

Chapter 15 Infrastructure Sectors Development Strategies

15.1 Development Strategies for Roads

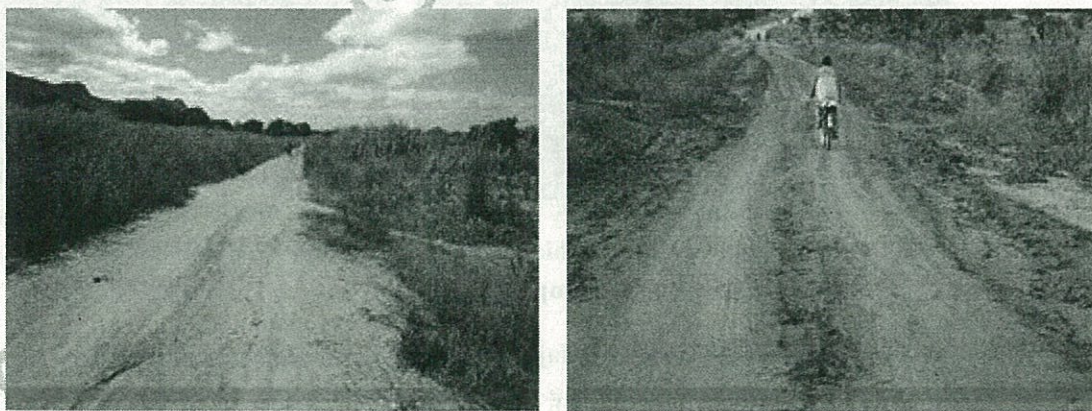
15.1.1 Issues on the Road Sector

A high-standard strategic road network in the Nacala Corridor Region is planned to be completed by 2017 based on the Integrated Road Sector Programme (PRISE) 2011-2014 and PII 2012-2015. The completion of these road projects will provide comfortable and reliable transport with all provincial capitals linked by these trunk roads.

However, there are still many issues to be solved for growing the regional economy. Additionally, these road improvements will trigger some new problems such as road safety and road maintenance. These issues and problems are summarized below.

(1) Inadequate Accessibility in Rural Areas

Accessibility means to provide at least minimal access throughout the year to communities and districts to which existing access roads have deteriorated to the extent that they are cut off from the main trunk network.



Source: Photo by JICA Study Team

Photo 15.1.1 Impassable Roads in Rainy Season (Left: To Lalaua, Right: To Mecburi)

(2) Lack of Reliable Alternative Routes and Redundancy

Even if on-going road projects and planned projects are completed, reliable alternative routes, detours and/or backup routes for main trunk roads will be insufficient in terms of the road density.



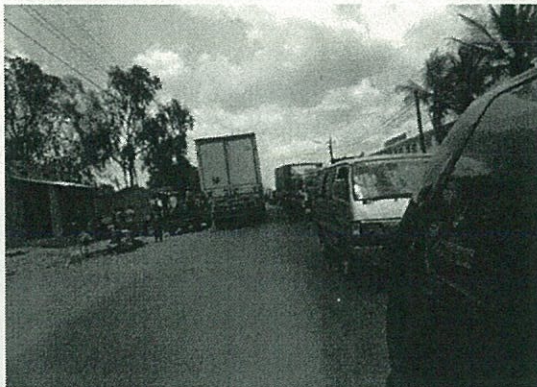
Source: Photo by JICA Study Team
Photo 15.1.2. Weight Limit for Bridge (R658)



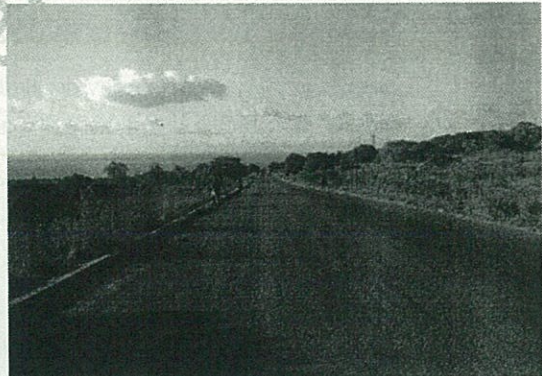
Source: Photo by JICA Study Team
Photo 15.1.3. Rolled Truck at Narrow Bridge (R658)

(3) Lack of Suitable Urban Road Network

The road network in urban areas such as Nampula city has a limited road network capacity and cannot accept the high volume of traffic that is expected after completion of Nacala Corridor and expansion of Nacala Port. The conditions for living in such cities are expected to get worse over the next few years due to increasing goods transportation (heavy trucks), car ownership and population growth.



Source: Photo by JICA Study Team
Photo 15.1.4. Long Queue of Vehicles in the Evening Peak Hour in Nampula



Source: Photo by JICA Study Team
Photo 15.1.5. Access Road to Nacala Port (no pedestrian way)

(4) Road and Traffic Safety Risk in Major Cities and Railway Level Crossings

Almost all trunk roads pass through the centres of cities and towns having a large number of pedestrians. An increase in traffic will also increase the risk of traffic accidents, primarily to the detriment of the most vulnerable road users, and negatively impact on the living conditions in the towns. In addition, the increase in the number of railway operations will cause a rise in conflicts with vehicle traffic at level crossings.

(5) Limited Capacity for Road Maintenance

Although the District Administrations have been expecting to benefit from fiscal decentralization, their available funding and technical capacity is, at this stage, insufficient to cope with their role in road construction and maintenance. It is for this reason that the District Administrations are often

side lined when it comes to designing and implementing district roads.

(6) Limited Financial and Technical Capacity of Construction Contractors

A specific problem related to the road sector is the limited availability of capable small-scale contractors to carry out labour based road works on tertiary and district roads. The few contractors available are occupied with works on the classified network.

15.1.2 Objectives for the Road Sector

Based on the discussion of current conditions written in Chapter 5 and issues as mentioned above, the objectives of the Road Sector are set as follows:

- (1) To upgrade the accessibility and the functionality of the roads in the Region**
 - By improving regional, provincial and district roads from agricultural/ fishing and tourism potential areas the trunk roads to contribute to the expansion of markets
 - By ensuring access to districts with the greatest economic potential, focusing on provinces with high population densities and high concentration of poverty.
 - By upgrading impassable roads to provide at least minimal access throughout the year to communities and districts
 - By strengthening regional connectivity between the major regions in the Nacala Corridor Region by formulating the main corridors
- (2) To establish urban road networks suitable for enhanced urban functions and increasing populations and economic activities**
 - By establishing hierarchical road networks
 - For contributing to smooth connection to main corridors from industrial and business areas.
 - For supporting efficient economic activities in city centres and new development areas
 - By providing sufficient road capacities for the future traffic demand
- (3) To provide safe and environmentally desirable road infrastructures by providing ring roads, bypass roads, multi-lane roads, flyovers, parking space and comfortable pedestrian routes**
- (4) To establish reliable and efficient road networks by providing backup and/or alternative roads to supplement the main corridors and by providing transport terminals for smooth modal changes**
- (5) To improve road maintenance capacities not only for national roads of the international corridors, but also regional and rural roads**

15.1.3 Strategies for the Road Sector

The strategies to achieve the objectives of the Road Sector are formulated as follows:

- (1) Strategy 1:** To provide and improve roads for serving particular areas of high potential for agricultural development and other economic development
 - By upgrading national roads which compose feeder lines
 - For establishing a ladder-shape network to connect the main corridor in order to improve reliability and redundancy of the regional road network

- By upgrading other national roads
 - For improving market access from areas of high development potential
 - For securing minimal access by providing passable roads from production areas
 - For providing equal opportunities to access social services
- (2) **Strategy 2:** To establish and maintain a region-wide trunk road network consisting of main corridors and sub-corridors for the purpose of covering wide areas in the Nacala Corridor Region
 - By upgrading and maintaining the national roads that compose the international major corridor from Nacala Port through Nampula, Cuamba, Mandimba, Liwonde, Lilongwe and Chipata up to Lusaka
 - For strengthening of the international corridor connecting Zambia, Malawi and northern Mozambique
 - By upgrading and maintaining the national roads that compose the major corridors 1) between Mandimba and Lichinga and 2) between Mandimba and Tete-Moatize thorough Malawi
 - For extending the coverage of the upgraded trunk road network (not simply a single corridor, but to organise an extended corridor network)
 - By upgrading and maintaining the national roads that compose the sub-corridor between Lichinga and Pemba through Montepuezu
 - For extending the upgraded trunk road network in the areas without railways
- (3) **Strategy 3:** To provide and improve urban roads for establishing hierarchical urban road networks to avoid concentrated traffic coming into the city centres, to provide access for new industrial areas and logistics areas, to guide urban development and to form new urban areas
 - For assuring the transport function of the Main Corridors in the Region
 - For supporting existing and prospective economic sectors' activities
 - For creating better residential and business environments
- (4) **Strategy 4:** To implement comprehensive measures for securing traffic safety through inter-provincial efforts, coordination with neighbouring countries
 - By paying attention to car users, pedestrians and bicycle riders
 - By considering the quality of life in residential areas along roads
- (5) **Strategy 5:** To develop a proper road maintenance mechanism through international and interprovincial coordination
 - By establishing a specialized implementation unit for maintaining national roads that compose the international main corridors, main corridors and sub-corridors
 - By establishing and using a road inventory database
- (6) **Strategy 6:** To create a sustainable management system and capacity development for construction and maintenance for regional and rural roads
 - Because it is expected that paved roads and urban roads will be expanded in the Region
 - For capacity development of paved road maintenance for both government and private sectors under outsourcing schemes
 - For capacity development for the government sector regarding planning budget and using budget for road maintenance
 - By paying attention not only to technical issues but also to creation of employment

opportunities through road construction and maintenance work

15.1.4 Programmes and Projects of the Road Sector

(1) Criteria for Selecting Short-Term, Medium-Term and Long-Term Projects

For project identification in the Road Sector, the following are proposed criteria for prioritization for road improvement:

Criteria for Selecting Short-Term Targets

- Completion of the backlogged and effective projects proposed by both PRISE and IIP
- Enhancement of accessibility to the large markets from high potential agricultural areas
- Support for on-going economic investment
- Securing of immediate road safety
- Establishment of actual plan for feeder and non-classified road improvement based on the results of the “Rural Road Investment Programme” by DFID

Criteria for Selecting Medium-Term Targets

- Improvement of the road network in wider urban areas within planned urban areas for supporting economic activities and urban residential environment
- Enhancement of accessibility for high economic potential areas (agriculture, fishing and tourism)
- Enhancement of capacity and expansion of network for international transportation routes
- Establishment of suitable road maintenance systems for both national/regional roads and district/feeder level roads

Criteria for Selecting Long-Term Targets

- Provision of improved roads for rural areas to connect with urban centres for better accessibility to job opportunities and other urban activities
- Formation and securing of reliable road network with improvement of detours

(2) Short-Term, Medium-Term and Long-Term Projects

Based on the above discussion, the identified list of projects which mainly have route numbers with their target-terms is shown in Table 15.1.1. .

Table 15.1.1 Strategies and Project List

Strategy	Project/Route No.	Location	Code	Corridor	Length (km)	Planned By	Term					Project Type	
							Scheduled	Proposed	Priority	Middle	Long		
Strategy-1 Road Network Improvement for Development Potential Areas	R698: Mueda -Montepuez	Cabo Delgado	C-3		216	PII 2012 - 2015						Upgrading	
	R698: Montepuez - Namuno	Cabo Delgado	C-5	Feeder Line	55	Study Team						Upgrading	
	R698: Namuno - Machoca	Cabo Delgado	C-6	Feeder Line	55	Study Team						Upgrading	
	R760: Balama - Namuno	Cabo Delgado	C-7		40	Study Team						Upgrading	
	R760: Pemba - Rio Lurio (Lurio Br.)	Cabo Delgado	C-8		55	Study Team						Upgrading	
	N360 Cuamba -Marrupa	Niassa	NI-1	Feeder Line	249	PII 2012 - 2015						Upgrading	
	R726,R732: Chimbonila - Unango	Niassa	NI-7		60	Study Team						Upgrading	
	R729: Massangulo - Malanga	Niassa	NI-8		107	Study Team						Upgrading	
	R1214: Nairubi - Mitande	Niassa	NI-9		55	Study Team						Upgrading	
	R723: Maiaça - Nungo (Rio Lurio Br.)	Niassa	NI-10		95	Study Team						Upgrading	
	R720: Cuamba - Insaca	Niassa	NI-11		80	Study Team						Upgrading	
	New: N13 - N360	Niassa	NI-12		30	Study Team						New Construction	
	N325,N324:Malci-Olinga-Pebane	Zambézia	Z-2		191	PII 2012 - 2015						Upgrading	
	R655: Gurue - Alto Molocue	Zambézia	Z-5	Feeder Line	92	Study Team						Upgrading	
	N326: Malema - Alto Molocue	Zambézia	Z-6		38	Study Team						Upgrading	
	N323: Alto Ligonha - Gile	Zambézia	Z-7		84	Study Team						Upgrading	
	N324: Pebane - Moma (Ligonha Br.)	Zambézia	Z-8		145	Study Team						Upgrading	
	R646: Gile - Puna	Zambézia	Z-10		80	Study Team						Upgrading	
	R689: Monapo-Angoche	Nampula	NA-1		173	PII 2012 - 2015						Upgrading	
	N104: Nampula-Namitil	Nampula	NA-2-1	Feeder Line	60	PII 2012 - 2015 PRISE						Upgrading	
	R683,R680,N324 e N320: Namitil-Chalaua-Moma	Nampula	NA-2-2	Feeder Line	159	PII 2012 - 2015 PRISE						Upgrading	
	N104: Namitil - Angoche	Nampula	NA-3	Feeder Line	80	Study Team						Upgrading	
	N324: Moma - Boila	Nampula	NA-4		80	Study Team						Upgrading	
	R696,R698: Rapale - Machoca (Rurio)	Nampula	NA-5	Feeder Line	110	Study Team						Upgrading	
	R694,R695: Ribave - Machoca	Nampula	NA-6		120	Study Team						Upgrading	
	N326: Malema - Alto Molocue	Nampula	NA-7		35	Study Team						Upgrading	
	R691,R1151,R695: Malema - Lalaua	Nampula	NA-8		173	Study Team						Upgrading	
	R698,R706: Machoca - Napaco (N1)	Nampula	NA-9		135	Study Team						Upgrading	
	R705,R706: Momba - Arua	Nampula	NA-10	Feeder Line	95	Study Team						Upgrading	
	R705: Nampuecha - Rio Lurio	Nampula	NA-11		63	Study Team						Upgrading	
	New: Nacala - Momba Road	Nampula	NA-18		60	Study Team						New Construction	
	N303: Bene-Figoe-Zumbo	Tete	T-2	Feeder Line	348	PII 2012 - 2012						Upgrading	
	R602: Mphende - Mukumbura	Tete	T-3		50	PRISE						Upgrading	
	N302: Tete - Mualadze	Tete	T-4		255	Study Team						Upgrading	
	R603, R604: Bene - Furancungo - Villa Coutinho	Tete	T-5		170	Study Team						Upgrading	
	Non-classified: N7 - R302	Tete	T-6		55	Study Team						Upgrading	
	R762: Metuga - Palma	Cabo Delgado	C-9	Tourisum Corridor	190	Study Team						Upgrading	
	N361: Lichinga - Metangula	Niassa	NI-6	Feeder Line	110	Study Team						Rehabilitation	
	TIZ Access Road	Nampula	NA-13	Tourisim Corridor	45	Study Team						Upgrading and New Construction	
	Nacala Tourisum Roads Improvement	Nampula	NA-21	Tourisim Corridor	235	Study Team						Upgrading	
	Strategy-2 Establishment of Region-Wide Road Network consisting of Main Corridors and Sub-Corridors	N380 Sonate-Macomia-Oasse	Cabo-Delgado	C-1	Negomane Corridor Sub-Corridor	189	PII 2012 - 2015						Rehabilitation and Bridge Replacement
		N1: Rio Lúrio- Meteorocom	Cabo-Delgado	C-2	Mozambique Highway Sub-Corridor	74	PII 2012 - 2015						Rehabilitation
		N381/R1251: Negomane - Mueda	Cabo Delgado	C-4	Nagomane Corridor	175	PRISE						Upgrading
		N13: Lichinga - Mandimba	Niassa	NI-2	Niassa Corridor Main Corridor	150	PRISE						Upgrading
		N13: Mandimba - Cuamba	Niassa	NI-3	Nacala Corridor, Niassa Corridor, Main Corridor	152	PRISE						Upgrading
R657: Magge - Cuamba		Niassa	NI-4	Niassa Corridor, Main Corridor, Feeder Line	90	PRISE						Upgrading	
R733,R1215: Unango - Matchedje		Niassa	NI-5	Metangula Corridor	155	Study Team						Upgrading	
N103: Magge-Lioma Mutuali-Lioma		Zambézia	Z-1	Main Corridor	67	PII 2012 - 2015						Upgrading	
N103: Rehabilitation of Existing 13		Zambézia	Z-3	Niassa Corridor	-	PRISE						Rehabilitation	
N11: Milange - Alt Benfica		Zambézia	Z-4	Quelimane Corridor	94	PRISE						Upgrading	
R650,R658: Magge - Milange		Zambézia	Z-9	Main Corridor	143	Study Team						Upgrading	
N1,N12: Nampula - Nacala (4-lane)		Nampula	NA-12	Main Corridor	145	Study Team						Widening	
New Nacala Port Access		Nampula, Nacala	NA-17	Main Corridor	14	Study Team						New Construction	
N322: Madamba Mutarara		Tete	T-1	Mutarara Corridor	350	PII 2012 - 2012						Upgrading	
Strategy-3 Urban Road Network		New: Cuamba Bypass	Niassa, Cuamba	NI-13		12	Study Team						New Construction
	Cuamba Urban Road Improvement	Niassa, Cuamba	NI-14		9	Study Team						Upgrading and New Construction	
	New: Nampula Ring Road (South)	Nampula, Nampul	NA-14-1		33	Study Team						New Construction	
	New: Nampula Ring Road (North)	Nampula, Nampul	NA-14-2		26	Study Team						New Construction	
	New: Nampula Outer Road (North)	Nampula, Nampul	NA-15		151	Study Team						New Construction	
	New: Nampula Urban Road	Nampula, Nampul	NA-16		3	Study Team						New Construction	
	Nacala Wide Area Urban Roads Improvement	Nampula, Nacala	NA-19		230	Study Team						New Construction	
R703: Nacala - Nacala Velha	Nampula, Nacala	NA-20		18	-						Upgrading		
Strategy-4 Road Safety	Level Crossing Improvement	Nampula	RS-1		0.4	Study Team						New Construction	
	Accident database system development	Whole Country	RS-2			Study Team						Study and/or Training	
	Safety engineering improvement	Whole Country	RS-3			Study Team						Study and/or Training	
	Safety Enforcement	Whole Country	RS-4			Study Team						Legal System	
Strategy-5 Strategy-6 Road Maintenance	Capacity Development for Budget Plan and Use	Whole Country	RM-1			Study Team						Study and/or Training	
	Road Inventory Database (Provincial, District Level)	Whole Country	RM-2			Study Team						Study and/or Training	
	LBT Training (Pilot Project) and Generalization	Whole Country	RM-3			Study Team						Study and/or Training	
	Establishment of Specialized Maintenance Unit	Whole Country	RM-4			Study Team						Study and/or Training	

Source: JICA Study Team

15.2 Development Strategies for Railways

15.2.1 Demand Forecast

Traffic volume of railway transportation is based on the forecast of cargo handled at the Nacala Port and Nacala-a-Velha Port.¹ According to Vale S.A., the amount of coal to be transported by railway is 18 million ton per annum (MMTA) in 2017, 20 MMTA in 2025 and 30 MMTA in 2035.

**Table 15.2.1 Forecast of Cargoes Handled at Nacala Port
(Import and Transit to Neighbouring Countries)**

	Commodity	2017	2025	2035
Internal/Regional Cargo including Import to Nacala Region	Containers	275	511	1,274
	Bulk (Fuel)	252	480	1,125
	Bulk (Clinker)	390	210	24
	Bulk (Wheat)	225	277	420
	Bulk (Rice)	333	333	708
	Vehicles	49	49	283
	Bulk (Others)	0	168	850
	Mineral (Coal, empty)	0	0	0
	Mineral (Other, empty)	0	0	0
	Total		1,524	2,028
Transit Cargo to Neighbouring Countries	Malawi			
	Containers	472	1,009	2,465
	Bulk (Fuel)	295	487	925
	Bulk (Wheat)	116	115	98
	Vehicles	69	148	298
	Bulk (Others)	286	565	1,144
	Sub-total	1,238	2,324	4,930
	Zambia			
	Containers	92	184	357
	Bulk (Fuel)	63	100	179
	Bulk (Wheat)	9	21	31
	Vehicles	8	13	23
	Bulk (Others)	52	114	241
	Sub-total	224	432	831
	Tanzania			
	Bulk (Wheat)	0	175	194
Sub-total	0	175	194	
Total		1,462	2,931	5,955
Ground Total		2,986	4,959	10,639

Source: JICA Study Team

¹ Coal will be handled at the port in Nacala-a-Velha and all other cargoes will be handled at Nacala Port in Nacala Porto.

**Table 15.2.2 Forecast of Cargoes Handled at Nacala Port
(Export and Transit from Neighbouring Countries)**

	Commodity	2017	2025	2035
Internal/Regional Cargo including Export from Nacala Region	Container	412	1,027	2,631
	Mineral (Others)	0	5,000	7,500
	Bulk (Wood chip)	0	192	576
	Bulk (Others)	76	189	485
	Total	488	6,408	11,192
Transit Cargo from Neighbouring Countries	Malawi			
	Containers	255	438	886
	Bulk (Others)	90	156	315
	Sub-total	345	594	1,201
	Zambia			
	Containers	4	8	15
	Bulk (Others)	10	19	36
	Sub-total	14	27	51
	Tanzania			
	Bulk (Food)	0	175	194
	Sub-total	0	175	194
	Total	359	796	1,446
	Ground Total		847	7,204

Source: JICA Study Team

It is assumed that the railways will transport the above cargoes in accordance with the modal share ratio shown in the table below.

