ministry of Communications. At the time of writing this report, the organization structure of the new ministry had not yet been announced. The organization chart of the former Ministry of Transport, which used to manage the water transport sector, is presented in Figure 13.

Figure 13: Ministry of Transport Organization Chart (until April 2016)



Source: Government of Myanmar, Ministry of Transport.

Within the MOTC, the main units of interest to this analysis are the Department of Marine Administration (DMA), the Directorate of Water Resources and Improvement of River Systems (DWIR), the Inland Water Transport (IWT), and the Myanma Port Authority (MPA). These units are discussed below.

The 2008 Constitution of the Republic of the Union of Myanmar sets the responsibilities of the union and state or region governments in the sector:

- The union legislature has domain over inland waterway transport, land transport, carriage by sea, maintenance of waterways, major ports, and shipbuilding repair and maintenance.
- The state or region legislature has domain over ports, jetties, pontoons having the right to be managed by the region or the state; and the systematic running of private vehicles within the region or state.

4.2 Department of Marine Administration

The DMA is within the MOTC. The DMA is headed by a director general who reports to the permanent secretary of the MOT. The director general is in turn supported by deputy directors general who are responsible for key areas of department's activity. The DMA has nine subdivisions:[8]

- Legal and Technical Standard Division
- Marine Engineering Division
- Maritime Safety, Security and Environmental Protection Division
- Nautical Division
- Planning Division
- Seafarer Division
- Shipping Division
- State & Region Offices Division (Upper Myanmar)
- State & Region Offices Division (Lower Myanmar)

Mandate and Responsibilities

DMA's mandate is to ensure marine safety. Specifically, it seeks to (i) set and enforce safety standards for vessels and marine personnel, (ii) manage and develop human resources for the water sector, and (iii) respect international obligations regarding sea rescue and environmental protection.

In these functions, DMA is responsible for the following:

- all maritime legislation and regulations,
- registration of ships and seafarers, and business licensing of vessels (including river vessels),
- accident investigation and arbitration,
- enforcement of port and vessel regulations, and certification of seafarers and,
- international relations.

[8] Department of Marine Administration. 2016. http://www.dma-mm.org/ (accessed on 20 May 2016).

4.3 Directorate of Water Resources and Improvement of River Systems

The DWIR manages Myanmar's river system. DWIR was founded in 1972 as the Waterways Department by combining the Dredging and River Conservancy sections of DMA and parts of Hydrographic Surveying section of the Port Corporation. In 1999, the department was extended and reorganized as DWIR. DWIR is headed by a director general and reports to the Minister of Transport.

The instrument that empowers DWIR in the execution of its tasks is the Conservation of Water Resources and Rivers Law. Enacted in 2006, the aims of the law as stated in the preamble are

- to conserve and protect the water resources and rivers systems for beneficial utilization by the public;
- to facilitate safe navigation along rivers and creeks;
- to contribute to the development of state economy through improving water resources and river systems; and
- to protect environmental impact.

Mandate and Responsibilities

DWIR's objectives are to (i) improve the navigation channel, including achieving adequate depth, and stabilize the inland river ports; (ii) protect the riverbanks from erosion; (iii) enable use of water for drinking and agriculture; and (iv) prevent river pollution.

DWIR's activities include the following:

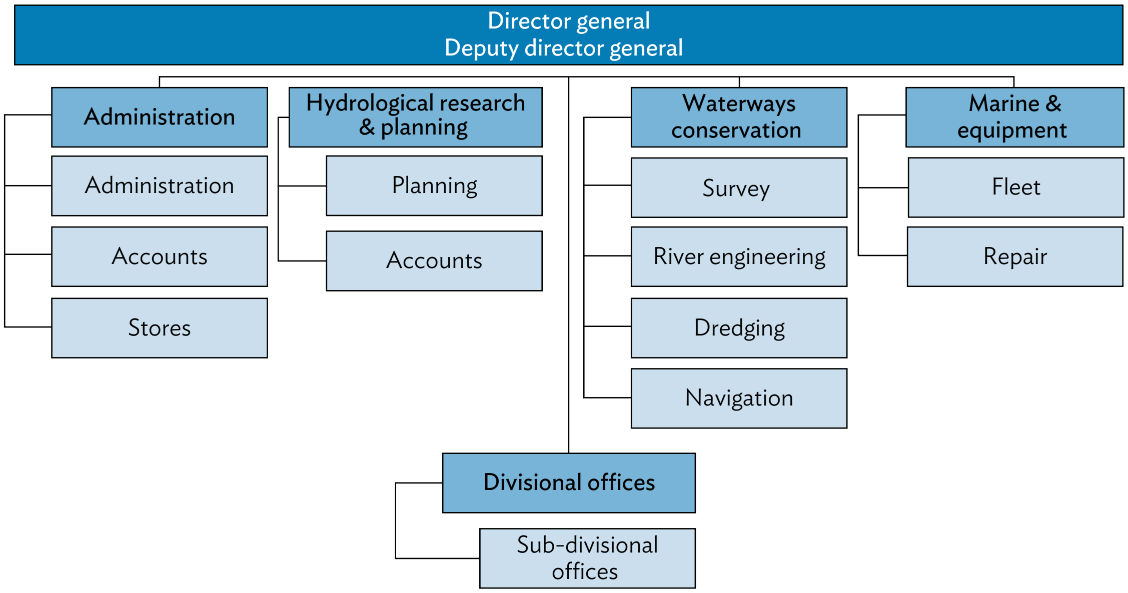
- monitoring activities such as (i) channel surveying and mapping, (ii) hydrographic monitoring, (iii) establishing databanks and research, and (iv) water quality monitoring,
- waterway management activities such as (i) river training structures, (ii) dredging, (iii) navigation aids, (iv) snag removal, (v) monitoring, marking, and maintenance of channels, and (vi) provision of information on least available depth (LAD) and issuance of warnings,
- implementation of riverbank protections and,
- facilitation works for agriculture pumping.

DWIR also plays an important role in river bridge construction by providing assistance during the design stage and implementing training and riverbank works to sustain the bridges.

Organization

The organization of DWIR is shown in Figure 14.

Figure 14: Directorate of Water Resources and Improvement of River Systems Organization Chart



Source: Directorate of Water Resources and Improvement of River Systems.

Analysis

Waterway improvements have been a low priority for DWIR. As a directorate within the MOTC, DWIR's funding is fully contained within the annual budget provided to the MOT by the government. Among its many activities, DWIR prioritizes river protection works and works related to bridge construction across the rivers. Little funding has been allocated to survey of river channels, establishment of river navigation aids, or dredging of river channels to ensure LAD is available. In essence, river navigation is not a high priority and, as a result, river transport is carried out by each vessel probing the current river channel to determine depth and navigability. River depth changes are not surveyed regularly or published for users.

DWIR faces considerable difficulties in executing its tasks. The law is silent on the development of river ports. Hence, while there is recognition that proper handling facilities are required but are not available, no one has taken the initiative to build these facilities.

Also, DWIR has no sufficient funds to carry out its mandate. It is unable to have access to modern technology and tools to manage the rivers properly. Maintenance dredging is insufficient to keep up with the rate of sedimentation, and river training works to regulate the flow of water cannot be implemented due to lack of funds.

The inadequate attention to the development of river transport is reflected in the meager budget allocated to the maintenance of the channels. The amount spent on improving and maintaining the channels is only an average MK300,000/km of navigable waterways ($300/km in 2014). It is also worth noting that within the minuscule amount spent on the channels, less than 40% was actually spent on channel improvement works, as the bulk of the budgeted amount went to river bank protection.

Other rivers within the immediate region have been improved and offer a competitive option to road transport. For instance, Viet Nam has invested in both the Red River in the north and in the Mekong River in the south. The Viet Nam Inland Waterways Administration, under the Vietnamese Ministry of Transport, manages the rivers. A summary of the status of the Viet Nam river system is provided in the box below.

Box: Case Study on the Viet Nam Inland Waterway Sector

The inland waterway transport sector in Viet Nam is governed by the Law on Inland Waterway Navigation (2004) and the Law on Dykes (2006). These laws govern the sector on the Red River and the Lower Mekong River. The Mekong River is an international river and complies with Vietnamese law and with agreements made through the Mekong River Commission; the agreements are binding on all member countries.

