## 12.6 Industrial Commodities

### 12.6.1 Sugar (Sub-group 18)

(1) Consumption

While gross consumption grew in the 1987-1992 period, consumption/cap. fell from 36 kg in 1987 to 31 kg in 1992. The Third 5-Year Plan and projections of this Study maintain consumption/cap. within the 28-30 kg range. These figures are on the conservative side, bearing in mind the Egyptian well-known sweet tooth. In gross consumption terms 2012 projection will be 1.4 times that of 1990.

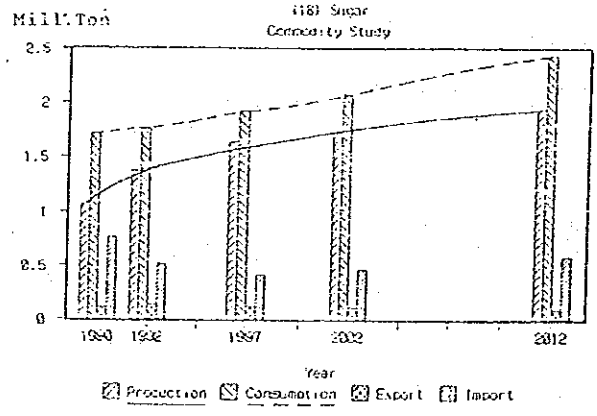
(2) Production

Production declined during 1987-1992 period, where an average annual growth rate of 0.99 was recorded. The Third 5-Year Plan projected a growth rate of 1.04 and 1997 projection is 1.5 that of 1990. Projections of this Study for the period after that plan, i.e. for 1997-2012 show a slower production growth of 1.01 per annum. The 2012 production projection is 1.2 that of 1997.

From the sugar cane production forecast for 2012 it is possible to produce 1.9 million tons of sugar. The same amount can be produced using a lesser amount of sugar cane by using sugar beet. Various studies on the sugar industry in the early 1980's projected a production of 1.75 million tons in 2000, of which 25% is produced from sugar beet. The projection for 2002 under this study is 1.74 million tons.

(3) Foreign Trade

Exports are projected to decrease by an annual rate of 0.98 throughout 1992-2012 period, while on the other hand imports will grow by annual rates of 0.95 and 1.02 during 1992-1997 and 1997-2012 periods respectively.



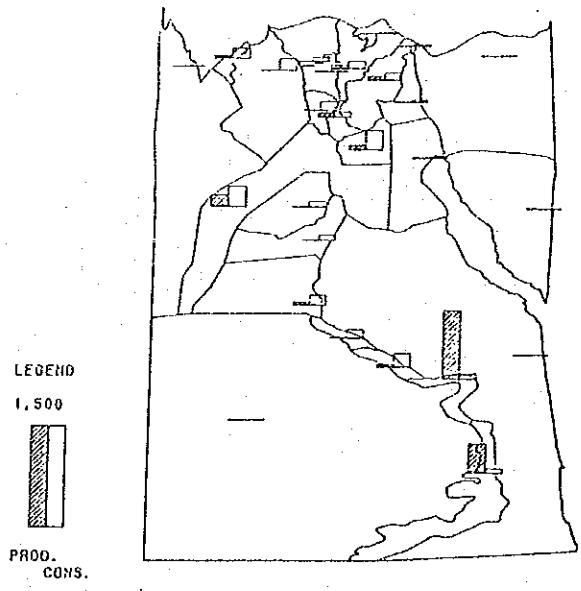




Fig. 12-6-1 Sugar Products Projection

12.6.2 Edible Oils/Fats (Sub-group 19)

(1) Consumption

The recorded annual growth rate in consumption/cap. for 1987-1992 period was 1.04. The Third 5-Year Plan projects a lesser growth of 1.01 p.a. and projections of this Study project growth during 1997-2012 to be 1.02 p.a. In actual terms consumption/cap. is forecast to increase from 15 kg in 1992 to 23 kg in 2012.

(2) Production

The 1987-1992 period witnessed a large increase in production at an annual growth rate of 1.23. Production in 1992 almost trebled to 432,000 ton compared with 153,000 ton at the start of the Plan. Annual growth rate projected in the Third 5-Year Plan and for the period thereafter by this Study, up to the year 2012 is 1.06. Production projected for 2012 is 2.9 that of 1992.

Based on past trend, roughly 85% of projected 2012 production amount shall be produced from oil seed, with the remainder from soybean crop. To produce that amount approximately 5.4 million ardabs (1 metric ardab = 120 kg) of cotton seed shall be required. It is worthwhile to note that in 1985 and 1986 recorded amounts of cotton seed production were 5.6 and 5.9 million ardabs respectively.

(3) Foreign Trade

Export amounts forecast in the Third 5-Year Plan are projected to continue more or less unchanged, and projected imports shall grow at a rate of 1.01 per annum during the Third 5-Year Plan and at a rate of 1.03 thereafter, up to 2012.

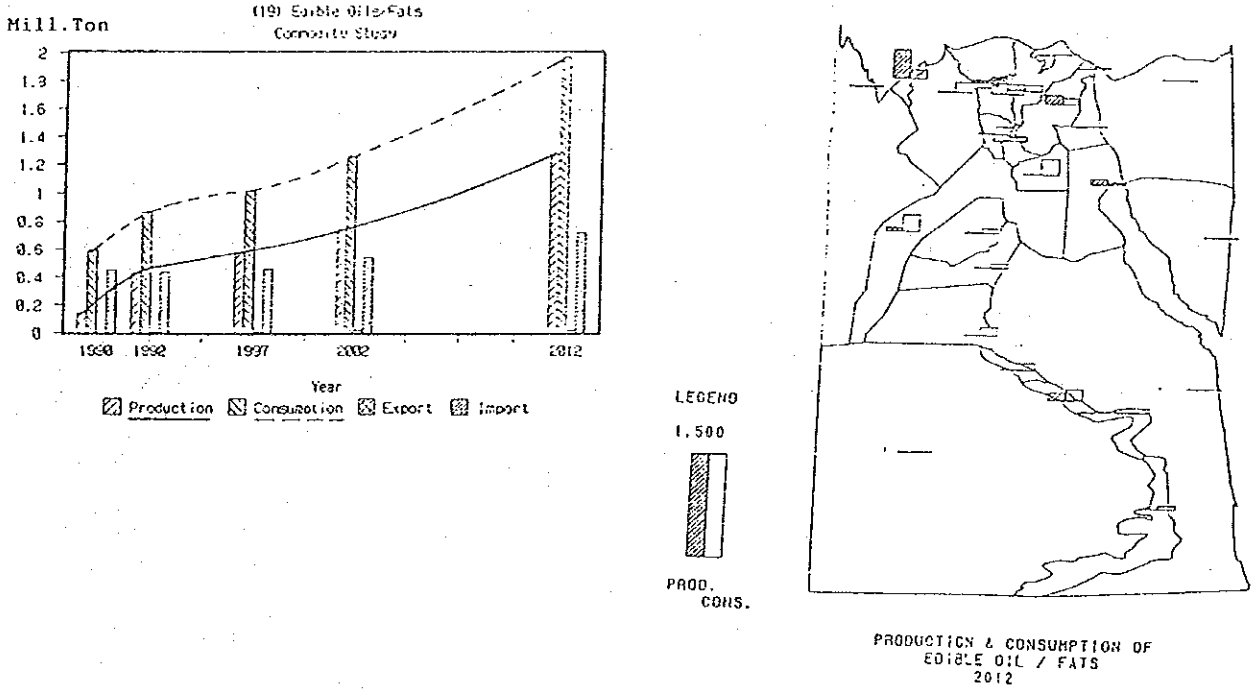



Fig. 12-6-2 Edible Oil/Fats Projection

12.6.3 Animal Feed (Sub-group 20)

(1) Consumption

The Third 5-Year Plan and projections of this Study for 1997-2012 period indicate a growth rate per annum of 1.05. Consumption in the year 2012 is forecast to reach 4.7 times that of 1990.

(2) Production

The 1987-1992 period recorded a large growth rate of 1.09 per annum. Production in 1992 exceeded that of 1987 by 1.5 times. Projected annual growth rate for the Third 5-Year Plan fell to 1.05 p.a. and that projected for 1997-2012 period by this study is 1.06 p.a. Projected production in 2012 is forecast to treble that of 1992.

This is reasonable when considering the government's initiative to decrease imports and recent increased activity of the private sector in the production of this commodity.

(3) Foreign Trade

Egypt is projected to continue importing this commodity up to the year 2002 to satisfy forecast local demand, however by the year 2012 Egypt will have become an exporter due to the projected high production. Therefore 2002 import amount and 2012 export amount have been projected by balancing supply with demand.

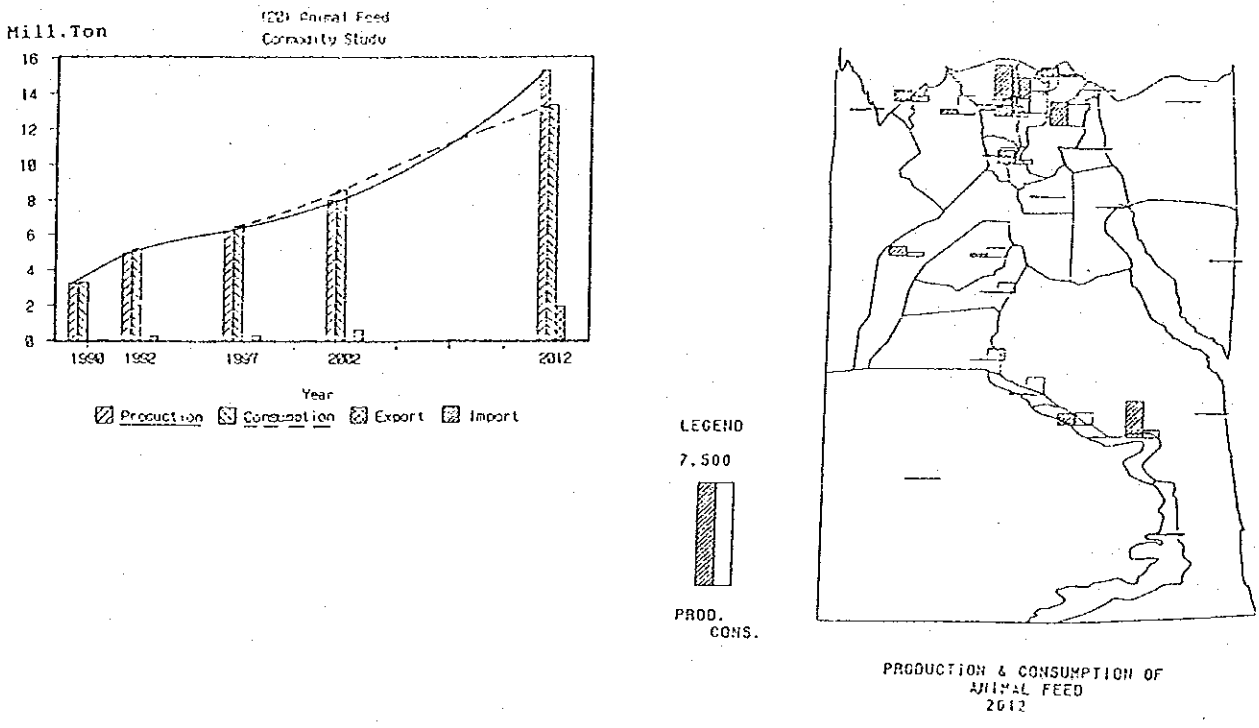



Fig. 12-6-3 Animal Feed Projection

12.6.4 Beverages (Sub-group 21)

(1) Consumption

Consumption/capita witnessed a sharp increase during the 1987-1992 period. Consumption/cap. in 1992 rose to 2.5 times that of 1987. Growth rate projected during the Third 5-Year Plan fell to 1.03 p.a. and the same growth rate was projected for 1997-2012 period by this Study. Consumption/cap. in 2012 is projected to be 1.7 times that of 1992 and 4.2 times the 1987 figure.

(2) Production

As explained above, growth rate for production in 1987-1992 period was high at 1.08 p.a. and is projected to decrease in the Third 5-Year Plan and thereafter to 1.05 p.a. The 2012 projected production is 2.7 times the 1997 production and 4 times that of 1992.

(3) Foreign Trade

Projected production is expected to satisfy local consumption and imports shall be zero. On the other hand, projected exports shall be the difference in production and consumption.

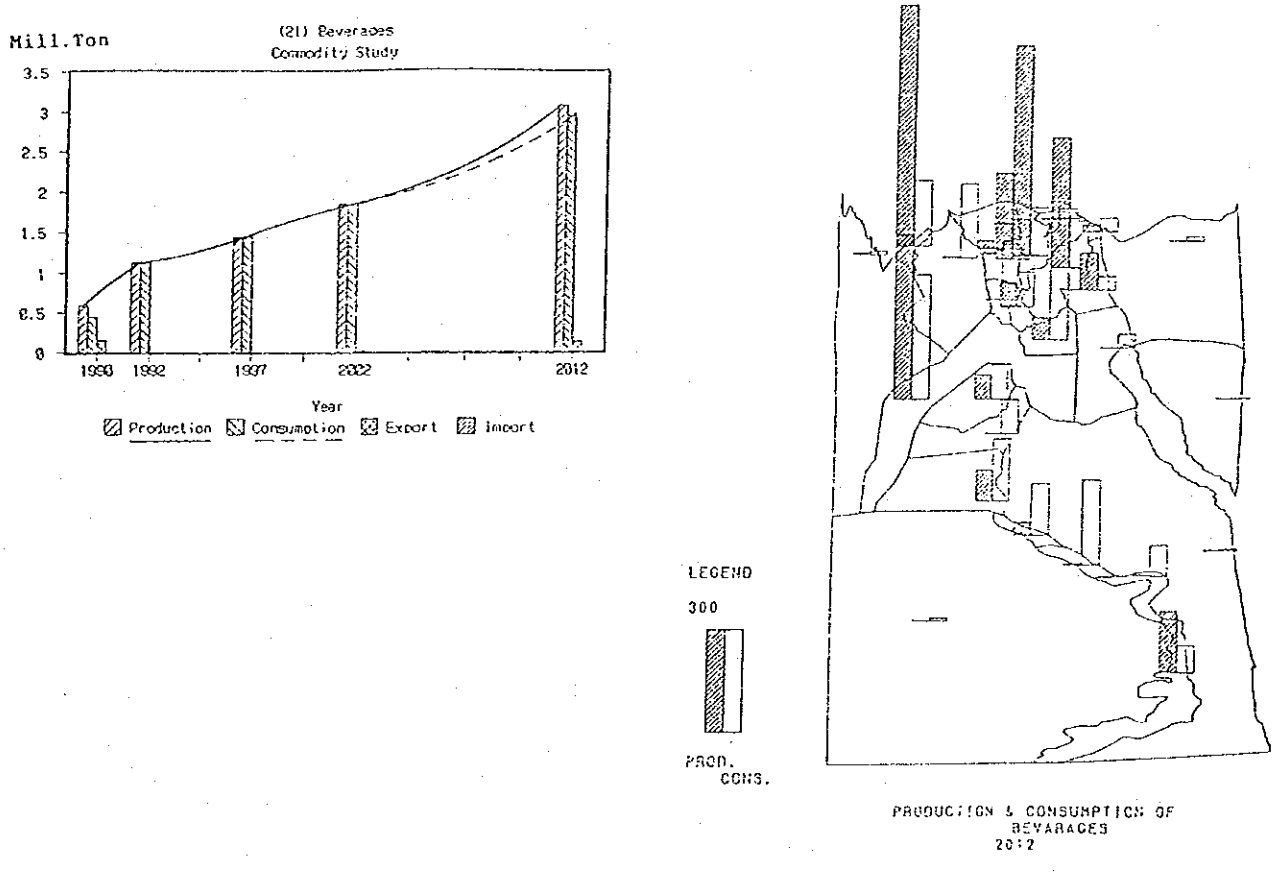



Fig. 12-6-4 Beverages Projection

### 12.6.5 Other Food Products (Sub-group 22)

(1) Consumption

The 1987-1992 period showed a growth rate of 0.93 per annum for consumption/capita. The Third 5-Year Plan projected a growth rate of 1.0 p.a. and this Study expects that rate continues up to year 2012. Therefore projected consumption/capita in 2012 is the same as that of 1992, while gross consumption for 2012 will exceed that of 1990 by 1.2 times.

(2) Production

Production during 1987-1992 period grew at an annual rate of 1.01. The Third 5-Year Plan projects a growth rate of 1.03 p.a. which this Study expects to continue up to 2012. This is supported by the presently thriving food industry in Egypt which is likely to continue to grow and therefore optimism is warranted.

(3) Foreign Trade

Constant import projections in the Third 5-Year Plan are forecast to continue up to the year 2012, while projected exports are the difference in production and consumption.

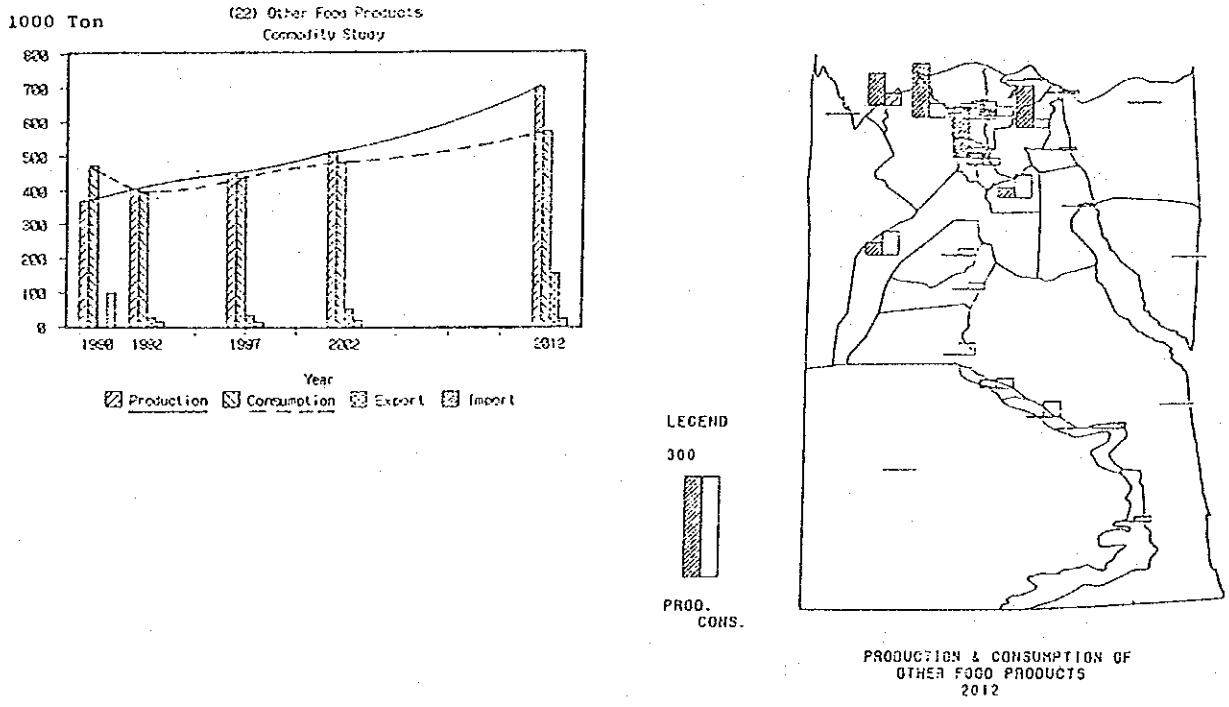



Fig. 12-6-5 Other Food Products Projections

### 12.6.6 Chemical Products (Sub-group 23)

(1) Consumption

In consumption/cap. terms 1987-1992 period witnessed a decreasing growth rate. The 1992 consumption/cap. was 0.85 that of 1987. The Third 5-Year Plan projects a mild growth rate of 1.005 p.a., and projections of this Study show a decreasing growth rate of 0.99 p.a. for 1997-2012 period. Consumption/cap. in 2012 is projected to drop to 0.88 that of 1992. In gross consumption terms 2012 value is expected to reach 1.7 times that of 1990.

(2) Production

During 1987-1992 production lagged behind consumption and imports were high. However growth rate during that period was 1.06 p.a. The government, stressing the importance of this commodity as a secondary product in many industries has set a similarly high growth rate of 1.04 p.a. for the Third 5-Year Plan. By 1997 production is forecast to exceed consumption demand and there will be room for imports. This study's forecasts project a continuing growth rate of 1.06 p.a. during 1997-2012. Production in 2012 is forecast to more than treble that of 1990.

(3) Foreign Trade

Production is forecast to exceed consumption during the Third 5-Year Plan and continue to grow. The importance of this commodity as an export item is evident from projected export amount in the year 2012 which is calculated to be 7 times that of 1997, the last year of the Third 5-Year Plan.