Table 15.2.3 Assumed Modal Share of Railways for Estimation of Railway Cargo Demand

Type of Traffic	Commodity	Modal Share (Rail)			Type of Wagon
		2017	2025	2035	
Internal/Regional	Containers	5%	10%		Flat wagon for containers
	Coal	100%			Flat wagon for coal
	Other minerals	100%			Flat wagon for ore
	Wood chips	5%	10%		Flat wagon
	Fuel	5%	10%		Tank wagon
	Clinker	5%	10%		Hopper wagon for clinker
	Wheat	5%	10%		Hopper wagon for wheat
	Rice	5%	10%		Box wagon
	Vehicles	0%			----
	Others	5%	10%		Box wagon
Transit	Containers	50%			Flat wagon for containers
	Fuel	100%			Tank wagon
	Wheat	50%			Hopper wagon
	Vehicles	5%			Flat wagon
	Others	50%			Box wagon

Source: JICA Study Team

15.2.2 Required Number of Trains

Based on the estimated traffic volume of cargoes for railway, the required number of wagons for each type of commodity and required number of trains are calculated.

The network capacity dedicated for coal is estimated based on the volume of coal (to be transported from Moatize to Nacala) that was reported by Vale S.A. The network capacities for other goods (general cargo, other minerals, and passengers) in 2025 and 2035 are estimated based on the ratio of the number of trains (5 pairs/day) and network capacity in 2017 (4 million tons per annum; MTPA).

**Table 15.2.4 Required Network Capacity of the Nacala Corridor
Railway between Moatize and Nacala**

Year	Required Number of Trains (pairs)						Network Capacity (MTPA)*
	General Cargo	Coal	Other Minerals	Passengers	Others	Total	
2017	2	9	0	1	2	14	22 (18)
2025	4	10	8	1	2	19	28 (20)
2035	9	14	11	1	2	28	42 (30)

*: () is network capacity for coal transportation

Source: JICA Study Team

In 2017, the network capacity should be 22 million tons per annum (hereinafter “MTPA”) to meet traffic demand. However, it is necessary to increase its capacity up to 28 MTPA by 2025 and 42 MMTP by 2035.

15.2.3 Issues on the Railway Sector

The issues for the railway sector for promoting integrated development for the Nacala Corridor Region are described below.

(1) How to realise benefits by upgrading of railways between Moatize and Nacala through Malawi for promoting development for the Nacala Corridor Region

By the completion of the upgrading of railways between Moatize and Nacala through Malawi, the number of trains and their average speed will increase. As a result, it is expected that the line capacity for general cargo will increase and their transportation cost will be reduced partly because the transit time between inland areas and Nacala will be reduced and partly because of improved efficiency of transport. Critical issues in the railway sector include how to realise or utilise benefits to be attained by upgrading of the railways between Moatize and Nacala through Malawi for promoting development for the Nacala Corridor Region.

(2) How to maintain or upgrade the line capacity of the railways and the railway cargo handling capacity

On the other hand, there is a concern that the railway line capacity will be insufficient for the expected growth of cargo demand. The handling capacity of the cargo stations will also be insufficient because the sites (cargo handling space) for cargo stations, especially those of Nacala and Nampula, are limited. When the expansion of the cargo station sites is difficult, the relocation of cargo stations might be required. To accommodate the growth in traffic volume, the doubling of railway tracks or the construction of bypasses for some cities might also be required. Another

critical issue in the railway sector is how to maintain or upgrade the line capacity of railways and handling capacity for cargos shipped by railway.

(3) How to deal with Social and Environmental Impacts of Coal Trains in Urban Areas

Moreover, there is a concern that running long and heavy trains will cause social and environmental impacts including noise, vibration and the increase in time required for closing level-crossings. Especially, at the level-crossings close to railway stations, since the long coal trains (on the way back to Tete from Nacala) run very slowly with closing time reaching over 10 minutes. This will cause traffic congestion in major urban areas. The number of trains which run through these areas is estimated to be 14 trains per day (in one direction) in 2017, 19 trains (in one direction) in 2025 and 28 trains (in one direction) in 2035. Out of these trains 9 trains in 2017, 10 trains in 2025 and 14 trains in 2035 will be coal trains of Vale.

(4) How to efficiently deal with international operation of trains

The Nacala Corridor Railway is expected to transport international cargoes between Zambia, Malawi, and Mozambique. The cargo demand from Zambia and Malawi should also be attended by the Nacala Corridor Railway connecting Moatize and Nacala. Under the circumstances of frequent operation of long coal trains, it is not easy to operate other cargo trains to satisfy the cargo demand from Zambia, Malawi and inland Mozambique (Niassa Province and Tete Province). One of the critical issues on the railway sector is how to efficiently deal with international operation of trains.

(5) How to transport more non-coal cargoes over the Nacala Corridor Railway

The Nacala Corridor Railway should be upgraded and operated in compliance with the concession agreements. Although the railway operating company is more concerned about efficiency and volume of coal transport, how to maintain and increase the railway capacity for non-coal cargoes, as well as for passengers, is a very critical issue for regional development.

(6) How to strengthen the railway line between Lichinga and Cuamba

In addition to the main corridor, the railway line between Lichinga and Cuamba is also an important line for northern Niassa. It is also important to expand the railway network in wider areas of the Nacala Corridor Region. The railway section between Cuamba and Moatize is also important for transporting non-coal cargoes for diversifying the economic sectors of Tete Province.

15.2.4 Objectives for the Railway Sector

Considering how to take advantage of upgrading of the Nacala Corridor Railway between Moatize and Nacala, the objectives of the railway sector are set as follows:

- To actively promote utilization of railways for long-haul transport (both international and domestic)
- To promote containerisation of railway transport in order to achieve higher efficiency and increase the transport capacity in both domestic transport and transit (international) transport
- To promote integration of railway and road transport (To increase the acceptance of more cargoes from road transport)
- To realize safe operation of the railway system
- To reorganise railway routes in harmony with the urban structure, especially for reducing

interruption of road traffic at railway crossings in city centres, as well as environmental impacts (noise and vibration) on the residential environment

- To secure the profitability of railway operation (including upgrading and maintenance) by creating cargo demand by promoting development of diversified economic sectors in the Nacala Corridor Region

15.2.5 Strategies for the Railway Sector

The strategies of the railway sector are formulated as follows:

- To strengthen the capacity of INATTER, a regulatory body for railway transport for ensuring that the concessionaire fulfils all obligations for regional transport of non-coal cargoes under the concession agreement
- To establish container depots in Zambia and Malawi and to introduce a tracking system for containers for promoting containerisation of railway cargo
- To establish multi-modal terminals between railways and roads at Nacala, Nampula and Cuamba for integrating railway transport and road transport
- To improve railway crossings as well as railway traffic control for promoting railway transport safety
- To construct railway bypasses to reduce social and environmental impacts (interruption of road traffic, noise and vibration) of coal railway operation in urban areas, especially in the city centre
- To promote various businesses related to the railway in order to sustain the management of railway operation, for example, by promoting tourism and by redeveloping former railway facilities
- To rehabilitate and resume operation of Lichinga-Cuamba Railway for expanding the railway network

15.2.6 Programmes and Projects for the Railway Sector

For implementing the strategies recommended in the previous section, the following programmes and projects are proposed:

- Nacala Corridor Railway Capacity Expansion Programme
- International Railway Network Integrated Operation Promotion Project
- Inland Container Depots (ICD) Development Projects in Nacala, Chipata, and at the border with Malawi
- ICT Applied Tracking Service Development Project
- Transportation Management System Development Project
- Grade Separation Programme at the Railway and Highway Crossings
- Railway Traffic Control System Implementation Project
- Railway Signalling Facilities Implementation Project
- Capacity Enhancement Project for INATTER
- Multimodal Logistics Centre Implementation Programme in Mutuali and Nampula
- Zoning Coordination Projects at Nacala and Nampula Industrial Areas
- Nampula Railway Bypass Route Construction Project
- Optical Fibre Cable Installation Project between Nampula and Nacala
- Seasonal Railway Promotion Project to the Island of Mozambique

- Nampula Depot Redevelopment Project

15.2.7 Nacala Corridor Railway Capacity Expansion Programme

Among these programmes and projects, the most important programme is the Nacala Corridor Railway Capacity Expansion Programme.

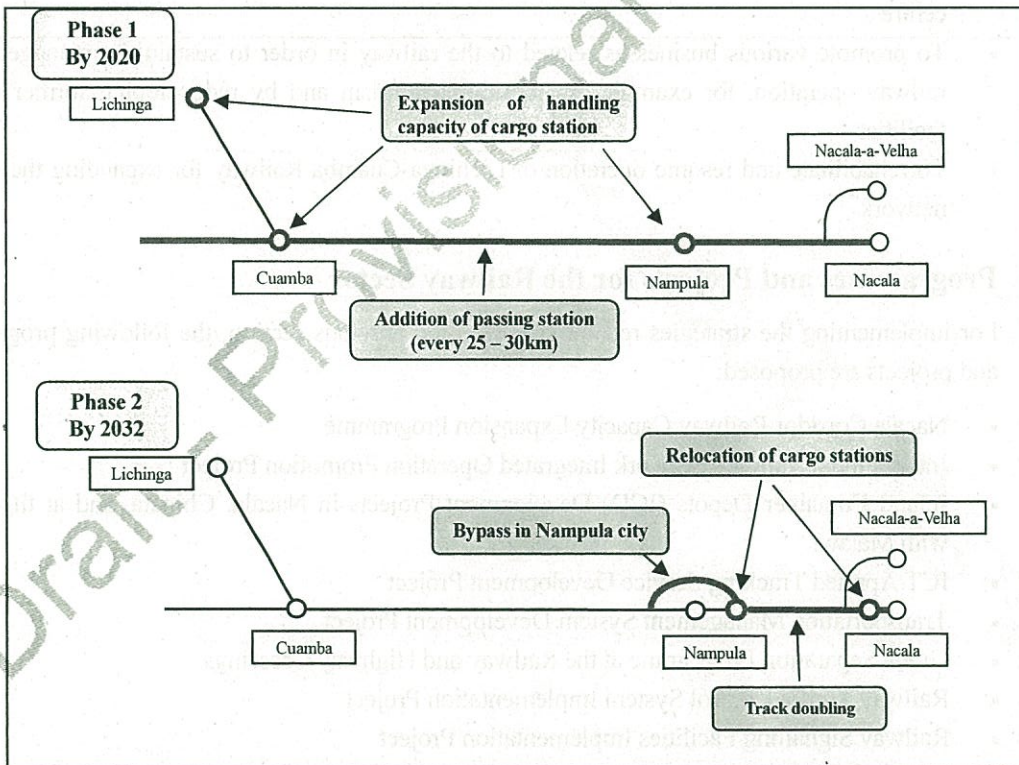
Scope of Major Projects

Key steps and major projects for the Nacala Railway Capacity Expansion Programme are as below.

Table 15.2.5 Major Projects composing the Nacala Railway Capacity Expansion Programme

	Main Projects
Phase 1 (by 2020)	Addition of passing stations (every 25 – 30km)
	Expansion of handling capacity of cargo stations (Nampula, Cuamba, Lichinga)
	Procurement of rolling stock (locomotives and wagons)
Phase 2 (by 2032)	Double tracking (Nacala – Nampula)
	Relocation of cargo stations (Nacala and Nampula)
	Construction of bypass (Nampula)
	Procurement of rolling stock (locomotives and wagons)

Source: JICA Study Team



Source: JICA Study Team

Figure 15.2.1 Main Projects for Nacala Railway Capacity Expansion Programme

15.3 Development Strategies for Ports

15.3.1 Future Prospects: Cargo Demand Forecast for Nacala Port

Currently the Nacala Corridor Region has two important existing ports, namely Nacala Port and Pemba Port. In the future, it will be necessary to effectively and widely utilize Nacala Bay by locating port facilities within Nacala Bay. As for Pemba Bay and Pemba Peninsula, there are other needs including tourism resort development and a support base for offshore natural gas exploitation. Furthermore, special attention is required for Palma Bay because of the prospective LNG production and other possibilities of chemical industries using offshore natural gas.

(1) Cargo Demand for the Ports of Nacala Bay including Nacala Port and Coal Terminal

The cargo demand for Nacala Port was projected for the years 2017, 2025, and 2035. Firstly, the actual cargo handled in Nacala Port (up to the year 2011) was estimated by upgraded statistical data based on the socio-economic framework established for the Nacala Corridor Region as the macro forecast. Furthermore, the existing forecast for cargo demand was adjusted based on the socioeconomic framework set by PEDEC-Nacala and considering future cargo prospects from the agriculture and mining sectors. The result of total cargo volumes in the target years is shown in Table 15.3.1.

It should be noted that the “Mineral” in the table below stands for coal to be transported from the Moatize coal mine (Vale S.A) and exported from the coal terminal in Nacala-a-Velha.

In addition to these cargo demands, more coal will be transported from Tete to Nacala Port for other mining companies; therefore, another large-scale coal terminal will be necessary in Nacala Bay. Furthermore, if another offshore natural gas reserve is discovered closer to Nacala, another LNG plant and other chemical industries will be developed in the Nacala Bay Area, requiring a new industrial port with a hinterland for accommodating chemical industries. Considering these future prospects, it is necessary to prepare a master plan for the ports within Nacala Bay.

Table 15.3.1 Cargo Throughput

Type of Cargo		Unit: 1,000 ton		
		2017	2025	2035
①	Container Cargo (Container Cargo) (1,000 TEU)	1,770 (192)	3,713 (393)	8,959 (944)
②	Mineral	18,000	25,000	37,500
③	Bulk (Wood Chip & Clinker)	490	577	951
④	Bulk (Liquid)	653	1,151	2,423
⑤	Bulk (Food)	683	974	2,379
⑥	Bulk (Others)	414	868	2,235
⑦	Vehicle	126	282	604
Total		22,136	32,565	55,051

Source: JICA Study Team

(2) Ports of Pemba Bay

Pemba has an existing port with a jetty and container yard, as well as warehouses. There is an expansion plan for Pemba Port, which was recently prepared for a new location south of the existing port. The expanded port area and facilities will be initially developed as a supply base for offshore oil/gas exploration and for drilling rig/pipeline construction, and then the expanded port is

expected to grow as it takes on the role of the service port for the economic sectors and urban centre in Pemba. If an offshore natural gas reserve is discovered, this expanded Pemba Port would serve as an industrial port for the gas-related chemical industries in the future.

(3) A New Port for Palma

In the southern part of Palma Bay, ENH reserves an area of 25,700 ha for an industrial development centring on the LNG plants and including other chemical industries that utilize natural gas, as well as for supporting the economic sectors and infrastructure. Anadarco's LNG plant construction plan, including their jetties and other port facilities, has been well advanced; however, the plan does not consider the location of the public port facilities or access to the sea from other land use areas including other chemical industries and supporting sectors. It is necessary to establish a port development plan including hinterland utilization, considering the whole situation of LNG plants, other chemical industries, and the public port function and access to the sea from other land use areas, as well as supporting sectors and infrastructure.

15.3.2 Issues on the Port Sector

Considering the present situations and future prospects, the following issues are defined for the Port Sector:

- Overall: Considering the a variety of prospective development opportunities in the coastal areas of the Nacala Corridor Region, it is necessary to have a clear future vision, differentiated roles and functions of the seaports of Nacala Bay, Pemba and Palma in order to promote development of the Nacala Corridor Region. .
- Seaports of Nacala Bay: The present Nacala Port does not have enough land or adjacent space to expand its capacity to accommodate the increasing demand for cargoes in the face of the Nacala Corridor Region's development in the future. Considering the possibilities 1) to receive an additional railway line for transporting coal from Tete and 2) to accommodate chemical industries in the coastal areas of Nacala Bay, it is necessary to develop the port facilities by widely using the whole of Nacala Bay.
- Pemba Port: It is necessary to determine the future roles of Pemba Port and its expansion by considering tourism resort development in Pemba Peninsula and its surrounding areas, the need to support the natural gas exploitation in Palma's offshore gas field, the possibility of locating LNG plants and other chemical industries if further offshore natural gas reserves are discovered and confirmed near Pemba. Because of the uncertainty of these future situations, flexible coastal planning and utilization of Pemba Bay and Pemba Peninsula is essential.
- The tourism resort base will be expanded in Pemba Peninsula and its surrounding areas. At the same time, Pemba Peninsula is expected to accommodate a support base for natural gas exploitation for a certain period.
- Natural Gas and Seaports: It is necessary to consider the roles of the seaports for supporting not only natural gas exploitation but also to support industrial chemical development using natural gas. The natural gas reserve has been confirmed only in the northern Area-1 and Area-4 of the Rovuma Basin. Currently, there is possibility for Palma to accommodate LNG plants and chemical industries including methanol and ammonia. However, if natural gas reserve is confirmed in other areas in the Rovuma Basin, which are closer to Pemba and Nacala, Pemba and Nacala will have possibilities to accommodate LNG plants and other chemical industries

using natural gas.

15.3.3 Objectives for the Port Sector

It is necessary to consider a variety of development opportunities and potentials available to different sea ports on the east coast of the Nacala Corridor Region. Seaports are an important part of the transport corridors which should form a region wide network in the Nacala Corridor Region.

The objective for the development of Ports in the Nacala Corridor Region is defined as follows:

- To develop and utilize seaports of the eastern coast of the Nacala Corridor Region under clear visions and roles in order to contribute to development of diversified economic sectors in the Nacala Corridor Region by flexibly fulfilling development opportunities available to different seaports

15.3.4 Strategies for the Port Sector

Strategies for the development of ports are as follows:

- To develop the seaports on the east coast of the Nacala Corridor Region in connection with the main corridors, sub-corridors and feeder lines, as well as emerging development opportunities for different seaports, and to effectively operate sea transport (both ocean-going and coastal shipping)
- To develop the seaports on Nacala Bay for fulfilling comprehensive functions of 1st-class international gateway and production centre, including 1) import and export of containers and general cargoes, 2) export of coking coal, 3) import of fuel, and 4) industrial port for the chemical industry (if natural gas is exploited in offshore gas fields near Pemba or Nacala)
- To develop Pemba Port as a support base for natural gas exploitation, as well as a sub-regional port
- To develop Palma Port as an industrial port to support the development of chemical industries, such as chemical processing of LNG, methanol and ammonia utilizing natural gas from the offshore natural gas fields in Rovuma Basin.

15.3.5 Programmes and Projects for the Port Sector

The following programmes, projects and measures are proposed, which are in line with the above Strategies:

Nacala Bay Area

- Nacala Port Management Improvement Project (on-going with assistance of the Japanese Government)
- Nacala Port Rehabilitation Project (on-going with the assistance of the Japanese Government)
- Nacala Port Upgrading Project (on-going with assistance of the Japanese Government)
- Project for Integration of Nacala Port with Railways
- Project for Nacala Port Access Road for better integration of Nacala Port with Roads
- Port Development Master Planning Study for Nacala Bay Area (Nacala and Nacala-a-Velha)
- Development of a New Industrial Port for Chemical Industries in Porta Belmore, North west of Nacala Bay
- Creation of Amusement Areas, such as Fishermen's Wharf and Historical Building Renovation in relation to Nacala Port

- Nacala Shipyard Construction (Dry Dock)

Pemba Port

- Pemba Port Expansion to become a Support Base for Natural Gas Exploitation
- Pemba Port Passenger Berth Project

Palma Port

- Palma Port Development for Supporting Natural Gas Exploitation and Gas-Based Chemical Industries

Other Ports

- Angoche Fishery Port Improvement Project
- Metangula Passenger/Cargo Berth for International Ships Project

Overall

- Port Sales Capacity Development
- Promotion of Nacala-Maputo Coastal Cargo Shipping
- Introduction of Short and Medium Haul Passenger Boat Service for Tourism and Regional Transport (Nacala-Pemba, Pemba-Palma)
- Customs, Immigration, and Quarantine (CIQ) Systems Improvement Project for Enhancing Safety and Convenience for Consignors
- Port Operation and Management Improvement

Draft - Provisional Translation

15.4 Development Strategies for Water Resources

15.4.1 Future Prospects: Water Demand

The water demand in the Nacala Corridor Region is expected to increase in line with the development of diversified economic sectors and the increase of population. Major water demand increase would come from the prospective economic sectors and population increase in major urban centres including Greater Nampula, Nacala Bay Area, Cuamba City and Pemba City and Lichinga City.

Table 15.4.1 shows the future water demand estimated for Greater Nampula Area, Nacala Bay Area, Cuamba City, Pemba City, and Lichinga City for the years 2017, 2020, 2025 and 2035. This estimation was done for water demand by residential population and institutions and that by industries.

Table 15.4.1 Estimated Water Demand of Greater Nampula Area

Unit: m³/day

	2017	2020	2025	2035
Water Demand by Residential People and Institutions in Greater Nampula Area (excluding that by Industries)	117,339	123,708	178,046	253,839
Water Demand by Industries	53,000	68,500	94,000	120,000
Total Water Demand	170,339	192,208	272,046	373,839

Source: JICA Study Team

Table 15.4.2 Estimated Water Demand of Nacala Bay Area

Unit: m³/day

	2017	2020	2025	2035
Water Demand by Residential Population and Institutions in Nacala Bay Area (excluding that by Industries)	73,398	76,599	101,125	268,178
Water Demand by Industries	71,000	80,250	105,500	185,000
Total Water Demand	144,798	156,849	206,625	453,178

Source: JICA Study Team

Table 15.4.3 Estimated Water Demand of Cuamba City

Unit: m³/day

	2017	2020	2025	2035
Water Demand by Residential People and Institutions in Cuamba City (excluding that by Industries)	4,358	7,613	12,257	22,854
Water Demand by Industries	7,800	20,000	32,000	52,000
Total Water Demand	12,158	27,613	44,257	74,854

Source: JICA Study Team

Table 15.4.4 Estimated Water Demand of Pemba City

Unit: m³/day

	2017	2020	2025	2035
Water Demand by Residential Population and Institutions in Pemba City (excluding that by Tourism)	14,492	21,094	33,011	58,404
Water Demand by Tourism	750	2,250	3,000	4,905
Total Water Demand	15,242	23,344	36,011	63,309

Source: JICA Study Team

Table 15.4.5 Estimated Water Demand of Lichinga City

Unit: m³/day

	2017	2020	2025	2035
Water Demand by Residential Population and Institutions in Lichinga City (excluding that by Industries)	8,679	15,411	27,568	60,000
Water Demand by Industries	2,500	4,000	5,000	7,500
Total Water Demand	11,179	19,411	32,568	67,500

Source: JICA Study Team

15.4.2 Issues on Water Resources Development

Considering the existing conditions on water resources and future prospects, the following issues are defined:

(1) Lack of Meteorological and Hydrological Data

The numbers of meteorological and hydrological monitoring stations that are functional and obtaining data are not sufficient. In addition, the observation period of the existing equipment is short. As a result, the current data is not sufficient to analyse the water resources of the wide Nacala Corridor Region.