The main river channels have (i) in the north, a width of 30–36 meters (m) and a least available depth (LAD) of 1.5–3.6 meters; and (ii) in the south, a width of 30–100 m and an LAD of 2.5–4.0 m. Out of the 220,000 kilometers (km) of rivers in Viet Nam, 41,900 km are navigable and 15,4366 km are receiving maintenance. The major routes are only 4,553 km.

Objectives of the River Master Plan to 2020

1. Exploit the natural advantages of waterways in transporting bulk cargo at lower costs and minimal environmental impact.
2. Achieve vertical integration within inland waterway transport by synchronizing the development of routes, ports, handling equipment, vessels, and managerial capacity to meet the demand for cargo and passenger transportation at higher quality and safety.
3. Develop inland waterway transport infrastructure to form a seamless system with other transport modes and in coordination with irrigation and hydropower sectors.
4. Upgrade the fleet with a more efficient configuration that is also safe and better suited to existing conditions in canals and rivers.
5. Broaden the financing base for inland waterway transport, with the public sector focusing on the river channels while collaborating with the private sector in port development.

River Management

The Viet Nam Inland Waterways Administration (VIWA) provides navigation aids and river management (dredging). It offers 24-hour navigation up to Ha Noi on the Red River and up to Viet Nam and Cambodia border on the Mekong River. VIWA maintains river stations. To upgrade canal infrastructure and implement navigation aids, VIWA received donor assistance from the World Bank, Asian Development Bank (ADB), and others. Still, backlog dredging remains a problem, as funding for river works is limited. Efforts to recover user fees have largely been dropped, but commercialization has been a success. Of the 15 river management stations, 5 stations have been equitized and operate under contract with some other commercial opportunities. Dredging is all done under contract.

Inland Waterways Outputs

In 2008, inland waterways still accounted for the highest tonnage share among all modes, at 48.3% (higher than road's share of 45.4%). The average length of haul is 112 km, which is lower than for roads (143 km). This contrasts with European countries, where rivers are only competitive on long distances.

Source: World Bank. 2013. *Facilitating Trade Through Competitive, Low-Carbon Transport: The Case for Vietnam's Inland and Costal Waterways*. Washington, DC.

4.4 Myanma Port Authority

Mandate and Responsibility

Myanma Port Authority (MPA) is a government agency vested with the responsibility to regulate and administer Myanmar's coastal ports. It is a department under MOTC. Located in Yangon, the current MPA was founded in 1989. The defining laws that govern the MPA are all preindependence. In 2015, the government was considering legislation to change the status of MPA into a self-financing state-owned enterprise.

MPA's objective is to "provide services (loading, discharging, storage of cargoes, receipt and delivery of transit cargoes etc.) for vessels calling to the *[sic]* all ports of Myanmar within the minimum ship turn round time."

The MPA is responsible for nine ports around the coast of Myanmar; Yangon Port is the principal one. MPA acts both as a landlord and as a port operator. MPA manages the port areas and is responsible for the development of port lands and keeping capacity in line with demand. MPA arranges for the maintenance and dredging of the port area and for access to the ports. In March 2011, MPA began dredging Yangon Port to increase the size of vessels that can dock at the port (from 15,000 to 35,000 tons deadweight). Dredging is also needed for maintenance of the two constraining bars on the river. MPA provides pilotage services for incoming and outgoing vessels. There is no vessel traffic control system, and pilots are responsible for the movement of the vessels in the port area. The port provides stevedoring services.

In addition to its own terminals, MPA is also responsible for the overall access and landlord functions for the private terminals in Yangon Port.

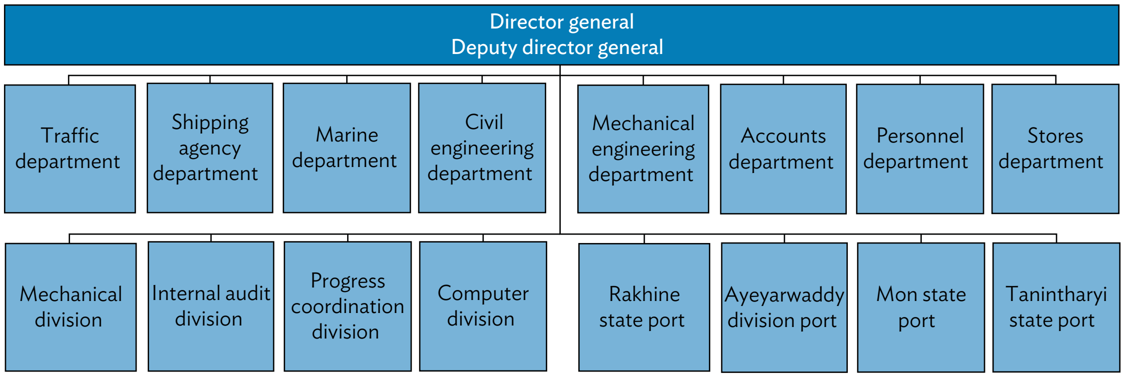
Organization

MPA's historic organization (Figure 15) has been recently expanded with the addition of the department of international relations and research. MPA staff was reduced from 11,000 to 3,200 during 2010–2013. Officers currently number approximately 300. In 2014, a new board of directors was formed with seven members:

- chair,
- managing director,
- port operations director,
- shipping operations director,
- legal specialist,
- business specialist, and
- management specialist.

Under the pending law, MPA staff would remain government employees with all rights, but MPA would be able to top up government-stipulated salaries. MPA would have the right to amend service fees, but all requests to amend the fee structure will still need to be submitted to the MOT for review and approval. Foreign or domestic investment in port service operations will be allowed. This covers areas such as port terminal construction and operation, and contracted delivery of services such as stevedoring.

Figure 15: Myanma Port Authority Organization Chart (as of 2014)



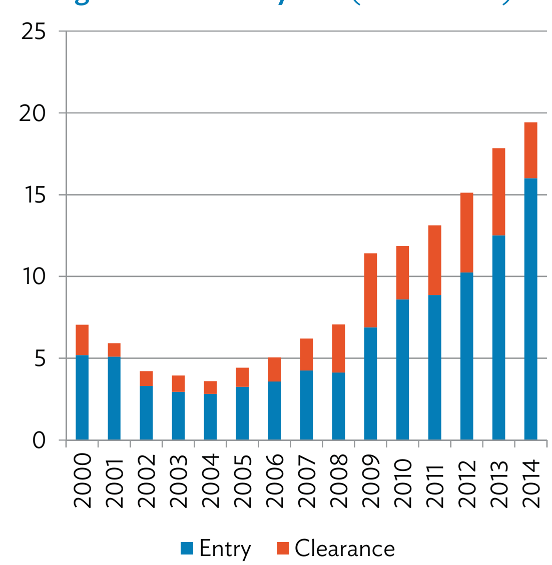
Source: Myanma Port Authority.

There are currently eight privately operated terminals in Yangon port. In addition, there are 18 international wharves, 2 inland container depots, and 40 pontoon type jetties catering to domestic traffic.

Traffic

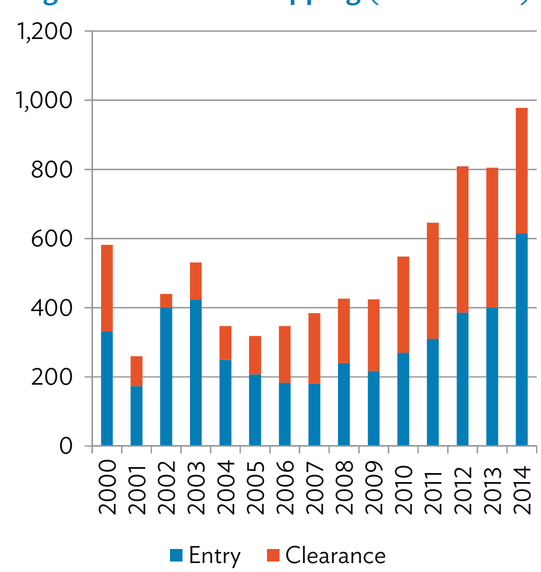
International transport by sea has grown steadily since 2004–2005, reaching about 20 million tons in 2014–2015 as reported by the Myanmar Customs Department (Figure 17). Coastal shipping shrank during 1990–2005, but has since been on a quick rise. Still, it only represented a marginal part of port traffic by volume, at 1 million tons only (Figure 18).

