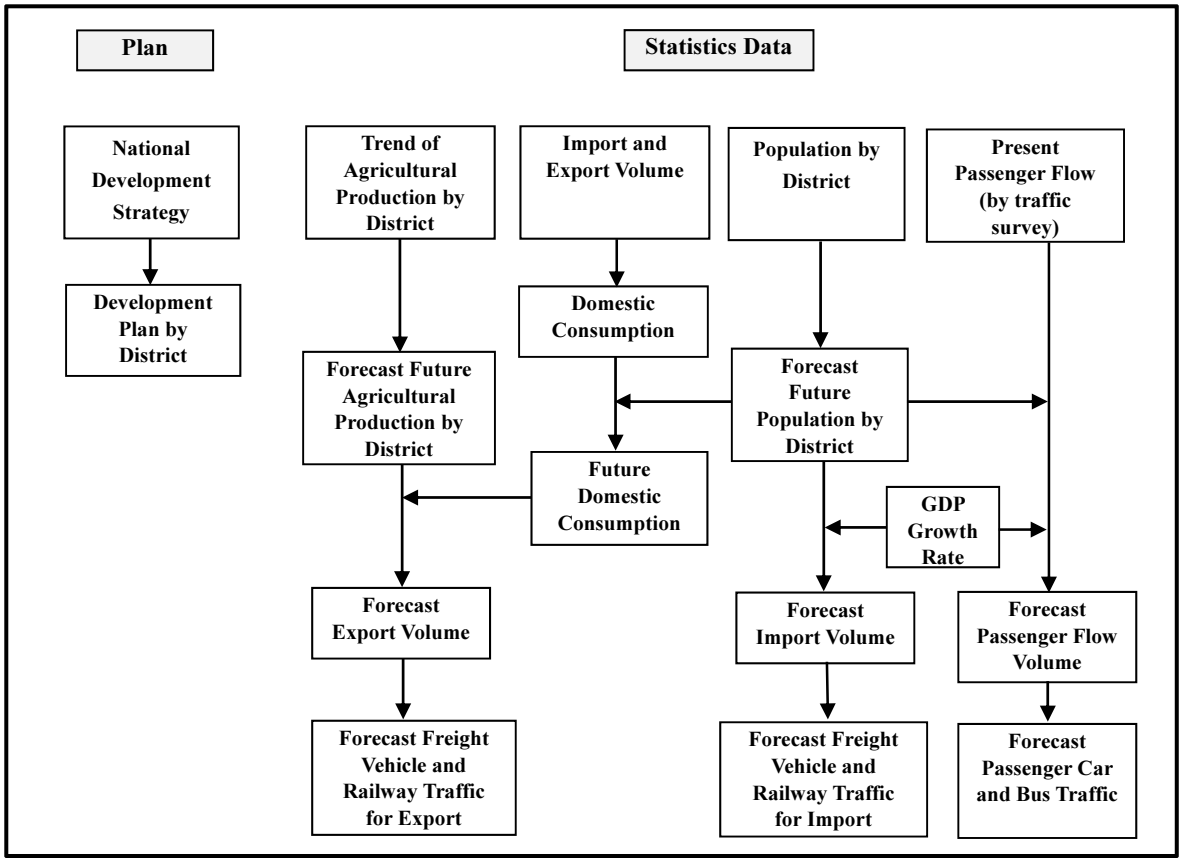
4.3 Future Traffic Demand Forecast

4.3.1 Methodology for Future Traffic Demand Forecast

(1) Methodology of Future Traffic Demand Forecast

In forecasting future traffic demand, passenger vehicles and freight vehicles are estimated separately as shown in Figure 4-43.



Source: Study Team

Figure 4-43 Flowchart of Future Traffic Demand Forecast

As for passenger vehicles and buses, the trip generation/ attraction model using population and Gross Regional Domestic Product (GRDP) as variables is initially built based on the traffic survey results. The number of passenger cars and buses are forecasted using the share between passenger car and buses as well as average number of passengers.

(2) Projection of Export and Import Volume

Regarding the forecast of freight vehicles, the volume of export and import is estimated separately.

a) Export Volume

The future export volume is projected based on the future export volume of the nine major agricultural commodities (tobacco, sugar, cotton, tea, pigeon peas, rice, maize, coffee, groundnuts), which account for almost 70% of exports by volume in Malawi. The major seven commodities also account for almost 80% of exports by value and are thus very important for the economic growth of Malawi. The export volume of commodities other than the nine

agricultural products is projected under the single category of "other products".

The future export volume of major agricultural commodities is projected by using the trends of crop acreage and cultivation volume. The difference between the projected future production and domestic consumption depending on the growth in population and GDP denotes the future export volume. The future export volumes of sugar by Illovo Sugar Ltd. are based on a definitive expansion plan, whereas the export volumes of other crops are estimated based on the trend in the case of the Study..

b) Import Volume

The future import volume is projected mainly based on the future import volume of the two major commodities of fertiliser and fuel, which account for almost half of total imports by volume. These commodities will still be very important in Malawi to support agricultural production and the export of major commodities. The import volume of commodities other than fertiliser and fuel is projected under a single category of "other products", because their quantities are limited compared with fertiliser and fuel.

The import volume of fertiliser is projected to increase in line with the increase of acreage of agricultural products mentioned in export volume above. The import volumes of fuels and other products are projected by using the elasticity of population and GDP growth.

Table 4-25 shows the forecasting methodologies of export and import commodities.

c) Future Transportation Volume

In this section, the future transportation volume is estimated based on the export and import volume of each commodity by using the modal share by commodity and converted into the number of freight vehicles with loading capacities by commodity.

Table 4-25 Methodology of Forecasting Import and Export Volumes by Commodity

Commodity	Method	Remarks
Export Commodities		
Tobacco	Trend forecast	Assuming production remains the same in consideration of world trends
Sugar	Development plan	Projection of Illovo Sugar Ltd.
Cotton	Development plan	National development plan
Tea, pigeon peas, rice, maize, coffee, groundnuts	Trend forecast	
Other commodities	Value of agricultural population and GDP	
Import Commodities		
Fertiliser	Value of agricultural production elasticity	Mainly sugar production
Fuel	Value of population and GDP elasticity	
Other commodities	Value of population and GDP elasticity	
Freight that Passes through Malawi		
Mozambican coal		EIA report prepared by Vale
Zambian copper		The EU's EDF Programme for Malawi

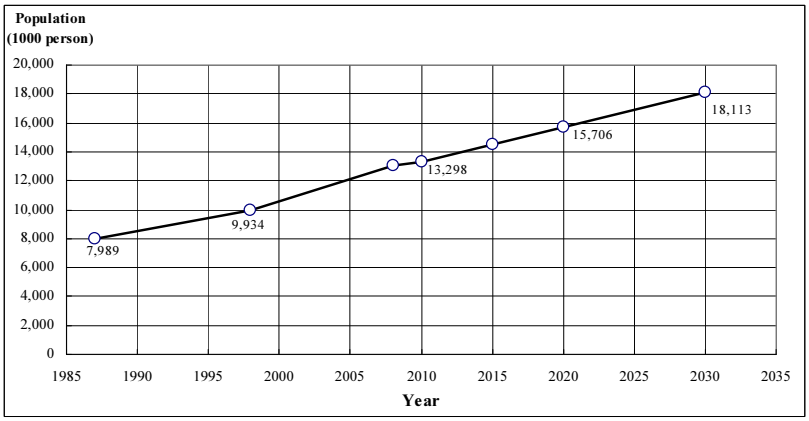
Source: Study Team

4.3.2 Future Socio-economic Framework

(1) Population

Figure 4-44 shows population projection for the whole Malawi, while Table 4-26 and Figure 4-45 show population projections by district based on the Population and Housing Census data in 1987, 1998 and 2008.

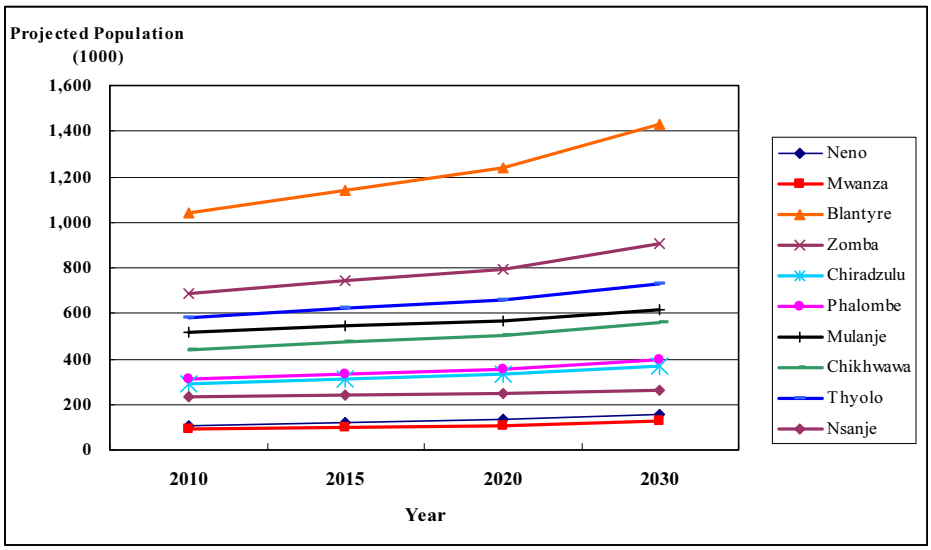
The population of 13.3 million in the whole of Malawi in 2010 is estimated to increase to 14.5 million (× 1.05), 15.7 million (× 1.16) and 18.1 million (× 1.34) in 2015, 2020 and 2030, respectively based on the past trend of population growth in each district according to the Population and Housing Census 2008.



Source: Study Team

Figure 4-44 Population Projection for the Whole Malawi

Higher population growth is projected for Blantyre and Zomba (urban areas), followed by Thyolo, Mulanje and Chikwawa (rural growth centres), where large-scale plantations exist. Hence, it is necessary to improve the transport network between these urban areas and rural growth centres to secure transport capacity.



Source: Study Team

Figure 4-45 Projected Population in Each District

Table 4-26 Projected Population in Each District

District/Region	1987*	1998*	2008*	2010	2015	2020	2030	2015 /2010	2020 /2010	2030 /2010
Malawi	7,988,507	9,933,868	13,066,320	13,298,462	14,502,069	15,705,676	18,112,890	1.09	1.18	1.36
Neno	61,208	74,795	108,897	109,429	120,697	131,966	154,503	1.10	1.21	1.41
Mwanza	60,305	63,220	94,476	92,457	100,479	108,502	124,548	1.09	1.17	1.35
Blantyre	589,525	809,397	999,491	1,040,340	1,137,990	1,235,640	1,430,939	1.09	1.19	1.38
Zomba	441,615	546,661	670,533	687,103	741,495	795,887	904,671	1.08	1.16	1.32
Chiradzulu	210,912	236,050	290,946	292,661	311,590	330,519	368,376	1.06	1.13	1.26
Phalombe	218,134	231,990	313,227	309,629	331,998	354,368	399,107	1.07	1.14	1.29
Mulanje	419,928	428,322	525,429	518,981	543,746	568,511	618,042	1.05	1.10	1.19
Chikhwawa	316,733	356,682	438,895	442,068	470,973	499,877	557,687	1.07	1.13	1.26
Thyolo	431,157	458,976	587,455	583,316	620,122	656,928	730,539	1.06	1.13	1.25
Nsanje (TA Mlolo)	49,050	46,782	57,141	55,622	57,499	59,376	63,131	1.03	1.07	1.14
Nsanje (Other TAs)	155,324	148,142	180,948	176,136	182,082	188,027	199,918	1.03	1.07	1.14
Other Southern Region	1,011,843	1,232,951	1,609,346	2,041,590	1,775,485	1,917,054	2,200,191	0.87	0.94	1.08
Lilongwe	1,199,945	1,786,831	1,897,167	1,633,916	2,209,270	2,376,950	2,712,309	1.35	1.45	1.66
Central Region (Excl. Lilongwe)	1,911,041	2,279,509	3,593,867	3,573,574	3,970,373	4,367,171	5,160,767	1.11	1.22	1.44
Northern Region	911,787	1,233,560	1,698,502	1,741,639	1,928,270	2,114,901	2,488,163	1.11	1.21	1.43

Source: * 1987, 1998 and 2008 populations are taken from the Population and Housing Census 2008, 2010 to 2030 projection by Study Team

The projected population is used for forecasting the import volume of commodities, domestic consumption of agricultural products and passenger flow volume.