(2) Lack of Overall Water Resources Development Plan

At the moment, individual studies and projects are being carried out in order to meet at least the minimum requirements for water in major cities. These efforts are vital to satisfy the immediate everyday demand. However, they will not be a solution for the long term future demand.

(3) Difficulty in Implementing Integrated Water Resources Management

Since there are no sufficient meteorological and hydrological data in the Nacala Corridor Region, it is difficult to establish an integrated water resources management plan and to conduct an integrated water resources management. Under this situation, there are risks in allowing negative impacts on the water resources and the environment of particular river basins by implementing water resources development like construction of dams for water supply.

15.4.3 Objectives for Water Resources Development

The estimated water demand in the above section is indispensable to realize the economic growth of the Nacala Corridor Region. In other words, the economic growth will not be realized without a sufficient amount of water. Thus, the objective of the development of water resources is defined as:

- To develop water resources to meet water demand for growing areas in an efficient and timely manner
- To conduct Integrated Water Resources Management (IWRM) by utilising appropriate metrological and hydrological data
- To sustain the water environment by conducting wise utilisation of water resources through the Integrated Water Resources Management (IWRM)

15.4.4 Strategies for Water Resources Development

Strategies of the development of water resources are as follows:

Strategy 1: To strengthen the data collection system and prepare an overall water resources development plan for the Nacala Corridor Region.

Strategy 2: To conduct Integrated Water Resources Management utilizing the data collection system on water resources

Strategy 3: To meet the immediate demand by small-scale water resources development and water supply systems

Strategy 4: At the same time, to conduct studies on major water resources development and water supply systems for satisfying long-term demand

Development of water sources should be determined by water demand and located as close as possible to the demand areas. When planning water sources, it is indispensable to consider the hydrological, meteorological and geographical situation of the surrounding area and to estimate the potential of surface water and groundwater. However, at the present, the number of reliable meteorology and hydrology monitoring stations are not sufficient to analyse the whole of the Nacala Corridor Region.

Therefore, the first step should be to establish a hydrological and meteorological data collection network in order to obtain basic data for planning and designing projects. Then, based on the obtained data, a study on Integrated Water Resources Management (IWRM) should be carried out to verify the water potential of the areas. These works will take time to develop.

On the other hand, the government needs to tackle the imminent lack of water supply. Considering the limited funds and time available, reinforcement of existing dams and wells should be carried out as an urgent action to relieve the situation as much as possible.

15.4.5 Programme and Projects for the Water Resources Development

Programmes and projects are proposed, which are in line with the above strategies. The number of each programme corresponds to the strategy number.

Programme 1.1 Conduct Data Collection by Reinforcement of the Metrological and Hydrological Network for the Nacala Corridor Region

- Project: Procurement of hydrometric equipment
- Project : Training staff of ARA-N and ARA-C

Programme 1.2 Implementation of an Integrated Water Resources Management (IWRM) Study

- Project: IWRM study on the water basins of Megaruma River, Lurio River,

Mecuburi River, Monapo River, Sanhute River, and Meluli River.

Programme 2.1 Greater Nampula

- Project: Monapo Dam rehabilitation on the Monapo River (2013)
- Project : Monte Tiza Dam construction on the Meluli River (medium-term)
- Project: Mutelele Dam construction on the Ligonha River (medium-term)

Programme 2.2 Nacala Bay Area

- Project: Raising the height of Muecula Dam on the Muecula River (May 2013)
- Project: Development of additional wells in Mutuzi and M'paco Well Fields (short-term)
- Project: Construction of Sanhute Dam on the Sanhute River (medium-term)
- Project: Lurio River Resource Development Project for Water Supply to Nacala Bay Area (long-term)
- Project: Project for Desalination Plant in Nacala Bay Area (to satisfy increasing water demand in Nacala Bay Area) (long-term)

Programme 2.3 Cuamba City

- Project: Raising the height of Mepopole Dam (short-term)
- Project: Construction of Mecuca Dam on the Muecula River (medium-term)
- Project: Construction of Chichemunda Dam (long-term)

Programme 2.4 Pemba City

- Project: Development of additional wells in the Metuge Well Field (medium-term)
- Project: Construction of Megaruma Dam (long-term)

Programme 2.5 Lichinga City

- Project: Construction of Mbahu Dam (medium-term)
- Project: Construction of a new dam (to be identified, long term)

The water supply sources and their potential supply amount after the implementation of the above programmes and projects in Greater Nampula Area and Nacala Bay Area are as shown in the table below.

Table 15.4.6 Proposed Major Water Supply Sources and Potential Supply Amount

Area	Dam	River	Supply Amount (m ³ /day)
Greater Nampula	Monapo Dam	Monapo River	20,000
	Monte Tiza Dam	Meluli River	259,000
	Mutelele Dam	Ligonha River	121,000
Nacala Bay Area	Muecula Dam	Muecula River	33,000
	Sanhute Dam	Sanhute River	40,000
	Lurio Dam	Lurio River	430,000

Source: JICA Study Team

The location of existing and planned dams in the Greater Nampula and Nacala Bay Areas are shown in Figure 15.4.1.

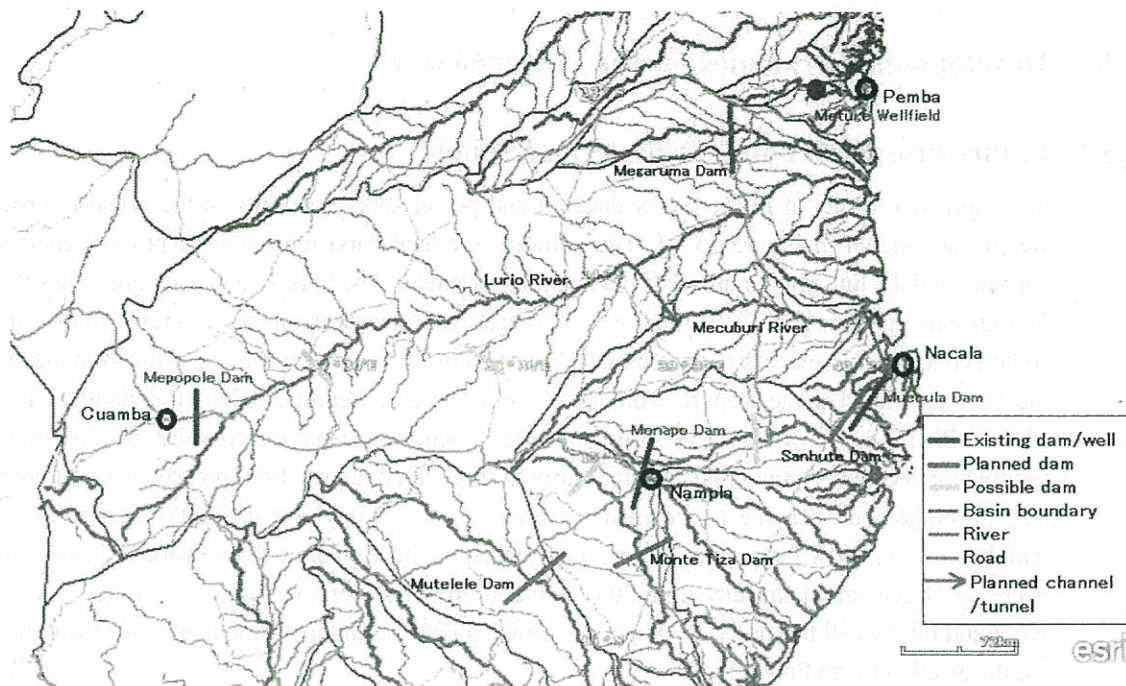


Figure 15.4.1 Existing and Planned Dams in Greater Nampula and Nacala Bay Area

The estimated water demand and the water supply from the proposed water resource projects are shown in Table 15.4.7.

Table 15.4.7 Water Demand and Proposed Supply Sources for Greater Nampula and Nacala Bay Area

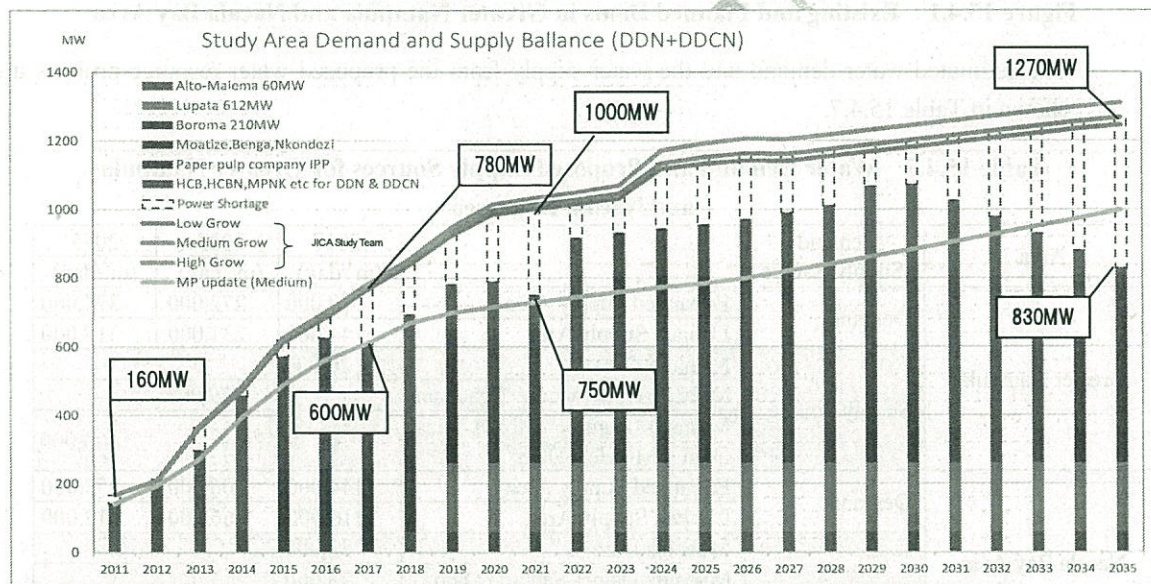
Area	Demand / Supply Source		2017	2025	2035
			(m ³ /day)	(m ³ /day)	(m ³ /day)
Greater Nampula	Demand	Expanded Supply Area	170,000	272,000	374,000
		Limited Supply Area	144,000	231,000	317,000
	Supply Source	Monapo Dam	20,000		
		Monapo Dam+Monte Tiza Dam		279,000	
		Monapo Dam + Monte Tiza Dam + Mutelele Dam			400,000
Nacala Bay Area	Demand	Expanded Supply Area	144,000	206,000	453,000
		Limited Supply Area	116,000	166,000	312,000
	Supply Source	Muecula Dam	33,000		
		Muecula Dam + Sanhute Dam	73,000		
	Muecula Dam + Sanhute Dam + Lurio River Reserve			503,000	

Note: Expanded Supply Area will serve 100% of the population while Limited Supply Area will serve 80% of the population
Source: JICA Study Team

15.5 Development Strategies for the Power Sector

15.5.1 Future Prospects: Power Demand and Supply

The estimated results of future power demand and power supply capacity in the Nacala Corridor Region are shown in Figure 15.5.1. The columns (vertical bars) represent the power generation capacity and the line graph represents the demand for power. The blue, orange, and grey lines show low-growth, medium-growth and high-growth scenarios, respectively, in accordance with the future socio-economic frameworks projected by this Study. For reference, the demand estimation made by the “Master Plan Update Report, Volume II Load Forecast Report (EDM)” (hereinafter “EDM Master Plan”) is shown as a yellow line. Both demand scenarios consider natural growth (population, economy) and large customer growth (individual reports from prospective customers). The difference between the two demand estimations, this Study and the EDM Master Plan, is mainly due to the difference in the big consumers in the economic framework scenarios. The decrease of generation capacity from 2031 is based on an assumption that the generated power of HCB and others will be shifted to supply the growing demand in the southern area of Mozambique via the South African Power Pool.



Source: JICA Study Team based on Draft Master Plan Update Report (Volume II Load Forecast Report, EDM Dec 2012)

Figure 15.5.1 Balance of Demand and Supply of Power (Peak Demand and Supply)

The medium growth scenario shows that the demand will be 7.7 times greater in 2035, compared to actual demand in 2011. The generation shortage will be significant from 2017 at around 180 MW, and in 2021 at around 250MW (red dotted column). It is proposed in the EDM Master Plan to install Static VAR Compensators (hereinafter “SVC”) which is expected to compensate the power factor, and as a result, increase the network capacity by around 200 MW. Nevertheless, it is assumed that in year 2021 the power shortage will become around 50 MW, and in year 2035 around 200 MW.

The other main points of each event and/or necessity on the graph shown in Figure 15.5.1 are as follows:

- 2015: Peak demand might exceed the base power ability, thus EDM will have to purchase more power from IPPs and/or install the SVC at over capacity substations in the north eastern area of the Nacala Corridor Region.
- 2017: Renewing of the contract for increasing the power volume to be purchased from Cahora Bassa hydro power station and so on will be necessary.
- 2019: The operation of new big hydro power stations, such as Cahora Bassa north, and Mphanda Nkuwa must be started for future increasing demand. Currently only 10% of the power generated in Cahora Bassa is purchased for domestic power supply. Almost all the power of Cahora Bassa is sent to other countries. By 2019, more purchasing plans will be needed.
- 2015-2023: The number of IPP contracts and power volume to be purchased will be increased (Brown & Grey bar, such as Moatize, Benga and Nkondezi etc.)
- 2019-2020: The power demand from the Sothern Region of Mozambique will be largely increased mainly by industrial demand increase. Thus, operation of planned middle-class hydro power stations, such as Alto-Malema, Lupata and Boroma, will have to be started by 2020 at the latest.
- 2022: Lurio paper pulp plant will start operation, additional IPP power supply will be needed.
- 2024: The power demand in the northern provinces will be increased by the increase in coal production and manufacturing sector demands for power.
- 2030- : Due there being no plan to begin new power generation construction or new additional power purchasing from IPP or PPP, the rapid increase in demand in the southern provinces of Mozambique would have an impact on the power supply capacity for the northern provinces and produce a serious power shortage, caused by most of the power being transferred to the South African Power Pool.

15.5.2 Issues on the Power Sector

Nampula and Nacala are the centres of economic activities in the Nacala Corridor Region and it is expected that they will continue to become more important urban centres in the face of the upgrading of Nacala Corridor and Nacala Port in the future. However, the facilities to supply power to these areas are old and their capacities are not sufficient even to meet the current demand. If this situation continues, unreliable power supply will become the limiting factor for Nacala Bay Area and Greater Nampula to become the driving force for economic development of the Nacala Corridor Region. The current issues in the power sector are as follows.

(1) Power Supply in Nacala Bay Area and Greater Nampula, in the Near Future

In general, the main target to be achieved during the first stage of power sector development is electrification of the area. After the subject area is electrified to a certain point, or if possible, even earlier depending upon the situation, the next stage will target increasing the reliability of power supply. Today, the Nacala Corridor Region can be said to be somewhere between these two stages.

As discussed above, Nampula already does not meet the power demand. It is critical to replace the old and overloaded transformers to enable the future development of the city.

In addition, Nacala is expected to grow rapidly with the on-going rehabilitation of the port and railway. Therefore, the same situation in Nampula will be seen in Nacala in the near future.

(2) Long Distance Transmission

Nampula and Nacala receive power from Cahora Bassa Hydro Power Plant, which is more than 1,000 km distant from Tete Province. The long transmission lines increase the risk of accidents. Furthermore, the condition of the transmission lines is one of the main reasons for the power loss because of its length. Even though EDM has a plan to install Static VAR Compensators (hereinafter “SVC”) to increase the network capacity, this will not be a fundamental solution considering the demand growth.

(3) Data Monitoring System

Old monitoring equipment and manual data recording are still used in the substations of Nampula 220, Nampula Central, and Nacala Substations. It is essential to obtain accurate data to plan for the future. Moreover, smooth and accurate communication between the substations is vital for reliable operation of the network.

15.5.3 Objectives for the Power Sector

Considering not only the whole system of power supply in Mozambique, but also the increasing power demand in the Nacala Corridor Region, the following objectives are set for developing the power supply sector:

- To develop a reliable power supply system in a timely manner in order to satisfy increasing demand for electricity in the Nacala Bay Area
- To improve the quality of power supply including reduction in interruption of power supply
- Upgrade the redundancy of the power supply system, especially for the Nacala Corridor Region
- To enhance the base power capacity not only getting power from large main power sources, but also purchasing additional power from sub power sources like IPP in order to satisfy the peak demand growth in the future
- To promote electrification in rural areas

15.5.4 Strategies for the Power Sector

Nampula and Nacala are, and will continue to be, the centres of economic activities in the Nacala Corridor Region. Therefore, it is essential to secure a stable and reliable power supply to Nampula and Nacala as soon as possible so that the economic sectors and their development will not be jeopardised due to insufficient supply of power.

However, the improvement of the power supply system cannot be carried out overnight. Considering the long time necessary for constructing new power plants, priority should be given to rehabilitation and reinforcement of the existing facilities in order to get full output from the existing system. At the same time, it is necessary to start a study for possible use of hydro, coal, and natural gas as sources of power generation. The consideration of diversification and dispersion of power sources is important from the point of view that the new anchor loads are expected to grow far from the current main generation plant (Cahora Bassa Hydro Power Plant).

The following strategies for development of the power sector are recommended:

- To improve power substations and distribution for securing stable power supply to priority areas, such as Nacala Bay Area and Greater Nampula, in the short term

- To improve the situation of long-distance transmission by strengthening of transmission lines and substations, considering possible ways in diversification and dispersion of power sources in the medium term
- To establish a new power plant in or around Nacala Bay Area and its surrounding areas for reducing the long-distance transmission from Cahora Bassa Dam to Nacala Bay Area
- To establish a new power plant in or around Palma by utilizing natural gas to be exploited from Rovuma Basin for supplying power to Nacala Bay Area and Greater Nampula in the medium and long terms
- To continue monitoring of power generation, transmission, and distribution, and utilize the data for future planning by introducing and operating SCADA in the short, medium and long terms

15.5.5 Programmes and Projects for the Power Sector

The following projects are proposed (projects in italics are on-going or already committed to):

Short-Term Projects

- Nampula-Nacala Power Substation Reinforcement (Construction of New Namialo Substation and Rehabilitation of Substations - Nampula 220, Nampula Central, Monapo, Nacala Substations)
- Project for new transmission line Caia-Alto Molocue-Nampula-Namialo-Nacala (400kV/200kV)
- Project for installation of SVC (Static VAR Compensator) at Alto-Molocue (2016)
- Project for a new hydro power plant (Cahora Bassa North 2017)
- Project for a new hydro power plant (Mphanda Nkuwa 2017)
- Feasibility Study of Natural Gas Pipeline from Palma to Nacala (and further to Maptuo)

Medium-Term Projects

- Nacala Thermal Power Plant Project (2025)
- Palma Thermal Power Plant Project
- Palma-Pemba-Nacala Transmission Line Project
- Renewable Energy Power Plants Project
- Project for New Hydro Power Plant for the Lurio River (2020)
- Project for New Hydro Power Plant at Alto Malema (2020)
- Project for New Substation for Nampula City Area (2020)

Medium to Long -Term Projects

- Project for New Transmission Line Namialo-Nacala (220kV)
- Project for New Transmission Line Namialo-Pemba (220kV)
- Project for Upgrading Substations at Cuamba, Marrupa, Lichinga, Ausse, Mocuba, and Nacala-a-Velha
- Palma-Thermal Power Generation Plant Project
- Palma-Pemba-Nacala Transmission Line Project

15.6 Development Strategies for the Telecommunications Sector

15.6.1 Future Prospects for Telecommunications

In general, the progress of innovation or advancement of information and communication technology is relatively faster than other technologies. Therefore, it is difficult to estimate the technology to be applied in the long term future, such as year 2035. In addition, since the communication network is mainly developed or improved by private companies, the development strategies, plans or methods are decided by individual companies.

The communication network in Mozambique will mainly be IP based NGN and it will have been interconnected with a Public Switched Telephone Network (PSTN) and Public Land Mobile Network (PLMN) by 2025. It is expected that the number of persons who use smartphones and/or tablets will increase and most of the government offices or private companies will be connected to the internet through internet service providers. The capacity of the backbone network for data communication or high speed wireless access points is expected to be improved according to the increase in the number of smart handset users. The technology to be applied to the communication network in year 2025 will be variable depending on the demand trends since the mobile phone carriers or internet service providers are operating in a competitive environment.

As for the coverage of communication networks in the territory of Mozambique, it is forecast that there will be no area where the people cannot access the communication network by the medium target year since INCM continues the universal access service project.

INCM, the regulator of the communication sector in Mozambique, is expected to supervise the improvement of the communication market in Mozambique by its function as a regulator such as monitoring the quality of services, competitive climate, authorized rights of granting licenses, and establishment of necessary decrees or regulations.

15.6.2 Issues on the Telecommunications Sector

Considering the existing conditions and development goals for the Nacala Corridor Region, for the telecommunications sector, the following issues are defined:

- (1) **Communication Infrastructure: Necessity to Expand Optic Fibre Network from the Backbone to Growing Areas**
 - Optical fibre cables are installed in the country as the backbone of the transmission network. In order to achieve reliable connections, the optic fibre network will need to be expanded from the backbone (trunk line) to high demand areas, especially to fastest-growing areas
 - Necessity of Circuit Leases to ISPs from the Owners of Communication Facilities
 - Circuit leases between the internet service providers (ISPs)/carriers and the owners of the communication facilities should be promoted in order to efficiently expand the internet service areas
- (2) **Coverage Area: Benefits and Necessity of Expansion of Coverage of Telecommunications**

There are still some areas which are not covered by telecommunications. The plan of INCM is to cover all areas of Mozambique within the next 10 years. Telecommunication facilities are quicker

and easier to install compared to most of the other basic infrastructures, such as power, water, and railways. Considering that telecommunications supports and benefits the quality of life and provides opportunities for businesses, the expansion of coverage of the telecommunications should be completed as soon as possible.