Figure 16: Trade by Sea (million tons)



Source: Myanmar Customs Department.

Figure 17: Coastal Shipping (million tons)

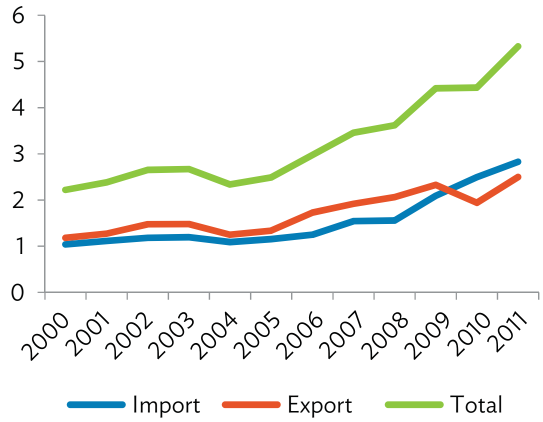


Source: Myanmar Customs Department.

MPA, which reports generally comparable figures, estimates that in 2011 total port traffic already reached 24 million tons, over 95% of which is from Yangon Port. Both containerized traffic and non-containerized traffic have grown steadily between 2005 and 2015.

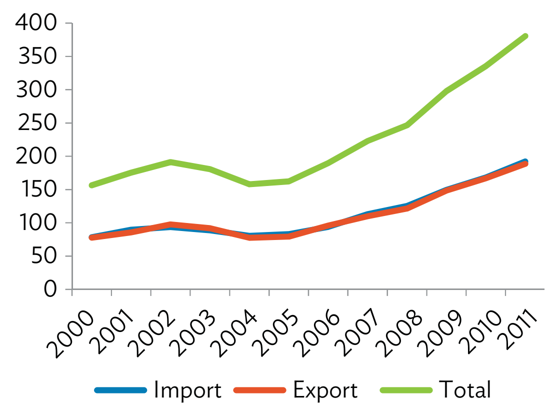
At present, non-containerized traffic is about four times larger than containerized traffic. As illustrated by Figure 19, non-containerized traffic for export grew quickly during 2007-2009.

Figure 18: Myanma Port Authority Container Traffic (million tons)



Source: Myanma Port Authority.

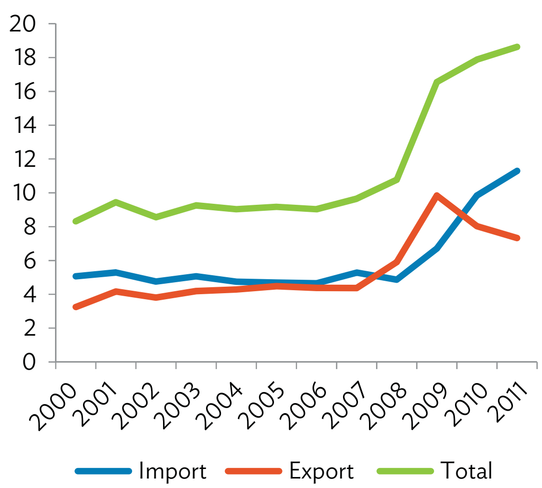
Figure 19: Myanma Port Authority Container Traffic ('000 TEUs)



FY = fiscal year, TEU = twenty-foot equivalent units.

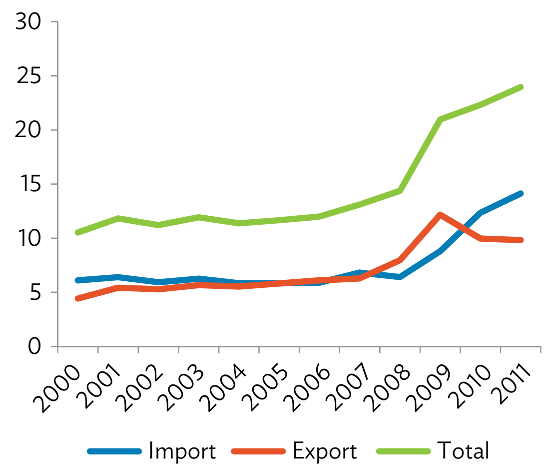
Source: Myanma Port Authority.

Figure 20: Myanma Port Authority Cargo (million tons)



Source: Myanma Port Authority.

Figure 21: Myanma Port Authority Total Traffic (million tons)



TEU = twenty-foot equivalent units.

Source: Myanma Port Authority.

Myanmar ports handled about 400,000 twenty-foot equivalent units (TEU) in 2011, representing about 5 million tons of freight. The MPA argues that this traffic level represents approximately 70% of the current berthing and handling capacity, and an expansion program is proposed to add an additional 14 wharves along the Yangon riverfront to cater to the growing traffic demand. Thilawa Port, located 16 km downriver from Yangon, is also slated for expansion.

Over the longer term, the deep-sea port of Dawei, 615 km south of Yangon, will likely be developed. While the long-term potential of Dawei is strong, in the short- to medium-term, the expansion and improvement of the ports at Yangon and Thilawa are likely to merit more attention.

Revenues and Expenditures

Until 2006, MPA revenues and expenditures were in balance. However, since the reform of fuel prices in 2007, revenues have remained consistently growing with tonnage but expenses have grown much faster. As a result, from 2007–2008 onward to 2010–2011 (last data available), MPA has run a deficit. This is a concern because port authorities around the world are largely net cash generating. As traffic grows, revenue also grows and, in most cases, many of the port costs remain fixed. Thus, revenue growth normally outpaces expenditure. This relationship may not be true for MPA now, particularly in the shorter term. MPA will need to invest in some areas if Yangon Port is to be keep up with expected international standards. The deepening of the berths in Yangon Port for 35,000 dwt vessels is costly. It also requires the dredging of two sandbanks downriver.

On the revenue side, the port tariff and dues have not been updated since 1998, even though costs have risen.

Several terminals operated by the private sector are engaged in container handling. These terminals are owned by MPA and leased to operators for a specified period under certain terms and conditions.

Analysis

A business model based on the principle of public ownership and private sector operation is appropriate. However, while the arrangement is generally satisfactory, there is still room for improvement. The number of berths is high and throughput per berth is low. Terminal operators' performance needs to be improved by requiring them to meet certain targets as a condition of the lease (berth throughput, vessel turnaround time, dwell time of containers in terminal, equipment downtime, etc.). Berth productivity can be improved by increasing the deployment of more equipment (quay cranes and yard stackers) and the use of information technology to drive operating systems and procedures. If the port is adequately equipped and properly operated, a throughput per berth of 1 million TEUs is achievable.

The port has outgrown its location, and there are compelling reasons to relocate it to a more suitable place. It occupies land in the heart of the city that can be put to more productive use. There is also limited space for expansion. Traffic to and from the port adds to Yangon's road congestion. In addition, Yangon port is only a river port, which cannot meet Myanmar's long-term needs. Access to the port is difficult and limited to vessels drawing a draught of less than 9 m. A new location with deeper water and better access is needed for Yangon to handle the new generation of container vessels.

With or without reform, the MPA will need to address a number of important issues:

- define a hierarchy of port services and function,
- define landlord functions and services,
- outsource service delivery to private operators (stevedoring—all terminals),
- define pricing policy and application,
- develop a competition policy for service providers,
- plan for efficient port operations—port facilities and services and,
- improve port management standards.

Most of these issues do not relate to the reform process itself, with the exception of whether MPA will continue to offer commercial services from its own terminal or become fully a landlord port authority.

One of MPA's operational priorities is the development of a port vessel management system. Ship movements in the harbor can be intensive. Until a new location is found, ship movements in the harbor are expected to increase. In a busy port, traffic monitoring and movement control is essential to safe navigation. The installation of a Vessel Traffic Management System (VTMS) may be timely. Once a VTMS is installed at Yangon Port, each ship will be given a temporary registration number and a Global Positioning System location tracking device. The Japan International Cooperation Agency (JICA) is providing assistance to develop such system.