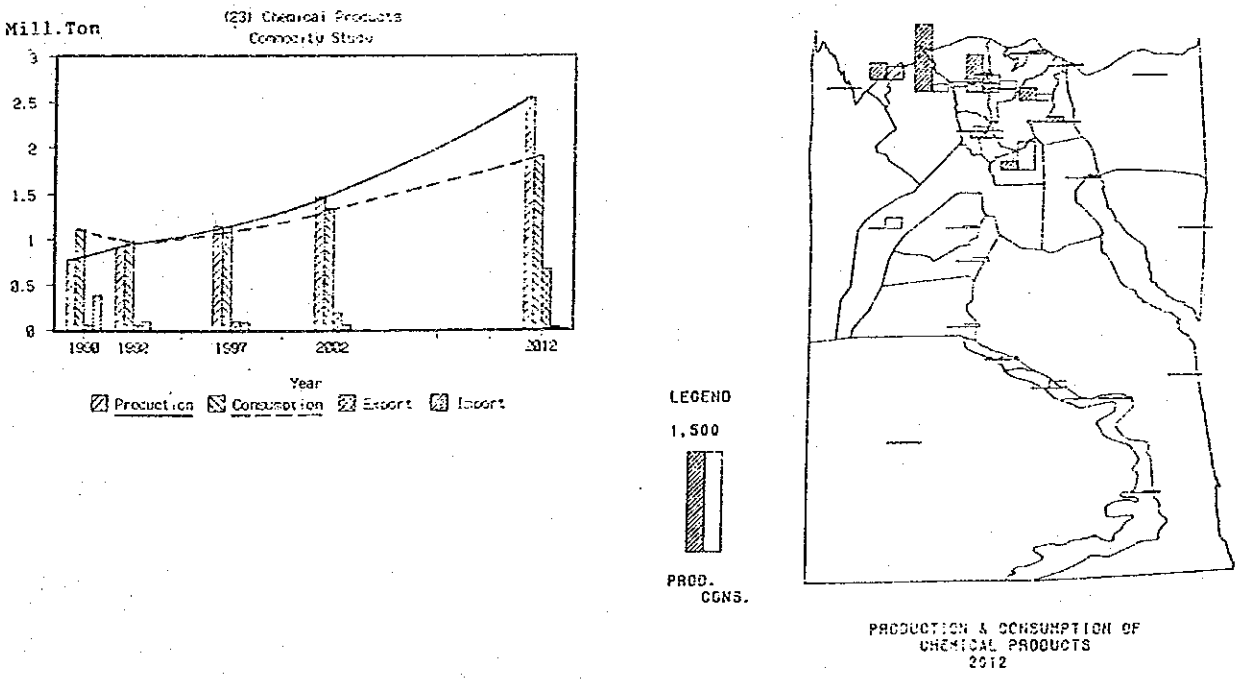



Fig. 12-6-6 Chemical Products Projection

12.6.7 Metal and Metal Products (Sub-group 24)

(1) Consumption

The 1987-1992 period produced a sharp increase in consumption/cap. at a growth rate of 1.1 per annum. The 1992 consumption was 85 kg/cap. The Third 5-Year Plan projected that consumption/cap. figure would remain unchanged throughout the plan period. Projections under this study for 1997-2012 period, at a growth rate of 1.02, indicate that consumption/cap. in 2012 will be 118 kg (i.e. 2.2 times the 1987 figure). This figure is reasonable when considering some 1977 worldwide figures as follows;

| | | | |
|---|---|---|---|
| Egypt: | 30 kg/cap. | Algeria: | 52 kg/cap. |
| Libya: | 168 kg/cap. | Saudi Arabia: | 96 kg/cap. |
| USA : | 704 kg/cap. | Japan: | 805 kg/cap. |

(2) Production

In the early 1980's the government had a plan to achieve a production amount of 30 million tons by the year 2000. Therefore not surprisingly annual production growth rate realized during 1987-1992 is quite high at 1.17. Production more than doubled in that period. However the Third 5-Year Plan projected a more modest growth of 1.03 p.a., and accordingly estimated 1997 production of 4.1 million tons falls far short of the government's above mentioned plan. The projections of this study for 1997-2012, at a growth rate of 1.05 p.a., estimate a 2012 production of 8.9 million tons, i.e. 2.8 times the 1990 figure.

(3) Foreign Trade

Demand is projected to continue to exceed domestic supply and imports in 2012 are expected to reach 1.2 times the amount of 1990. Exports are also projected to grow and 2012 amount is projected to exceed 1.4 times that of 1990. Ratio of import to export will however decrease from 1990 (4.2:1) to 2012 (3.5:1).

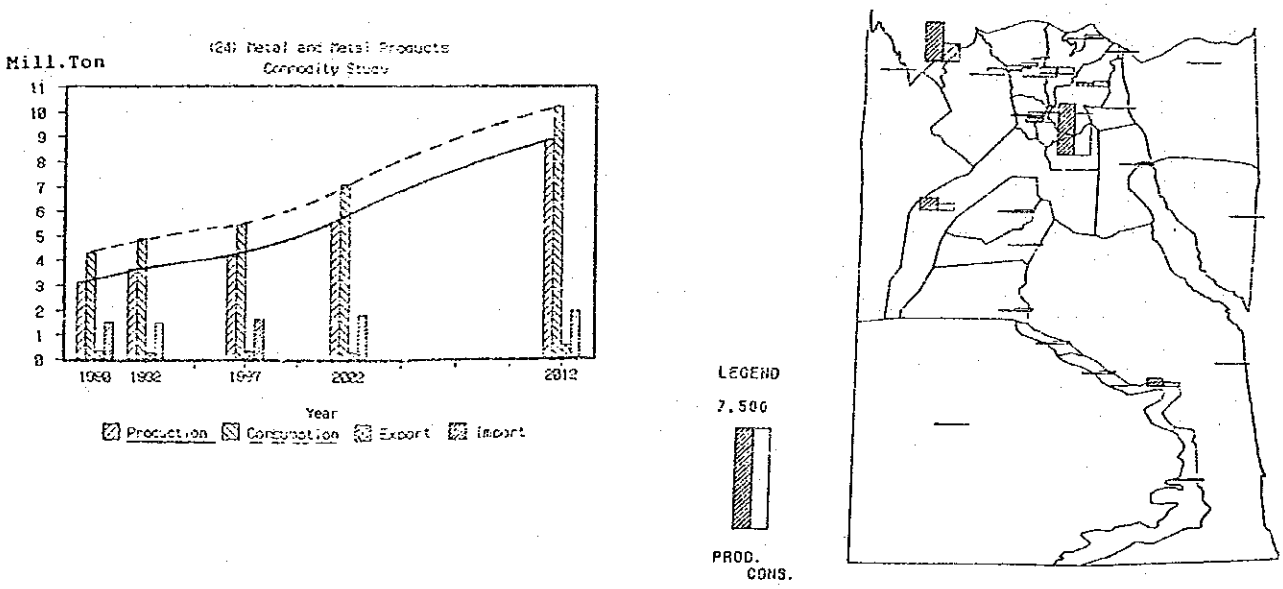



Fig. 12-6-7 Metal and Metal Products Projection

12.6.8 Textiles (Sub-group 25)

(1) Consumption

Consumption/capita achieved in 1987-1992 period under an annual growth rate of 1.03 is projected to remain unchanged during the Third 5-Year Plan. However thus study's projections show a growth rate of 1.01 p.a. for 1997-2012 period and therefore consumption/capita in 2012 is forecast to be 1.2 times that of 1992.

(2) Production

Production in the Third 5-Year Plan is expected to grow at a rate of 1.04 per year, a rate which is larger than that witnessed in the 1987-1992 period (1.02). Therefore in 1997 production is forecast to be 1.4 that of 1987. These projections are supported by the bustling private sector garment industry that has developed in Egypt in the 1980's and is expected to continue. Projections under this study show that annual growth rate for 1997-2012 period will slightly decrease to 1.03, and production in 2012 is expected to reach 2.3 times that of 1987.

(3) Foreign Trade

This commodity has always played a role in Egypt's export industry and it is forecast to continue to do so in the future. The Third 5-Year Plan projects that in 1997 exports will almost treble that of 1987, and this Study shows that exports will reach 4 times the 1990 figure in the year 2012. Even at present Egyptian textiles and garments are being sold at major shops in Japan.

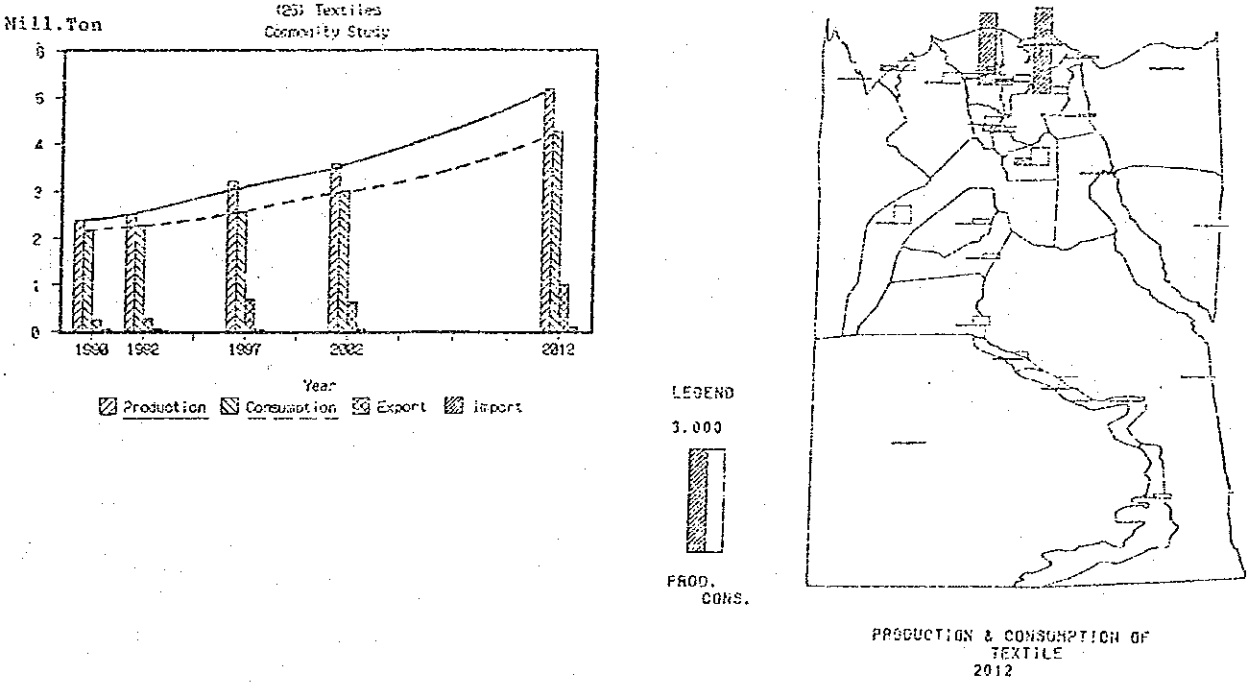



Fig. 12-6-8 Textiles Projection

12.6.9 Manufactured Fertilizer (Sub-group 26)

(1) Consumption

Consumption grew at a rate of 1.05 p.a. during 1987-1992 period, and is forecast to grow at a lesser rate of 1.04 during the Third 5-Year Plan. This study projects that growth rate will further decline to 1.03 p.a. during 1997-2012. The 2012 projected consumption shall double that of 1990.

(2) Production

During 1987-1992 production grew at a high rate of 1.06 p.a., and in 1992 imports are projected to almost reach zero. The Third 5-Year Plan projects a smaller growth rate of 1.04 p.a., which however is still sufficient to increase supply over demand and satisfy the domestic market. The projected high phosphate production (see 12.4.1) is expected to give a boost to the fertilizer industry and increase production. Therefore this Study's projections for 1997-2012 show a continued growth rate of 1.03 p.a. and production in 2012 will more than double that of 1992.

(3) Foreign Trade

With increased production and strong demand in foreign markets, exports in 1997 (the last year of the Third 5-Year Plan) are expected to almost reach 4 times that of 1990. Exports are further forecast to increase by a strong growth rate of 1.06 p.a. during 1997-2012 period.

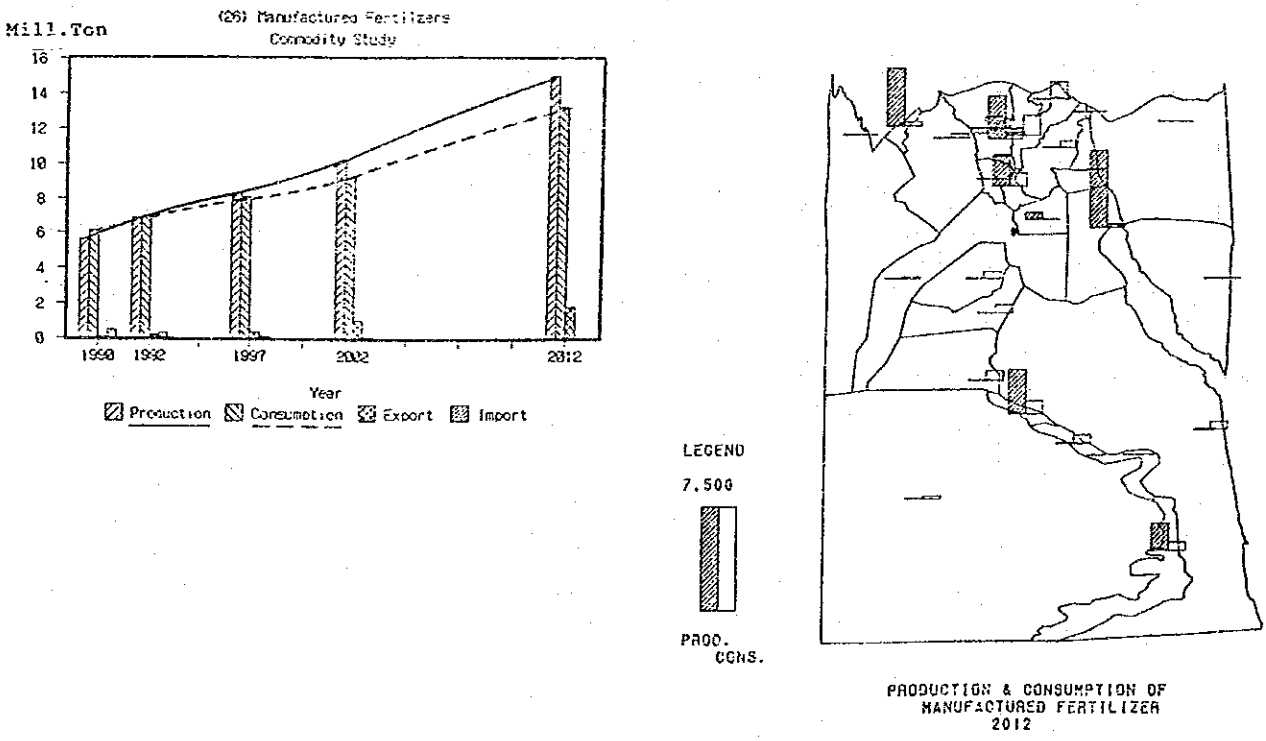



Fig. 12-6-9 Manufactured Fertilizer Project

12.6.10 Pulp and Paper Products (Sub-group 27)

(1) Consumption

Consumption/capita grew rapidly at a 1.08 annual rate in 1987-1992 period, however the Third 5-Year Plan projects growth rate to drop to 1.01 p.a. The 1997 consumption/capita is projected to reach 1.6 times that of 1987. This study projects that during 1997-2012 period growth rate will again pick up, reaching a high 1.16 p.a., and that forecast 2012 consumption/capita will double that of 1987.

(2) Production

In the absence of timber produced locally, the domestic industry relies upon the remains of agricultural production to produce this commodity. The 1987-1992 period witnessed a growth rate of 1.08 p.a. in production, which is projected to decrease during the Third 5-Year Plan to 1.05 p.a. Due to overall low growth projected in agriculture (1997-2012 growth rate is 1.03 p.a. for all agricultural commodities) the growth rate in 1997-2012 forecast by this Study, at 1.06 p.a., while exceeding that of the Third 5-Year Plan, will not reach that realized during 1987-1992 period.

(3) Foreign Trade

As described above, consumption growth will far outdistance that of production and dependence upon imports will continue to be strong. Imports in the Third 5-Year Plan are forecast to grow at a rate of 1.03 p.a., and that forecast for 1997-2012 period under this study is 1.04 p.a. Imports in 2012 are projected to be 2.5 times that of 1990.

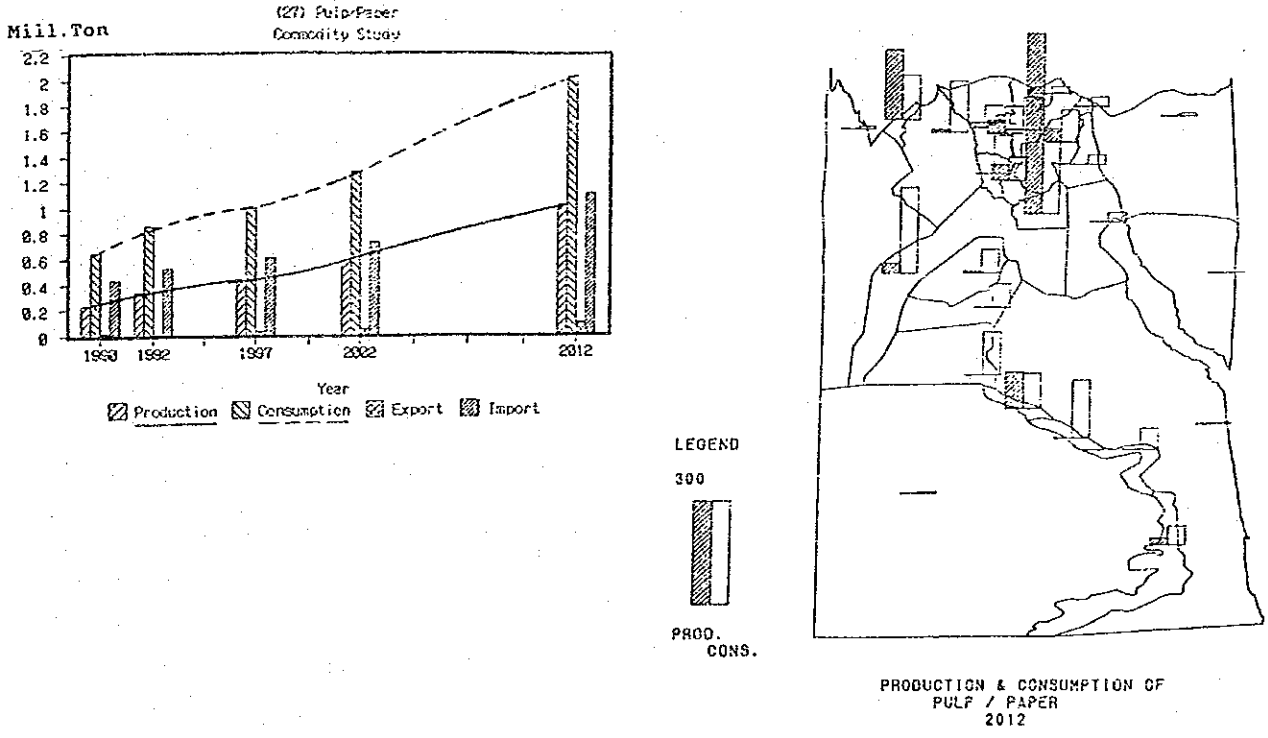



Fig. 12-6-10 Pulp/Paper Projection

12.6.11 Lumber/Timber (Sub-group 28)

(1) Consumption

Regression models could not be satisfactorily employed in this commodity for projecting future consumption figures as available data is only for four years (1987-1990) and shows a downward trend. There are no projections in the Third 5-Year Plan.

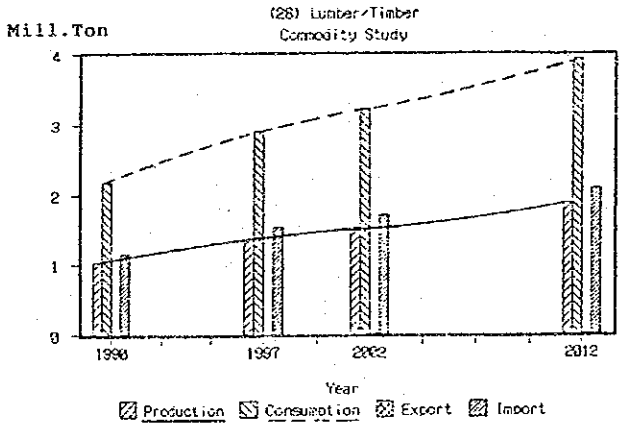
The highest recorded consumption rate per capita of the above four years (45 kg in 1987) was therefore applied to project the 1997, 2002 and 2012 consumption figures.

(2) Production

From the import projections below, applying a fixed ratio determined from past data for amount of lumber produced from timber, production projections of lumber are calculated.

(3) Foreign Trade

All timber used to produce lumber and wood products is presently imported and this is projected to continue through 2012 along the same pattern and in quantities sufficient to satisfy the calculated consumption projections in (1) above. The little amount of exports are projected to continue in the same pattern as the data of the four available years.



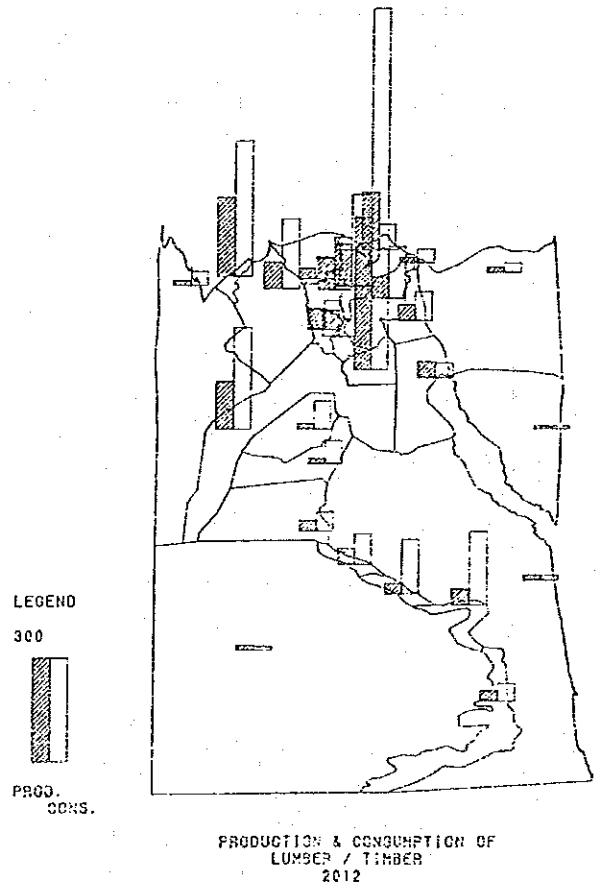




Fig. 12-6-11 Lumber/Timber Projection

12.6.12 Other Manufactured Goods (Sub-group 29)

(1) Consumption

Data is available for production, consumption and foreign trade for 1987-1990 period, however the Third 5-Year Plan provides projections for production only. Due to lack of sufficient data modeling did not produce satisfactory results. However, a consumption rate of 5 kg/cap for 1997 was projected by most of the models. The consumption/capita tended to fall when projected further to 2002 and 2012 using the same model.

Therefore a consumption rate of 5 kg/cap for the years 1997 and 2002, and of 6 kg/cap for the year 2012 were assumed and consumption projections calculated.

(2) Production

Production grew in 1987-1992 period by a 1.03 p.a. rate, and the Third 5-Year Plan projected a growth rate of 1.04 p.a. for the following five years. This study's projections indicate a similar growth rate as that of the Third 5-Year Plan during 1997-2012 period. Production in 2012 is forecast to exceed that of 1987 by 2.6 times.

(3) Foreign Trade

Imports are projected to continue their slight increasing tendency up to 2002, after which they are projected to slightly fall back to the 1990 level (as production continues to increase). Exports projections will grow at a 1.08 p.a. rate during the 1997-2012 period.