(3) Quality of Service: Necessity to Improve the Quality of Service of Voice and Data Communication

In 2009, voice communication quality was a serious issue in Mozambique. In 2011, a regulation on the obligation to secure quality of service was enforced. However, connection failures and system disruptions still occur in voice and data communication. This situation is not favourable to doing business and may discourage investors from coming to the Nacala Corridor Region.

(4) TV Communication System: Utilization of TV Communication System between Provincial Governments

TV conference facilities are installed in all provincial government offices in the provincial capitals. However, at the moment, these facilities may not be utilized effectively for communication between the provincial governments. Since the Nacala Corridor Region is very large, it is not always feasible to make a long trip to hold meetings. The TV conference system between provinces should be utilized as much as possible in order to discuss inter-provincial programmes and projects in the Nacala Corridor Region.

15.6.3 Objectives for the Telecommunications Sector

Considering their relatively ease, the objectives of the development of the telecommunications sector are defined as:

- To maintain a competitive environment in business for telecommunications for promoting the introduction of state of the art technologies
- To cope with the increasing demand for data communication in growing areas
- To expand the coverage areas to rural districts
- To raise the quality of voice and data communication
- To enhance the capacity of ICT users

15.6.4 Strategies for the Telecommunications Sector

Strategies for the development of the telecommunications sector are formulated as follows:

- For the government, to facilitate reasonable commercial contracts related to circuit leases between the telecommunications carrier and internet service providers (ISPs)
- For the government, to introduce field tests to monitor the indicators related to mobile phone carriers for improving the quality of service
- For the government, to continue government policies to encourage private sectors to expand their coverage areas for telecommunication services
- To expand capacity development programmes for ICT users, as well as to promote the continuation of existing and ongoing programmes
- To promote utilization of IT technology to allow efficient communication between the government authorities

- To promote utilization of IT technology to efficiently monitor and control the infrastructure provided by the government

15.6.5 Programmes and Projects for the Telecommunications Sector

The following programmes, projects and measures are proposed, which are in line with the above Strategies:

- Promotion of facility sharing of communication networks. (short-term)
- Connection of Public Switched Telephone Network (PSTN) and Public Land Mobile Network (PLMN) with the IP based New Generation Network (NGN). (short-term)
- Implementation of field tests to monitor the quality of service and promote the private sector to comply with the "Quality of Service regulations" (short-term)
- Introduction of a TV conference system (as well as utilisation of the existing TV conference system) between the local and central government agencies related to the Nacala Corridor Development (short-term)
- Introduction of a Smart Industrial Free Zone in Nacala (short-term)
- Universal Service Fund Projects 1, 2, 3 (and further if necessary) (short-medium-term)
- Regulate protection of communication equipment (medium-term)
- Duct installation along the roads/railways for the installation of optical fibre cables in the future (medium-term)
- Enhancement of the backbone transmission network (long-term)

15.7 Development Strategies for Rural Water Supply

15.7.1 Issues on the Rural Water Supply Sector

The Nacala Corridor Region will continue to encompass vast rural areas even after the establishment of the region-wide transport corridor network in the future. In rural areas, rural water supply based on boreholes and hand pumps will continue to be essential tools for maintaining the quality of life. Considering the existing conditions and development goals, the following issues regarding rural water supply are defined:

(1) Two Different Indicators for Evaluating Water Supply Rates

At the moment two different indicators (“Access” and “Use”) for showing the conditions of water supply rates are used in Mozambique. There is a difference of approximately 1.5 to 1.7 times depending on which indicator is used. The “Access” rate is calculated using the number of facilities and served population per facility. The “Use” rate is calculated from the results of interviews with sampled villagers and is currently used by WHO/UNICEF to evaluate the progress of MDGs. This has been creating confusion for evaluating the progress towards the target.

(2) Usage of Unimproved Drinking Water Sources

The usage rate of unimproved drinking water sources (unprotected dug well, rivers, dams, lakes, ponds, etc.) is high in the rural areas of Nacala Corridor Region at over 40% while that of other provinces in Mozambique is below 30%. Out of the five provinces, Nampula Province has the highest rate of using unimproved drinking water at 50.5%.

(3) Inadequate Capacity of Operation and Maintenance of Boreholes with Hand Pumps

In many cases, the water committees, who should perform routine maintenance and minor repairs of hand pumps, do not work after the project period because they cannot collect fees from users unless major breakdowns occur. Even in the event that water committees are established, they do not undertake their responsibilities fully. In such areas although repairing with U-seals and O-rings is the task of the water committees, local mechanics should undertake the repair work.

(4) Poor Hand Pump Spare Parts Supply Network

Due to the limited locations where spare parts for hand pumps can be purchased, local area mechanics play a role as spare parts vendors. These vendors travel a long distance to provincial capitals or the few other places where such spare parts are sold. As a result, hand pump users have to purchase spare parts at high prices that include the transportation cost from the provincial capital. DNA is planning to approve some new hand pumps as well, which that means a better hand pump spare parts network is required. If the hand pump spare parts network is not maintained, the functional rates of facilities will deteriorate.

15.7.2 Objectives for Rural Water Supply Sector

The objectives of the rural water supply sector are defined as:

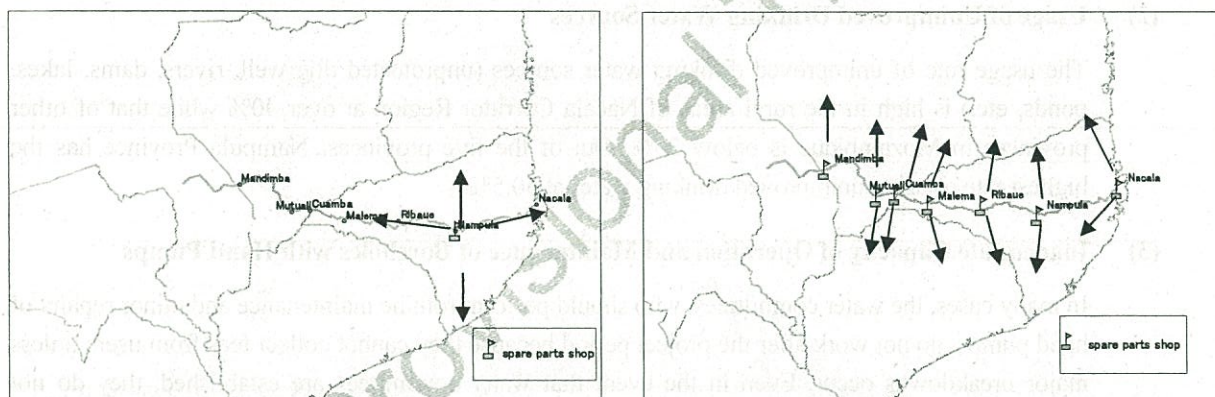
- To have a correct understanding of the situation of water supply in the rural area by uniting the indicators for evaluating the water supply rate

- To increase the access to safe and stable water supply for rural populations by reducing the number of rural residents that must use unimproved water sources as drinking water and by strengthening the maintenance capacity of the existing rural water supply facilities
- To expand a hand pump spare parts supply network along the transport corridors to be extended widely in the Nacala Corridor Region

15.7.3 Strategies for the Rural Water Supply Sector

The strategies for the rural water supply sector are formulated as follows:

- To unite the indicators for evaluating the water supply rate by shifting the usage of “Access” rate to “Use” rate
- For the government, to support the expansion of the hand pump spare parts supply network by utilising District Planning and Infrastructure Offices (SDPIs) located along the transport corridors, which are to be extended widely in the Nacala Corridor Region
- For the government, to promote the implementation of new construction and rehabilitation of boreholes with hand pumps in order to increase the use rate of safe and stable water
- For the government, to activate or re-establish water committees for existing boreholes with hand pumps in order to maintain the hand pumps for boreholes



Source: JICA Study Team

Figure 15.7.1 Expansion of Spare Parts Supply Network along Transport Corridors (Left: Current Condition, Right: Future)

15.7.4 Programmes and Projects for the Rural Water Supply Sector

The following programmes, projects and measures are proposed for rural water supply:

- Hand Pump Spare Parts’ Supply Network Establishment Project
- Small Water Supply Facilities Rehabilitation Project
- Water Committee Establishment Programme
- Borehole Implementation and Rehabilitation Project
- Capacity Development Project for Local Area Mechanics

Chapter 16 Urban Development Strategies

16.1 Urban Development Strategies for Nacala Bay Area

16.1.1 Future Prospects for Nacala Bay Area

The existing deep seaport, together with the status of SEZ, will continue to attract FDIs heading to the area of the Nacala SEZ. The start of coal handling at the new port in Nacala-a-Velha will change the shape of the spatial structure. Employment opportunities will extend to the western side of Nacala Bay and dynamic movements of goods will take place along the coast.

Locating FDIs is critically important to the development of the Northern Region of the country beyond the Nacala SEZ alone. Preparation for an efficient and reliable base for operation of factories is the key to success accepting FDIs as envisaged. The industrial base for FDI promotion will include accommodation and housing, office and convention facilities, and resort and recreational spaces to support foreign expatriates, on top of the reliable infrastructure for manufacturing.

16.1.2 Vision for Nacala Bay Area

The target image for the development of Nacala Bay Area is to create a new international gateway to Africa, equipped with the first class urban environment, facilities and infrastructure to attract the FDIs. To this end, a longer vision needs to be established with possible involvement of the surrounding areas. For instance, the possibility of a third deep seaport development may need to be taken into consideration, and thus the planning area should include Memba-sede Administrative Post in Memba District located to the north of Nacala-a-Velha. Like-wise, inclusion of Matibane Administrative Post in Mossuril District is also necessary as available land for urban use is limited in the territory of Nacala Porto Municipality. The future residential area will inevitably extend to the territory of Mossuril District.

16.1.3 Development Framework for Nacala Bay Area

A set of development frameworks for the Nacala Bay Area is forecast to the planning horizon as described below.

(1) Population Framework

The population of the Nacala Bay Area in 2035 will reach 1,386,000 persons combining a municipality and four administrative posts as summarized in Table 16.1.1. The total population will be doubled from the present level of around 600 thousand. The future urban population in the area may reach 828,400 persons in 2035 by faster growth rates compared with the growth rate of the total population. Table 16.1.2 presents forecasts of the urban population for Nacala Bay Area.

Table 16.1.1 Population Forecast for Nacala Bay Area

Municipality/District/ Administrative Post	Population				Population Annual Growth Rate (% per annum)		
	2007	2017	2025	2035	2007-17	2017-25	2025-35
Nacala Porto Municipality	211,915	299,000	413,000	656,000	3.5%	4.1%	4.7%
Nacala-a-Velha District	90,991	128,000	178,000	282,000	3.5%	4.2%	4.7%
Memba-sede AP (Memba District)	109,899	155,000	214,000	340,000	3.5%	4.1%	4.7%
Matibane AP (Mossuril District)	34,890	49,000	68,000	108,000	3.5%	4.2%	4.7%
Total of Nacala Bay Area	447,695	631,000	873,000	1,386,000	3.5%	4.1%	4.7%

Source: JICA Study Team

Table 16.1.2 Forecast of Urban Population for Nacala Bay Area

Municipality/District/ Administrative Post	Population				Population Annual Growth Rate (% per annum)		
	2007	2017	2025	2035	2007-17	2017-25	2025-35
Nacala Porto Municipality	169,532	239,200	330,400	524,800	3.5%	4.1%	4.7%
Nacala-a-Velha District	9,099	25,600	53,400	169,200	-	9.6%	12.2%
Memba-sede AP	2,747	7,750	32,100	102,000	-	19.4%	12.3%
Matibane AP	872	2,450	10,200	32,400	-	19.5%	12.3%
Total of Nacala Bay Area	182,251	275,000	426,100	828,400	4.2%	5.6%	6.9%

Source: JICA Study Team

(2) Urban Land Requirements

To accommodate the future population of the Nacala Bay Area, the land area required for urbanization is estimated as shown in Table 16.1.3. Since the level of urbanization may differ by location, the ratio of urban population is firstly examined and set for each administrative territory. The incremental urban population from year 2007 to 2035 will be around 560,000 persons, and will require an additional 11,000 ha to be used for residential, public facilities, office and commercial, urban infrastructure, and some cottage type industries. It should be noted that the urban land requirement by administrative area as presented in Table 16.1.3 is not necessarily supplied within the respective territories as movement of population may be likely to occur among the constituent administration areas.

Table 16.1.3 Urban Land Requirements for Nacala Bay Area

Municipality/District/ Administrative Post	Population Increase 2007-2035	Urban Population Share (%)	Incremental Urban Population	Urban Land Requirement (ha)
Nacala Porto Municipality	444,085	80	160,868	3,217
Nacala-a-Velha District	191,009	60	44,301	886
Memba-sede AP (Memba District)	230,101	30	29,353	587
Matibane AP (Mossuril District)	73,110	30	9,328	187
Total	938,305	(average) 60	243,849	4,877

Source: JICA Study Team

(3) Industrial Land Requirements

The industrial land requirement is calculated separate from the urban land requirement, because the nature of industrial development in the Northern Region may be influenced largely by external

factors, especially by the locations of FDIs. It is expected that the factories will be located mostly in the industrial estates in the future, and thus, the unit land area for a worker will be larger than the conventional type of factories. The estimate is made as a sequence of Table 16.1.4 and Table 16.1.5. The number of factory workers is firstly estimated based on the economic development forecast for Nampula Province, and assumed that half of the incremental number of workers in the province will be settled in Nacala Bay Area. The land requirement is then estimated by type of industry by year as shown in Table 16.1.6. It is assumed that the FDIs and new establishment of domestic factories will settle in areas relying on the existing infrastructure until 2017. The new establishment of factories after 2017 will be accommodated in industrial estates, except for cottage type industries. The total area required for an industrial estate will be around 700ha, among which, metals, machinery, electrical products and equipment will be dominant to cover 530ha.

Table 16.1.4 Economic Forecast for Nampula Province

	2007	2035	Share in 2035 (%)
GRDP (MT million, 2003 constant price)			
Nampula Province	20,346	148,500	100.00
Sector GRDP (MT million, 2003 constant price)			
Agriculture		49,100	33.06
Mining		30	0.02
Manufacturing/Construction/Utilities		35,800	24.11
Services		63,600	42.83
Work force of Nampula Province Manufacturing			Annual Growth (%)
Economically Active Population	38,467	161,238	5.25
Labour Productivity	59,179	135,397	3.00

Source: JICA Study Team

Table 16.1.5 Industrial Land Requirement for Nacala Bay Area

	2007	2035	Remarks
Economically Active Population (Nampula Province)	38,467	161,238	
Existing Industrial Land (Nampula Province) (ha)	385		100 persons/ha
Industrial Land Requirement (Nampula Province) (ha)		2,015	80 Persons/ha
Nacala SEZ+ Area Industrial Land Requirement (ha)	154	1,000	40% in 2007 50% in 2035

Source: JICA Study Team

Table 16.1.6 Industrial Land Requirement by Type by Year for Nacala Bay Area

Broad Type of Industry	Required Industrial Land				Increased Area
	2007	2012	2017	2035	2017-2035
Food/Beverage/Agro-processing (ha)	92.4	128.4	150	300	150
Metal/Machinery/Electrical products & equipment (ha)	15.4	21.4	70	600	530
Wood/Furniture, Construction Materials and Others (ha)	46.2	64.2	80	100	20
Total (ha)	154	214	300	1000	700

Source: JICA Study Team

(4) Urban Water Requirements

To supply water for the future urban population in Nacala Bay Area, the demand for urban water is estimated as shown in the table below.

Table 16.1.7 Summary of Urban Water Demand for Nacala Bay Area

		2013	2017	2025	2035
Demand (m ³ /d) Expanded Supply Area	Nacala Porto	Water Supply	33,638	48,675	132,371
	Nacala-a-Velha	Volume after rehabilitation of existing source	14,400	20,979	56,904
	Memba		18,285	22,628	56,499
	Matibane		7,475	8,844	22,404
	Sub Total		73,798	101,125	268,178
	Industrial Area		71,000	105,500	185,000
	Total		33,000	144,798	206,625
Demand (m ³ /d) Limited Supply Area	Nacala Porto	Water Supply	26,910	38,940	71,223
	Nacala-a-Velha	Volume after rehabilitation of existing source	3,491	5,340	18,934
	Memba		12,613	13,801	29,357
	Matibane		1,730	2,275	8,218
	Sub Total		44,744	60,356	127,732
	Industrial Area		71,000	105,500	185,000
	Total		33,000	115,744	165,856

Source: JICA Study Team

16.1.4 Conceptual Spatial Structure for Nacala Bay Area

(1) Urban Cores

1) New CBD (Airport City)

Lands in the current city centre are almost fully occupied mostly by the mixed use of offices, commercial and other business usages. A new Business zone needs to be developed at a strategic location, with the growth of industry in Nacala-a-Velha taken into consideration. The location of the new CBD requires land availability, as well as closeness to the existing city centre. The area west of the airport seems suitable and most reliable, as the area is managed by the Mozambique Airport Authority on land distributed to the armed forces. Participation of various entities may be the key for successful development of the new CBD, or the Airport City. Inviting specialized land developers may be essential, while involving public bodies including the Airport Authority and the Army may be conditional.

2) MICE and Tourism Complex

It is fundamental to have high level MICE functions to attract the FDIs and support their operational activities. To this end, facilities and services need to be established for MICE and tourism with first class quality, and to become a part of the identities of the Nacala Bay Area. It is proposed that the development of Crusse and Jamali resorts should include the function of MICE, and should be connected with the existing and new CBDs efficiently. By doing so, the operation of Crusse and Jamali may also be stabilized by introduction of business visitors along with the resort tourists.

3) Industrial Zone

The current designated area for establishment of an Industrial Free Zone largely consists of steep slopes. This is a major disadvantage as the development cost will be hiked by the large amount of soil that must be moved for the grading of the estate plots. At the same time, the area is located near the coast, and thus, has an advantage in managing flood water drainage. It is proposed that the establishment of an IFZ should be realized in the area next to the originally designated IFZ area to avoid steep slopes and existing water channels from upstream areas.

As mentioned in the previous sub-section, the supply of industrial land may have to rely on readily available infrastructure during the earlier stage of the Nacala Bay Area development. In this line, the earlier part of the industrial land supply should take place south of the junction of NE-12 and the railway, where a new road is already constructed on a relatively flat hill-top. This will be considered as an extension of the ongoing concentration of factories along NE-12 within the territory of Nacala Porto Municipality. Another area to accommodate spontaneous development of FDI factories may be at the south end of the Port Expressway which is proposed and described in the following sub-section.

For the subsequent years beyond 2017, part of the large-scale IFZ near the coast will become operational, and will start accepting operation of factories. The full scale development of this IFZ will be around 500ha to cope with the land requirement, mostly by industries involved in metals, machinery, electrical products and equipment.

4) New Housing Area and Guided Urbanization

It is important to prevent the formulation of ribbon type sprawl along the long extending coastal road and other regional trunk roads. To this end, a strategic introduction of urban trunk roads is vitally important. These will form a network and promote housing estate development by private land developers. The area suitable for extension of urbanization may be two directions; one to the area of Matibane Administrative Post, and the other at the coastal flat area near the expected third seaport. The development needs to be initiated for the former area, while the area for the latter should be well reserved until the development of the third seaport becomes a reality. Once the third seaport is developed, these two urbanization areas, along with the existing centres of Nacala Porto and Nacala-a-Velha, will be good locations for commuting to the new CBD, helped by introduction of a bridge over Nacala Bay.

5) Existing Built-up Area

There are two major urban areas in the current land use of the Nacala Bay Area as the central districts of Nacala Porto Municipality and Nacala-a-Velha District. Both were developed at the time of Portuguese governance. The infrastructure of these districts are aged and overloaded by the increase of population. At the same time, surroundings of the central districts are populated by large informal settlements without necessary urban infrastructure. The existing central districts, together with the surrounding areas, will continue to be the host towns for the major part of the population who provide vital working force for the development of the Nacala Bay Area. The upgrading of the living environment in these areas needs to be pursued along with the development of new urban cores.

6) Suburban Agriculture Promotion Zone

The transformation of agricultural products needs to be promoted in the agricultural area within the Nacala Bay Area. Production of fresh vegetables, fruit, and other urban consumption needs should be achieved as much as possible, in order to provide an alternative to imports from South Africa.

7) Transport System

The international airport, existing deep seaport for general cargos as well as the new bulk port under construction, and the location of a possible new deep seaport need to be well connected with each other. These key transport facilities also need to be connected with wider regions both by railway and road systems. The major components of the future transport system include the following:

Seaports

Nacala Port to be expanded as planned in the JICA Study, the bulk port for coal export, and the third port located at the southern end of Memba-sede Administrative Post with the possible function of an additional bulk and general cargo port.