4.5 Inland Water Transport

Mandate and Responsibility

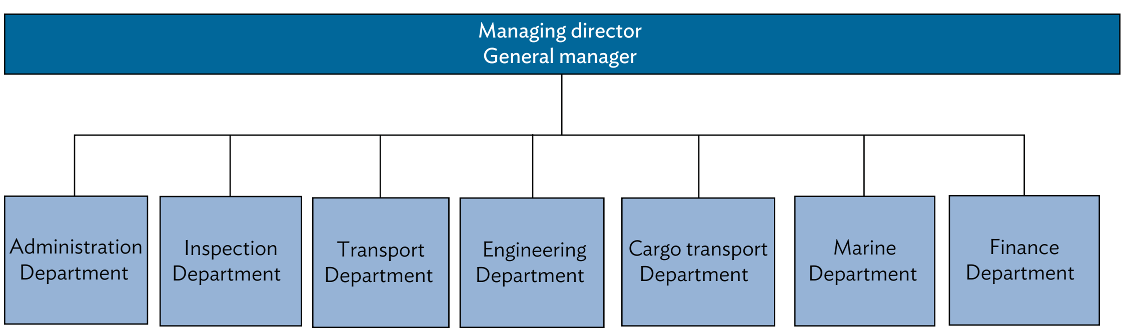
A 2015 law on inland water transport updated the mandate and responsibility of IWT. For the past 50 years, IWT has functioned under the requirements of the Road and Inland Water Transport Law of 1963. As indicated in the IWT documents, the mandate and role of IWT are to

- carry out transportation of passengers and freight along the waterways of Ayeyarwaddy River, the Chindwin River, and also in the Delta areas, Rakhine, Mon, and Kayin states; and
- operate ferry services for the convenience of passengers and shippers.

Organization

The organization structure of IWT is shown in Figure 22.

Figure 22: Inland Water Transport Organization Chart



Source: Inland Water Transport.

This structure is very similar to the structure in 1994 as reported in the Comprehensive Transport Study, except that the Transport Department has been split into two: (i) cargo to better address the demand for freight services, and (ii) inspection.

The Administration Department is responsible for the overall management of IWT, under the guidance of the managing director and general manager.

The Inspection Department determines if the work of the other departments is efficient and complies with targets. It is also responsible for maximizing IWT's profitability, and ensuring that there is no leakage of funds from passenger and freight service revenues.

The Transport Department is responsible for operating the passenger and passenger-cum-cargo vessels.

The Cargo Transport Department is responsible for operating the 75 powered cargo vessels and 137 noncargo vessels. The department's vessels mainly carries bulk commodities.

The Engineering Department is responsible for constructing new vessels, repairing and overhauling older vessels, repairing mechanical equipment, and re-engining vessels. The work of the Engineering Department is allocated to six dockyards.

The Marine Department essentially functions as the personnel department of IWT. It manages the vessels crew, dockyards staff, and survey and inspections staff.

The Accounting Department manages the finances of IWT. It monitors revenue and expenditure, carries out internal audit, and prepares statements of account and other financial reports.

Staffing

The overall staff levels of IWT is shown in Table 15. The sanctioned staff levels are not likely to be ever achieved. As noted below, the lack of profitability and the challenge of recapturing market share will keep staff levels at current or even at lower levels in the future. All staff are government employees and enjoy government pension guarantees.

Table 15: Staff Levels of Inland Water Transport

Item	Sanctioned	Appointed
Officers	273	132
Staff	10,666	2,862
Total	10,939	2,994

Source: Inland Water Transport. Data as of October 2015.

Traffic

IWT remains a significant player in the water transport system, but that position is at risk. IWT currently operates 225 vessels and 148 barges, comprising passenger vessels and ferries, passenger-cum-cargo vessels that also carry cargo, a significant fleet of bulk cargo vessels and dumb barges (Table 16). Statistics show that 30% of IWT's passenger vessels was renewed in the 1990s, but almost none in the 2000s. Half of passenger vessels are more than 40 years old, and the average age is 39 years.

IWT stagnated during 1990–2005. Even with considerable fleet resources, IWT is unable to retain market share because of poor navigable river system capacity and absence of port handling facilities. A transition to moving bulk cargo over long distances was not made. Considerable focus remained on passenger services, but service quality continued to fall. Meanwhile, roads have improved, and river transport faced stronger competition from trucks and buses. While river transport activity grew, IWT's market share tumbled as demand shifted steadily to road transport.

IWT's financial position then deteriorated during 2006–2011. In 2006–2007, the government removed IWT's access to cheap fuel. But because of fears of inflation, IWT was prevented from aligning its rates to match costs. As a result, government subsidies were needed as losses began. IWT also began to focus on captive markets (short-distance government freight, passenger ferries, remote communities). But as the fleet aged, service quality deteriorated.

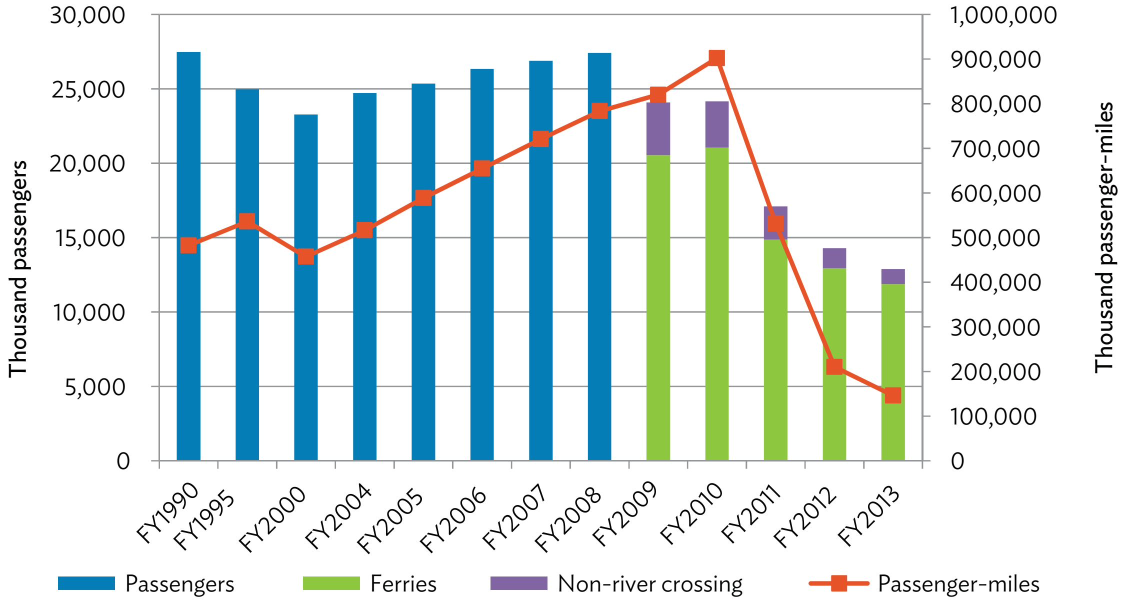
IWT market collapsed after 2011. In 2012, the government moved to a market-based exchange rate, improved business conditions and access to credit, abolished the fuel subsidization system, and reduced tariffs on vehicle imports, sparking a quick growth in the number and scale of private sector transport operators (particularly road). Increased input costs forced IWT to raise rates against an aggressive competitive market. The combined effect of more private competition and higher IWT rates lead to a collapse of IWT traffic. Since 2010–2011, there has been a major contraction of traffic for both freight (–58% in volume, –65% in quantity) and passenger (–52% in volume, –83% in quantity). Long-distance passenger traffic almost disappeared in 2013–2014 (Figure 23 and Figure 24).