(2) GDP

In recent years, the economy has been growing at over 6% a year. IMF estimated that this will accelerate slightly to 6.6% up to 2015 and then slow down slightly to 5.4% from the following year. A number of key baseline macroeconomic assumptions underlie these projections by IMF. These include:

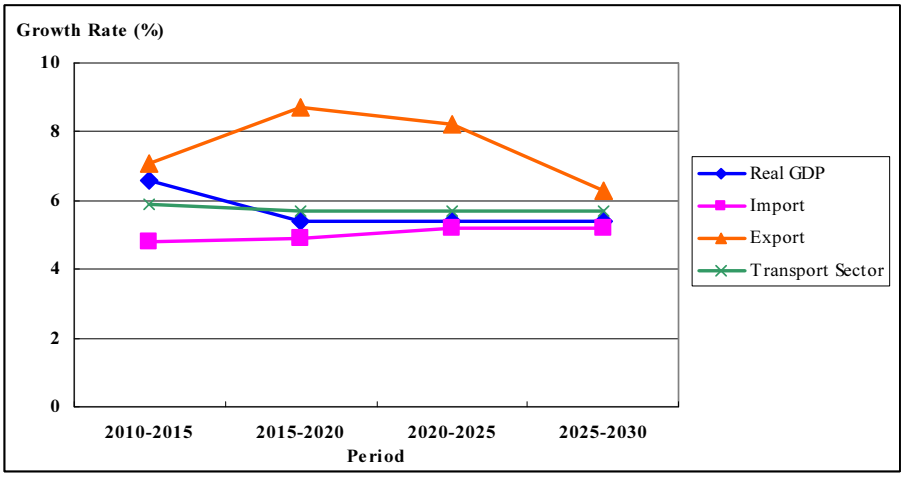
- A more moderate growth of imports than in the past decade.
- Export growth is expected to remain strong.
- The Kayelekera uranium mine is expected to operate up to 2020 and to act as a major stimulus to export growth.
- Inflation is expected to remain in single digits from current rates of around 7.7% to 7% over the longer period.
- The real exchange rate is assumed to remain stable.
- The current external account, including aid transfers, but excluding interest payments, is assumed to improve over the medium term as the reserve position improves, before returning to its historical average.
- Foreign aid is expected to average around 14.5% of GDP up to 2015, and decline thereafter, averaging 8% over the projection period.

In the Study, the GDP growth rate shown in Table 4-27 and Figure 4-46 is employed to forecast the amount of import volume and passenger flow volume.

Table 4-27 GDP Growth Rate

Period	Average Annual Growth Rate (%)			
	Real GDP	Import	Exports	Transport & Storage Sector
2010-2015	6.6	4.8	7.1	5.9
2015-2020	5.4	4.9	8.7	5.7
2020-2025	5.4	5.2	8.2	5.7
2025-2030	5.4	5.2	6.3	5.7

Source: IMF



Source: IMF

Figure 4-46 GDP Growth Rate by Sector

The highest GDP growth rate is projected for exports, while real GDP growth is expected to remain constant from 2020. To accommodate import freight demand, the GDP growth rate of the transport sector is projected to remain stable for the whole period.

These growth rates will cause the GDP to increase by 1.38 times, 1.79 times and 3.03 times the value of 2010 by 2015, 2020 and 2030, respectively (see Figure 4-47).

4.3.3 Future Traffic Demand Forecast

(1) Basic Conditions for Forecasting Freight Demand

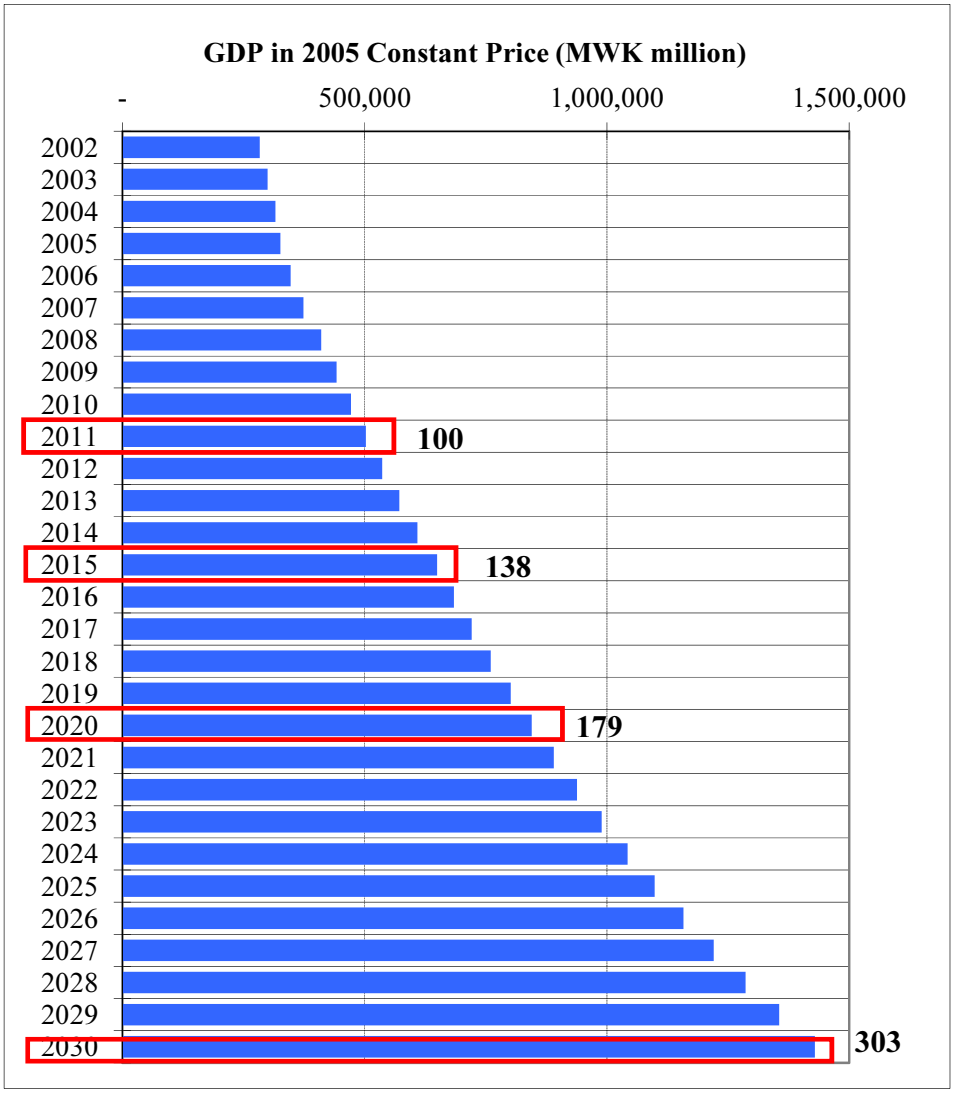
The export freight demands are projected considering the following flows of commodities:

- Transport demand from producing centres of each commodity to processing factories or warehouses.
- Transport demand from processing factories or warehouses to ocean ports for export or destination countries (in cases of only by land transportation).

The import freight demands are projected considering the following flow of commodities:

- Transport demand from ocean ports for import or countries of origin (in cases of only by land transportation) to import areas in Malawi.
- Transport demand from import areas in Malawi to consuming areas throughout the country.

In addition to the export and import freight demand, the domestic transportation from production to consuming areas is also projected.



Source: Study Team based on TSIP

Figure 4-47 Projected GDP in Malawi

These estimates are conducted annually and calculated by volume. These annual freight volumes are then converted into a daily basis by commodity. For the conversion process, the peak monthly exports and import freight volume in June based on the statistics of the Malawi Revenue Authority are used as the basis to convert monthly volume to daily freight volume.

(2) Freight Demand Forecast

a) Export Freight

Agricultural products are the main export items in Malawi. The volume of exports is estimated from future domestic production as the difference between total production and domestic consumption, as shown in Table 4-28. The amount of exports is expected to increase from 588 thousand tonnes to 2,041 thousand tonnes in 2030. This increase is mainly due to large increases in the export volumes of certain products, such as groundnuts, sugar, and others (rice, maize, etc.). This amount corresponds to 3.5 times the total export volume of agricultural

products in 2010.

Mining products in Malawi are expected to increase in the future. Mining products are considered as export freight for the demand forecast. Table 4-29 shows estimations for mined products in Malawi; these amounts will be added as export freight.

Table 4-28 Present and Future Export Freight Volume

(Unit: 1000 tonnes)

Commodity	2010	2015	2020	2030	2030/2010
Tobacco	154	169	166	159	1.0
Pigeon peas	30	82	115	114	3.8
Cotton	24	82	96	108	4.6
Groundnuts	22	92	140	164	7.6
Coffee	1	7	8	8	5.2
Sugar*	98	280	320	400	4.1
Tea	51	59	64	75	1.5
Others	209	825	1,044	1,013	4.8
Total	588	1,596	1,953	2,041	3.5

Note: Future export volume of sugar is included based on the expansion plan of Illovo Sugar Ltd.
Source: 2010 customs data, 2015-2030; Estimated by Study Team

Table 4-29 Future Volume of Mining Products

(Unit: tonne)

Mining Products	Projection in 2030
Uranium	10,000
Titanium	250,000
Pig iron	125,000
Alumina (Bauxite)	200,000
Nickel	1,000,000
Nal Cola	60,000
Total	1,645,000

Source: Estimated by Study Team based on EU Multimodal Transport Study

b) Transit Freight

According to the EIA report prepared by Vale and the EU Multimodal Transport Study, coal from the Moatize Coal Mine in Mozambique, and copper from Zambia are expected as transit freight through Malawi to Nacala Port in Mozambique.

The estimated volumes of transit freight are shown in Table 4-30. According to Vale's EIA report, all coal will be transported by railway, as Vale will construct a new section and rehabilitate the whole stretch of the existing Nacala Railway.

Table 4-30 Estimated Transit Freight Volume from Mozambique and Zambia

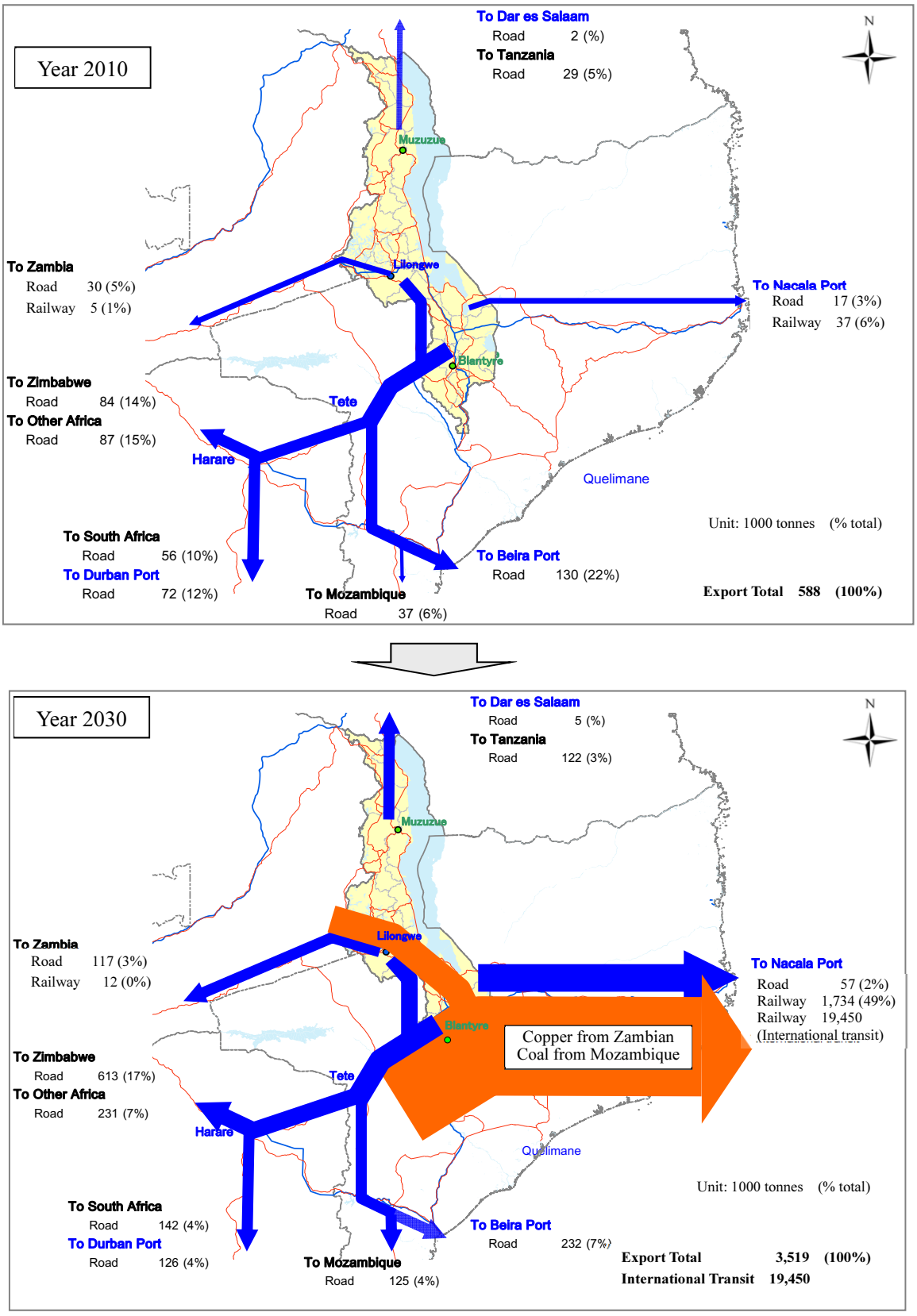
(Unit: 1000 tonnes)

Year	Coal from Mozambique *1	Copper from Zambia *2
2015	12,000	725
2020	18,000	1,450
2030	18,000	1,450

*1: Vale EIA report

*2: EU Transport Sector Multimodal Development Study

Figure 4-48 illustrates the forecasted export and transit freight demand for 2010 and 2030 by using the present pattern method. Regarding the present transport network, the export freight volume on each transport corridor will increase significantly.



