Chapter 4 Traffic Demand Forecast for the Study Road

Chapter 4 Traffic Demand Forecast for the Study Road

4.1 Data Gathering

4.1.1 Historical Traffic Data Counted by ANE

Latest traffic counts conducted by ANE in 2005 are shown in Figure 4.1.1 and Table 4.1.1. According to this data, 50 to 272 veh/day (totaling both directions) were recorded between Nampula and Cuamba, and 7 to 64 veh/day were recorded on the vicinal roads.

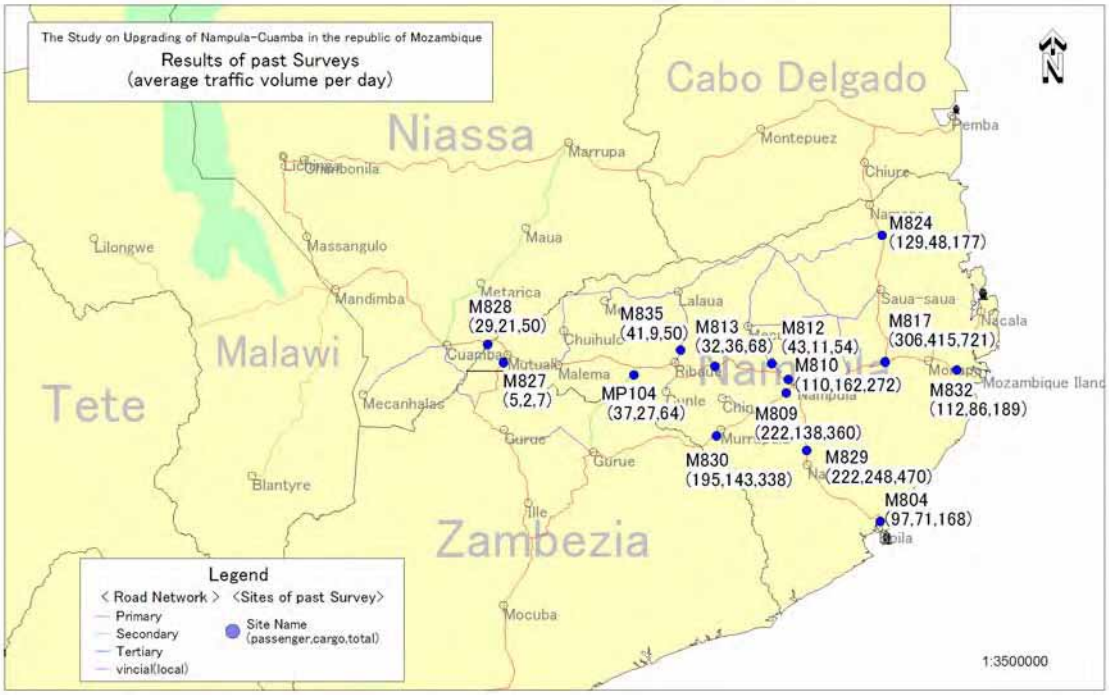


Figure 4.1.1 Traffic Volume of past Survey Results (Source: ANE, in 2005)

Table 4.1.1 Traffic Volume Survey Results in 2005

Road No.	Site	The latest volume [veh/12h]		
		Light Vehicle	Heavy Vehicle	Total
N1	M808	47	55	102
	M809	222	138	360
	M817	306	415	721
	M818	71	136	207
	M824	129	48	177
	M830	195	143	338
N13	M810	110	162	272
	M813	32	36	68
	M828	29	21	50
N103	M827	5	2	7
N104	M804	97	71	168
	M829	222	248	470
N105	M821	186	38	224
	M832	112	86	189
N326	M104	37	27	64
R694	M835	41	9	50
R696	M812	43	11	54

Source: ANE, in 2005

4.1.2 Seasonal Variation

The data for seasonal variation of the traffic counts were obtained through the Traffic Counting Manual prepared by SweRoad for DNEP (1996). Table 4.1.2 below gives the seasonally adjusted Average Annual Daily Traffic (AADT).

Table 4.1.2 Average Monthly Traffic as Percentage (95% Confidence Range)

	Maputo	Gaza	Inhambane	Sofala	Manica	Tete	Zambezia	Nampula	Cabo Delgado	Average
January	110.4	118.9	118.9	115.2	115.2	115.2	113.6	111.7	111.7	114.5
February	105.3	109.3	109.3	105.5	105.5	105.5	102.1	96.6	96.6	104.0
March	100.3	97.6	97.6	97.5	97.5	97.5	96.5	94.5	94.5	97.1
April	99.4	87.0	87.0	88.2	88.2	88.2	87.9	85.0	85.0	88.4
May	90.1	82.9	82.9	85.2	85.2	85.2	85.0	84.2	84.2	85.0
June	86.2	83.8	83.8	93.0	93.0	93.0	91.9	93.6	93.6	90.2
July	93.1	98.8	98.8	99.7	99.7	99.7	97.4	95.4	95.4	97.6
August	89.4	97.5	97.5	94.0	94.0	94.0	98.4	105.0	105.0	97.2
September	94.7	102.8	102.8	96.2	96.2	96.2	100.9	106.4	106.4	100.3
October	103.1	105.2	105.2	98.8	98.8	98.8	101.6	103.4	103.4	102.0
November	117.8	109.0	109.0	115.9	115.9	115.9	115.6	116.2	116.2	114.6
December	110.2	107.1	107.1	110.9	110.9	110.9	109.3	108.0	108.0	109.2

Source: "SWEROAD-DNEP Traffic Counting System User Manual"- 1996

4.1.3 Cross Border Traffic

The traffic volume data and the origin-destination matrix at the border crossing between Mozambique and Malawi were obtained from the pre-feasibility study for the upgrading of the EN7 (currently classified as the N11) financed by the European Union (EU). These traffic volume surveys were counted by the Malawi National Road Authority in 2004.

The traffic counts are summarized in Table 4.1.3. The table shows that the traffic volume through the Zobue border crossing is the highest of all border posts part of the study.

Table 4.1.3 Cross Border Traffic Volume in 2004

Border	Road		ADT
	Mozambique	Malawi	
Zobue (Tete)	EN7	M6	983
Mandimba (Niassa)	EN13	M3	152
Milange (Zambezia)	EN11	M2	56
Calomue (Tete)	RN304	M1	50
Vila Nova de Fronteria (Tete))	RN300	M1	12

Source: Malawi National Road Authority, in 2004

The origin-destination survey was conducted at the weigh station in Malawi.

The origin-destination information at the Zobue and Milange border crossings are summarized in Table 4.1.4 and 4.1.5, respectively.

Table 4.1.4 Origin-Destination Matrix for weighted Vehicles at Zobue in 2004

Origin	Destinetion (%)						
	Beira	Blantyre	Durban	Harare	Jhb	Lichinga	Lilongwe
Beira	0	23	0	0	0	1	8
Blantyre	2	0	1	1	6	0	0
Capetown	0	0	0	0	0	0	0
Durban	0	2	0	0	0	0	0
Geneva	0	0	0	0	0	0	0
Harare	0	14	0	0	0	0	2
Jhb	0	16	0	0	0	0	9
Lilongwe	1	0	0	0	2	0	0
Mulanje	0	0	0	0	0	0	0
Mutare	0	1	0	0	0	0	0
Mwanza	0	0	0	0	0	0	0
Tete	0	0	0	0	0	0	0
Thyolo	0	0	0	0	0	0	0
Other	0	1	0	0	1	0	0

Origin	Destinetion (%)				
	Machinga	Mulanje	Mzuzu	Nampula	Other
Beira	1	1	0	0	2
Blantyre	0	0	0	0	1
Capetown	0	0	1	0	0
Durban	0	0	0	0	0
Geneva	0	0	0	0	0
Harare	0	0	0	0	1
Jhb	0	0	0	0	1
Lilongwe	0	0	0	0	0
Mulanje	0	0	0	1	0
Mutare	0	0	0	0	0
Mwanza	0	0	0	0	0
Tete	0	0	0	0	0
Thyolo	0	0	0	0	0
Other	0	0	0	0	0

Source: Malawi National Road Authority, in 2004

Table 4.1.5 Origin-Destination Matrix for weighted Vehicles at Milange in 2004

Origin	Destinetion (%)						
	Beira	Blantyre	Gurue	Limbe	Limbuli	Luchenza	Maputo
Beira	0	0	0	0	0	0	0
Chikwawa	0	0	0	0	0	0	0
Gurue	0	6	0	2	0	0	0
Ile	0	0	0	0	0	0	0
Maputo	0	0	3	0	0	0	0
Milange	0	3	0	6	2	0	2
Mocuba	0	2	0	0	0	0	0
Moza	0	0	0	0	0	2	0
Moz'bique	5	2	0	0	0	0	0
Mukuliwa	0	0	0	0	0	0	0
Nampula	0	0	0	0	0	0	0
Quelimane	0	5	0	3	0	0	0
RSA	0	0	2	0	0	0	0
Villa	0	5	0	0	0	0	0
Zimbabwe	0	0	0	0	0	0	0
Total	**5**	**22**	**5**	**11**	**2**	**2**	**2**

Origin	Destination (%)					
	Muloza	Nampula	Quelimane	RSA	Sucoma	Tete
Beira	0	0	2	0	0	0
Chikwawa	0	0	2	0	0	0
Gurue	0	0	0	0	2	17
Ile	0	0	0	0	0	11
Maputo	0	0	0	0	0	0
Milange	0	0	0	0	0	0
Mocuba	0	0	0	0	0	2
Moza	0	0	0	0	0	0
Moz'bique	0	0	0	0	0	0
Mukuliwa	2	0	0	0	0	0
Nampula	0	0	0	5	0	5
Quelimane	0	0	0	0	0	2
RSA	0	0	0	0	0	0
Villa	0	0	0	0	0	0
Zimbabwe	0	5	0	0	0	0

Source: Malawi National Road Authority, in 2004

4.2 Traffic Survey

4.2.1 Objective

Traffic surveys were carried out on the Study road, for the purpose of developing a traffic model which could be used to assess the impact of improvements to the Study Road. The

objectives of the surveys were to gather data on both the scale and pattern of traffic movement.

The survey data was analyzed to determine the existing traffic volume and composition on the Study road. The data was subsequently used, in conjunction with figures for expected economic growth, to forecast, traffic.

4.2.2 Survey Specifications

As shown in Table 4.2.1, six different types of traffic surveys were carried out. Traffic counts were undertaken in the dry season and rainy season during the periods of 18th to 20th Oct. 2006 (1st Survey) and 13th to 15th Nov. 2006 (2nd Survey), respectively.

Traffic counts and Origin and Destination (OD) surveys were carried out at 9 different locations as shown in Figure 4.2.1 below.,

- 24-hour counts (07.00 to 07.00) and OD surveys were carried out at 4 locations at the intersections of major towns and
- 12-hour counts (07.00 to 19.00) were carried at 5 locations at district borders.

The classified counts were taken at 1 hour intervals. Eight vehicle types, shown in Table 4.2.2, were recorded in accordance with the HDM 4 / RED requirements.

Table 4.2.1 List of the Traffic Survey

Type		Period of Survey	Survey place
A	Traffic Intersection Survey (24-hour)	• 3 days (weekday) in Rainy Season • 3 days (weekday) in Dry Season Total 6 days Dry Season: October Rainy Season: November or December	Major Intersections • Nampula • Ribaue • Malema • Caumba
B	Traffic Cross Section Survey (12-hour)	• 2 days (weekday) in Rainy Season • 2 days (weekday) in Dry Season Total 4 days Dry Season: October Rainy Season: November or December	District Borders on the Nacala Corridor (5 sections)
C	Origin and Destination (OD) Survey for Vehicles	• 12-hour survey • 3 days (weekday) in Dry Season	Same point as item A
D	Interview Survey Passengers of Train and Bus Services	• 3 days (weekday) in Dry Season • Extracted Operating Trains and Buses • Passenger Interview Survey	Nacala corridor Section
E	The Northern Mozambique Railway Operation Situation Survey	• Hearing Survey	Railway Company
F	Major Cargo Transportation Company Survey	• Hearing Survey	• Port of Nacala • Custom Service Office in Cuamba

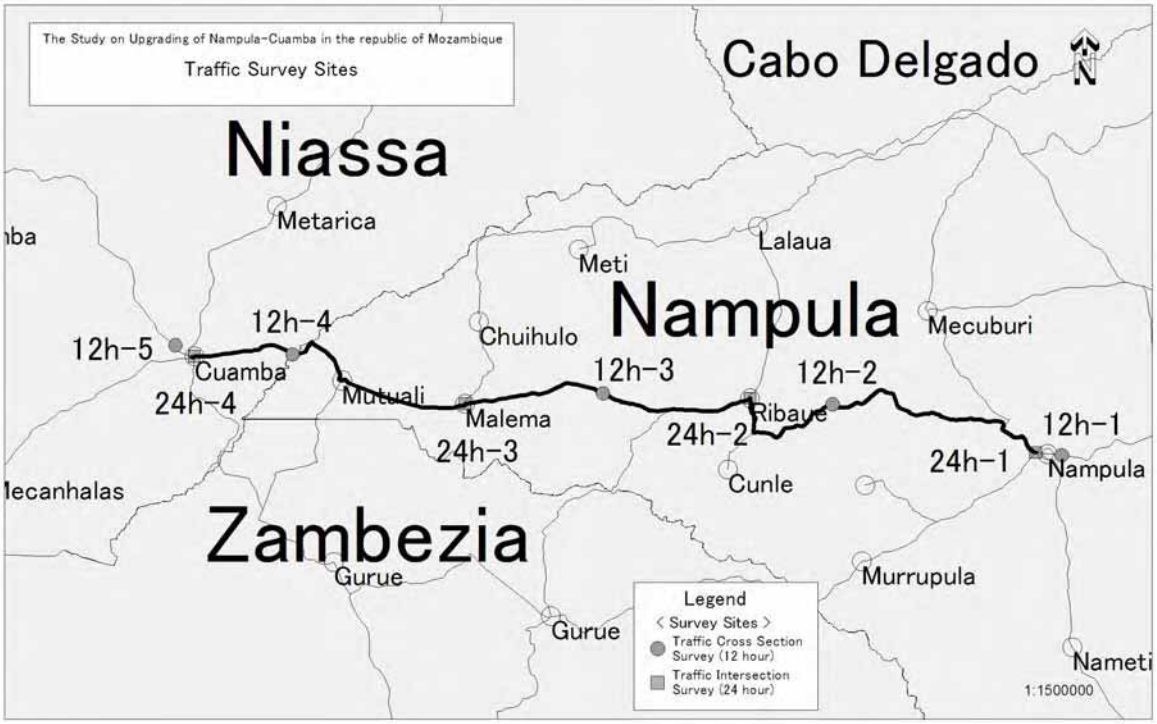


Figure 4.2.1 Traffic Survey Sites

Table 4.2.2 Vehicle classification for the Traffic Survey

Classification		Remarks
LIGHT VEHICLES	Medium Passenger Car – MPC	
	4-Wheel Drive Vehicle – 4WDV	i.e. Toyota Land Cruiser, Land Rover etc.
	Light Goods Vehicle – LGV	Pickups, Vans and Light Trucks (single tire on rear wheels)
	Minibus and Light Bus – LIB	< 20 passengers (single tire on rear wheels)
MEDIUM VEHICLES	Medium / Large Bus – LAB	20+ passengers (double tire on rear wheels)
	Medium Goods Vehicle – MGV	2 axle Truck
HEAVY VEHICLES	Heavy Goods Vehicle – HGV (with or without trailer)	3+ axle Rigid Truck
	Very Heavy Goods Vehicle – VHGV	Articulated Truck/Trailer combination

4.2.3 Traffic Survey Result

1) Aggregate Traffic Count Result

Tables 4.2.3 and 4.2.4 list the results of the 24-hour and 12-hours traffic count surveys at each location, respectively.

Note that site “24h-1” for the 1st survey is different from the 2nd survey, because the 1st

survey point corresponds to the bus stop of the mini-busses that are operated between Nampula city (the terminal is located at the beginning of the N13). Therefore the results of the 1st traffic count at site "24h-1" are not considered for this study.

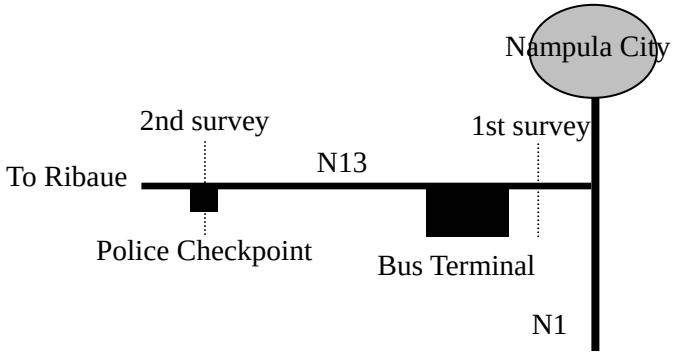


Figure 4.2.2 1st and 2nd Survey Point for 24h-1

Figure 4.2.3 shows the composition of traffic volume for each site of the 1st survey. Note that location "24h-1" was evaluated only for the 2nd survey result.

Roughly 61 % of the total traffic volume comprises of light vehicles at location "24h-1" in Nampula. The share of 4WD vehicles proved to be more than 40% at survey locations "24h-2", "12h-3" and "24h-3" between Malema and Ribaue. This is no doubt due to the poor condition of the road. On the other hand, the share of medium and heavy vehicles was shown to be 63% at the survey location "12h-4" between Malema and Cuamba. This can be explained by the better road conditions between Ribaue and Malema.

Table 4.2.3 24-hour Traffic Survey Result

1st Survey	24h-1	24h-2	24h-3	24h-4
18th.Oct	3,212	106	143	387
19th.Oct	3,076	85	98	339
20th.Oct	3,558	124	166	410
Total	9,846	315	407	1,136
Average	3,282	106	138	390
2nd Survey	24h-1	24h-2	24h-3	24h-4
13th.Nov	552	135	226	343
14th.Nov	447	133	258	504
15th.Nov	360	93	280	412
Total	1,359	361	764	1,259
Average	453	121	255	419

Table 4.2.4 12-hour Traffic Survey Result

1st Survey	12h-1	12h-2	12h-3	12h-4	12h-5
18th.10.Oct	2,384	76	31	128	237
19th.10.Oct	2,059	105	30	157	173
Total	4,443	181	61	285	410
Average	2,222	91	31	146	205
2nd Survey	12h-1	12h-2	12h-3	12h-4	12h-5
13th.Nov	2,345	448	22	101	296
14th.Nov	2,573	439	30	59	294
Total	4,918	887	52	160	590
Average	2,460	444	26	80	295

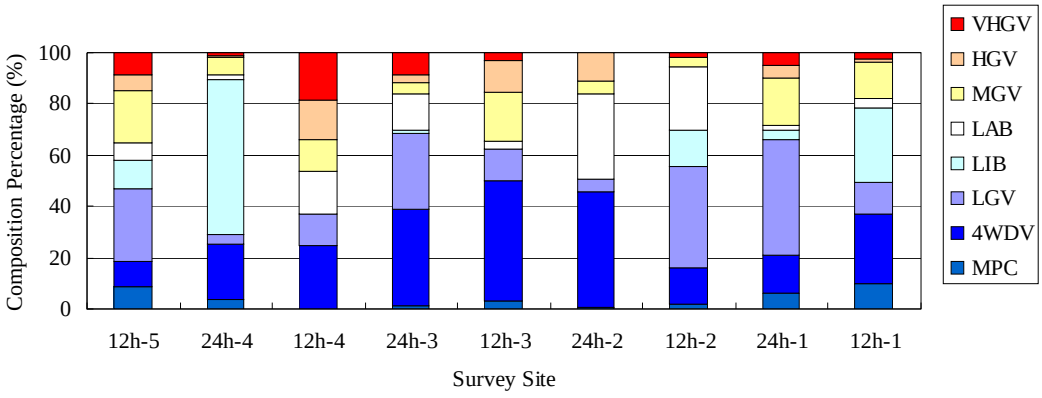


Figure 4.2.3 Vehicle Composition Ratio for 1st survey

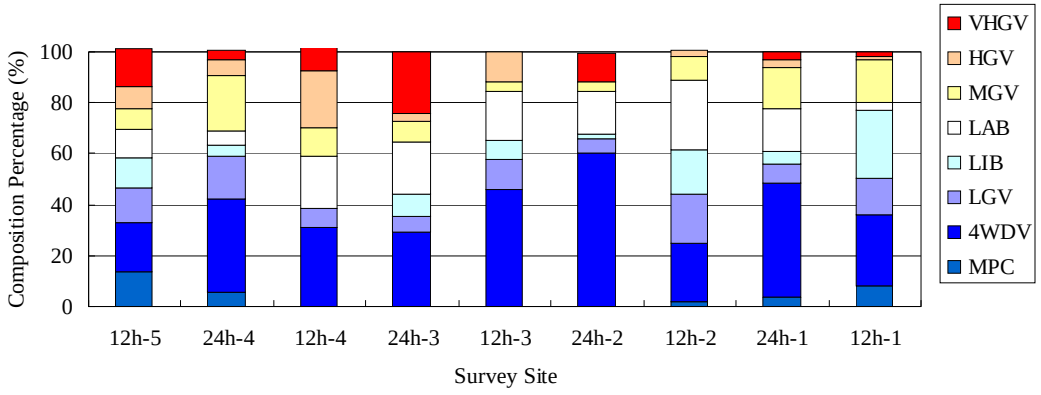


Figure 4.2.4 Vehicle Composition Ratio for 2nd survey

Figures 4.2.5 and 4.2.6 show the hourly profiles over the 12 hour count of the 1st and 2nd survey for each survey location, respectively.

All survey locations, except for "12h-1", display relatively uniform profiles over the survey time. However the location "12h-1" on the N1 tends to have a large variation. Site "12h-1" shows a strong peak in the evening between 16.00 and 18.00 hours.

Figures 4.2.7 and 4.2.8 show the hourly profiles over the day for the 1st and 2nd survey for each location , respectively.

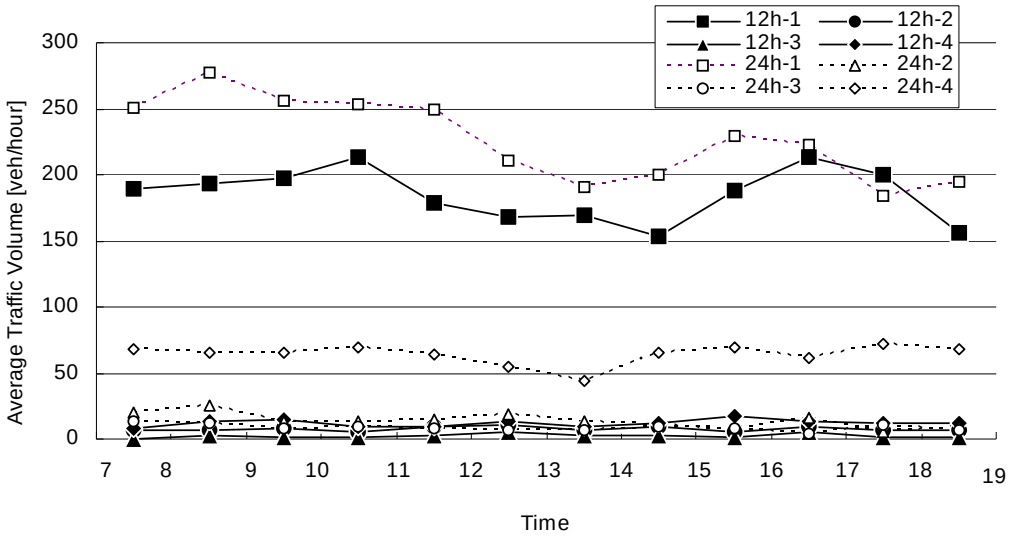


Figure 4.2.5 Hourly Total Traffic Variations 07.00 to 19.00 hours (1st Survey)

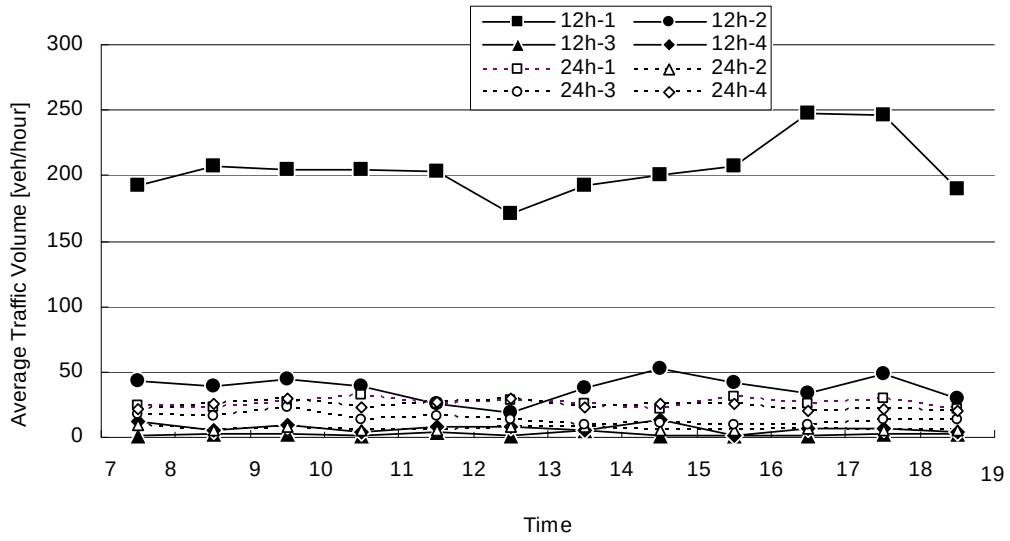


Figure 4.2.6 Hourly Total Traffic Variations 07.00 to 19.00 hours (2nd Survey)

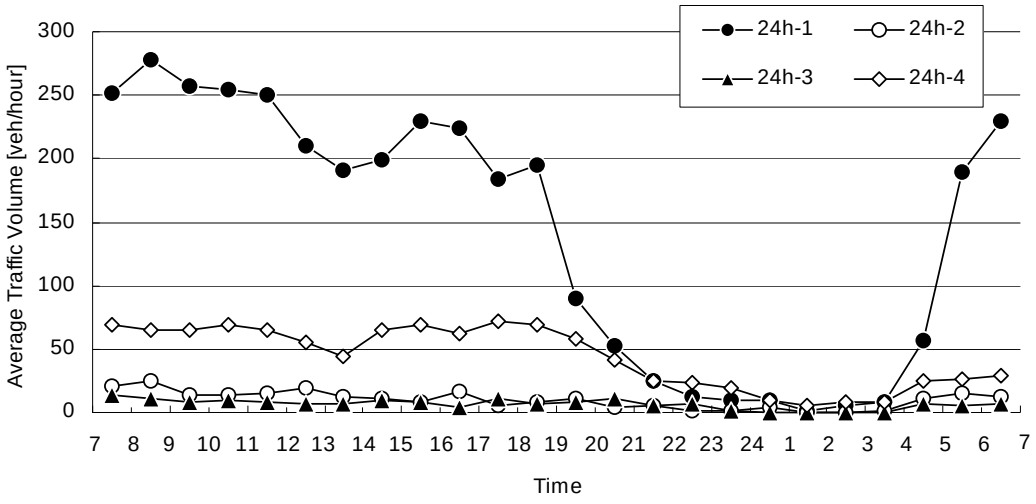


Figure 4.2.7 Hourly Total Traffic Variations Over the Day (1st Survey)

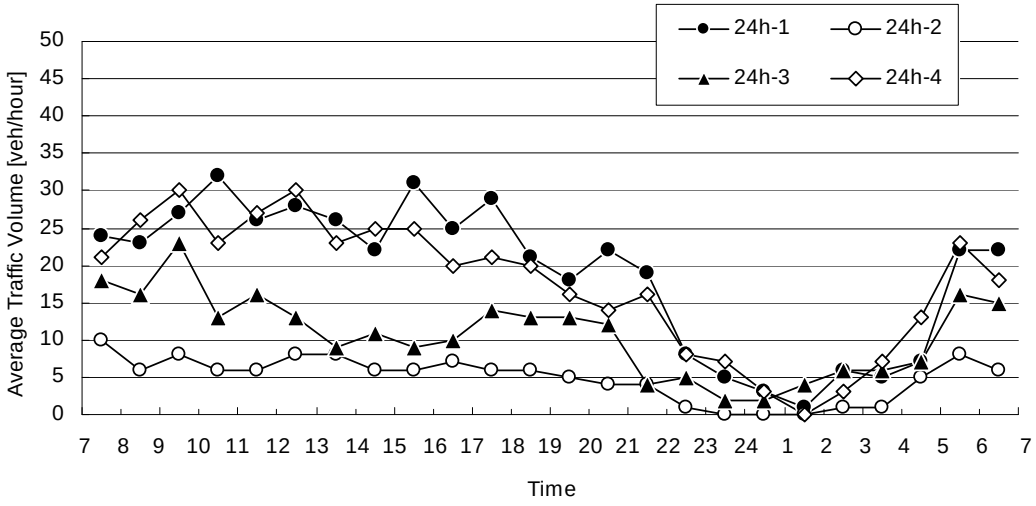


Figure 4.2.8 Hourly Total Traffic Variations Over the Day (2nd Survey)

2) ADT Conversion Factor

Data for the 12-hour surveys should be converted to a 24-hour figure (Average Daily Traffic - ADT) in order to simulate the existing traffic movement. Data for converting 12-hour counts to 24-hour counts is available from this survey, as shown in Table 4.2.5. The conversion factor from 12-hour to 24-hour is 1.28 on average.