Table 16: Inland Water Transport Vessels in Use (2014)

Type of Vessels	Number
Powered Craft	
Passenger-cum-cargo	122
Powered barge	48
Tug	22
Oil tanker	1
Water tanker	1
Multipurpose vessels (departmental use)	5
Dumb Craft	
Cargo barge	131
Oil barge	11
Station pontoon	32
Total	
Powered Craft	**199**
Dumb Craft	**174**

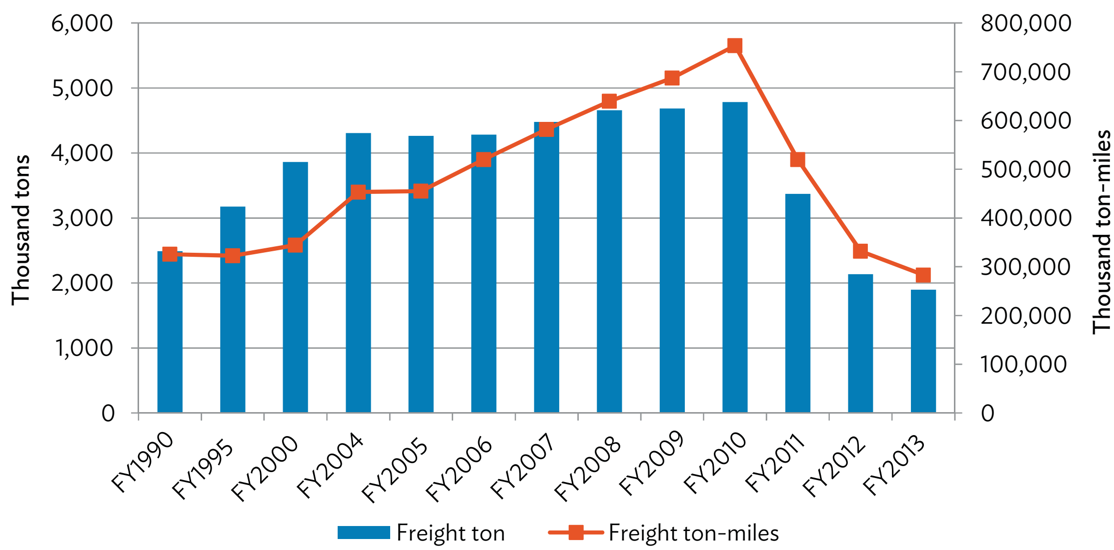
Source: Inland Water Transport.

Figure 23: Inland Water Transport Passenger Traffic



FY = fiscal year.
Source: Inland Water Transport annual traffic and financial accounts.

Figure 24: Inland Water Transport Freight Traffic



FY = fiscal year.
Source: Inland Water Transport annual traffic and financial accounts.

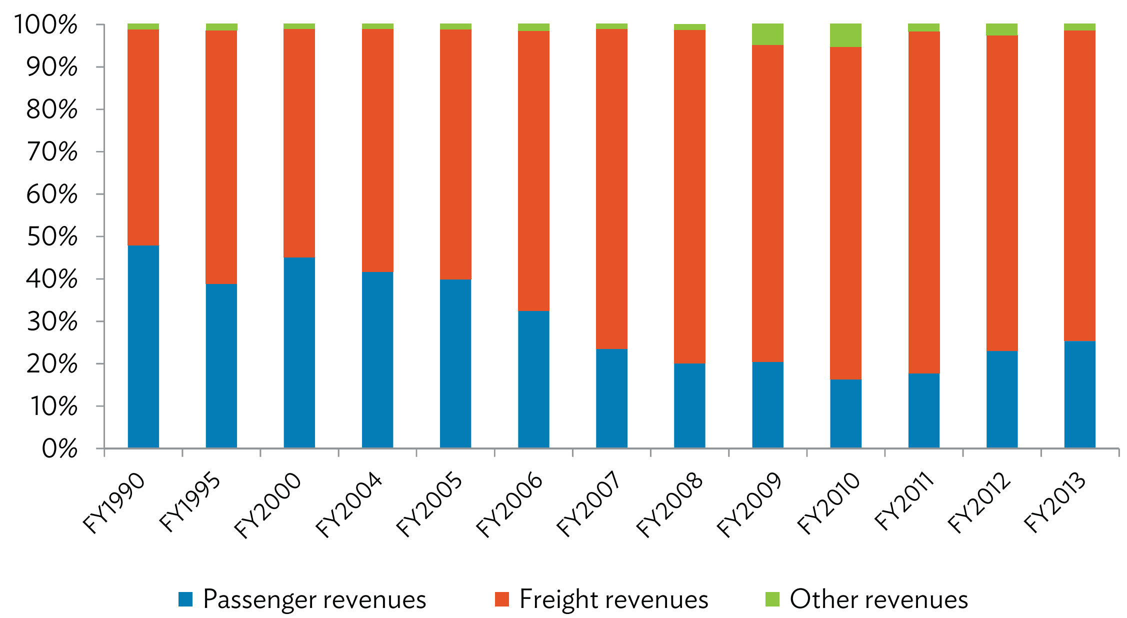
Financial Status

Passenger transport has become a loss-making business for IWT, but it still accounts for about half its operations. IWT's passenger and freight revenues only covered direct operational expenses in the 1990s (not including depreciation and capital costs). The situation is now similar for freight, but passenger rates barely covered 20% of direct expenses until 2011. Since the increase in rates, freight now accounts for 50% of IWT's revenues, the same level as in 2000. Passenger transport now generates 30% of total revenues (but possibly half of the costs).

During 2005–2006 and 2011, IWT ran a large operational deficit which was financed by the general government budget. IWT's cash expenditures—not including investments needed to renew capital—are more than twice its cash receipts. But as illustrated in Figure 26, while traffic has fallen and costs have risen, IWT has been able to bring its operating ratio back to approximately 1.0. IWT is still very much in financial trouble, but its financial situation can be improved.

IWT needs to reduce costs even more and increase its positive cash flow and retained earnings. As indicated in Figure 27, IWT is now achieving an operating ratio of 1.0. This is a significant achievement given the difficulties IWT faced in providing competitive transport services and maintaining market share. But more needs to be done. Figure 27 illustrates the key components of IWT's operating and overhead cost. Two items stand out. First, pension obligations are very high; IWT has 3,200 working staff and 4,500 pensioners. Second, there is long-term debt. Both cost items are possible sources of savings.[9]

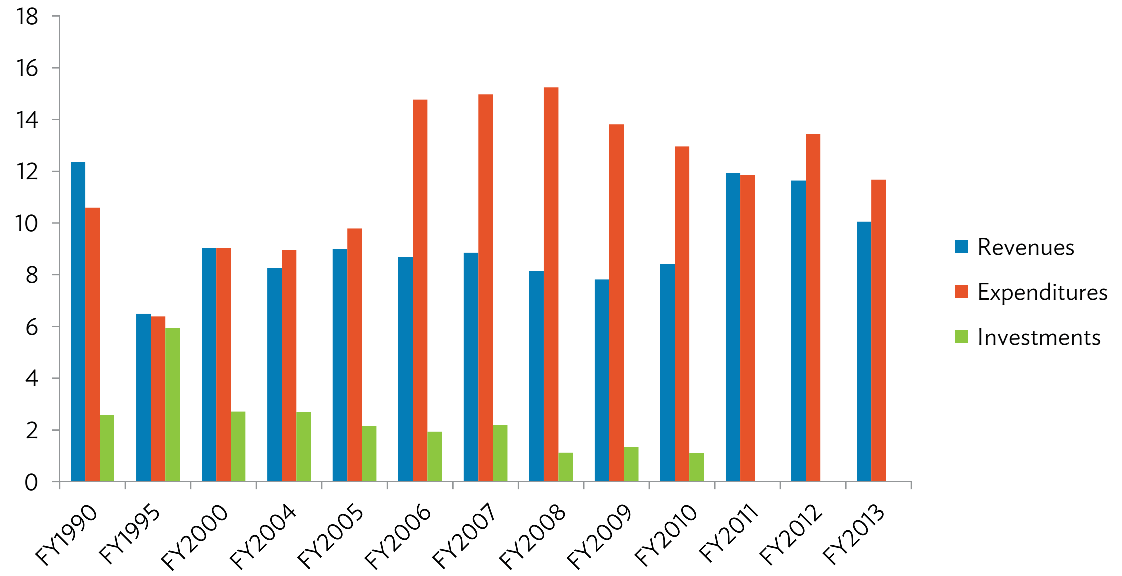
Figure 25: Origin of Inland Water Transport Revenue



FY = fiscal year.
Source: Inland Water Transport.