Railways

The main structure of the railroad system will be formed by the following:

- The existing railway connecting to the Nacala Seaport from the entire catchment of the Nacala Corridor
- A new line to branch out from the existing railway to connect the bulk port under construction in Nacala-a-Velha
- A possible extension of the bulk port line to the north to connect to the third port

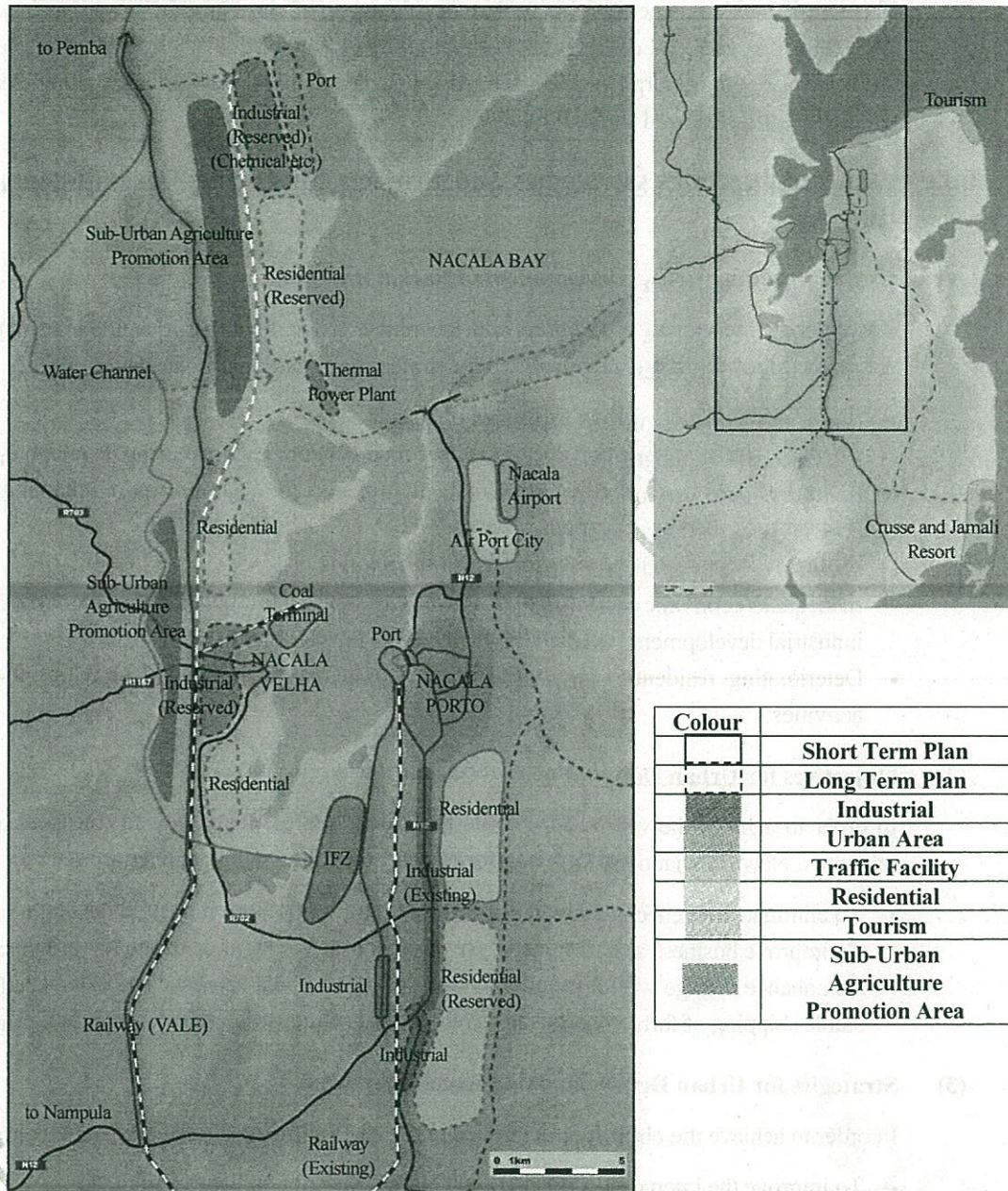
The last one is likely to be a different gauge size from the others if the envisaged alternative railway link from Tete to Nacala becomes a reality.

Road Network

The main structure of the road system will be formed by the following:

- Two wider access roads will connect the Nacala Bay Area with Nampula and Pemba.
- A circular road will be introduced to accept the traffic from the wider access roads as well as regional and urban trunk roads. This circular road may be completed by introduction of a great bridge over the mouth of the bay to link the currently separated two areas for promotion of urbanization, and establish the location of the Airport City at the central part between the urban areas of the east coast and west coast.
- The port-expressway, proposed by the Port Study funded by JICA, needs to be realized for the entire success of the efforts of Nacala Corridor development. The route is proposed to bypass the NE-12 which is heading to the Nacala seaport across the central area of the city of Nacala Porto. The alignment of the port-express way is proposed to by-pass the central urban area of Nacala Porto Municipality. At the same time the road will serve as the major access to the above mentioned large scale IFZ and the industrial area for the spontaneous factory development.
- Urban trunk roads need to be introduced in accordance with the pace of urbanization. Among the many possible routes, two segments are critically important, namely: a) a north-south line from the airport that runs parallel to the segment of EN-12 in the municipal area of Nacala

Porto to promote the housing estate development in the flat area of Matibane Administrative Post area, and b) a link to the Crusse and Jamali resort development area from the circular road mentioned above.



Source: JICA Study Team

Figure 16.1.1 Conceptual Spatial Structure of Nacala Bay Area Development

(2) Supporting Water Resources

The existing plan for water supply to Nacala Porto and surroundings will not meet the demand generated by the future urbanization and industrial activities, even though the water supply will be enhanced by the Sanhute Dam project. The most promising option to achieve the water supply to meet the future requirements seems to be a water conveyance system from the Lurio River. This system will be capable of transmitting more than 400,000m³/day of raw water. Some small portion of the transmitted raw water may be utilized for irrigation purposes in the proposed suburban

agriculture promotion zone. This will be effective if combined with irrigation ponds for local water irrigation systems.

If more demand is generated by further development of the Nacala Bay Area, it will become necessary to construct a dam in the upstream reaches of Mecuburi River and/or Lurio River. The dam may be a multipurpose type, having functions of urban water supply, hydroelectric power generation, irrigation and flood mitigation.

16.1.5 Issues, Objectives, Strategies and Projects for Urban Development of Nacala Bay Area

(1) Issues regarding Urban Development of Nacala Bay Area

Considering the existing conditions and the future vision for urban development of Nacala Bay Area, the following issues are identified for strategy formulation for Nacala Bay Area:

- Rapid and disorderly urban expansion of Nacala
- Increased traffic congestion due to the poor road network and increasing development activities
- Poor integration of ongoing development projects: for example, port rehabilitation/upgrade projects and road development
- Little guidance regarding sites for industrial factories
- Inadequate economic infrastructure (electricity and water supply) to support not only current industrial development but also future industrial development
- Deteriorating residential environment due to increasing economic activities including port activities

(2) Objectives for Urban Development of Nacala Bay Area

In order to achieve the vision for Nacala Bay Area “the first class city for business, industry and tourism, a New International Gateway for Africa”, the following objectives are set:

- To eliminate bottlenecks in both infrastructure and services for industrial development
- To improve business and residential environments as the regional economic growth centre
- To enhance linkage with the agricultural lands of Nampula Province and Zambezia Province for stable shipping of farmed goods to develop the agro-industrial potential in Nacala Bay Area

(3) Strategies for Urban Development of Nacala Bay Area

In order to achieve the objectives identified above, the following strategies should be implemented:

- To improve the interconnection between Nacala Port, the railways and roads
- To upgrade the investment environment by improvement of SEZ laws and regulations
- To provide industrial parks supported by high-standard infrastructures
- To develop a sub-centre for increasing office space and hotel capacity
- To promote MICE by developing and utilizing city hotels and conference facilities
- To expand orderly residential areas by providing a reasonable standard of infrastructures
- To provide recreational facilities for urban dwellers
- To upgrade the Airport to accommodate larger airplanes for developing an international hub for passengers and cargos

(4) Projects for Urban Development of Nacala Bay Area

In order to implement the strategies above, the implementation of the following various projects are required in an integrated manner:

- Nacala Port Access Road Project
- Nacala Multi-Modal Terminal and Railway Shunting Yard Development Project
- SEZ and IFZ Management Improvement Project (Investment Environment Upgrading Project)
- Nacala Industrial Park Project (IFZ establishment and IFZ Support Centre Project)
- Project for Water Conveyance from the Lurio River to Nacala Bay Area
- Nacala Urban Water Supply Expansion Project
- Nampula-Nacala Power Substation Reinforcement Project
- Nacala Thermal Power Plant Development Project for Upgrading Electricity Supply Nacala Airport City Development Project (for office space provision and MICE promotion)
- Nacala Recreation Area Development Project (including golf and multiple amusement facilities near Nacala International Airport)
- Nacala Airport Upgrading Project (further upgrading in the future)
- Nacala Industrial Waste Management Project
- Suburban Agriculture Promotion Project (improvement of investment climate, crop selection suitable for demand in Nacala, irrigation by pond water conveyance, farmers' organizations promotion, improvement of laws etc.)

16.1.6 Future Prospects, Objectives, Strategies and Projects for Urban Water Supply for Nacala Bay Area

(1) Future Prospects for Urban Water Supply for Nacala Bay Area

Nacala Bay Area is expected to grow as a business-commercial and industrial centre taking advantage of upgraded Nacala Port, corridor railways and roads. An adequate and stable water supply to the urban population and economic activities is essential. To supply water for the future urban population for Nacala Bay Area, the demand for water in the urban areas is estimated as shown in the table below.

Table 16.1.8 Summary of Urban Water Demand for Nacala Bay Area

		2013	2017	2025	2035
Demand (m ³ /d) Expanded Supply Area	Nacala Porto	Water Supply Volume after rehabilitation of existing source	33,638	48,675	132,371
	Nacala-a-Velha		14,400	20,979	56,904
	Memba		18,285	22,628	56,499
	Matibane		7,475	8,844	22,404
	Sub Total		73,798	101,125	268,178
	Industrial Area		71,000	105,500	185,000
	Total		33,000	144,798	206,625
Demand (m ³ /d) Limited Supply Area	Nacala Porto	Water Supply Volume after rehabilitation of existing source	26,910	38,940	71,223
	Nacala-a-Velha		3,491	5,340	18,934
	Memba		12,613	13,801	29,357
	Matibane		1,730	2,275	8,218
	Sub Total		44,744	60,356	127,732
	Industrial Area		71,000	105,500	185,000
	Total		33,000	115,744	165,856

Source: JICA Study Team

(2) Issues on Urban Water Supply for Nacala Bay Area

Considering existing conditions and the future vision for urban development of Nacala Bay Area, the following issues are identified for strategy formulation regarding urban water supply:

- Current shortage of water resources available for urban water supply
- Relatively poor service level of water supply
- High cost of getting enough water for people's lives and industrial business operation
- Poor level of urban water supply to attract investors for manufacturing sectors for the future

(3) Objectives for Urban Water Supply for Nacala Bay Area

The objective for the urban water supply for Nacala Bay Area is as follows:

- To provide urban water supply at a high service level for supporting the development of a 1st-Class City for Business, Industry and Tourism by developing water resources in order to secure ample and stable water supply sources

(4) Strategies for Urban Water Supply for Nacala Bay Area

The following strategies are to be implemented for achieving the objectives above:

- To develop water resources for the long term, large enough to satisfy the demand for urban water to support the development of a 1st level city in the Nacala Corridor Region
- To develop water resources by constructing small-scale dams to satisfy urban water demand in the short term (until 2017)
- To expand service areas of urban water supply and at the same time to conduct water demand management until 2025 in order to minimize the increase in demand for urban water and to promote balanced water supply for domestic use, commercial-business use, industrial use and tourism use (because it would not be easy to complete large-scale water resources development by 2025)
- To encourage water users (domestic users, institutional users and industrial users) to implement water saving measures

(5) Projects for Urban Water Supply for Nacala Bay Area

In order to implement the proposed strategies above, the following projects are proposed:

Short-Term (2013-2017)

- Project for Sanhute River Water Resources Development by Construction of Sanhute Dam
- Project for Construction of Water Pipeline from Sanhute Dam to the Existing Water Treatment Plant (near Mecula Dam)

Medium and Long-Term Projects (2017-2025-2035)

- Project for Water Conveyance from the Lurio River to Nacala Bay Area (by Construction of Lurio-Mecuburi Water Channel or Pipeline)
- Project for Construction of Mecuburi River Water Intake and Water Treatment Plant
- Project for Water Distribution System from Mecuburi Water Treatment Plant to Greater Nacala (using Lurio River water)

16.1.7 Future Prospects, Objectives, Strategies and Projects for Sewerage and Drainage Systems for Nacala Bay Area

(1) Future Prospects for Sewerage and Drainage Systems for Nacala Bay Area

In order to achieve the vision of a 1st-Class City for Business, Industry and Tourism, the development of sewerage and drainage systems should be an essential part of urban development.

(2) Issues on Sewerage and Drainage Systems for Nacala Bay Area

Considering existing conditions and the future vision for urban development of Nacala Bay Area, the following issues are identified for strategy formulation on sewage and drainage systems for Nacala Bay Area:

- Currently there is no substantial coverage of a modern sewerage system in Nacala Bay Area
- Poor management and utilisation of septic tanks due to the lack of septage treatment facilities
- Poor level of sanitary situation and sewerage system to attract investment for establishing a 1st-Class City for Business, Industry and Tourism

(3) Objective for Sewerage and Drainage Systems for Nacala Bay Area

The objective to develop sewerage and drainage systems for Nacala Bay Area is as follows:

- To create a sanitary environment and to reduce the occurrence of waterborne diseases for the increasing urban population and expanding urban areas in order to make Nacala Bay Area a 1st-Class City for Business, Industry and Tourism

(4) Strategies for Sewerage and Drainage Systems for Nacala Bay Area

The present situations of sanitation, sewerage and drainage are far behind the desirable situations in the Nacala Bay Area. Under this circumstance, the following strategies for sewerage and drainage systems for Nacala Bay Area are proposed:

- To make an effort at promoting the utilisation of safe sanitation facilities for the short term
- To prepare for establishment of treatment ponds for septage and sewerage systems and drainage systems for the central areas of the Nacala Bay Area for the short term
- To establish treatment ponds for septage and sewerage systems and drainage systems for the central areas for Nacala Bay Area for the medium term

(5) Projects for Sewerage and Drainage Systems for Nacala Bay Area

In order to achieve the identified objectives and to implement the proposed strategies above, the following projects are proposed:

Short-Term (-2017)

- Preparation of the project for treatment ponds for storage and treatment of septage from septic tanks/pit-latrines
- Preparation of the project for a sewerage system and drainage system for the central area and industrial zones (detailed design and bidding documents)
- Preparation and Implementation of the project for "Emergency Cleaning and Rehabilitation of septic tanks"

- Promotion of utilisation of low-cost sanitation facilities in peri-urban areas (suburban areas)
- Study on and implementation of collection systems and institutional frameworks for septage from septic tanks and pit-latrines

Medium-Term (2018-2025)

- Construction of treatment ponds for storage and treatment of septage from septic tanks/pit-latrines
- Construction of a sewerage system and drainage system for the central area (cement city) and industrial zones

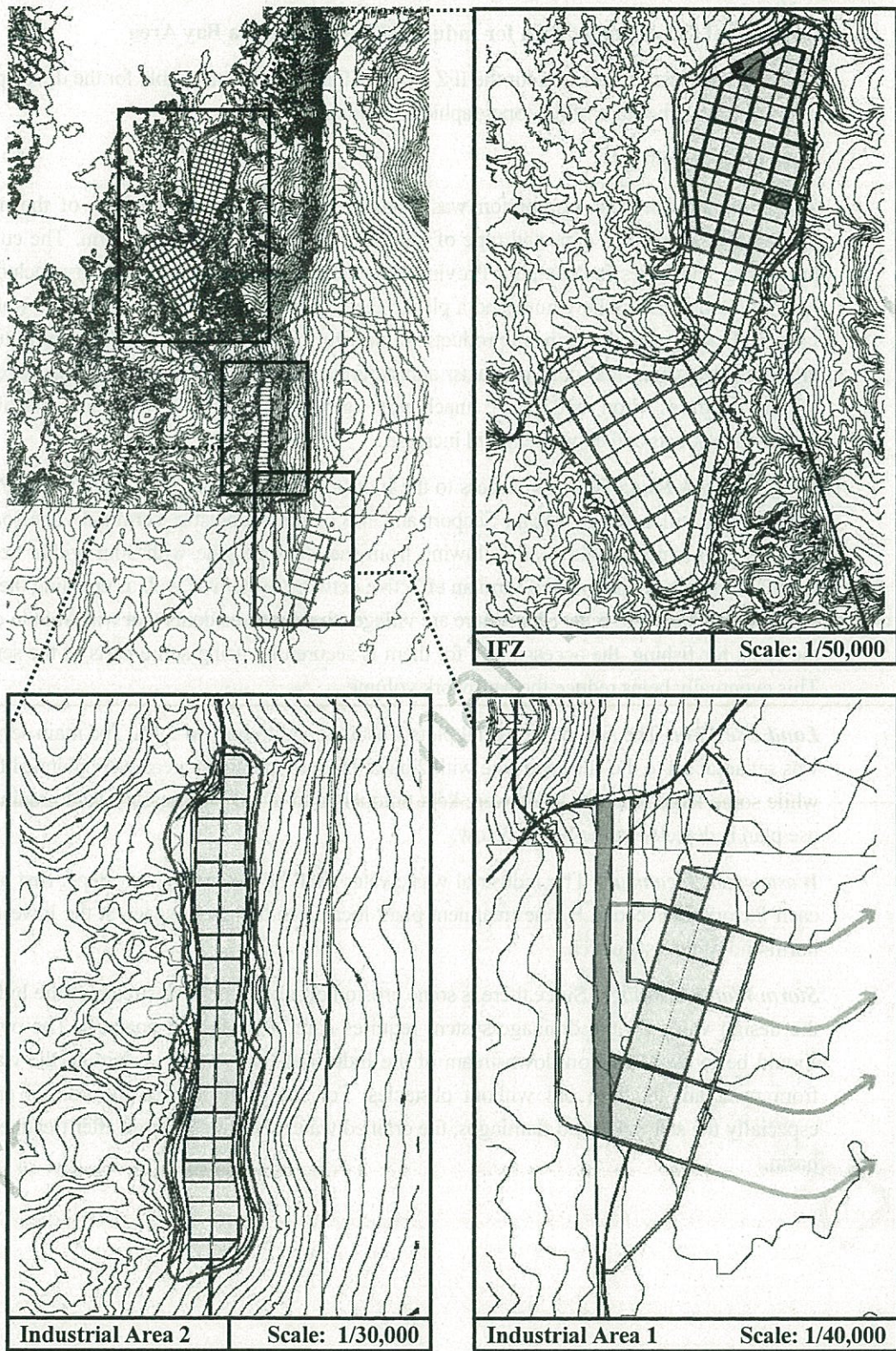
Long-Term (2026-2035)

- Implementation of regular maintenance of septic systems
- Expansion of sewerage and drainage systems

16.1.8 Conceptual Development Plan for Industrial Estates in Nacala Bay Area

(1) Strategic Provision of Industrial Land

As mentioned earlier, readily available land suitable for manufacturing direct investment is scarce in Nacala Bay Area. Many investors have visited Nacala but decided not to invest as they learned that the land plots for their factory construction have to be obtained by themselves through a set of legal procedures for establishment of DUAT. To avoid losing these investments, the Nacala Bay Area needs to secure readily available industrial land plots and simplify the leasing of land for the potential investors. The ultimate solution is to establish industrial estates with and without the status of IFZ. At the current stage, it is highly recommended to secure industrial land by the municipality or GAZEDA in suitable areas. The area should be designated in the Structure Plan of the Nacala Porto Municipality through a minor modification and approval, so that to obtain legal base for the land acquisition together with allocation of budget for the required amount of compensation. The recommended sites are shown in the figure below, along with the recommended site for developing an Industrial Park. The area for the early industrial land, or the Industrial Belt, may be 50 to 100 ha.



Source: JICA Study Team

Figure 16.1.2 Proposed General Location and Conceptual Layout of Industrial Lands in Nacala Bay Area

(2) Conceptual Development Plan for Industrial Park in Nacala Bay Area

The originally designated area for the IFZ by GAZEDA seems unsuitable for the development of an industrial estate because of the topographic conditions.

Development Concepts

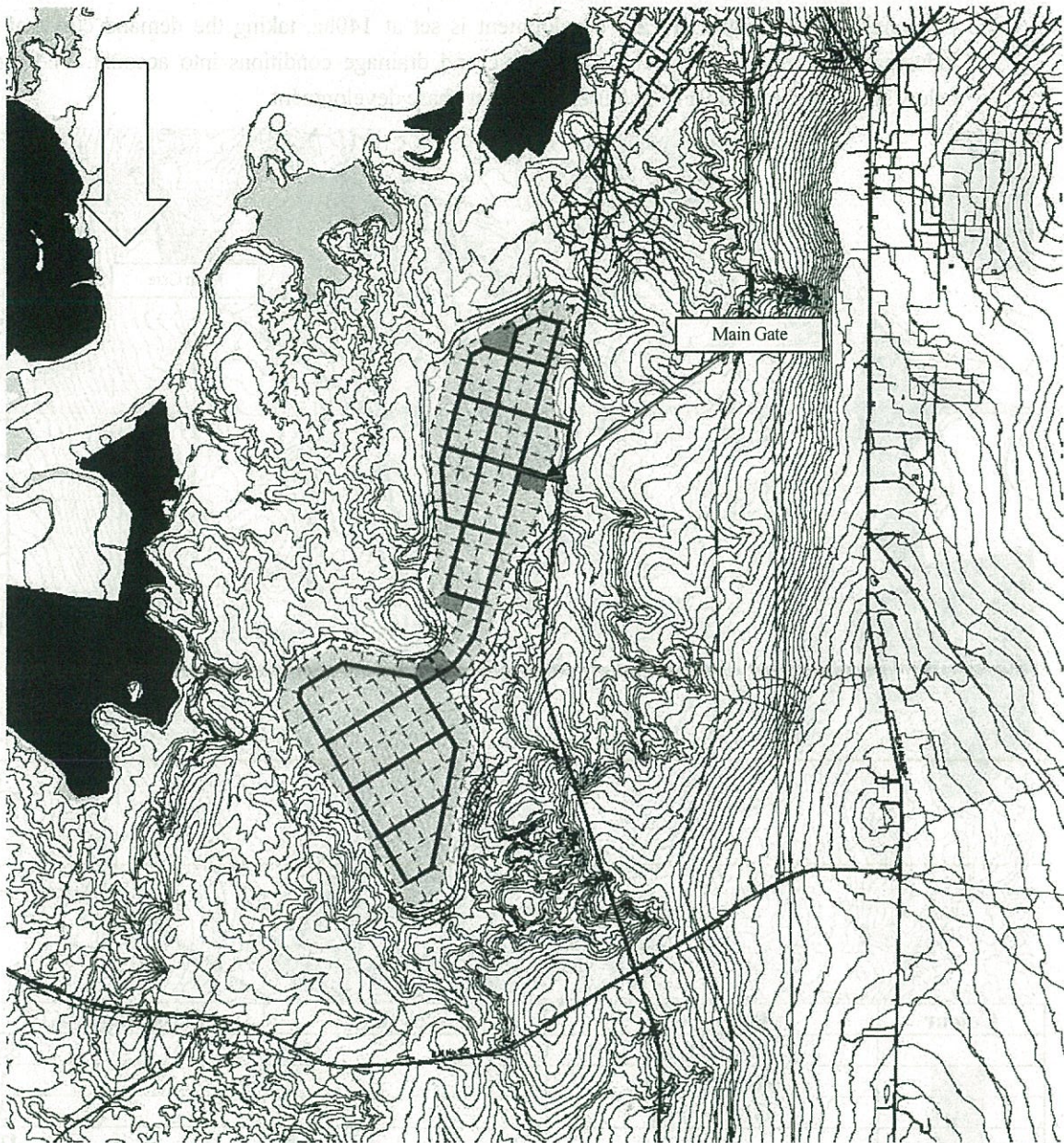
Target Industries: The assumption was made based on the current trends of the new factory investments, as well as expected type of industries in the middle to long term. The current major processing industries in Nampula Province are cement factories, agro-industry including wheat, milling factory and cashew nuts, and a plastic factory, while those along EN-12 are warehouses (7 factories), construction and metal products manufacturing industry (2), furniture and fixtures, plastic products, petroleum and coal products, and ceramics. In the coming decades, it is expected that mining factories (iron and coal), machinery (general machinery, precision machinery), and electrical products and equipment will increase.