Source: Study Team

Figure 4-48 Results of Export and Transit Freight Demand Forecast

For each transport corridor, the export freight demand on the Nacala Corridor will increase greatly from 54 thousand tonnes in 2010 to 21,000 thousand tonnes, including mineral products of Malawi, in 2030. This large increase in freight demand, however, will be mostly transit freight of coal from Mozambique and copper from Zambia. On the other hand, the export freight demand on the Beira Corridor will almost double from 130 thousand tonnes in 2010 to 232 thousand tonnes in 2030. The export freight demand on the Durban Corridor will also increase from 72 thousand tonnes in 2010 to 126 thousand tonnes in 2030.

c) Import Freight

The main imports in Malawi are fuel (petrol, and diesel oil) and fertiliser. The future volumes of import products are estimated based on future population, GDP and agricultural output, as shown in Table 4-31. The volume of imported cargo is expected to increase to 4,738 thousand tonnes in 2030, or 2.7 times the amount in 2010. This increase of imports is mainly due to large increases in the import volumes of fuel and other products.

Table 4-31 Present and Future Import Freight Volume

(Unit: 1000 tonnes)

Commodity	2010	2015	2020	2030	2030/2010
Fuel	556	772	1,005	1,700	3.1
Fertiliser	333	448	506	564	1.7
Others	893	1,124	1,462	2,474	2.8
Total	1,782	2,345	2,973	4,738	2.7

Source: 2010 customs data, 2015-2030; Estimated by Study Team

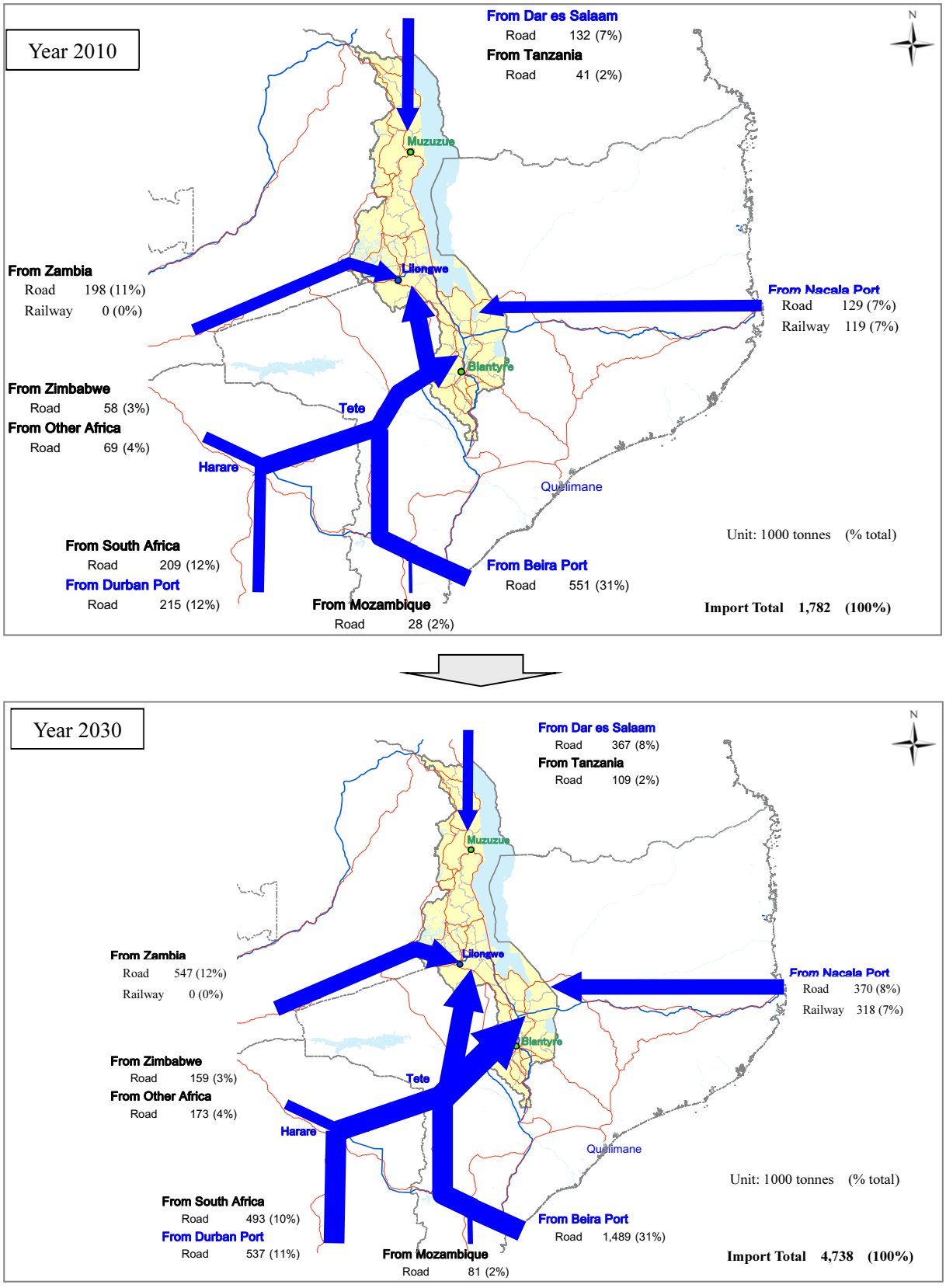
Figure 4-49 illustrates the forecasted import freight demand for 2010 and 2030 by using the present pattern method. Regarding the present transport network, the import freight volume on each transport corridor will increase greatly.

For each transport corridor, the import freight demand on the Nacala Corridor will increase by about 2.8 times from 249 thousand tonnes in 2010 to 687 thousand tonnes in 2030. On the other hand, the import freight demand on the Beira Corridor will increase from 551 thousand tonnes in 2010 to 1,489 thousand tonnes in 2030. The import freight demand on the Durban Corridor will also increase from 215 thousand tonnes in 2010 to 537 thousand tonnes in 2030.

d) Future Freight Demand on Each Transport Corridor

Based on the freight demand forecasted by the present pattern method, freight demand in 2030 based on the present transport network will increase greatly on each transport corridor. In line with the freight demand, it will be necessary to increase the capacities of the corridors connecting to Nacala and Beira Ports in order to cope with the increasingly high freight demand through ports.

Comparing export and import freight volumes, the export volume will far exceed the import volume, due to the huge volume of exported mineral products. If these huge volumes of mineral products are excluded from the export volume, the import volume will exceed the export volume. In particular, the import freight volume (1,489 thousand tonnes) at Beira Port will be more than 6 times the export freight volume (232 thousand tonnes).



Source: Study Team

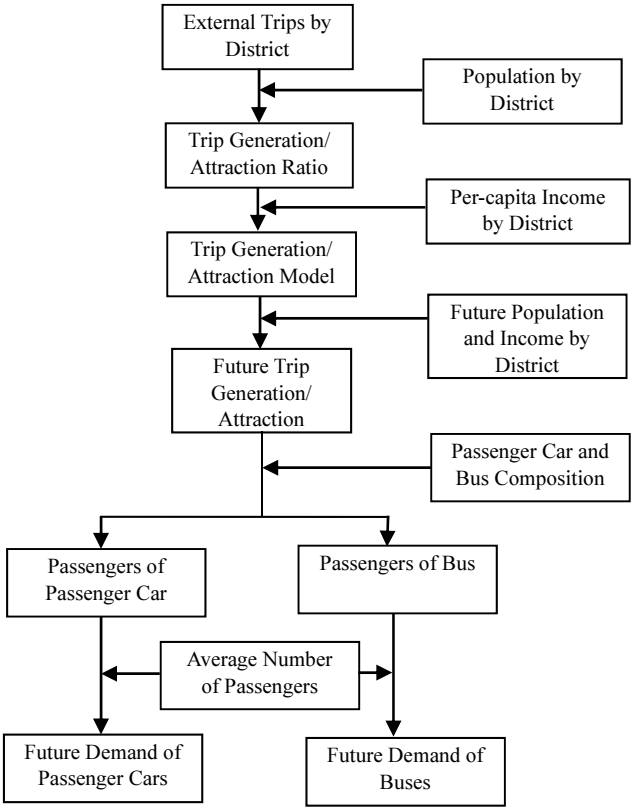
Figure 4-49 Results of Import Freight Demand Forecast

In order to fully accommodate the huge increase of export freight volume on each transport corridor as well as to help other transport networks efficiently import freight, an additional corridor, such as the Sena Corridor, will be necessary to provide additional transport capacity. Since the capacity of the Nacala Railway for general freight will be limited due to the transportation of huge volumes of coal from Mozambique and copper from Zambia, surplus freight is expected to divert through Beira Port either by railway or inland waterway.

Regarding the future freight demand of an additional corridor, freight demand diverted from the Nacala Corridor, Beira Corridor and Durban Corridor is expected.

(3) Traffic Demand Forecast of Passenger Vehicles

The flowchart for forecasting the demand for passenger cars and buses is shown in Figure4-50.



Source: Study Team

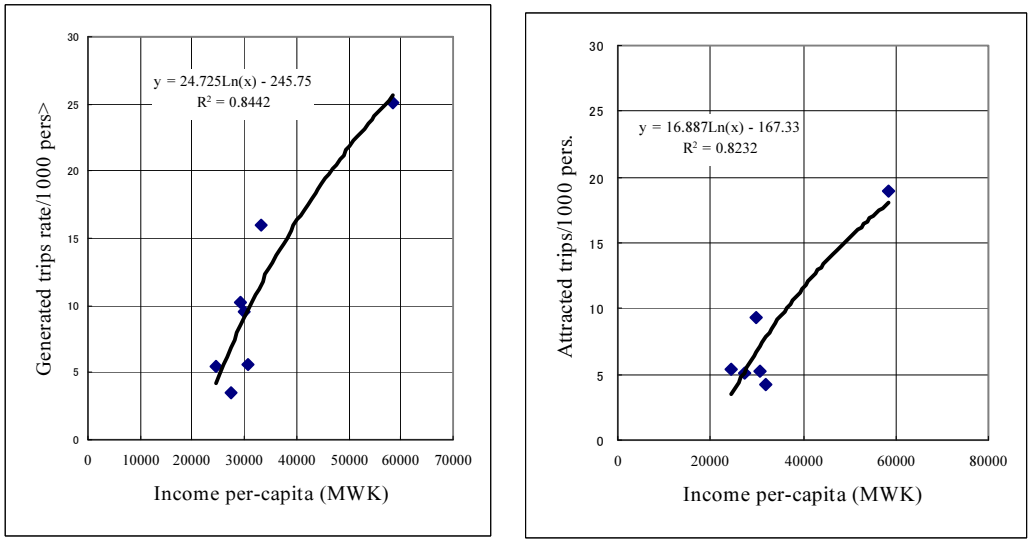
Figure 4-50 Flowchart for Forecasting the Demand of Passenger Cars and Buses

Table 4-32 shows the current trip generation and attraction of passengers by district. These figures are calculated by multiplying the number of vehicles (passenger cars, minibuses and conventional buses) by the corresponding average occupancy in passenger cars, minibuses, and conventional buses. The ratio of generated/attracted passengers per 1000 population is closely correlated with average per-capita income in each district, based on the regression analysis shown in Figure 4-51, meaning that a higher income tends to generate/attract more external trips.

Table 4-32 Generated/Attracted Trips

District	Passenger[*1]			Population 2010 [*2]	Generated/Attracted Ratio by 1000 persons		Per-capita Income[*3]
	Generation (a)	Attraction (b)	Total	(X)	Generation (a)/(X)	Attraction (b)/(X)	(MWK)
Mwanza	3,250	3,192	6,442	201,885	16.10	15.81	33,094
Blantyre	26,742	20,225	46,967	1,040,340	25.71	19.44	58,354
Zomba	1,833	2,905	4,738	687,103	2.67	4.23	31,741
Chiradzulu	3,013	5,219	8,232	292,661	10.30	17.83	29,267
Phalombe	384	1,278	1,662	309,629	1.24	4.13	33,350
Mulanje	4,971	4,832	9,803	518,981	9.58	9.31	29,827
Chikhwawa	1,573	2,246	3,819	442,068	3.56	5.08	27,313
Thyolo	3,275	3,089	6,364	583,316	5.61	5.30	30,817
Nsanje	1,273	1,250	2,523	231,758	5.49	5.39	24,627

Source: *1: Inter-zonal trip estimated by Study Team
*2: Trend estimates based on 2008 Census data
*3: Integrated Household Survey 2005 (Estimated GDP growth rate)



Source: Study Team

Figure 4-51 Correlation between Income and Generated/Attracted Trip Ratio

The result of correlation analysis shows that there is no correlation between the share of passenger cars and buses used by passengers, and the average per-capita income, so the present share of passenger cars and buses is used for the estimation. Table 4-33 shows the future trip generation/attraction of external trip by passenger cars and buses in each district. From this table, the growth rates of passenger cars and buses are estimated as 3.91 times and 3.57 times, respectively.