The resultant ADT's are shown in Table 4.2.6.

Table 4.2.5 Conversion Factor for 12-hour to 24-hour

	Total	24h-1	24h-2	24h-3	24h-4
7:00 -19:00	3,070	2,619	80	91	280
19:00 - 7:00	844	663	23	47	111
Total	3,916	3,282	106	138	390
Ratio of Daily to Daytime	1.28	1.25	1.33	1.52	1.39

Table 4.2.6 12-hour to 24-hour Conversion

	1st Survey		2nd Survey	
	Average	Converted Daily Traffic	Average	Converted Daily Traffic
12h-1	2,222	2,844	2,460	3,592
12h-2	91	116	444	648
12h-3	31	40	26	38
12h-4	146	187	80	117
12h-5	205	262	295	431

Figure 4.2.9 and 4.2.10 show the ADT of 1st and 2nd survey for each site, respectively.

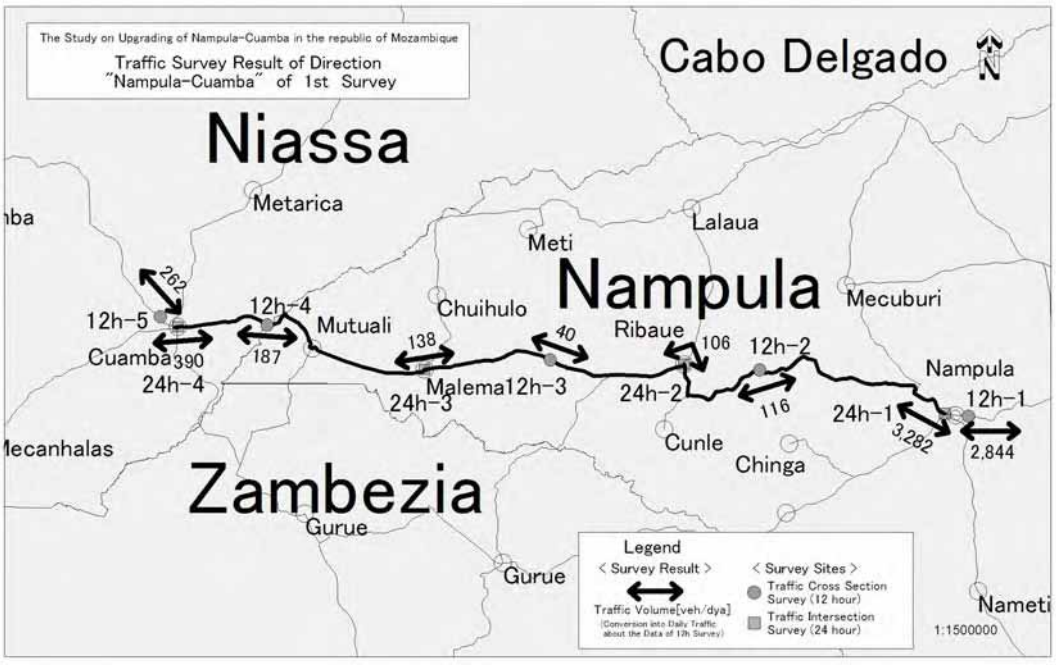


Figure 4.2.9 ADT for 1st Traffic Survey Result

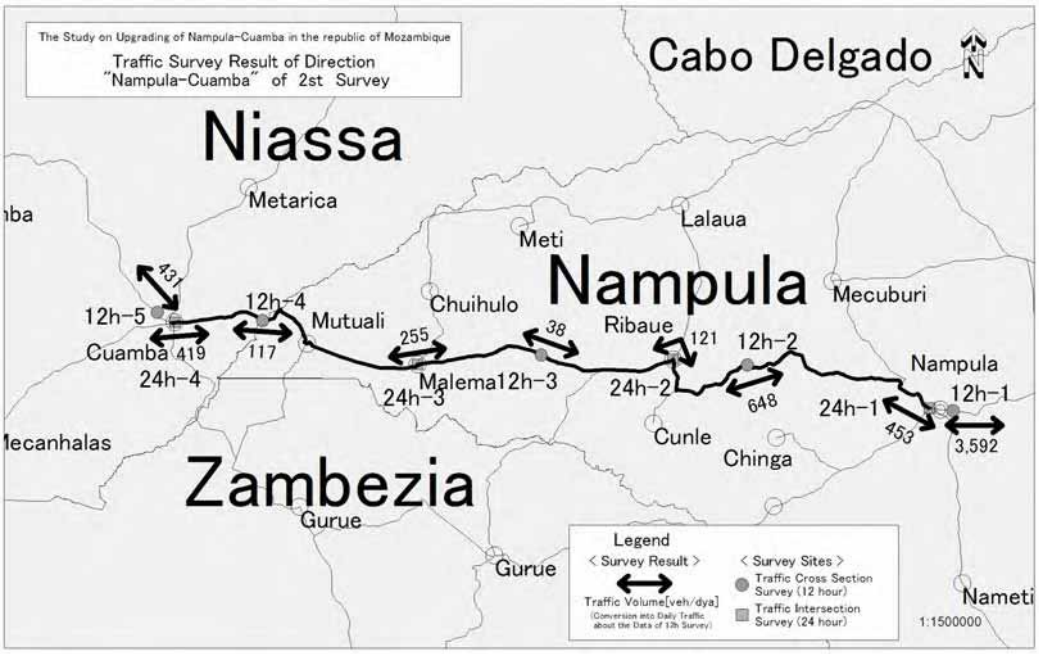


Figure 4.2.10 ADT for 2nd Traffic Survey Result

3) Convert to the Annual Average Daily Traffic (AADT)

The above traffic counts were conducted in October and November. According to the Table 4.2.4, traffic volume in October and November shows a higher traffic volume than the Annual Average Daily Traffic (AADT). Therefore the above ADT should be converted to the AADT based on the seasonal variations as presented in Table 4.2.4.

The resultant AADT's are shown in Table 4.2.7.

Table 4.2.7 Conversion to the Annual Average Daily Traffic (AADT)

Survey Point	ADT		Seasonal Variation		Converted Traffic		AADT
	1st (Oct)	2nd (Nov)	Oct	Nov	1st	2nd	
12h-1	2,844	3,592	1.034	1.162	2750	3091	2921
24h-1	-	453	1.034	1.162	-	390	390
12h-2	116	648	1.034	1.162	112	558	335
24h-2	106	121	1.034	1.162	103	104	103
12h-3	40	38	1.034	1.162	39	33	36
24h-3	138	255	1.034	1.162	133	219	176
12h-4	187	117	1.034	1.162	181	101	141
24h-4	390	419	1.034	1.162	377	361	369
12h-5	262	431	1.034	1.162	253	371	312

4.2.4 Origin and Destination Survey

1) Survey Method and Zoning

The origin-destination surveys recorded the following information: vehicle type, journey purpose, origin, destination, number of passengers, frequency of journey, type of cargo, and the weight of cargo.

Vehicles' origins and destinations were recorded with 17 traffic zones taking into consideration the provincial and district borders, as shown in Table 4.2.8 and Figure 4.2.11.

Table 4.2.8 Origin and Destination to zone coding

Zone No	Place name
1	Nampula
2	Ribaue
3	Malema
4	Cuamba
5	Angoche, Mogincual, Ilha de Moçambique, Meconta, Mogovolas, Moma, Monapo, Mossuril, Muecate, Murrupula
6	Nacala, Nacala_a_velha
7	Erati, Memba, Nacaroa
8	Mecuburi
9	Lalaua
10	Marrupa, Maua, Mecula, Metarica, Nipepe
11	Mecanhelas
12	Mandimba, Ngauma
13	Lichinga, Majune, Muemba, Mavago, Lago, Sanga
14	Alto_Molocue, Gile, Gurue, Ile, Lugela, Namarroi, Pebane
15	Tete
16	Other districts in Mozambique than those mentioned above
17	Malawi

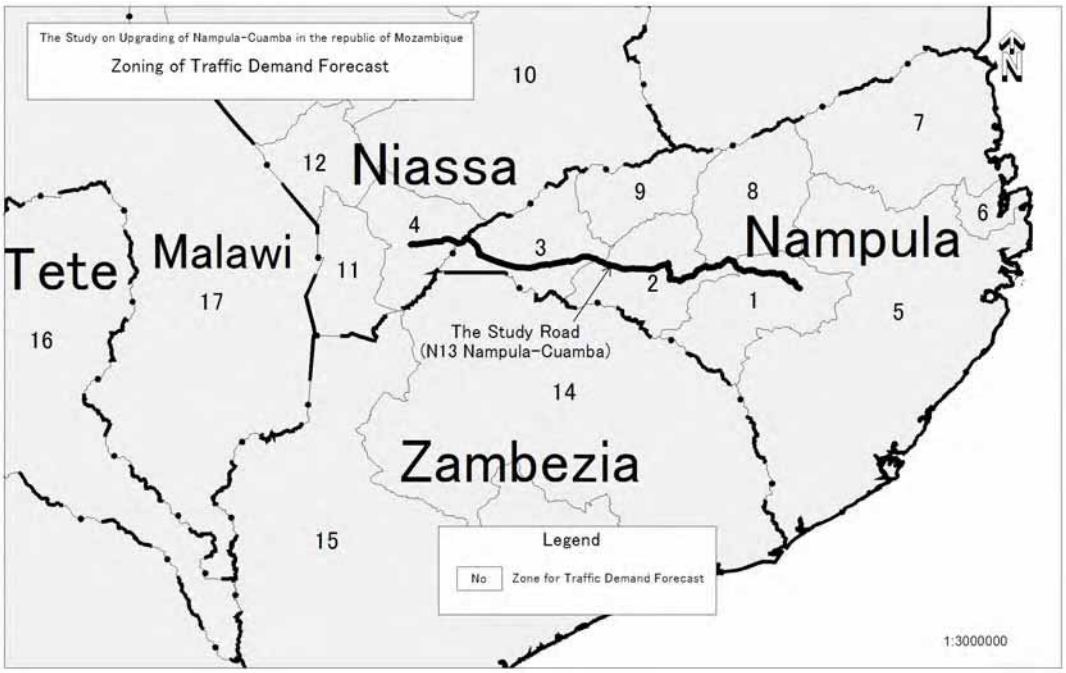


Figure 4.2.11 Zoning of Traffic Demand Forecast

2) Origin and Destination Survey

Table 4.2.9 lists the distribution of the origins and destinations based on the data recorded during the surveys.

Table 4.2.9 OD Table for Existing Vehicle Movement (1 of 2)

Origin \ Destination		1	2	3	4	5	6	7	8	9
		Nampula	**Ribaue**	**Malema**	**Cuamba**	**Monapo**	**Nacala**	**Namialo**	**Mecuburi**	**Lalaua**
1	**Nampula**	34	41	47	15	-	-	2	22	3
2	**Ribaue**	30	5	8	5	-	-	2	-	7
3	**Malema**	21	2	5	-	-	-	-	-	-
4	**Cuamba**	30	7	2	8	-	1	-	3	-
5	**Monapo**	-	-	-	2	-	-	-	-	-
6	**Nacala**	-	-	-	2	-	-	-	-	-
7	**Namialo**	-	-	4	-	-	-	-	-	2
8	**Mecuburi**	27	-	1	-	-	3	-	-	-
9	**Lalaua**	3	6	-	-	-	-	-	-	-
10	**Marupa**	-	-	-	5	-	-	-	-	-
11	**Mecanhelas**	1	-	-	-	-	-	-	-	-
12	**Mandimba**	-	-	-	5	-	-	-	-	-
13	**Lichinga**	1	2	-	15	-	-	-	-	-
14	**Gurue**	13	-	-	3	-	-	-	-	-
15	**others**	7	12	-	9	-	-	-	-	5
16	**Tete**	-	-	-	-	-	-	-	-	-
17	**Malawi**	-	-	-	3	-	-	-	-	-
Total		**167**	**75**	**67**	**72**	**-**	**4**	**4**	**25**	**17**

Table 4.2.9 OD Table for Existing Vehicle Movement (2 of 2)

Origination \ Destination		10	11	12	13	14	15	16	17	Total
		Marupa	Mecanhelas	Mandimba	Lichinga	Gurue	others	Tete	Malawi	
1	Nampula	-	-	-	3	-	-	-	-	**167**
2	Ribaue	-	1	-	1	-	-	-	-	**59**
3	Malema	-	4	-	3	-	-	-	-	**35**
4	Cuamba	3	12	-	4	3	-	-	-	**73**
5	Monapo	-	-	-	-	-	-	-	-	**2**
6	Nacala	-	-	-	2	-	-	-	-	**4**
7	Namialo	-	-	-	-	-	-	-	-	**6**
8	Mecuburi	-	-	-	-	-	-	-	-	**31**
9	Lalaua	-	-	-	-	-	-	-	-	**9**
10	Marupa	-	-	-	-	-	-	-	-	**5**
11	Mecanhelas	-	-	-	-	-	-	-	-	**1**
12	Mandimba	-	-	-	-	-	-	-	-	**5**
13	Lichinga	-	-	-	3	4	2	-	-	**27**
14	Gurue	-	-	-	-	-	-	-	-	**16**
15	others	-	-	-	-	4	-	2	-	**39**
16	Tete	-	-	-	-	-	-	-	-	**-**
17	Malawi	-	-	-	-	-	-	2	-	**5**
Total		**3**	**17**	**-**	**16**	**11**	**2**	**4**	**-**	**484**

Figure 4.2.12 shows the existing demand for the study area. These results indicate that the travel demand between Nampula and Malema is currently the largest in the Study area. On the contrary, demand between Malema and Cuamba is the lowest in this area

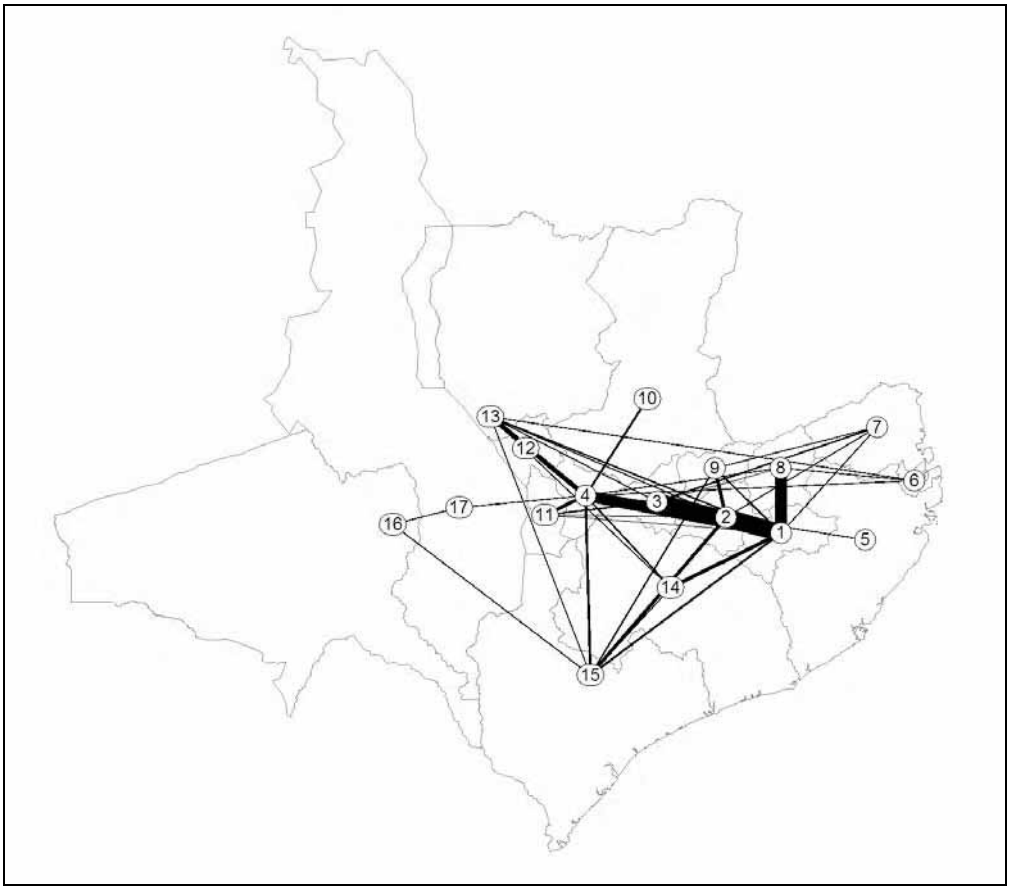


Figure 4.2.12 Existing Movement Demand in the Study Area

4.2.5 Other Survey Results

1) Cargo Transportation Company Survey

This survey interviewed 8 transportation companies (that use the Port of Nacala) about the criteria being used for selection whether to use the railway line or the road connection.

Table 4.2.10 Survey Company List

Company	Owner	Name of the Interviewee and Details
Ismael Sadardine Transports	Ismael Sadardine	Mr. Ismael Sadardine - President of the Association of Transporters of Nampula Province; Member of the Road Commission of Nampula Province.
Pala – pala Transports	Abdula Tarmamad Abdula	Mr. Abdula Tarmamad Abdula - Vice - President of the Association of Transporters of Nampula Province; Member of the Road Commission of Nampula Province.
Adolfo Matias Transports	Adolfo Matias	Mr. Adolfo Matias – The president of the Association of Transporters of Nampula Province; Member of the Road Commission of Nampula Province.
Gulamo Transports	GULAMO GROUP	Mr. Artur Monteiro – Chief of Transport
AMBAR Transports	Barrata da Silva	Mr. Albano Artur Barreiros – Chief of Transport
Helder Meneses Transports	Helder Meneses	Mr. Helder Meneses
Narciso Transports	Narciso	Chief of Transport
MOTTI Transports	Gulamo Motti	Mr. Gulamo Motti

Their opinions show the following trends:

- Transportation cost using the railway line is cheaper than the road. (100%)
- Railway transportation is convenient because of the high density of railway stations. (90%)
- Railway transportation is less secure, but punctuality is better than the road connection. (90%)

2) Railway Passenger Interview

This survey also interviewed railway passengers with regard to criteria for selection of the railway connection.

Their opinions show the following trend:

- Railway fares are cheaper than bus fares.
- Railway transport is safer compared to road transport (bus).
- Road transport (bus) leaves the passengers covered with dust.

4.3 Traffic Growth Rate

4.3.1 Objective

The purpose of this sub-chapter is to establish the socio-economic framework for the Study area within which traffic forecasts can be made. As a general rule there is a strong relationship between economic conditions and traffic volumes.

ANE has made an "ASSESMENT OF ROAD TRAFFIC GROWTH" based on economic growth figures. This sub-chapter shows a summary of the data presented in this paper .

4.3.2 Available Information

1) General

The available information on the past growth of road traffic on Mozambique's road network comprises the results of traffic counts over time and some indirect indicators of traffic growth, such as:

- Trends in the consumption of petrol and diesel.
- Trends in the number of registered motor vehicles.

Each of these indicators have to be considered within the overall context of economic growth and the trends in automotive fuel prices.

2) ANE Traffic Count Data

An aggregation and trend analysis of the ANE 1995 – 2004 traffic count data by province indicated the following trends on traffic growth rates by province.

Province	Average annual trend change (%)
Maputo	2.6
Gaza	6.1
Inhambane	10.4
Sofala	8.5
Manica	5.9
Tete	11.8
Zambezia	15.7
Nampula	11.2
Niassa & Cabo Delgado	7.9

3) Vehicle Registration Data

Information on the total number of registered vehicles (the 'vehicle park') is collected and analyzed by the Instituto Nacional de Viacao (INAV) of the Ministry of Transport and Communications. A trend analysis of the data for the period 1998 – 2005 indicates that the total vehicle park was growing at a rate of 10.1% per year during the same period, but there were considerable variations by province as shown in Figure 4.3.1.

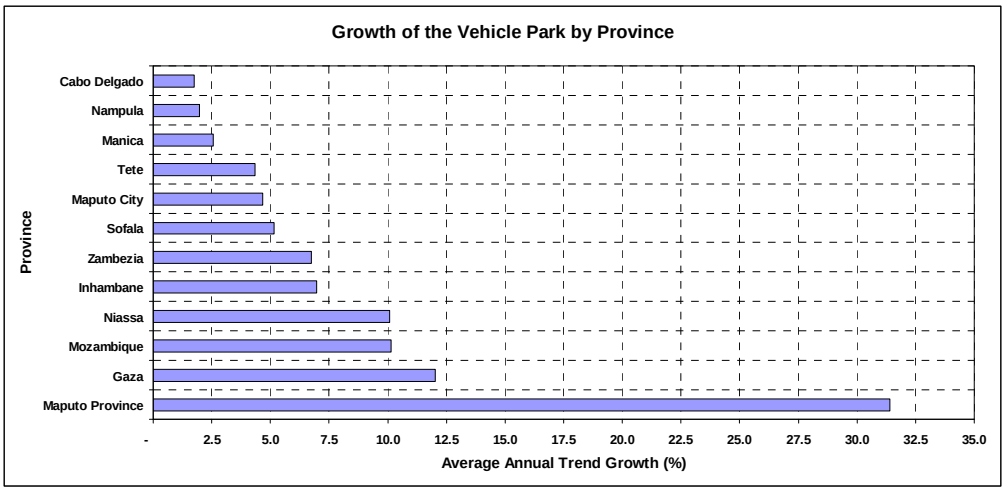


Figure 4.3.1 Growth of the Vehicle Park by Province

4) Automotive Fuel Consumption

The growth of automotive fuel consumption is illustrated in Figure 4.3.2. The trend growth of petrol consumption was 6.1 % a year between 1998 and 2005. For diesel it was slightly lower at 5.5% a year. Petrol is mainly used by light vehicles such as passenger cars, minibuses and some pickups. Heavier vehicles such as buses and trucks use diesel. The sharp drop in diesel consumption in 2001 could be a reflection of the effects of the 2000 floods (hurricane) which caused major disruptions to the road network. However, it may also be a result of statistical errors in reporting the data for that year. The utilization of petrol (by the nation's light vehicle park with its heavy concentration in the greater Maputo area) was probably less affected by the floods.

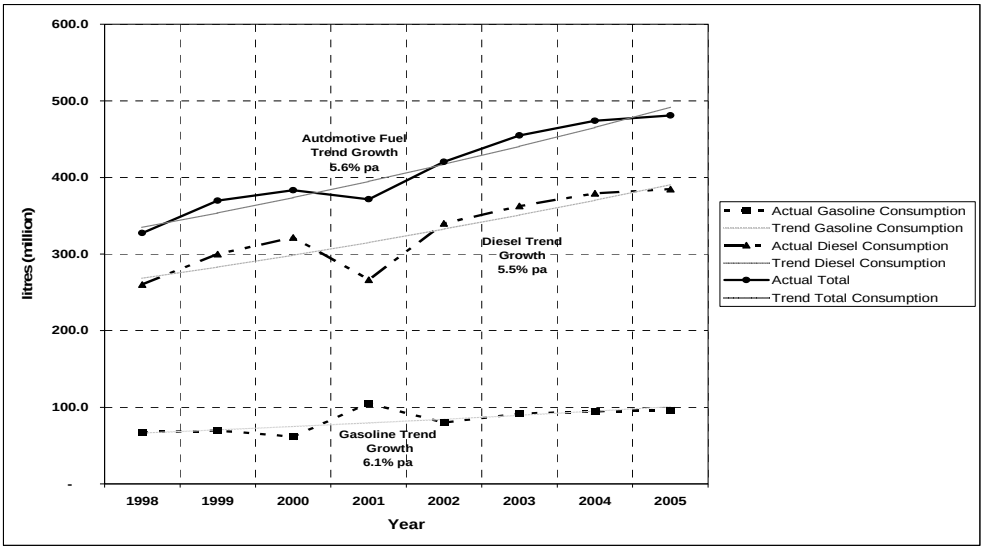


Figure 4.3.2 Growth of Automotive Fuel Consumption

5) Population and Real Gross Domestic Product

During the past decade Mozambique has had one of the fastest growing economies in Africa. With the exception of the 'hurricane year' 2000, the rate of growth has been relatively stable. The growth of population is estimated by Instituto Nacional de Estatistica (INE) to have been around 2.75% a year since 1997, the year of the last population census. The accuracy of these projections will not be known until the results of the 2007 population census become available. The growth of real Gross Domestic Product (GDP at constant 2000 prices) has been at a trend rate of just under 8% a year and per capita real GDP growth has accordingly been just under 5% a year. Trends in the recent growth of real GDP are illustrated in Figure 4.3.3 below.

Indicative projections of the growth of the Mozambique economy by the International Monetary Fund (IMF) suggest that real GDP could be expected to grow at 7.1% a year between 2005 and 2010 and at 6.5% a year thereafter. These are quite ambitious long term economic growth rates, but they will need to be sustained if the Millennium Development Goals are to be achieved. Given that the rate of population growth can be expected to decelerate, the projected real GDP growth rates imply a growth of real per capita GDP of well over 4% a year.

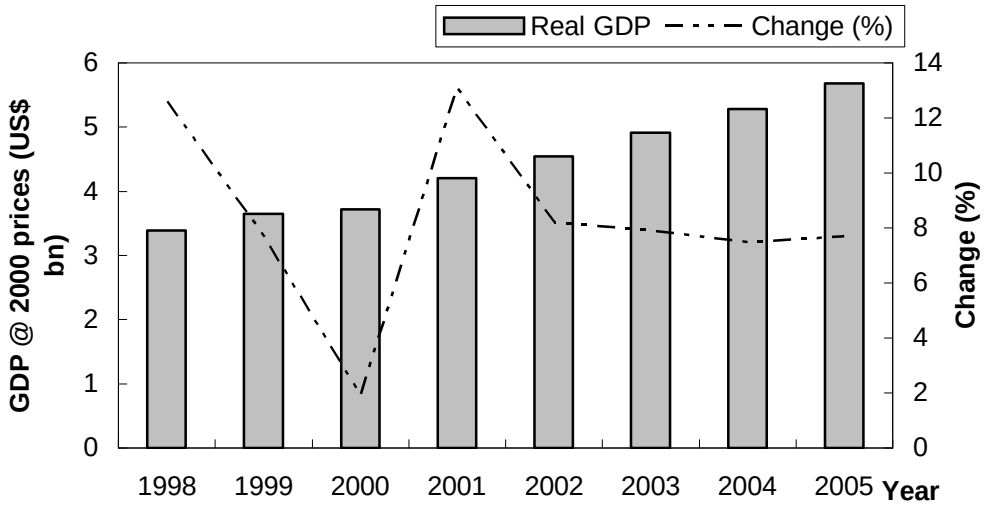


Figure 4.3.3 Growth of Real GDP

6) Population and Real Gross Domestic Product

Changes in the retail prices of petrol and diesel might be expected to have an impact on the growth of automotive fuel consumption and, hence, road traffic, but the effect seems to be much less significant than the impact of economic growth. The present 'spike' in crude oil prices and the associated sharp increases in retail prices of gasoline and diesel began in 2004. Trends in crude oil prices and retail prices of automotive fuels in Mozambique are illustrated in Figure 4.3.4 below.

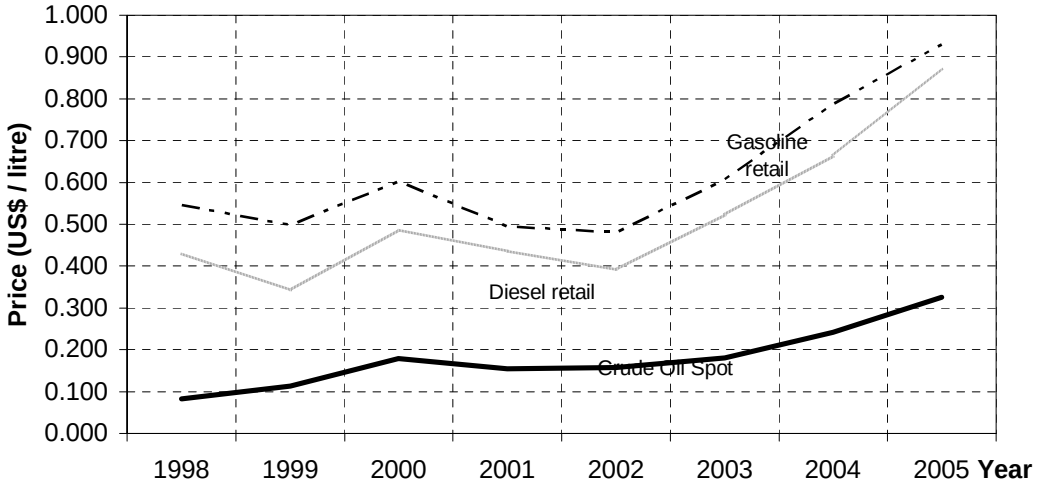


Figure 4.3.4 Crude Oil Spot Prices and Automotive Fuel Retail Prices

4.3.3 Forecasting Road Traffic Growth

1) Approach Method

The approach suggested is to develop a simple model of automotive fuel consumption as a means of forecasting road traffic growth rates. The growth of automotive fuel consumption is used as a proxy for the growth of road traffic. The reason for choosing automotive fuel, as discussed earlier, is because the available data is considered to be more consistent and reliable than other alternatives such as traffic count results or vehicle registration data.