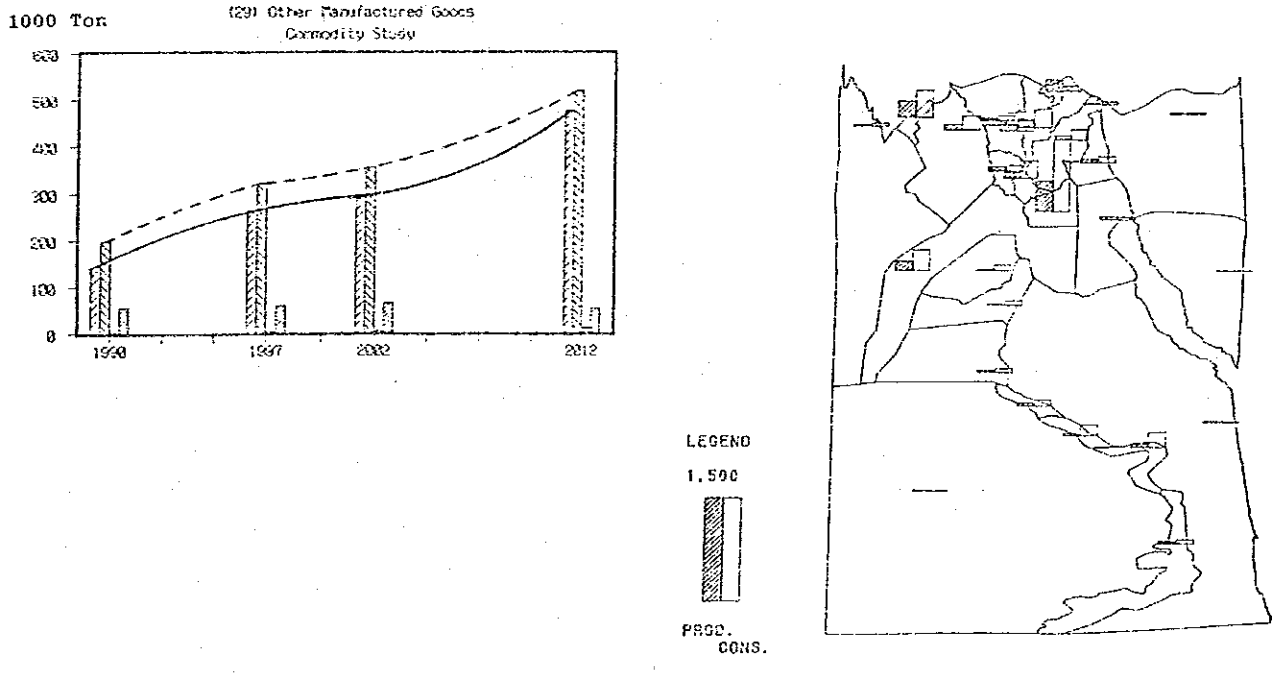



Fig. 12-6-12 Other Manufactured Goods Projection

# *CHAPTER 13 TRANSPORT DEMAND FORECAST*

## 13.1 General

The future transport demand is forecast by the process shown in Fig. 13-1-1. The passenger demand and freight demand generation and attraction were estimated based on the future socio economic indices, the demand was split to the transport modes, then they were converted to the vehicle nos. and assigned to the road network to obtain the future vehicle demand on each link.

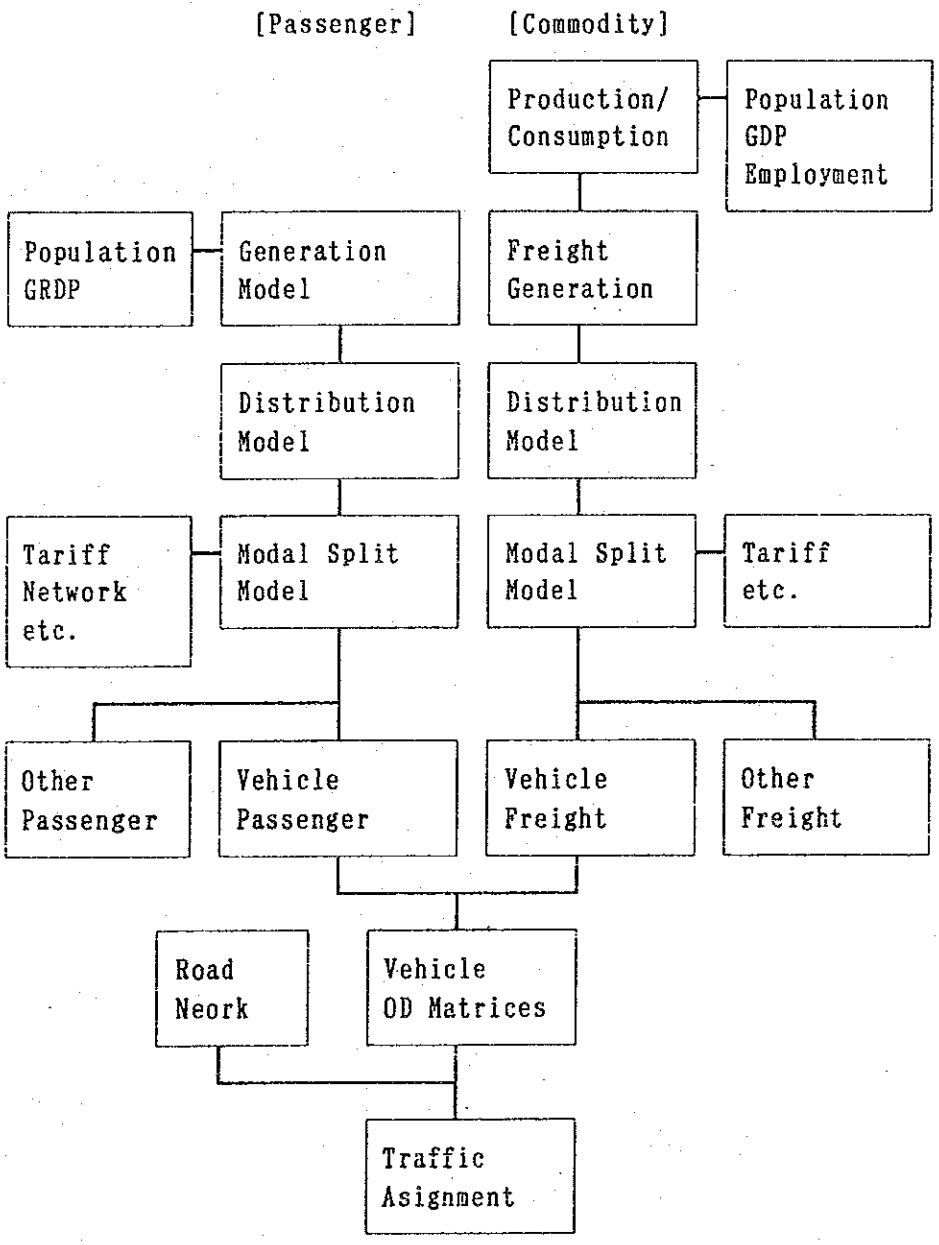



Fig. 13-1-1 Transport Demand Forecast Process

## 13.2 Generation and Distribution Models for Passenger

### 13.2.1 Passenger Demand Generation

Generally the passenger demand will be estimated by generation and attraction models separately if the demand can be divided into home based demand and non-home based demand, however as the road side OD survey does not include the passenger trip purpose, the Study take a single model for the average of generation and attraction of the passenger. The passenger attributes at their trip end are socio economic indices and the location of the zones they belong to, therefore the generation model should be developed applying these factors as dependent variables.

The regression analysis of the all modes, including rail passenger, 188 Markaz base passenger OD matrix by 1992 population and per capita GRDP resulted the high correlation coefficient of 0.99. The future passenger generation demand is estimated by the following formula;

$$G = P^{a} \times (GRDP/P)^{b} \times D^{c} \times d$$

where G: Passenger Generation Demand (Pass/Day)
P: Population (1,000)
GRDP: Gross Regional Domestic Product(1,000LE in 1992 Price)
D: Dummy
a: 0.640309
b: 0.919123
c: 1.035084
d: 96.04312

Table 13-2-1 shows the estimated passenger demand based on the future socio-economic frames in the case of GDP growth rate of 6.5% p.a., population and GDP. The passenger in the long term target year of 2012 is estimated at 2.8 times the present, which is 1.8 times of the population growth.

Table 13-2-1 Future Passenger Demand
(GDP 6.5% Case)

| | Pass.(1000) | | POPULATION(1000) | | GDP(1000MLE) | |
|---|---|---|---|---|---|---|
| YEAR | PASS | IDX | POP | IDX | GDP | IDX |
| 1992 | 2,304 | 1.00 | 57,060 | 1.00 | 125 | 1.00 |
| 1997 | 2,960 | 1.28 | 64,069 | 1.12 | 161 | 1.29 |
| 2002 | 3,849 | 1.67 | 71,294 | 1.25 | 220 | 1.76 |
| 2012 | 6,490 | 2.82 | 86,907 | 1.52 | 414 | 3.31 |

### 13.2.2 Passenger Distribution

The future passenger distribution in each cell of OD matrix is estimated by the present pattern method shown in the

following formula and the totals of rows and columns are adjusted to the generation and attraction volumes estimated in the section 13.2.1 above by frater method, thus each cell will reflect the future passenger demand generation of the zones.

Tij=Pij x Ai x Gj
where Tij:trip between i and j zones
Pij:present percentage of trips between i and j zones
Ai :Attraction volume of i zone
Gj :Generation volume of j zone

## 13.3 Modal Split of Passenger

### 13.3.1 Present Preference Model

The present preference model is to follow the present passenger mode preference by the present travel cost or time by mode. Only the fuel cost is taken as the present travel cost of passenger car, because most of the car users do not count depreciation cost of their car, etc. when they travel. The travel cost of railway and inter city buses are unified from the present five class fare system by the regression analysis based on the weighed average of fare by class using actual transported passenger number or operating seat capacity in case of buses by travel distance. In case of inter city taxi, the regression analysis of interviewed fare by distance resulted into rather good relationship and the deducted formula is applied.

The comparison of travel cost by distance and by each mode is given in Fig. 13-3-1. The Fig. shows the little deference between inter city bus and taxi. In case of inter city taxi and bus, there is also little deference in travel time, because they normally operate from terminals to terminals unlikely to chartered taxi, therefore the present passenger mode preference between inter city bus and taxi can not be explained by these factors. The inter city taxi is considered as just the small capacity bus and the modal split between these two modes will not be made by model and the role of each mode will be discussed in relation with passenger demand, operation frequency, fare level and optimum transport capacity.

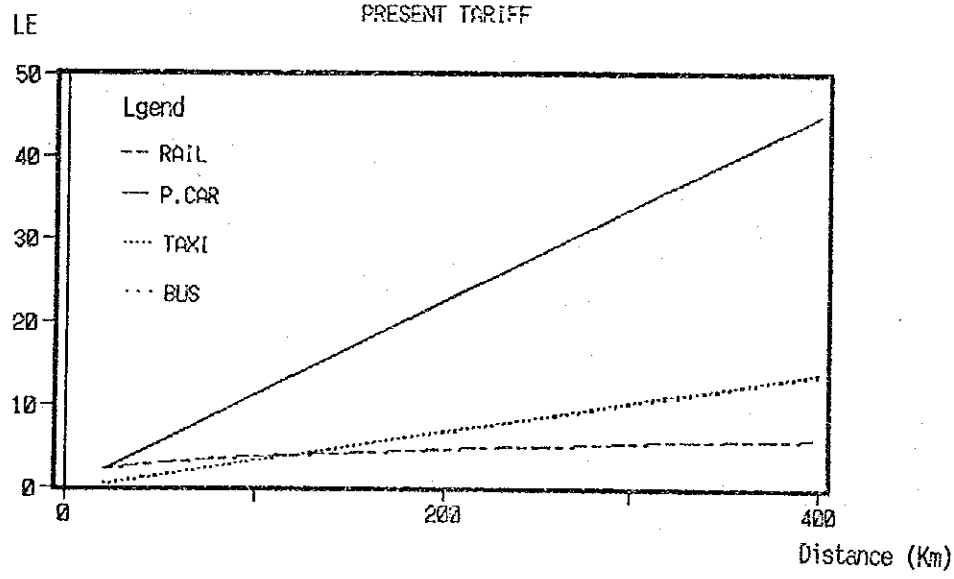



Fig. 13-3-1 Present Tariff of Various Modes

The passengers will be split to modes by the following binary choice process.

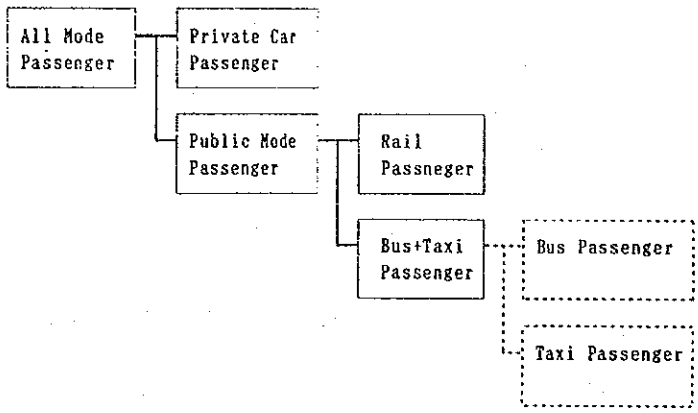



Fig. 13-3-2 Binary Choice Process

13.3.2 Modal Split between Passenger Car and Public Modes

Modal split models are classified into two types; trip end model and trip interchange model. The former model is to explain the mode share by attributes of zones where trip will generate, and the later model will explain the mode share by the characteristics of the routes which different mode trips will take (i.e.. trip cost or time). In the case of the modal split model of passenger car and public modes, the private car ownership is applied as the independent variable in the trip end model, and in many cases in the countries where private car ownership is not so high, the passenger car share is affected only by the private car ownership and trip interchange model can not be developed.

Fig. 13-3-3 shows the share distribution of passenger car and public mode passengers by their travel cost deference. The weighed average of travel costs of rail, bus and taxi by the corresponds passenger numbers is applied at the travel cost of the public mode. The public mode travel cost includes the access cost to the nearest terminal of 25 Pt for one way, and the travel cost of rail includes the access bus fare to the nearest station when there is no direct access.

The figure shows the tendency that the deference of the travel cost affect the use of the private car share and the maximum private car share is about 0.14. Therefore the trip interchange model by the trip cost is applied in the Study and passenger car share is estimated by the following regression equation. The equation does not include the travel time factor, which did not show any tendency to the mode share.

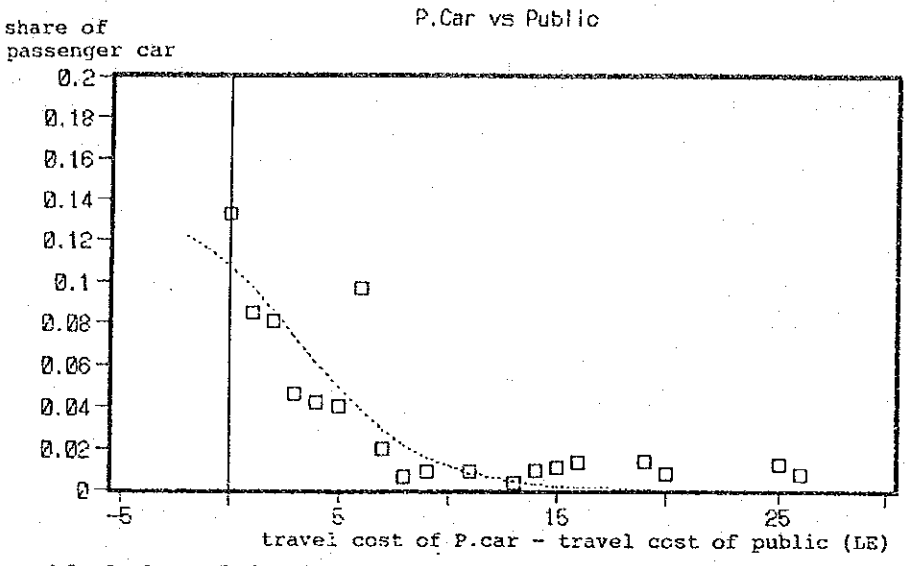



Fig. 13-3-3 Modal Shear of Passenger Car and Public Modes

R=K/(1+exp(a x dc + b))
where R:share of passenger car (0.0 - 1.0)
K:constant(0.14)
dc:travel cost of P.car - travel cost of public (LE)
a:parameter(0.1086)
b:parameter(-1.567)
r=0.85

### 13.3.3 Modal Split between Rail and Bus+Taxi Passenger

Fig. 13-3-4 shows the share distribution of rail and bus+taxi passenger by the deference of their travel costs. The travel cost includes the access cost as the same way as in the case of 13.3.2 above. The figure shows the tendency that the rail passenger share decreases by the increase of travel cost deference, the maximum share of rail passenger will be 1.0 and the half of public mode passengers basically select the rail mode unless the deference of the travel cost of rail will reach to LE 7.0. The mode share of rail passenger is estimated by the following regression equation. The equation does not include the travel time factor, which did not show any tendency to the mode share.

R=K/(1+exp(a x dc + b))
where R:share of Rail passenger (0.0 - 1.0)
K:constant(1.0)
dc:travel cost of Rail - travel cost of Bus+Taxi (LE)
a:parameter(0.1383)
b:parameter(-0.975)
r=0.85

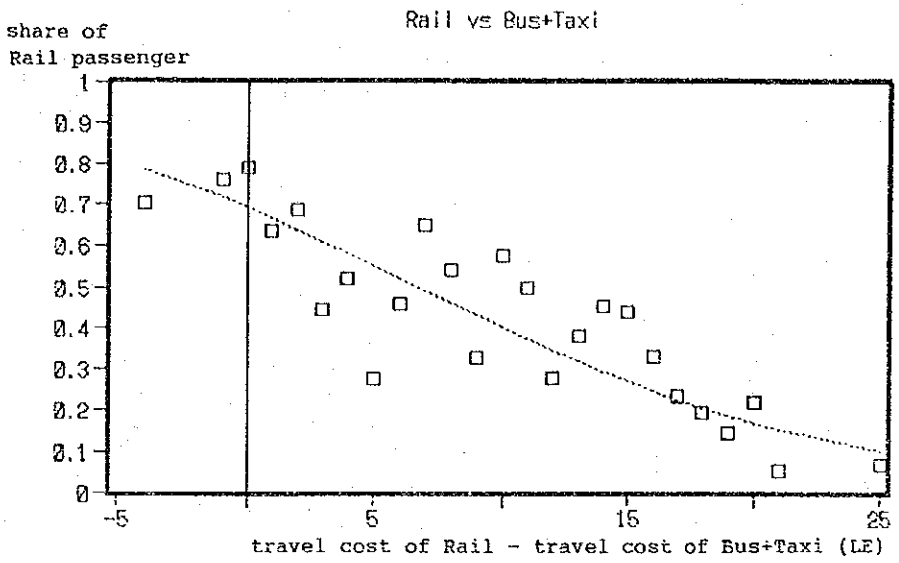



Fig. 13-3-4 Modal Shear of Rail and Taxi+Bus Passenger

### 13.3.4 Modal Split Result

The modal split results based on the present fare system are shown in Table 13-3-1. Because travel costs for intra zone movements can not be estimated, the results do not include the 188 Markaz base intra zone traffic, and the total is not equal to the total generation demand.

Table 13-3-1 Future Passenger by Mode
(GDP 6.5% Case)

| Item | P.CAR | TAXI+BUS | RAIL | TOTAL |
|---|---|---|---|---|
| 1.Pass./day(Excl.188 Intra) | | | | |
| 1992(Obs) | 205,363 | 824,541 | 997,972 | 2,027,876 |
| 1992(Est) | 197,340 | 822,727 | 999,748 | 2,019,815 |
| 1997 | 254,288 | 1,059,955 | 1,282,538 | 2,596,781 |
| 2002 | 331,598 | 1,381,969 | 1,667,502 | 3,381,069 |
| 2012 | 562,025 | 2,338,045 | 2,816,276 | 5,716,346 |
| 2.Growth Rate(1992Est.=1.00) | | | | |
| 1992(Obs) | 1.04 | 1.00 | 1.00 | 1.00 |
| 1992(Est) | 1.00 | 1.00 | 1.00 | 1.00 |
| 1997 | 1.29 | 1.29 | 1.28 | 1.29 |
| 2002 | 1.68 | 1.68 | 1.67 | 1.67 |
| 2012 | 2.85 | 2.84 | 2.82 | 2.83 |
| 3.Composition(%) | | | | |
| 1992(Obs) | 10.1 | 40.7 | 49.2 | 100.0 |
| 1992(Est) | 9.8 | 40.7 | 49.5 | 100.0 |
| 1997 | 9.8 | 40.8 | 49.4 | 100.0 |
| 2002 | 9.8 | 40.9 | 49.3 | 100.0 |
| 2012 | 9.8 | 40.9 | 49.3 | 100.0 |

The table shows that if the present fare level by mode will be maintained in future, the deference of population growth or GRDP growth by locations will not affect the future modal share.

13.3.5 Future Passenger Flow Pattern

(1) Private Car Passenger

Fig. 13-3-5 shows the future private car passenger in the year 2012 in a form of desire line. Comparing with the pattern in 1992, the following characteristics are observed. The concentration to Cairo - Alexandria corridor will not change. The flows between neighboring zones in Upper Egypt will appear. The flow between Cairo - Suez will loose its share. The flows Damietta - East Dakahlia, Minufia - North Gahrbia will increase.

(2) Bus+Taxi Passenger

Fig. 13-3-6 shows the future inter city bus+taxi passenger in the year 2012 in a form of desire line. Comparing with the pattern in 1992, the following characteristics are observed. The direct flow between Cairo and Alexandria will increase significantly. The flow Cairo - Aswan will increase and the flows in Upper Egypt will increase its share. The importance of Cairo - Alexandria corridor will not change.