Table 4-33 Projected Future Inter-district Trip Generation/Attraction

(Unit: trip)

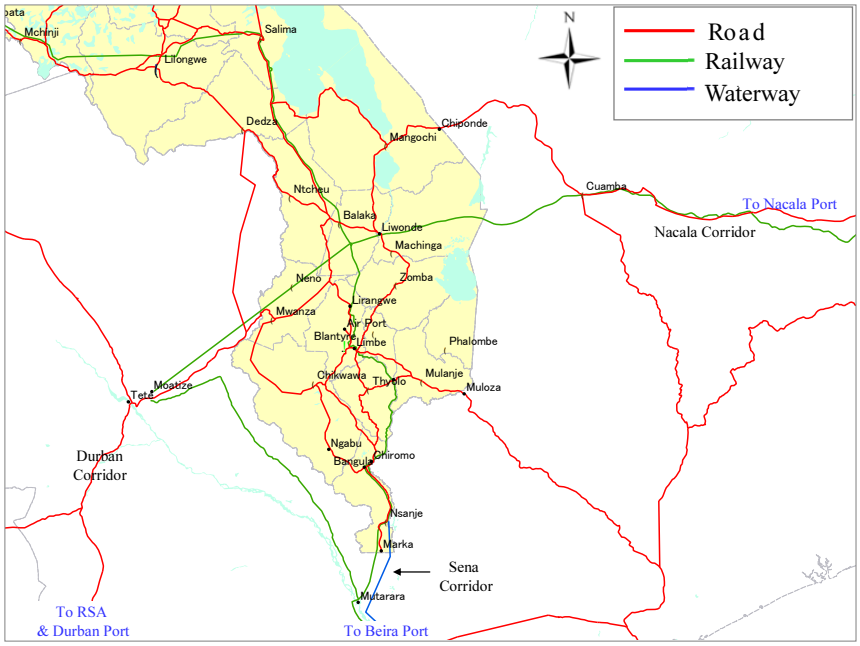
District	Passenger Car				Bus			
	2010*1	2015	2020	2030	2010*1	2015	2020	2030
Mwanza	328	565	817	1,423	321	604	874	1,522
Blantyre	3,852	5,301	6,862	10,509	2,233	3,120	4,039	6,188
Zomba	892	1,744	2,516	4,322	191	296	427	734
Chiradzulu	615	1,062	1,561	2,711	486	703	1,033	1,791
Phalombe	135	243	342	572	85	143	201	338
Mulanje	662	1,058	1,524	2,566	601	794	1,144	1,925
Chikwawa	411	909	1,379	2,465	201	374	567	1,012
Thyolo	623	1,394	2,009	3,416	368	662	953	1,619
Nsanje	238	833	1,310	2,347	79	410	644	1,154
Total	7,756	13,109	18,320	30,331	4,565	7,106	9,882	16,283
Growth Rate	100	169	236	391	100	156	216	357

Source: *1: Inter-zonal trip estimated by Study Team

4.3.4 Transport Network for the Future Traffic Demand Forecast

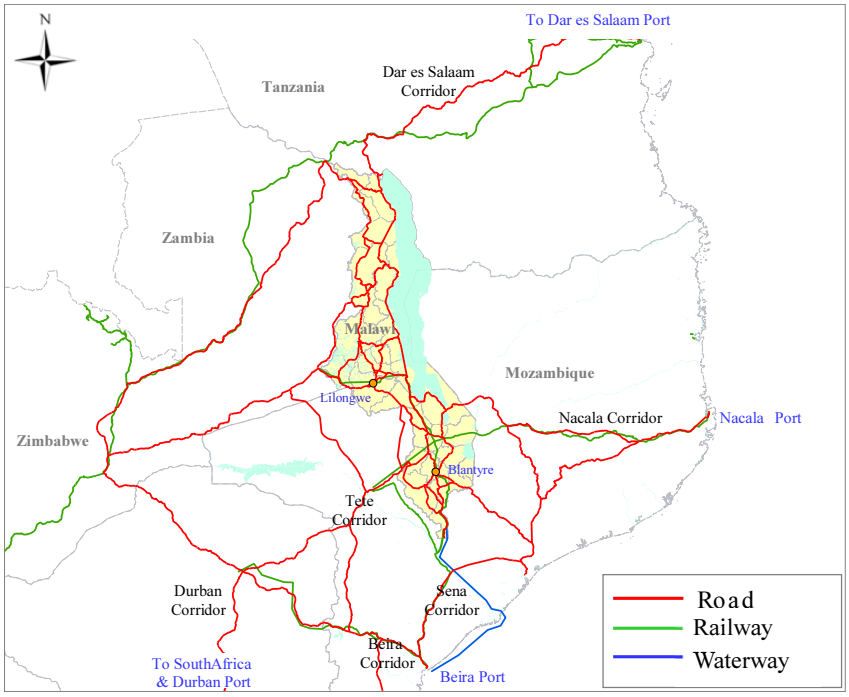
(1) Transport Network for the Future Traffic Demand Forecast

Figures 4-52 and 4-53 illustrate the transport network (road, railway and inland waterway) for the future traffic demand forecast prepared in the Study. This network includes the existing transport network and planned network in the near future.



Source: Study Team

Figure 4-52 Transport Network for the Future Traffic Demand Forecast in the Study Area



Source: Study Team

Figure 4-53 Transport Network for the Future Traffic Demand Forecast in a Wide Region

(2) Alternative Transport Networks for Traffic Assignment

As described in Section 6.3.1, alternative transport networks for traffic assignment as well as evaluation are proposed by considering possible combinations of connections between Makhanga and Bangula, and Marka and Beira Port. Table 4-33 shows the connection combinations.

Table 4-34 Alternative Transport Networks for Traffic Assignment

Alternative	Makhanga–Bangula		Marka–Beira Port in Mozambique	
	Road	Railway	Road	Railway
Zero Option	-	-	-	-
Alt. 1	X	X	X	X
Alt. 2	-	X	X	X
Alt. 3	X	X	X	-

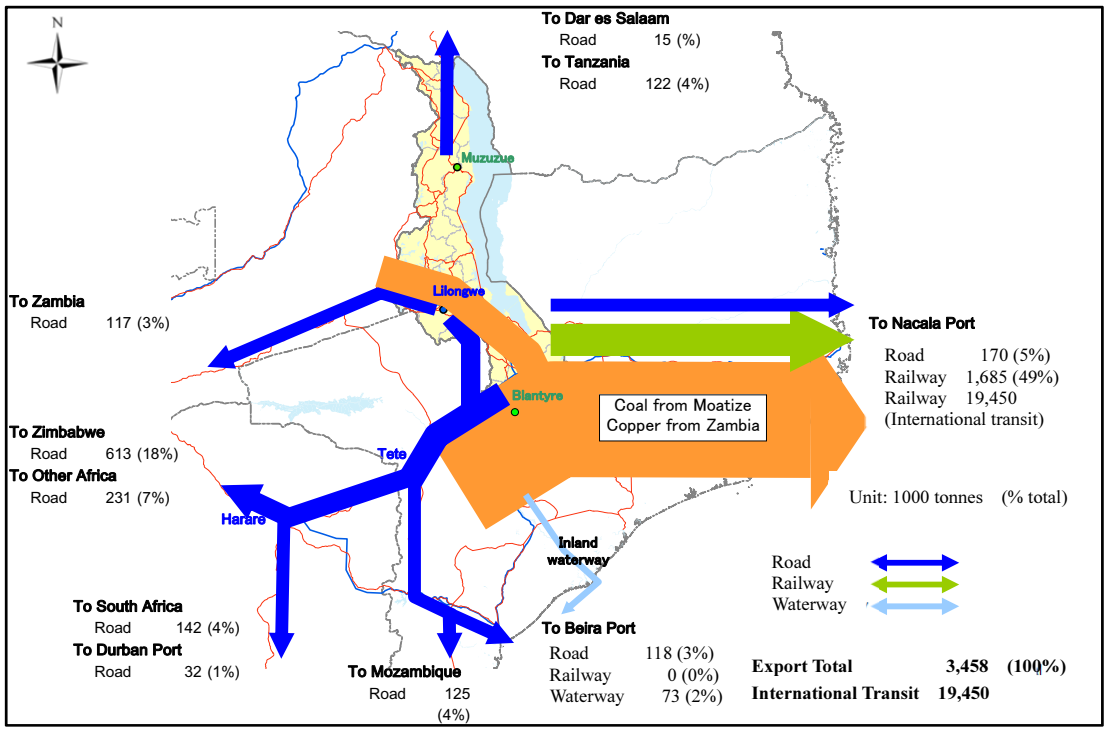
Source: Study Team

4.3.5 Forecast of Future Freight Flow

Based on the present freight volumes and future transport network and their condition for each scenario, future freight volumes for export and import are forecasted. In this case, the modal shares on each corridor are also forecasted by using predicted transport time, including transit and cargo handling time, and transport cost by commodity, obtained from the logistics survey, as parameters for the modal split.

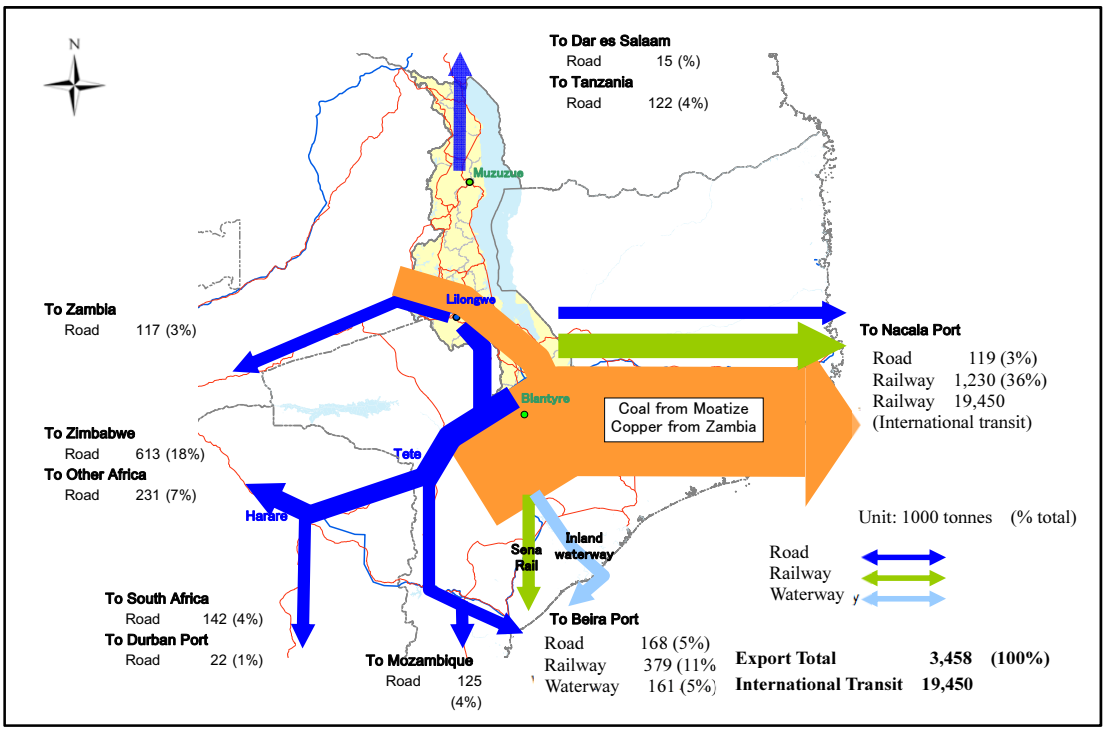
(1) Future Export Freight Flow

Figures 4-54 and 4-55 show the future export freight flows of the transport network defined for Zero option and Alt. 1 in 2030.



Source: Study Team

Figure 4-54 Future Export Freight Flow for Zero Option in 2030



Source: Study Team

Figure 4-55 Future Export Freight Flow for Alt. 1 in 2030

- In the case of future export freight for Scenario 1, 54% of freight goes through Nacala Port, other than the huge volume of transit mineral products (coal and copper). On the other hand, only 5% of freight goes through Beira Port by road and the Shire–Zambezi inland waterway.

- In the case of future export freight for Alt. 1, 39% of freight goes through Nacala Port, other than the huge volume of transit mineral products (coal and copper). On the other hand, 21% of freight goes through Beira Port by road, the branch line of the Sena Railway and the Shire–Zambezi inland waterway.

(2) Future Import Freight Flow

Figures 4-56 and 4-57 show the future import freight flows of the transport network defined for Zero option and Alt. 1 in 2030.

- In the case of future import freight for Zero option, 36% of freight will come through Nacala Port. On the other hand, 20% of freight will come through Beira Port by road and the Shire–Zambezi inland waterway.
- In the case of future import freight for Alt. 1, 27% of freight goes through Nacala Port. On the other hand, 29% of freight will go through Beira Port by road, the branch line of the Sena Railway and the Shire–Zambezi inland waterway.