Road Network Plan: The main access to the Industrial Park will be from the planned Port Express Way which will connect Nacala Seaport and the planned Logistic Terminal. The road network consists of a main straight road following from the entrance gate with 30m width. Service roads with 20 m width are planned to form an effective network system as well as enabling the division of land plots to have 1 to 5 ha. Since there are villages that have residents that will want to commute to the coast for fishing, the accessibility for them is secured by using some parts of the service roads. This eventually helps reduce the earthwork volume.

Land Use Plan: The size of industrial plots was assumed to be 1 to 5 ha. The main service facility was set adjacent to the entrance gate with 2 ha of land. Some green areas were planned for workers, while some large block of lands were kept untouched to avoid unnecessary land grading. The land use plan is depicted in the figure below.

Wastewater Treatment: The industrial wastewater shall be treated by two steps: first at the site of each factory and second by the treatment plant located in the green space at the lowest part in the north-end of the estate area.

Storm Water Drainage: Since there is some erosion observed in the upstream of the Industrial Park, the design work for the drainage system requires careful study and analysis. The overall policy should be to avoid erosion downstream of the Industrial Park, while permitting the water coming from upstream to drain out without obstacles. For the protection of the coastal environment, especially the salt fields and flamingos, the drained water should discharge after treatment in a sand basin.



Colour	Type of Use	Area (ha)	Percentage (%)
	Industry	305	87
	Management	2	1
	Green Area	10	3
	Road	33	9
	Total	350	100

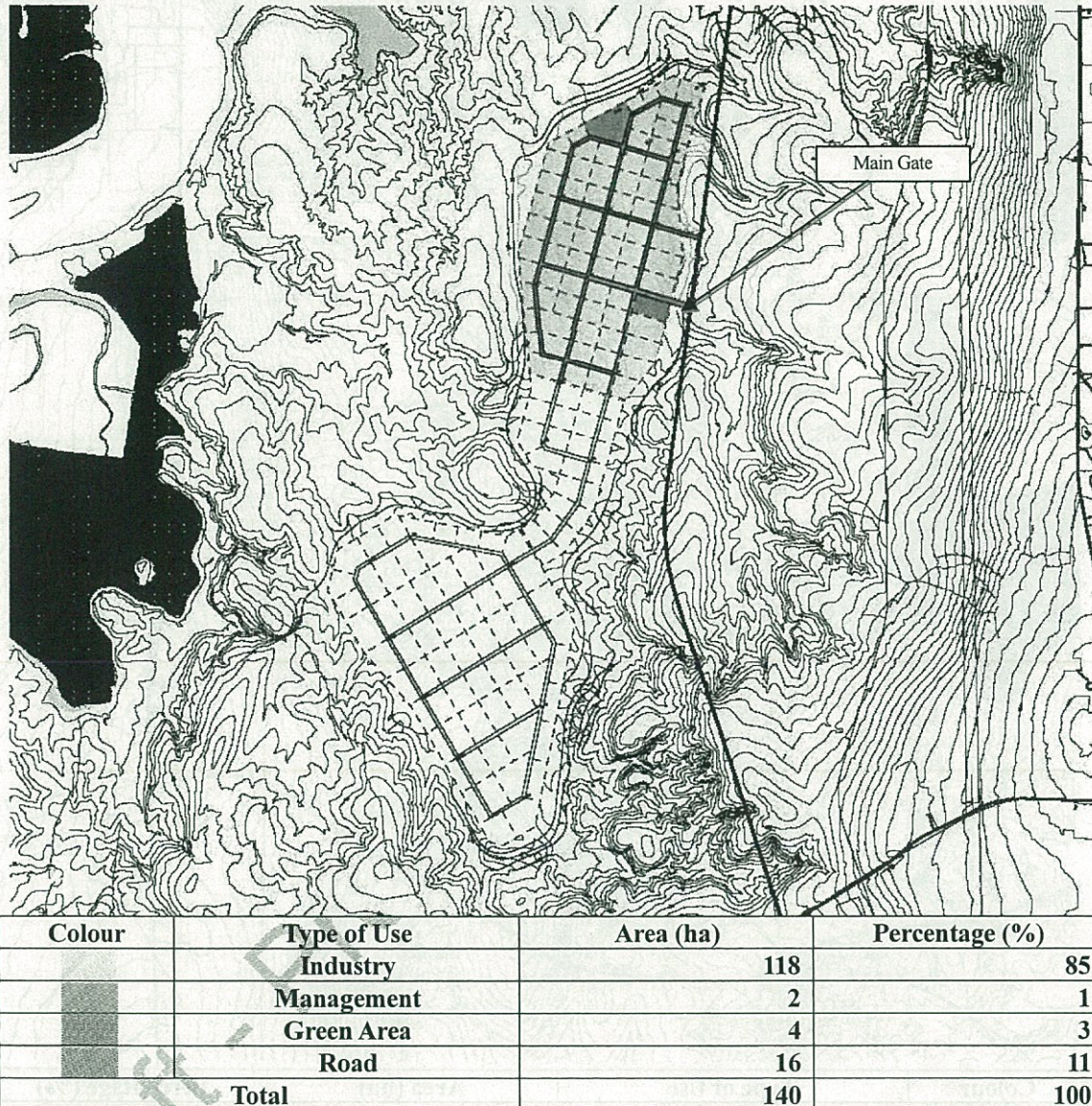
Source: JICA Study Team

Figure 16.1.3 Conceptual Land Use Plan of Nacala Industrial Park

(3) Phased Development Plan

The land provision of the Industrial Park at the full development of 500 ha will meet the total requirement of industrial use in the year 2035. A step-wise development of the Industrial Park is recommended as the available utilities infrastructure is limited at the earlier stages, while different sources of utilities may be introduced in the later stage. For the planning purpose, the size of the

first phase of the Industrial Park development is set at 140ha, taking the demand curve of the industrial land requirements, and topographic and drainage conditions into account. The figure below shows the location and land use of the first phase development.



Source: JICA Study Team

Figure 16.1.4 Location and Land Use of the First Phase Development of Nacala Industrial Park

16.2 Urban Development Strategies for Greater Nampula

16.2.1 Future Prospects for Greater Nampula

Being a dominant city in the Northern Region of the country, development of Nampula will keep a steady pace, even after significant development takes place in Nacala Bay Area. The city will continue to be the administration centre, as well as a centre of production and consumption with a significant scale. However, there are various risks for healthy development of Nampula City brought as side effects of being a major node of the Nacala transport corridor. The most explicit example is the increase of railway traffic caused by mass-scale coal transport. Significant efforts will be required by all relevant organisations to help avoid the risks of traffic accidents and degradation of the urban environment for ordinary lives. These efforts also need to consider effective contributions to create/enhance conditions for industry, services and other economic activities.

16.2.2 Vision for Greater Nampula

The target image of the development of the Nampula Regional Growth Centre is to create a growth pole of the Northern Region and contribute to the national development, through not only preventing the deterioration of the urban environment by the increased transport and other economic activities, but also enhancing the quality of lives. To this end, it is critically important to concentrate efforts on diversion of major transport infrastructure. The function of production and service centre may be strengthened by creation of a highly efficient city with a rather compact built-up area. The ongoing rapid urbanization should be contained within a certain area, and prevent involvement of neighbouring rural areas.

16.2.3 Development Framework for Greater Nampula

(1) Population

The population of the Greater Nampula Area in 2035 will reach 1,300,000 persons combining the Municipality and three neighbouring administrative posts of Nampula Rapale District as summarized in the Table 16.2.1. The total urban population in the same area in 2035 is forecast to be 875,200 persons as shown in Table 16.2.2. The pace of population increase will be moderate compared with the case of Nacala Bay Area, but still in a rapid state.

Table 16.2.1 Population Forecast for Greater Nampula

Municipality/District/ Administrative Post	Population				Average Annual Population Growth Rate (% per annum)		
	2007	2017	2025	2035	2007-2017	2017-2025	2025-2035
Nampula City	483,572	622,000	739,000	888,000	2.5%	2.2%	1.9%
Anchilo AP (Nampula Rapale District)	75,543	109,000	136,000	168,000	3.7%	2.8%	2.1%
Namaita AP (Nampula Rapale District)	52,464	76,000	95,000	116,000	3.8%	2.8%	2.0%
Rapale AP (Nampula Rapale District)	57,491	83,000	104,000	128,000	3.7%	2.9%	2.1%
Total of Greater Nampula	669,070	890,000	1,074,000	1,300,000	2.9%	2.4%	1.9%

Source: JICA Study Team

Table 16.2.2 Forecast of Urban Population for Greater Nampula

Municipality/District/ Administrative Post	Population				Average Annual Population Growth Rate (% per annum)		
	2007	2017	2025	2035	2007-2017	2017-2025	2025-2035
Nampula City	386,858	497,600	591,200	710,400	2.5%	2.2%	1.9%
Anchilo AP (Nampula Rapale District)	3,777	10,900	27,200	67,200	11.2%	12.1%	9.5%
Namaita AP (Nampula Rapale District)	2,623	7,600	19,000	46,400	11.2%	12.1%	9.3%
Rapale AP (Nampula Rapale District)	2,875	8,300	20,800	51,200	11.2%	12.2%	9.4%
Total of Greater Nampula	386,858	524,400	658,200	875,200	3.1%	2.9%	2.9%

Source: JICA Study Team

(2) Urban Land Requirement

To accommodate the future population of the Nampula Regional Growth Centre, the land area required for urbanization is estimated as shown in the table below. To promote the creation of a compact city, the ratio of urban population in the administrative posts of Nampula Rapale District is set to be 40%, while that of Nampula Municipality may reach the level of 80%. The incremental urban population from year 2007 to 2035 will be around 414,000 persons, and will require an additional 11,000 ha to be urbanized for residential, public facilities, office and commercial uses, urban infrastructure, and some cottage type industries.

Table 16.2.3 Urban Land Requirement for Greater Nampula

Municipality/District/ Administrative Post	Population Increase 2007-2035	Urban Population Share (%)	Increased Urban Population	Urban Land Requirement (ha)	Density (persons/ha)
Nampula City	404,428	80	323,542	8,089	40
Anchilo AP (Nampula Rapale District)	92,457	40	36,983	1,233	30
Namaita AP (Nampula Rapale District)	63,536	40	25,414	847	30
Rapale AP (Nampula Rapale District)	70,509	40	28,204	940	30
Total of Greater Nampula Area	630,930	(Average) 50	414,143	11,109	

Source: JICA Study Team

(3) Industrial Land Requirement

The industrial land requirement is calculated separately as it is promoted to locate the factories in the industrial estate as much as possible. Thus, the unit land area for a worker will be larger than the conventional type of factories. The estimation was done as shown in Table 16.2.4 and Table 16.2.5. The number of factory workers is estimated based on the economic development forecast of Nampula Province, and assuming that 25% of the incremental number of workers in the province will be settled in that area. The land requirement is then estimated by type of industry by year as shown in Table 16.2.6. The total area required for the industrial estate is around 300 to 350ha, among which, types of food, beverage, agro-processing will be dominant to cover more than 130ha.

Table 16.2.4 Economic Forecast for Nampula Province

	2007	2035	Share in 2035 (%)
GRDP (MT million, 2003 constant price)			
Nampula Province	20,346	148,500	100.00
Sector GRDP (MT million, 2003 constant price)			
Agriculture		49,100	33.06

Mining		30	0.02
Manufacturing/Construction/Utilities		35,800	24.11
Services		63,600	42.83
Work force of Nampula Province Manufacturing			Annual Growth Rate (%)
Economically Active Population (Persons)	38,467	161,238	5.25
Labour Productivity (Persons)	59,179	135,397	3.00

Source: JICA Study Team

Table 16.2.5 Industrial Land Requirement for Greater Nampula

	2007	2035	Remarks
Economically Active Population (Nampula Province)	38,467	161,238	
Existing Industrial Land (Nampula Province) (ha)	385		100 persons/ha
Industrial Land Requirement (Nampula Province) (ha)		2,015	80 Persons/ha
Greater Nampula Area Industrial Land Requirement	154	500	40% in 2007 25% in 2035

Source: JICA Study Team

Table 16.2.6 Industrial Land Requirement by Type by Year for Greater Nampula

Unit: ha

Broad type of industry	2007	2012	2017	2035
Food/Beverage/Agro-processing	92.4	104.4	120	250
Metal/Machinery/Electrical Products & Equipment	15.4	17.4	20	150
Wood/Furniture, Construction Materials and Others	46.2	52.2	60	100
Total	154	174	200	500

Source: JICA Study Team

16.2.4 Conceptual Spatial Structure for Greater Nampula

(1) Diversion of Concentrated Traffic

The most critical factor for the development of the area is to divert the existing concentrated traffic to prevent creating risks for both human lives and the city's efficiency. The effort to match the changed nature of the transport is required even though it is costly. Major components for the diversion of existing traffic include the following:

1) Rerouting of Railway for Coal Transport

The highest risk potential to the urban lives will be brought by the change of the nature of railway operation. By the significant increase of the number of trains (28/day in 2035), the city will be totally divided as crossing of the railway will become a very time consuming factor. Plus the current ground level separation of the space from the ROW of the railway will cause the risk of accidents and may create social instability. After analyses for several options, it is proposed to divert the coal transport portion of the railway traffic to a new line in the north of the municipal territory, while trains for general cargos and passengers will continue to use the present alignment. The new segment of the diverted route will be less undulating and far enough to be involved into the built-up area again.

2) Relocation of Airport

The existing airport is located at the centre of the city and is causing incredibly loud noise in the city centre. Although it is convenient to have an international airport at the centre of the city, the number of airline operations seems incredibly high compared to other cities in the world. The threat to the health of the citizens caused by the jet noise will become a social issue sooner or later. The efficiency of the air operation will also face risk by increased air traffic. This will become more critical in the near future as the late night operation might be stopped. Thus the relocation of the airport is proposed as another key to create an efficient and competitive city with quality urban lives.

3) Relocation of Railway Shunting Yard

Currently a large scale shunting yard is located along the platform of Nampula Station. This is not causing critical risk to the city life, but the efficiency of land use is largely degraded as the facility is not useful for the ordinary citizens. In addition, if the coal train route is diverted, the coal trains will have very limited chance to utilize the shunting yard even in case of emergency. It is proposed that a new shunting yard be constructed at the eastern side of the branch point with the diverted railway dedicated to the coal transport.

4) Ring Road Development

A ring road has been proposed as a result of the joint effort by the municipality and UN-HABITAT. The general alignment is set to serve as the trunk road of the city as well as encouraging the through traffic to avoid reaching the city centre. This concept is effective and needs to be shared by the relevant authorities.

(2) Urban Cores for Greater Nampula

Along with the diversion of major transport infrastructure, there will be many opportunities generated to achieve formulation of a highly efficient and compact city. The major chances include the following:

1) New CBD at Shunting Yard and Airport Sites

The site of the railway shunting yard is an ideal location to redevelop and form a new CBD for the city. As most of the planned area is already occupied, the scarceness of office space will become critical. It is not promising to expect the reconstruction of old buildings as they are mostly apartments. As the price of properties in the central area is already reaching the level that would make construction of multi-story buildings viable, there is a high potential for projects for urban complex development. This is also true of the site of the airport.

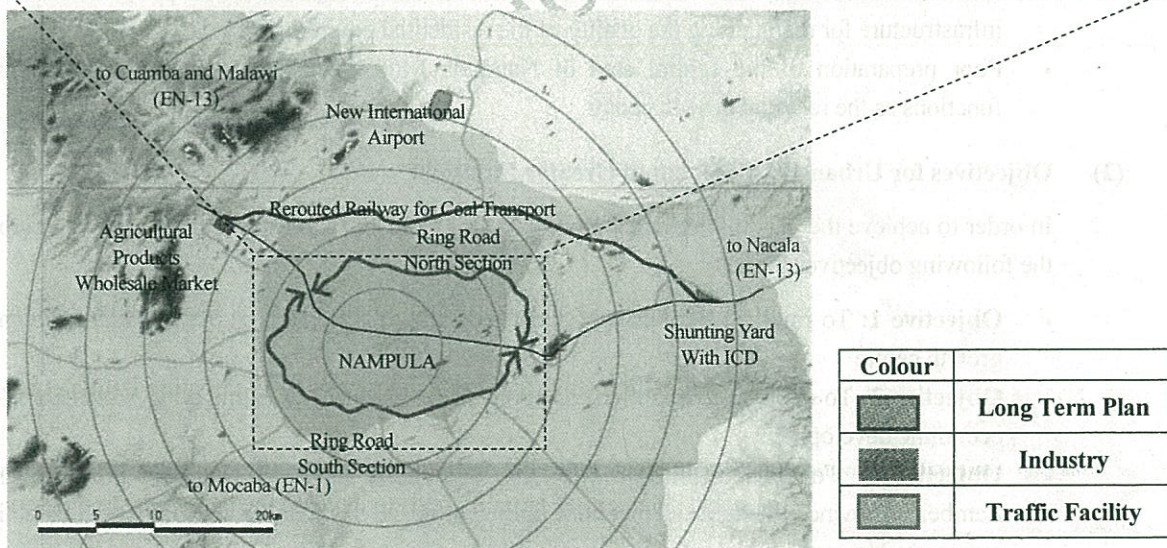
2) Industrial Zones in Outskirts along Ring Road

Formation of industrial zones along the planned ring road is also proposed by the Municipality-Habitat joint effort. It is expected that this land use will help prevent creation of ribbon type sprawl.

3) New Housing Area and Urbanization

Having unique hills and rivers, the future urbanization needs to be effectively guided by a clear definition of the restricted area. To create a compact city it is also critically important to set the

Urban Growth Boundary.



Source: JICA Study Team

Figure 16.2.1 Conceptual Spatial Structure of Greater Nampula Development

16.2.5 Supporting Water Resources

Surface water of the Monapo River is important for both urban and irrigation water supplies. The water potential in the rainy season is sufficient, but it is scarce in the dry season. Utilizing surface water in the dry season is necessary for irrigation, especially in the downstream areas. Consequently,

the water source for urban water is considered to be conveyed from Meluli River. Construction of Monte Tiza Dam is proposed for the future water source of Nampula urban water that may satisfy the demand of 374,000m³/day in 2035. Detailed study is required for the development of dam construction conducted by IWRM.

16.2.6 Issues, Objectives, Strategies and Projects for Urban Development of Greater Nampula

(1) Issues on Urban Development of Greater Nampula

Considering the existing conditions and the future vision for urban development of Greater Nampula, the following issues are identified for strategy formulation for Greater Nampula:

- Increased traffic congestion partly due to increased concentration of through traffic at national roads in the central area, such as National Road No.13 and National Road No.1 and partly due to rapidly increasing development activities
- Poor coordination between ongoing development projects: for example, poor coordination between the upgrading of the railway for coal transport and the improvement of railway crossings
- Rapid and disorderly urban expansion from Nampula Municipality toward surrounding districts
- Inadequate infrastructure (electricity and water supply) for supporting not only the present urban people's lives and economic activities, but also future urban development including economic development
- Deterioration of the residential environment because it is difficult to provide sufficient infrastructure for maintaining the quality of the residential environment
- Poor preparation of the central area of Nampula Municipality for fulfilling higher urban functions as the regional growth centre

(2) Objectives for Urban Development of Greater Nampula

In order to achieve the vision for Greater Nampula: Regional Growth Pole of the Northern Region, the following objectives are set:

- **Objective 1:** To improve the business and residential environment as the regional economic growth centre
- **Objective 2:** To create a competitive environment for business by eliminating bottlenecks for economic development
- **Objective 3:** To enhance linkage with the agricultural lands of Nampula Province and Zambezia Province for stable shipment of farmed goods to develop the agro-industrial potential in Greater Nampula

(3) Strategies for Urban Development of Greater Nampula

In order to achieve the objectives identified above, the following strategies should be implemented:

Objective 1

- To mitigate negative environmental impacts due to prospective railway coal transport and increased road traffic in response to the opening of an upgraded trunk road for

Lichinga-Mandimba-Cuamba-Nampula-Nacala

- To transform the transportation network
- To redevelop large sites for creation of business and residential functions in the central area of Nampula

Objective 2

- To strengthen economic infrastructures, such as water and electricity supply
- To develop human resources for economic development
- To support business start-up for entrepreneurs

Objective 3

- To upgrade new roads between Nampula and surrounding rural areas

(4) Projects for Urban Development of Greater Nampula

In order to achieve the identified objectives and to implement the proposed strategies above, the following projects are proposed:

Short-Term (-2017)

- Ring Road Construction Project Phase 1 (southern segment)
- Project for relocation of existing wholesale market to Rapale (to resolve congestion in downtown Nampula)
- Project for establishment of a multi-modal logistic terminal in Anchilo (efficient cargo transfer and improvement of urban environment)
- Industrial Human Resources Development Project
- Business Start-up Support Project (finance, incubation, legal issues etc.)

Medium to Long-Term (2018-2035)

- Railway Bypass Construction Project (for securing safety and efficiency of urban area, as well as mitigating environmental impacts)
- Ring Road Construction Project Phase 2 (northern segment)
- New Nampula International Airport Development Project
- New CBD Development Project (phase 1 at shunting yard, phase 2 at airport site)
- Urban Infrastructure Projects (water, electricity)

16.2.7 Future Prospects, Objectives, Strategies and Projects for Urban Water Supply for Greater Nampula

(1) Future Prospects on Urban Water Supply for Greater Nampula

Greater Nampula is expected to become a regional growth pole for the Northern Region taking advantage of its corridor of railways and roads, as well as its proximity to Nacala Port. Stable and extensive water supply to the urban population and economic activities is essential for supporting urban and economic development in Greater Nampula. To supply water for the future urban population for Greater Nampula, the future demand of urban water supply is estimated as shown in the table below.