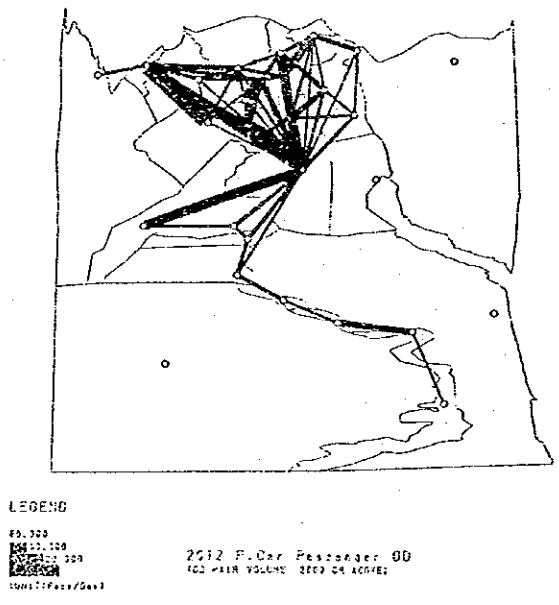



Fig. 13-3-5 2012 Private Car Passenger Flow

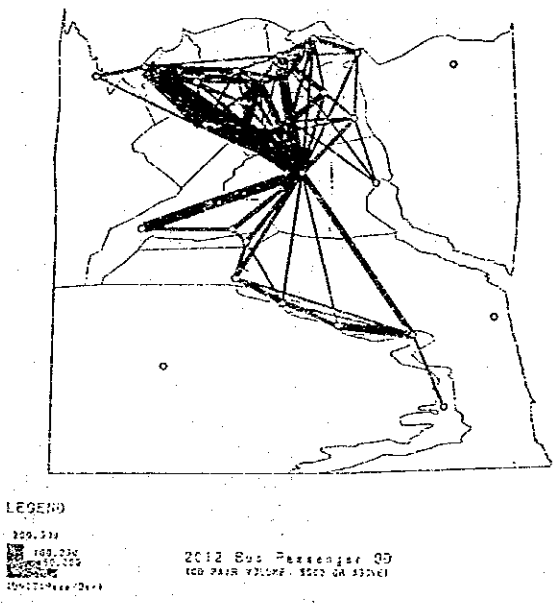



Fig. 13-3-6 2012 Inter City Bus+Taxi Passenger Flow

(3) Rail Passenger

Fig. 13-3-7 shows the future rail passenger in the year 2012 in a form of desire line. Comparing with the pattern in 1992, the following characteristics are observed. In 1992 pattern, no direct flow from Delta Area to Upper Egypt Area was seen, and all the flow passed Cairo, however in 2012 the direct flow from Suez to Qena and Aswan appeared. Also the flow from Qena to Safaga is seen in the 2012 pattern. Beside the high demand along Cairo - Alexandria corridor, the high flow from Cairo to West Dakahlia is seen in 2012.

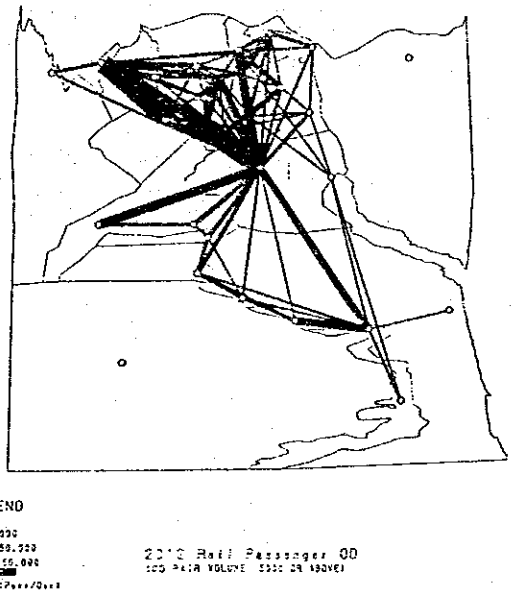



Fig. 13-3-7 2012 Rail Passenger Flow

13.3.6 Modal Split between Bus and Taxi

There is no deference between bus and taxi from the view points of passenger fare and travel time, however if OD pairs suitable either for bus operation or taxi operation are classified from the view point of their profitability based on their passenger capacity and operation cost, the optimum mode share of bus and taxi can be calculated. This mode share does not mean the mode share by the passenger preference, however if there is no advantage in the taxi operation comparing to bus operation, taxi drivers will stop or they will move to the more advantageous locations, and finally the share will reach to the optimum level. The details will be discussed in the chapter of Public Passenger Transport Master plan.

## 13.4 Freight Generation and Distribution Model

### 13.4.1 Freight Generation Model

Commodities are transported from their production places to the final consumption places changing transport modes and their forms, therefore the production is not necessarily equal to the freight generation amount, however they should have some relation with production/consumption amount, and their relation will vary depend on commodity type. Bulk commodities will be transported rather directly from their production places to the final consumption places, while miscellaneous goods will be transported via various places as warehouses, wholesalers, retailer and so on.

The future freight generation demand was calculated based on the present transport demand generation rate and the future production and consumption by 30 commodity groups and by zone, which was estimated in the chapter 11.

The future freight demand in the long term target year of 2012 by 30 commodities and by semi-governorate zone and is summarized in Table 13-4-1 excluding 29 semi governorate intra movement. The total freight growth in 2012 is estimated at 3.31 times that of 1992.

Table 13-4-1 Future Freight Generation Demand by Commodity (GDP 6.5% Case)

| ZONE | GENERATION(1,000TON/Y) | | | ATTRACTION(1,000TON/Y) | | | ZONE | GENERATION(1,000TON/Y) | | | ATTRACTION(1,000TON/Y) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 2012 | 12/92 | 1992 | 2012 | 12/92 | | 1992 | 2012 | 12/92 | 1992 | 2012 | 12/92 |
| 1 CAI | 32,604 | 170,311 | 5.22 | 37,874 | 171,640 | 4.53 | 17 BHN | 6,186 | 15,779 | 2.55 | 11,019 | 20,459 | 1.86 |
| 2 GIZ | 8,234 | 15,024 | 1.82 | 6,754 | 22,935 | 3.40 | 18 ALX | 23,914 | 75,941 | 3.18 | 17,511 | 64,944 | 3.71 |
| 3 QAL | 5,791 | 15,558 | 2.69 | 5,821 | 15,817 | 2.72 | 19 WDS | 8,815 | 12,336 | 1.40 | 2,184 | 6,670 | 3.05 |
| 4 SKS | 7,014 | 19,630 | 2.80 | 10,852 | 16,726 | 1.54 | 20 SIN | 1,300 | 2,711 | 2.08 | 1,686 | 3,543 | 2.10 |
| 5 SKN | 2,139 | 6,918 | 3.23 | 2,077 | 6,087 | 2.93 | 21 FAY | 1,677 | 9,588 | 5.72 | 2,986 | 12,431 | 4.16 |
| 6 DKE | 4,886 | 17,612 | 3.60 | 8,064 | 20,980 | 2.60 | 22 BES | 1,993 | 6,801 | 3.41 | 2,540 | 11,238 | 4.42 |
| 7 DKW | 1,724 | 6,264 | 3.63 | 1,996 | 6,768 | 3.39 | 23 MYA | 2,518 | 12,360 | 4.91 | 4,127 | 20,380 | 4.94 |
| 8 DAM | 5,054 | 12,245 | 2.42 | 4,831 | 9,248 | 1.91 | 24 ASY | 2,011 | 22,497 | 11.19 | 4,198 | 28,475 | 6.78 |
| 9 PTS | 3,223 | 4,185 | 1.30 | 4,249 | 8,478 | 2.00 | 25 NEW | 17 | 9,448 | 546.13 | 177 | 1,337 | 7.54 |
| 10 ISM | 3,929 | 6,511 | 1.66 | 3,575 | 6,786 | 1.90 | 26 SOH | 1,494 | 13,776 | 9.22 | 3,629 | 24,034 | 6.62 |
| 11 SUZ | 19,737 | 25,097 | 1.27 | 3,594 | 17,959 | 5.00 | 27 QEN | 2,494 | 21,371 | 8.57 | 3,833 | 13,596 | 3.55 |
| 12 MIF | 4,703 | 10,086 | 2.14 | 10,026 | 19,526 | 1.95 | 28 ASW | 1,706 | 18,888 | 11.07 | 1,689 | 10,653 | 6.31 |
| 13 GHS | 10,213 | 20,868 | 2.04 | 9,741 | 15,295 | 1.57 | 29 RED | 1,865 | 5,071 | 2.72 | 2,031 | 8,455 | 4.16 |
| 14 GHN | 2,135 | 9,816 | 4.60 | 3,754 | 7,637 | 2.03 | | | | | | | |
| 15 KAF | 4,477 | 13,825 | 3.09 | 4,168 | 9,974 | 2.39 | TOTAL | 178,350 | 591,097 | 3.31 | 178,350 | 591,097 | 3.31 |
| 16 BHS | 6,500 | 10,580 | 1.63 | 3,363 | 9,026 | 2.68 | | | | | | | |

### 13.4.2 Freight Distribution

The base case freight distribution was calculated by the two methods. The first method is the present pattern method as the same way as in the case of passenger. The second method is gravity method by the following equation;

$$Cij = Gi \times Aj / Dij^2$$

where Cij: Freight between i and j zones
Gi : Freight Generation in zone i
Aj : Freight Attraction in zone j
Dij: Transport Distance between i and j zones

In both methods, the raw and column total of the calculated distribution results were adjusted to the generation and attraction volumes by frater method.

The first method gives complicated flow reflecting actual movements, which sometimes includes movements which can not be explained by logic, and the second method gives rather simple flow reflecting the calculation logic, but with the advantage that a new flow can be estimated. The final results were selected from these two calculation results judging commodity by commodity.

### 13.4.3 Future Commodity Flow Pattern

(1) Petroleum Products

Fig. 13-4-1 shows the future petroleum products flow pattern in the year 2012. The total freight of petroleum products in the year 2012 was estimated at 17.4 mill.ton/year, which is 1.4 times the present. Comparing with the flow pattern in 1992, concentration to Alexandria, Cairo and Suez becomes significant. The flows between Cairo - Alexandria is estimated at 3.1 mill.ton, and between Suez - Cairo 2.6 mill.ton reflecting industrialization at Suez Port Area.

(2) Cement

Fig. 13-4-2 shows the future cement flow pattern in the year 2012. The total freight of cement in the year 2012 was estimated at 110.8 mill.ton/year, which is 4.3 times the present. Comparing with the flow pattern in 1992, Cairo will remain as the distribution center. The flow between Cairo - Alexandria shows 31.0 mill.ton, followed by the flows between Cairo - Suez, Cairo - Asyut and Cairo - South Beheira.

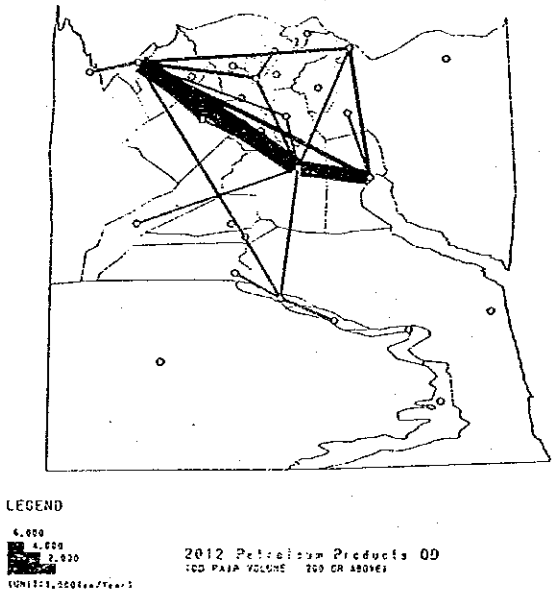



Fig. 13-4-1 2012 Petroleum Products Flow

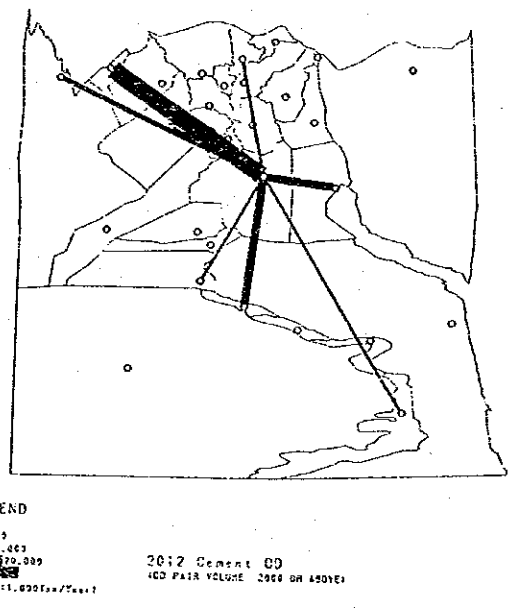



Fig. 13-4-2 2012 Cement Flow

(3) Other Construction Materials

Fig. 13-4-3 shows the future other construction materials flow pattern in the year 2012. The total freight of other construction materials in the year 2012 was estimated at 204.0 mill.ton/year, which is 4.8 times the present. Comparing with the flow pattern in 1992, the flow between Cairo - Alexandria is estimated at 24.7 mill.ton.

(4) Phosphate Ore

Fig. 13-4-4 shows the future phosphate ore flow pattern in the year 2012. The total freight of phosphate ore in the year 2012 was estimated at 13.2 mill.ton/year, which is 17.2 times the present. Comparing with the flow pattern in 1992, the flow pattern will change significantly, because of the phosphate development project in New Valley zone. 2.2 mill. ton of the phosphate ore from New Valley and 2.3 mill.ton from Aswan will be transported to Safaga port.

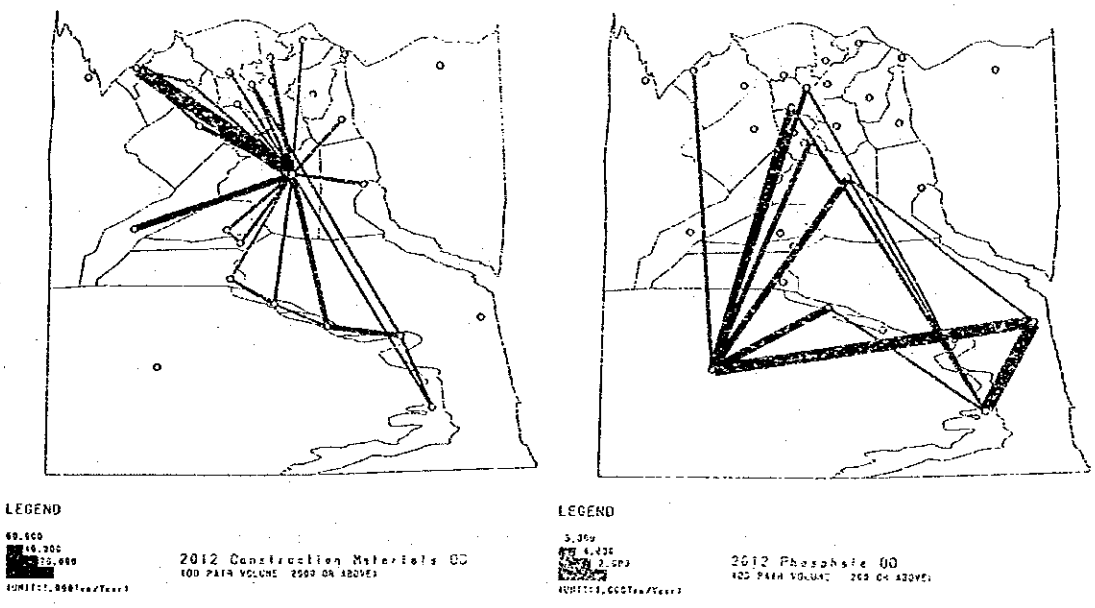



Fig. 13-4-3 2012 Other Construction Materials Flow

Fig. 13-4-4 2012 Phosphate Flow

(5) Iron Ore

Fig. 13-4-5 shows the future iron ore flow pattern in the year 2012. The total freight of Iron ore in the year 2012 was estimated at 11.2 mill.ton/year, which is 5.0 times the present. Comparing with the flow pattern in 1992, no significant change will be expected. The major flow remains from Bahareia Oasis in Giza to Helwan in Cairo with 5.5 mill.ton.

(6) Coal and Coke

Fig. 13-4-6 shows the future coal and coke flow pattern in the year 2012. The total freight of coal and coke in the year 2012 was estimated at 7.1 mill.ton/year, which is 3.8 times the present. Comparing with the flow pattern in 1992, the major flow between Alexandria to Cairo (4.3 mill. ton) will not change, however the coal quarry development in Sinai zone will create a new flow to Cairo.

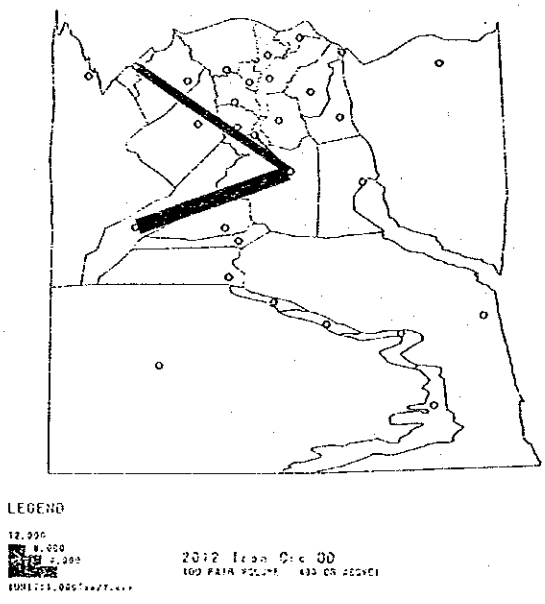



Fig. 13-4-5 2012 Iron Ore Flow

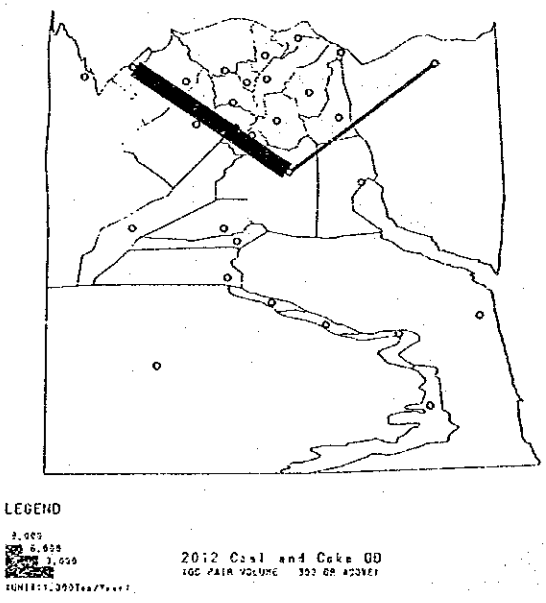



Fig. 13-4-6 2012 Coal and Coke Flow

(7) Other Minerals

Fig. 13-4-7 shows the future other minerals flow pattern in the year 2012. The total freight of other minerals in the year 2012 was estimated at 13.6 mill.ton/year, which is 4.4 times the present. Comparing with the flow pattern in 1992, the flow between Cairo and Aswan, which is estimated at 5.7 mill.ton is characterized

(8) Wheat

Fig. 13-4-8 shows the future wheat flow pattern in the year 2012. The total freight of wheat in the year 2012 was estimated at 17.3 mill.ton/year, which is 2.1 times the present. Comparing with the flow pattern in 1992, import flows from Alexandria, Damietta, Port Said, Suez and Safaga are significant, especially, Safaga port to the zones in the south of Cairo. Safaga port is expected to have large import share of wheat. Among these flows, 0.6 mill. ton from Safaga to Sohag and 0.4 mill. ton to Asyut will be transported.

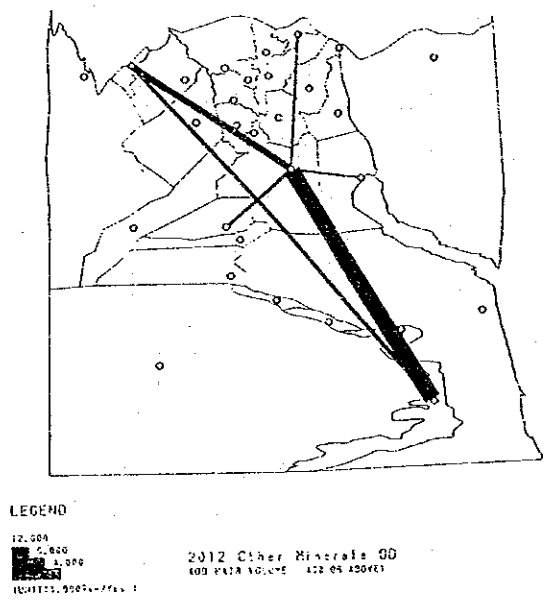



Fig. 13-4-7 2012 Other Minerals Flow

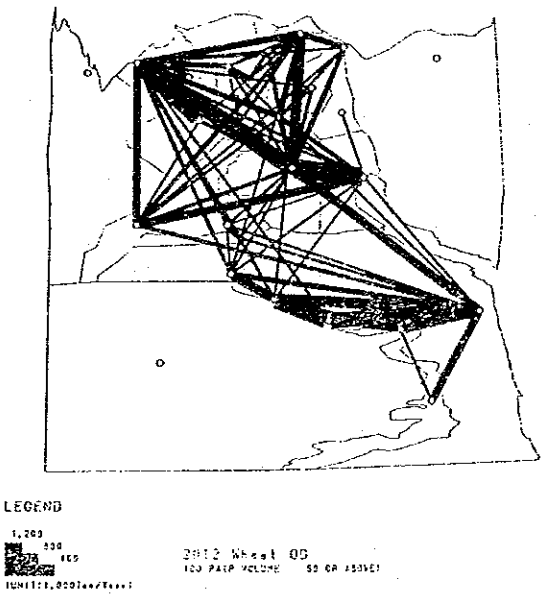



Fig. 13-4-8 2012 Wheat Flow

(9) Other Cereals

Fig. 13-4-9 shows the future other cereals flow pattern in the year 2012. The total freight of other cereals in the year 2012 was estimated at 12.4 mill.ton.year, which is 1.7 times the present. Comparing with the flow pattern in 1992, the basic pattern will not change, however high concentration to Cairo and 1.1 mill.ton flow between Cairo - Minya is expected.

(10) Fruits and Vegetables

Fig. 13-4-10 shows the future fruits and vegetables flow pattern in the year 2012. The total freight of fruits and vegetables in the year 2012 was estimated at 33.3 mill.ton/year, which is 2.4 times the present. Comparing with the flow pattern in 1992, the basic pattern will not change, however the flows from zones in Upper Egypt to Cairo and between Cairo - Giza (1.7 mill.ton) are expected to increase.