(3) Share of Total Export and Import at Major Ports and Corridors

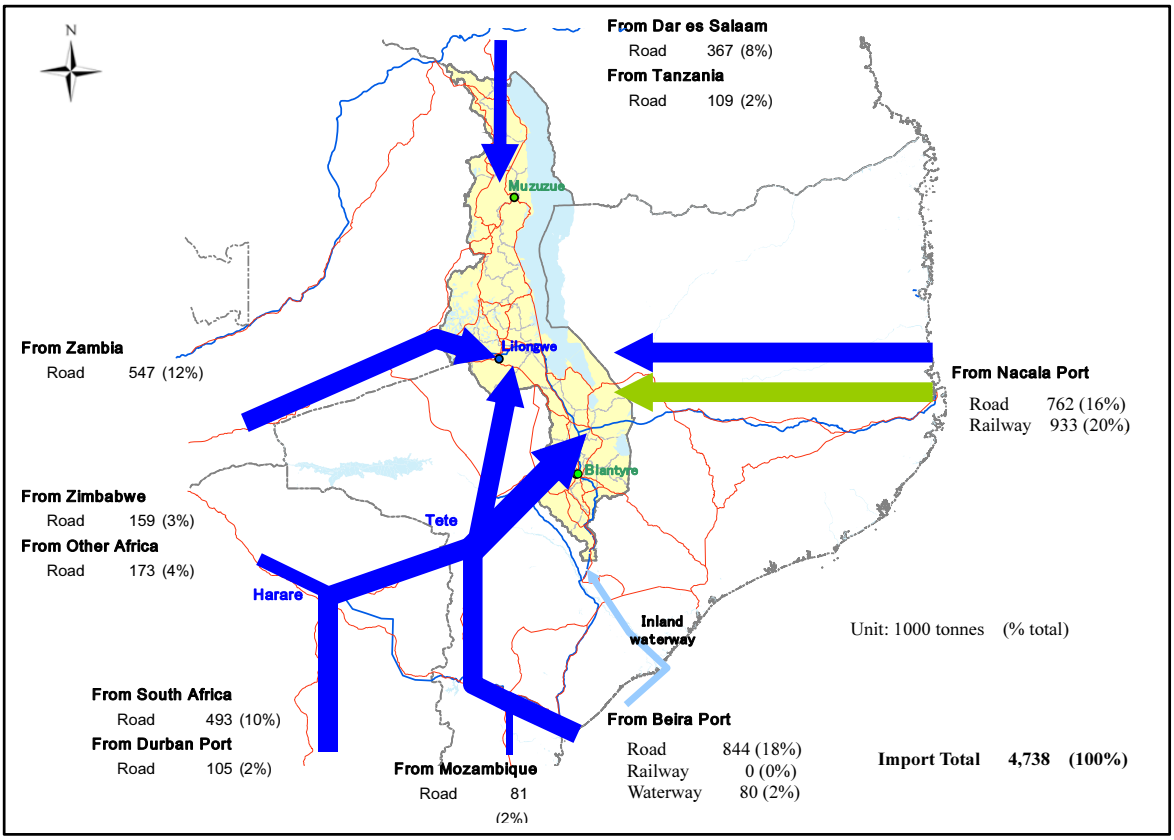
Table 4-35 shows the share of total export and import at major ports and corridors according to alternatives.

- In the case of Zero option, the handling share of Nacala Port will increase from 23% at present to 55% in 2030, while the share of Beira Port will decrease from 48% at present to 31% in 2030. In the case of Alt. 1, the share of Beira Port will slightly decrease from 48% at present to 45% in 2030, while the share of Nacala Port will increase from 23% to 41%. In both cases, the share of Durban Port will decrease from 19% to 4%.
- In the case of Alt. 1, the share of the Sena Corridor will become 18%: 14% by the branch line of the Sena Railway and 4% by the Shire–Zambezi inland waterway.

Judging from these forecasted results, the Sena Corridor in Alt. 1 will be able to function as an additional corridor to the existing Nacala and Beira Corridors to transport cargoes mainly to/from the Southern Region with a shorter distance.

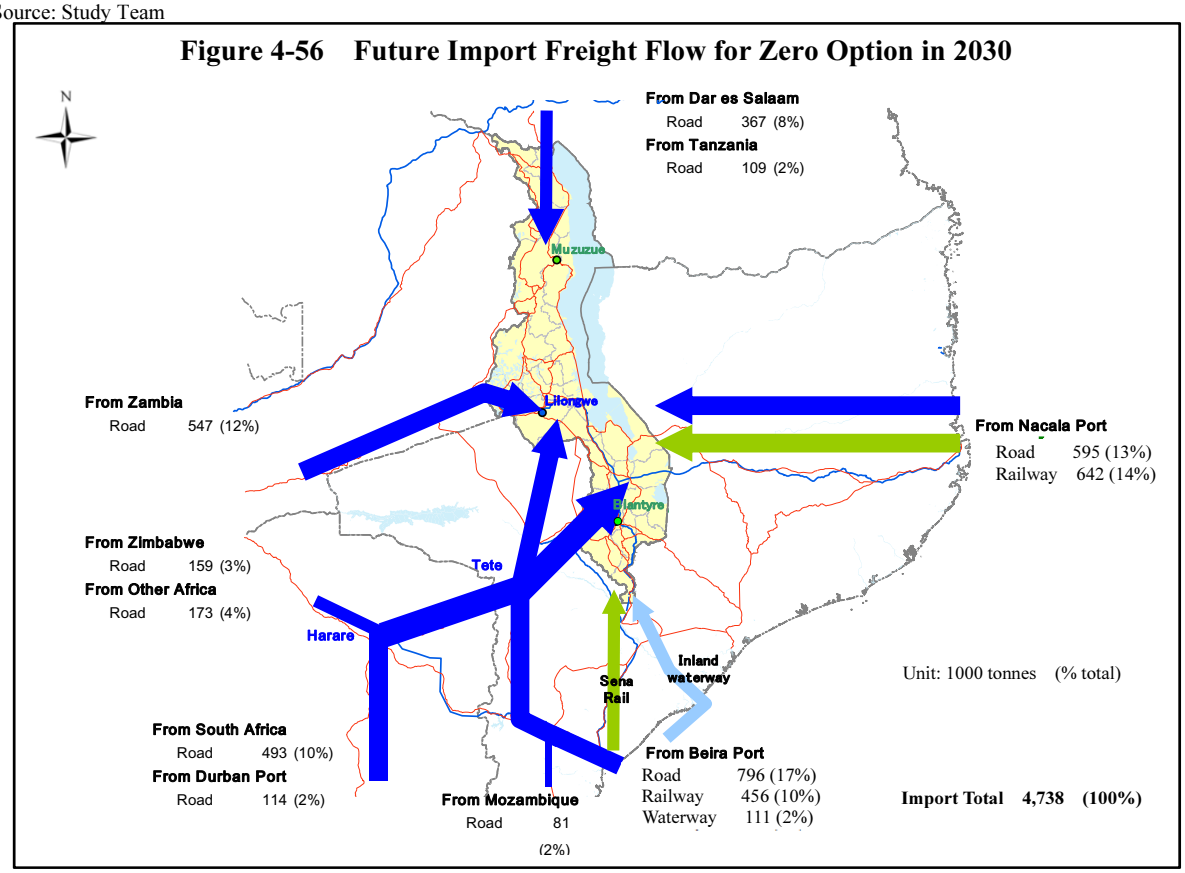
(4) Expected Future Transport Conditions

The Beira Corridor (road) carries 41% of Malawi's international cargo at present, which will decrease to less than 17% in 2030. The Nacala Corridor (road and railway) accounts for 18% at present, which will increase to 44% in 2030. The Sena Corridor will account for at least 19% by 2030. The present and expected future transport conditions by each corridor are summarised in Table 4-36.



Source: Study Team

Figure 4-56 Future Import Freight Flow for Zero Option in 2030



Source: Study Team

Figure 4-57 Future Import Freight Flow for Alt. 1 in 2030

Table 4-35 Share of Total Export and Import at Major Ports and on Major Corridors

Port & Corridor		Mode	Present	Zero Option	Alt. 1
Port	Nacala	Road + Railway	23%	55%	41%
	Beira	Road + Railway + Waterway	48%	31%	45%
	Durban	Road	19%	4%	4%
	Dar es Salaam	Road	10%	10%	10%
Corridor	Nacala	Road	12%	26%	20%
	Nacala	Railway	11%	30%	21%
	Beira (Tete)	Road	48%	27%	27%
	Sena	Railway	0%	0%	14%
	Sena	Railway + Waterway	0%	4%	4%
	Durban	Road	19%	4%	4%
	Dar es Salaam	Road	10%	10%	10%

Source: Study Team

Table 4-36 Present and Expected Future Transport Conditions

Corridor	Mode	Distance from Blantyre (km)	Present Condition				Expected Future Condition	
			Share (tonne)	Transport Cost (US$)*2		Commodity	Share (tonne)	Commodity
				Export	Import.			
Beira (Tete)	Road	825	41 %	2,300	2,800	Export: Tobacco, Tea, Sugar, Cotton Import: Fuel, Fertilizer, Wheat	(17 %) *1	Export: Tobacco, Tea, Sugar, Cotton, Import: Fuel, Fertilizer, Wheat
Nacala	Railway	800	18 %	1,940	2,500	Export: Sugar, Tea, Pulses Import: Fuel, Fertilizer	32 %	Export: Sugar, Tea, Pulses, Nickel, Import: Fuel, Fertilizer
	Road	850		-	-	-	12 %	Export: Tea, Pulses, Import: Fuel, Fertilizer
Durban	Road	2,340	33 %	4,400	7,500	Export: Tobacco, Tea, Coffee, Import: Fertilizer	2 %	Import: Fertilizer
Johannesburg *3	Road	1,820		3,200	5,800	Import: Consumer goods	11 %	Import: Consumer goods
Dar es Salaam	Road	1,980	8 %	3,500	5,000	Import: Fuel, Fertilizer, Vehicles	7 %	Import: Fuel, Vehicles
Sena	Railway	575	-	-	-	-	14 %	Export: Tobacco, Sugar, Tea, Alumina, Titanium, Import: Fuel, Fertilizer
	Road	820	-	-	-	-	(17 %) *1	Export: Tobacco, Tea, Import: Fertilizer, Fuel
	Inland waterway	530 *4	-	-	-	-	5 %	Export: Cotton Import: Fertilizer
Quelimane Sub-corridor	Road	300	-	-	-	-	-	Export: Tea, Pulses Import: -

Note: *1 - Total share between Blantyre and Beira Port.
*2 - Rates based on one 40-ft container or a full truck load. Excludes port charges, storage, demurrage, insurance, etc.
*3 - Origin/destination in the city.
*4 - Distance from Nsanje International Port.
Cargo price share (present condition): Beira road (21%), Nacala railway (19%), Durban road (51%), Dar es Salaam (4%)
Source: Study Team

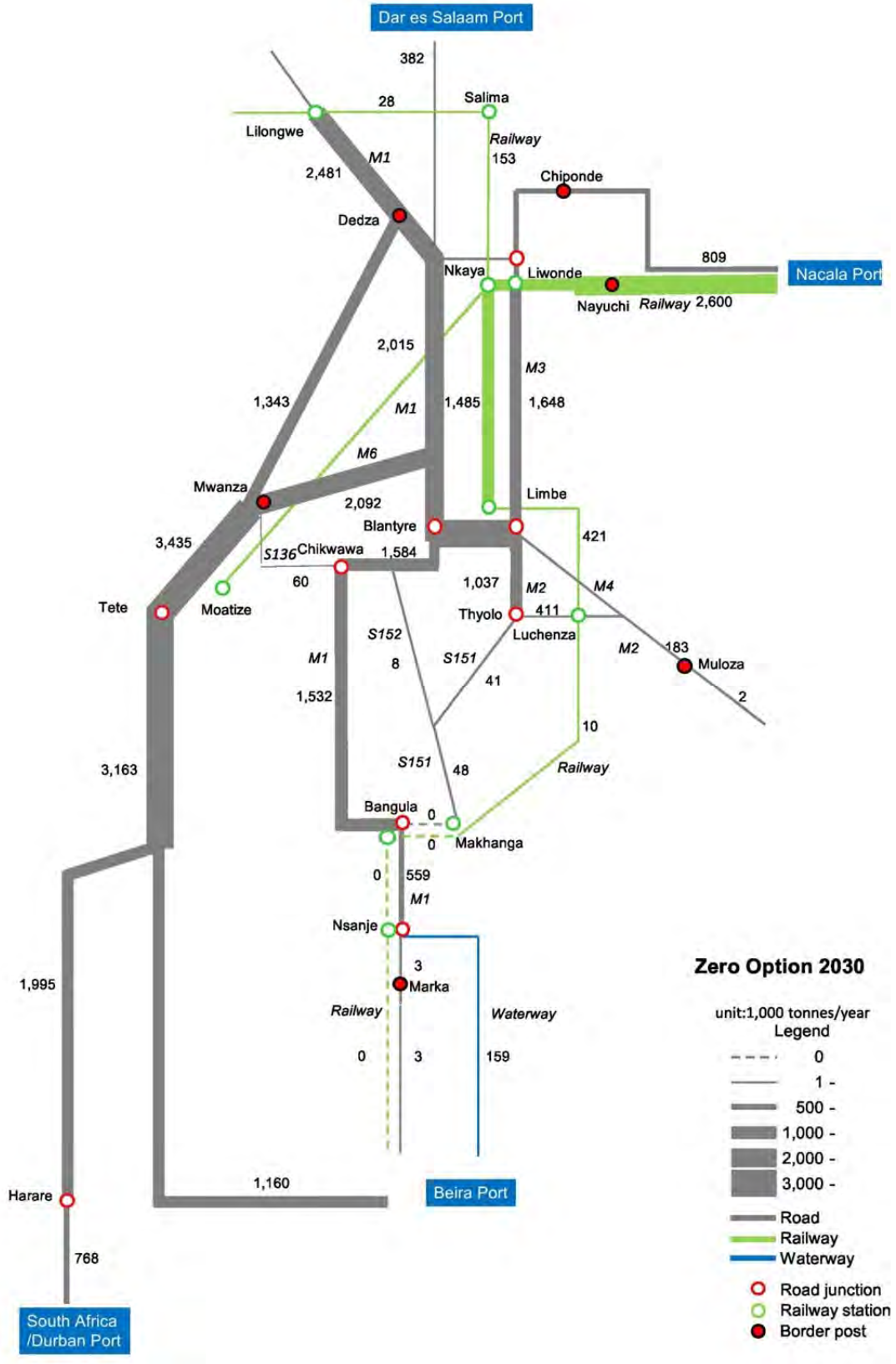
Other specific points for the expected future transport conditions are as follows:

- There are an expansion plan and on-going dredging work at the approach channel. Hence, Beira Port will become more convenient for Malawi, attracting the main liners in particular.
- The Nacala Corridor will become one of the main corridors for Malawi, when the port facility, railway and road have been improved.
- The Durban and Dar es Salaam Corridors will be less preferable because of their long-haul transportation.
- The Sena Corridor (railway and inland waterway) will minimize the time and cost of transport.