Table 16.2.7 Summary of Urban Water Supply Demand for Greater Nampula

		2013	2017	2025	2035
Demand (m ³ /d) Expanded Supply Area	Nampula	Water supply volume after rehabilitation of existing source(m ³ /d)	50,861	87,096	132,371
	Namaita		21,888	29,691	56,904
	Anchilo		22,559	31,229	56,499
	Rapale		22,031	30,029	22,404
	Sub Total		117,339	178,046	268,178
	Industrial Area		53,000	94,000	185,000
	Total	20,000	170,339	272,046	453,178
Demand (m ³ /d) Limited Supply Area	Nampula	Water supply volume after rehabilitation of existing source(m ³ /d)	40,689	69,677	71,223
	Namaita		16,739	22,271	18,934
	Anchilo		16,941	22,862	29,357
	Rapale		16,782	22,401	8,218
	Sub Total		91,151	137,211	127,732
	Industrial Area		53,000	94,000	185,000
	Total	20,000	144,151	231,211	312,732

Source: JICA Study Team

(2) Issues on Urban Water Supply for Greater Nampula

Considering existing conditions and the future vision for urban development of Greater Nampula, the following issues are identified for strategy formulation on urban water supply for Greater Nampula:

- Current shortage of water resources available for urban water supply not only for the present populations and economic activities, but also for the future populations and economic activities
- Relatively poor service level of water supply for the present populations
- High cost of getting enough water for people's lives and industrial business operation
- Poor level of urban water supply to attract investors for manufacturing sectors for the future

(3) Objectives for Urban Water Supply for Greater Nampula

The objective for the urban water supply for Greater Nampula is as follows:

- To provide urban water supply at a reasonable service level for supporting the development of the Regional Growth Pole for the Northern Region

(4) Strategies for Urban Water Supply for Greater Nampula

The following strategies are to be implemented for achieving the objectives above:

- To fully utilize existing water resource facilities and water supply facilities
- To reduce Non-Revenue Water (NRW) and to increase water volume to be supplied for achieving healthier management of the water company
- To expand the service areas for urban water supply and at the same time to conduct water demand management by regulating the increase in the number of house connections
- To supply water to the central area of Greater Nampula at a higher service level than for other areas, for supporting the development of the Regional Growth Pole for the Northern Region

(5) Projects for Urban Water Supply for Greater Nampula

In order to implement the proposed strategies above, the following projects are proposed:

Short-Term (-2017)

- Project for Rehabilitation of Monapo Dam on the Monapo River (to increase the water supply capacity by 20,000 m³/day) by constructing a small weir on the Meluli River and taking water from the Meluli River for providing to the reservoir of Monapo Dam

Medium-Term (2018-2025, at the earlier time by 2025)

- Project for Development of Water Treatment Plant (to treat water from Monte Tiza Dam on the Meluli River to supply 259,000 m³/day of treated water to Greater Nampula) and Water Pipeline (for transmission of treated water to Greater Nampula)
- Project for Strengthening of Water Distribution System of Greater Nampula (for utilizing the water from Monte Tiza Dam)

Long-Terms (2025-2035, as soon as possible after 2025)

- Project for Development of Water Treatment Plant (to treat water from Mutelele Dam on the Ligonha River to supply treated water to Greater Nampula) and Water Pipeline (for transmission of treated water to Greater Nampula)
- Project for Strengthening of Water Distribution System of Greater Nampula (for utilizing the water from Mutelele Dam)

16.2.8 Sewerage and Drainage Systems for Greater Nampula

(1) Future Prospects on Sewerage and Drainage Systems for Greater Nampula

The present situations of sanitation, sewerage and drainage are far behind the desirable situations in Greater Nampula. However, in order to seek the vision of Regional Growth Pole for the Northern Region, the development of sewerage and drainage systems should be an essential part of urban development.

(2) Issues on Sewerage and Drainage Systems for Greater Nampula

Considering the existing conditions and the future vision for urban development of Greater Nampula, the following issues are identified for strategy formulation on sewerage and drainage systems for Greater Nampula:

- Currently small coverage of a modern sewerage system in Nampula Municipality
- Poor management and utilisation of septic tanks due to the lack of septage treatment facilities
- Poor level of sanitary situation, sewerage and drainage systems to attract investment for establishing a Regional Growth Centre

(3) Objective for Sewerage and Drainage Systems for Greater Nampula

The objective to develop sewerage and drainage systems for Greater Nampula is identified as follows:

- To create a sanitary environment and to reduce the occurrence of waterborne diseases for increasing urban population and expanding urban areas in order to make Greater Nampula a Regional Growth Pole for the Northern Region.

(4) Strategies for Sewerage and Drainage Systems for Greater Nampula

Under this circumstance, the following strategies for sewerage and drainage systems for Greater Nampula are proposed:

- To make an effort at promoting the utilisation of safe sanitation facilities for the short term
- To prepare for establishment of treatment ponds for septage and sewerage systems and drainage systems for the central areas of Greater Nampula for the short term
- To establish treatment ponds for septage and sewerage systems and drainage systems for the central areas for Greater Nampula for the medium term

(5) Projects for Sewerage and Drainage Systems for Greater Nampula

In order to achieve the identified objectives and to implement the strategies proposed above, the following projects are proposed:

Short-Term (-2017)

- Preparation of the project for treatment ponds for storage and treatment of septage from septic tanks/pit-latrines
- Preparation of the project for a sewerage system and drainage system for the central area and industrial zones (detailed design and bidding documents)
- Preparation and Implementation of the project for "Emergency Cleaning and Rehabilitation of Septic Tanks"
- Promotion of utilisation of low-cost sanitation facilities in peri-urban areas (suburban areas)
- Study on and implementation of collection systems and institutional frameworks for septage from septic tanks and pit-latrines

Medium-Term (2018-2025)

- Construction of treatment ponds for storage and treatment of septage from septic tanks/pit-latrines
- Construction of a sewerage system and drainage system for the central area (cement city) and industrial zones

Long-Term (2026-2035)

- Implementation of regular maintenance of septic systems
- Expansion of sewerage and drainage systems

16.3 Urban Development Strategies for Cuamba City

16.3.1 Future Prospects for Cuamba City

The strategic location of the city has not been utilized effectively due largely to the poor conditions of national roads connecting Cuamba to other regions of the country. The urbanization, however, will be dramatically accelerated after completion of the improvement of the N-13 Nampula-Cuamba segment. Despite the fact that the past urbanization was in a moderate pace, the city is already facing the shortage of land for housing use of the migrants. It is necessary to expand the area for urbanization by connecting the flat area located north-east of the city centre across the river running roughly from west to east.

16.3.2 Vision for Cuamba City

The target image of the development of Cuamba City is to create an Inland Regional Logistics and Industrial Centre, which will help bring the benefit of the transport corridor development to the areas distant from the corridor route. In other words, the development of Cuamba is a touch stone to assess the effectiveness of the Nacala Corridor development as a development corridor beyond being a mere transport corridor. Expanding the dynamism of economic development along the corridor to the remote areas can be achieved by strengthening the urban functions of the central towns located along the corridor. In this light, the development of Cuamba needs to focus on accumulation of higher urban functions, such as efficient cargo transit, availability of higher education and health services, and creation of value added on the products of its remote catchment area.

16.3.3 Development Framework for Cuamba City

A set of development frameworks for Cuamba City is forecast to the planning horizon.

(1) Population Framework

The population of the Cuamba Municipality area in 2035 is expected to be 179,000 persons, while that of the Cuamba District area is 418,000, as presented in Table 16.3.1. The total population will be doubled from the record of 2007 census population (81,982).

Table 16.3.1 Population Forecast for Cuamba

	Population				Average Annual Population Growth Rate (% per annum)		
	2007	2017	2025	2035	2007-2017	2017-2025	2025-2035
Cuamba District (incl. Municipality)	191,642	275,000	334,000	418,000	3.7%	2.5%	2.3%
Cuamba Municipality	81,982	118,000	143,000	179,000	3.7%	2.4%	2.3%

Source: JICA Study Team

(2) Urban Land Requirement

To accommodate the future population of the city, the land area required for urbanization is estimated as shown in Table 16.3.2. It is expected that over 3,600ha of urban land will be newly required, even though the overall population density of the city will increase from 15.3 persons/ha

in 2007 to 20.0 persons/ha in 2035.

Table 16.3.2 Urban Land Requirement for Cuamba City

	2007	2035	Increase
Population (persons)	81,982	179,000	97,018
Urban Land (ha)	5,346.6	8,950.0	3,603.4
Density (persons/ha)	15.3	20.0	

Source: JICA Study Team

(3) Industrial Land Requirement

The industrial land requirement is calculated from the share of the economically active population in Niassa Province. It was 7,689 persons in the province, according to the census result. Assuming the density of the number of workers was 100 persons/ha in 2007, it is estimated that there might have been around 19.5ha of land in industrial use as a total in the municipality. Assuming the density will be reduced to 80 persons/ha in 2035, there will be 128ha of industrial land in the municipality as a whole. Thus the land requirement for industrial use from 2007 to 2035 is estimated to be around 109.5ha. The share of the Cuamba Municipality, in terms of the number of workers is assumed to be 40%.

Table 16.3.3 Industrial Land Requirement for Cuamba City

	2007	2035	Increase
Niassa Province (ha)	77.0	320+	
Cuamba Municipality (ha)	19.5	128+	App. 100
Share of Cuamba Municipality (%)		40	

Source: JICA Study Team

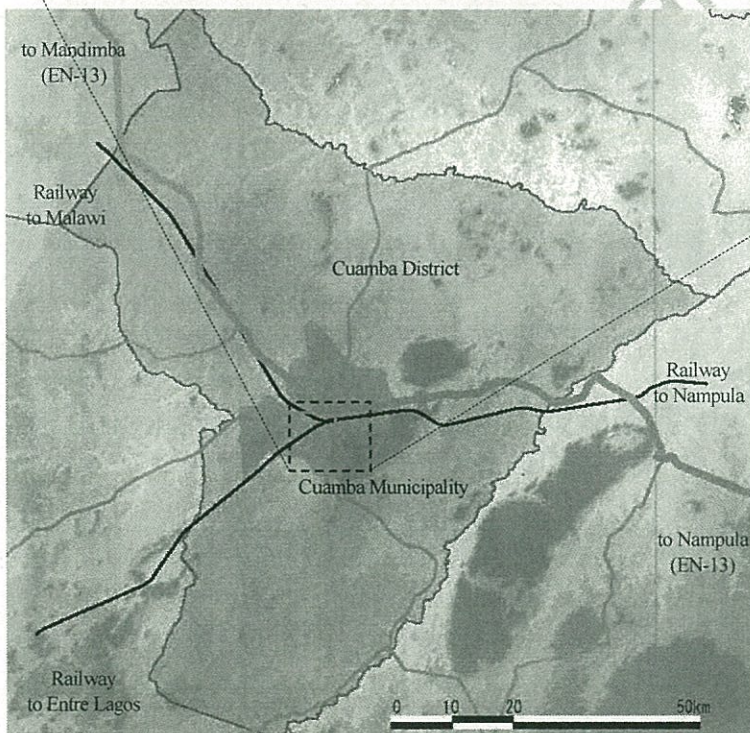
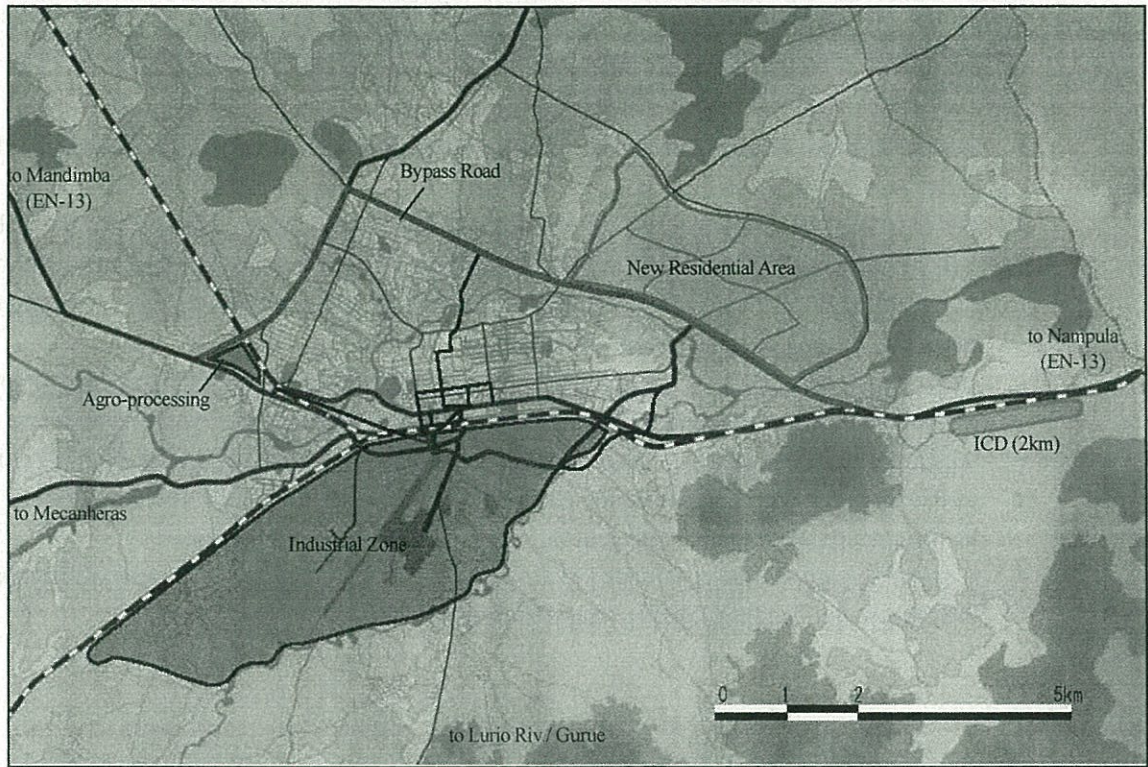
16.3.4 Conceptual Spatial Structure for Cuamba City




Similar to the case of Nampula Municipality, the railway crosses the geographical centre of the urban area of the municipality. Therefore it is necessary to deal with the expected division of the city brought by the operation of the coal forwarding by the railway. At the same time, it is necessary to expand the urban area to the north-east by crossing the river course. Taking these issues into account, three alternatives can be generated as follows:

- A bypass road will be introduced to the north side of the river to ease the influx of traffic to the city centre as well as to facilitate the development of new urbanization areas on the north-eastern side of the river. The railway will be kept as it is to support locating of distribution and logistics industries by transforming the south side of the city into an industrial zone.
- A bypass road will be introduced in the same manner as in the above alternative, but the railway will be relocated to the south end of the city. By doing this, the south part can be used as a residential area, as the division of the city will be avoided.
- A bypass road will be introduced in the same manner. The junction of the railway will be relocated to the east of the city and the line toward Lichinga will be realigned along the proposed bypass. By doing this, the introduction of an agro-processing complex may be better located on the north side of the river, while the distribution industry will be located in the south part of the city.

Taking the relatively small size of the city as well as the need for momentum to create a new urban area north-east of the river, it is proposed that the following options may be the most efficient way of achieving the above two requirements:

- A road to bypass National Road No.13 will be introduced along the north-eastern side of the river
- No rerouting of the railway will be planned, but the area on the southern side of the railway will be designated as the industrial promotion zone, where construction of factories and other non-residential facilities are encouraged but new construction and/or major renovation of residential facilities is discouraged or prohibited
- The road to Marrupa will be strengthened to provide better access from the high potential agriculture area, and help form the agricultural product triangle together with Lichinga
- An agro-processing zone will be established to support the increase of the value-added portion of the agricultural products from the remote catchment area of the city. The best location may be the junction point of the roads to/from Nampula, Lichinga, and Marrupa
- A shunting yard will be constructed at the eastern end of the city along the railway to enhance the capacity for handling goods to and from Nacala



Colour	
	Industry
	Traffic Facility
	Residential

Source: JICA Study Team

Figure 16.3.1 Conceptual Spatial Structure of Cuamba City Development

16.3.5 Supporting Water Resources for Cuamba City

There will be a shortage of urban water against the demand generated between 2029 and 2035 based on the existing plan of water supply. To cope with this, the ASNANI is planning to improve

Mepopole Dam as a first step. Construction of Mecuca Dam and Chichemunda Dam is recommended and preparation needs to be initiated. Further study and analysis for IWRM development is also recommended.

16.3.6 Issues, Objectives, Strategies and Projects for Urban Development of Cuamba City

(1) Issues on Urban Development of Cuamba City

Considering the existing conditions and the future vision for urban development of Cuamba City as the “Inland Regional Logistics and Industrial Centre”, the following issues are identified for strategy formulation for Cuamba City:

- Difficulty to manage through traffic on roads because the upgraded trunk road (National Road No.13) runs through the central area of the city
- Physical divide of urban areas by two railway lines: namely, Northern Railway (to be upgraded for coal transport) and Lichinba-Cuamba Railway Line (to be rehabilitated)
- Limited land for urban expansion due to the river running on the north side of the exiting urban area
- Weak infrastructure base for future economic development including manufacturing sectors

(2) Objectives for Urban Development of Cuamba City

In order to achieve the vision for Cuamba City as the “Inland Distribution and Service Delivery Centre”, the following objectives are set:

- **Objective 1:** To strengthen the transportation hub function for inland areas
- **Objective 2:** To improve the urban spatial structure
- **Objective 3:** To strengthen the industrial base

(3) Strategies for Urban Development of Cuamba City

In order to achieve the objectives identified above, the following strategies should be implemented:

Objective 1

- To strengthen integration of Cuamba City with surrounding agricultural-forestry areas by improving the roads
- To strengthen the cargo terminal function at Cuamba City for the Nacala Corridor

Objective 2

- To expand residential areas by constructing a bypass road for National Road No. 13
- To develop industrial and logistics areas in the southern part of the city

Objective 3

- To establish an agro-processing industrial park

(4) Projects for Urban Development of Cuamba City

In order to achieve the identified objectives and to implement the proposed strategies above, the following projects are proposed:

Short-Term (-2017)

- Road Bypass Project
- Truck Terminal Project
- Southern Area Land Use Conversion Programme (from residential area to industrial area)

Medium-Term (2018-2025)

- North-eastern Residential Area Expansion Project
- Agro-processing Industrial Park Project (pulp, agricultural products etc.)

16.3.7 Urban Water Supply for Cuamba City

(1) Future Prospects on Urban Water Supply for Cuamba City

Cuamba City is expected to become an Inland Regional Logistics and Industrial Centre taking advantage of the corridor railways and roads to Malawi, as well as important feeder roads to Lichinga and Marupa. Stable water supply to the urban population and economic activities is essential for promoting such urban centre development. To supply water for the future urban population for Cuamba City, the future demand for urban water supply is estimated as shown in Table 16.3.4.

Table 16.3.4 Summary of Urban Water Supply Demand for Cuamba City

		2013	2017	2025	2035
Demand (m ³ /d)	Domestic and Small Business	Water Supply Volume after rehabilitation of existing source(m ³ /d)	4,358	12,257	22,854
	Industrial Area (Light Industry)		7,800	32,000	52,000
	Total		11,000	12,158	44,257

Source: JICA Study Team

(2) Issues on Urban Water Supply for Cuamba City

Considering the existing conditions and the future vision for urban development of Cuamba City, the following issues are identified for strategy formulation on urban water supply for Cuamba City:

- Current shortage of water resources available for urban water supply for the present populations, as well as for the future populations
- Relatively poor service level of water supply for the present populations
- Poor level of urban water supply to attract investors for the manufacturing sectors in the future

(3) Objectives for Urban Water Supply for Cuamba City

The objective for the urban water supply for Cuamba City is as follows:

- To secure the service level of urban water supply for supporting the development of commerce-business, government administration and industry as the Inland Regional Logistics and Industrial Centre.

(4) Strategies for Urban Water Supply for Cuamba City

The following strategies are to be implemented for achieving the objectives above:

- To fully utilize existing water resource facilities and water supply facilities

- To reduce Non-Revenue Water (NRW) and to increase water volume to be supplied for achieving healthier management of the water company
- To expand the service areas for urban water supply and at the same time to conduct water demand management by restricting the increasing number of house connections
- To supply water to the central area of Cuamba City at a higher service level than for other areas, for supporting the development of the Inland Distribution and Service Delivery Centre

(5) Projects for Urban Water Supply for Cuamba City

In order to implement the proposed strategies above, the following projects are proposed:

Short-Term (-2017)

- Project for Raising the Height of the Dam (4m)

Medium-Term (2018-2025)

- Project for Development of a Water Treatment Plant (to treat water from the new dam to supply treated water to Cuamba City) and Water Pipeline (for transmission of treated water to Cuamba City)
- Project for Strengthening of the Water Distribution System of Cuamba City (for utilizing the water from the new dam)

Long-Term (2025-2035)

- Project for Development of a Water Treatment Plant (to treat water from another new dam to supply treated water to Cuamba City) and Water Pipeline (for transmission of treated water to Cuamba City)
- Project for Strengthening of the Water Distribution System of Cuamba City (for utilizing the water from another new dam)

16.3.8 Sewerage and Drainage Systems for Cuamba City

(1) Future Prospects on Sewerage and Drainage Systems for Cuamba City

The present situations in Cuamba City of sanitation, sewerage and drainage are far behind the desirable situations. However, in order to promote the vision of Inland Distribution and Service Delivery Centre, the development of sewerage and drainage systems should be an essential part of urban development.

(2) Issues on Sewerage and Drainage Systems for Cuamba City

Considering existing conditions and the future vision for urban development of Cuamba City, the following issues are identified for strategy formulation on sewage and drainage systems for Cuamba City:

- Currently there is no modern sewerage system in Cuamba City
- Poor management and utilisation of septic tanks due to the lack of septage treatment facilities
- Inadequate level of sanitation situation, sewerage and drainage systems to attract investment for establishing an Inland Regional Logistics and Industrial Centre

(3) Objective for Sewerage and Drainage Systems for Cuamba City

The objective to develop sewerage and drainage systems for Cuamba City is as follows:

- To create a sanitary environment and to reduce the occurrence of waterborne diseases for increasing urban population and expanding urban areas in order to make Cuamba City an Inland Regional Logistics and Industrial Centre.