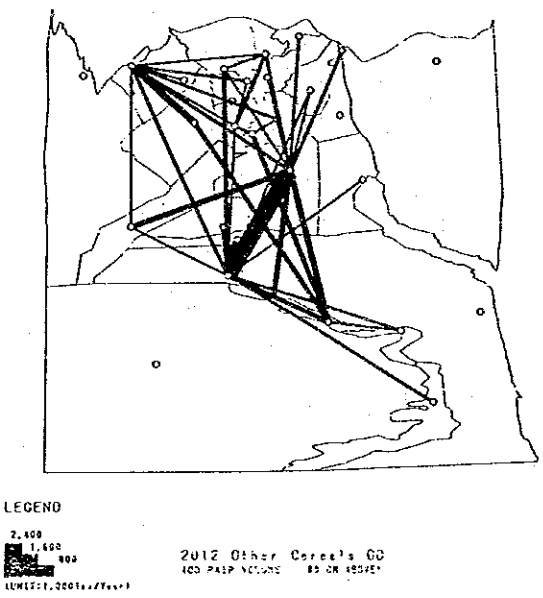



Fig. 13-4-9 2012 Other Cereals Flow

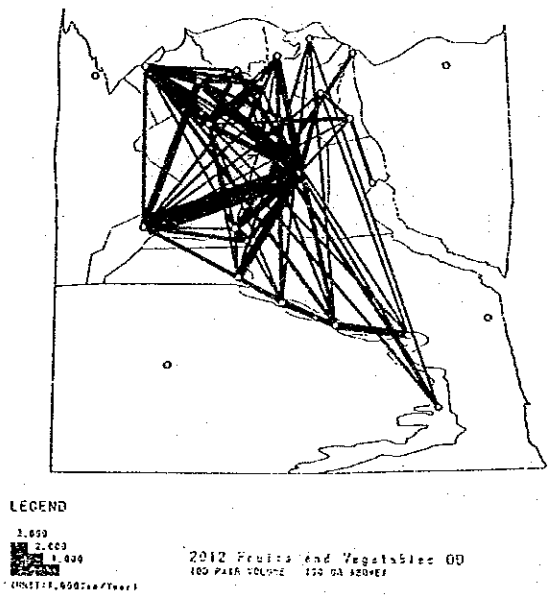



Fig. 13-4-10 2012 Fruits and Vegetables Flow

(11) Sugar Cane

Fig. 13-4-11 shows the future sugar cane flow pattern in the year 2012. The total freight of sugar cane in the year 2012 was estimated at 0.9 mill.ton/year, which is 1.2 times the present. Comparing with the flow pattern in 1992, the flows in Delta Area are expected to disappear because of crops transition to sugar beet or other high productivity crops, while the flows in Upper Egypt area are expected to remain.

(12) Fiber Crops

Fig. 13-4-12 shows the future fiber crops flow pattern in the year 2012. The total freight of fiber crops in the year 2012 was estimated at 0.7 mill.ton/year, which is 0.8 times the present. The demand decrease was caused by the more rationalized transport in future than the present. Comparing with the flow pattern in 1992, there is no significant change, however the flows appear in Upper Egypt area.

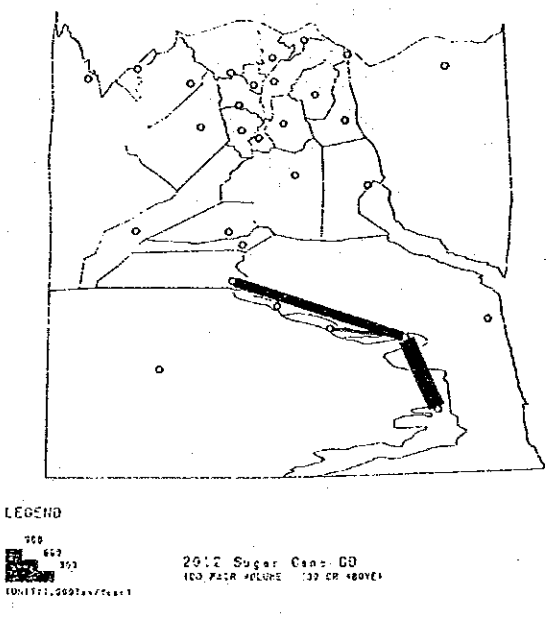



Fig. 13-4-11 2012 Sugar Cane Flow

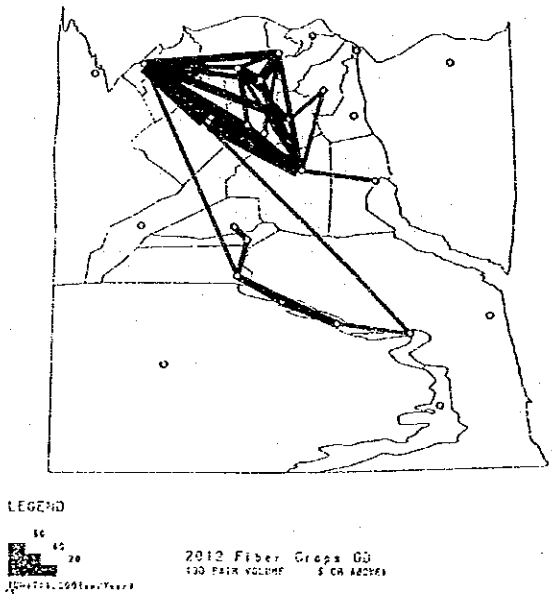



Fig. 13-4-12 2012 Fiber Crops Flow

(13) Live Stocks

Fig. 13-4-13 shows the future live stocks flow pattern in the year 2012. The total freight of live stocks in the year 2012 was estimated at 2.3 mill.ton/year, which is 1.5 times the present. Comparing with the flow pattern in 1992, the flows among neighboring zones will increase and production/ consumption will be dispersed than present.

(14) Animal Products

Fig. 13-4-14 shows the future animal products flow pattern in the year 2012. The total freight of animal products in the year 2012 was estimated at 4.0 mill.ton/year, which is 1.7 times the present. Comparing with the flow pattern in 1992, there is no significant change, however the flow between Alexandria to Cairo will increase to 0.3 mill. ton.

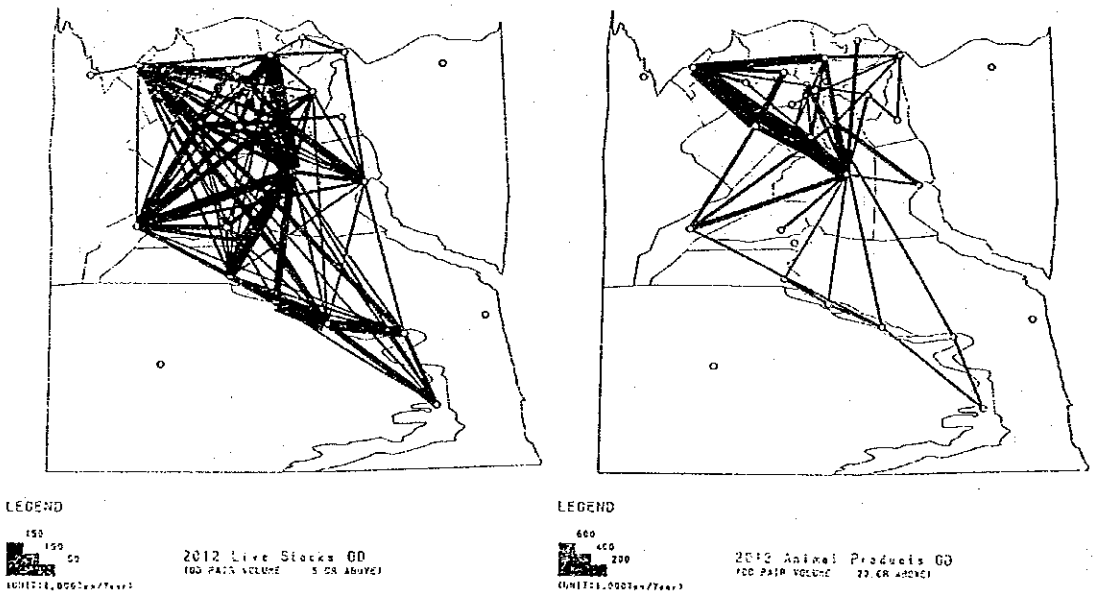



Fig. 13-4-13 2012 Live Stocks Flow

Fig. 13-4-14 2012 Animal Products Flow

(15) Other Agricultural Products

Fig. 13-4-15 shows the future other agricultural products flow pattern in the year 2012. The total freight of other agricultural products in the year 2012 was estimated at 18.2 mill.ton/year, which is 4.7 times the present. Comparing with the flow pattern in 1992, there is no significant change, however Cairo - Kafr el Sheik is estimated at 0.9 mill. ton and Alexandria - Kafr el Sheik 0.8 mill.ton.

(16) Refined Sugar and Molasses

Fig. 13-4-16 shows the future refined sugar and molasses flow pattern in the year 2012. The total freight of refined sugar and molasses in the year 2012 was estimated at 3.2 mill.ton/year, which is 1.5 times the present. Comparing with the flow pattern in 1992, the major flows will continue between Aswan - Cairo and Qena - Cairo, while the import flow from Port Said will loose their share.

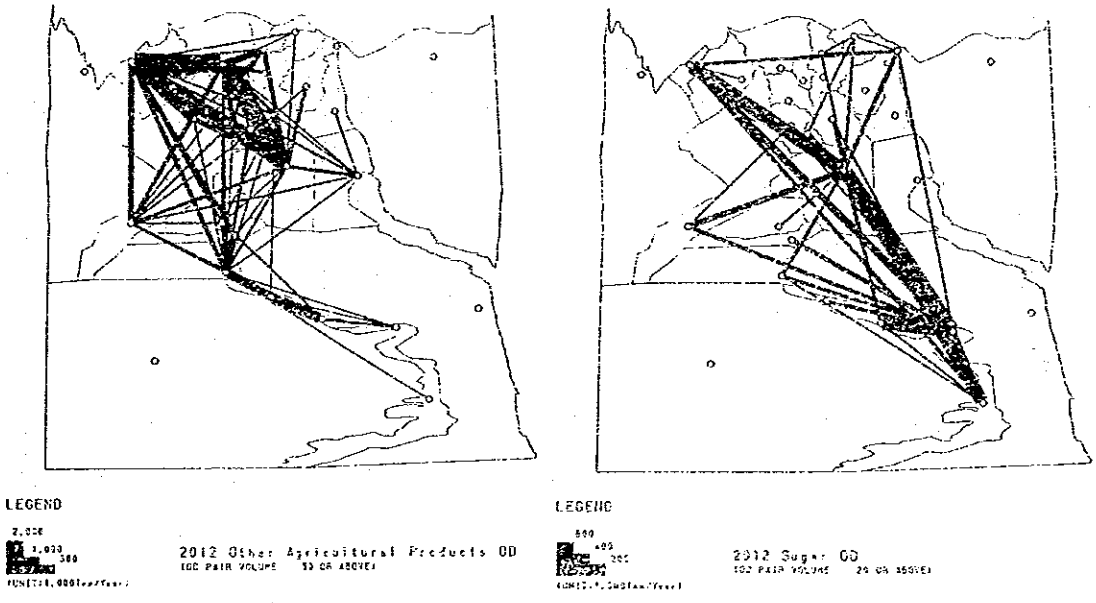



Fig. 13-4-15 2012 Other Agri- cultural Products Flow

Fig. 13-4-16 2012 Sugar Flow

(17) Edible Oil and Fats

Fig. 13-4-17 shows the future edible oil and fats flow pattern in the year 2012. The total freight of edible oil and fats in the year 2012 was estimated at 4.0 mill.ton/year, which is 3.7 times the present. Comparing with the flow pattern in 1992, the pattern in 2012 is characterized by the high concentration to Alexandria including import.

(18) Animal Feeds

Fig. 13-4-18 shows the future animal feeds flow pattern in the year 2012. The total freight of animal feeds in the year 2012 was estimated at 26.5 mill.ton/year, which is 4.9 times the present. Comparing with the flow pattern in 1992, the high concentration to Alexandria is observed and another concentration to Qena appears.

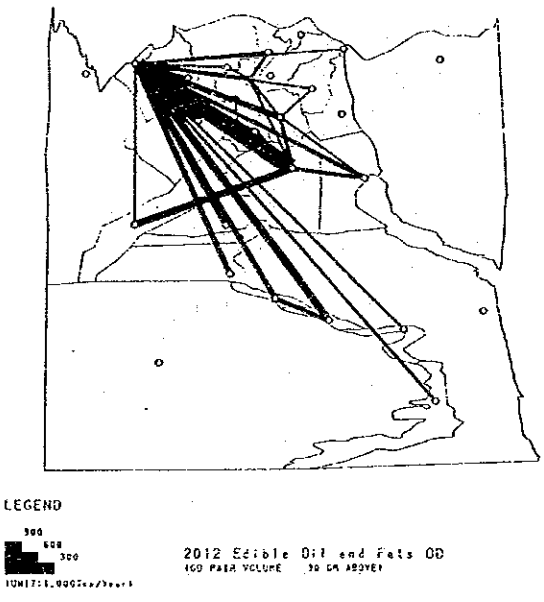



Fig. 13-4-17 2012 Edible Oil and Fats Flow

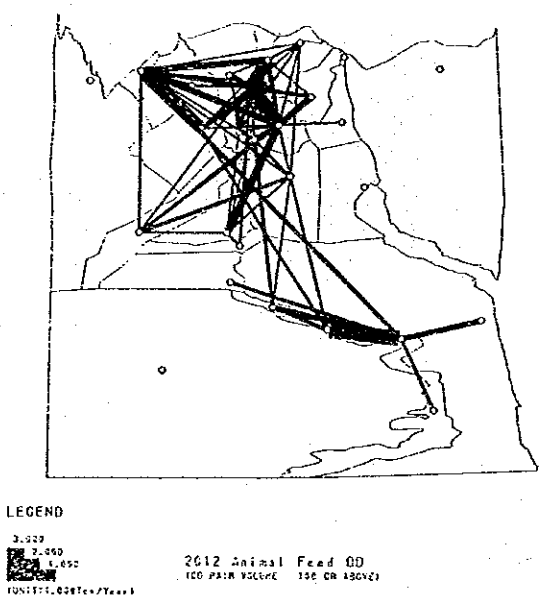



Fig. 13-4-18 2012 Animal Feeds Flow

(19) Beverages

Fig. 13-4-19 shows the future beverages flow pattern in the year 2012. The total freight of beverages in the year 2012 was estimated at 2.4 mill.ton/year, which is 5.5 times the present. Comparing with the flow pattern in 1992, the highest 0.14 mill. ton flow between Cairo and Giza appears and many small movements are observed.

(20) Other Food Products

Fig. 13-4-20 shows the future other food products flow pattern in the year 2012. The total inter zone freight of other food products in the year 2012 was estimated at 1.5 mill.ton/year, which is 0.4 times the present despite of the 1.9 times of the production and 1.2 times of the consumption increase. The difference is counted as intra zone movement. Comparing with the flow pattern in 1992, the figure shows the high concentration to Alexandria, which counts at 0.3 mill. ton in total.

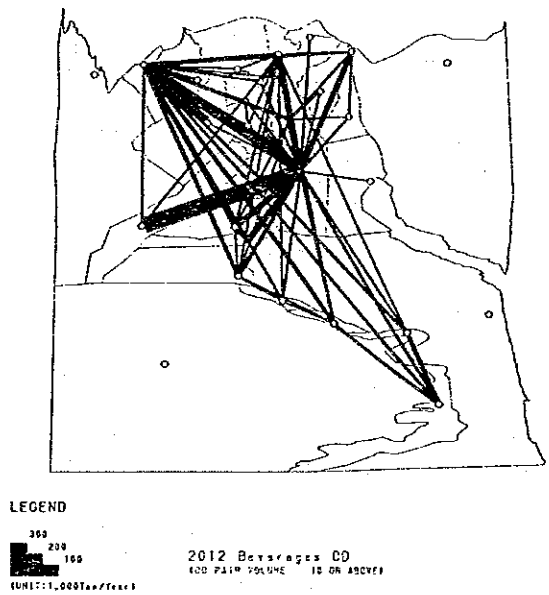



Fig. 13-4-19 2012 Beverages Flow

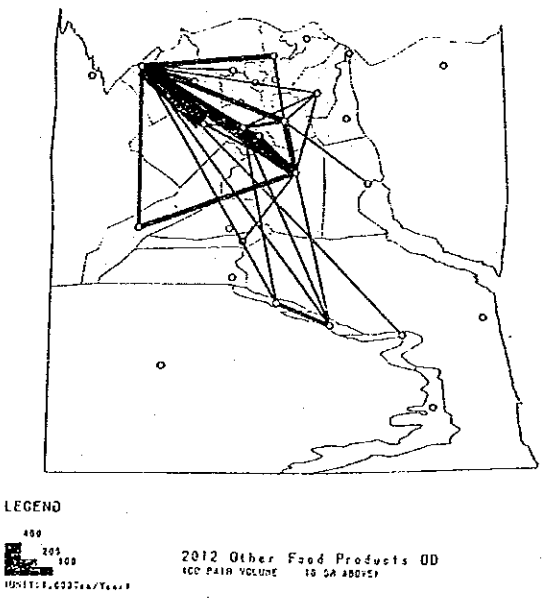



Fig. 13-4-20 2012 Other Food Products Flow

(21) Chemical Products

Fig. 13-4-21 shows the future chemical products flow pattern in the year 2012. The total freight of chemical products in the year 2012 was estimated at 5.1 mill.ton/year, which is 0.6 times the present despite of 3.3 times of the production and 1.7 times of the consumption increase. The most part of production increase will be consumed within the same zone and is counted as intra zone movement. Comparing with the flow pattern in 1992, the two flows between Cairo - South Beheira and South Beheira - Alexandria are significant. The concentration to Giza zone will reduce its share.

(22) Metal and Metal Products

Fig. 13-4-22 shows the future metal and metal products flow pattern in the year 2012. The total freight of metal and metal products in the year 2012 was estimated at 9.8 mill. ton/year, which is 2.2 times the present. Comparing with the flow pattern in 1992, the highest flow is between Cairo,and Alexandria, which is estimated at 3.5 mill. ton.

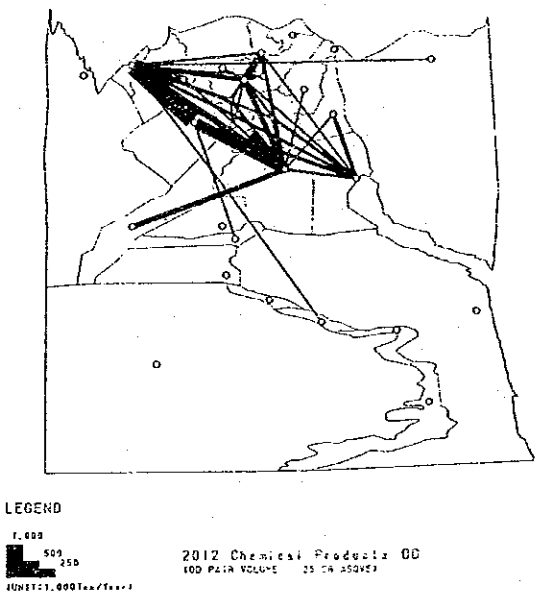



Fig. 13-4-21 2012 Chemical Products Flow

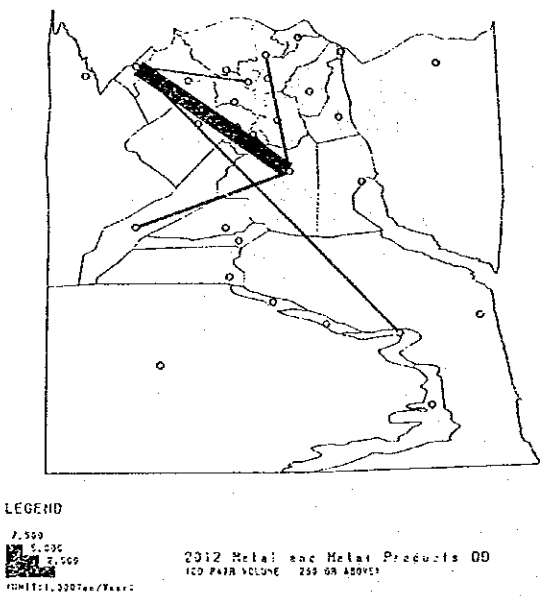



Fig. 13-4-22 2012 Metal and Metal Products Flow

(23) Textile

Fig. 13-4-23 shows the future textile flow pattern in the year 2012. The total freight of textiles in the year 2012 was estimated at 4.5 mill.ton/year, which is 2.5 times the present. Comparing with the flow pattern in 1992, the distribution center will shift to South Sharkia zone. The highest flow appears between Alexandria and South Sharkia with 0.6 mill. ton.

(24) Manufactured Fertilizer

Fig. 13-4-24 shows the future manufactured fertilizer flow pattern in the year 2012. The total freight of manufactured fertilizer in the year 2012 was estimated at 13.3 mill. ton/year, which is 3.5 times the present. Comparing with the flow pattern in 1992, the high concentration to Alexandria is observed reflecting expected high production in Alexandria zone.

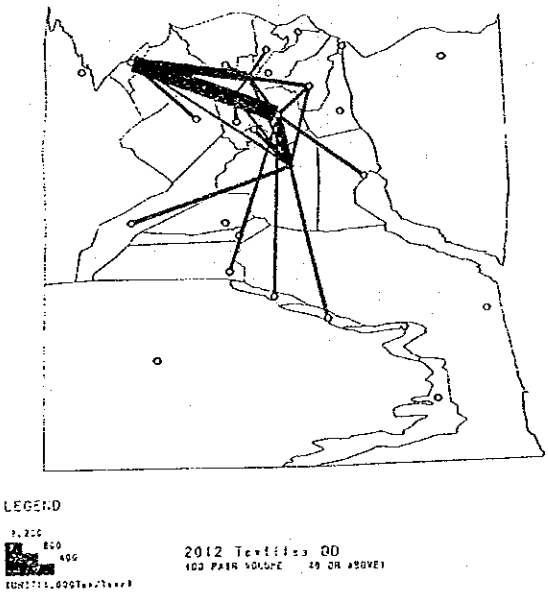



Fig. 13-4-23 2012 Textile Flow

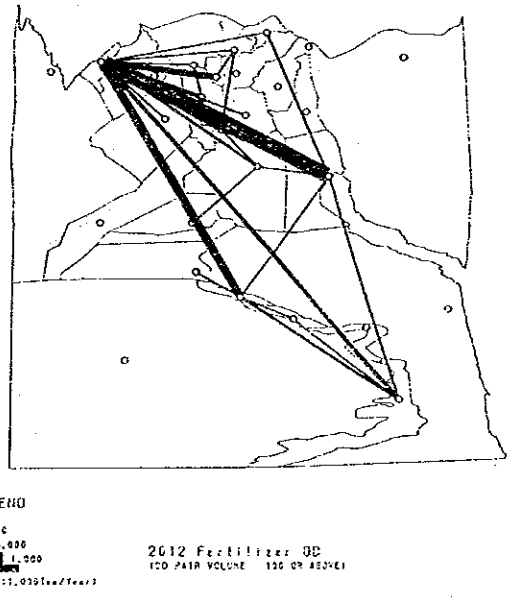



Fig. 13-4-24 2012 Manufactured Fertilizer Flow

(25) Pulp and Paper

Fig. 13-4-25 shows the future pulp and paper flow pattern in the year 2012. The total freight of pulp and paper in the year 2012 was estimated at 4.2 mill.ton/year, which is 2.2 times the present. Comparing with the flow pattern in 1992, the high concentration to Alexandria zone is observed with the highest flow between Cairo and Alexandria zones of 1.2 mill. ton.