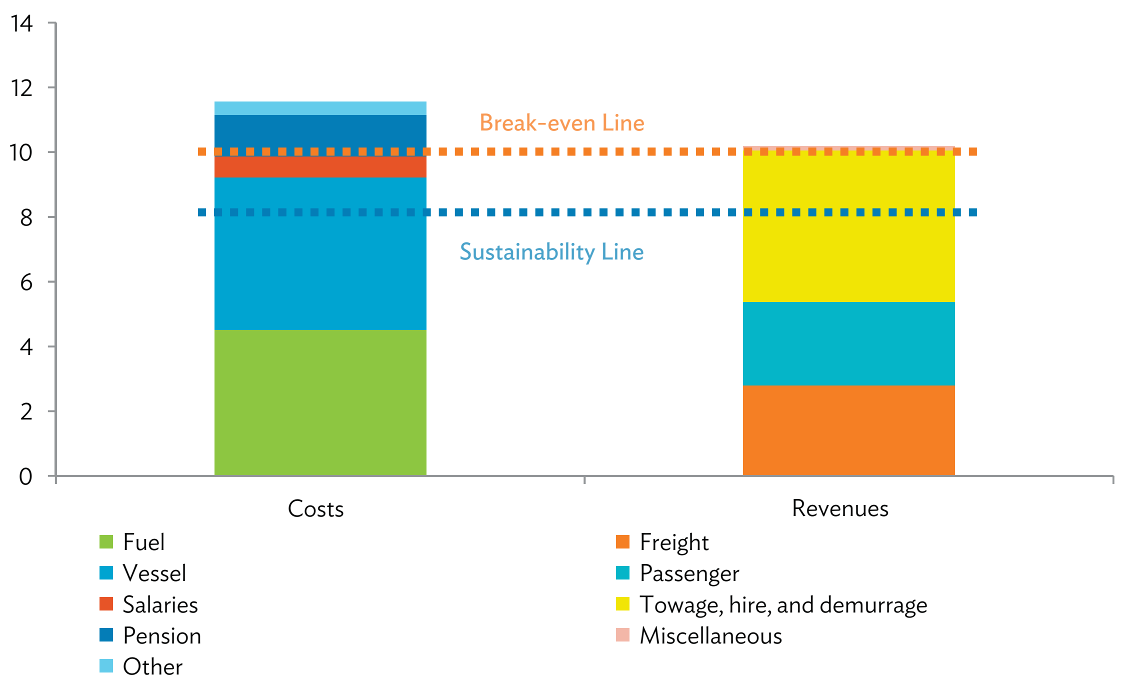
[9] ADB. 2016. *Myanmar Transport Sector Policy Note: How to Reform Transport Institutions.* Manila.

Figure 26: Inland Water Transport Revenue and Expenditure
(MK billion)



FY = fiscal year.
Source: Asian Development Bank estimates, based on data from Inland Water Transport.

Figure 27: Inland Water Transport Costs and Revenues as of 2013
(MK billion)



Source: Inland Water Transport annual traffic and financial accounts; Asian Development Bank estimates.

4.6 Status of River Ports

The institutional structure for management of the river ports is still in a state of flux. According to the Constitution, the states or regions have jurisdiction over "state and regional" ports, but no port has yet been designated that way. By law, the Directorate of Water Resources and Improvement of River Systems (DWIR) has jurisdiction over the riverside facilities up to 150 feet above the high water mark. However, that space is insufficient to create a functioning port unless the port is totally constructed on reclaimed land and remains below the 150-foot line. Such is the case for the new proposed port facility in Mandalay to be constructed by JICA which will be within the DWIR sphere of responsibility. But even in that case, the ancillary space beyond the formal port remains the responsibility of the municipal or regional or state government.

Local governments have been reluctant to invest in port infrastructure, partly because the waterside facilities are not available and partly due to lack of investment funds. However, once decent river port facilities at key locations are available, the port dockage fees and port handling fees should cover the initial investment cost and the cost of operation and maintenance.

4.7 Possible Directions for Improvements

Issues

The main institutional issues to be solved to enable river transport development are the following:

- absence of a clear entity leading the policy-making;
- lack of internal resources and government support;
- absence of a clear custodian for river ports (even MPA is not clearly in charge of Yangon Port's river shipping operations which, among others, prevents the development of direct river or sea transshipments); and
- quick decline of IWT, which creates the risk that river transport operations remain dominated by small-scale transporters unable to achieve sector modernization.

Institutional Reforms

A policy-making body in charge of development of river transport and sea transport is needed. Currently, the Department of Marine Administration (DMA) ensures the regulation and inspection of all vessels and crew, but not services; the Transport Planning Department regulates river transport services; MPA ensures the development of seaports but not river ports; and DWIR manages inland waterways but has no mandate to develop ports or services.

To fill the gaps within this framework, several options are possible:

- DMA could become the leading policy-making department in charge of developing all water-based transport. It would keep its regulatory and licensing functions (possible alternatives include creating a dependent maritime safety agency, or delegating operational licensing tasks to local governments), develop capacity for policy and planning, take over licensing of services, and ensure oversight of delivery units.

- DWIR could be turned into a river management authority that would be in charge of Myanmar's rivers, waterways, and river ports. To function effectively, this authority would need new financial resources, e.g., water taxes, riverbank development, fuel tax, and maybe a share of the hydropower revenues.
- Alternatively, DWIR and MPA could be merged into a port and waterways authority. This authority would manage and develop water transport infrastructure on behalf of the government. The advantage would be that such entity could be fully self-financing, and ensure some cross-subsidization of insufficiently funded river transport by sea transport. Since the river approaches Yangon Port, the river and seaports should be managed by the same entity, as was the case until 1972.

Either the River Management Authority or the Port and Waterways Authority would be a state-owned enterprise under the supervision of DMA.

River Port Management

The following are some options for better allocating responsibilities for river ports:

- DWIR could receive by law the task of developing and operating major river ports, which would have to be designated as such. DMA could then take the lead in planning.
- Large local ports could be planned by the union government, and managed as companies jointly owned by the central and local governments.
- Should customs clearance become feasible at Mandalay Port, MPA would then have jurisdiction over the port.

Financing

Cost recovery of river improvements is rare, and the resources are limited. Total turnover of river transport in Myanmar in 2013 was just $35 million, of which $10 million was from IWT. With improvements, the turnover of river transport may increase to $130 million by 2025. Assuming that the government is able to levy 10% of the sector turnover to finance maintenance and investments, this would generate a maximum of $3.5 million currently and up to $12.5 million by 2025, which would be just enough to finance proper river channel maintenance and operations. Major improvements would have to be fully financed without direct cost recovery from the government.

Assuming that this is the objective, the simplest ways to charge would be the following:

- **Fuel levy**. A level of $0.10 per liter for road use is recommended.[10] If this is applied to river operators, a fuel levy would raise about $1.5 million–$2.0 million from river transport.
- **Vessel registration fee**. The average turnover of each vessel is just below $10,000 a year. Up to 5% of that amount ($500/vessel) could be charged on average for powered vessels (more than 20 horsepower) in proportion to the vessel horsepower.

10 ADB. 2016. Transport Sector Policy Note: How to Improve Road User Charges. Manila

Capital investments could be financed through government budgets, international financing institutions (loans to be repaid by the budget), and cross-subsidies from nontransport activities. This is the model used for the Rhone River in France.

Private Sector Opportunities

There are some opportunities for larger private sector development:

- Should the government make minimum investments needed to improve the waterway, modern river transport operations would become feasible. This sector could then attract private investments in modern barges and vessels.
- Dredging could be outsourced and even become a lucrative activity.
- MPA could fully transform into a landlord port manager, and cease direct operation of its terminals.
- MPA, once financially sustainable, could also be partly commercialized with private investors.

Information Systems

After a VTMS is established in Yangon Port, basic information systems should also be developed for the rivers. A simple requirement would be a Global Positioning System tracking device on each river vessel.

Inland Water Transport Restructuring

Without major restructuring, IWT will quickly face the threat of insolvency. Options for restructuring are discussed in Appendix 1 to the 2016 Asian Development Bank (ADB) publication *Myanmar Transport Sector Policy Note: How to Reform Transport Institutions*. Under the technical assistance for Transport Sector Reform and Modernization, ADB is providing advice on a restructuring strategy.[11]

[11] ADB. 2014. *Technical Assistance to the Government of Myanmar for Transport Sector Reform and Modernization*. Manila.