2) Simple Forecasting Model

Three simple models for forecasting automotive fuel consumption have been tested, each one being based on data for the 1998 – 2005 period. The models can be summarized as follows:

A: Petrol and diesel consumption are assumed to be a function of the growth of real Gross Domestic Product (GDP).

B: Petrol and diesel consumption are assumed to be a function of the growth of GDP and retail prices of gasoline and diesel.

C: Gasoline and diesel consumption are assumed to be a function of population, real GDP per capita and retail prices of gasoline and diesel.

The results show that Model C is the least satisfactory in terms of statistical significance, having a lower adjusted R^2 for both petrol and diesel than Models A and B. There is little to choose between Models A and B. Model A is a slightly better predictor of diesel consumption and Model B is a marginally better predictor of gasoline consumption. Intuitively, Model B, which includes the price of fuel, seems logically to be more appropriate for long term projections. The fact that it does not make a statistically significant contribution in Model B results may be due to the fact that the 1998 – 2005 time series of available data is too short.

3) Results – Forecasts of Automotive Fuel Consumption

The IMF forecasts of economic growth and the US EIA crude oil price forecasts were applied to Model B to produce forecasts of petrol and diesel consumption for the years 2010, 2015, 2020 and 2025. Intermediate values were interpolated. The best estimated forecasts of petrol and diesel consumption are summarized in Table 4.3.1 below.

Table 4.3.1 Best Estimate Forecasts of Automotive Fuel Consumption

Year	Petrol Consumption		Diesel Consumption		Total Automotive Fuel Consumption	
	(litres million)	Average annual change (%)	(litres million)	Average annual change (%)	(litres million)	Average annual change (%)
2005	96.2		384.8		481.0	
2010	146.7	8.8	507.3	5.7	654.0	6.3
2015	207.3	7.2	655.0	5.2	862.3	5.7
2020	288.6	6.8	857.7	5.5	1,146.4	5.9
2025	400.7	6.8	1,135.4	5.8	1,536.0	6.0

4) Generalized Traffic Growth Forecast

The forecast growth of automotive fuel is a proxy for the generalized forecast growth of 'normal' road traffic. Light vehicle traffic is assumed to grow in line with the predicted growth of petrol consumption and heavy vehicle traffic will grow in line with diesel consumption.

The following growth rates should be used for appraisal periods of 10, 15 and 20 years respectively: For appraisal periods starting later than 2006 the single period growth rates can easily be modified using the more detailed forecast rates in Table 4.3.2.

Table 4.3.2 Detailed Forecast Rate

Forecasting period		Annual change (%)		
		Light vehicles (petrol)	Heavy vehicles (diesel)	Overall
2005-2015	10 years	8.0	5.4	6.0
2005-2020	15 years	7.6	5.5	6.0
2005-2925	20 years	7.4	5.5	6.0

The single period traffic growth forecasts by region would then be as shown below.

Table 4.3.3 Provincial Generalized Traffic Growth Rates (% / Year)

	Light Vehicles (petrol powered)			
	2005-2010	2010-2015	2015-2020	2020-2025
Niassa	9.49	7.76	7.33	7.33
Cabo Delgado	7.14	5.84	5.51	5.51
Nampula	6.86	5.61	5.30	5.30
Zambezia	7.74	6.33	5.98	5.98
	Heavy Vehicles (diesel powered)			
	2005-2010	2010-2015	2015-2020	2020-2025
Niassa	6.14	5.61	5.93	6.25
Cabo Delgado	4.62	4.22	4.46	4.70
Nampula	4.44	4.05	4.28	4.52
Zambezia	5.01	4.57	4.83	5.10
	All Vehicles			
	2005-2010	2010-2015	2015-2020	2020-2025
Niassa	6.79	6.14	6.36	6.47
Cabo Delgado	5.11	4.62	4.78	4.87
Nampula	4.91	4.44	4.60	4.67
Zambezia	5.54	5.01	5.19	5.27

4.4 Traffic Demand Forecast

4.4.1 Methodology of Traffic Demand Forecast

The overall demand for traffic movement has been formulated using a combination of data from the traffic surveys and the economic growth figures. The way in which traffic assignment on the road network is forecast using the traffic assignment model JICASTRADA.

Tangible methodologies and scenarios of future traffic demand forecast are shown below. These procedures are illustrated in Fig. 4.4.1.

a) Future traffic demand has been derived based on future OD matrices with trend growth rates considered as shown in table 4.3.3.

b) In case the study road is improved and upgraded, the study road attracts additional traffic from other roads or from other transportation modes. The traffic survey indicates the following two possibilities of diverted traffic.

- Passenger and cargo traffic with transportation mode change

- Cargo traffic with route change

c) Future traffic demand has been estimated by applying the scenarios mentioned under a) and b)

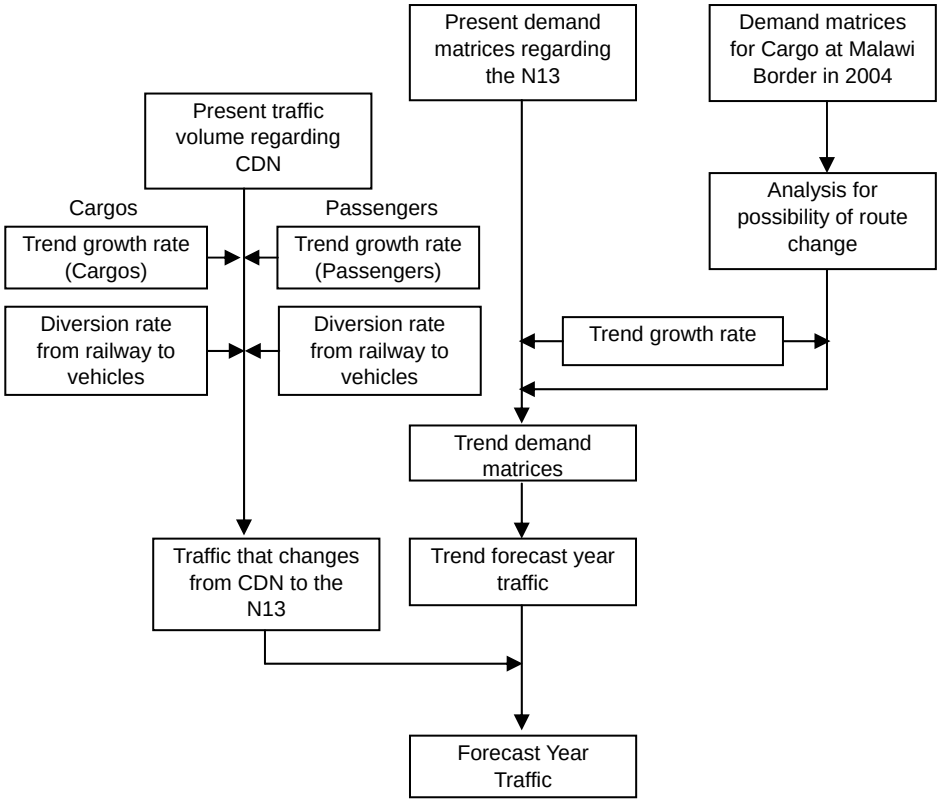


Figure 4.4.1 Future Traffic Volume Forecast Procedures

4.4.2 Future Traffic Volume Based on the OD Matrix

1) Zoning for Future Traffic Forecast

The Study Team obtained the following OD matrices from surveys:

- OD matrix (all vehicle) for the study road (2006)
- OD matrix (freight car) at the Zobue border (2004)
- OD matrix (freight car) at the Milange border (2004)

The target area was zoned as indicated below based on the obtained OD matrices. Far away areas such as South Africa, Zambia and Malawi were consolidated into large zone from the viewpoint of efficiency.

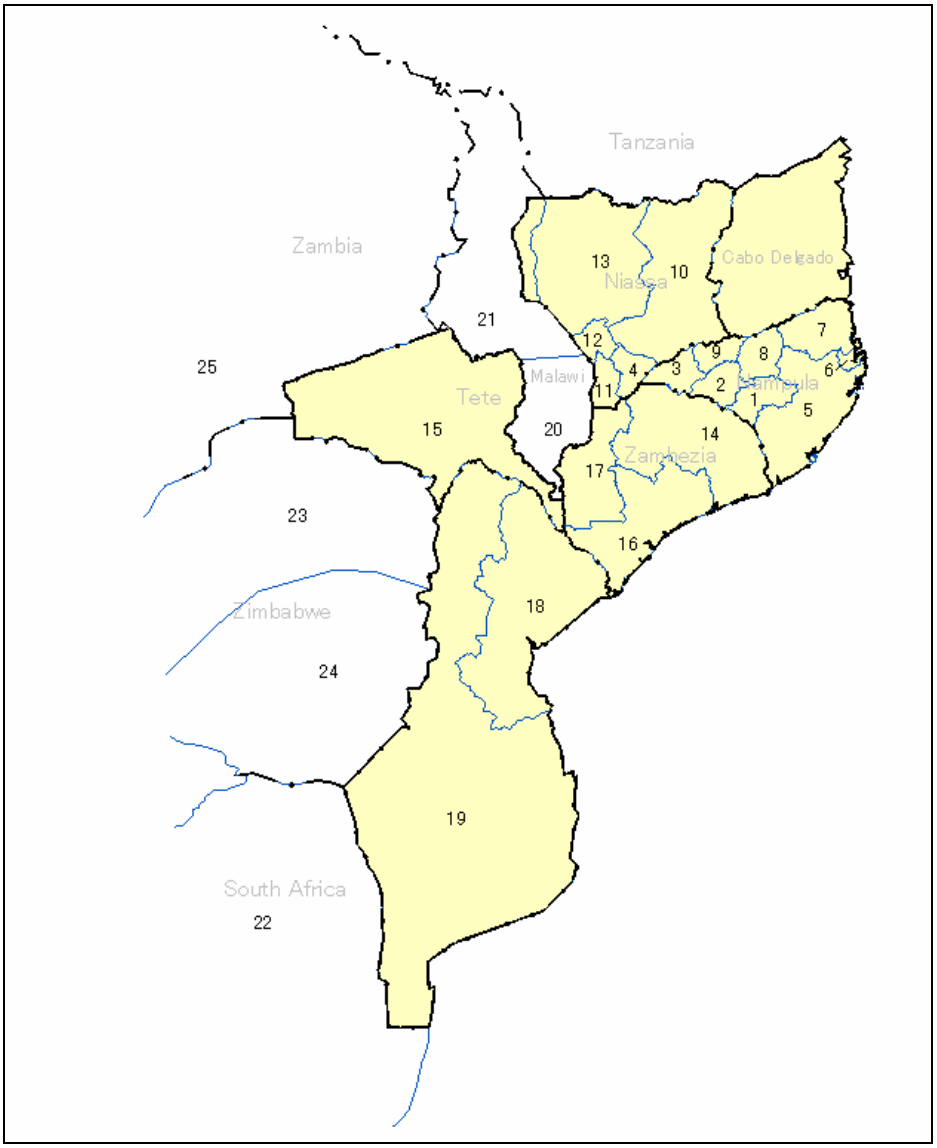


Figure 4.4.2 Zoning for Future Traffic Forecast

Table 4.4.1 Consolidated Zone

Zone No	Zone	Zone No	Zone
1	Nampula	14	Alto Molocue, Gile, Gurue, Ile, Lugela, Namarroi, Pebane
2	Ribaue	15	Tete
3	Malema	16	Quelimane
4	Cuamba	17	Mocuba,Milange
5	Angoche, Mogincual, Ilha de Mocampique, Meconta, Mogovolas, Moma, Monapo, Mossuril, Muecate, Murrupula	18	Beira
6	Nacala, Nacala Velha	19	Maputo
7	Erati, Memba, Nacaroa	20	Malawi-south
8	Mecuburi	21	Malawi-north
9	Lalaua	22	South Africa
10	Marrupa, Maua, Mecula, Metarica, Nipepe	23	Zimbabwe-north
11	Mecanhelas	24	Zimbabwe-south
12	Mandimba, Ngauma	25	Zambia
13	Lichinga, Majune, Muemba, Mavago, Lago, Sanga		

2) Road Network

The future road network in Mozambique was defined based on the “Road Sector Strategy 2007-2011 ANE”. Note that other countries such as Malawi had similar road network plans. Zambia has plans to upgrade the road between Lusaka and Chipata (located near the border with Malawi). Malawi plans to upgrade the bypass section between Mchinji and Mandimba. (see Figure 4.4.3) These plans should be considered as part of the future network because they form a part of the Nacala Corridor.

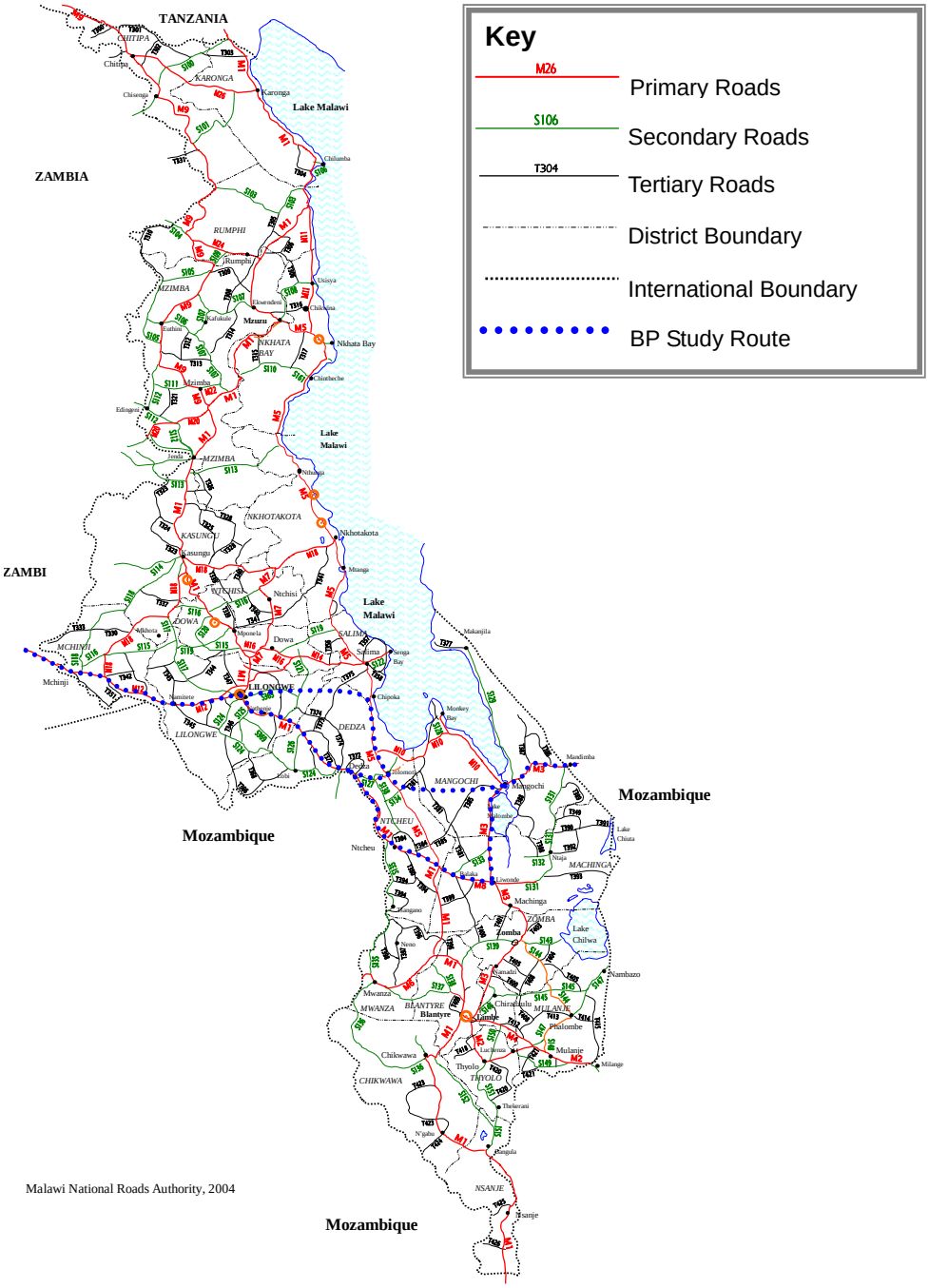


Figure 4.4.3 Future Network Plan for Malawi

All links were coded as to their length, maximum speed, capacity. QV code (Volume-Velocity code) for future road networks are as shown in table 4.4.2, and two cases of travel speed were defined for the Study Road.

- Case 1: 80km/hr
- Case 2: 100km/hr

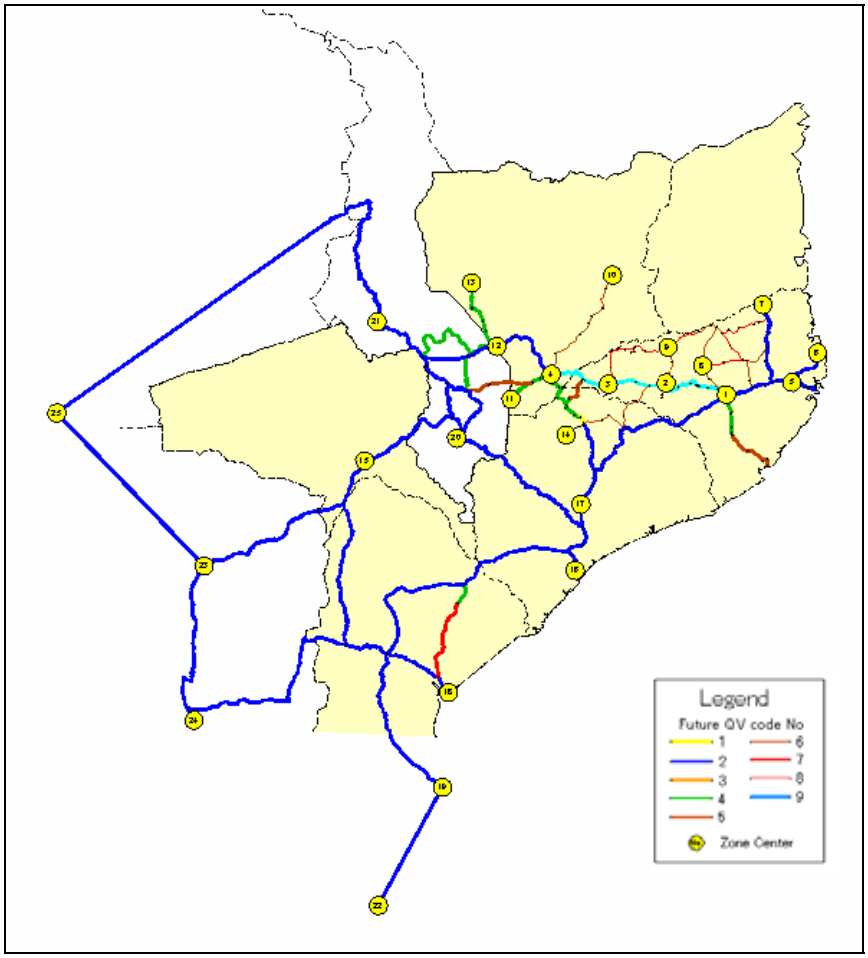


Figure 4.4.4 Future Network of Traffic Demand Forecast

Table 4.4.2 Applicable QV Code

QV	Vmax	Qmax	Remark
1	30	8000	Pavement , Urban area
2	80	8000	Pavement Trunk Road
3	30	8000	Gravel , Urban area (Very Good)
4	40	8000	Gravel , Very Good
5	30	8000	Gravel , Good
6	30	4000	Gravel , Good
7	20	8000	Gravel , Poor
8	20	4000	Gravel , Poor
9	100 or 80	8000	Pavement , Study Road

3) Shortest Route from Main Cities in Malawi to Each Port

Result of the shortest route analysis using the current network and future network in 2026 are shown in table 4.4.3. The acceptable speed for the Nampula – Cuamba Road is 80km/h.

Table 4.4.3 Shortest Route Analysis

Port Name			Nacala	Quelimane	Beira
Current Network	Blantyre	Shortest Length	765 km	420 km	831 km
		Time	19.3 H	13.2 H	10.4 H
	Lilongwe	Shortest Length	869 km	720 km	1,039 km
		Time	20.6 H	17.0 H	13.0 H
Future Network	Blantyre	Shortest Length	765 km	420 km	831 km
		Time	12.1 H	5.2 H	10.4 H
	Lilongwe	Shortest Length	869 km	720 km	1,039 km
		Time	11.5 H	9.0 H	13.0 H

The main competitor for the Nacala port is the port of Beira. The Quelimane port with its low capacity (depth of the port is only 3.5m) and lower performance of the transit cargo is not a real alternative.

In the shortest route analysis, the time from Lilongwe to the Nacala port is less than to the Beira port considering the future network. According to the calculation based on the VOC rates of the RED, vehicles trips from each of the zones that arrive at Nacala port 20 minutes earlier than at Beira port (refer below) are considered more economical.

Economical Comparison for the use of Beira and Nacala port

VOC	VOC(US$/km)	Av. Speed IRI=2	VOC(US$/hr)
Heavy Track	0.76 US$/km	86.29 km/h	65.58 US$/hr
Articulated Track	0.98 US$/km	86.15 km/h	84.43 US$/hr
Average	0.87 US$/km	86.22 km/h	75.00 US$/hr

Usage Fee (Average Use Period: 5days)					
Nacala Port	5737.5	MT			
Beira Port	5115.93	MT			
Difference	621.57	MT	=	23.91 US$	(1US$ = 27MT)

23.91US$/75.00US$ x 60min. = 19.1min.

According to the table 4.4.3, after placing of service of the Study Road, the Nacala Port will be nearer from Lilongwe than the Beira Port more than 2 hours. Result is that the trip between the Beira port and the zone where is in the north of Lilongwe will be change to the trip to the Nacala port.

4) Preparation of Forecast Demand Traffic Matrices

Future OD matrices have been estimated based on trends in traffic growth rates as shown in table 4.4.4. Future traffic volume has been calculated by multiplication of traffic volume in each zone and the trends in growth rate, and these volumes have been distributed to the network based on the OD pattern surveyed by the Study Team.

Table 4.4.4 Future OD Matrices (All Vehicles)

Origin - Destination		1 Nampula	2 Ribaue	3 Malema	4 Cuamba	5 Monapo	6 Nacala	7 Namialo	8 Mecuburi	9 Lalaua	10 Marupa	11 Mecanhelas	12 Mandimba	13 Lichinga	14 Gurue	16 Tete	15 Quelimane	17 Mocuba	18 Beira	19 Maputo	20 Malawi-south	21 Malawi-north	22 South Africa	23 Zimbabue-north	24 Zimbabue-south	25 Zambia	Total
1	Nampula	90	131	46	52	–	–	3	48	3	–	–	–	7	–	–	3	–	–	–	–	–	3	–	–	–	380
2	Ribaue	38	6	10	19	–	–	3	–	10	–	4	–	4	–	–	–	–	–	–	–	–	–	–	–	–	94
3	Malema	27	7	6	–	–	–	–	–	–	–	26	–	26	–	–	–	–	–	–	–	–	–	–	–	–	92
4	Cuamba	143	28	13	124	–	3	–	36	–	22	189	–	84	36	–	–	–	–	–	–	–	–	–	–	–	678
5	Monapo	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	3	–	–	–	–	–	3
6	Nacala	–	–	–	22	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	25
7	Namialo	–	–	10	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
8	Mecuburi	30	–	4	–	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	42
9	Lalaua	3	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43
10	Marupa	–	–	–	58	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	58
11	Mecanhelas	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
12	Mandimba	–	–	–	278	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	278
13	Lichinga	4	8	–	640	–	–	–	–	–	–	–	–	36	11	–	–	–	–	36	–	–	–	–	–	–	735
14	Gurue	38	–	–	32	–	–	–	–	–	–	–	–	–	–	–	20	–	–	–	8	–	–	–	–	–	70
16	Tete	8	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	6	–	–	–	–	–	11
15	Quelimane	46	92	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	141
17	Mocuba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	3	14	–	–	–	–	–	–
18	Beira	–	–	–	84	–	–	–	–	6	–	–	–	12	–	6	–	–	–	–	343	137	–	–	–	–	93
19	Maputo	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–
20	Malawi-south	12	–	–	36	–	–	–	–	–	–	–	–	–	–	25	–	–	27	–	–	12	97	12	–	–	58
21	Malawi-north	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12	–	12	–	43	–	–	–	–
22	South Africa	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	249	152	–	–	–	–	–
23	Zimbabue-north	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	191	43	–	–	–	–	–
24	Zimbabue-south	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12	–	–	–	–	–	–
25	Zambia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–
Total		431	315	89	1,348	–	11	6	84	22	22	219	–	160	50	25	–	–	–	36	–	–	–	–	–	–	2,818

5) Result of Future Traffic Demand Based on Current OD Matrices (2026)

The results of future traffic demand in 2026 are as shown in tables 4.4.5 and 4.4.6 using the traffic distribution model JICASTRADA.

Table 4.4.5 Future Traffic Demand (V=100km/h)

Section Name	Passenger Car	Mini-Bus	Bus	Cargo	Total
Nampula-Ribaue	111	276	130	694	1211
Ribaue-Malema	153	123	69	682	1027
Malema-Cuamba	138	59	60	772	1029
Sections Average	134	153	86	716	1089

Table 4.4.6 Future Traffic Demand (V=80km/h)

Section Name	Passenger Car	Mini-Bus	Bus	Cargo	Total
Nampula-Ribaue	111	238	130	700	1179
Ribaue-Malema	153	85	69	676	983
Malema-Cuamba	138	59	60	766	1023
Sections Average	134	127	86	714	1062

4.4.3 Diversion of Transportation Mode

According to the interview survey, passengers and transportation companies appear to be discontent with the railway company's operation and performance. Therefore, it is expected that if the Study Road is upgraded, some passengers and transport companies using the railway line will change to road transport.

1) Passenger Transportation Mode

a) Trend Growth Rate

Future passenger-km was analyzed by the regression analysis method based on the data from the 2003-2005 period. According to this analysis, the total number of passenger-km in 2026 will be 146 x 10^6. Baseline data and result of the regression analysis are shown in figures 4.4.5 and 4.4.6.

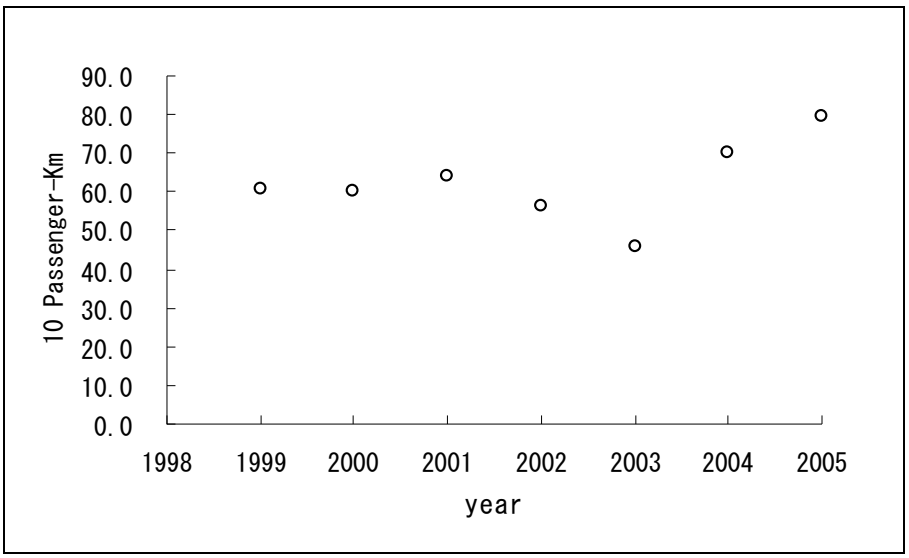


Figure 4.4.5 Passenger-Km Baseline Data (2003-2005)

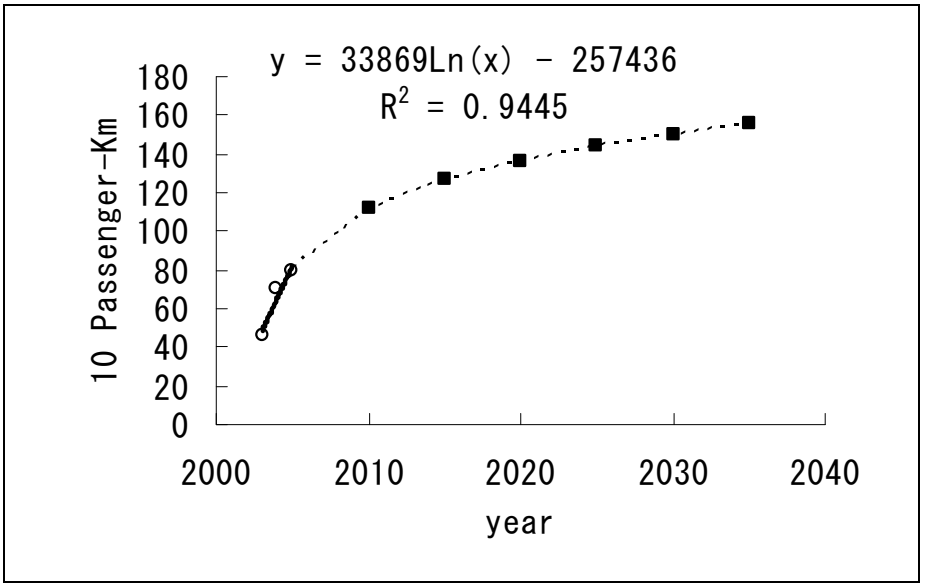


Figure 4.4.6 Result of Regression Analysis in 2026

b) Logic behind the diversion of Passengers from Railway to Road Transportation Mode.