(26) Lumber and Timber

Fig. 13-4-26 shows the future lumber and timber flow pattern in the year 2012. The total freight of lumber and timber in the year 2012 was estimated at 4.1 mill.ton/year, which is 1.8 times the present. Comparing with the flow pattern in 1992, import from Suez will loose its share and most of lumber and timber will be imported from Alexandria. 0.9 mill. ton flows appear between Alexandria and Cairo.

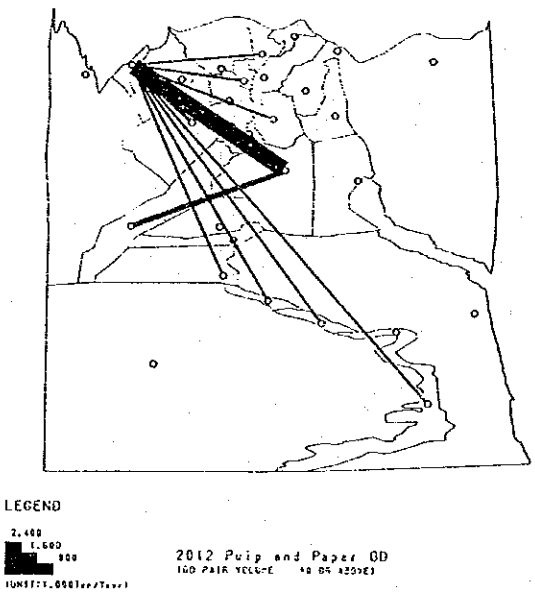



Fig. 13-4-25 2012 Pulp and Paper Flow

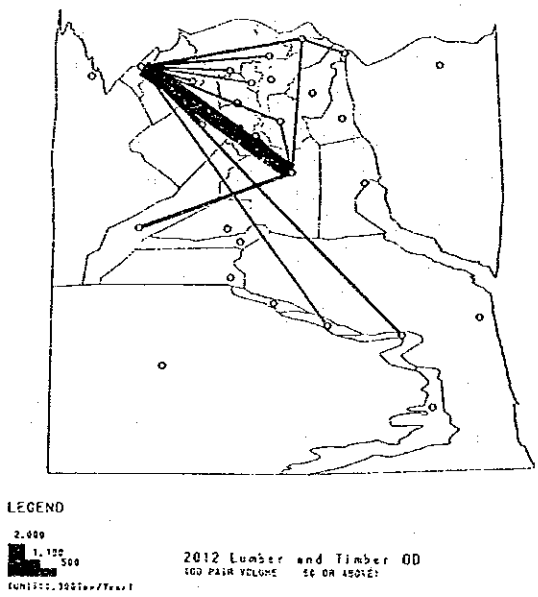



Fig. 13-4-26 2012 Lumber and Timber Flow

(27) Other Manufactured Goods

Fig. 13-4-27 shows the future other manufactured goods flow pattern in the year 2012. The total freight of other manufactured goods in the year 2012 was estimated at 21.0 mill. ton/year, which is 3.2 times the present. Comparing with the flow pattern in 1992, basically no change except for the influence of population and GRDP distribution pattern is expected on the freight distribution pattern of this item.

(28) Mixed Commodities

Fig. 13-4-28 shows the future mixed commodities flow pattern in the year 2012. The total freight of mixed commodities in the year 2012 was estimated at 5.2 mill.ton/year, which is 3.5 times the present. Comparing with the flow pattern in 1992, basically no change except for the influence of population and GRDP distribution pattern is expected on the freight distribution pattern of this item.

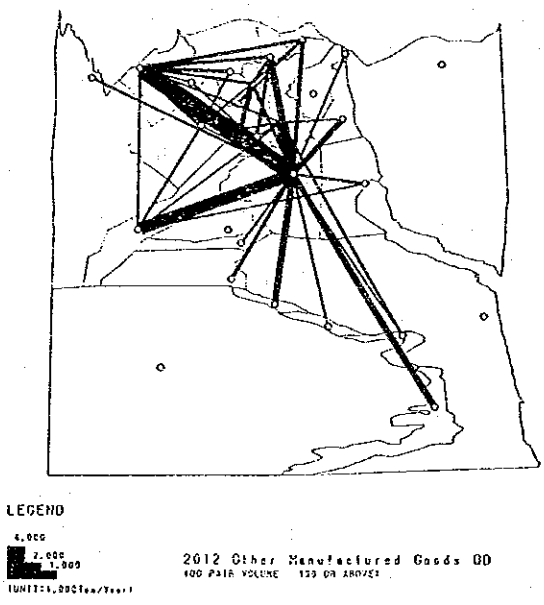



Fig. 13-4-27 2012 Other Manufactured Goods Flow

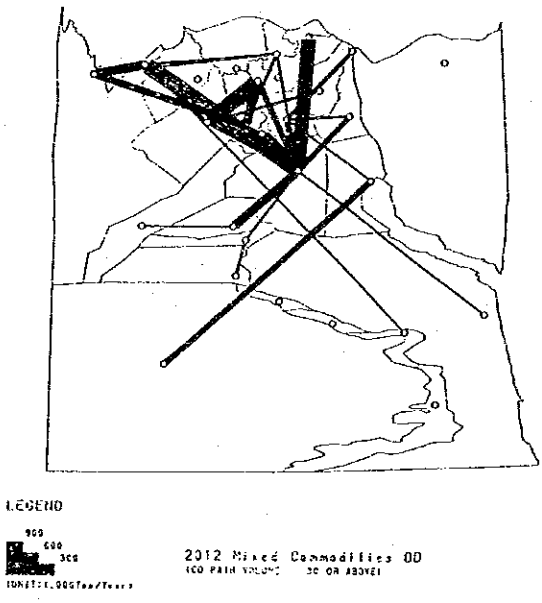



Fig. 13-4-28 2012 Mixed Commodities Flow

## 13.5 Modal Split of Freight

The freight was split to the three modes of highway, railway and waterway by the following three methods to check the influence to the road transport demand by the deference of approaches.

(1) Present Share Method,
(2) Minimum Cost Method, and
(3) Pre-determined Method

### 13.5.1 Present Share Method

The present share of the road transport freight occupies 94% of the total freight demand in terms of ton, therefore even if the Study assumes that all the commodities will be transported by road only, the estimate error of the road freight transport demand will remain within 6% level. Taking this fact into consideration, the present mode share by 29 zone base OD pair and by 30 commodities is applied to estimate the future road transport demand as the base case. The total mode share will be affected by the deference of the growth rate in each OD pair and in commodities.

Table 13-5-1 shows the results of modal split by the present mode share by commodity and by 29 based OD pair. The growth of road transport share in phosphate shows the significant increase of 180 times the present reflecting the high growth of production, however the railway is scheduled for the transportation of new developed phosphate to Safaga port, and such mass and bulk transport should be further discussed in this case. On the other hand, in the case of the other food products, the rail transport shows the high growth of 11 times the present and also the appropriate transport mode for these kind of small sized - high frequency transport demand should also be discussed.

Table 13-5-1 Future Freight Demand by Mode
(GDP 6.5% Case, Present Share Method)

| Commodity | 1992 (1,000ton/year) | | | | 2012 (1,000ton/year) | | | | 2012/1992 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total |
| 1 COIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 2 PETR | 11,104 | 1,208 | 423 | 12,736 | 14,962 | 2,853 | 0 | 17,815 | 1.3 | 2.4 | 0.0 | 1.4 |
| 3 NGAS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 4 CEMT | 25,843 | 341 | 1,010 | 27,194 | 91,414 | 6,876 | 12,493 | 110,783 | 3.5 | 20.2 | 12.4 | 4.1 |
| 5 CMAT | 43,662 | 737 | 160 | 44,558 | 192,277 | 11,170 | 576 | 204,023 | 4.4 | 15.2 | 3.6 | 4.6 |
| 6 PHOS | 69 | 649 | 82 | 801 | 12,639 | 594 | 0 | 13,233 | 182.1 | 0.9 | 0.0 | 16.5 |
| 7 IORE | 0 | 2,502 | 0 | 2,502 | 1,658 | 2,953 | 0 | 4,611 | - | 1.2 | - | 1.8 |
| 8 COAL | 209 | 807 | 805 | 1,821 | 2,993 | 3,423 | 661 | 7,077 | 14.3 | 4.2 | 0.8 | 3.9 |
| 9 MNRL | 4,997 | 46 | 400 | 5,443 | 13,538 | 31 | 46 | 13,615 | 2.7 | 0.7 | 0.1 | 2.5 |
| 10 WHET | 6,551 | 1,351 | 19 | 7,921 | 14,648 | 2,635 | 0 | 17,283 | 2.2 | 2.0 | 0.0 | 2.2 |
| 11 CERE | 5,358 | 93 | 0 | 5,450 | 12,132 | 240 | 0 | 12,372 | 2.3 | 2.6 | - | 2.3 |
| 12 FRUT | 13,965 | 0 | 0 | 13,965 | 33,307 | 2 | 0 | 33,309 | 2.4 | 10.0 | - | 2.4 |
| 13 SCAN | 609 | 8 | 0 | 617 | 695 | 210 | 0 | 905 | 1.1 | 28.0 | - | 1.5 |
| 14 FCRP | 466 | 0 | 0 | 466 | 755 | 0 | 0 | 755 | 1.6 | - | - | 1.6 |
| 15 LSTK | 1,462 | 0 | 0 | 1,462 | 2,338 | 0 | 0 | 2,338 | 1.6 | - | - | 1.6 |
| 16 APRD | 2,613 | 5 | 0 | 2,617 | 4,039 | 8 | 0 | 4,047 | 1.5 | 1.7 | - | 1.5 |
| 17 AGPR | 5,291 | 1 | 0 | 5,291 | 27,492 | 0 | 0 | 27,492 | 5.2 | 0.0 | - | 5.2 |
| 18 SGAR | 1,540 | 511 | 253 | 2,303 | 2,032 | 1,073 | 158 | 3,263 | 1.3 | 2.1 | 0.6 | 1.4 |
| 19 FATS | 1,049 | 128 | 0 | 1,178 | 3,739 | 222 | 0 | 3,961 | 3.6 | 1.7 | - | 3.4 |
| 20 AFED | 5,681 | 1 | 0 | 5,682 | 26,462 | 28 | 0 | 26,490 | 4.7 | 40.0 | - | 4.7 |
| 21 BVRG | 455 | 0 | 0 | 455 | 2,427 | 0 | 0 | 2,427 | 5.3 | - | - | 5.3 |
| 22 OFOD | 3,563 | 11 | 0 | 3,574 | 5,559 | 23 | 0 | 5,582 | 1.6 | 2.1 | - | 1.6 |
| 23 CHEM | 6,239 | 0 | 0 | 6,239 | 13,640 | 0 | 0 | 13,640 | 2.2 | - | - | 2.2 |
| 24 MTAL | 6,587 | 463 | 36 | 7,086 | 13,896 | 2,376 | 87 | 16,359 | 2.1 | 5.1 | 2.4 | 2.3 |
| 25 TXTL | 2,097 | 0 | 0 | 2,097 | 4,548 | 0 | 0 | 4,548 | 2.2 | - | - | 2.2 |
| 1 FTLZ | 3,683 | 241 | 8 | 3,932 | 8,652 | 465 | 0 | 9,117 | 2.3 | 1.9 | 0.0 | 2.3 |
| 2 PULP | 1,870 | 0 | 0 | 1,870 | 5,889 | 0 | 0 | 5,889 | 3.1 | 0.0 | - | 3.1 |
| 3 LUMB | 2,249 | 13 | 0 | 2,262 | 3,915 | 153 | 0 | 4,068 | 1.7 | 11.8 | - | 1.8 |
| 4 MANU | 6,545 | 526 | 2 | 7,073 | 19,506 | 1,403 | 7 | 20,916 | 3.0 | 2.7 | 3.3 | 3.0 |
| 5 MEXC | 1,738 | 0 | 18 | 1,756 | 5,146 | 0 | 33 | 5,179 | 3.0 | - | 1.9 | 2.9 |
| Total | 165,495 | 9,642 | 3,214 | 178,350 | 540,298 | 36,738 | 14,061 | 591,097 | 3.3 | 3.8 | 4.4 | 3.3 |
| Share | 92.8 | 4.2 | 1.9 | 100.0 | 91.4 | 6.2 | 2.4 | 100.0 | | | | |

### 13.5.2 Minimum Cost Method

The minimum cost method is to pick up the minimum cost routes and mode in terms of economic cost between OD pairs and to assign all the OD pair freights to these routes. The economic transport cost is calculated based on the various factors and they normally are divided into fixed cost and variable cost portions and thus are influenced by the transport demand and distance itself. However for the estimation process of the transport demand, the cost should be fixed as the input value before starting calculation, so that the results of the Transportation Economic Study, Feb. 1991 were applied in the Study, where economic costs by mode and by

commodity were calculated in terms of ton-Km based on the past transport records.

The following economic costs by transport mode were applied to estimate the freight by minimum cost route. In the above Study, the railway cost were divided into five commodities, and for the truck and waterway, bulk cargo was assumed to be transported by 24 ton trailer or twinship and others by 8 ton truck or self propelled barges.

Table 13-5-2 Economic Cost of Various Modes

| Commodity | Economic Cost (LE/1,000 ton-Km) | | |
|---|---|---|---|
| | Hwy | Rwy | Wwy |
| Petroleum Products | 40.392 | 22.849 | 30.350 |
| Construction Material | 40.392 | 44.377 | 30.350 |
| Iron Ore and Mining Prod. | 40.392 | 30.375 | 30.350 |
| Cole/Coke | 40.392 | 35.433 | 30.350 |
| Wheat and Cereals | 40.392 | 48.035 | 30.350 |
| Mixed Commodities and Others | 52.375 | 44.377 | 38.710 |

The freight will be estimated by the linear programming (LP) to minimize the following object function under the conditions of the generation at the production zone and the attraction at the consumption zone. The freight by mode will be estimated at the same time with the estimate of distribution volume.

$$\Sigma\Sigma\Sigma\ Cmij \times Pmij$$

where C:freight cost by ton
P:freight volume
m:transport mode
i:generation zone
j:attraction zone

subject to;

$$\Sigma\ Pi=Gi$$
$$\Sigma\ Pj=Ai$$

where G:generation volume
A:attraction volume

The minimum cost route by mode and by commodity was searched and the minimum cost routes and their costs for each OD pair were listed up for LP. The calculation was done by Simplex big-M tableau method. The number of variables in the object function were 841 (29 x 29), and the constraints functions were 58 (2 x 29). In cases of railway or waterway, they can not transport commodities from their origin to the destination unless the origins or destinations are connected to the zone centroids, so that the transport cost includes these access costs and if the main route is either railway or waterway, then they are classified as rail transport or

water transport modes.

Table 13-5-3 Freight by Minimum Cost Mode in 2012

| Commodity | 1992 (1,000ton/year) | | | | 2012 (1,000ton/year) | | | | 2012/1992 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total |
| 1 COIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 2 PETR | 11,104 | 1,208 | 423 | 12,736 | 12,216 | 2,439 | 3,160 | 17,815 | 1.1 | 2.0 | 7.5 | 1.4 |
| 3 NGAS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 4 CEMT | 25,843 | 341 | 1,010 | 27,194 | 95,428 | 11,402 | 3,953 | 110,783 | 3.7 | 33.4 | 3.9 | 4.1 |
| 5 CMAT | 43,662 | 737 | 160 | 44,558 | 192,751 | 0 | 11,272 | 204,023 | 4.4 | 0.0 | 70.4 | 4.6 |
| 6 PHOS | 69 | 649 | 82 | 801 | 3,079 | 10,154 | 0 | 13,233 | 44.4 | 15.6 | 0.0 | 16.5 |
| 7 IORE | 0 | 2,502 | 0 | 2,502 | 0 | 4,127 | 484 | 4,611 | - | 1.6 | - | 1.8 |
| 8 COAL | 209 | 807 | 805 | 1,821 | 2,378 | 0 | 4,699 | 7,077 | 11.4 | 0.0 | 5.8 | 3.9 |
| 9 MNRL | 4,997 | 46 | 400 | 5,443 | 8,992 | 64 | 4,559 | 13,615 | 1.8 | 1.4 | 11.4 | 2.5 |
| 10 WHET | 6,551 | 1,351 | 19 | 7,921 | 16,536 | 0 | 747 | 17,283 | 2.5 | 0.0 | 39.9 | 2.2 |
| 11 CERE | 5,358 | 93 | 0 | 5,450 | 11,628 | 0 | 744 | 12,372 | 2.2 | 0.0 | - | 2.3 |
| 12 FRUT | 13,965 | 0 | 0 | 13,965 | 28,870 | 0 | 4,439 | 33,309 | 2.1 | 0.0 | - | 2.4 |
| 13 SCAN | 609 | 8 | 0 | 617 | 605 | 0 | 300 | 905 | 1.0 | 0.0 | - | 1.5 |
| 14 FCRP | 466 | 0 | 0 | 466 | 692 | 0 | 63 | 755 | 1.5 | - | - | 1.6 |
| 15 LSTK | 1,462 | 0 | 0 | 1,462 | 2,129 | 0 | 209 | 2,338 | 1.5 | - | - | 1.6 |
| 16 APRD | 2,613 | 5 | 0 | 2,617 | 3,795 | 0 | 252 | 4,047 | 1.5 | 0.0 | - | 1.5 |
| 17 AGPR | 5,291 | 1 | 0 | 5,291 | 26,159 | 0 | 1,333 | 27,492 | 4.9 | 0.0 | - | 5.2 |
| 18 SGAR | 1,540 | 511 | 253 | 2,303 | 2,810 | 0 | 453 | 3,263 | 1.8 | 0.0 | 1.8 | 1.4 |
| 19 FATS | 1,049 | 128 | 0 | 1,178 | 3,690 | 3 | 268 | 3,961 | 3.5 | 0.0 | - | 3.4 |
| 20 AFED | 5,681 | 1 | 0 | 5,682 | 24,620 | 0 | 1,870 | 26,490 | 4.3 | 0.0 | - | 4.7 |
| 21 BVRG | 455 | 0 | 0 | 455 | 2,246 | 0 | 181 | 2,427 | 4.9 | - | - | 5.3 |
| 22 OFOD | 3,563 | 11 | 0 | 3,574 | 5,171 | 6 | 404 | 5,582 | 1.5 | 0.6 | - | 1.6 |
| 23 CHEM | 6,239 | 0 | 0 | 6,239 | 12,300 | 0 | 1,340 | 13,640 | 2.0 | - | - | 2.2 |
| 24 MTAL | 6,587 | 463 | 36 | 7,086 | 14,521 | 0 | 1,838 | 16,359 | 2.2 | 0.0 | 51.5 | 2.3 |
| 25 TXTL | 2,097 | 0 | 0 | 2,097 | 4,425 | 0 | 123 | 4,548 | 2.1 | - | - | 2.2 |
| 26 FTLZ | 3,683 | 241 | 8 | 3,932 | 7,634 | 0 | 1,483 | 9,117 | 2.1 | 0.0 | 195.1 | 2.3 |
| 27 PULP | 1,870 | 0 | 0 | 1,870 | 5,674 | 0 | 215 | 5,889 | 3.0 | 0.0 | - | 3.1 |
| 28 LUMB | 2,249 | 13 | 0 | 2,262 | 3,965 | 0 | 103 | 4,068 | 1.8 | 0.0 | - | 1.8 |
| 29 MANU | 6,545 | 526 | 2 | 7,073 | 19,897 | 0 | 1,019 | 20,916 | 3.0 | 0.0 | 485.2 | 3.0 |
| 30 MEXC | 1,738 | 0 | 18 | 1,756 | 5,089 | 0 | 90 | 5,179 | 2.9 | - | 5.1 | 2.9 |
| Total | 165,495 | 9,642 | 3,214 | 178,350 | 517,300 | 28,195 | 45,601 | 591,097 | 3.1 | 2.9 | 14.2 | 3.3 |
| Share | 92.8 | 5.4 | 1.8 | 100.0 | 87.5 | 4.8 | 7.7 | 100.0 | | | | |

The resulted future freight by mode was summarized in Table 13-5-3. The share of highway reduces to 87.5%, railway share will remain in the same level of 4.8%, and waterway share increases to 7.7%, which is 4 times the present.

Railway shows the advantage in terms of economic transport cost only in the seven commodities of petroleum products, cement, phosphate, iron ore, other minerals, fiber crops and edible oil and fats, mainly in the mining products. Especially in the case of phosphate, its share reaches to 77% of the total. Waterway shows the advantage in various commodities, especially in the case of Coal/Coke, its share

reaches to 66%.

The cost of self propelled barges was assumed as the economic transport cost of general cargo in waterway adding access cost of loading and unloading, however the cost was calculated based on transport records of such bulk and high volume cargoes as wheat, coal and coke or petroleum products, therefore if the smaller barge capacity is applied to the general cargoes then the waterway operating cost in these commodities will increase and their share will decrease. Practically general cargo requires high frequency - low capacity transport, and thus the present share of general cargo shows the high inclination to the highway mode.

The mode share by minimum cost method will show the future desirable mode share in terms of economic transport cost and will not give the future modal split projection. However the present share method include unexpected results by sticking to the present mode share. Therefore future modal split projection will be made by selecting from these two results commodity by commodity.

13.5.3 Pre-determined Method

The road transport freight occupies 94% of the total inter semi-governorate freight at present, however minimum cost method proved there are some commodities suitable for railway or waterway from the view point of economic transport cost, and in some commodities they look more realistic than the calculation results by present pattern method. However minimum cost method determines commodity distribution at the same time and the resulted distribution patterns are always idealistic. Therefore in this case, the freight calculated in the section 13.5.2 is allocated to the most economy modes in 29 OD pair base in the following 7 selected commodities.

1. Phosphate Ore
2. Iron Ore
3. Coal and Coke
4. Sugar Cane
5. Sugar
6. Edible Oil and Fats
7. Fertilizer

These commodities showed 15% or more mode share in the minimum cost method and are considered more suitable for rail or waterway transport.

In ENTS-II and III, the pre-determined method was applied based on the almost same logic as above. The commodities with the specific OD pairs were allocated to the specific modes which show its economic advantage comparing with the other modes, giving some mode shares based on observed or estimated results.

Table 13-5-4 shows the results of calculation. Comparing with the results of minimum cost method, coal and coke lost its share in the waterway, because of transport of coals from Sinai to Cairo by highway. While in other commodities, railway or waterway obtained more share than those by the minimum cost method. The total share of highway is calculated at 85.3%, rail 7.7% and waterway 6.9%.