APPENDIX 1

Rivers of Myanmar

Ayeyarwaddy River

The 2,100-kilometers long Ayeyarwaddy originates in Kachin State, at the confluence of the Mali River and N'Mai River about 45 km north of Myitkyina. The western Mali River branch starts from the end of the southern Himalayas, north of Putao. The river dissects the country from north to south and empties through a nine-armed delta into the Indian Ocean. On its way to the sea, it is joined by the Chindwin River, about 800 km from its source on its right bank. At Hinthada, about 218 km north of Yangon, the Ayeyarwaddy enters its delta. The river to Pathein forms the western limit, while the Yangon River forms the eastern limit of the delta.

The delta has a network of rivers and creeks that collectively make up about 2,400 km of navigable waterways. In some parts of the delta, these waterways are the only form of transport between economically important centers of the rice and fishing industries. The network may be divided into three sections: (i) a northern route from Yangon to Hinthada, (ii) a central network from Yangon to Pathein, and (iii) a southern network from Yangon to Mawlamyinegyun.

Generally, the Ayeyarwaddy, which is a wide and shallow river, has numerous islands and narrows sharply from 800 m to just 45 m at five points (Sinbo–Bhamo, Sinkan–Thinbawin, Male–Shwediak, Minhla–Migyaungye, and Kama–Sitsayan) which impact on the flow of the current and place some navigational constraints in the process.

Chindwin River

The Chindwin is the major tributary of the Ayeyarwaddy. Originating in the Himalayas, it runs south through a region of fertile meadows rich in natural resources for about 1,100 km before it joins the Ayeyarwaddy south of Mandalay. The upper reaches of the Chindwin are very shallow during the low water season, and commercial navigation is only possible from the confluence of the rivers at Homalin (some 500 km away) and Hkamti. The river becomes braided below Monywa.

Thanlyin River

The Salween originates in Tibet and flows through Yunnan where it is known as Nu Jiang before it enters Myanmar. The river is 2,815 km long, of which 2,410 km is in Myanmar. A stretch of the river meanders through Thailand on its way to Mawlamyine and the Andaman Sea. It is navigable between Mawlamyine to Hpa'an, and for about 90 km from the mouth in the rainy season.

Sittaung River

As described in the Encyclopedia Britannica: "*The Sittaung, in east-central Myanmar, rises from the edge of the Shan Plateau northeast of Yamethin and flows south for 420 km to empty into the Gulf of Martaban. The broad Sittaung River valley lies between the forested Bago Mountains on the west and the steep Shan Plateau on the east, and holds the main road and railway from Yangon to Mandalay as well as the major towns of Bago, Taungoo, Yamethin, and Pyinmana. The river is navigable for 40 km year-round and for 90 km during 3 months of the year. It has been used mainly to float timber, particularly teak, south for export. Its lower course is linked by canal to Bago River. This canal, built to bypass the tidal bore that afflicted the mouth of the Sittaung, once provided the only route from Yangon to Taungoo.*"[12]

Kaladan River

The Kaladan rises in the Lushai Hills and flows about 650 km through Chin State, entering the Bay of Bengal near Sittwe. It is navigable for about 176 km.

Table A1: Major Rivers of Myanmar

River	Length (km)	Catchment (m^2)	Discharge (million m^3)
Ayeyarwaddy	2,100	288,900	313,720
Chindwin	1,100	115,300	141,290
Sittaung	420	34,395	41,900
Thanlyin	2,410	158,000	257,920
Kaladan	650	22,611	53,800

km = kilometer, m^2 = meter square, m^3 = meter cube.
Source: Directorate of Water Resources and Improvement of River Systems.

Other Rivers

Other rivers worth mentioning, although their use for transportation has not been exploited to any significant extent, are the (i) Attayan River which runs south to north in Mon State to join the Thanlwin just to the east of Mawlamyine, reported to be navigable for about 117 km from Kya-In Seikkyi to Mawlamyine; (ii) Gyaing River which has its source in Thailand and flows westwards to join the Thanlwin about 5 km east of Mawlamyine, reported to be navigable for about 88 km from Kyondoe to Mawlamyine; (iii) Lemyo River with its headwaters in Chin State and flowing into the Bay of Bengal near the town of Myebon, navigable for about 96 km from Sittwe to Pan Myaung; and (iv) Mayu River which flows into the Bay of Bengal near Sittwe and navigable from Buthidaung to the sea for about 128 km.

[12] Sittang River. http://www.britannica.com/place/Sittang-River (accessed on 29 October 2015).

APPENDIX 2
Constraint Locations

Table A2.1: Constraint Locations on Ayeyarwaddy River in Low Water Season (November 2013—May 2014)

No	Regional Office	Stretch	Reach from Yangon (km)	Name of the Channel	Name of the Constraint Location	Situation of Bottleneck (minimum feet)			Duration	
						Depth	Width	Length	From	To
1	Region 5	Bhamo–Katha	1,309	Nyaungpinthar	Nyaungpinthar–Kyatuywae	3.0	40	200	December	March
2			1,305	Kyatuywaekyun	Nyaungpinthar–Kyatuywaekyun	4.0	50	100	December	March
3		Katha–Tagaung	1,128	Dingyikya	Maunggone–Nyaungpinthar	5.0	40	300	December	March
4		Tagaung–Thabeikkyin	1,052	Male	Pan Pin–Male	4.5	40	200	December	March
5		Thabeikkyin–Mandalay	980	Sithal	Sithal–Hte Saung	5.0	40	150	January	March
6			952	Bogyikyun	Aungmingalarkyun–Sheinmakar	4.5	40	120	December	March
7			918	Mingoon	Mingoon–Mandalay	6.0	60	150	December	March
8		Mandalay–Myinmu	907	Shankalaykyun	Mandalay–Wachat	6.0	70	200	December	March
9			867	Kinepyin	Kyauktalone–Myithtar	7.0	70	100	January	March
10			858	Paletan	Natsinkyauk–Myinmu	6.0	60	200	December	March
11		Myinmu–Shwetantic	833	Shwepaukpin	Aungthar–Mayoekone	6.0	70	100	January	February
12			796	Pattarkyun	Singaung–Pauktaw	6.0	60	200	December	March
13		Shwetantic–Lannywar	740	Thithtuakkyun	Myinkyun–Kyarpasat	6.0	50	200	December	March
14		Shwetantic–Lanywar	690	Htaunchaukpin	Thirikyun–Lanywar	6.0	60	200	December	March
15	Region 4	Lanywar–Nayunghla	653	Sanikhon	Nabaetin–Sanikhon	6.5	120	200	January	May
16			632	Thanatgone	Pakhannge–Bogone	6.0	120	300	January	May

continued on next page

Table A2.1: *continued*

No	Regional Office	Stretch	Reach from Yangon (km)	Name of the Channel	Name of the Constraint Location	Situation of Bottleneck (minimum feet)			Duration	
						Depth	Width	Length	From	To
17			620	Marnpyaykyun	Nyaunggone–Marnpyaykyun	6.0	150	200	January	May
18		Nyaunghla–Minhla	597	Ngachuakkyun	Nantawkyun–Baeseik	6.5	150	200	January	May
19			580	Magway Bridge	Kyarkan–Magway bridge	6.0	120	200	January	June
20			547	Myinkoon	Myinkoon–Thanpayarkan	6.0	80	250	February	May
21		Minhla–Aunglan	494	Kyaukchat	Tharwithti–Nyaungpinthar	6.5	80	150	January	March
22		Aunglan–Sisayan	445	Taungnathar	Taungnathar–Kanni	7.0	150	100	January	May
23			426	Kwanlaung	Pahtoe–Nyaungpinthar	7.0	150	200	January	May
24			416	Kanma	Nyaungpinseik–Kanma	6.5	180	125	December	April
25	Region 3	Sisayan–Kyangin	392	Nawin	Latkhotpin	6.5	150	150	December	March
26			356	Thayetann	Thayetann–Padaetharkyun	7.0	150	300	December	March
27			395	Tayokemhaw	Akauktaung–Tayokemhaw	5.5	100	300	January	March
28		Kyangin–Pyinkatoe	313	Marlakargone	Yinmugone–Marlakargone	7.0	100	350	December	March
29			292	Kanaunglay	Phoesatawkyun–Aikalaw	7.5	150	250	December	April
30			261	Thonesalkyun	Thonesalkyun–Paetakhwe	6.5	100	400	December	March
31			254	Shwethaung kyun	Laylan–Shwethaungkyun	6.5	150	300	January	March
32			248	Kyungyi	Shwethaungkyun–Pyinkatoekyun	6.5	150	100	February	March
33		Pyinkatoegone–Gyonegyonekya	205	Tharduchaung	Yoonthwel–Zinyawkyun	7.0	150	200	November	March
34			201	Pharrlatkhon	Zinyawkyun–Talokegone	7.0	150	150	January	March
35			162	Yaypyan	Ayeywar–Yaypyan	6.5	150	350	January	March

km = kilometer.