According to the interview surveys of railway passengers, most of them do not own vehicles. The railway connection has some advantages over other modes such as low fares and a more comfortable ride. Hence after upgrading of the N13, it is predicted that these railway passengers will divert to vehicles as a result of cost change.

According to this scenario, the selection of the transportation mode is derived from the hourly cost and time crunch. Hourly bus fares after upgrading of the N13 are shown in tables 4.4.7 and 4.4.8, respectively.

Table 4.4.7 Hourly Bus Fare

Operation Area	Length	Travel Time	Fare	Hourly Fare
Nampula-Cuamba (bad road condition)	348km	9.0hr	250Mtn	27.8Mtn/hr
Nampula-Ribaue 間 (good road condition)	136km	3.5hr	70Mtn	20.0Mtn/hr

Table 4.4.8 Rate between Nampula and Cuamba

Operation Area	Length	Travel Time	Fare per an Hour	Brock rate after upgrading
Current Bus	348km	9.0hr	27.8Mtn/hr	250Mtn
Future Bus	348km	4.5hr	20.0Mtn/hr	90Mtn
(note) Current Railway	347km	10.0hr	10.0Mtn/hr	100Mtn

Based on this scenario, the bus fare after upgrading the N13 will be more economical as against a current railway fare; thus it is anticipated that most railway passengers will divert to vehicle transportation.

This phenomenon has already been observed between Nacala and Nampula, and the railway service has subsequently been aborted.

The following calculation was used for estimation of future traffic demand for passenger transport;

- The calculated passenger-km in Figure 4.4.5 is divided by the length of the railway line and the annual operation days, and the number of passengers per day (one-way) are estimated.
- This number of passengers on round trip per day is divided by the average number of bus passengers.

A figure of 134 transport vehicles a day was compiled based on these calculations.

Table 4.4.9 Traffic Volume by Conversion of Transportation Mode

Item	Value in 2026
Passenger-Kilometers (million km)	146
Nampula-Cuamba Number of Passengers	420,000
Number of Passengers (a day and one-way)	1,337
Traffic with Transportation Mode Conversion from Railway to Vehicles (vehicle numbers/ day, round trip)	134

2) Cargo Transportation Mode

a) Trend Growth Rate

Future ton-km of cargo transport was analyzed by the regression analysis method based on the data from the 1994-2005 period. According to this analysis, the total number of tonne-km was 290 x 10^6 in 2026. Baseline data and results of the regression analysis are shown in figures 4.4.7 and 4.4.8

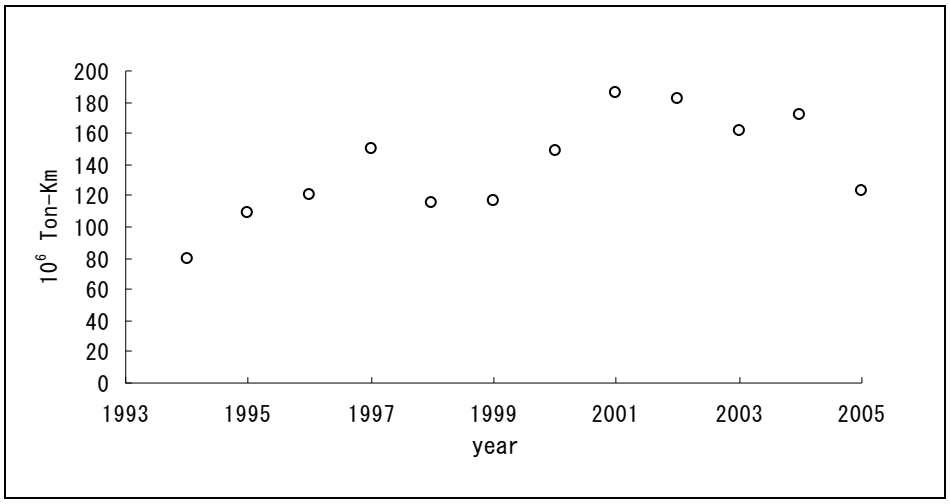


Figure 4.4.7 Baseline Data of Ton-Km of Cargo Transport (2003-2005)

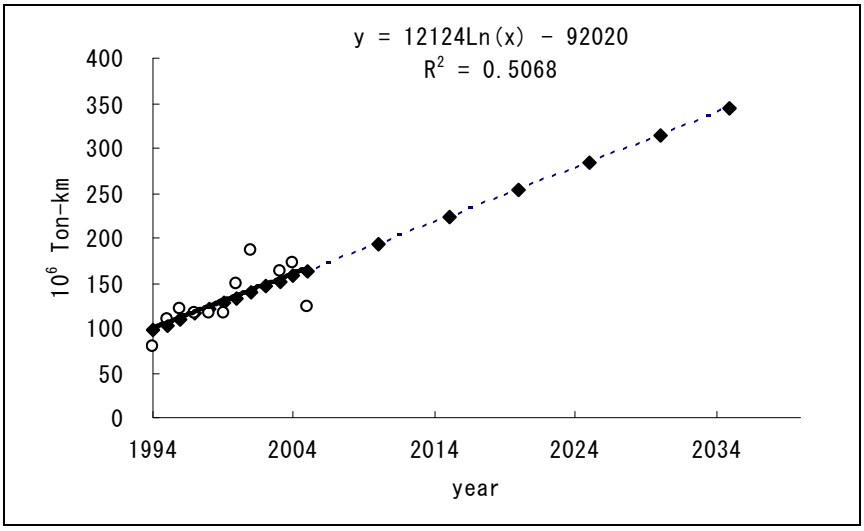


Figure 4.4.8 Result of Regression Analysis in 2026

b) Logic behind the diversion of Cargo from Railway to Road Transportation Mode

Transportation costs of cargo by railway line and vehicles have been obtained from some of the transportation companies.

Diverted traffic is derived from the relationship of the current transportation cost, time and

traffic volume. According to this scenario, a total of 68 veh / day and 82 veh / day were derived in case of a 80kms/hr and 100kms/hr travel speed, respectively. These vehicle numbers respectively mean that 25% and 38% of the total cargo transported by train will convert to road transportation.

Table 4.4.10 Cargo Transport Cost and Travel Time in Nampula - Cuamba

	Cost (MT)	Traffic Volume	Shifting Rate
Vehicle (present)	32,500	40	0
Vehicle (after upgrading) (Travel time V=80kms/hr)	23,500	68	25
Vehicle (after upgrading) (Travel time V=100kms/hr)	19,000	82	38
Railway (present)	9,158	113	100

Note-1) Transportation cost after upgrading was estimated through interviews with some companies
Note-2) Traffic volume of railway is derived from a relation of the annual ton-kilometers of cargo transport, operation days, operation kilometer and average cargo volume by vehicle.

According to the relationship of the calculated cargo transport and the diversion rate, a total of 70 veh / day and 100 veh / day were obtained as conversion traffic from railway to road transport in 2026.

Table 4.4.11 Shifting Cargo Traffic from Railway

Item	Value in 2026
Ton-Km (10^6 Ton-Km)	290
Cargo Traffic Volume (Nampula-Cuamba)	262
Shifting Cargo Traffic Volume after upgrading (Vehicles a day) (V=100kms/hr, shifting rate is 38%)	100
Shifting Cargo Traffic Volume after upgrading (Vehicles a day) (V=80kms/hr, shifting rate is 25%)	70

4.4.4 Result of Future Traffic Demand Analysis

Average traffic demand in 2026 is 1,262 veh/day in case-1 (80kms/hr travel speed) and 1,324 veh/day in case-2 (100kms/hr travel speed). These traffic demands are summarized in tables 4.4.12 and 4.4.13. Note that convertible passenger traffic from railway is grouped under bus and mini bus by the ratio of traffic demand forecast based on the future OD matrix in 2026. As a result, percentage of mini bus in case of 100kms/hr is higher than 80kms/hr. (See appendix-E)

Table 4.4.12 Traffic Volume by Section in 2026 (Case-1: V=80kms/hr)

[Unit : vehicles/day]

Section Name	AADT in 2006	Passenger Car	Mini-Bus	Bus	Cargo	Total
Nampula-Ribaue	335	111	324	177	767	1379
Ribaue-Malema	36	153	159	129	743	1184
Malema-Cuamba	141	138	125	127	833	1223
Sections Average	171	134	203	144	781	1262

Table 4.4.13 Traffic Volume by Section in 2026 (Case-2: V=100kms/hr)

[Unit : vehicles/day]

Section Name	AADT in 2006	Passenger Car	Mini-Bus	Bus	Cargo	Total
Nampula-Ribaue	335	111	367	173	795	1446
Ribaue-Malema	36	153	209	117	783	1262
Malema-Cuamba	141	138	125	127	873	1263
Sections Average	171	134	234	139	817	1324

4.4.5 Comparison with results of the Lichinga-Montepuez Road

The Lichinga – Montepuez Road is located on the N14 which is approximately 170km to the north of the N13. Although the surveyed traffic volume is larger than on the N13, according to the "ECONOMIC FEASIBILITY OF THE REHABILITATION OF THE EN-242 ROAD LICHINGA – MONTEPUEZ", future traffic demand is less than on the N13. The main reason of the phenomenon is due to the difference of diverted traffic that is changing route and mode. Characteristics of each of the roads are as follows:

Nampula - Cuamba Road: This road will take over the passenger transport from the railway line.

Lichinga - Montepuez Road: This road will only take charge of part of the farm products transportation in gravitational sphere.

Table 4.4.14 Comparison of AADT

Road Name	N13 (2006)	Lichinga-Montepuez (2005)	N7 (2005)*
AADT	171	176	59

*) Traffic volume for EN7 is shown just for reference.

Table 4.4.15 Future Traffic Demand in 2015

Road Name / Category	N13	Lichinga-Montepuez	N7*
Passenger Car	74	121	203 (Light Vehicle)
Bus	207	12	
Cargo	484	200	64 (Heavy Vehicle)
Total	764	333	267

Note-1) Traffic volume for N7 is shown just for reference.

Note-2) Future traffic volume of N7 is indicated for a period of 10 years after from placing of a service. But the year for placing of a service is not indicated in the report.

Chapter 5 Environmental & Social Considerations

Chapter 5 Environmental and Social Considerations

5.1 Environmental Legislation

5.1.1 Environmental Impact Assessment Law and relevant guidelines in Mozambique

1) Environmental Organization

In Mozambique, the approval of environmental impact assessment procedures is the responsibility of the Ministry of Environmental Coordination (hereinafter referred to as "MICOA"). The Ministry of Public Works and Housing manages the environmental standards and the Ministry of Agriculture oversees the protection of rare and endangered species.

The organization chart concerning environmental issues is as follows.

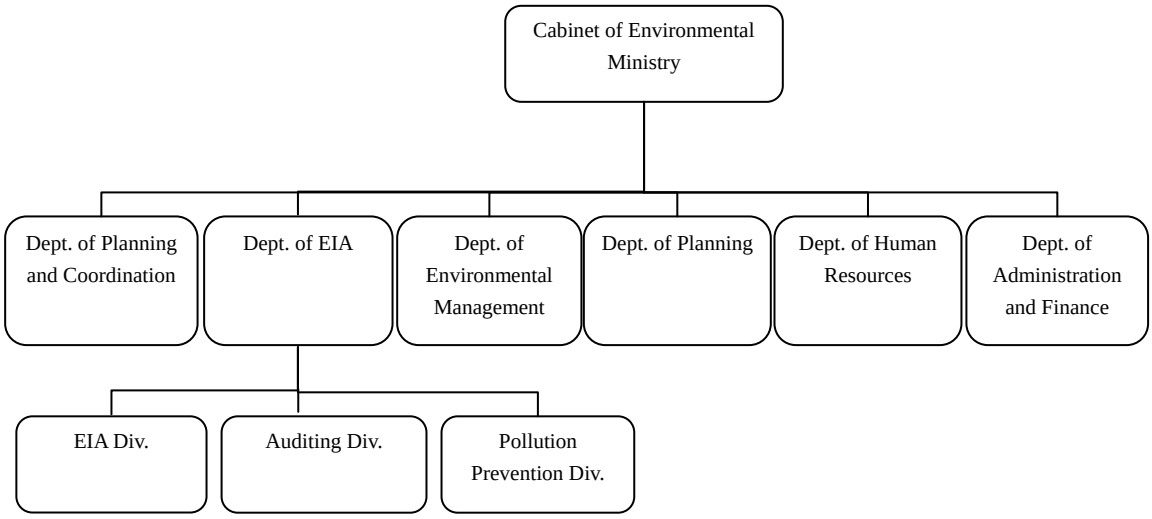


Figure 5.1.1 Organizations Concerning Environmental Issues

ANE also has an environmental department named "UASMA" which acts independently from the other Directorates.

2) EIA Legislation and Guidelines

Major Laws and Regulations

There are fourteen laws in Mozambique regarding the environment. Seven regulations are shown in the table below.

Table 5.1.1 Major Laws and Regulations regarding Environment

Name of Law/Regulation	Outline
Environmental Law, no.20/97 "Regulamento sobre o Processo de Avallacao do Impacto Ambiental", Ministerio para a Coordenação da Accão Ambiental, 2004"	No project can proceed to construction without approval from the Ministry of Environmental Coordination; such approval is based, inter alia, on approval of documents such as an environmental impact report.
Water Law (Lei no. 16/91 de 3 de Agosto de 1991)	Prescribes the management of fishery rights and aquatic resources in the Mozambique coastal area
Land Law (Lei no 19/97)	All land belongs to the government. Government can hand out land-use titles. Right of land-use is applicable to individuals and communities.
Hunting Regulation (Decreto no. 7/87 de 18 de Abril de 1987)	Prescribes measures for hunting
Forestry Regulations (Diploma Legislativo no. 2642 de 20 de Setembro de 1965)	Prescribes management of forestry resources
Cultural heritage law (Lei no. 10/88 de 22 de Dezembro de 1988)	Prescribes management and protection of cultural heritage
Regulation of mines (Despacho de 18 de Maio de 1979)	Prescribes approval for the exploration of mines

Regulations for EIA in 2004 by project types are presented in Table 5.1.2.

According to the table, construction of roads in rural areas will be classified as category "A" which requires a full EIA. However, road rehabilitation, improvement or upgrading, do not appear to be covered by any category.

Table 5.1.2 Project Definitions by Category

Category	Definition	Project Type and Scale
A	a) Sensitive area (International and domestic sensitive area to be protected) b) Area with potential for re-colonization c) High density residential area (Area where there may be significant adverse impacts to residents) d) Developed area where there may be conflicts between persons who are competing for natural resources e) Area which has drinking water resources f) Area which has rare natural resources such as	1. Infrastructure Project a) Re-colony b) Construction of residential estates (exceeding 20ha) c) Tourism service and infrastructures (exceeding 150 beds or 10ha) d) Construction of camp site (exceeding than 650 persons or 5ha) e) Establishment of industrial estates and factories (exceeding than 15ha) f) Recreation services and infrastructures (exceeding 5ha) g) Construction of port/harbor (exceeding 50 ships) h) Construction of new section road except in urban area i) Construction of bridge (exceeding 100m) j) Construction of railway (exceeding 5km) k) Construction of water pipe (exceeding 0.5 m diameter and 10km) l) Pipeline for oil, gasses and mineral resources or mineral resource (exceeding 5km) m) Construction of port and expansion of port (exceeding

Category	Definition	Project Type and Scale
	water, mineral and medicated plants	4000GT) n) Construction of dam (exceeding 5ha watering area) o) Construction of drainage (exceeding 1m width and 10km) p) Project with pumping of water from underground (exceeding 500m3/hr or 12,000m3/day) q) Construction of canal connected port 2. Project in forest area 3. Agricultural projects 4. Industrial projects
B	Not exceed Category A	No specification
C	Projects which have few adverse impacts	Construction of small scale projects, factories and so on (see detailed criteria in appendix)

EIA Guidelines

The GOM has established "Environmental Guidelines for Road Works in Mozambique" for the road sector in 1997 at the same time as the establishment of environmental laws based on the World Bank's EIA guidelines. Additionally, the Ministry of Environmental Coordination prepared a document containing practical instructions named "Environmental Directive for the Roads Sector" in 2002. According to these guidelines, the following procedures are required for approval of environmental licenses before commencement of construction.

✓ Preliminary Information File (FIP)

- Contents of FIP

The Preliminary Information File is a standard form (see Annex IV in Environmental Directive for the Roads Sector), to assist in the understanding of the nature, and the dimension of a project.

The Preliminary Information File has to be completed for all road rehabilitation projects. Only routine maintenance and periodic maintenance of unpaved roads are exempted. The information containing details for the FIP is to be compiled at the appropriate stage of the project.

The FIP is compiled by the Competent Authority in the Road Sector (hereinafter referred to as "ACE") or by a mandated consultant, and contains information available about the project in question and presents at least the following data:

a) Road identification (number and name)
b) Type of surfacing
c) Road starting and end point (to be shown on map of 1:250,000 scale)
d) Poles of development along the road

e) Social requirements for road
f) Traffic counts
g) Additional data such as "Possibilities of new alignments" and "Proximity to protected areas or sensitive habitats".

- Criteria for analysis of the FIP

The need for the execution of an EIA is described, in general terms, in Decree 76/98, more specifically in.

· Number 2 (reclamation of areas covered by indigenous vegetation, superior to 100ha),
· Number 13 (construction of new road alignments of unit cost superior to US$100,000 per km) and,
· Number 21 (sensitive or vulnerable areas).

✓ Environmental Impact Assessment (EIA)

The EIA establishes a number of recommendations and defines measures whose applications have the potential to expand with the passage of time. From this arises the need for the project to be closely monitored during the implementation phase, for verification and adaptation, where necessary, of the proposed measures.

✓ Monitoring

Monitoring is meant for verifying the impact of the project and the appropriate application of mitigation measures. Monitoring will be carried out by ACE, MICOA, specialized consultants and public institutions responsible for the environmental quality.

As part of the PGA (Environmental Management Plan) and PAC (Environmental Action Plan), a monitoring calendar will be elaborated to deal with each of the impacts. This calendar shall contain the following details:

a) The parameter to be monitored (what);
b) The responsibility for monitoring and the sample information to be collected and the indicated laboratories if testing is to be done (who and how);
c) The duration and periodicity of monitoring (for how long and when)

The correct execution of the PGA and PAC enhance the public image of ACE, as an entity concerned with the environmental protection.

✓ Audit

An environmental audit of the selected project is carried out to verify if it is being implemented in accordance with plan and if the specified mitigation measures have been effective for the necessary environmental protection.

An environmental audit permits:

a) Evaluation of the actual impact of the project;

b) Verification whether the predictions presented in the EIA have materialized;

c) Sanctions infractions and require coercive accomplishment of previewed measures in the EIA / PGA.

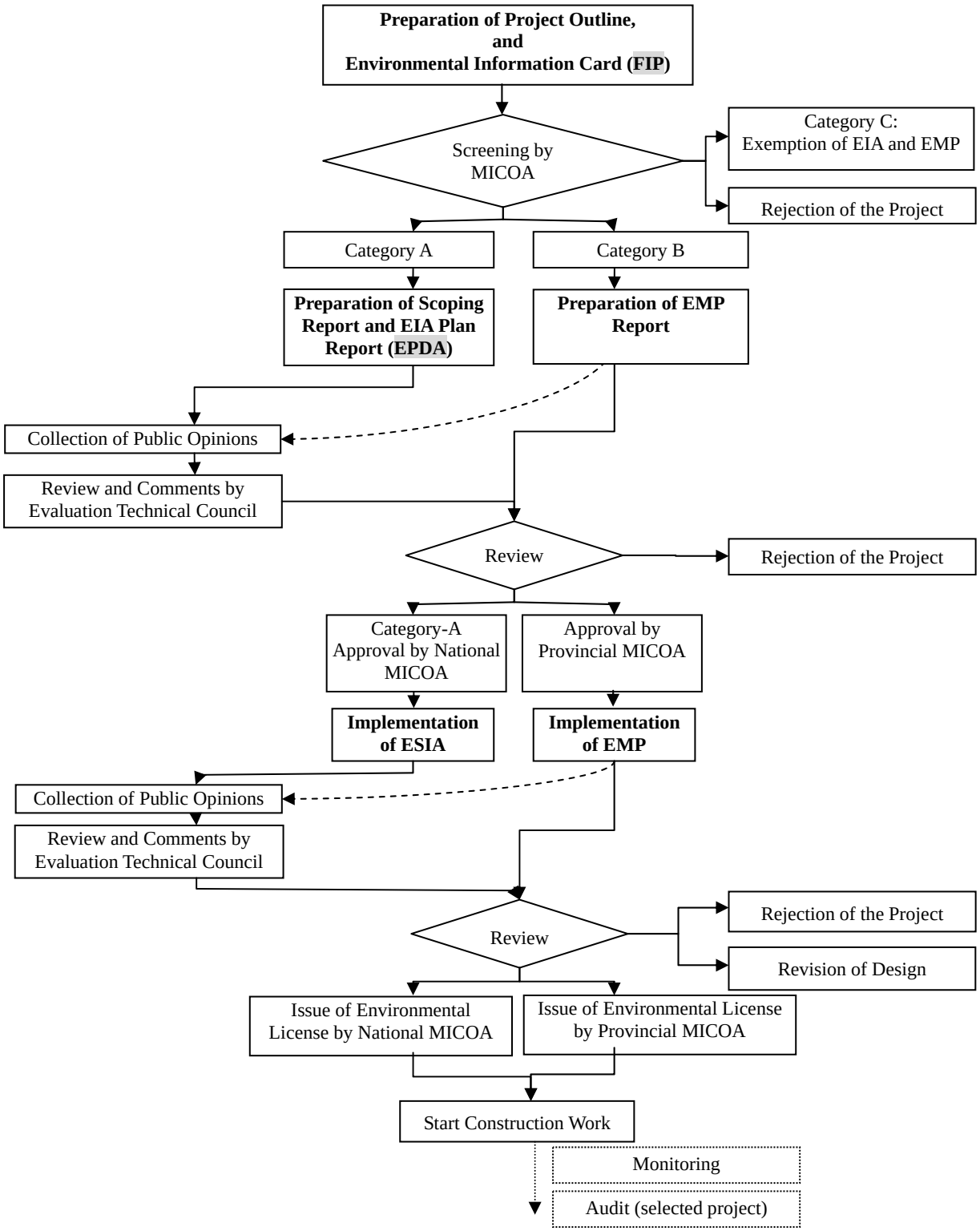


Figure 5.1.2 Law Based EIA Approval Procedures

5.1.2 Land Acquisition Law and relevant guidelines in Mozambique

1) Land Law

The current land law of Mozambique was established in 1997. This legislation covers regulation of the key aspects of land occupation and land use in Mozambique. Also covered in the legislation are the various scenarios of land acquisition, including among others:

a) The acquisition of the right of land use and benefit by customary occupancy,
b) The acquisition of the right of land use and benefit through the official channels;
c) The rules governing protection zones;
d) The relationship between the public and the Cadastral Services; and
e) The rights and duties of the title holders

Dome of the Articles of relevance to construction projects are briefly described below:
Article 3 in the land law stipulates that land is the property of the government. This is also captured in Article 46 of the Constitution. Hence, land may not be sold, alienated, mortgaged or attached. The law stipulates that although land is owned by the government, all Mozambicans have the right to use land and benefit from it. Specifically, Article 9 provides for the acquisition of the right of land use and benefits by local communities; Article 10 provides for the right of land use and benefit by occupancy, in good faith, by national individuals.
And Article 18 stipulates in case of land acquisition "revocation of the right of land use and benefit for reasons of public interest, should be preceded by payment of fair indemnification and /or compensation"
The Mozambique Land Law Legislation, spelled out in Article 24, recognizes the rights acquired through the system of customary occupancy and the role of communities in the management of land, natural resources and conflict resolution. Article 27 provides for the requirements and modalities regarding consultation on land matters, with the local communities.
Article 30 dictates that the mechanisms for representation of and action by local communities, with regard to the rights of land use and benefit, shall be established by law; while Article 23 empowers District Administrators, to authorize applications for land use and benefit, in cases where there are no Municipal Councils.
The Land Law Legislation captures and observes internationally innovative features that facilitate equitable development, based on relations that are mutually beneficial to local communities and to investors whether these are national or foreign.

The Right of land acquisition (Article 86 of the new constitution of Mozambique) provides for individuals and entities to have the right to equitable compensation for expropriated assets and the right to a new and equal plot of land.

According to this article, the properties in question are assessed by nominated organizations and compensated by government. Generally, real estate (structures and compounds) is assessed by Ministry of Public Works & Housing, and agricultural land and crops are evaluated by the Ministry of Agriculture.

Lastly the Land Law governs the right of way with the provisions of Chapter II Article 8 about Partial Protection Zone. The following are considered partial protection zones:

The land occupied by motorways and four lane highways, aerial, surface, underground and underwater installation and conduits for electricity, telecommunication, petroleum, gas, and water, including a bordering strip of 50 m on each side, as well as, the land occupied by roads including a bordering strip of 30 m for primary roads and 15 m for secondary and tertiary roads. Generally the "bordering strip" is understood to be outside the shoulder of the road.

2) Resettlement Policy Framework (RPF) for the Road Sector

A resettlement policy framework (hereinafter referred to as "RPF") has been established in November 2006 and is being translated into Portuguese by ANE with support from the World Bank. This RPF will be considered in all projects (starting from 2007) for carrying out the social impact assessment and preparing the Resettlement Action Plan (hereinafter referred to as "RAP").

The RPF has two basic objectives::

a) To provide a Policy Framework that will guide the preparation of any future Resettlement Action Plan for the road sector. The RPF is prepared based on the policies of the GOM and the World Bank.

b) To provide a framework for RAP for the three road sections to be rehabilitated namely Jardim-Benfica, Xai-Xai – Chissibuca and Massingue-Nhachengue . (The Resettlement Action Plan for the above three road sections has been prepared as a separate document)

This RPF establishes the general principles to be considered in preparation of RAPs. The RPF will be required whenever the final section and alignment of roads to be constructed, rehabilitated or maintained under the project are not precisely known. Once a segment of road is selected and designed, a detailed RAP will be prepared in order to guide land acquisition and resettlement activities of that particular section.

The RPF it to outline procedures for future road development activities to ensure that where acquisition of land and other assets, or impact on livelihood by the project

activities is inevitable, resettlement and compensation activities for lost resources shall be conceived and executed in a sustainable manner. This entails providing for sufficient investment resources to meet the needs of the persons affected and/or displaced from their habitat and resources.

It also requires adequate a process of collaborative consultation and consensus building to achieve an agreement with the project-affected persons (hereinafter referred to as "PAPs") to ensure that they maintain or improve their livelihood and standards of living after the project.

Basically all activities relevant resettlement and compensation on this project will be carried out based on this RPF, accordingly ANE/UASMA.

3) Present Resettlement Procedure

The present land acquisition and resettlement process is as follows.

After preparation of a draft alignment of the proposed road project, a RAP should be prepared by the project proponent based on a preliminary survey and census. The identification of project boundaries and proposed land / property acquisition is issued in a declaration and based on the final road project. Assessment of the value of land / property affected is done by the Ministry of Agriculture and the Ministry of Public Works & Housing, and the project proponent negotiates with the affected owners and provides for the compensation scheme.

The project proponent can then start the intended project.