Table 13-5-4 Pre-Determined Modal Share

| Commodity | 1992 (1,000ton/year) | | | | 2012 (1,000ton/year) | | | | 2012/1992 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total |
| 1 COIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 2 PETR | 11,104 | 1,208 | 423 | 12,736 | 14,963 | 2,852 | 0 | 17,815 | 1.3 | 2.4 | 0.0 | 1.4 |
| 3 NGAS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 4 CEMT | 25,843 | 341 | 1,010 | 27,194 | 91,416 | 6,875 | 12,492 | 110,783 | 3.5 | 20.2 | 12.4 | 4.1 |
| 5 CMAT | 43,662 | 737 | 160 | 44,558 | 192,277 | 11,170 | 576 | 204,023 | 4.4 | 15.2 | 3.6 | 4.6 |
| 6 PHOS | 69 | 649 | 82 | 801 | 2,144 | 11,089 | 0 | 13,233 | 30.9 | 17.1 | 0.0 | 16.5 |
| 7 IORE | 0 | 2,502 | 0 | 2,502 | 0 | 4,127 | 484 | 4,611 | - | 1.6 | - | 1.8 |
| 8 COAL | 209 | 807 | 805 | 1,821 | 2,993 | 0 | 4,084 | 7,077 | 14.3 | 0.0 | 5.1 | 3.9 |
| 9 MNRL | 4,997 | 46 | 400 | 5,443 | 2,129 | 60 | 11,427 | 13,616 | 0.4 | 1.3 | 28.6 | 2.5 |
| 10 WHET | 6,551 | 1,351 | 19 | 7,921 | 11,491 | 2,557 | 3,235 | 17,283 | 1.8 | 1.9 | 173.0 | 2.2 |
| 11 CERE | 5,358 | 93 | 0 | 5,450 | 12,132 | 240 | 0 | 12,372 | 2.3 | 2.6 | - | 2.3 |
| 12 FRUT | 13,965 | 0 | 0 | 13,965 | 33,307 | 2 | 0 | 33,309 | 2.4 | 10.0 | - | 2.4 |
| 13 SCAN | 609 | 8 | 0 | 617 | 141 | 0 | 764 | 905 | 0.2 | 0.0 | - | 1.5 |
| 14 FCRP | 466 | 0 | 0 | 466 | 755 | 0 | 0 | 755 | 1.6 | - | - | 1.6 |
| 15 LSTK | 1,462 | 0 | 0 | 1,462 | 2,338 | 0 | 0 | 2,338 | 1.6 | - | - | 1.6 |
| 16 APRD | 2,613 | 5 | 0 | 2,617 | 4,038 | 9 | 0 | 4,047 | 1.5 | 2.0 | - | 1.5 |
| 17 AGPR | 5,291 | 1 | 0 | 5,291 | 27,492 | 0 | 0 | 27,492 | 5.2 | 0.0 | - | 5.2 |
| 18 SGAR | 1,540 | 511 | 253 | 2,303 | 1,082 | 6 | 2,175 | 3,263 | 0.7 | 0.0 | 8.6 | 1.4 |
| 19 FATS | 1,049 | 128 | 0 | 1,178 | 1,870 | 1 | 2,090 | 3,961 | 1.8 | 0.0 | - | 3.4 |
| 20 AFED | 5,681 | 1 | 0 | 5,682 | 26,462 | 28 | 0 | 26,490 | 4.7 | 40.0 | - | 4.7 |
| 21 BVRG | 455 | 0 | 0 | 455 | 2,427 | 0 | 0 | 2,427 | 5.3 | - | - | 5.3 |
| 22 OFOD | 3,563 | 11 | 0 | 3,574 | 5,560 | 22 | 0 | 5,582 | 1.6 | 2.0 | - | 1.6 |
| 23 CHEM | 6,239 | 0 | 0 | 6,239 | 13,640 | 0 | 0 | 13,640 | 2.2 | - | - | 2.2 |
| 24 MTAL | 6,587 | 463 | 36 | 7,086 | 11,184 | 5,088 | 87 | 16,359 | 1.7 | 11.0 | 2.4 | 2.3 |
| 25 TXTL | 2,097 | 0 | 0 | 2,097 | 4,548 | 0 | 0 | 4,548 | 2.2 | - | - | 2.2 |
| 26 FTLZ | 3,683 | 241 | 8 | 3,932 | 5,563 | 0 | 3,554 | 9,117 | 1.5 | 0.0 | 467.6 | 2.3 |
| 27 PULP | 1,870 | 0 | 0 | 1,870 | 5,889 | 0 | 0 | 5,889 | 3.1 | 0.0 | - | 3.1 |
| 28 LUMB | 2,249 | 13 | 0 | 2,262 | 3,916 | 152 | 0 | 4,068 | 1.7 | 11.7 | - | 1.8 |
| 29 MANU | 6,545 | 526 | 2 | 7,073 | 19,512 | 1,396 | 7 | 20,915 | 3.0 | 2.7 | 3.3 | 3.0 |
| 30 MEXC | 1,738 | 0 | 18 | 1,756 | 5,146 | 0 | 33 | 5,179 | 3.0 | - | 1.9 | 2.9 |
| Total | 165,495 | 9,642 | 3,214 | 178,350 | 504,415 | 45,674 | 41,008 | 591,097 | 3.0 | 4.7 | 12.8 | 3.3 |
| Share | 92.8 | 5.4 | 1.8 | 100.0 | 85.3 | 7.7 | 6.9 | 100.0 | | | | |

## 13.6 Vehicle Demand Forecast

### 13.6.1 Vehicle OD

Future passenger and freight OD was converted to the future vehicle OD applying the present average occupancy of passenger vehicles and by the present average loading weight by commodities. The empty trucks were assigned to the opposite direction of the commodity origin and destination. Table 13-6-1 shows the vehicle demand generation in the years 1992 and 2012 by zone. The average growth ratio of all the vehicles and all the zones is 2.73 times the 1992 level.

Table 13-6-1 Vehicle Generation Forecast (Base Case)

| ZONE | GENERATION 1992 (VEH/DAY) | | | | | GENERATION 2012 (VEH/DAY) | | | | | 2012/1992 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P.CAR | TAXI | BUS | TRUCK | TOTAL | P.CAR | TAXI | BUS | TRUCK | TOTAL | P.CAR | TAXI | BUS | TRUCK | TOTAL |
| 1 CAI | 15,554 | 12,086 | 2,559 | 19,766 | 49,965 | 28,237 | 34,409 | 5,735 | 67,046 | 135,427 | 1.82 | 2.85 | 2.24 | 3.39 | 2.71 |
| 2 GIZ | 2,395 | 2,416 | 756 | 4,756 | 10,323 | 6,731 | 6,961 | 855 | 12,494 | 27,041 | 2.81 | 2.88 | 1.13 | 2.63 | 2.62 |
| 3 QAL | 3,232 | 3,561 | 492 | 4,502 | 11,787 | 10,666 | 8,689 | 1,909 | 10,697 | 31,961 | 3.30 | 2.44 | 3.88 | 2.38 | 2.71 |
| 4 SKS | 7,588 | 5,269 | 1,186 | 5,885 | 19,928 | 14,108 | 13,147 | 2,101 | 15,241 | 44,597 | 1.86 | 2.50 | 1.77 | 2.59 | 2.24 |
| 5 SKN | 2,741 | 2,137 | 480 | 1,503 | 6,861 | 7,213 | 6,950 | 1,079 | 5,134 | 20,376 | 2.63 | 3.25 | 2.25 | 3.42 | 2.97 |
| 6 DKE | 6,575 | 4,986 | 1,147 | 5,593 | 18,301 | 14,428 | 13,815 | 2,216 | 13,277 | 43,736 | 2.19 | 2.77 | 1.93 | 2.37 | 2.39 |
| 7 DKW | 894 | 819 | 137 | 1,083 | 2,933 | 6,096 | 6,101 | 1,007 | 3,716 | 16,920 | 6.82 | 7.45 | 7.35 | 3.43 | 5.77 |
| 8 DAM | 2,978 | 1,796 | 424 | 3,864 | 9,062 | 8,473 | 8,357 | 1,297 | 7,500 | 25,627 | 2.85 | 4.65 | 3.06 | 1.94 | 2.83 |
| 9 PTS | 2,218 | 1,453 | 183 | 2,853 | 6,707 | 3,753 | 2,966 | 778 | 3,286 | 10,783 | 1.69 | 2.04 | 4.25 | 1.15 | 1.61 |
| 10 ISM | 2,080 | 1,876 | 226 | 2,624 | 6,806 | 4,688 | 3,584 | 893 | 5,185 | 14,350 | 2.25 | 1.91 | 3.95 | 1.98 | 2.11 |
| 11 SUZ | 648 | 488 | 137 | 4,546 | 5,819 | 1,651 | 3,281 | 456 | 7,952 | 13,340 | 2.55 | 6.72 | 3.33 | 1.75 | 2.29 |
| 12 MIF | 3,358 | 4,316 | 723 | 4,940 | 13,337 | 13,764 | 11,023 | 2,296 | 10,918 | 38,001 | 4.10 | 2.55 | 3.18 | 2.21 | 2.85 |
| 13 GHS | 3,222 | 3,879 | 816 | 7,736 | 15,653 | 14,730 | 12,680 | 2,372 | 14,477 | 44,259 | 4.57 | 3.27 | 2.91 | 1.87 | 2.83 |
| 14 GHN | 1,694 | 1,045 | 513 | 2,019 | 5,271 | 9,648 | 9,458 | 1,234 | 5,881 | 26,221 | 5.70 | 9.05 | 2.41 | 2.91 | 4.97 |
| 15 KAF | 2,354 | 3,156 | 496 | 3,684 | 9,690 | 8,031 | 6,929 | 1,398 | 9,896 | 26,254 | 3.41 | 2.20 | 2.82 | 2.69 | 2.71 |
| 16 BHS | 1,740 | 1,762 | 266 | 4,497 | 8,265 | 5,594 | 5,299 | 1,009 | 7,907 | 19,809 | 3.21 | 3.01 | 3.79 | 1.76 | 2.40 |
| 17 BHN | 2,978 | 3,948 | 701 | 6,437 | 14,064 | 9,379 | 8,100 | 1,532 | 13,790 | 32,801 | 3.15 | 2.05 | 2.19 | 2.14 | 2.33 |
| 18 ALX | 6,150 | 4,957 | 823 | 15,104 | 27,034 | 16,109 | 14,536 | 3,455 | 36,219 | 70,319 | 2.62 | 2.93 | 4.20 | 2.40 | 2.60 |
| 19 WDS | 1,683 | 474 | 375 | 3,477 | 6,009 | 1,061 | 2,338 | 94 | 2,546 | 6,039 | 0.63 | 4.93 | 0.25 | 0.73 | 1.00 |
| 20 SIN | 490 | 343 | 91 | 595 | 1,519 | 578 | 966 | 72 | 1,840 | 3,456 | 1.18 | 2.82 | 0.79 | 3.09 | 2.28 |
| 21 FAY | 1,035 | 1,237 | 378 | 1,354 | 4,004 | 3,844 | 4,188 | 494 | 7,146 | 15,672 | 3.71 | 3.39 | 1.31 | 5.28 | 3.91 |
| 22 BES | 1,202 | 1,426 | 376 | 998 | 4,002 | 4,497 | 5,269 | 687 | 3,295 | 13,748 | 3.74 | 3.69 | 1.83 | 3.30 | 3.44 |
| 23 MYA | 765 | 1,050 | 254 | 1,073 | 3,142 | 3,318 | 4,792 | 778 | 5,233 | 14,121 | 4.34 | 4.56 | 3.06 | 4.88 | 4.49 |
| 24 ASY | 831 | 1,595 | 180 | 905 | 3,511 | 2,876 | 3,393 | 692 | 5,183 | 12,144 | 3.46 | 2.13 | 3.84 | 5.73 | 3.46 |
| 25 NEW | 13 | 51 | 12 | 40 | 116 | 45 | 120 | 13 | 979 | 1,157 | 3.46 | 2.35 | 1.08 | 24.48 | 9.97 |
| 26 SOH | 690 | 1,424 | 124 | 695 | 2,933 | 3,366 | 3,397 | 828 | 5,376 | 12,967 | 4.88 | 2.39 | 6.68 | 7.74 | 4.42 |
| 27 QEN | 625 | 1,438 | 178 | 781 | 3,022 | 3,064 | 5,833 | 998 | 5,426 | 15,321 | 4.90 | 4.06 | 5.61 | 6.95 | 5.07 |
| 28 ASW | 113 | 555 | 50 | 527 | 1,245 | 774 | 919 | 274 | 3,154 | 5,121 | 6.85 | 1.66 | 5.48 | 5.98 | 4.11 |
| 29 RED | 178 | 255 | 58 | 407 | 898 | 487 | 737 | 109 | 974 | 2,307 | 2.74 | 2.89 | 1.88 | 2.39 | 2.57 |
| TOTAL | 76,024 | 69,798 | 14,141 | 112,244 | 272,207 | 207,209 | 208,237 | 36,661 | 291,768 | 743,875 | 2.73 | 2.98 | 2.59 | 2.60 | 2.73 |
| SHARE | 27.9 | 25.6 | 5.2 | 41.2 | 100.0 | 27.9 | 28.0 | 4.9 | 39.2 | 100.0 | | | | | |

### 13.6.2 Traffic Assignment Methodology

1) General Methodology

Vehicles are assigned to road links by minimum route method. In the first iteration, traffic is assigned to the minimum routes with free flow speed for each of 188 OD pairs, part of OD pair traffic is assigned to the minimum routes, the speeds on links are re-calculated according to the capacity reduction formula and the minimum routes for 2nd iteration are searched, and so on. The assignment is calculated on the hourly traffic basis and then converted to the daily traffic volume with PHF of 8% in normal rural highways.

2) Passenger Car Unit (PCU)

The traffic capacity is expressed in terms of PCU, and the figures on Table 13-6-2 are applied.

Table 13-6-2 Passenger Car Unit

| Vehicles | PCU |
|---|---|
| Passenger Car | 1.0 |
| Taxi | 1.0 |
| Bus | 3.0 |
| Truck | 3.0 |

3) Free Flow Speed

The six types of free flow speed as given in Table 13-6-3 are applied according the road link characteristics, taking the average free flow speed of all types of vehicles. referring the actual speed limits on rural highways, which are 100kph for passenger car, 80kph for buses and 70kph for trucks.

Table 13-6-3 Free Flow Speed

| Road Type | Speed(Km/Hr) |
|---|---|
| Toll Divided Highway | 90 |
| Other Divided Highways | 80 |
| Dual Carriage Highway with Carriageway width of 7.5m | 75 |
| Dual Carriage Highway with Carriageway width of 7.0m | 70 |
| Dual Carriage Highway with Carriageway width of 6.5m | 65 |
| Dual Carriage Highway with Carriageway width of 6.0m | 60 |

4) Speed Reduction Formula

There are many formulas to express the relationship between Volume Capacity Ratio (V/C) and travel speed. Fig. 13-6-1 shows a comparison of relationships of travel time increase

(reciprocal of speed reduction) and V/C reported in the Engineering Research Bulletin of University of Helwan, Oct. 1990, where JICA TS curve is the most pessimistic and the two curves of Federal Highway Administration, USA are too optimistic. The curves developed in Uk, known as COBA (Cost Benefit Model) and MOTORS package show the intermediate results and do not exceed 1.0 of V/C. Also the theoretical relationship between link speed and V/C ratio is included in the figure. The following MOTORS curve will be applied to the Study.

$$T_a = T_0 \times (0.75 + 0.25/(1.0-V/C \times Q)$$

Where, $T_a$: Travel time having traffic volume V
$T_0$: Travel Time by Free flow speed
C : Link Capacity
V : Link Volume
Q : Factor(1.00)

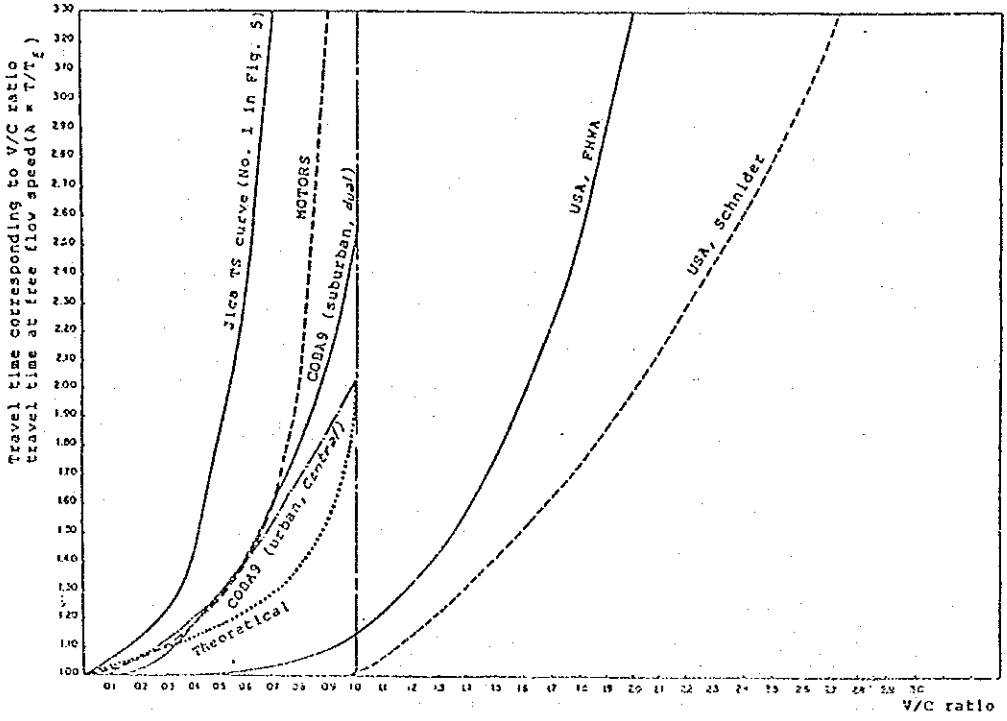



Fig. 13-6-1 Comparison of the Trends of the CRF's according to different practices including the theoretical CRF
source:Engineering Research Bulletin, University of Helwan, Oct. 1990

5) Traffic Capacity

As a basic lane capacity, 2,400 pcu/Hr. is applied to the calculation and the lane capacity is reduced in accordance with the factors given in Table 13-6-4 by carriageway and shoulder width and the factors given in Table 13-6-5 by pavement condition.

Table 13-6-4 Capacity Reduction Factor by Width

| Carriageway Width(m) | Shoulder Width (m) | | | |
|---|---|---|---|---|
| | 0.00 | 0.50 | 1.00 | 1.50 |
| 7.5 | 0.88 | 0.93 | 0.97 | 1.00 |
| 7.0 | 0.84 | 0.89 | 0.93 | 0.96 |
| 6.5 | 0.76 | 0.80 | 0.84 | 0.87 |
| 6.0 | 0.71 | 0.75 | 0.70 | 0.81 |

Table 13-6-5 Capacity Reduction Factor by Pavement Condition

| Pavement Condition | Reduction Factor |
|---|---|
| Good | 1.00 |
| Fair | 0.92 |
| Poor | 0.81 |

## 13.7 Policy Alternatives for Demand Forecast

### 13.7.1 Transport Demand by Alternative Socio-Economic Frame

In the chapter of socio-economic frame forecast, the GDP growth rate in real term was set at 5.1% p.a. for the period of 3rd 5 year plan of 1992 - 1996, and slightly high target of 6.5% p.a. afterwards, however an alternative case with the moderate growth with the same rate as in the 3rd 5 year plan period will be studied.

Figs. 13-7-1 and 13-7-2 shows the evolution of GDP in the base case and the alternative case with the growth rate of 5.1% p.a. after the 3rd 5 year plan period. The GDPs in the long term target year of 2012 were calculated at 414 billion LE in the base case and 339 billion LE or 82% of the base case in the alternative case. The passenger demand estimated based on these GDPs is given in Table 13-7-1. In the alternative case, the 2012 passenger demand was estimated at 82% of that in the base case, which is the same rate as GDPs, and corresponds to 2.33 times the 1992 demand.

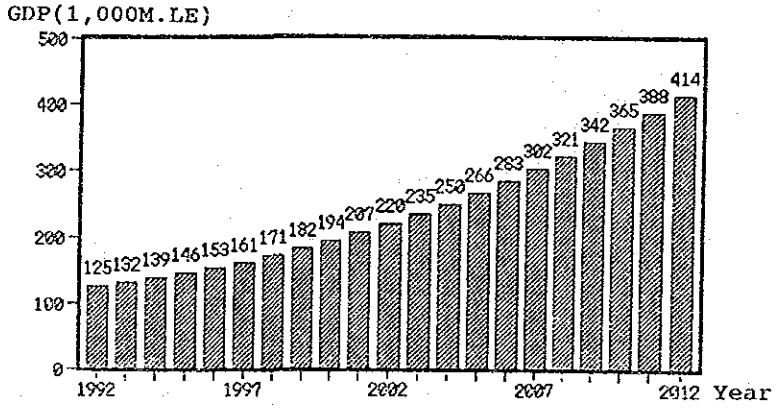



Fig. 13-7-1 Trend of GDP with Growth Rate of 6.5%

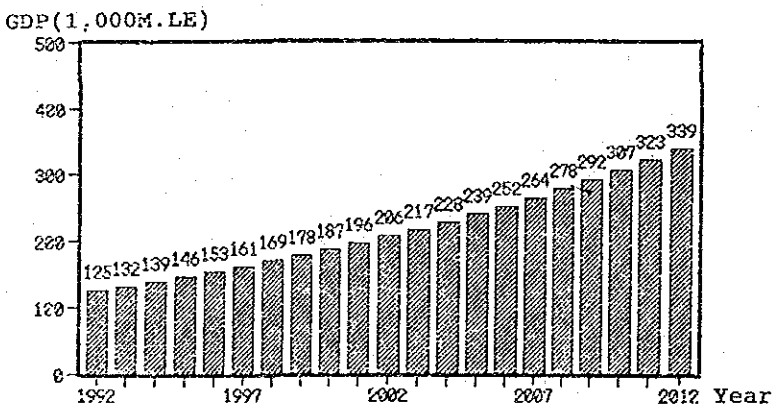



Fig. 13-7-2 Trend of GDP with Growth Rate of 5.1%

Table 13-7-1 Comparison of Passenger Demand with Different GDP Growth Rate

| Item | A GDP 6.5% Case | B GDP 5.1% Case | B/A |
|---|---|---|---|
| GDP in 2012 | 413,573 | 339,116 | 0.82 |
| Total Passenger | 5,736,097 | 4,725,511 | 0.82 |
| P.Car | 558,330 | 459,733 | |
| Taxi+Bus | 2,349,625 | 1,936,159 | |
| Rail | 2,828,142 | 2,329,619 | |

Table 13-7-2 shows the comparison of freight demand in the year 2012 with different GDP growth rate factors in the 3rd 5 years planning period. The case with GDP growth rate of 5.1% p.a. will have 0.86 times of freight to the base case with GDP growth rate of 6.5% p.a. The most affected commodity is phosphate, which will have 0.64 times the base case.