4.3.6 Traffic Assignments on Alternative Transport Networks

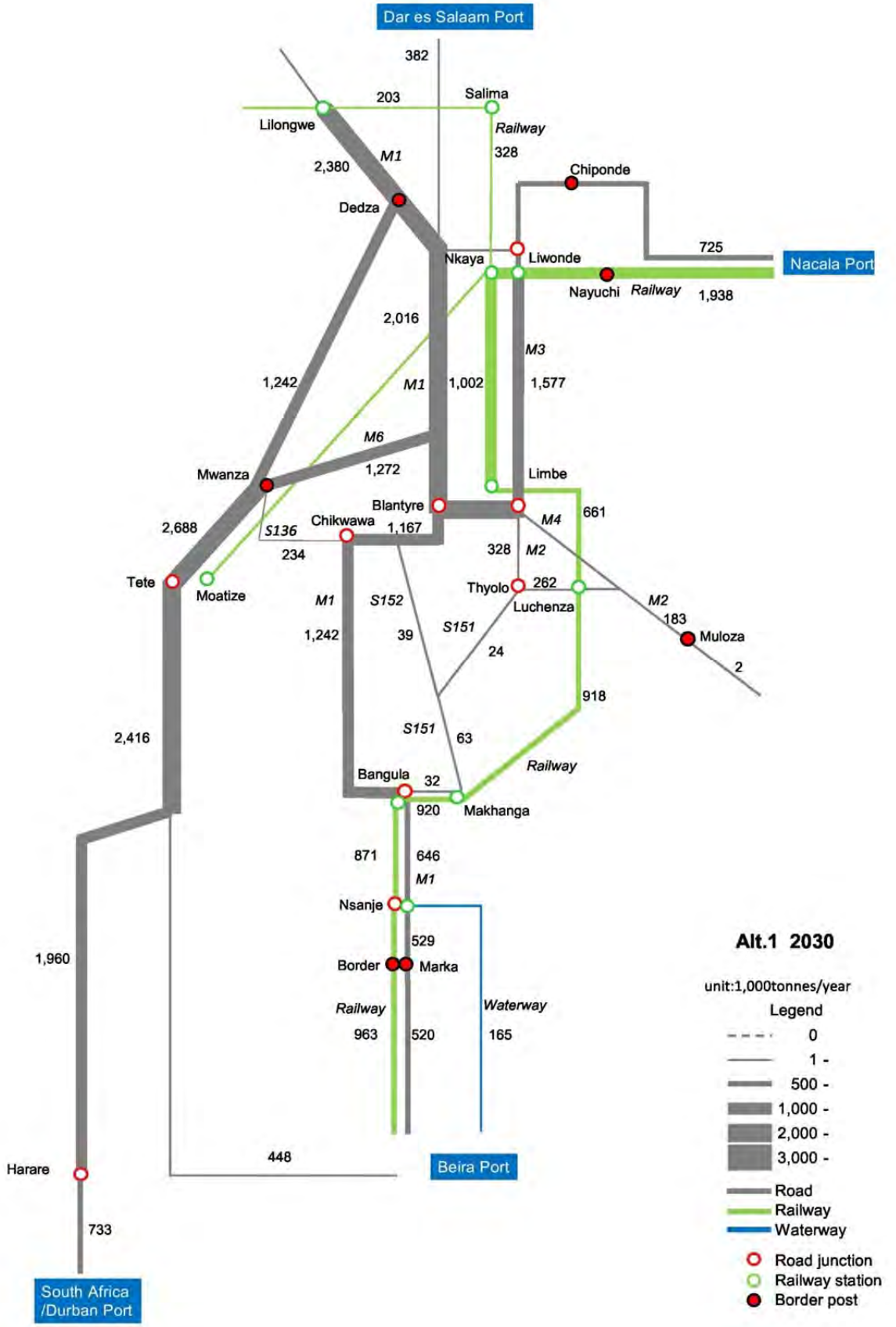
(1) Assignment of Freight Demand on Alternative Transport Networks

Based on the future export and import freight flows, freight demands of export and import commodities are assigned to alternative transport networks. This traffic assignment excludes the transit freights demand for coal and copper to avoid confusion on certain networks, particularly the Nacala Railway network. Figures 4-58 to 4-61 show the results of freight demand assignments on networks Zero option, Alt. 1, Alt. 2 and Alt. 3, respectively.



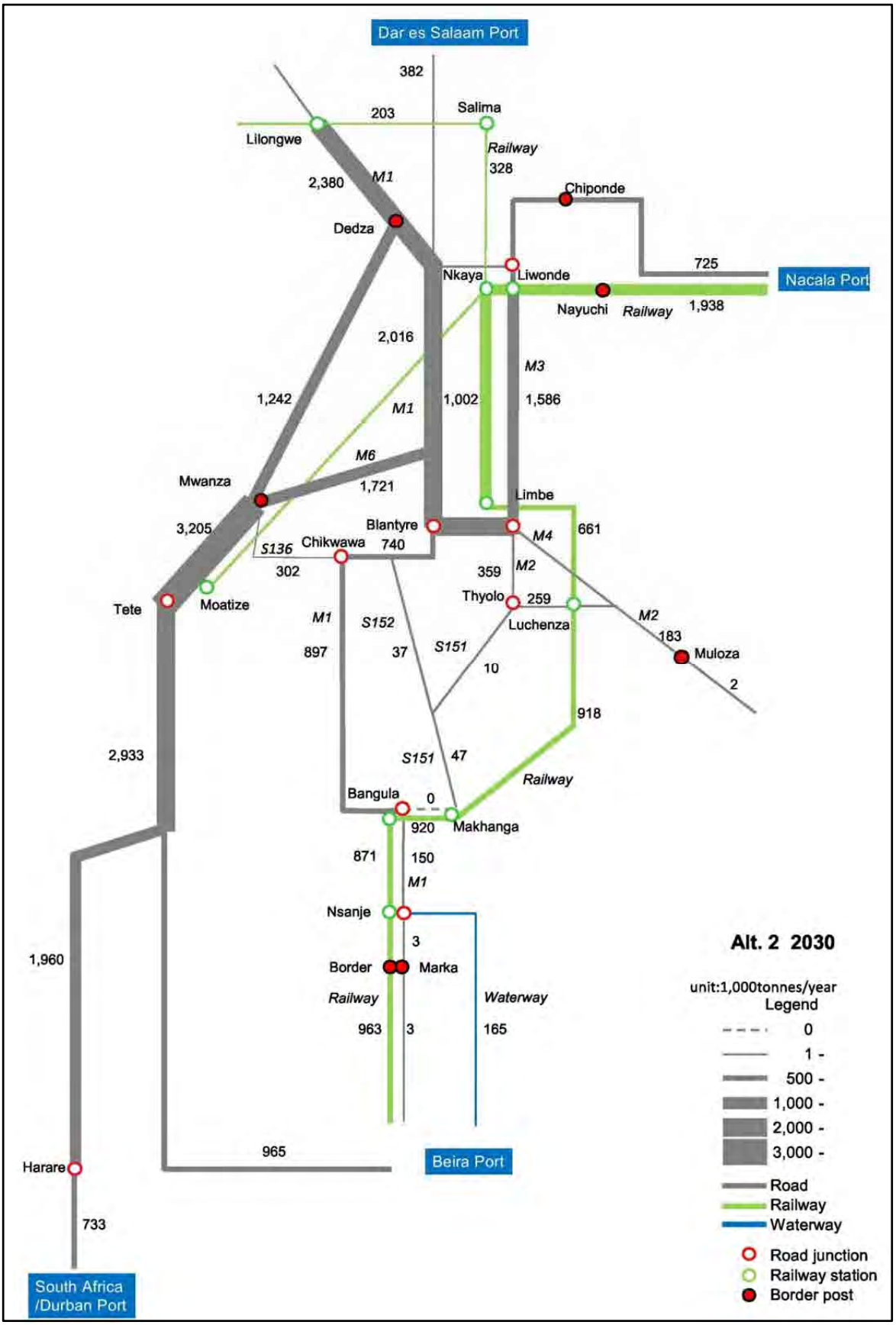
Source: Study Team

Figure 4-58 Results of Freight Demand Assignment for Zero Option



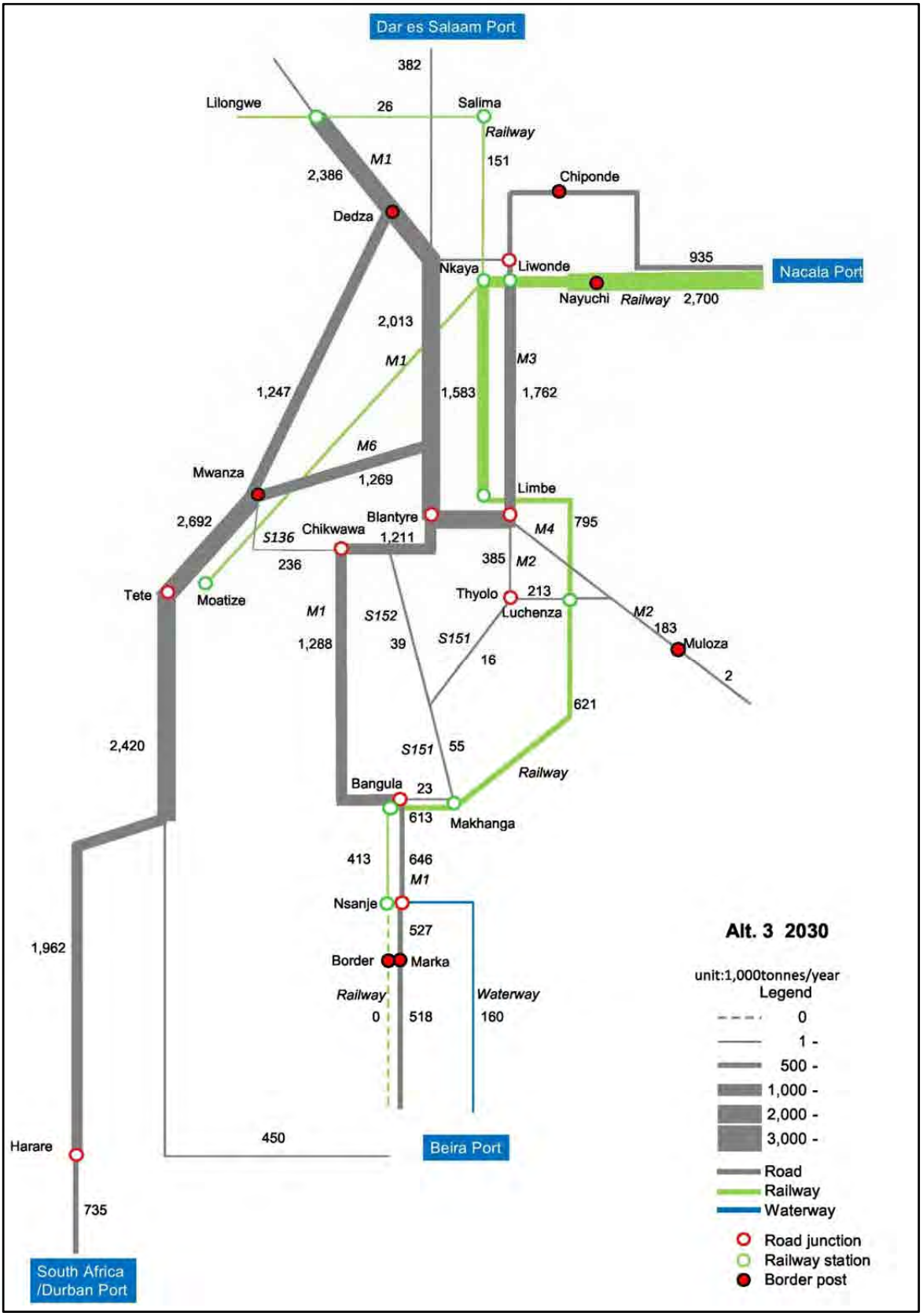
Source: Study Team

Figure 4-59 Results of Freight Demand Assignment for Alternative Alt. 1



Source: Study Team

Figure 4-60 Results of Freight Demand Assignment for Alternative Alt. 2



Source: Study Team

Figure 4-61 Results of Freight Demand Assignment for Alternative Alt. 3

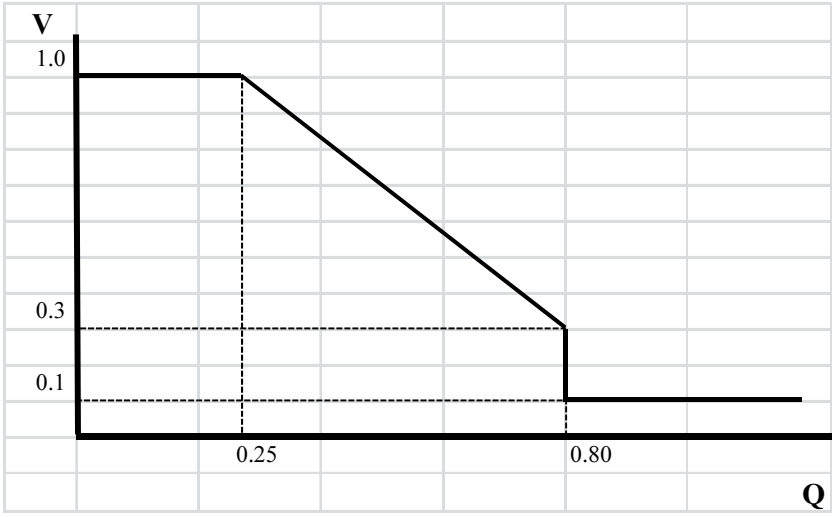
(2) Assignment of Vehicular Traffic on Alternative Transport Networks