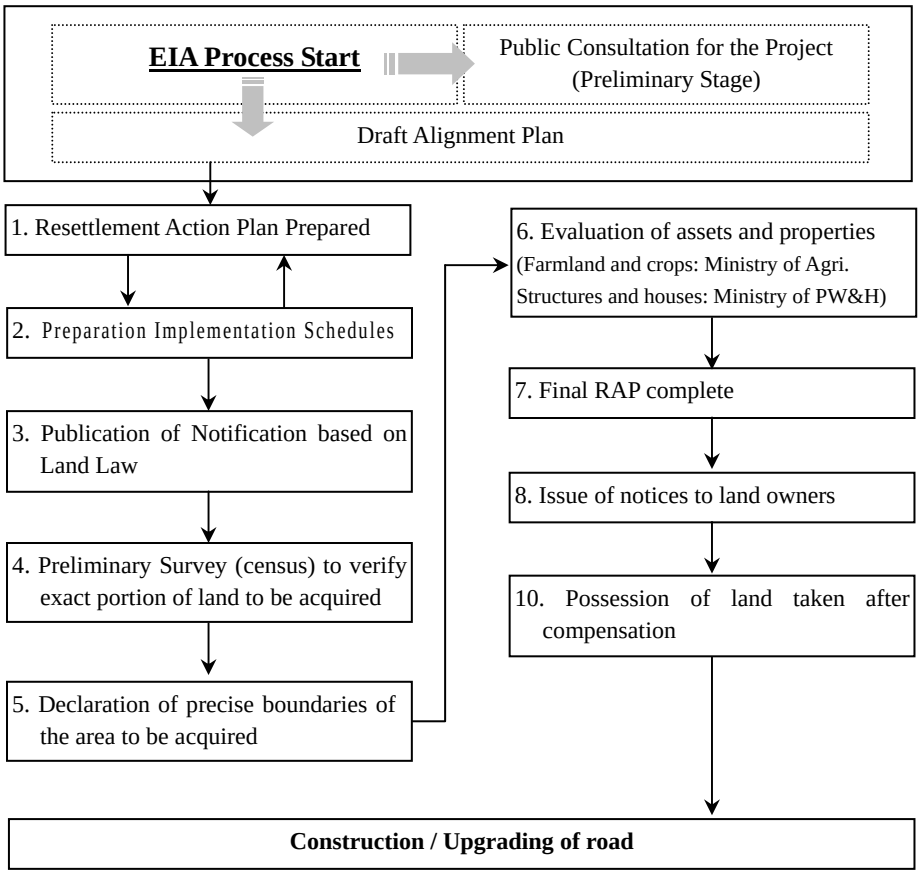


Figure 5.1.3 Land Acquisition / Resettlement Process

Source: Interview with ANE UASMA

5.1.3 Comparison with other EIA Guidelines

When comparing the content of the JICA's guidelines and the requirements of MICOA, no significant differences have been identified, except for social aspects. In addition, JICA makes reference to a Strategic Environmental Assessment (SEA), which MICOA does not mention. A full comparison is provided below in Table 5.1.3:

Table 5.1.3 JICA and Mozambique's EIA Guidelines -A Comparison of Requirements-

Scope of Impacts for Evaluation in Environmental Assessments		
Item	**JICA**	**Mozambique**
Potential	Direct and indirect	Direct/indirect, magnitude and timeframe
Affected Area	Environmental impacts on a trans-boundary or global scale, e.g. global warming	Project-related impacts
Target Items	Social Environment Involuntary resettlement, Local economy, employment and livelihood, Land use and local resources utilization, Existing social infrastructures and services, Local communities, Benefit and damage misdistribution, Gender, Children's rights, Cultural heritage, Local conflicts of interests, Public sanitation, Infectious diseases such as HIV/AIDS, Water usage and rights, Traffic accidents	Human Environment Socio economic activity, land acquisition and resettlement, cultural heritage, vehicle and traffic noise, aesthetic and landscape, road safety
	Natural Environment Global warming, Biota and ecosystems, Geographical features, Soil erosion, Underground water, Hydrological situation, Coastal zone (mangroves, coral reefs, tidal flats, etc.), Climate, Landscape	Natural Environment Fauna, Flora and ecosystem
	Pollution Air pollution, Water pollution, Soil contamination, Waste, Noise and vibration, Ground subsidence, Offensive odors, Bottom sediment in sea and rivers	Physical Environment Soil and erosion (erosion, stability of slopes, excessive water flow, soil contamination), water (surface water, groundwater, water quality), air (health, smoke, smell, dust)

Source: JICA's Environmental and Social Consideration Guidelines, Mozambique's Environmental Impact Assessment Guidelines for Road Sector

5.2 Initial Environmental Examination based on JICA's Environmental and Social Consideration Guidelines

5.2.1 Initial Environmental Examination

1) Objectives

The Initial Environmental Examination (IEE) is a preliminary study carried out to analyse alternative plans, a prediction and assessment of environmental impacts, preparation of mitigation measures and a preparation of monitoring plans on the basis of secondary data and simple field surveys.

The objectives of such an IEE are as follows:

- Before starting the environmental and social activities under Mozambique's EIA law, the proponent should assess the current status of the project site, possible impacts, required approval procedures and other relevant issues.
- The proponent should describe the required mitigation measures based on IEE results, or adopt alternatives for the project including the option "without the project."

- The proponent should conduct an environmental and social baseline survey through a scoping (explain!!!) report based on the IEE.

2) Target Items for the IEE

An IEE is carried out based on reconnaissance visits of the project site and by literature studies. Items to be considered for the IEE are as presented below in Figure 5.2.1

Table 5.2.1 IEE Items

	Items
1) Social Environment	a. Involuntary resettlement b. Local economy, employment and livelihood c. Land use and local resources utilization d. Existing social infrastructures and services e. Local communities f. Benefit and damage misdistribution g. Gender h. Children's rights i. Cultural heritage j. Local conflicts of interests k. Public sanitation l. Infectious diseases such as HIV/AIDS m. Water usage and rights n. Traffic accidents
2) Natural Environment	o. Global warming p. Biota and ecosystems q. Geographical features r. Soil erosion s. Underground water t. Hydrological situation u. Coastal zone (mangroves, coral reefs, tidal flats, etc.) v. Climate w. Landscape
3) Pollution	x. Air pollution y. Water pollution z. Soil contamination aa. Waste ab. Noise and vibration ac. Ground subsidence ad. Offensive odors ae. Bottom sediment in sea and rivers

3) IEE Results

Outline of the IEE

The IEE for the Study Road has been carried out by ANE in cooperation with the Environmental Specialists of the JICA Study Team, and included the following activities.

Table 5.2.2 IEE Outline

	Items
Data and Time Table	[23rd –25th October, 2006] ・ Site environmental rough survey ・ Interviews at district offices (Nampula, Mecuburi, Malema, Ribaue, Cuamba) [31st October –2nd November, 2006] ・ Preliminary resettlement survey (rough counting 30m width from each shoulder) ・ Interview survey regarding elephant corridor [6th –8th, 16th November, 2006] ・ Stakeholder Meetings (Nampula, Mecuburi, Malema, Ribaue, Cuamba district and Nampula Municipality) [9th November, 2006] ・ Water use survey in the rivers ・ Cultural heritage survey (graveyard) [15th November, 2006] ・ Literature study and interviews with the Ministry of Agriculture in Nampula Province

Current Environmental Status through IEE

The current environmental status of the study road as identified through the IEE can be summarized as follows:

- **Social Environment**

a) Involuntary Resettlement

The target road is called the N13 (National Road 13), and it passes through Nampula Municipality, Nampula District, Mecuburi District, Ribaue District, Malema District and Cuamba District. Cuamba district is located in Niassa Province. The other municipalities and 4 districts fall within Nampula Province.

As described in article 5.1.2 Land Law, the Right of Way (ROW) for national roads extends to 30m outside the shoulders of the existing roads, on each side.

According to an reconnaissance survey, done while driving, a total of approximately 5,000 structures including houses, small structures and kiosks (mostly semi-permanent structures) are located in the right of way. In the Natikeri area of Nampula Municipality, roughly 50% of the identified structures are commercial shops

or smaller structures and the remainder is houses.

The N13 is located parallel to the North Mozambique Railway line. Most of the structures that are located within the ROW are situated in the high-density villages near the railway stations.

Furthermore preliminary stakeholder meetings were held in the Study Area by ANE with support from the JICA study team. During such meetings ANE explained to the stakeholders that the GOM will compensate any property such as structures, crop and farmland in case this would be required for resettlement and land acquisition purposed.

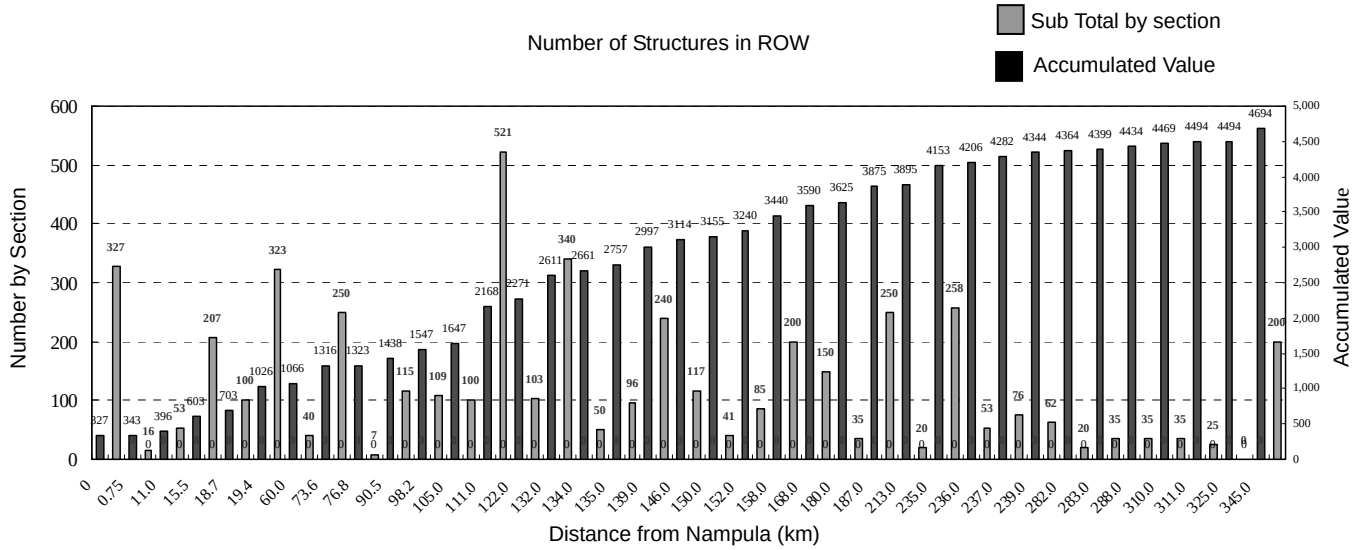


Figure 5.2.1 Number of Structures in Right of Way

source: JICA Study Team

b) Local Economy, Employment and Livelihood

The N13 passes through the main towns of three districts namely those of Ribaue, Malema and Cuamba. In these districts, a number of small towns and around 35 railway stations, commercial activities and relevant small structures were observed. Otherwise, the project site consist mostly of y farmland located along the road with crops such as cassava (mandioca), cashew nuts, bananas, copra, tea, tobacco, sugarcane, cotton and maize. Major cash crops are cashew, cotton, copra and tea. Some cotton factories are located in each district.

c) Land Use and Local Resources Utilization

As can be concluded from the previous paragraph, the principal land use is agriculture. Cashew trees are predominating; however these trees are not planted at a high density as, for instance, on the Mtwara corridor in Tanzania.

Forests in the study area are diminishing due to the ongoing deforestation for the making of charcoal. Protected forest reserves such as the ones in Mecuburi, Ribaue and Mpalwe are an exception.

The Mecuburi forest reserve is located at a distance of around 40kms from the N13. The Ribaue and Mpalwe forest reserves are located just outside of the road reserve (by some 500m).

d) Social Infrastructure and Local Decision-making Institutions

In Nampula Municipality and the centers of Rapale , Ribaue , Malema and Cuamba Towns, water supply and electricity are readily available. Other villages along the road have electricity but no piped water supply available.

An organizational chart regarding the decision-making process at provincial level is shown below.

The political post of Provincial Governor and District Administrators are appointed by the President. The District Administrator can appoint village leaders, and community leaders are selected in each community.

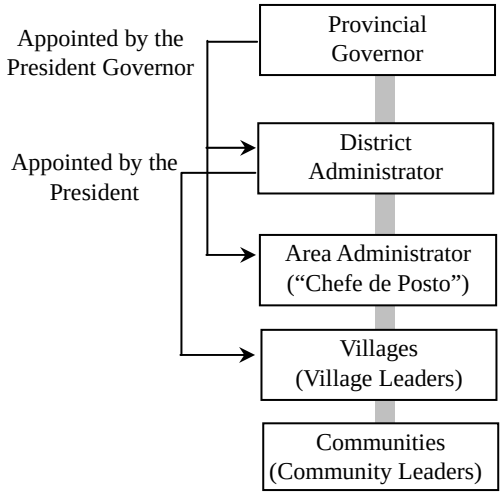


Figure 5.2.2 Provincial Organization Structures for Decision Making

e) Local Communities

The people of Mozambique generally speak one or more of the eight native languages. Their language partially defines their ethnicity. Most of the languages are Bantu in origin. In the extreme northern part of the country are the Makonde people, who are related to the population of southern Tanzania. Their neighbors are the Yao, who live along the shore of Lake Niassa. Most of Nampula Province is inhabited by Macua speakers, who are the largest single linguistic group in the country. The Macua

language is used in the study area from Nampula to Cuamba.

The Zambezi Valley has been a meeting place of many different people over the centuries, and its linguistic makeup reflects this history. People north of the river speak languages related to those of Malawi and Zambia, often referred to as the Maravi language group. South of the Zambezi as far as the Save River are groups who speak languages related to Shona. South of the Shona-speaking people are Tonga speakers, consisting of ethnic Tonga people and ethnic Chopi, a distinct group near the coast. In the extreme south and in areas near the Malawi border are Nguni speakers whose ancestors migrated from South Africa in the 19th century. Because there are so many different languages, Portuguese, the colonial language, has remained the country's official language. Few if any of Mozambique's linguistic groups are unified; they are subdivided into numerous ethnic identities that have been fashioned by external cultural influences. Near the northern coast are Muslims who share many cultural traits with the Swahili of Tanzania and Kenya. For centuries these groups were heavily influenced by Arab trade and customs. In the central Zambezi Valley, the identities of the many fragmented groups were influenced by Portuguese settlerst. Roman Catholicism, which enjoyed a privileged status under the Portuguese, claimed a significant number of followers in the Zambezia valley, as well as in the southern part of the country. Various forms of Protestantism also are practiced. About half of Mozambique's population adheres to traditional, animist religions. Because Mozambique's population is divided into numerous small ethnic subgroups, there is no dominant ethnic group. Ethnicity generally has not been a major factor in Mozambican politics landscape or social status.

f) Unfair distribution of Benefits and negative side effects

The improvement of the N13 will not only reduce the traveling time between Nampula and Cuamba, but also create benefits in the social and economic areas. Although residents who are living directly along the road will be faced withdirect negative impacts such as possible resettlement, they will also benefit from positive impacts in economic areas at the same time. Hence, the general impression is that negative and positive impacts will balance out and be distributed fairly.

g) Gender

Generally women (besides their domestic chores to take care of children, washing and cooking) and children have an important role in local customs to transport drinking water from wells or rivers to the homesteads, herding livestock, farming and collecting firewood

Improvement of the road will provide improved accessibility to both women and children. Road improvement may also become a trigger for the provision of improved water supply to each household. As are result this project is likely to have an overall positive impact on women and children.

On the other hand, migration of the labor work force from villages along the road to major city such as Nampula may also give rise to adverse impacts on women and children.

h) Children's Rights

See above article "g) Gender".

i) Cultural Heritage

According to the first stakeholder meetings in each district and municipality, there are many cultural heritage sites at local level such as praying sites (trees, rocks, mountains, forests and so on. There are no designated regional or national heritage sites in the study area.

Furthermore, local graveyards are located along the road in the Malema and Cuamba districts. These sites must be recorded in the topographic survey and mentioned in the EIA baseline survey. Due to traditional customs it is not acceptable to re-locate them to other areas.

The following graveyards have been confirmed in a reconnaissance survey.

Table 5.2.3 Location of Observed Graveyards in the survey

Distance from Nampula M.	Direction (Nampula to Cuamba)	District/Location	Remarks
310km	Right Hand Side	Cuamba/Lurio River (upstream 200m)	Mainly Christian's tombs
330km	Right Hand Side	Cuamba / road side	Mainly Christian's tombs
332km	Right Hand Side	Cuamba / road side	Mainly Christian's tombs

j) Local Conflict of Interest

As described in article "f) Benefit and damage misdistribution", the proposed project is unlikely to yield an unfair distribution of benefits and damages which may cause rise to conflicts between local people and the local/ provincial government.

k) Public Sanitation

In the project area, no proper drainage or sanitation facilities exist, except for the

district capital towns. Due to lacking of hygiene education, awareness and financial resources, most of domestic sanitary facilities are inadequate.

l) Infectious Diseases such as HIV/AIDS

According to the Ministry of Health, the HIV prevalence is approximately 16 % under pregnant women as reported in 2004. The prevalence rate is still increasing. The rate is especially high near the border with Malawi apredominatend Zimbabwe.

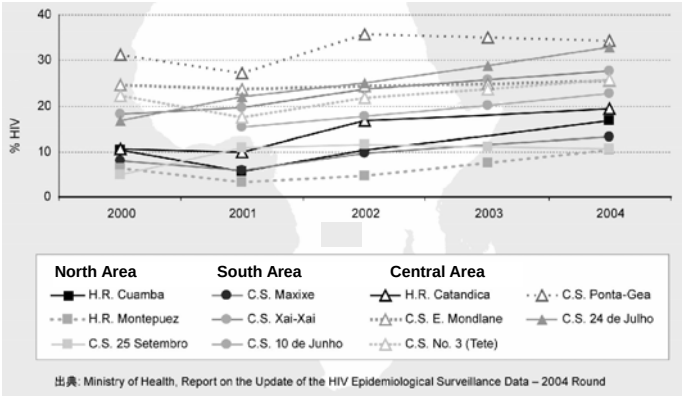


Figure 5.2.3 2000-2004 The Rate of Positive HIV by Area

In the central and southern regions of Mozambique, the rate of HIV is even higher (18%) especially because of the economic migration to Zimbabwe and South Africa, countries with very high HIV infection rates. In the northern area, including Nampula Province, the rate is around 9%, through increasing.

m) Water Usage and Rights

Designated places with water usage rights do not exist in the study area. Most of the residents use water from boreholes, wells and rivers for their livelihood. Piped water supply systems do hardly exist.

The drinking water supply points should be recorded in the topographic survey and mentioned in the EIA baseline survey because they are one of the most important aspects of the basic human needs and it is extremely difficult to provide new wells in a short period of time.

The following rivers are used by residents for supply of drinking water.

Table 5.2.4 Location of Rivers and Water Streams Used by Residents

Distance	District/ River Name	Distance	District/ River Name
36km	Nampula	209km	Malema
81km	Nampula	217km	Malema
85km	Border between Mecuburi and Nampula/Mecuburi River	225km	Malema (With rock river bed)
86km	Mecuburi	230km	
87km	Mecuburi	234km	Near Malema Town and polluted discharged water form the town
134km	Ribaue	242km	Malema/Malema River Habitat of the Nile crocodile

Distance	District/ River Name	Distance	District/ River Name
138km	Ribaue	259km	Malema
153km	Ribaue	264km	Malema /Bailey bridge
159km	Ribaue	282km	Malema/ Nalame River (near Mutuale)
168km	Ribaue	283km	Malema/Nuail River
177km	Ribaue	302km	Malema
186km	Border between Ribaue and Malema	310km	Border between Malema and Cuamba
193km	Malema	348km	Cuamba

Note) There was no heavy rain before the survey was carried. It therefore seems that the above mentioned rivers and streams are flowing all year round

n) Traffic Accidents

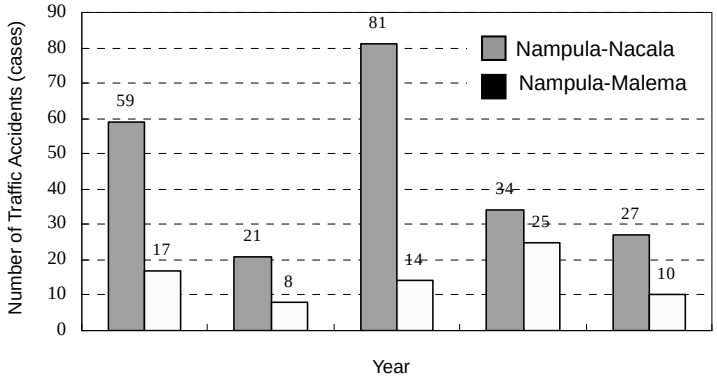
Some dangerous points exist along the Study Road, from a traffic safety viewpoint, especially in mountainous sections at railway crossings (tight angles) or near river crossings. Heavy rains and surface runoff water also causes erosion gullies on the road surface and across steep slopes. At times, heavy trucks get stuck in gullies, ditches and muddy pools.

Such danger spots were pointed out by the village leaders in the first stakeholder meetings.

According to the statistical data on the Nacala-Nampula Road, the number of traffic accidents increased significantly in 2003 when the road was improved.

It is assumed that initially over speeding was the main reason behind the rising number of accidents. Most of the danger spots have since been improved by realigning the road. Subsequently, the number of accidents has reduced.

The number of traffic accidents on the N13 (Nampula – Malema) range from 10-30 cases a year.



Source: Traffic Department, Provincial Command Nampula 2006

Figure 5.2.4 Number of Traffic Accidents in Nampula

➢ **Natural Environment**

o) Global Warming

From a literature study, the estimated greenhouse gas emission is calculated using the formulas presented in table 5.2.5.

Table 5.2.5 Formula for CO2 Emission

Year	Vehicle Category	Formula for Estimation of CO2 Emission (g-CO2/km)
2000	Passenger car / Mini bus	$EF= 1524.94/v – 2.9973v+0.02494v^2+202.844$
	Big bus / Cargo truck	$EF= 50.6414/v – 27.313v+0.20876v^2+1592.74$
2010	Passenger car / Mini bus	$EF= 1427.33/v – 2.8375v+0.02360v^2+191.762$
	Big bus / Cargo truck	$EF= 50.2788/v – 27.312v+0.20876v^2+1592.69$
2020	Passenger car / Mini bus	$EF= 1353.01/v – 2.7243v+0.02264v^2+183.809$
	Big bus / Cargo truck	$EF= 50.2141/v – 27.312v+0.20876v^2+1592.67$

Source: Ministry of Land, Infrastructure and Transport in Japan

According to these formulas, the current volume of greenhouse gas emission is estimated at approximately 80tonne/day for the 348km long Nampula- Cuamba Section.

p) Biota and Ecosystems

✓ Flora

The main native vegetation encountered in the Study area is savanna, deciduous broadleaf forest and cropland/woodland. Most of the native vegetation has disappeared by the “slash-and-burn” farming practice what is left are mostly cashew trees and seasonal grasslands in the swampy areas.

The scale of forestation is very limited due to the sudden deforestation created by charcoal production, except in forest reserves such as at Mecuburi, Ribaue and Mpalwe which are protected.

The Mecuburi forest reserve is located at a distance of around 40kms from the N13, and the Ribaue and Mpalwe forest reserves are located at some 500m outside of the road reserve.

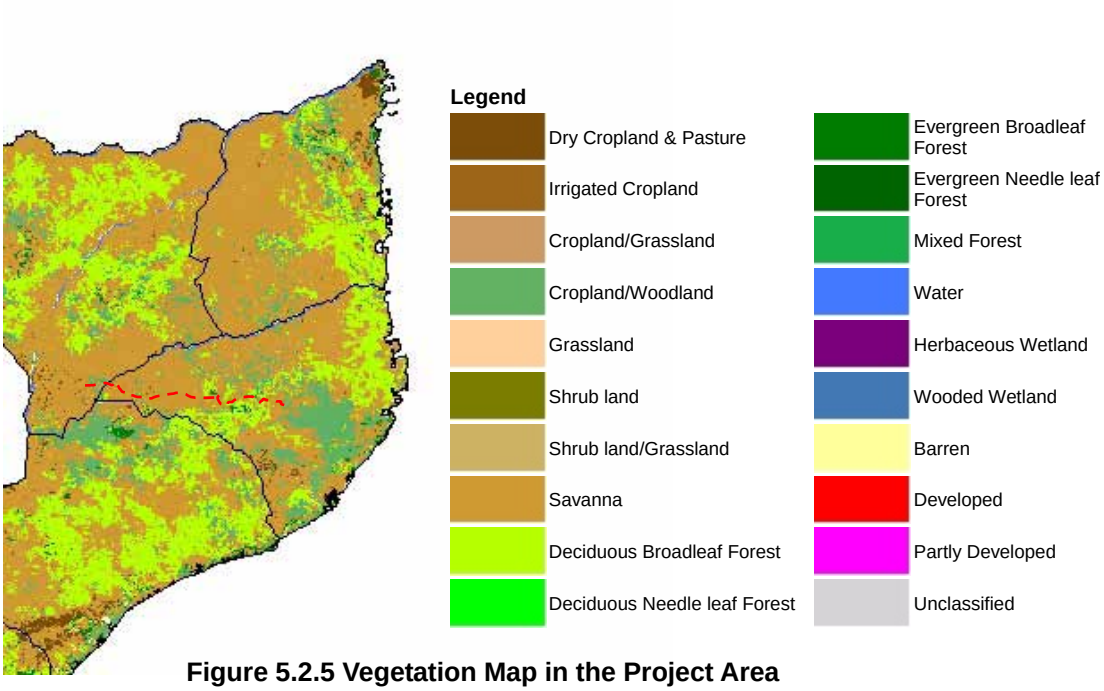


Figure 5.2.5 Vegetation Map in the Project Area

Source: JICA's preliminary study 2006

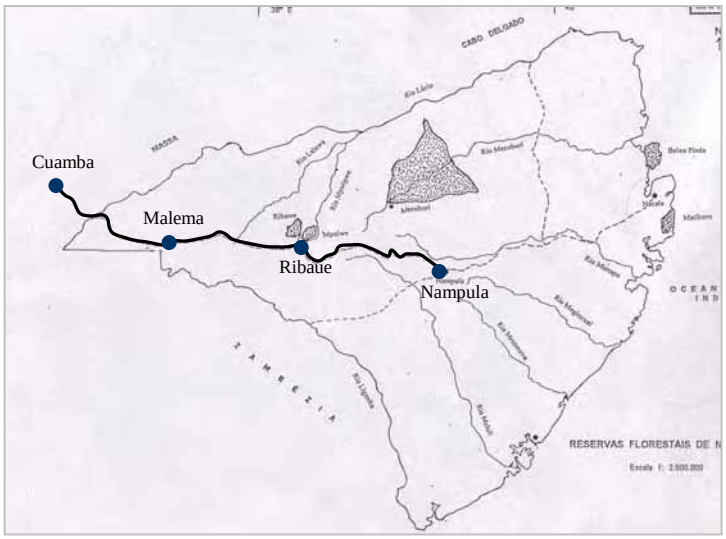


Figure 5.2.6 Forest Reserve Map in the Project Area

Source: Reservas florestais de Nampula December 1998, Ministry of Agriculture

According to the IUCN red list, 80 flora species and 229 of rare fauna species are listed as endangered in Mozambique. However there is no detailed flora and fauna survey of the study area available at the moment.

✓ Fauna

Regarding wildlife, some documents state that rich animal diversity such as hyena, wildcat, mongoose, lion and African elephant exist in the study area.

However, only the presence of African elephant, lion, Nile crocodile and mongoose has been confirmed by the interviews during the stakeholder meetings.
A Map of the wildlife habitat is shown below.

Figure 5.2.7 Mammals Distribution Map

Source: Head of wildlife Department, Provincial coordinator of community unit & wildlife management, Ministry of Agriculture in Nampula

African elephants in the Niassa forest reserve are well known for their migration. Some minor corridors are located in Mozambique, but the main corridor is situated between the Niassa and Selous forest reserve in Tanzania.

According to the Ministry of Agriculture Wildlife Department, 7 minor corridors exist between the Niassa forest reserve and the eastern coast in Cabo Delgado province. (see Figure 5.2.7)
One of the corridors “Route II” passes near the border of Nampula and Niassa Province. The migration happens both ways; once a year from Niassa Forrest Reserve to the coastal area during the rainy season from December to June. Route II, passes along the west side of Cuamba,(border of Niassa and Nampula) , through the Ribaue,Mpalwe and Mecuburi (northern area of Namina).forest reserves There are a total of 30 families and it is estimated that some 400 – 500 elephants are moving annually along route II.
The number of elephants has reduced in the last few years due to poaching and the lack of control by the relevant organization in the Niassa Forrest Reserve.