(4) Strategies for Sewerage and Drainage Systems for Cuamba City

The present situations of sanitation, sewerage and drainage are far behind the desirable situations in Cuamba City. Under this circumstance, the following overall strategies for sewerage and drainage systems for Cuamba City are identified:

- To make effort at promoting the utilisation of safe sanitation facilities for the short term
- To establish treatment ponds for septage for Cuamba City for the medium term
- To establish treatment ponds for septage and sewerage systems and drainage systems for the central areas for Cuamba City in the long term

(5) Projects for Sewerage and Drainage Systems for Cuamba City

In order to achieve the identified objectives and to implement the strategies proposed above, the following projects are proposed:

- Promotion of utilisation of low-cost sanitation facilities in peri-urban areas (suburban areas)
- Preparation of the project for treatment ponds for storage and treatment of septage from septic tanks/pit-latrines

Medium-Term (2018-2025)

- Study on and implementation of collection systems and institutional frameworks for septage from septic tanks and pit-latrines
- Construction of treatment ponds for storage and treatment of septage from septic tanks/pit-latrines
- Preparation of the project for a sewerage system and drainage system for the central area and industrial zones (detailed design and bidding documents)

Long-Term (2026-2035)

- Construction of a sewerage system and drainage system for the central area (cement city) and industrial zones
- Implementation of regular maintenance of septic tanks

16.4 Urban Development Strategies for Other Major Urban Centres

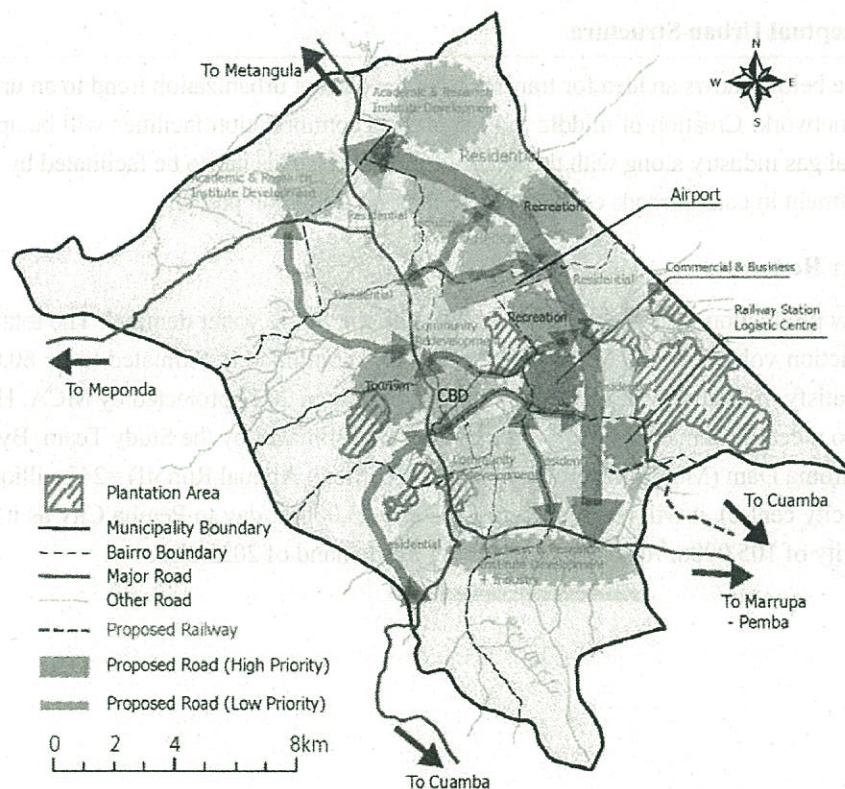
16.4.1 Lichinga Municipality

(1) Directions of Development

The rapid population growth of the city has been bringing deterioration of the urban environment mostly caused by expansion of informal settlement areas. It is desired to transform the current ribbon type sprawl to one forming an area of urban space with a grid of secondary roads. To realize this in a small city with limited financial capacity, it will be effective to introduce some work space to trigger the transformation to urbanization. The work place in the case of Lichinga may be a processing factory or a research centre matching the character of the city, such as forest and agriculture. As there is a university dedicated to the study of these fields, further accumulation of research functions may be a key to create an industrial base of the city and surroundings.

(2) Conceptual Urban Structure

The figure 16.4.1 shows an idea for transforming the current linear urbanization into an urban space with hierarchical road network. The key to kick start the plan is to invite work place to the designated areas which are located apart from the present major roads.



Source: JICA Study Team

Figure 16.4.1 Conceptual Drawing to Transform Spatial Structure for Lichinga Municipality

(3) Supporting Water Resources

Locumue Dam (or Mini Cabora Dam) is located on the Locumue River about 8 km from the city centre. The water supply capacity of this reservoir is 5,000m³/day, which is insufficient to meet the future water demand of 31,800m³/day in 2029 estimated by MCA or 68,000m³/day in 2035 estimated by the Study Team. No development of a groundwater aquifer can be expected in or around Lichinga City. Development of Mbahu Dam, located on Lucheringo River, is recommended to ensure the future water source by an ASNANI Study (2008). However, it may satisfy only mid-term water demand of 33,000 m³/day projected by MCA. Consequently, development of new water sources will be required downstream, located 30 to 50km from Lichinga City.

16.4.2 Pemba Municipality

(1) Directions of Development

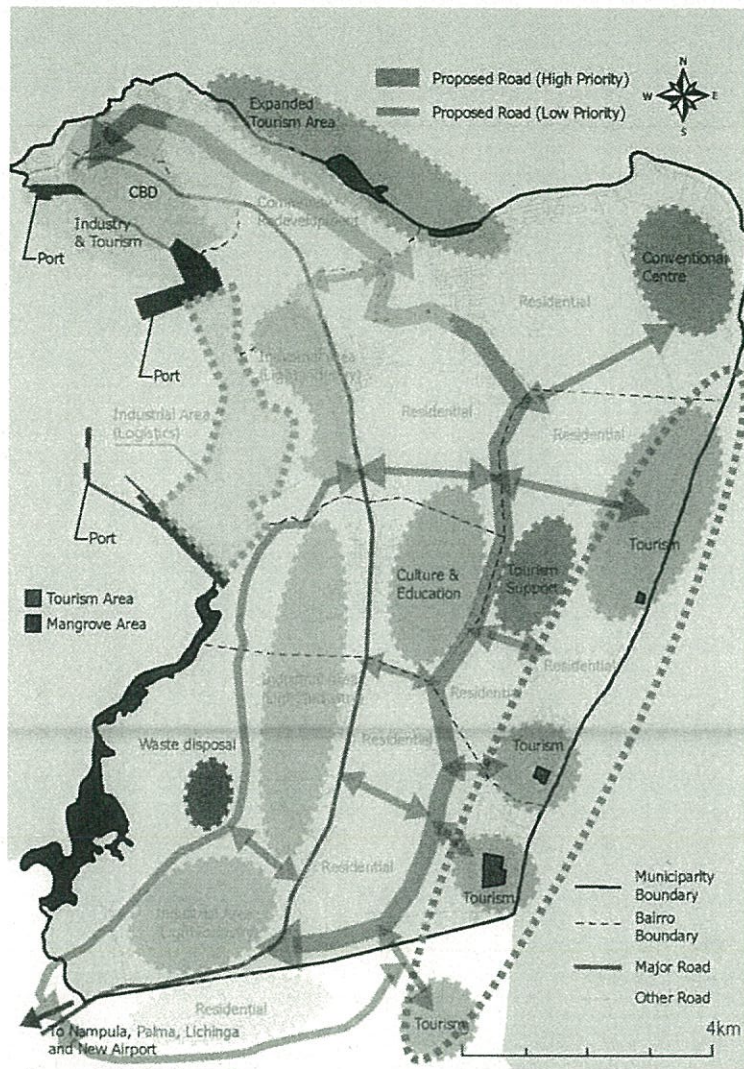
Pemba is also experiencing a rapid population growth and with an expansion of informal settlements. It is necessary to develop new residential areas to form an urban space with secondary road network. As one of the growing economic bases of the city, it is necessary to enhance the tourism industry and attract more visitors to the territory. In addition, because it is expected that the natural gas extraction industry of Palma will start in 2018, Pemba needs to function as a base city for the industry for some time to come.

(2) Conceptual Urban Structure

Figure below shows an idea for transforming the current urbanization trend to an urban space with a road network. Creation of middle to high class accommodation facilities will be appreciated by the natural gas industry along with the coastal resort areas. This has to be facilitated by the public sector investment in coastal roads connecting the tourism attraction points.

(3) Water Resources

A new production well is proposed to cope with the future water demand. The total of groundwater production volume of the existing and new wells combined is estimated to be 60,000m³/day. This will satisfy the future water demand of 40,500m³/day in 2029 projected by MCA. However, it is not able to meet the demand of 63,000m³/day in 2035 estimated by the Study Team. By development of Megaruma Dam (Monitoring point E152: MAR (Mean Annual Runoff) =247million m³/year, 80km from city centre), it will be able to supply some 45,000m³/day to Pemba City as it will have a total capacity of 105,000m³/day. This will satisfy the demand of 2035 also.



Source: JICA Study Team

Figure 16.4.2 Conceptual Plan to Transform Spatial Structure for Pemba Municipality

Chapter 17 Environmental Management Strategies

17.1 Future Prospects of the Environmental Management

Various types of support have been given for establishing environmental management systems and environmental administration in Mozambique by development partners, including human resources development. However, the situations surrounding Mozambique has been rapidly changing and the present structure of the environmental administration and management systems are not suitable for responding to the newly emerging situations.

In fact, in the Nacala Corridor Region, coal extraction in Tete and coal transport from Tete to sea ports will be enormously increased, resulting in not only resettlement but also many other environmental problems. Off-shore extraction of natural gas will also be expanded in Cabo Delgado Province at an unprecedented level, which might increase the risk of deterioration of the sea water and coastal environment. The implementation of mega projects will require environmental monitoring to cover the wide areas likely to be influenced by those mega projects.

Manufacturing operation is also expected to increase largely in Nacala and other major urban centres. Therefore, the number of EIA applications and the needs for monitoring of their production and operation and the implementation of their Environmental Management Plans would be very much increased.

17.2 Issues on the Environment Management

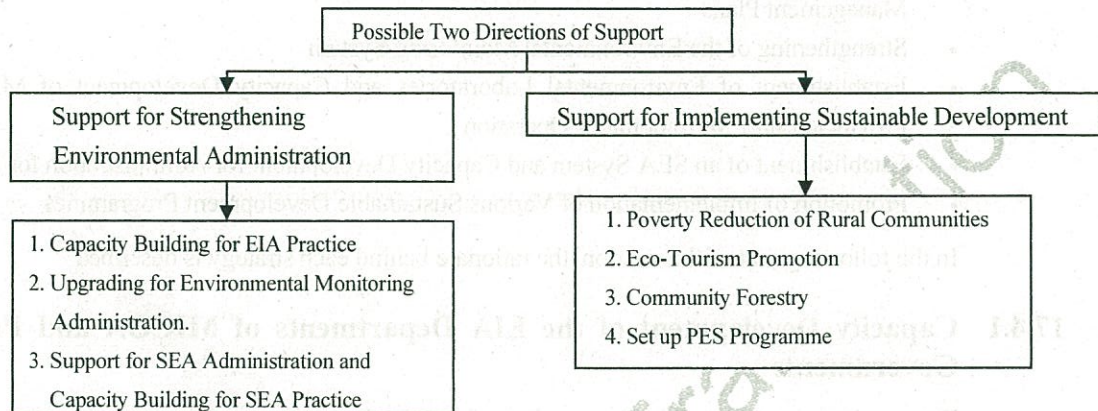
Although various laws and regulations have been established, actual implementation and capacities for implementation of environmental management activities stipulated by those laws and regulation are inadequate. The capacities addressed above include not only of the number of staff and capacity of staff, but also equipment, buildings and motor vehicles and sufficient budgeting. Though the issues to be defined below are common to other provinces and at the national level, the situation is particularly serious in the Nacala Corridor Region.

Considering the existing conditions and future prospects in the Nacala Corridor Region, the following issues are defined for environmental management:

- Shortage of well-trained staff for administrating EIA in the MICOA and its provincial directorates, especially those for monitoring and guiding the implementation of environmental management plans
- Shortage of well-equipped facilities and well-trained technical staff for environmental monitoring and conducting laboratory tests in the MICOA and provincial governments
- High necessity of comprehensive establishment of the SEA administration and preparation of appropriate environmental considerations at an earlier planning stage while establishing policies/programmes and/or project consensus among various stakeholders
- High necessity for implementing sustainable development programmes, especially for rural people

17.3 Objectives for the Environmental Management

There are broadly two basic directions of support to environmental management as shown in Figure 17.3.1. One is the support to the environmental administration for controlling and managing various development projects. The other is the support to promotion of sustainable development.



Source: JICA Study Team

Figure 17.3.1 Two Basic Directions of Support to Environmental Management

The overall objective for the environmental management in relation to Nacala Corridor regional development is to effectively utilize the existing systems (including laws, regulations and procedures) for environmental management by strengthening the capacity of the administrative and technical organisations and their personnel. For identifying the objectives for environmental management for Nacala Corridor regional development, it is necessary to pay careful attention to environmental problems that may arise due to the characteristics of Nacala Corridor regional development, as well as the problems generally found in the government administration.

The following objectives are identified for environmental management for Nacala Corridor regional development:

- To effectively utilize EIA systems including monitoring of implementation of environmental management plans submitted by projects
- To monitor the environmental situations and to take necessary actions in a timely manner
- To develop the capacity of MICOA and provincial governments to examine environmental impacts
- To mainstream the concept of environmental management into the sector development plans at an earlier stage of development planning
- To pay much attention to environmental aspects which are special to the Nacala Corridor Region

17.4 Environment Management Strategies

In order to achieve the above identified objectives, the following strategies for environmental management should be implemented:

- Capacity Development for EIA including Monitoring of Implementation of Environmental Management Plans
- Strengthening of the Environmental Monitoring System
- Establishment of Environmental Laboratories and Capacity Development of MICOA and Provincial Staff for Laboratory Operation
- Establishment of an SEA System and Capacity Development for Administration for SEA
- Promotion of Implementation of Various Sustainable Development Programmes

In the following part of this section, the rationale behind each strategy is described.

17.4.1 Capacity Development of the EIA Departments of MICOA and Provincial Governments

Due to the recent bursts in the number of applications for environmental approvals for many projects, created by national and foreign investments, MICOA and provincial environmental departments are not able to examine the environmental impact assessments in an appropriate manner due to lack of their capacity. Moreover, it is difficult to conduct coordination in order to harmonize different projects under the long-term national and regional development strategies.

The EIA system is composed of 1) examination of environmental impact assessment (EIA) studies and processes and 2) monitoring and evaluation of implementation of environmental management plans (prepared by the EIA studies). Currently, the MICOA and provincial environmental departments have been overwhelmed with the work for examination of the EIA studies and processes. They cannot cope with monitoring and evaluation of the implementation situation of environmental management plans (EMPs). In Mozambique, since more development projects will be at the stage of implementation, MICOA and the provincial environmental departments should allocate their workforce to the monitoring of EMPs.

17.4.2 Upgrading for Environmental Monitoring Administration

Currently, MICOA does not own its own laboratory and/or institution for the environmental monitoring and/or inspection. Whenever it is required to carry out chemical analyses for collected water, soil and/or air samples, those analyses are conducted at laboratories of other institutions and/or schools that sometime do not have proper expertise and/or experience. When accurate and reliable test results are required, those samples are delivered to laboratories in Johannesburg, South Africa. This cross border environmental analysis takes a lot of time and money, and eventually does not catch up with the pace of requests for environmental audits, mandatory in all EMP of development projects.

Also, it would be beneficial if there would be MICOA's own environmental laboratory in order to implement a comprehensive regional environmental monitoring policy. One important aspect of the capacity development of the environmental audit is to accumulate insight and expertise to be obtained through frequent on-site measurements/or sampling and analyses of those results at the

laboratory. By repeating this process, it would be possible to continue self-sustaining environmental management in the long-term period. To achieve this goal, it is imperative to establish their own laboratories and obtain the necessary equipment and initiate intensive OJT training in the field.

What may be even more important for the environmental management at urban and rural sites is to continue long-term monitoring activities and create a reliable database. It would be beneficial to make this database accessible to the public and any organisations and/or groups that are interested by putting it in the public domain. Table 17.4.1 summarizes the outline of this hardware upgrading support for the environmental audit administration.

Table 17.4.1 Outline of Establishment of Environmental Laboratories

<p>Objectives: Set up of Environmental Laboratories at strategically-key sites.</p>
<p>Candidate Sites:</p> <ol style="list-style-type: none"> 1. Maputo (Headquarters) 2. Tete (Intensive Coal Exploitation) 3. Nampula (Growing Nacala SEZ) 4. Pemba (Intensive Natural Gas Exploitation)
<p>Functions:</p> <ol style="list-style-type: none"> 1. Conduct environmental analyses such as air quality, water quality, noise/vibration, soil and sediment and others 2. Create a database to store monitoring data 3. Develop regional environmental management policy and/or programme.

Source: JICA Study Team

17.4.3 Establishment of Strategic Environmental Assessment (SEA) System and Capacity Development for SEA Administration

Strategic environmental assessment (SEA) is a system of incorporating environmental considerations into policies, plans, programmes and strategies at the early planning stage. Recently, decision-making regarding large-scale development projects is increasingly being provided through strategic-level interventions aimed to make projects more effective and sustainable. SEA meets the need to ensure environmental considerations are taken into account in this new context.

The environmental legal framework of Mozambique is still in a rapid development stage, and the central and local environmental administrations are facing new challenges to meet the torrential inflow of investments.

Currently, MICOA is preparing the draft of an SEA Law, and will take more time in order to seek out a suitable SEA framework for Mozambique. SEA is a useful tool to manage and coordinate many potential development policies, strategies and projects at a very early stage of the project cycle.

In that sense, it is important to support the establishment of the SEA system including SEA law and actual SEA procedures. It is also important to support effective implementation of SEA studies and processes for long-term development efforts for the mining sectors of coal and natural gas.

Within the SEA framework, all development projects are to be examined and evaluated, and then, some of them would be required to modify partially and/or to be aborted based on those evaluation results. The establishment of a new agency and/or department responsible for SEA administration, directly belonging to the Office of President would be one option in order to properly and

effectively implement the rulings that will be derived from the SEA study results. Otherwise, from the hierarchical point of view, MICOA would continue to be the same as the other line ministries. So it may take inter-ministerial coordination efforts and would take extensive discussions to reach an agreement.

17.4.4 Support for Promotion of Sustainable Development

(1) Poverty and the Environment

Although Mozambique was devastated during the past long civil war, it still boasts colourful terrestrial and marine biodiversity across the country, and most rural communities' lives therein highly depend on the rich natural resources such as timber and non-timber products. Forest coverage is about 50 %, and poverty reduction in the rural parts of Mozambique is one of the urgent tasks to be achieved.

In this sense, Poverty-Environmental Initiative (PEI) activities are suitable for Mozambique's situation. In fact, recently, several poverty reduction pilot programmes such as PEI were initiated, and proved that comprehensive measures focusing on the interaction between poverty and the environment across rural parts of Mozambique such as PEI are useful tools to improve sustainable development. It is necessary to promote the PEI projects in the Nacala Corridor Region.

(2) Promotion of More REDD+ and/or PES-based Projects

Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to create a financial value for the carbon stored in forests, thus offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. "REDD+" goes beyond the deforestation and the forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

As mentioned earlier, about 80% of Mozambique's population live in rural areas and depend on wood for their daily lives while nation-wide forest cover is almost 50 %, but is being reduced gradually. This indicates that the REDD+ and/or PES-based community support programmes would play vital roles to improve their incomes under certain conditions. In general, REDD+ and/or PES-based community support projects contain concepts similar to PEI.

Payments for ecosystem services (PES), also known as payments for environmental services, is the practice of offering incentives to farmers and/or landowners in exchange for managing their land to provide some sort of ecological service including the carbon sequestration. There are many small-scale farmers across the northern part of Mozambique and most of them use traditional agricultural methods. Therefore, some kinds of PES programmes would have the potential to lead to poverty reduction as well as regional ecosystem conservation although the successful implementation of those programmes needs concerted efforts using multi-sector approaches.

A variety of PES mechanisms exist, but significant challenges remain to upscale PES so that substantial resources can be raised for protected areas. New approaches to mapping "natural capital" and valuing ecosystem services have been applied in Mozambique. However, in the absence of accurate and comprehensive data, it is likely that conservation areas' contribution to Mozambique's natural capital is being undervalued. Although economic valuation tools can show potential values of ecosystem services provided by different land uses, the analysis of the legal

framework and the market for a particular ecosystem service is needed to determine whether it is feasible for protected area financing. Also, it is important that the design, implementation and priorities of those programmes shall be right. Otherwise, it could cause severe negative natural and social impacts.

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17.5 Programmes and Projects for Environmental Management

For the purpose of implementing the above strategies on environmental management, the implementation of the following projects is required:

- (1) Projects for Capacity Development for EIA including Monitoring of Implementation of Environmental Management Plans**
 - Capacity Development for EIA (including increase in the number of staff and the capacity of the staff)
 - Capacity Development for Monitoring of Implementation of Environmental Management Plans (including improvement of laws, regulations and procedures for environmental inspection, increase in the number of inspection officers, and improvement of staff capacity)
- (2) Projects for Strengthening of the Environmental Monitoring System**
 - Development of an Inspection System covering Factories and Large-scale Development Projects
 - Development of fixed observation or sampling points for environmental monitoring
- (3) Projects for Establishment of Environmental Laboratories and Capacity Development of MICOA and Provincial Staff for Laboratory Operation**
 - Establishment of Environmental Laboratories in Maputo, Nampula, Tete and Pemba
 - Capacity Development of Technical Staff
- (4) Projects for Establishment of SEA System and Capacity Development for Administration for SEA**
 - Establishment of Operational Procedures for SEA
 - Capacity Development for SEA (increase in the number of staff, improvement of staff capacity and implementation of activities for promoting SEAs)
- (5) Projects for Sustainable Development**
 - Rural Development Projects for a Sustainable Environment
 - Community Forestry Projects
 - PES Programme
 - Eco-Tourism Projects