In the Study, vehicular traffic demand is assigned as follows:

- Convert the results of the freight demand assignment into freight vehicular traffic volume.
- Convert passenger flow volume into passenger car volume and bus traffic volume by using the occupancy ratio of passenger cars and buses, obtained from the cordon line traffic survey.

The vehicular traffic assignment model is then performed using the incremental assignment module, contained in the JICA STRADA system. In this model, trips of cars, buses and trucks/trailers are assigned to the minimum path, and the assumed travel speed is revised depending on the accumulated traffic volume in an iterative manner.

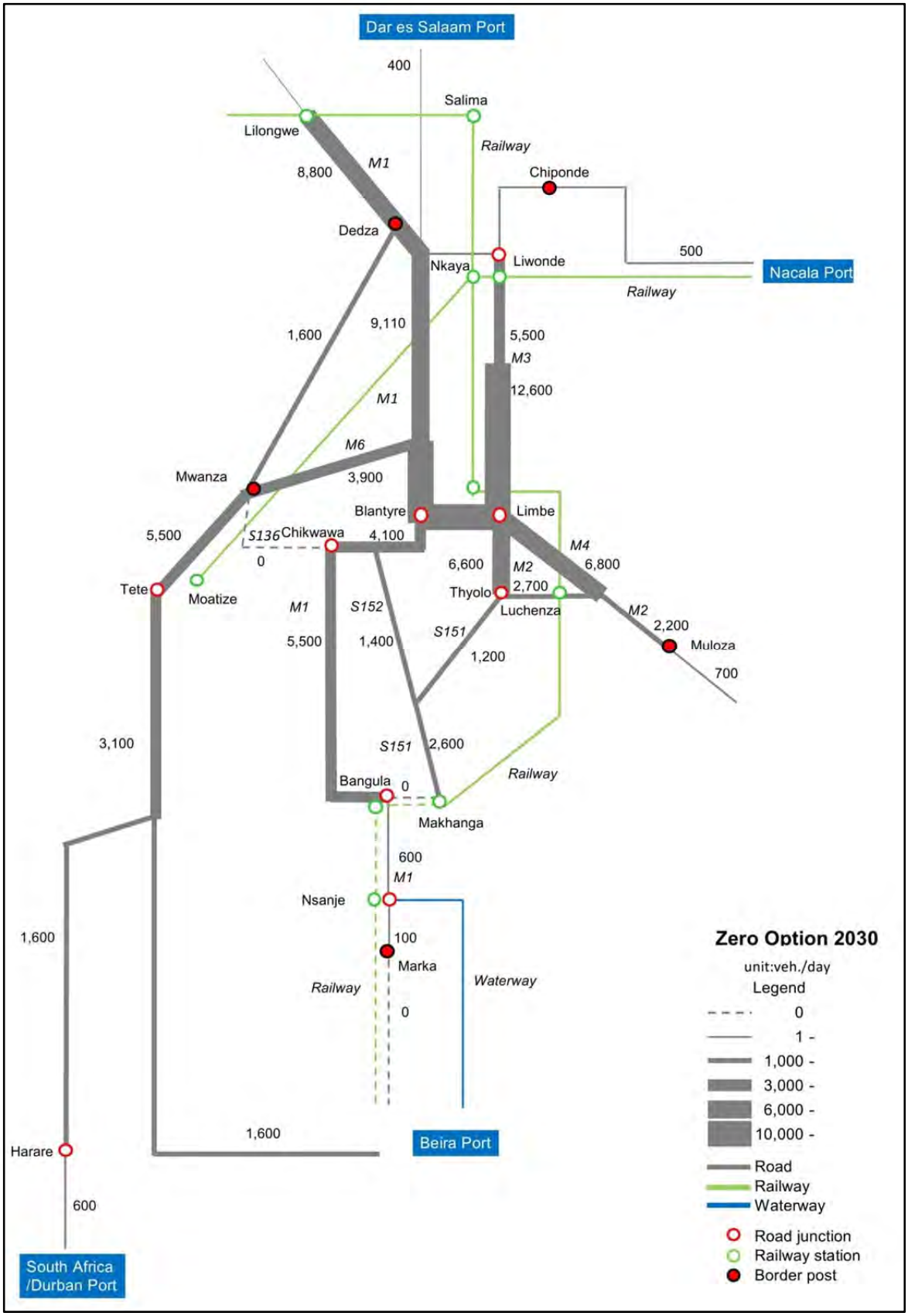
A volume delay function called Quantity-Velocity (QV) formula for road link data was set up as shown in Figure 4-62. The free flow speed and ideal capacity in each road link are defined.



Note: V=Ratio of velocity to design standard speed, Q=Ratio of quantity to ideal capacity
Source: Study Team

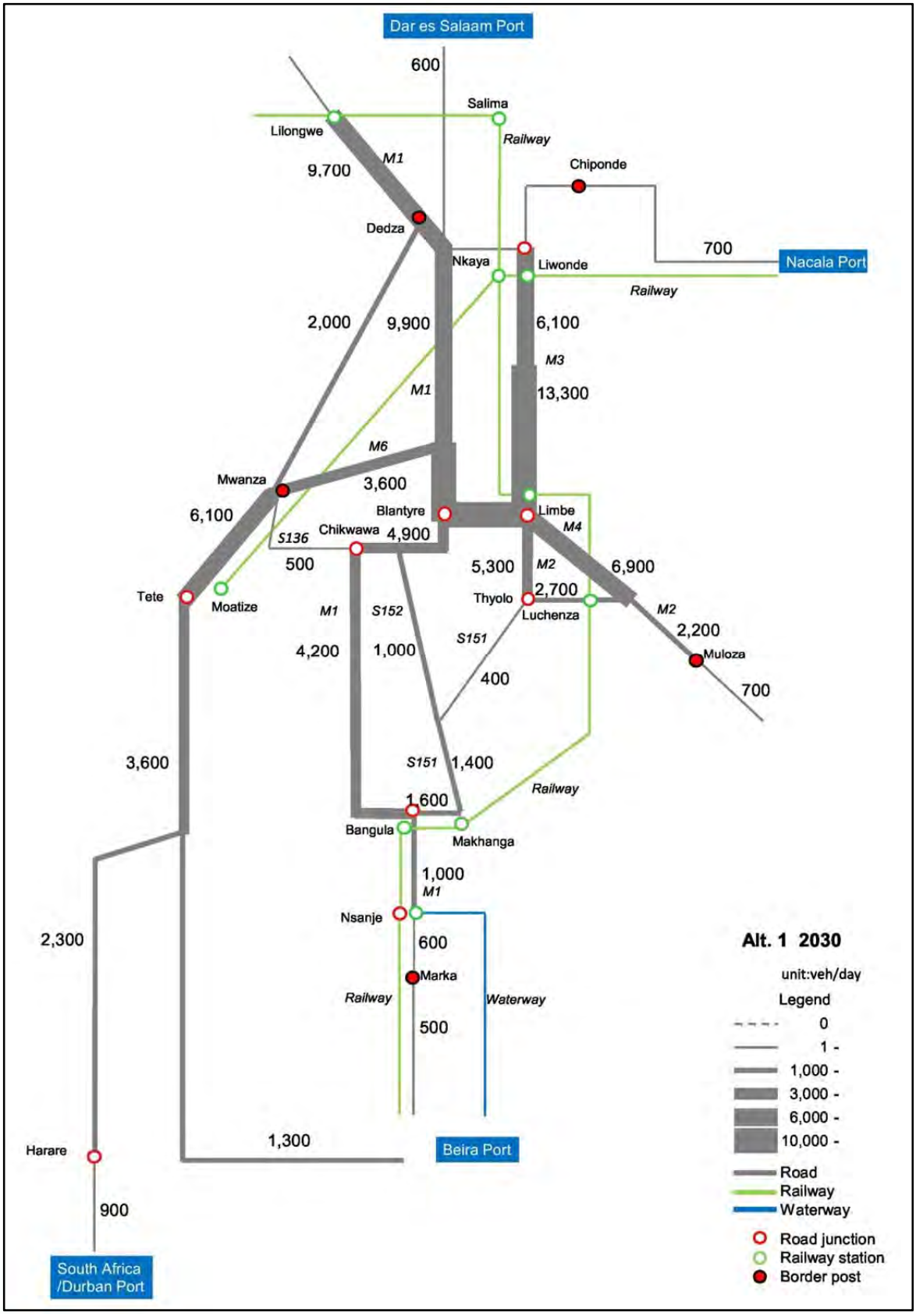
Figure 4-62 Volume Delay Function

Figures 4-63 and 4-66 show the results of vehicular traffic assignments on networks Zero option, Alt. 1, Alt. 2 and Alt. 3, respectively.