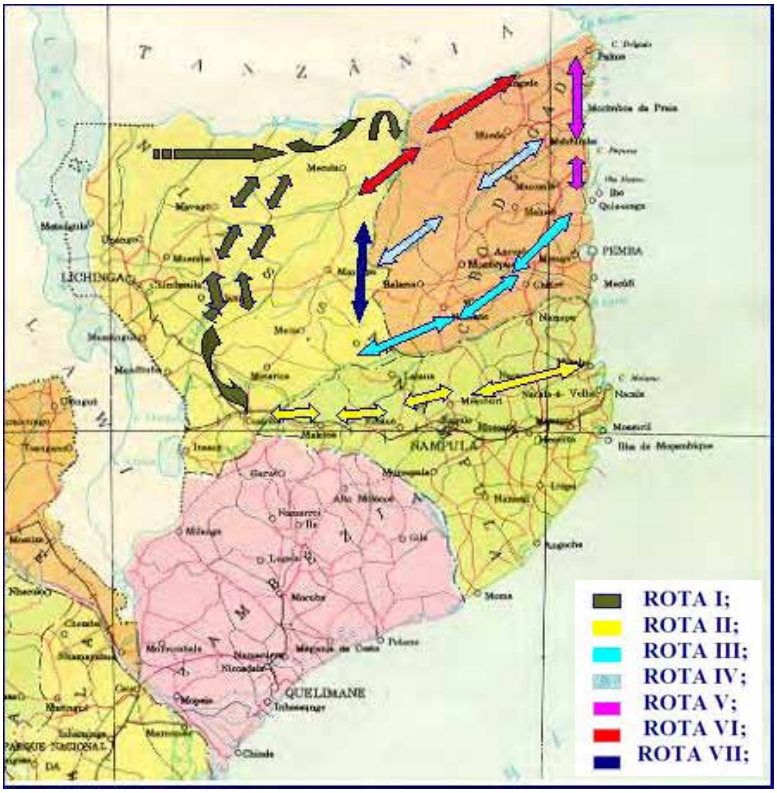


Figure 5.2.8 African Elephant Corridors from Niassa Forest Reserve

Source: presentation material "Conflicts between human and animals" Mr. Aly Awasse / Head of wildlife Department, Provincial coordinator of community unit & wildlife management, Ministry of Agriculture in Nampula

According to a specialist of World Wildlife Fund (WWF) in Maputo, two minor migration routes are located near the project area. One migration route is passing through Maua, Nipepe, Mutuali in Malema district and west of Cuamba from the Niassa forest reserve, and arrives at the Lake Amaramba near the border of Malawi. Another route is passing Maua and goes to the lake directly.

(see following map of the migration routes based on interview)

The migration routes are not crossing the N13 due to the many human activities near the road side.

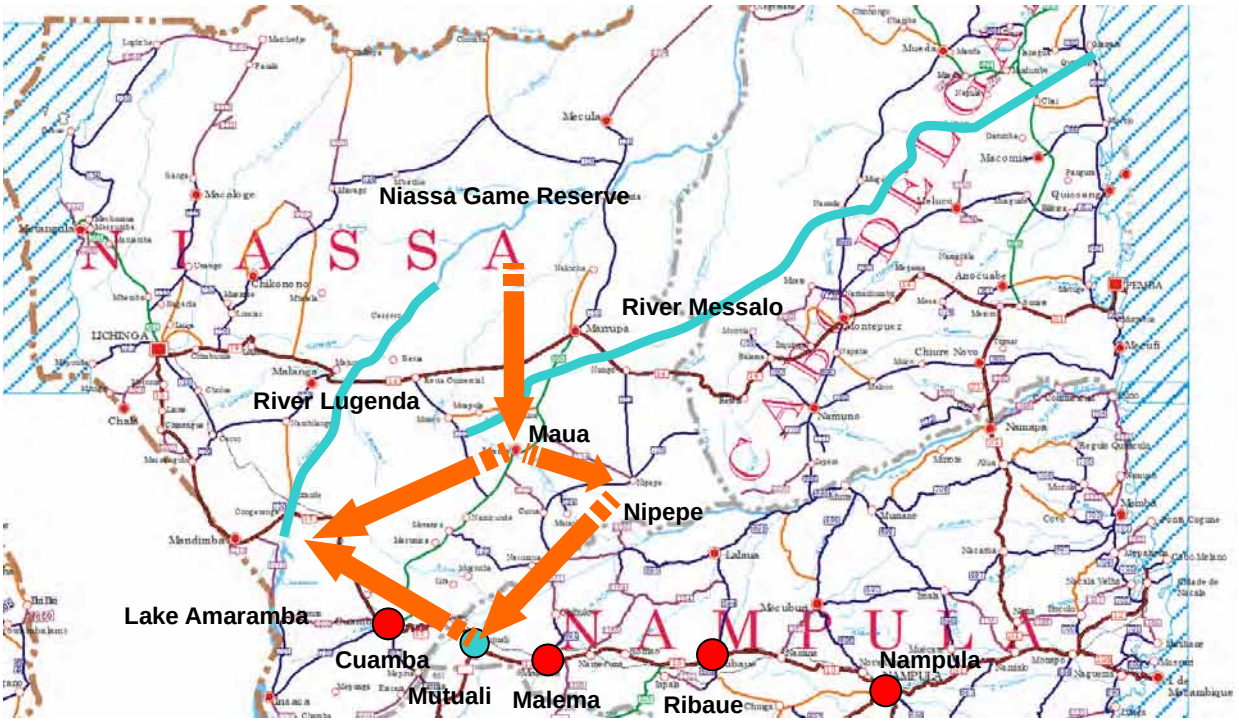


Figure 5.2.9 African Elephant Corridors from Niassa Forest Reserve to Lake Amaramba

Source: JICA study team based on interview with Mr. Albino NANADJA (Communities official)

In addition, some village people reported that 3-5 elephant families had passed from Ribaue Mountain to the border of Niassa Province in the period from December 2005 to January 2006.

It is expected that such migrations use the forest reserves Mecuburi, Ribaue and Mpalwe as part of their route for resting and feeding purposes.

One officer in the Ministry of Agriculture in Nampula stated that the intended road improvements are not likely to cause significant adverse direct impact on the elephant population if appropriate mitigation measures are set up such as sign boards that alert drivers on animal-crossings, However indirect impacts such as increased illegal hunting, deforestation for charcoal production and land development for farming and urbanization will have a much more serious effects in the future.

q) Geographical Features

The project site is located in the eastern area of the Lake Niassa at a distance of several hundred kilometers from the Lake. The mountain area on the west and east side of Lake Niassa is called the “Great Rift valley” which was formed by volcano activity. These mountains have been eroded for a long time, and one of the parts remaining is called “Monad knock”.

These rock mountains are located around the project site and provide a particular beautiful and characteristic landscape.

Most of the elevation in the project site is between 400 to 600m altitudes as shown in the figure below.

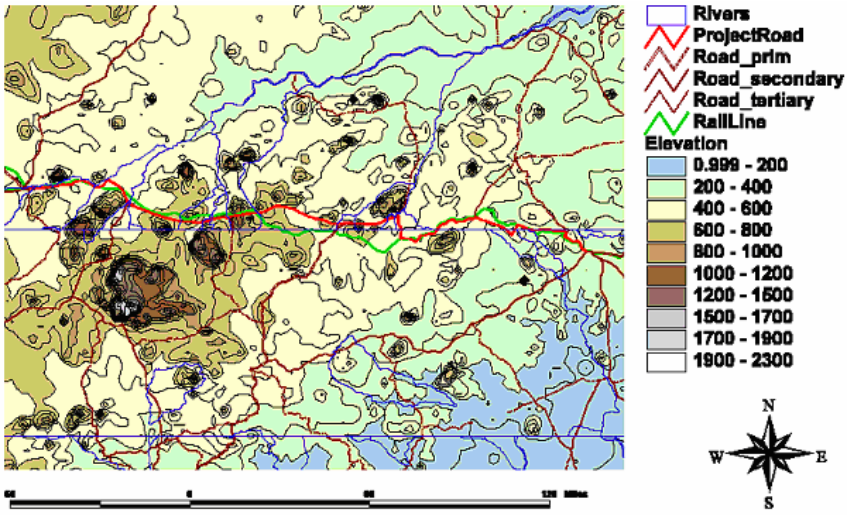


Figure 5.2.10 Topographic Map of the Project Site

Source: JICA Project Formulation Study Report 2006

r) Soil Erosion

Soil erosion is common on the road, particularly on some of the steep slopes. Annual rainfall is around 1,000 mm, but the rainfall intensity can be very intense washing out soils from the agricultural fields to the seasonal rivers.

s) Underground Water

There are some boreholes along the road. According to the local people, the underground water is fresh, found at about 10 to 30m depth.

t) Hydrological Situation

The N13 has approximately 40 bridges and 450 culverts on the section from Nampula to Cuamba.

The presence of bridges and culverts near Ribaue is especially high due to the existence of some mountain ranges. Most of the rivers and streams are seasonal, however rich water streams or rivers were confirmed at 26 points such as Mecuburi, Malema and Lurio even in dry season (see article “m) Water usage and rights”)

u) Coastal Zone (mangroves, coral reefs, tidal flats, etc.)

There are no coastal zones in the study area or otherwise sensitive habitat along the rivers.

v) Climate

The climate in the project site differs clearly between the rainy and dry season. Generally, the rainy season is from November to April, and the dry season is from May to October. Total annual rainfall is around 1,000 – 1,100mm. Average temperatures range from 20 to 26 degrees Celsius.

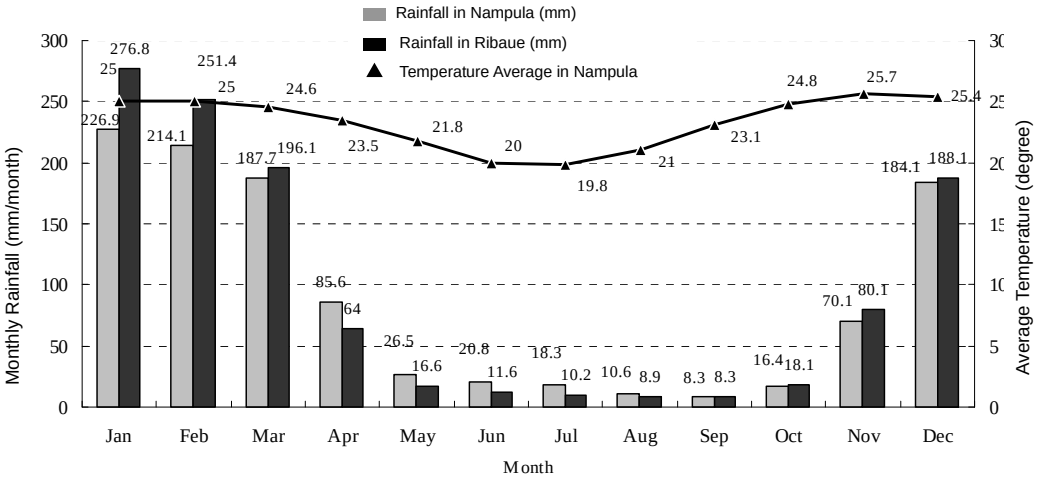


Figure 5.2.11 Rainfall and Temperature in Nampula and Ribaue

Source: NAMPULA data derived from the Global Historical Climatology Network, version 2 beta. 253 months between 1970 and 1991, RIBAUE data derived from the Global Historical Climatology Network, version 1 (GHCN 1) 593 months between 1916 and 1974, NAMPULA data derived from the Global Historical Climatology Network, version 1 (GHCN 1) 662 months between 1931 and 1990

w) Landscape

The landscape is categorized into two types: savanna plains and mountainous (rocky) areas. The most representative features of these areas are cashew nut trees and beautiful characteristic mountains called "Monad Knock" (see photograph).

Some of the mountains such as Mt. Ribaue and Mt. Mplawe are designated as forest reserves due to rich forests and water resources. It seems that some of the mountains are also g symbols of worship according to their traditional beliefs.

Figure 5.2.12 Typical Landscape at the site

source: JICA Study Team

- **Pollution**

x) Air Pollution

Most residents along the road, pedestrians, bicycles and passengers in open trucks suffer from terrible dust pollution along from the road.

At times high dust levels are believed to be the principal reason for traffic accidents.

Although Ambient Air Quality Standards (AAQS) such as NOx, SOx and CO have been established in the environmental policies in Mozambique, no significant air pollution (except dust) exists on the Study road due to the low traffic volumes.

Table 5.2.6 Environmental Standard Value for Air Quality

Parameter ($\mu g/m^3$)	Time of sampling			
	1 hr	8 hrs	24 hrs	Annual
Sulphur dioxide (SO_2)	800		365	80
Nitrogen dioxide (NO_2)	400		200	100
Carbon Monoxide	40,000	10,000		
Ozone	160		50	70
Total suspended particles			200	
Lead	3			0.5-1.5

Source: Decree nº 18/2004 of 2 June, Regulation for Environmental Quality Standards and effluents emission

y) Water Pollution

A total of 26 rivers and streams with permanent water are confirmed in the study area. It is observed that some of them are polluted by organic matters originating from residential areas such as Malema and Cuamba.

z) Soil Contamination

Soil contamination is not confirmed as an issue in the study area.

aa) Waste

Most residents live with a constrained financial budget which does not allow them to buy consumer goods. Therefore solid waste is not an issue at the moment.

ab) Noise and Vibration

Data for noise and vibration does not exist, and there are no complaints from residents regarding noise or vibration at the moment.

ac) Ground Subsidence

Ground subsidence is not an issue in the study area

ad) Odors

Offensive odors are not an issue in the study area.

5.2.2 Predicted Major Impacts by the Study Road

1) Project Outline

The project road alignment will follow an existing road. Road structures such as drainage, bridges and culverts will follow the same alignment. It is further expected that most of the existing gravel road will be paved.

The major concepts of design are as follows;

The Upgrading of the study road will essentially satisfy the geometric standards of SATCC for road safety; however, it is clearly important that the negative impacts on the social and natural environmental aspects be minimized. Accordingly, the following concepts of re-alignment were accepted through discussions between ANE and the Study Team.

- ✓ The existing centerline shall be followed in the towns and major villages sto minimize of the necessity of resettlement
- ✓ Other sections shall satisfy the SATCC Standards but should as much as possible take into account the existing centerline
- ✓ Bridges considered to be in good condition shall be used with a view to minimize the initial capital costs
- ✓ Two design speeds(80 and 100km/hr) were initially considered, but eventually the 80km/hr was adopted to reduce the cost and spare the environment

2) Project Activities by Stage

The project activities that may result in adverse direct impacts during the construction stage are: clearance of right of way, cutting and fill operations on slopes, escarpments and for creating embankments. Additionally borrow pits and quarries will be explored near the study road as required.

On the other hand, major indirect activities or changes will be observed after implementation of the construction works such as increased vehicle transportation

Table 5.2.7 Project Activities (by Stage)

	ACTIVITIES	DEGREE OF PREDICTED IMPACTS
During Construction	1. Clearance (Right of way, yard and base camp)	A
	2. Cutting land	C
	3. Creation of embankment	C
	4. Operation of heavy vehicles	C
	5. Labor's occupation in the base camp and around villages	B
	6. Establishment of borrow pits and quarries and their operation	C
Post Construction	1. Existence of the road and embankment	C
	2. Traveling of vehicles	E

A: Serious impact expected
B: Certain impact expected
C: Not clear, further detailed information is required
D: Minor impact expected
E: Positive impact expected

3) Environmental and Social Impacts by Stages

An outline of the expected positive and negative impacts by project stage and type of works is summarized and presented below

It is anticipated that the project activities may give rise to some adverse direct impacts such an involuntary resettlement and reduction of the biodiversity near the project site.

Both resettlement and biodiversity are therefore identified as key items in this project.

Table5.2.8 Predicted Impacts Outline

Items		Predicted Impacts			
		Rating	During Construction	Rating	Post Construction
Social Environment	1. Involuntary resettlement	A	Approximately 5,000 structures are located in right of way (each 30ms from road shoulder breakpoint). According to aerial photo with 80kms/hr alignment, approximately 600 affected structures were counted in COI / affected area. (see degree of impacts by alternatives in table 5.3.1)	B	Inappropriate resettlement process may give negative impact to project affected persons.
	2. Local economy, employment and livelihood	E	Most of workers for the project will be hired from nearest residential areas. Related consumption shall take place in the same residential area, which is likely to have a positive impact in the area.	C	Human migration may cause adverse impacts (both positive and negative)
	3. Land use and local resources utilization	C	Land use along the road is farmland. Such land may be expropriated depending on the new road alignment.	B	Design less urbanization, haphazard land development and expanding human activities will give serious impacts to local natural resources such as forest and water.

Items	Predicted Impacts			
	Rating	During Construction	Rating	Post Construction
4. Existing social infrastructures and services	B	There are some social infrastructures such as schools, hospitals and religious facilities located along the road. Such infrastructures may disappear depending on the new road alignment.	E	User of social infrastructures will be able to access easily all the year due to paved road. Additionally such easy accessibility may lead other social serve ices such as public transportation and water supply.
5. Local communities	C	According to the stakeholder meetings, all participants agree with this project. However detailed survey regarding ethnic groups is required. Major conflicts between communities should also be surveyed.	C	According to stakeholder meetings, all participants agree with this project. However detailed survey regarding ethnic groups is required. And major conflicts between communities should be surveyed.
6. Benefit and damage misdistribution	E	According to stakeholder meetings, all participants agree with this project. And most of workers for the project will be hired from nearest residential areas. Consumption shall take place in the same residential area, which is likely to have a positive impact in the zone.	E	According to stakeholder meetings, all participants agree with this project. And traveling cost and time will be reduced, and such benefit will be distributed fairly.
7. Gender	C	Work opportunities may not be fair in terns of gender balance. The main issues should be defined in ESIA survey.	C	Improvement of accessibility and provision of good condition road may reduce heavy daily works such as carrying water from wells and rivers, farming and household works. However men's migration through the new road may cause rise to a new kind of problem.
8. Children's rights	C	Detailed information regarding children's customs and right in the study area should be surveyed.	C	Improvement of accessibility and provision of good condition road may reduce heavy daily works such as carrying water from wells and rivers. However detailed information should be defined through survey in the ESIA
9. Cultural heritage	B	No world heritage or national monuments are located in the area nearby. However some local heritage sites such as worship places and graveyards along the road. New alignment and road expansion may cause adverse impacts.	D	No activities likely to cause adverse impact have been identified.
10. Local conflicts of interests	C	Basically no conflict between communities regarding this project has been identified. However these facts should be define in the ESIA survey	C	Basically no conflict between communities regarding this project has been identified. However these facts should be define in the ESIA survey
11. Public sanitation	C	Most of workers are from nearest residential area and stay there. Public sanitation facilities including toilets and water supply may improve as a result of additional earnings due to the project.	E	Traveling cost and time will be reduced through implementation of this project, resulting in a considerable economic benefit to the project area. This project will also improve public sanitation systems in the future.
12. Infectious diseases such as HIV/AIDS	B	Some of the workers are from outside of region. Possibilities of spreading sexually transmitted disease (STD) and other infectious diseases among workers and residents are a real threat.	B	Some residents will seek temporary employment opportunities in the nearest major city such as Nampula. This may increase the spread of infectious diseases

	Items	Predicted Impacts			
		Rating	During Construction	Rating	Post Construction
	13. Water usage and rights	B	New alignment may reduce number of existing wells or affect other water supply points which are used for bathing, drinking and laundry. As new alignment is not defined no detailed information is available.	E	Improvement of accessibility may reduce daily work load such as carrying water from wells and rivers.
	14. Traffic accidents	D	Some activities may cause adverse impact	B	Present dangerous alignments (tight corners and railway cross points) will be improved, but on the other hand, increased speeding may cause fatal accidents.
Natural Environment	15. Global warming	D	Some activities may cause adverse impact	D	Greenhouse gases volume will increase in comparison with 'no project scenario' due to natural traffic growth and traffic diversion from railway. According to a rough estimate, volume is approximately twice that of 'without project'
	16. Biota and ecosystems	D	A few rare and endangered species such as listed in the IUCN and CITES may be found in the area. The Ribaue and Malema sections of the road are located near a corridor of elephant migration. Although direct impacts by road improvements are not considered as serious and will be mitigated.	B	Although direct impacts by the road improvement are not considered serious, indirect impact such as uncontrolled development and expanding human activities will have a serious impact on the ecosystem. Deforestation and poaching are pointed out by some specialists as potential problems.
	17. Geographical features	C	Detailed information should be collected in the ESIA survey	C	Detailed information should be collected in the ESIA survey
	18. Soil erosion	C	Cutting steep slopes without appropriate design and erosion control may provoke soil erosion. Detailed information should be collected.	C	Cutting steep slopes and creation of embankment without erosion control may provoke soil erosion. Detailed information should be collected.
	19.Underground water	C	New alignment may reduce the number of existing wells.	D	No activities are likely to cause give adverse impacts
	20. Hydrological situation	C	Some activities may cause adverse impact Design of the drainage system will consider the watershed for protection of the road.	C	Some activities may cause adverse impact Design of drainage system will consider the watershed for protection of the road.
	21. Coastal zone	D	There are no vulnerable ecosystems such as mangroves or swampy areas	D	There are no vulnerable ecosystems such as mangroves and swampy areas
	22. Climate	D	No activities that cause adverse impacts	D	No activities that are likely to cause adverse impacts
	23. Landscape	C	Some quarries and borrow pits will be explored along the road, and landscape may change However such sited have not been identified yet	D	No activities likely to cause adverse impacts
Pollution	24. Air pollution	B	Earthworks and transportation of materials will provoke dust pollution.	D	Ambient air quality is expected to be the same as the present condition. Approximately a 1,000 vehicles a day is not likely to give any significant adverse impact to human health.
	25. Water pollution	D	Although re-construction activities for existing bridges and culverts at streams and rivers may give some adverse impact such as turbidity water and loss of washing places.	D	No activities are likely to cause adverse impacts

Items	Predicted Impacts			
	Rating	During Construction	Rating	Post Construction
26. Soil contamination	D	No activities likely to cause adverse impacts	D	No activities likely to cause adverse impacts
27. Waste	B	The labor workforce may result in solid waste and night soil in work site camp and its surrounding areas.	C	No activities likely to cause adverse impacts Illegal waste dumping along the road may occur.
28. Noise and vibration	D	Construction vehicles will drive along the existing road. Traffic noise is not likely to exceed 70 dB (A) for the daytime, and the impact is considered moderate due to the limited duration of the works.	D	Traffic noise levels are not available However it is predicted that calculated traffic noise after construction is likely to be less than 70 dB (A), thus not exceeding the WHO Guidelines.
29. Ground subsidence	D	No activities are likely to cause adverse impact	D	No activities are likely to cause adverse impact.
30. Offensive odors	D	No activities are likely to cause adverse impact	D	No activities are likely to cause adverse impact
31. Bottom sediment in sea and rivers	D	No activities likely to give adverse impact	D	No activities are likely to cause adverse impact

4) Proposed Mitigation Measures and alternatives by Stages

Alternatives

- With Project

Alternatives for new alignments are categorized into 2 options. The first is the alignment for a design speed of 80km/hr, and another for a design speed of 100km/hr. The 80km/hr alignment will largely follow the existing route, however the 100km/hr alignment may need to be realigned on some of the sections passing pass through a forest and some residential areas.

To avoid the realignment of the road and from an environmental, social and economic point of view, it is recommended adopting the 80km/hrs alignment.

The adopted clearance width (ROW) will also have a significant impact on the magnitude of resettlement. (see also table 5.3.1)

Table5.2.9 Comparison Between 80km/hr and 100km/hr Alignment

Alternatives / Indicator/Item		80km/hr Alignment	100km/hr Alignment
Economic	Construction cost	2.75 million USD	2.86 million USD
Environmental and Social	Main impacted area	Mainly within law based ROW of the existing road	Mainly out of ROW such as Agricultural land, natural vegetation and residential area
	Number of structures	COI are: 369	COI area: 571
	Other Issue	There will be few isolated residential areas from new road	There will be some isolated residential areas from new road

- Without Project

The 'without project scenario' will not cause any adverse environmental impact due to no congestion now. However, economic growth may be stagnant and levels of absolute poverty may grow as a result of this.

Mitigation Measures

Proposed mitigation measures are shown in Table 5.2.9 below

Table5.2.10 Proposed Mitigation Measures

Items		Proposed Mitigation Measures			
		Rating	During Construction	Rating	Post Construction
Social Environment	1. Involuntary resettlement	A	a) Construction of diversion road within the predicted affected area b) Holding stakeholders meetings at districts and municipal centres * The first stakeholder meetings have already been held in 4 districts and Nampula Municipality. A summary of the results is attached in appendix D c) Set up complaint register by relevant bodies d) Carry out appropriate Resettlement Action Plan (RAP) and compensation scheme under land law and Resettlement Policy Framework (RPF)	B	Change of living conditions for resettled persons should be monitored based on the RAP
	2. Local economy, employment and livelihood	E	Not required	C	Not required basically
	3. Land use and local resources utilization	C	Same mitigation measures are required as mentioned under item “Involuntary Resettlement”	B	Periodical monitoring of land use is required
	4. Existing social infrastructures and services	B	Same mitigation measures as mentioned under item “Involuntary Resettlement”. Reconstruction of social infrastructures that have been displaced	E	Not required
	5. Local communities	C	Not required	C	Not required
	6. Unfair distribution of benefits and negative impacts	E	Contractor? should hire labors from the nearest villages	E	Positive impacts should be monitored by interviews as against the base line survey
	7. Gender	C	AIDS prevention program Recruitment of women’s labor for construction	C	Positive and negative impacts should be monitored
	8. Children’s rights	C	Not required	C	Not required
	9. Cultural heritage	B	All local heritage and any kinds of sanctuary and religious symbols should be recorded in the baseline / topographic survey. These heritages must be conserved	D	Not required
	10. Local conflicts of interests	C	Holding of stakeholders meeting in district and municipal centers	C	Not required
	11. Public sanitation	C	Not required	E	Not required
	12. Infectious diseases such as HIV/AIDS	B	Healthcare education for workers and local residents	B	HIV/AIDS protection campaign should be carried out by relevant organizations
	13. Water usage and rights	B	The proponent should set up a new wells at appropriate place for water supply points that have been closed down	E	Not required
	14. Traffic accidents	D	a) Education on traffic rules and safety for workers b) Employing staff for traffic control and traffic safety	B	Traffic safety campaign by police and relevant organizations Installation of traffic safety facilities such as zebra crossing and sign boards in the town sections.

Items		Proposed Mitigation Measures			
		Rating	During Construction	Rating	Post Construction
Natural Environment	15. Global warming	D	Not required	D	Not required
	16. Biota and ecosystems	D	a) Minimize cutting trees along the road b) Setting up sign boards for elephant migration and crossings c) Re-planting trees along the road	B	a) Appropriate development plan and management of land use b) Control of illegal hunting and deforestation c) Management of forest reserves by ministry of agriculture
	17. Geographical features	C	Not required	C	Periodical monitoring and maintenance
	18. Soil erosion	C	Setting up slope protection	C	Periodical monitoring and maintenance
	19. Underground water	C	In the case of closing down drinking water supply, the proponent should set up new wells.	D	Not required
	20. Hydrological situation	C	Not required	C	Not required
	21. Coastal zone (mangroves, coral reefs, tidal flats, etc.)	D	Not required	D	Not required
	22. Climate	D	Not required	D	Not required
	23. Landscape	C	Not required	D	Not required
Pollution	24. Air pollution	B	Spraying water near residential areas to reduce dust level	D	Not required
	25. Water pollution	D	Adoption of cofferdam construction methodology for prevention of turbidity water	D	Not required
	26. Soil contamination	D	Not required	D	Not required
	27. Waste	B	Education for promoting waste separation and appropriate disposal	C	Setting up signboards for prohibition of littering
	28. Noise and vibration	D	a) Fixing construction work hours (daytime only) b) Consideration for praying times and Sundays	D	Not required
	29. Ground subsidence	D	Not required	D	Not required
	30. Offensive odors	D	Not required	D	Not required
	31. Bottom sediment in sea and rivers	D	Not required	D	Not required

5.3 Screening for Environmental and Social Consideration in the future

5.3.1 Basic Project Component and Current Status of Planning

Generally road works are categorized into four types; maintenance, rehabilitation, upgrading and new road construction. This project is categorized as a rehabilitation and upgrading project, including paving the existing road surface, but also re-alignment of

existing sections such as sharp curves and railway crossing points.

Options and alternatives for new alignments are not yet identified due to the non availability of the road topographical survey.

5.3.2 Focused Key Items

Serious impacts are not expected based on the pre-EIA, however some key items have been picked up through an initial environmental examination by ANE in cooperation with the JICA Study Team.

These key items are "Social impacts" such as resettlement and infection diseases, and "Biodiversity". The elephant migration corridor is an issue which was raised by the Ministry of Agriculture in Nampula. Resettlement is a major issue in any large development project. Some air and noise pollution levels will also occur in high density residential area.

Predicted impacts and required mitigation measures are as follows.

1) Social Issues

a) Resettlement

✓ Predicted impact for each of the alternatives

Approximately 5,000 structures are located in the right of way (within 30m from road shoulder). The exact impact is unknown until the new alignment is defined.

The affected number of structures will eventually depend on which alignment alternative is selected and also depend on the space needed for the project construction phase. With respect to the latter, three alternatives can be considered:

- Clearing of the full ROW (30m on either side of the shoulder breakpoint),
- Clearing of partial ROW (10m on either side, as has been adopted in the Lichinga-Montepuez Road Project
- Clearing the COI *note (corridor of impact: construction zone) (only 7m on either side of the shoulder meant for diversion of traffic and other activities related to the road construction)

According to the following table, at least 280 households may have to be relocated. Most of the families will be able to continue living in the same community due to existence of sufficient space for relocation.