Source: Directorate of Water Resources and Improvement of River Systems.

Table A2.2: Constraint Locations on Chindwin River in Low Water Season (November 2013—May 2014)

No	Regional Office	Stretch	Reach from Yangon (km)	Channel	Constraint Location	Situation of Bottleneck (Minimum feet)			Duration	
						Depth	Width	Length	From	To
1	Region 6	Khante–Hommalin	806	Sinthay	Khante–Hommalin	2.75	20	200	March	May
2			795	Ngotetahtaung	Katoethatnan–Heinsoon	3	30	300	March	May
3			777	Kyarkite	MileNaung–Kyarkite	2.75	20	300	March	May
4			720	Thayetgone	Malin–Htonelone	3	20	200	March	May
5			688	NannUte	Tharyargone–Awwthaw	2.75	25	100	March	May
6			633	Kawyar	Kawyar–Hteinlin	3	30	100	March	May
7		Hommalin–Outtaung	608	Katthar	Hommalin–Htonmate	3.25	20	300	March	May
8			546	Natsat	Innthar–Myaingthar	3.75	20	400	March	May
9		Outtaung–Kalaywa	328	Kyawenan	Kyawenan–Manlon	3.5	30	300	March	May
10		Kalaywa–Thintaw	249	Latpanseik	Yonethar–Nanwinchaung	3.5	30	200	March	May
11		Thintaw–Monywa	135	Natgyi	Kani–Natgyi	3.5	20	200	March	May
12		Monywa–Chindwinwa	68	Amyint	Amyint–Thayetgine	3.25	20	200	March	May
13			38	Shwetachaung	Maau–Shwetachaung	3.5	30	200	March	May

km = kilometer.

Source: Directorate of Water Resources and Improvement of River Systems.

APPENDIX 3
Yearly Vessel Accidents

Table A3.1: Yearly Losses and Causes of Vessel Accidents

Fiscal Year	Causes and Numbers of Accidents					Number of Accident	Losses		
	Unfair Waterway Condition	Lack of Vessel Strength	Careless Vessel Operator	Bad Weather Condition	Others		Number of Vessel Sunk	Human	
								Dead	Lost
2004	6	5	7	1	4	23	13	1	4
2005	4	3	6	3	2	18	12	8	7
2006	3	1	2	1	5	12	9	1	0
2007	4	3	9	1	2	19	10	12	21
2008	7	5	2	1	0	15	9	2	-
2009	4	2	6	1	0	13	13	21	50
2010	2	7	2	0	1	12	7	20	7
2011	3	7	4	2	0	16	13	11	14
2012	4	3	5	1	2	15	12	16	6
2013	5	3	6	1	6	21	10	3	6
1 April–30 June 2014	1	1	1	0	0	3	2	0	0
Total	**43**	**40**	**50**	**12**	**22**	**167**	**110**	**95**	**115**

Source: Directorate of Water Resources and Improvement of River Systems.

Table A3.2: Yearly Vessel Accidents in Myanmar's Inland Waterways

Fiscal Year	Number of Accidents in Inland Waterways									Number of Accidents
	Ayeyarwaddy River	Chindwin River	Thanlwin River	Ataran River	Delta Waterways	Twante Canal	Pun Hlaing River	Ngamoeyeik Creek	Yangon River	
2004	9	6	1	1	3	2	1	0	0	23
2005	7	6	0	0	0	5	0	0	0	18
2006	2	3	0	0	3	4	0	0	0	12
2007	8	3	0	0	0	7	1	0	0	19
2008	5	1	1	0	1	5	2	0	0	15
2009	8	1	0	0	2	2	0	0	0	13
2010	4	2	0	0	0	3	1	1	0	12
2011	10	1	0	0	1	1	1	1	1	16
2012	8	2	0	0	1	4	0	0	0	15
2013	6	12	1	0	0	0	1	1	0	21
1 April–30 June 2014	2	0	0	0	0	0	0	1	0	3
Total	**69**	**37**	**3**	**1**	**12**	**33**	**7**	**4**	**1**	**167**

Source: Directorate of Water Resources and Improvement of River Systems.

APPENDIX 4
Inland Water Transport Charges

Table A4.1: Loading and Unloading Charges
(MK/ton)

Commodity	Rate	Remarks
Rice	2,625	
Cement	2,730	
Fertilizer	2,730	
Timber	16,900	4' x 4' (lower)
	33,800	4' x 4' (upper)
	50,700	6' x 6' (upper)
Iron	8,450	
Furniture	13,000	
Miscellaneous	8,450	

' = feet.
Source: Inland Water Transport.

Table A4.2: Port Charges
(MK/day)

Vessel Length (feet)	Rate
25	500
25–50	1,000
50–75	1,500
75–100	2,000
100–125	2,500
125–150	3,000
150–175	3,500
175–200	4,000
200–225	4,500
225–250	5,000
250–275	5,500
275–300	6,000

Source: Inland Water Transport.

APPENDIX 5

Cargo Forecast 2030

A5.1: Cargo Forecast 2013 (1,000 ton/day)

Commodity	Truck	River	Railway	Coastal	Total
1 Live animal and animal products	4.2	0.1	0.0	0.0	4.3
2 Fish and aquatic products	13.0	0.0	0.0	0.0	13.0
3 Vegetable and fruits	15.5	0.0	0.0	0.0	15.6
4 Grain and grain products	157.4	3.2	1.8	4.4	166.9
5 Other agricultural products (e.g., plantation product)	104.0	5.0	0.8	0.0	109.9
6 Foodstuff, beverage, and animal food	56.2	3.5	7.6	8.9	76.2
7 Petroleum, oil, and gas	30.3	21.0	1.9	63.9	117.1
8 Coal, ore, stone, and sand	63.4	0.8	2.6	0.0	66.9
9 Cement, construction material (including steel frame)	136.9	10.1	15.5	4.2	166.7
10 Fertilizer (including urea)	33.3	0.2	0.2	0.0	33.7
11 Garment, textiles, and fabric	9.4	0.3	0.1	0.0	9.8
12 Wood and wood products	9.1	1.1	4.2	0.0	14.4
13 Paper and printed matter	3.1	0.0	0.1	0.0	3.2
14 Metal and metal products (excluding construction material)	5.8	0.3	0.8	0.0	6.9
15 Industrial material, chemicals	19.6	0.9	1.0	0.9	22.3
16 Household articles, miscellaneous	106.2	7.1	2.8	0.8	116.8
17 Machinery and parts, transportation	27.4	0.5	0.3	0.1	28.3
Total	**794.9**	**54.3**	**39.8**	**83.1**	**972.1**
Share	87%	2%	2%	9%	100%

Note: Totals may not add up due to rounding.

Source: Japan International Cooperation Agency. 2014. *The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar*. Naypyitaw.

Myanmar Transport Sector Policy Note

River Transport

Better transport is essential to Myanmar's development. After decades of underinvestment, Myanmar's transport infrastructure lags behind other regional countries. Sixty percent of trunk highways and most of the railways need maintenance or rehabilitation. River infrastructure does not exist, while 20 million people lack basic road access. Can the transport sector deliver upon the master plan's objectives? What is needed to improve the quality of the infrastructure and services for the industry? How can basic transport services be provided to all? How can Myanmar reduce the economic and social cost of transport? This report is an attempt to answer these questions.

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