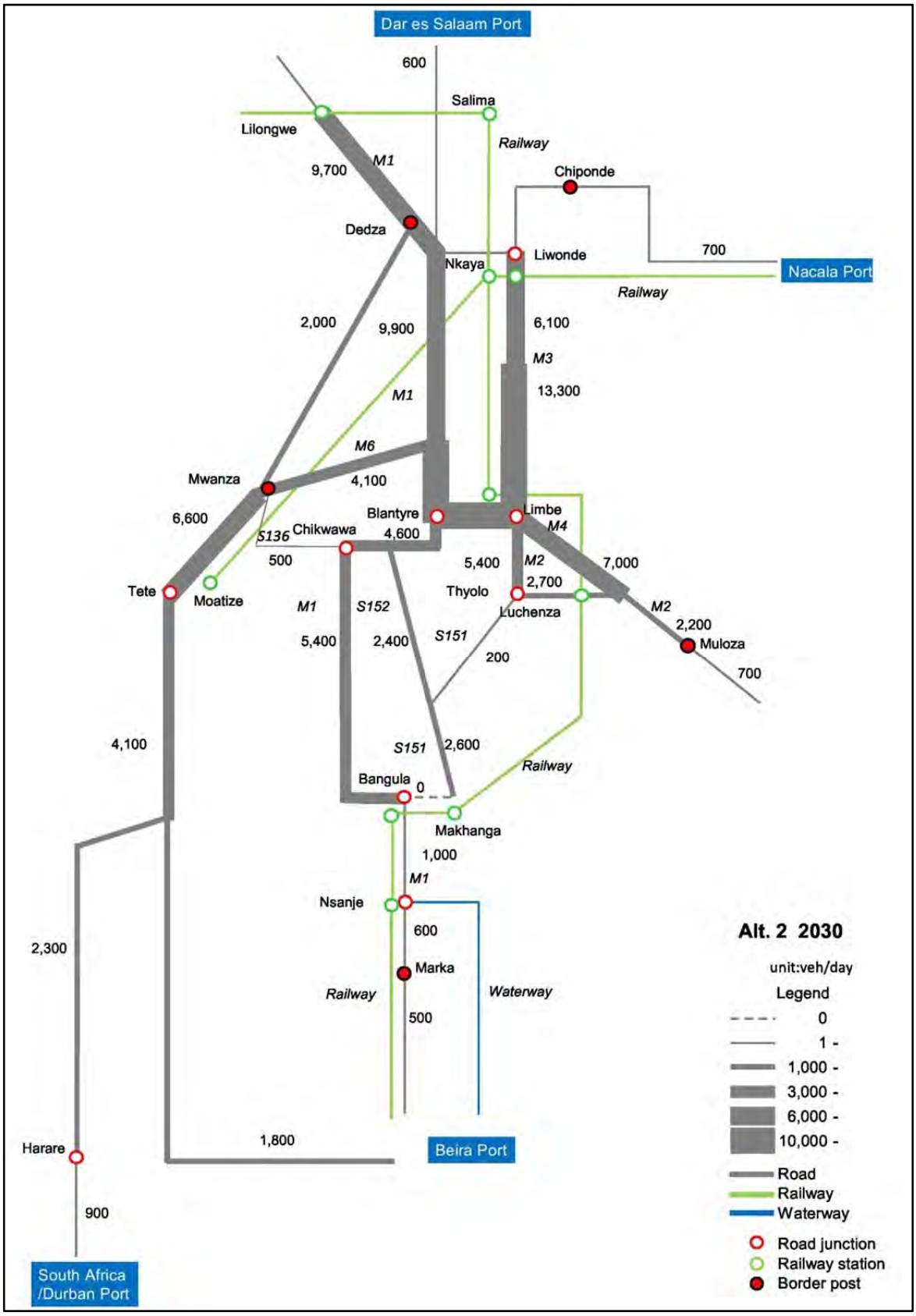
Source: Study Team

Figure 4-63 Results of Vehicular Traffic Demand Assignment for Zero Option



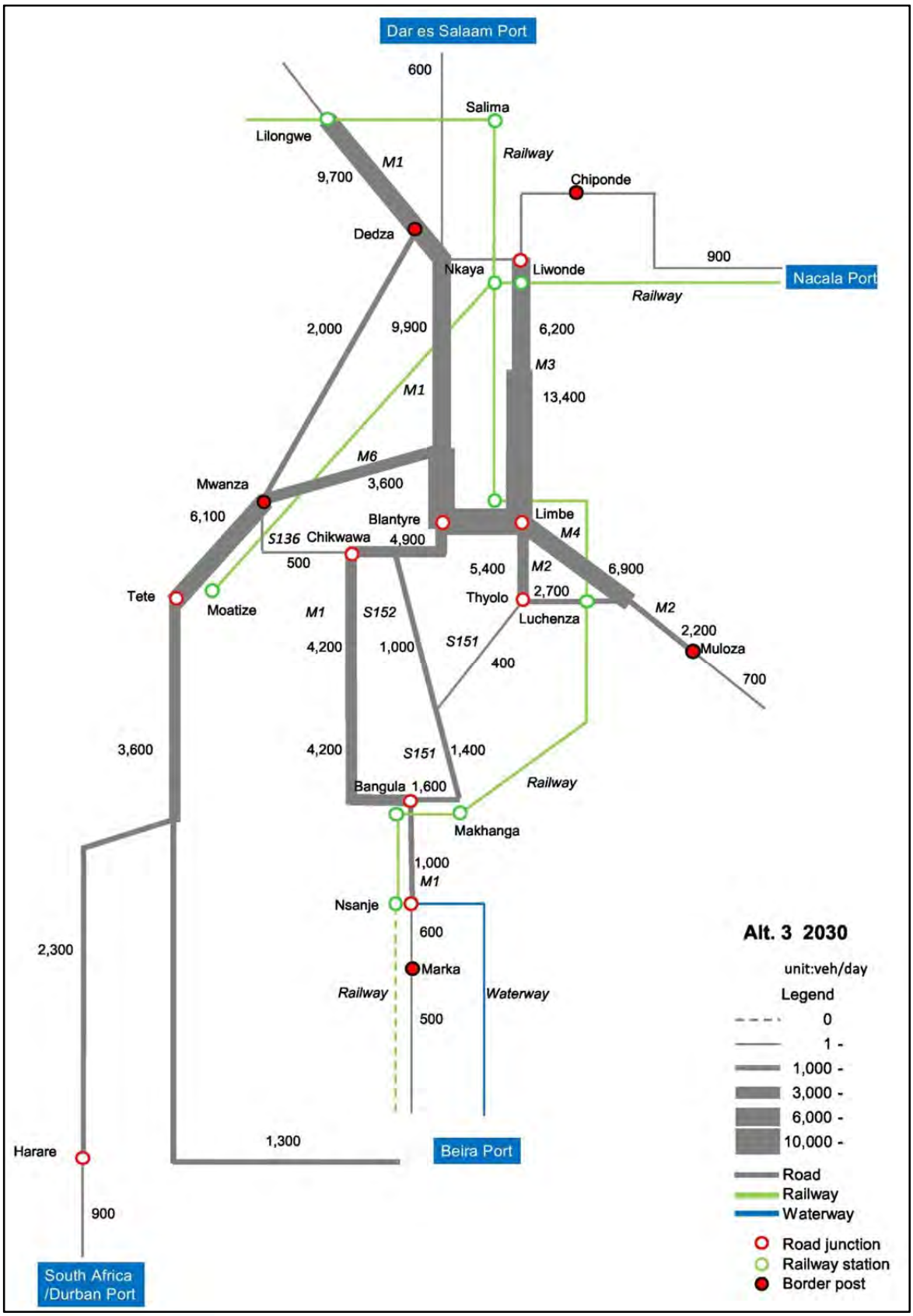
Source: Study Team

Figure 4-64 Results of Vehicular Traffic Assignment for Alternative Alt. 1



Source: Study Team

Figure 4-65 Results of Vehicular Traffic Assignment for Alternative Alt. 2

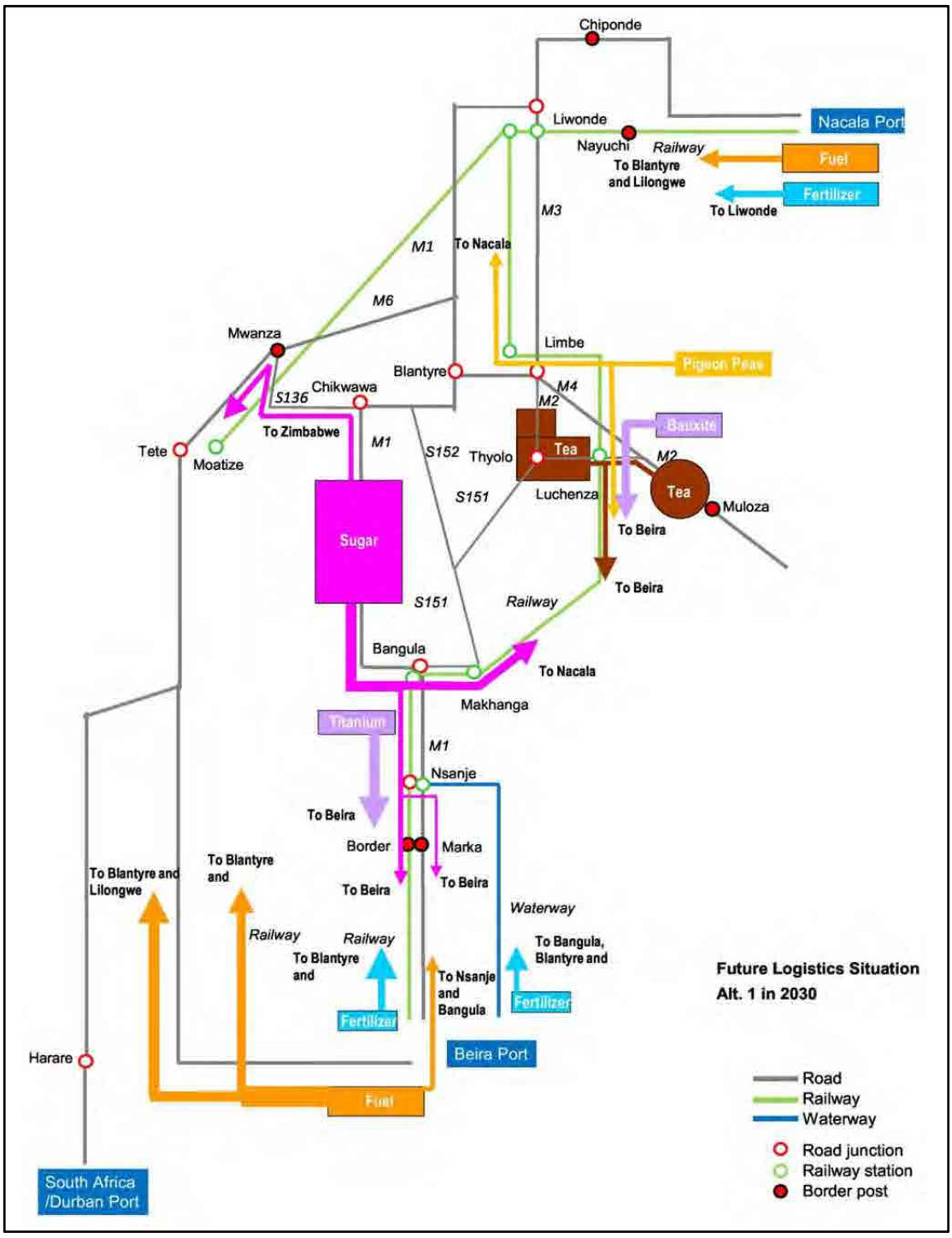


Source: Study Team

Figure 4-66 Results of Vehicular Traffic Assignment for Alternative Alt. 3

4.3.7 Future Commodity Transport Routes

Based on the results of the freight demand assignment for Alt. 1, the major routes for transporting commodities to/from ocean ports are expected to be as shown in Figure 4-67:



Source: Study Team

Figure 4-67 Future Commodity Transport Route for Alt. 1

- Cash crops are expected to be mainly placed in containers at Bangula and Luchenza (new logistics centres), thus avoiding the concentration of freight vehicles in the central districts of Blantyre and Limbe and resulting traffic congestion.

- Sugar is expected to be mainly transported to Nacala Port by railway from Bangula, except exports to Zimbabwe by truck (bulk) through S136.
- Tea is expected to be transported to Beira Port by railway from Luchenza, which is the centre of the tea cultivation/processing areas.
- Bauxite and titanium are expected to be transported to Beira Port by railway from Luchenza and Nsanje, respectively.
- Fuel is expected to be transported from Beira and Nacala Ports by both railway and road.
- Fertilizer is also expected to be transported from Beira and Nacala Ports by railway and inland waterway.

4.3.8 Freight-km and Passenger-km by Each Alternative Transport Network

The accumulated freight-km and passenger-km for each alternative transport network in 2030 are calculated from the results of traffic assignment described above. Tables 4-37 and 4-38 show the freight-km and freight-hour for each alternative transport network, respectively, while Tables 4-39 and 4-40 show the passenger-km and passenger-hour for each alternative transport network, respectively.

Table 4-37 Accumulated Freight-km of Each Alternative Transport Network

(Unit: 1000 tonnes -hour/year)

Transport Mode	Zero Option		
	In Malawi	Outside Malawi	Total
Road	2,501,398	3,653,164	6,154,562
Railway	529,109	1,880,980	2,410,089
Inland Waterway	71,416	-	71,416
Total	3,101,923	5,534,144	8,636,067

Transport Mode	Alt. 1			Alt. 2			Alt. 3		
	In Malawi	Outside Malawi	Total	In Malawi	Outside Malawi	Total	In Malawi	Outside Malawi	Total
Road	2,332,066	3,278,737	5,610,803	2,305,518	3,397,148	5,702,666	2,415,947	3,388,489	5,804,436
Railway	564,450	1,835,105	2,399,555	564,450	1,835,105	2,399,555	646,101	1,942,311	2,588,413
Inland Waterway	74,271	-	74,271	74,271	-	74,271	72,192	-	72,192
Total	2,970,787	5,113,842	8,084,629	2,944,239	5,232,253	8,176,492	3,134,241	5,330,800	8,465,041

Source: Study Team

Table 4-38 Accumulated Freight-hour of Each Alternative Transport Network

(Unit: 1000 tonnes-hour/year)

Transport Mode	Zero Option		
	In Malawi	Outside Malawi	Total
Road	67,029	91,330	158,359
Railway	12,107	37,620	49,727
Inland Waterway	2,381		2,381
Total	81,517	128,950	210,466

Transport Mode	Alt. 1			Alt. 2			Alt. 3		
	In Malawi	Outside Malawi	Total	In Malawi	Outside Malawi	Total	In Malawi	Outside Malawi	Total
Road	61,757	81,989	143,747	60,924	84,930	145,853	63,910	84,735	148,644
Railway	12,329	36,703	49,032	12,329	36,703	49,032	14,504	38,847	53,351
Inland Waterway	2,476		2,476	2,476		2,476	2,406		2,406
Total	76,562	118,692	195,254	75,729	121,632	197,361	80,820	123,581	204,402

Source: Study Team

Table 4-39 Accumulated Passenger-km of Each Alternative Transport Network

(Unit: Passenger-km/day)

Vehicle Type	Zero Option	Alt. 1	Alt. 2	Alt. 3
Passenger car	11,203,447	10,800,165	11,188,902	10,800,165
Bus	48,993,412	46,762,160	48,717,854	46,762,160
Total	60,196,859	57,562,324	59,906,755	57,562,324

Source: Study Team

Table 4-40 Accumulated Passenger-hour of Each Alternative Transport Network

(Unit: Passenger-hour/day)

Vehicle Type	Zero Option	Alt. 1	Alt. 2	Alt. 3
Passenger car	227,511	217,126	225,081	217,126
Bus	1,026,194	963,414	1,003,538	963,414
Total	1,253,705	1,180,540	1,228,618	1,180,540

Source: Study Team