Discussion on such definitions should take place at a later stage, based on the results of the detailed RAP.

*NOTE : Explanation of the **COI** (The Corridor of Impact)
COI means area which is affected and developed by construction of new road and diversion during construction period. Image of COI is shown in Figure 5.3.2

Table 5.3.1 Estimated Affected Numbers of Structures in ROW

Number of Alternative	Clearance Width of ROW (each side from road shoulder	Other Conditions	Number of All Structures	Estimated Number of Households (70% of all structures)	Number of Structures per 1km	Remarks
Alernative-1	Approximately 30m (total 60ms width 30 + 30 + road width without shoulder)	Including all towns and villages	4,694	3,286	14	Concept: Full-ROW 30ms of ROW is established by the Land Law
Alernative-2	Approximately 30 m (total 60ms width)	Excluding major villages and towns	2,427	1,699	7	
Alernative-3	Approximately 10m (total 20ms width 10 + 10 + road width without shoulder)	Including all towns and villages	1,565	1,095	5	Concept: Parcial-ROW The Lichinga –Montepuez Road adopted 15ms from the road centerline for clearance
Alernative-4	Approximately 10m (total 20ms width)	Excluding major villages and towns	809	566	2	
Alernative-5	Approximately 7m (total 14ms width 7 + 7 + road width without shoulder)	Including all towns and villages	1,095	767	3	COI concept Present road width + diversion during construction of the road
Alernative-6	Approximately 7m (total 14ms width)	Excluding major villages and towns	566	396	2	

✓ Number of Affected Structures in Case of Alternative 6:

The number of affected structures by the project has been counted based on aerial photographs. The results are shown in the next table.

The counting was done based on a total width of 24m consisting of a Carriageway 7.0m, road shoulder 3.0m and construction zone 14.0m -

Table 5.3.2 Counted Affected Structures based on Aerial Photo in case of Alternative 6

Number of Alternative	Clearance Width of ROW (from present road shoulder on each side)	Other Condition	Number of All Structures	Remarks
Alernative-6	Approximately 7m (total 14ms width)	Excluding major villages and towns	369	COI concept Present road width +diversion during construction of the road

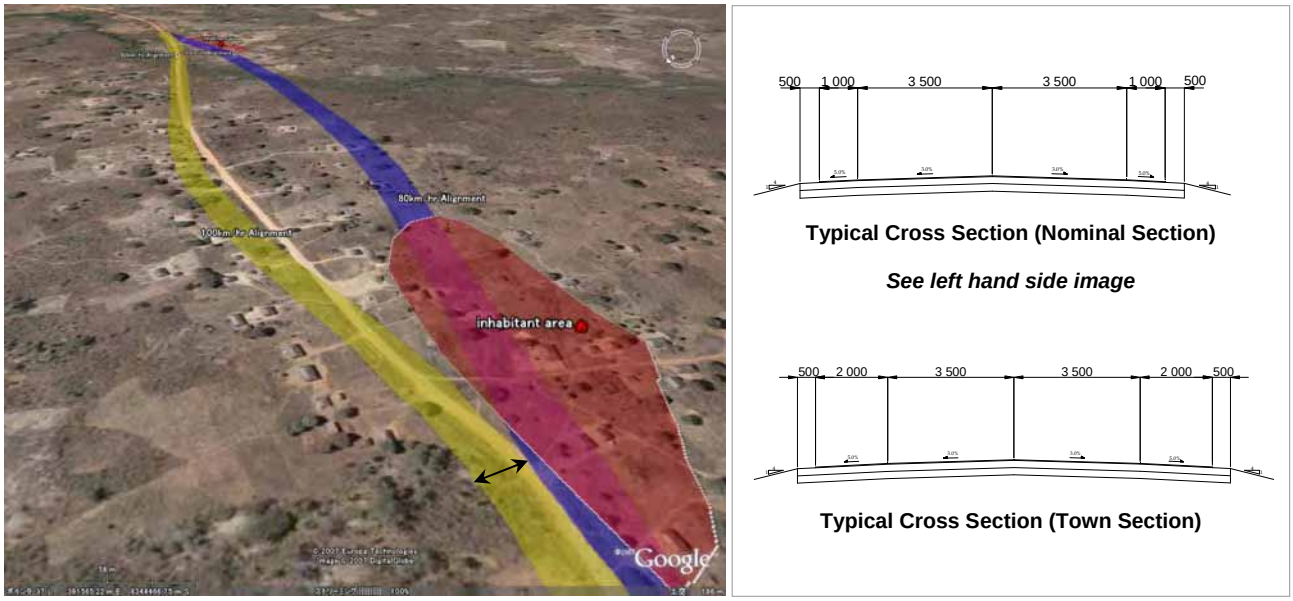


Figure 5.3.1 Typical image of Affected Structures by Road Expansion at change 169kms Point (Rural Area Section)

✓ Proposed Mitigation Measures at this stage are:

a) Alternative 6 should be adopted for minimization of resettlement (**COI** Concept(Construction Zone concept))

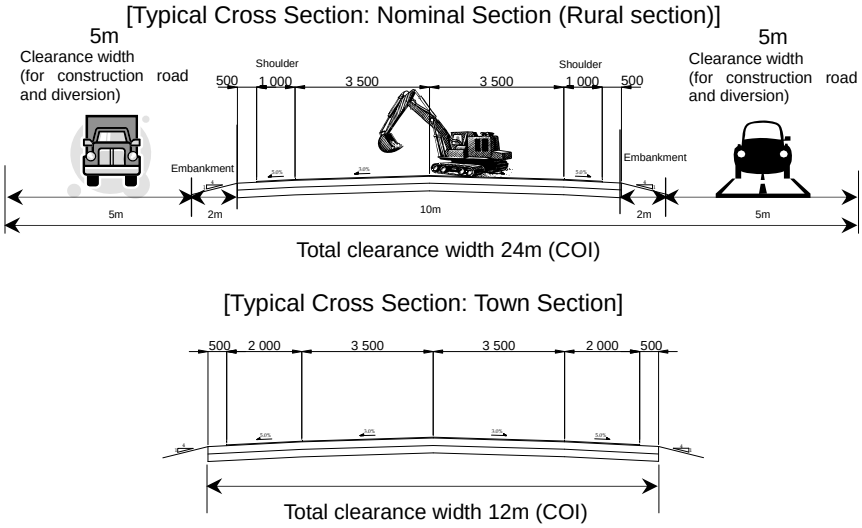


Figure 5.3.2 Construction Zone Concept f(Limiting Affected Area)

For the rural sections of the road, the clearance width in the ROW should be limited with less 7m to minimize resettlement. In the town sections, basically construction activities should be carried out within the present road width to spare the high density residential areas along the road.

b) Holding meetings with the affected persons

c) Setting up of a complaint register by relevant bodies (ANE and the provincial authorities)

d) Carrying out a Resettlement Action Plan (RAP) and pay compensation under the land law and Resettlement Policy Framework (RFP)

b) Infection Diseases

✓ Sexual Transmitted Diseases (STDs)

In construction phase, project base camp of constructor will be constructed in the project site. It is estimated that roughly 2,000 labors per day will work in the site, and more than 90% of them are from project site. Generally such concentration of labors creates downtown with commercial sex workers, and STDs such as HIV/AIDS are spreading in the project site. Therefore ANE should control labors behavior in some ways such as STDs education and supply of condom during construction from the view of protection STDs.

Furthermore human migration between rural area and prime towns/cities is one of the reasons for spreading STDs post construction. Hence not only ANE but also relevant organizations should mitigate spreading STDs in some ways such as campaign.

2) Biodiversity: Elephant Migration Corridor

✓ Anticipated Impact

The Ribaue and Malema sections of the road are located near the corridor of elephant migration. Although direct impacts by the road improvement are not marginal, indirect impacts such as uncontrolled land development and other human activities will have serious effects on the elephant corridor.

✓ Proposed Mitigation Measures at this stage:

For direct impacts (measures to be implemented mainly by the project proponent)

a) Minimize cutting of trees along the road

b) Setting up sign boards to alert drivers on elephant migration routes

c) Re-planting trees along the road

For indirect impacts (by responsible organizations)

a) Preparing development plans and management of land use

b) Control of illegal hunting and deforestation

c) Management of forest reserves

3) Pollution and Other Items

With regard to pollution, even though currently not much attention is being paid to this issue in Mozambique,traffic volume is expected to increase by a factor 30 times at some of the road sections in the future, This will cause negative impacts, and such issues

were pointed out by the JICA's environmental and social consideration committee. Therefore, a quantification of expected pollution through modeling and by taking relevant samples will be required.

The magnitude of these impacts for the scope of this study will be indicated by NO2 levels and noise pollution

✓ Air quality

According to the traffic forecast, approximately 1,200-1,300 vehicles a day are expected in the year 2026 (see table 5.3.3).

Table 5.3.3 Traffic Number in the Target Year (2026)

LEG	Present 2006	Target Year 2026 (80km/hr)
Nampula-Ribaue (24hs survey data*)	453 /day	1379 /day
Ribaue-Malema (converted data from 12hr to 24hr)	36 /day	1184 /day
Malema-Cuamba (converted data from 12hr to 24hr)	141 /day	1223 /day

*: Average number of 3 days in the second traffic survey for 24hrs at the station 24h-1

The 'Plume and puff' methodology will be adopted as an atmospheric diffusion modelto forecast air quality. This forecast methodology requires hourly wind direction,wind velocity and a reference background air quality .

However such information obtained from weather stations that monitor wind and air quality does not exist in the Study area. Thus, the study team opted for use of a case study to forecast the air pollution for the Study road.

The example is from Tokyo Japan, and shows the following air quality data;

Table 5.3.4 Air Quality in Tokyo

		a) In the Residential Area	b) along the road*1	Distribution Concentration from Vehicles b) – a) (%) of total concentration	Environmental Standard Value	
					Mozambican	Japanese
NO_2	hourly. Max.	0.101	0.108	0.007ppm (6.5%)	0.426ppm	-
	daily Ave.	-	-	-	0.194ppm	-
	an. Ave.	**0.024ppm**	**0.037ppm**	**0.013ppm (35.1%)**	0.043ppm	0.04ppm
SO_2	hourly Max.	-	-	-	0.426ppm	0.1ppm
	daily Ave.	-	-	-	0.194ppm	0.04ppm
	an. Ave.	-	0.002ppm	-	0.043ppm	0.04ppm
CO	hourly Max.	-	4.3ppm	-	34.360	-
	8 hours Ave.	-		-	8.590	20ppm
	an. Ave.	-	0.8ppm	-	-	10ppm

Note)

-a) Residential Area station: Tachikawa city Nishiki-machi in Tokyo, b) along the road station: Koshu-kaido kunitati in Tokyo

- Data was obtained from the web-site http://soramame.taiki.go.jp National Institute for Environmental Studies in Japan 2004

- * GOM standard is converted to Japanese Units (ppm)

NO2: 1 ppm nitrogen dioxide = 1880 μg/m3, 1 μg/m3 nitrogen dioxide = 5.32 × 10–4 ppm

SO2: 1 ppm (20 °C, 1013 hPa) = 2660 μg/m3, 1 mg/m3 = 0.3759 ppm

CO: 1μg/m3 carbon monoxide = 8.59 × 10–4 ppm

*1: National Trunk Road Route 20 : daily traffic volume is 38,350 (Kunitachi city Yaho5128)

According to the above data, the annual average of the background air quality concentration of NO2 is 0.024ppm, and the contribution of vehicle emission in the NO2 concentration is estimated at 0.013ppm annual average respectively. It means that approximately 40,000 vehicles a day contribute to only 35% of the total NO2 concentration along the road. These values do neither exceed the Japanese environmental standard value nor the Mozambican standards.

The traffic volume of a 1,000 vehicles a day projected for the Study road in the year 2026 is estimated to only contribute 2-3% of the NO2 values in the total background concentration. These levels are is not likely to cause any significant adverse impacts to the local residents' health.

✓ Noise

The MOG does not establish an environmental standard for permissible noise level at the moment. Therefore some criteria should be adopted from other relevant organizations such as the Japanese Government or the World Health Organization (WHO).

The main criteria for noise levels are as follows;

Table 5.3.5 Noise Criteria in some guidelines

	Criteria	Description
WHO	70 dB(A) Laeq24	Industrial, commercial shopping and traffic areas, indoors and outdoors
Japanese	70 dB(A) Laeq Daytime 65 dB(A) Laeq Night time	Along trunk roads

Note) Laeq: Equivalent level with an A frequency weighting
- WHO: WHO Guidelines for Community Noise, Japanese: Environmental standard value

With regard to the noise prediction methodology, a formula will be proposed by the JICA study team which is based on the Acoustical Society of Japan.

Outline of the formula is as follows;

[ASJ Model 1998]

ASJ Model-1998 predicts equivalent continuous A-weighted sound pressure level according to energy-based calculation. In this model, the first step is to calculate the time history of A-weighted sound level at the receptor point caused by an isolated vehicle passage on the road (lane) under consideration. This gives a "unit pattern" (for each vehicle type and for each lane of a particular road under consideration) at a receptor point. By squaring and integrating the unit pattern, total sound pressure exposure over the time interval during which the source passes the lane under consideration is obtained. The quantity expressed in dB(A) of the total sound pressure exposure is sound exposure level (L_{AE}). By considering the traffic volume, equivalent continuous sound pressure (A weighted) level (L_{Aeq}) for a particular lane is obtained by using the following equation:

$$L_{Aeq}(without\ buildings) = 10\log_{10}(10^{L_{AE}/10}\frac{N}{T}) \quad (1)$$

where, N is traffic volume (vehicles/ second) and t is time interval in seconds.

The calculation mentioned above is carried out for all the lanes of the road under consideration and for all vehicle type, and finally L_{Aeq} is calculated by combining these results on energy base (for detailed calculation procedures refer to Tachibana [4], Oshino [7] &Yamamoto [8]).

Precise calculation of multiple scattering, diffraction and reflection, is practically very difficult in built-up areas. The problem is approached by statistical methods to predict noise level in such area. In this case ASJ Model-1998 provides a method for estimating sectional energy-averaged equivalent continuous A-weighted sound pressure level ($\overline{L_{Aeq}}$) which is calculated by the next equation:

$$\overline{L_{Aeq}} = L_{Aeq,T} + \overline{\Delta L_{builds}} \quad (2)$$

where, $L_{Aeq,T}$ is the predicted noise level assuming no buildings are present (see eqn (1)) and $\overline{\Delta L_{builds}}$ is the sectional energy-averaged excess attenuation by the buildings. $\overline{\Delta L_{builds}}$ is calculated according to the density of the buildings and the distance from road to the evaluation section, by summing the sound-energy contributions from the sound paths propagating through the buildings and over them . In this model the buildings are classified as first row of buildings (FRB) directly facing a road and the rear group of buildings (RGB) behind it.

$$\Delta L_{builds} = \log_{10}(\frac{C_1 + C_2 + C_3}{C}) \quad (3)$$

where,

- C is the sound-energy contributing from the line source without buildings;
- C_1 is the contribution from Path 1 which propagates through both FRB and RGB;
- C_2 is the contribution from Path 2 which propagates over FRB and through RGB;
- C_3 is the contribution from Path 3 which propagates over both FRB and RGB; (see fig. 1)

Detailed calculation procedure can be found in Uesaka [1]. The method has been validated by field survey in Tokyo. The values calculated by the method are in good agreement with the measured data [1].

A prediction of the noise level assuming 1,000 vehicles a day in major towns is shown in the next table.

The result is not exceeding the permissible 70dB(A) and therefore satisfies the proposed norms.

Table 5.3.6 Predicted Noise Level

Item / Target Year		Predicted Noise Level		Criteria (Japanese Standard Value)
		In Town 60km/h	Out of Town 80km/h	
Present calculated noise level (2006)	0600-2100	60.2 dB(A)	61.7 dB(A)	70 dB(A)
	2100-0600	55.5 dB(A)	57.0 dB(A)	65 dB(A)
Future's calculated noise level (2026)	0600-2100	66.5 dB(A)	68.0 dB(A)	70 dB(A)
	2100-0600	62.2 dB(A)	63.7 dB(A)	65 dB(A)

Note)
-Check point: in front of Bamboo restaurant Nampula Municipality, at shoulder of the road 1.2m height.
-Estimated traffic volume: 1379 vehicles a day (based on this FS report, see table 5.3.2)
-Traffic pattern: refer to the value of the baseline survey at station 24-1 (average date in the second survey)
- Typical cross section is shown in Chapter 6

As shows in the above table, noise levels will increase due to higher traffic volumes , however on the other hand, driving noise from surface of existing gravel road and squeak noise from vehicles will decrease due to paving. Hence, this project is not likely to give any significant adverse impact to the inhabitants.

✓ Global Warming

As mentioned in previous article, the formula for the production of greenhouse gasses is given in following table.

Table 5.3.7 Formula for CO2 Emission

Year	Vehicle Category	Formula for Estimation of CO2 Emission (g-CO2/km)
2000	Passenger car / Mini bus	$EF= 1524.94/v – 2.9973v+0.02494v^2+202.844$
	Big bus / Cargo truck	$EF= 50.6414/v – 27.313v+0.20876v^2+1592.74$
2010	Passenger car / Mini bus	$EF= 1427.33/v – 2.8375v+0.02360v^2+191.762$
	Big bus / Cargo truck	$EF= 50.2788/v – 27.312v+0.20876v^2+1592.69$
2020	Passenger car / Mini bus	$EF= 1353.01/v – 2.7243v+0.02264v^2+183.809$
	Big bus / Cargo truck	$EF= 50.2141/v – 27.312v+0.20876v^2+1592.67$

Source: Ministry of Land, Infrastructure and Transport in Japan

The current and future level of greenhouse gases is estimated in the next table.

The current volume is estimated at approximately 77t/day. For the projected year 2026, the levels without and with the project are respectively 136t/day and 264t/day. The estimated volume of greenhouse gasses with the project in 2026 is about twice of the scenario "without project". This forecast demonstrates that although the impact cannot be ignored in the project site, however the total number of vehicles and gas emission in the country

stays almost at the same level.

Table 5.3.8 Estimated Greenhouse Gasses Volume

Case \ Item		Traffic Volume (Nampula-Ribaue)			Average Speed	Unit volume g-CO2/km a vehicle		Estimated Volume (t/day)
		Total	Small	Large		Small	Large	
2006 (present)		453	277	176	29km/hr	186	963	77
2026 (target year)	With project	1379	435	944	80km/hr	128	744	264
	Without project	693	349	344	29km/hr	168	963	136

Note) most of vehicles in the site are old model 6-7 years ago, thus unit volume is adopted 2000 for present 2006, 2020 for target year 2026

5.3.3 Evaluation of Environmental Screening based on relevant guidelines

The environmental procedures are based on Mozambique's EIA regulation. These procedures have not commenced as yet for this project. According to MICOA, this project will be classified as a category "A", due to the project scale and the potential re-alignments.

In the study team's understanding, "resettlement" and "setting back" are not the same magnitude of negative impacts. "Resettlement" means relocation to another community with inherent impacts such as separation of traditional communities and inaccessibility to their farmland, wells, schools and so on. On the other hand, "setting back" is a relocation within the same community, in almost equal living conditions. Hence "setting back" is considered to have a less serious impact than relocation to other communities.

Table 5.3.9 Criteria for identification of EIA Category

Law or Guidelines	Category Criteria	Tentative Result of Screening
1. Mozambique's EIA Law	Ⓐ Category A: Req. EIA New road construction in rural area Sensitive area (more than 50ha felling), infrastructure, agricultural, industrial development projects Ⓑ Category B: Req. IEE (EAS): Minor impacts expected than Category A) Ⓒ Category C: no IEE/EIA required: (Few to no impacts expected)	According to MICOA, ANE (UASMA), thr project will be classified as typeA
2. JICA's Environmental and Social Consideration Guidelines	Ⓐ Category A: Req. EIA Major impacts projects Ⓑ Category B: Req. IEE: (Minor impacts expected than Category A) Ⓒ Category C: no IEE/EIA required: (Few to no impacts expected)	Category B (according to the first screening)
3. Japan Bank for International Cooperation's Environmental Guidelines	Ⓐ Category A: Req. EIA Major impacts projects (road projects; 4 carriage ways or exceed 10km distance), significant impacts for social and natural environment (the number of resettlements, sensitive habitats) Ⓑ Category B: Req. IEE (EAS): Minor impacts project than Category A Ⓒ Category C: no IEE/EIA required: Few to no impacts expected	Category A (if the number of resettlement exceeds 50 households or 100 inhabitants)
4. African Development Bank's Integrated Environmental and Social Impact Assessment Guidelines	Category 1: projects require a full ESIA, including the ESMP. These projects are likely to induce important adverse environmental and/or social impacts that are irreversible, or to significantly affect environmental or social components considered sensitive by the Bank or the borrowing country. The ESIA examines the project's potential beneficial and adverse impacts, compares them with those of feasible alternatives (including the "without project" scenario), and recommends any measures needed to prevent, minimize, mitigate or compensate for adverse impacts and to enhance environmental and social project benefits. Category 2: require the ESMP. These projects are likely to have detrimental and site-specific environmental and/or social impacts that are less adverse than those of Category 1 projects and that can be minimized by the application of mitigation measures or the incorporation of internationally recognized design criteria and standards. Category 3: require no impact assessment These projects shall involve no adverse physical intervention in the environment and induce no adverse environmental or social impact. Beyond categorization, no further ESA action is required for this category of project.3 Category 4: projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental and/or social impacts. FIs include among others banks, insurance and leasing companies, and investment funds that on-lend Bank's funds to small and medium size enterprises (refer to the Glossary). FI responsibilities under the ESAP are outlined in Annex 6	According to AfDB in Maputo, the project will be classified as a Type 1 project (required detailed EIA)

5.3.4 Proposed Activities on Environmental Impact Assessment

As discussed in the proceeding paragraph, a full detailed EIA, based on Mozambique's guidelines is likely to be required by MICOA. JICA, on the other hand, would classify it as a type B project which would require only an IEE as required by the degree of the expected impacts.

The Study team concludes that conducting a full EIA as required by the Mozambique's

guidelines is considered reasonable and appropriate

5.3.5 Scoping for Environmental and Social Considerations in the future

1) Scope Items and their Methodologies

As mentioned above, execution of a detailed EIA is expected in the course of 2007.

Proposed items and methodologies for the baseline survey and the impact forecast are as presented below.

These items and methodologies are taken from the following regulations and guidelines:

- ✓ Mozambique
  - -Environmental Guidelines for Road Works in Mozambique, 1997
  - -Environmental Directive for the Roads Sector, 2002 MICOA
- ✓ JICA guidelines
  - -Environmental and Social Consideration Guidelines, 2003 JICA
- ✓ JBIC guidelines
  - -JBIC Environmental Guidelines, 2002 JBIC
- ✓ AfDB guidelines
  - -Environmental and Social Assessment Procedures for African Development Bank's Public Sector Operations, 2001 AfDB
  - -Integrated Environmental and Social Impact Assessment Guidelines, 2003 AfDB
  - -Involuntary Resettlement Policy, 2003 AfDB
  - -African Development Bank Group's Policy on the Environment, 2004 AfDB

Table 5.3.10 Baseline Survey Items and Methodology

-	No	Item	Physical Site Survey Methodology	Quanti-tative data	Use GIS
Human Environment / Social Environment	1	Migration and resettlement	Count all structures in the affected area due to the re-alignment of the road, and survey resettlement costs based on RFP by WB /ANE. The consultant should use aerial photo, if provided by ANE Explain resettlement and compensation procedures based on relevant laws and guidelines such as Land Act and RFP by WB/ANE.	+	+
	2	Local economy, employment and livelihood (including quality of life, fuel price increase)	Interview survey by district, and preliminary site survey (Main sources of business, income, livelihood and commodity prices. etc.)	+	
	3	Land use and local resources utilization	Interview survey by district, and preliminary site survey (Aerial photograph must be used in the GIS analysis)		+
	4	Existing social infrastructures and services (accesses to	Survey social infrastructure by location using a GPS and Mapping (school, public buildings, hospitals, meeting places and so forth)	+	+
	5	Local communities/ Ethnic group and aborigine	Survey all communities / tribes / language groups (area, population and relevant issues) in site survey and interview district offices. Collection their opinions regarding this project through SHM.	+	+
	6	Benefit and damage misdistribution and Local conflicts of interests	Survey presence of local conflicts by interviewing district offices Collection of information through SHM		
	7	Gender	Interview with relevant government institutions, key women's group, NGO's and district offices (Define present issues and activities)		
	8	Children's rights	Interview with relevant government institutions, NGO's and district offices (Define present issue and activities)		
	9	Cultural heritage (sanctuary, local heritage)	Survey and map all cultural heritage sites 's location by using GPS (religious places, , sanctuaries, historical monuments and so forth) Mapping in the site survey	+	+
	10	Communicable diseases and Non-communicable diseases	Collection of statistical data. Interview with relevant government institutions NGO's and district offices (Define present issue and activities)	+	+
	11	Public sanitation	Interview with relevant government institutions NGO's and district offices (Define present issue and activities)		
	12	Water usage and rights	Survey major sources for drinking water (wells, rivers, etc.…. Record and map locations using GPS. Mapping in the site survey And confirm existence of water usage rights through interviews with relevant government institutions and district offices (Define present issue and activities)	+	+
	13	Traffic accidents	Interviews with police and relevant government institutions (Define present issue and activities)	+	+
	14	Information, education and communication	Interview with relevant government institutions, NGO's and district offices (Define present issue and activities)		

-	No	Item	Physical Site Survey Methodology	Quanti-tative data	Use GIS
	15	Democratic trend	Interview with relevant government institutions, NGO's and district offices (Define present issue and present activities)		
	16	Participation (Consultations, Civil Society strengthening)	Survey in interview with relevant governmental section, NGO's and district office (Define present issue and present activities)		
	17	Social instability	Survey in interview with relevant governmental section, NGO's and district office (Define present issue and activities)		
Pollution	18	Air pollution	Measure dust pollution along the road and the surrounding areas for confirmation of impacts. (Measure weight of dust per day perm2)	+	
	19	Water pollution	Measure turbidity in rivers which residents are using for drinking water, laundry and bathing (rainy season/dry season)	+	+
	20	Soil contamination	Survey history of land use along the road through interviews with relevant government institutions and district offices. (Biochemical factory, leather factory and existence of hazardous material)		+
	21	Waste	Survey solid and liquid waste management and systems through interviews with relevant government institutions and district offices. Estimate waste volume.	+	+
	22	Noise and vibration	Measure ambient noise level and traffic noise by proper instruments (equivalent noise dB (A)) along the project road and the Nacala– Nampula road	+	+
	23	Ground subsidence	Survey such phenomenon through interviews with relevant government institutions and district offices.		
	24	Odors	Survey such phenomenon through interviews with relevant government institutions and district offices.		
	25	Bottom sediment in sea and rivers	Survey such phenomenon through interviews with relevant government institutions and district offices.		
	26	Hazard management	Survey through interviews with relevant government institutions and district offices. (define existence of any management systems)		
Physical and Natural Environment	27	Global warming	Estimate present emission of greenhouse gases by using unit rates of emission and current traffic volume.	+	
	28	Biota (Flora, Fauna), ecosystems and natural heritage	Flora - Preparation of vegetation map by physical site survey (define all vegetation along the road) Flora and Fauna - Check protected species along the road and the future alignment based on IUCN list, CITES list, etc… through interviews with residents and relevant organizations (Mapping by GPS is required) - Define major routes of elephant migration (Mapping by GPS is required) - Define major ecosystem by vegetation type	+	+
	29	Geographical features	Survey precious geographical sites and map in site survey		+
	30	Soil erosion and stability of slopes	Survey soil erosion and instable slopes in preliminary site survey and mapping by GPS		+

-	No	Item	Physical Site Survey Methodology	Quanti-tative data	Use GIS
	31	Underground water	Survey major wells for drinking water and natural springs. Record all locations by GPS and Map in the site survey.	+	+
	32	Hydrological situation	Survey major river basin in preliminary site survey, and show these basins as diagrams on the map.	+	+
	33	Coastal zone (mangroves, coral reefs, tidal flats, etc.)	Survey major ecotone (transition zone between water edge and land) and precious habitats through fauna-flora survey. Record all location by GPS and map		+
	34	Climate	No need for a physical site survey, but literature survey is required from the weather stations.	+	
	35	Landscape	Take pictures of aesthetic landscape and record locations by GPS.		
	36	Natural disasters	Survey major disasters (floods, earthquakes and typhoons) and show them as diagrams on the map.	+	

Table 5.3.11 Impact Forecast and Evaluation Methodology

-		No	Item	Prediction Items/Methodology	Quanti-tative data	Use GIS
Human Environment	Social Environment	1	Migration and resettlement	- Counting of number of resettlement cases (by using aerial photo which will be provided by ANE) - Cost estimation and preparing plans *Detailed information and mitigation measure must be described in the RAP	+	+
		2	Local economy, employment and livelihood (including quality of life, fuel price increase)	Describe degree of change		
		3	Land use and local resources utilization	Describe degree of change (Forest , agricultural and urban areas)		+
		4	Existing social infrastructures and services	Describe degree of change (Accesses to infrastructure, and change of services)		+
		5	Local communities/ Ethnic group and aborigine	Describe degree of change		
		6	Benefit and damage misdistribution and Local conflicts of interests	Describe degree of change		
		7	Gender	Describe degree of change (change of women's activities)		
		8	Children's rights	Describe degree of change (change of children's works)		
		9	Cultural heritage (sanctuary, local heritage)	-Number of cultural sites and locations along the new alignment -Cost estimation of displacement / relocation	+	+
		10	Communicable diseases and Non-communicable diseases	Describe degree of change (predict number of cases based on previous road projects "with" and "without" mitigation measures	+	
		11	Public sanitation	Describe degree of change		

-	No	Item	Prediction Items/Methodology	Quanti-tative data	Use GIS
	12	Water usage and rights	-Number of cultural sites and location along the new alignment	+	+
	13	Traffic accidents	Describe degree of change		
	14	Information, education and communication	Describe degree of change		
	15	Democratic trend	Describe degree of change		
	16	Participation (Consultations, Civil Society strengthening)	Describe degree of change		
	17	Social instability	Describe degree of change		
Pollution	18	Air pollution	Literature survey should be carried out due to low traffic volume.	+	
	19	Water pollution	Describe degree of change during construction phase		
	20	Soil contamination	No need (generally such contamination will not be expected for the road project)		
	21	Waste	Describe degree of change		+
	22	Noise and vibration	- Post Construction phase Calculate the sound level in 20 years after construction of the road (use forecasted traffic volume after 20 years) -During Construction phase Refer to other examples or calculate estimated noise level	+	
	23	Ground subsidence	Describe degree of change		
	24	Offensive odors	Describe degree of change		
	25	Bottom sediment in sea and rivers	Describe degree of change		
	26	Hazard management	Describe degree of change		
Physical and Natural Environment	27	Global warming	Estimate greenhouse gases and compare between current and future situation	+	
	28	Biota (Flora, Fauna), ecosystems and natural heritage	- Calculate loss of vegetation by area and type along the new alignment, and show them on the map - Number of species lost, and their location - Predicted ecosystem pattern before/after construction of the road	+	+
	29	Geographical features	- Number of precious sites lost		
	30	Soil erosion and stability of slopes	Describe degree of change (identify areas with potential erosion problems)		
	31	Underground water	- Number of lost wells and springs along new alignment - Estimate size of affected area and number of residents	+	+
	32	Hydrological situation	Describe degree of change		+
	33	Coastal zone (mangroves, coral reefs, tidal flats, etc.)	Describe degree of change		+
	34	Climate	Describe degree of change (impact by cutting land areas or mountain)		

-	No	Item	Prediction Items/Methodology	Quanti-tative data	Use GIS
	35	Landscape	Describe degree of change (Loss of aesthetic landscapes and their location)		
	36	Natural disasters	Describe degree of change (Predict a degree of weakness by disasters)		

2) Recommendations for the EIA and Design

The following are the recommendations for the EIA and the Design.

a) TOR for EIA

- Mozambique's EIA guidelines cover most of the important issues that are included by other relevant guidelines such as those from JICA, JBIC and AfDB. However Mozambique's guidelines do not present much detail on social areas. These social items should be added to the TOR for the EIA.
- With regard to the stakeholder's meetings, ANE in cooperation with JICA has held preliminary meetings in November 2006 with the affected persons. However ANE should hold additional other stakeholder meetings for those directly affected by the resettlement action plan after the new alignment has been confirmed.

  ANE should divide the RAP in 2 stages, namely as a "preliminary RAP"in the feasibility study phase and as a "detailed RAP" in the detailed design stage (detailed information will not be available for completion of the RAP during the feasibility study).
- The main issues identified such as resettlement, elephant migration and the spread of infectious diseases should be picked up. With regard to the infectious diseases, HIV/AIDS in particular, it was noted that most of the women in the Study Area have little knowledge about prevention. Such themes should be raised and explained in the stakeholder meetings.

b) Alignment of the road

According to SHM, there are local cultural heritage sites (worship places graveyard, sanctuaries) and social infrastructure along the present alignment of the road. These can not be relocated. These sites should be recorded in the topographic survey, and should be considered when deciding on the new road alignment. It means the following design concepts should be adopted:.

- 80km/hr driving speed
- alignment which is following as much as possible the existing road

- Clearance width should be minimized to approximately 7m each side from the shoulder of the new alignment (see Figure 5.3.2)

c) Planning of Bridges and Culverts

Most residents suffer from shortages of water supply, except for Nampula Municipality and the district capital towns. Residents transport water from rivers, streams and ponds. Such precious sites should be recorded on the topographic survey and considered in the EIA baseline survey. The planning of bridges / culverts should be carefully evaluated to preserve such important resources.

d) Appropriate Environmental and Social Consideration for other relevant activities

Key activities for the project consist of road rehabilitation and exploring new quarry and borrow pits. According to ANE's experiences, it is possible that environmental permission will be issued on both issues in the same ESIA. However, detailed information for exploring the quarry and borrow pits is necessary for analysis and evaluation of the ESIA such as location and estimated volume of soils / stones to be extracted.

This information should be revised in the detailed design phase.

During the detailed design phase, ANE should also submit detailed plans to MICOA in Nampula for opening up of the quarries and borrow pits, accompanied by a standard application form attached to apply for an environmental license from the Ministry of Mineral Resources in Nampula.

According to interviews with ANE Maputo, such procedures for opening the quarry must be done during the detailed design phase.

e) Securing of Labor Environment by Demining

According to the Mozambique National Demining Institute, it is suspected the project site is located in the mining area. Hence ANE should confirm detailed information from relevant organization during detailed design stage, and collect practical information from inhabitants in the public consultation of the EIA.

5.4 Current Progress of Environmental and Social Considerations in Mozambique

UASMA in ANE will undertake the required EIA procedures based on the following proposed timetable (Table 5.4.1) as proposed by JICA in May 2007.

ANE has contracted an environmental consultant for carrying out the study and present the ESIA report by October 2007. And ANE will be able to receive an EIA approval from

MICOA by end of 2007.

Table 5.4.1 Proposed EIA Timetable and Current Progress (2006-2007)

Year/Month / ITEMS		2006	2007										
		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Preparation of pre-TOR and Collection of comments by MICOA and AfDB														
Tendering/Negotiation with local consultant														
Baseline survey														
Preliminary RAP														
SHM (public consultation for ESIA)										1st		2nd		
Review and Approval Procedures by MICOA and ANE														
Submission of Report	Baseline Survey										△			
	ESIA+Pre-RAP											△	▲	

△: Interim report ▲ Draft report

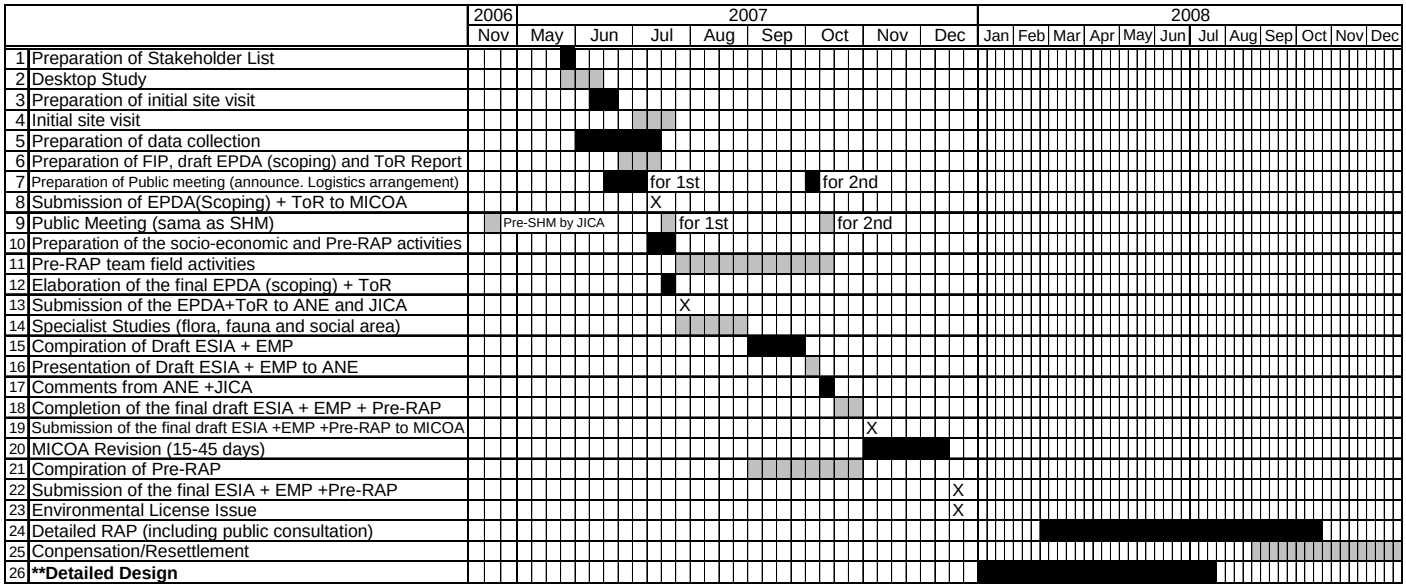
Table 5.4.2 Proposed Environmental Activities after Approving of EIA (2008-2011)

Year/Month / ITEMS	2008												2009 - 2011
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Detailed Road Design													
Detailed RAP													
Implementation of Compensation for resettlement and cash crops													
Construction 2009-2011 Nampula-Ribaue: 132km Ribaue-Malema:103km Malema-Cuamba:113km													

△: Interim report ▲ Draft report

In this feasibility study, only a preliminary RAP will be carried out as no detailed design is available. Because the environmental law prescribes to submit an EIA, and not only a RAP. Thus a more detailed RAP will be carried out during the detailed design phase, and compensation & resettlement will be conducted after the detailed RAP preparation.

Table 5.4.3 Proposed Detailed ESIA Activities (ANE)



Chapter 6 Applicable Design Standards

Chapter 6 Applicable Design Standards

6.1 Introduction

The application of a proper design standard will ensure that the following objectives are achieved:

- Ensure safety, a high standard service level and comfort for road users by the provision of adequate sight distance and roadway space,
- Ensure that the roadway is designed economically
- Ensure uniformity in the design
- Ensure safety of the structures (bridges and culverts).

The selection of design standards is largely influenced by the topography, traffic characteristics and the function of the road itself. Special attention is also required to allow for the fact that the Study Road forms part of the Nacala Corridor. Accordingly, the applicable design standards will be selected also taking note of the standards applied on the other sections of the Corridor.

For the design study of the Nampula – Nacala Project financed by the EU, the Terms of Reference did not require the consultant to follow any predefined standards, specifications or documents. In 1994, the consultant proposed to use the Southern Africa Transport and Communications Commission (SATCC) design standards, as these were commonly used for other projects in the region.

Table 6.1.1 Applicable Design Standards for Nacala Corridor

Section	Design Standard	Funding
Nampula - Nacala	SATCC	EU
Cuamba - Lichinga	SATCC	Suspended

After these considerations, ANE and the Study Team agreed that the SATCC Standards are the most appropriate standards to be applied for the Study Road.

6.2 Road Design Standards

6.2.1 Design Speed

The SATCC standards recommend a design speed of 120km/h for trunk roads if the topography permits so. In case of rolling or mountainous terrain, the design speed should be reduced to 100km/h or 80km/h, respectively. Observations during the field survey, indicate that the majority of the Study Road lies in rolling terrain. However, it is also observed that the road crosses over various topographical conditions. Thus, improvements to a constant design speed of 100 km/h would mean a substantial increase in earthworks, with the concomitant increase in costs and additional risks to the destabilization of the local soil strata.

6.2.2 Geometric Design Standard

A summary of the applicable geometric design standard is given below:

1) Horizontal Alignment

Minimum radius & maximum super-elevation

Design Speed 80 kph	Design Speed 100 kph	
Minimum radius	Minimum radius	Max. super-elevation
250-230-210	420-380-350	6%-8%-10% respectively

Minimum Length of Curve

Suggested (m)	Absolute (m)	
	DA > 5	DA < 5
300	150	150+30(5-DA)

*DA: Deflection Angle

Maximum Length of Curves

Suggested (m)	Absolute (m)
800	1,000

Stopping sight distance

Design speed	Stopping sight distance
80 km/h	115 m
100 km/h	155 m

Passing sight distance

Design speed	Passing sight distance
80 km/h	540 m
100 km/h	670 m

Super-elevation

Design Speed	Minimum radius	Maximum super-elevation	Exceptional Super-elevation
80 km/h	250	6%	10%
100 km/h	420	6%	10%

Normal camber

Usual	Heavy Rainfall
2%	3%

Sharpest curve without super-elevation

Based on a 2.5% camber:

Design Speed	Sharpest curve without super-elevation
80 km/h	R>1300 m
100 km/h	R>2000 m

Maximum radius for use of a spiral

Design Speed	Maximum radius for use of a spiral
80 km/h	R=800 m
100 km/h	R=1250 m

Spirals lengths (SATCC 1998):

L (spiral) =0.0702V3/ (RC)

V: design speed (km/h)

R: radius of circular curve (m)

C: rate of increase in centripetal acceleration (m/s3); 1<C<3

Design Speed=	80
C (SATCC)=	1.438

R	L spiral (m)
250	100
300	83
400	63
500	50
600	42
700	36
800	N/A

Design Speed=	100
C (SATCC)=	1.438

R	L spiral (m)
420	116
500	98
600	81
700	70
800	61
900	54
1000	49
1100	44
1200	41
1300	38
1400	35
1420	N/A

Run-out & run-off lengths:

L (run-off) = ewl/(s x 150%) where:

w = lane width (m)

e = super-elevation at the start of the circular curve (%)

s = relative slope factor (%); s = 0.5 or 0.4 (respectively design speed = 80 or 100 km/h)

l = lane factor (= 1 in case of undivided two lanes)

The same formula is used for run-out, but super-elevation goes from 2.5% (Consultant's recommended camber) to 0%.

2) Vertical Alignment

Minimum values of K for vertical curves

Design speed (km/h)	Crest curve	Sag curve
80	33	25
100	60	36

Minimum lengths of vertical curves

Design speed (km/h)	Curve length (m)
80	140
100	180

Maximum gradients

Design speed (km/h)	Maximum gradient (%)		
	Flat	**Rolling**	**Mountainous**
80	5	6	7
100	4	5	6

Critical lengths of grades

Gradient (%)	Length of grade (m)
3	500
4	300
5	240
6	200

Minimum longitudinal gradient

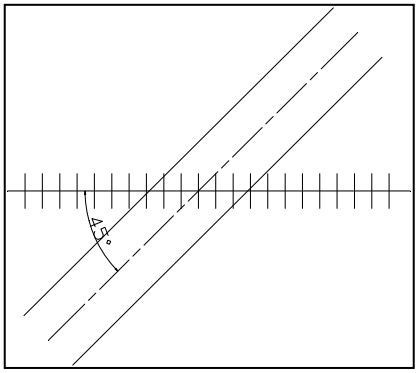
It's recommended that longitudinal gradients of less than 0.3% not be used, to ensure good drainage.

3) Railway Crossing

Cross Angle : more than 45 degrees

It's recommended that angles for crossing railway lines of more than 45degrees should not be used and to allow for short crossing lengths to prevent run off into the rail track.

Sorce: Japan Geometric Standard



6.2.3 Typical Cross Section

For the Nampula – Nacala Project, the standard cross section adopted for the road which is Road Type VII from table 4.2.1 of the SATCC Design Standard – Volume I, is given as a

carriageway width of 6.0m with a shoulder width of 1.5m. In the 1994 study, 7.0m carriageway width with a 2.5m wide paved shoulder was proposed in the urban section, as a large number of pedestrians use the road. In the final decision, the following typical cross section was adopted for the Nampula – Nacala Project through discussions with ANE and EU.

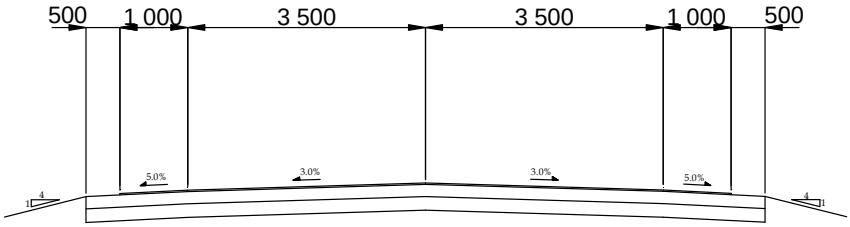


Figure 6.2.1 Typical Cross Section of Nampula – Nacala Road (Normal Section)

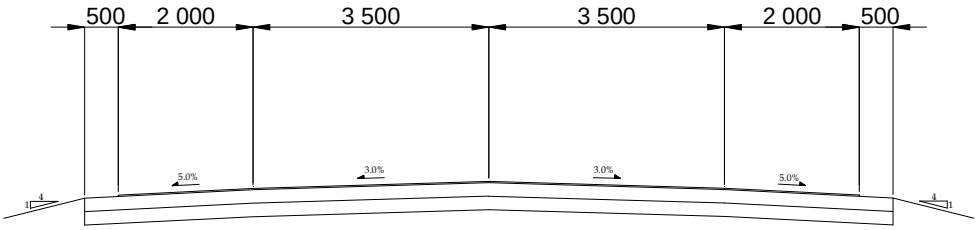


Figure 6.2.2 Typical Cross Section of Nampula – Nacala Road (Town Section)

In a more recent project, the Lichinga – Montepuez road, a 7.0m carriageway width and a 1.5m paved shoulder was adopted, as recommended in SATCC 1998 p. 5-1, p. 5-4.
It is recommended that, for this road, a similar typical cross section to that of the Nampula – Nacala Road be adopted to ensure consistency in the design standard.

6.2.4 Pavement Design Standards

The design of pavement structures will be based on the methods given by the "SATCC Practice for the Design of Road Pavements" and "Practice for Pavement Rehabilitation". However, other design methods such as "SATCC Low Volume Sealed Roads" and "A Guide to the Use of Otta Seals" will also be considered, wherever relevant.
The SATCC method of pavement design is briefly described below:

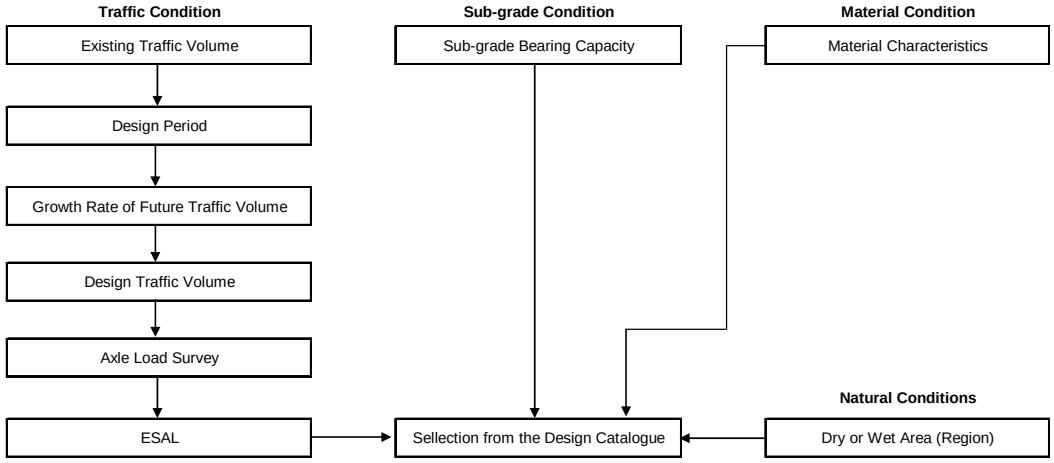


Figure 6.2.3 Flowchart for the Pavement Design based on SATCC

1) Pavement Design Life

The design life of a road can have a large impact on the design specifications of its pavement structure and it is therefore important to decide on an appropriate period. Usually, a 10-, 15-, or 20-year period is adopted, with the selection of an appropriate design life being dependent on the unique circumstances of the individual project. The following table from the SATCC standard provides some guidance on the selection.

Table 6.2.1 Pavement Design Life Selection Guidance

		Importance/Level of Service	
		Low	High
Design Data Reliability	Low	10 – 15 Years	15 years
	High	10 – 20 Years	15 – 20 Years

In the case of a selection of a "long" design life, the initial capital cost may be large in order for the road to be able to sustain the forecasted cumulative traffic loading over the lengthy period of service time. On the other hand, maintenance and rehabilitation costs would be lower in the long run. Usually a balance between initial and future investment costs is sought. Another consideration is that there are uncertain factors with the use of a long design period, such as the difficulty in forecasting traffic over extended periods of time, especially in the case of unclear socio-economic trends. Such a situation can lead to over-design and a misallocation of resources.

The Study road is mostly located in poor areas with no reliable historic traffic data being available and runs parallel to an existing railway line. In such cases, the potential for making significant errors in long-term traffic forecasting is significant. Given this, it is recommended that a 15-year design life be applied, and that the necessary maintenance

and/or rehabilitation be carried out via the monitoring of traffic conditions to minimize the risk of over investment.

2) Axle Loading

Equivalency factors, which convert heavy vehicle traffic into equivalent standard axles (ESA), were derived applying the results of Heavy Vehicle Overloading Control Study - "Axle-Load Survey Report: Draft 3" (October 2005) carried out by Africon. The equivalency factors (EF) are as follows:

Table 6.2.2 Summary of ESALS by Vehicle Type

Province	No.	Location	ESALs per Heavy Vehicle						
			Vehicles by Axle Configuration						
			Bus or Truck (Rigid)	Bus or Truck (Rigid)	Truck (Rigid)	Articulated	Articulated	Articulated or Rigid	All Heavy Vehicles
			R1-2 2 axles	R1-22 3 axles	R1-222 4 axles	T1-22-22 5 axles	T1-22-xxx 6 axles	T1-22-22-22 7 axles	
Maputo	N4	Moamba	2.08					4.20	3.51
Maputo	N2	Boane	0.76	1.32			6.45		2.01
Gaza	N1	Macia E.	1.54			8.17	5.59		3.59
Gaza	N1	Macia W.	1.94	3.62		11.06	4.59		5.67
Inhambane	N5	Inhambane	0.08						0.18
Inhambane	N1	Maxixe	0.69				9.45		5.24
Sofala	N6	Dudo	2.24			15.46	7.79		6.49
Sofala	N1	Inchope N.	3.32				11.28		6.14
Manica	N6	Machipanda					5.98		3.44
Manica	N7	Vaduzi	0.59				7.20		5.72
Manica	N6	Inchope W.	0.70				5.83		4.92
Tete	N8	Luanha					6.93		5.86
Tete	N9	Tete	0.16						1.51
Tete	N304	Zobue (N304/N7Jct)					3.80		3.67
Niassa	N13	Mandimbva N.	0.40						2.05
Niassa	N13	Mandimbva E.	0.09						0.51
Zambesia	N10	Nocoadala	1.20						2.31
Zambesia	N1	Macuba	1.18						2.40
Nampula	N1	Nampula	1.58				7.87		3.48
Nampula	N12	Monapo	2.98	6.50		10.37			6.08
Cabo Delgado	N1	Pemba	0.87						0.90
Cabo Delgado	N1	Metoro							
OVERALL			**1.20**	**5.98**		**9.93**	**6.54**	**4.07**	**4.06**

Source: Heavy Vehicle Overloading Control Study - "Axle-Load Survey Report: Draft 3" in 2005

6.3 Bridges and Culverts

6.3.1 Applicable Design Standards

For a long time, the Portuguese standards and specifications have been widely used for bridge & culvert design in Mozambique After SATCC codes were introduced in 1998, this became the principal design standard and specification for bridges & culverts in this country, although it still appears to have a provisional status. Since the SATCC codes are formulated on the basis of British Design Codes, ANE staff still uses the Portuguese codes for checking the design.

After these considerations, it has been decided that the SATCC specification should be adopted as the standard for bridge and culvert design for the Study road.

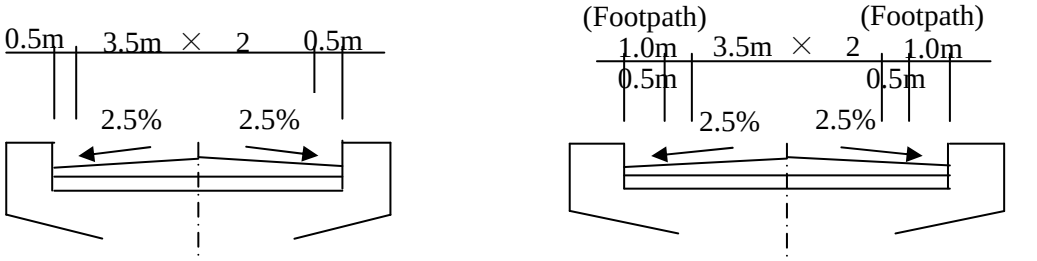
However, since some of the bridges on the Project Road were constructed with funds from the Japan's Grant Aid, the Japanese Standard will also be considered, where relevant.

6.3.2 Cross-sections for Bridges and Culverts

1) Bridge Cross-section

Presently, there is no standard cross section for bridges (including width) in the above mentioned design codes. Accordingly, previous bridge projects have applied different bridge widths depending on the conditions surrounding the areas where the bridges are located. Whereas it is recognized that a difference in cross-section width between bridges and approach roads would affect traffic safety, it must be noted that the bridge width affects the bridge construction costs, which accounts for a high portion of the total cost of a road project.

Considering these aspects, the Study Team recommends the use of different bridge widths depending on the local circumstances (surrounding areas being unpopulated or populated areas).



Unpopulated Area **Populated Area or Long Span Bridge**

Figure 6.3.1 Bridge Cross-section

2) Culvert Cross-section

As the construction cost for a culvert is not as high as that of a bridge, the cross-sections for culverts will be selected on the basis of the traffic safety aspect rather than the cost aspect.

6.3.3 Design Criteria

1) Loading Criteria for Bridges

Live Load

The following three types of live loading due to traffic will be considered as per the SATCC codes:

- NA loading: representing normal traffic.
- NB loading: a unit loading representing a single abnormally heavy vehicle.
- NC loading: representing a multi-wheeled trailer combination

These loadings will be applied separately, in a way that will cause the most severe effects in the elements of the structure under consideration.
The live load will be increased due to dynamic and vibration effects in accordance with Article 2.6.1.3 of the SATCC codes.

Dead Load

The dead load is a main component in determining the weight of a bridge structure. The dead load can be calculated on the basis of the unit weights specified in the SATTC and SABS codes. The major unit weights for materials are as follows:

Steel :	7.850 tf/m^3
Reinforced concrete:	2.600 tf/m^3
Prestressed concrete:	2.600 tf/m^3
Plain concrete:	2.400 tf/m^3

Other loads

The following loads will be considered for the bridge designs.

- Wind loads
- Braking forces
- Thermal effects
- Seismic forces

It is understood that seismic forces have, generally, not been considered in previous bridge designs in Mozambique. However, Seismic forces will be considered at the minimum level in line with the new ANE policy.

2) Flood, Navigation and Other Clearances

Frequency of Design Flood

The selection of the return period for bridge or culvert design will have a large impact on the size of the structures, which, in turn, will affect the total cost involved. The adoption of a higher return period would decrease the probability of flooding on the road, damages to the road and other facilities as well as result in a more reliable road connection for the road users. However, this could also cause a substantial increase in the initial capital and future maintenance costs.

The ANE guidelines in the National Roads Strategy propose a return period appropriate to the design discharge. The return periods for bridge design are proposed to be selected in the following way:

Table 6.3.1 Design Return Period for Crossing Structure by Design Discharge

Flood Discharge	Recurrence Interval (yrs)
$20m^3/s > Q$	20
$20m^3/s < Q < 250m^3/s$	50
$Q > 250m^3/s$	100

Design discharges

The rational method will be used for calculation of design discharges of catchment areas of less than $250km^2$. These design discharges will however be checked by other methods such as the TRL East African Flood Model and by interviews with local residents wherever possible. Catchments of areas larger than $250km^2$, will be sub-divided into sub-catchments of less than $250km^2$.

Flood Clearance

There is no standard for flood clearance (free board) in the SATCC codes. Flood clearance is normally determined taking into consideration the presence of debris such as drifting timber in a river during flood as well as the flood discharge volume. Although previous bridge projects applied a clearance ranging from 1.5 to 2.0m, the design specifications of South African Road Boards will be applied for the new bridges on the Study Road considering the similarity of the region. This specification determines clearance from the

girder bottom based on the design flood discharge shown in Table 6.3.2.

Table 6.3.2 Flood Clearance for Bridge Design

V: Design Discharge (m^3/s)	V:0-100	100<V<200	200<V<400	400<V<1000	1000<V
Clearance (m)	0.3	0.5	0.7	1.0	0.6+HWL/15

Source: Code of procedures for the planning and design of structures, South African Road Boards

For culvert design, an additional flow of 20% will be considered when determining culvert size, to allow for flood clearance.

Navigation Clearance

There is no river that requires clearance for navigation on the Study Road. Accordingly, forces due to ship collision will not be considered in the bridge design.