Table 13-7-2 Comparison of Freight Demand with Different GDP Growth Rate

| Commodity | 6.5% (1,000ton/year) | | | | 5.1% (1,000ton/year) | | | | 5.1%/6.5% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total | Hwy | Rwy | Wwy | Total |
| 1 COIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 2 PETR | 14,963 | 2,852 | 0 | 17,815 | 14,235 | 2,722 | 0 | 16,957 | 0.95 | 0.95 | - | 0.95 |
| 3 NGAS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |
| 4 CEMT | 91,416 | 6,875 | 12,492 | 110,783 | 72,750 | 5,105 | 9,451 | 87,306 | 0.80 | 0.74 | 0.76 | 0.79 |
| 5 CMAT | 192,277 | 11,170 | 576 | 204,023 | 166,610 | 9,672 | 499 | 176,781 | 0.87 | 0.87 | 0.87 | 0.87 |
| 6 PHOS | 2,144 | 11,089 | 0 | 13,233 | 1,344 | 7,178 | 0 | 8,522 | 0.63 | 0.65 | - | 0.64 |
| 7 IORE | 0 | 4,127 | 484 | 4,611 | 0 | 3,438 | 455 | 3,893 | - | 0.83 | 0.94 | 0.84 |
| 8 COAL | 2,993 | 0 | 4,084 | 7,077 | 2,496 | 0 | 3,534 | 6,030 | 0.83 | - | 0.87 | 0.85 |
| 9 MNRL | 2,129 | 60 | 11,427 | 13,616 | 1,745 | 46 | 9,239 | 11,030 | 0.82 | 0.77 | 0.81 | 0.81 |
| 10 WHET | 11,491 | 2,557 | 3,235 | 17,283 | 11,013 | 2,697 | 0 | 13,710 | 0.96 | 1.05 | 0.00 | 0.79 |
| 11 CERE | 12,132 | 240 | 0 | 12,372 | 11,813 | 161 | 0 | 11,974 | 0.97 | 0.67 | - | 0.97 |
| 12 FRUT | 33,307 | 2 | 0 | 33,309 | 28,203 | 2 | 0 | 28,205 | 0.85 | 1.00 | - | 0.85 |
| 13 SCAN | 141 | 0 | 764 | 905 | 134 | 0 | 715 | 849 | 0.95 | - | 0.94 | 0.94 |
| 14 FCRP | 755 | 0 | 0 | 755 | 704 | 0 | 0 | 704 | 0.93 | - | - | 0.93 |
| 15 LSTK | 2,338 | 0 | 0 | 2,338 | 2,099 | 0 | 0 | 2,099 | 0.90 | - | - | 0.90 |
| 16 APRD | 4,038 | 9 | 0 | 4,047 | 4,016 | 9 | 0 | 4,025 | 0.99 | 1.00 | - | 0.99 |
| 17 AGPR | 27,492 | 0 | 0 | 27,492 | 27,492 | 0 | 0 | 27,492 | 1.00 | - | - | 1.00 |
| 18 SGAR | 1,082 | 6 | 2,175 | 3,263 | 1,075 | 6 | 2,144 | 3,225 | 0.99 | 1.00 | 0.99 | 0.99 |
| 19 FATS | 1,870 | 1 | 2,090 | 3,961 | 1,653 | 1 | 1,921 | 3,575 | 0.88 | 1.00 | 0.92 | 0.90 |
| 20 AFED | 26,462 | 28 | 0 | 26,490 | 21,895 | 23 | 0 | 21,918 | 0.83 | 0.82 | - | 0.83 |
| 21 BVRG | 2,427 | 0 | 0 | 2,427 | 2,428 | 0 | 0 | 2,428 | 1.00 | - | - | 1.00 |
| 22 OFOD | 5,560 | 22 | 0 | 5,582 | 5,544 | 38 | 0 | 5,582 | 1.00 | 1.71 | - | 1.00 |
| 23 CHEM | 13,640 | 0 | 0 | 13,640 | 12,247 | 0 | 0 | 12,247 | 0.90 | - | - | 0.90 |
| 24 MTAL | 11,184 | 5,088 | 87 | 16,359 | 10,784 | 4,265 | 90 | 15,139 | 0.96 | 0.84 | 1.03 | 0.93 |
| 25 TXTL | 4,548 | 0 | 0 | 4,548 | 4,137 | 0 | 0 | 4,137 | 0.91 | - | - | 0.91 |
| 26 FTLZ | 5,563 | 0 | 3,554 | 9,117 | 4,526 | 0 | 3,302 | 7,828 | 0.81 | - | 0.93 | 0.86 |
| 27 PULP | 5,889 | 0 | 0 | 5,889 | 5,386 | 0 | 0 | 5,386 | 0.91 | - | - | 0.91 |
| 28 LUMB | 3,916 | 152 | 0 | 4,068 | 3,442 | 135 | 0 | 3,577 | 0.88 | 0.89 | - | 0.88 |
| 29 MANU | 19,512 | 1,396 | 7 | 20,915 | 16,893 | 1,219 | 7 | 18,119 | 0.87 | 0.87 | 1.00 | 0.87 |
| 30 MEXC | 5,146 | 0 | 33 | 5,179 | 4,456 | 0 | 27 | 4,483 | 0.87 | - | 0.82 | 0.87 |
| Total | 504,415 | 45,674 | 41,008 | 591,097 | 439,120 | 36,717 | 31,384 | 507,221 | 0.87 | 0.80 | 0.77 | 0.86 |
| Share | 85.3 | 7.7 | 6.9 | 100.0 | 86.6 | 7.2 | 6.2 | 100.0 | | | | |

Table 13-7-3 shows the results of passenger and freight demand distribution, modal split and conversion to vehicle generation demand. The total vehicle generation will reduce by 0.86 times to the base case by the decrease of GDP.

Table 13-7-3 Comparison of Vehicle Generation Demand with Different GDP Growth Rates

| Vehicle Type | (A) GDP 6.5% Case | (B) GDP 5.1% Case | (B)/(A) |
|---|---|---|---|
| P.Car | 207,209 | 169,507 | 0.82 |
| Taxi | 208,237 | 173,305 | 0.83 |
| Bus | 36,661 | 29,579 | 0.81 |
| Truck | 291,768 | 268,031 | 0.91 |
| Total | 743,875 | 640,422 | 0.86 |

## 13.7.2 Introduction of Standard Rail Fare

ENR applies the many types of discount fare at present. If these discount fare system is not applied, passenger may shift to the other transport modes. Table 13-7-4 shows the result of this case. The same modal split model was applied to estimate the passengers by mode with increased fare on ENR passengers. About 200,000 passengers in the year 2012 will shift to passenger car and bus or taxi, and the share of ENR will loose only by 2.0%.

Table 13-7-4 Standard Fare Case of ENR Passenger

| Item | P.CAR | TAXI+BUS | RAIL | TOTAL |
|---|---|---|---|---|
| 1.Pass./day(Excl.188 Intra) | | | | |
| 1992(Obs) | 205,363 | 824,541 | 997,972 | 2,027,876 |
| 1992(Est) | 225,301 | 873,686 | 924,318 | 2,023,305 |
| 1997 | 290,209 | 1,124,830 | 1,186,324 | 2,601,363 |
| 2002 | 378,457 | 1,465,563 | 1,542,861 | 3,386,881 |
| 2012 | 641,986 | 2,477,980 | 2,606,272 | 5,726,238 |
| 2.Growth Rate(19920bs.=1.00) | | | | |
| 1992(Obs) | 1.00 | 1.00 | 1.00 | 1.00 |
| 1992(Est) | 1.10 | 1.06 | 0.93 | 1.00 |
| 1997 | 1.41 | 1.36 | 1.19 | 1.28 |
| 2002 | 1.84 | 1.78 | 1.55 | 1.67 |
| 2012 | 3.13 | 3.01 | 2.61 | 2.82 |
| 3.Composition(%) | | | | |
| 1992(Obs) | 10.1 | 40.7 | 49.2 | 100.0 |
| 1992(Est) | 11.1 | 43.2 | 45.7 | 100.0 |
| 1997 | 11.2 | 43.2 | 45.6 | 100.0 |
| 2002 | 11.2 | 43.3 | 45.6 | 100.0 |
| 2012 | 11.2 | 43.3 | 45.5 | 100.0 |

# *Part III Master Plans*

# *CHAPTER 14 BASIC HIGHWAY MASTER PLAN*

## 14.1 General

As a result of the economic and social development of the country, the traffic will increase on the inter city highway network. Additional capacity has to be added to the network through upgrading the existing links to cope with the increase of traffic and also through the construction of new links, especially in new development areas. The present chapter deals with the elaboration of the basic master plan to cope with the increase of traffic on the inter city highway network till the year 2012.

The chapter starts by presenting the 1992 base year present level of service of the inter city highway network. This is necessary for comparison purposes with future level of services of different network development strategies.

The master plan projects will be elaborated within the framework of a well defined network hierarchy. A network hierarchy, consisting of primary and secondary routes within which the master plan projects will be developed is proposed.

The investment scale required for the upgrading of the existing links and the construction of new ones has to be determined based on operational and economic evaluation of different levels of services corresponding to different network improvement. The savings in vehicle operating costs compared to the Do-Nothing case minus the construction costs for the network improvement have to be calculated for different level of services. The level of service which maximizes the net benefits is the optimum level of service for future highway development strategy. A theoretical analysis of the optimum level of service will be carried out for the Egyptian conditions.

The theoretical analysis for the determination of the optimum level of service has considered only the upgrading of the existing network to cope with the increase of future traffic, and does not include any new projects needed to improve the network configuration, or even for the overall socioeconomic development of the country. Several highway development projects, however have been accepted in the 1992/97 five year development plan:

(1) The Giza/Asyut desert road for the development of the desert areas western of the narrow cultivated Nile valley and for the release of the heavy loaded existing agriculture upper Egypt highway,

(2) The completion of the northern international coastal highway from Rafah on the eastern borders, to Sallum on the western borders, will develop the northern areas

in the middle of the Delta and along the northern western coast and are complement the northern African international highway,

(3) The connection between the Nile valley network, and the highway along the Red Sea with several transverse links across the red see mountain will help the development of tourism along the red sea,

These are all examples of such new development projects which are not included in the analysis of the optimum level of service. Traffic using the congested highway network could be diverted in future to these new highways when they are opened to traffic. For the determination of the list of the master plan projects necessary for the development of the inter city highway network till the year 2012, assignment runs have been carried out using the OD matrices for the years 1997, 2002, and 2012 and the 1992 base year network together with all projects proposed by governmental agencies including all development projects. Some of these projects were already accepted for financing in the third five year plan, and the others have been postponed for scheduling in following plans. Based on these assignment runs, all critical links having V/C ratio more than the optimum V/C ratio are identified together with their future assigned traffic volumes. These critical links are proposed for upgrading to cope with the future assigned traffic volumes. The upgrading of the successive links are considered to have continuity of the same class within the same route of the primary or the secondary network according to the highway network hierarchy defined. The proposed upgrading projects together with the new development projects form the master plan project lists for the target years.

The master plan project lists have then been subject to operational evaluation. Scheduling of the short, medium, and long term project lists on yearly basis based on their economic priorities and subjected to budget constraints have been worked out. Finally, the scheduled master plan list of projects has been economically evaluated.

With the implementation of the master plan projects up till the year 2012, almost all routes of the primary network will be physically realized. Routes in the primary network which do not need upgrading due to the increase of their traffic volumes, and which are mainly two-lane two-way routes, will be identified, and have to be upgraded after the year 2012.

## 14.2 Proposed Network Hierarchy for the Future Egyptian Inter City Highway Network.

The determination of the highway master plan will be done in the framework of a well defined highway network hierarchy. For the identification of a network hierarchy, the present inter city highway network will be classified into two network levels. The primary level will include all the routes which connect the capitals of the governorates together, and also connect Egypt with neighboring countries. The secondary level will include the routes connecting the marakez with each others and with their capitals. The primary level will have the highest design, operating, safety, and maintenance standards.

The proposed primary network for the 1992 base year is presented in Fig. 14-2-1 and Table 14-2-1, with classification by carriageway width: 6-lane divided, 4-lane divided, and full 2-lane non-divided highways with 7.5m carriageway width.

The total length of the primary road network equal 7,583.60 km from which only 1,650.90 km are divided highways in 1992. The rest of the network equals 5,932.70 km is undivided highways. The route numbering system given in Fig. 14-2-1 and Table 14-2-1 is that determined by RBA till the present time. A new numbering system has to be defined by RBA, so that differentiation between primary and secondary routes by inter city highway users could be identified based on the route code number.

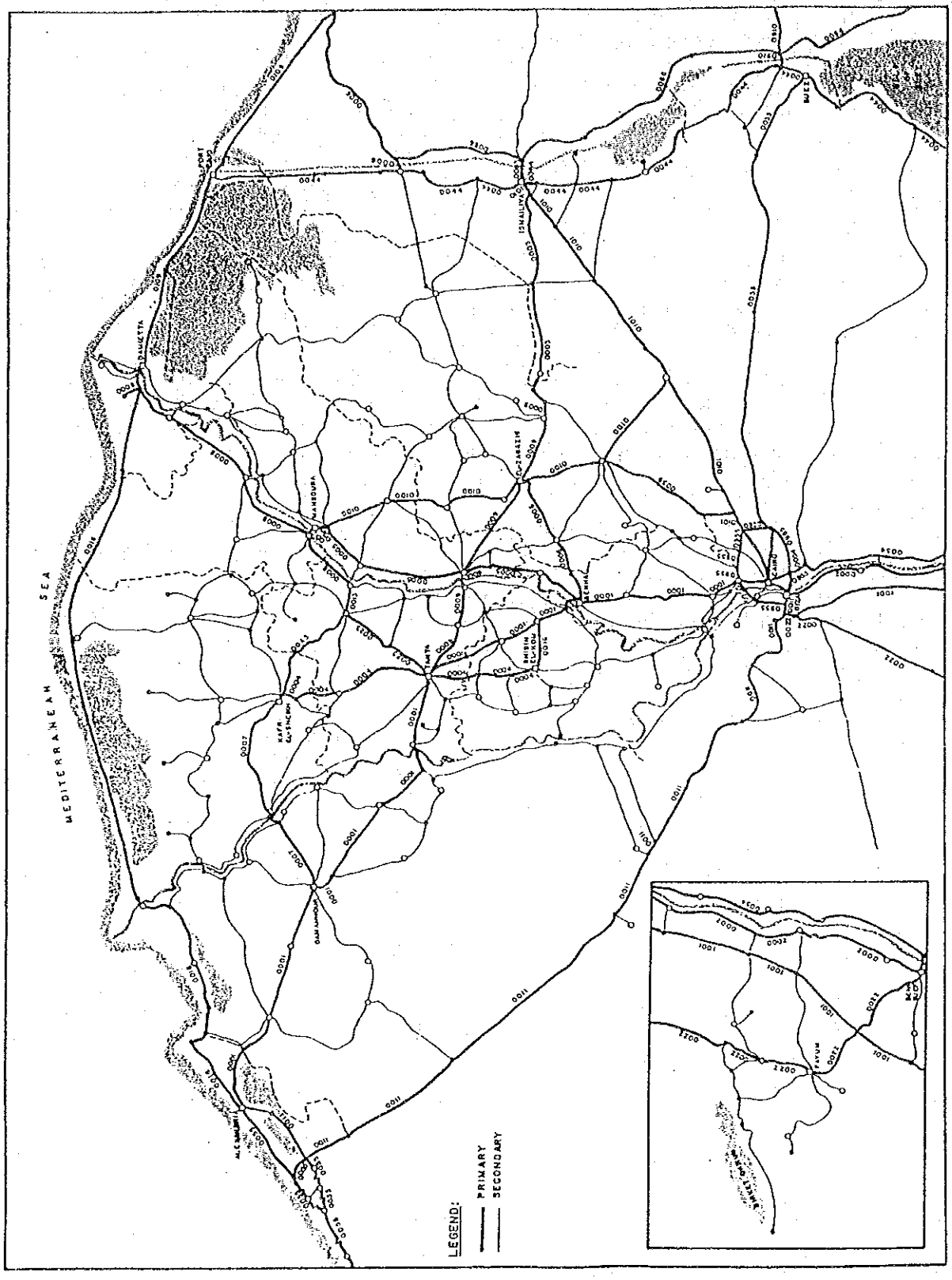



Fig. 14-2-1 Proposed Primary and Secondary Routes in the Inter city Highway Network.
(a) Lower Egypt.

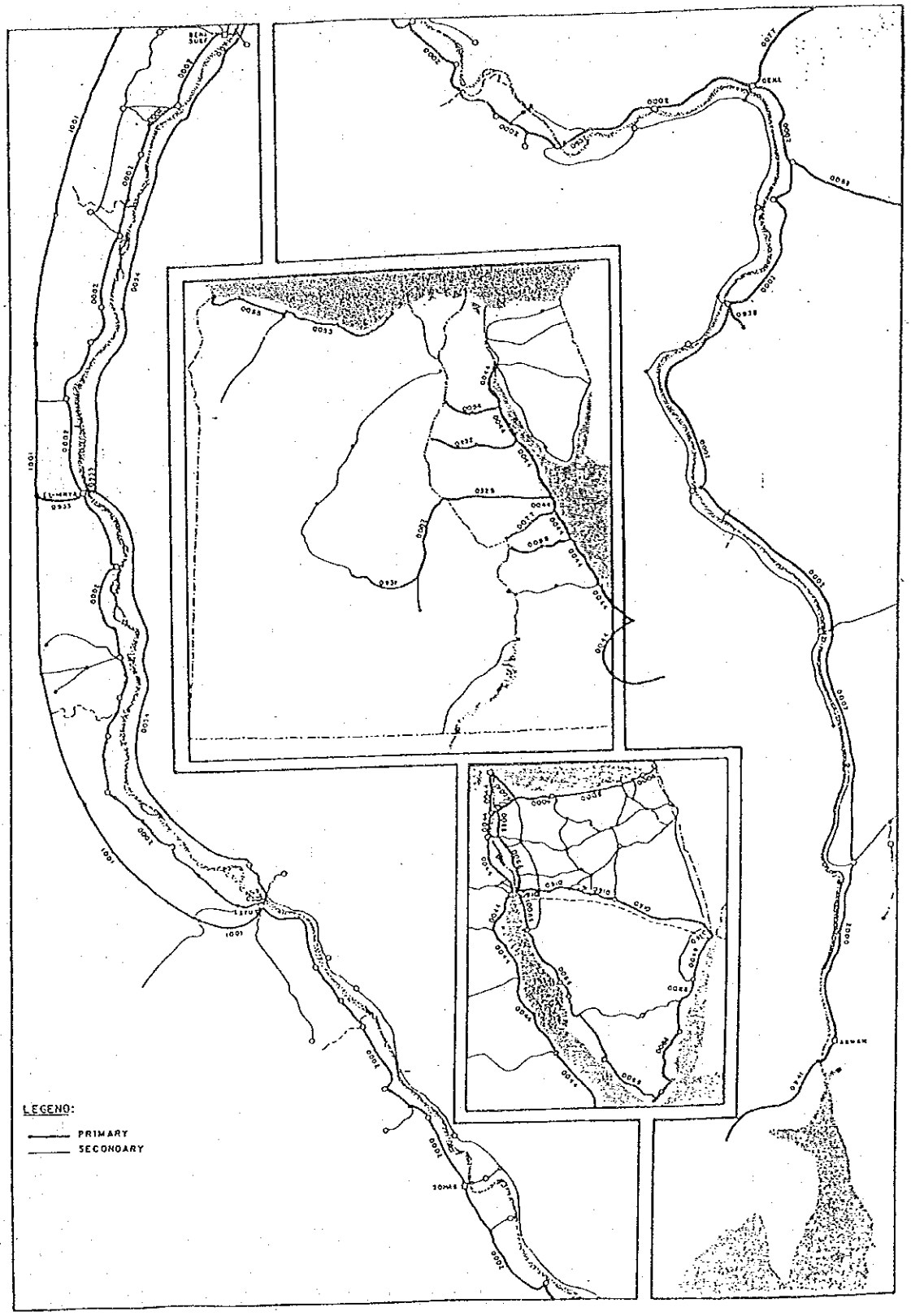



Fig. 14-2-1 Proposed Primary and Secondary Routes in the Inter city Highway Network.
(b) Upper Egypt.

## Table 14-2-1 Description of the Proposed Primary Inter City Highway Network in 1992.

| Route No. | Route Name | Divided | | | 2 Lane Non Divided | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (10.5*2) 6-Lane | (7.5*2) 4-Lane | Sub-total | 7.5 mt | 7 mt | 6.5 mt | 6 mt | Sub-total | |
| 0001 | Cairo-Alex(Agricultural) | 54.50 | 169.50 | 224.00 | - | - | - | - | 0.00 | 224.00 |
| 0002 | Cairo-Aswan | 10.00 | 47.00 | 57.00 | 812.00 | - | - | - | 812.00 | 869.00 |
| 0002 | Asuit-New Valley | - | - | 0.00 | 225.00 | | | | 225.00 | 225.00 |
| 0003 | EL Abassa-East No.6(Ism.East) | - | - | 0.00 | - | - | - | 54.50 | 54.50 | 54.50 |
| 0004 | Shibin EL KOm-Kafr EL Sh. | - | - | 0.00 | 65.00 | - | - | - | 65.00 | 65.00 |
| 0005 | Benha-Meet Ghamr-EL Mansoura | - | 13.00 | 13.00 | 61.00 | - | - | - | 61.00 | 74.00 |
| 0006 | Benha-EL Zagazig | - | - | 0.00 | 44.50 | - | - | - | 44.50 | 44.50 |
| 0006 | EL Qantara-EL Arish-Rafah | - | - | 0.00 | 212.00 | - | - | - | 212.00 | 212.00 |
| 0007 | Kafr EL Sheikh-Damanhour | - | - | 0.00 | 51.00 | - | - | - | 51.00 | 51.00 |
| 0008 | Samannud-Damietta | - | - | 0.00 | 77.80 | - | - | - | 77.80 | 77.80 |
| 0009 | Abu Hamad-Zagazig-Tanta | - | - | 0.00 | 33.00 | - | - | 45.50 | 78.50 | 78.50 |
| 0010 | 10th of Ramadan-EL Mansoura | - | 22.00 | 22.00 | 71.00 | - | - | 3.50 | 74.50 | 96.50 |
| 0011 | Cairo-Alex(Desert) | 19.00 | 205.00 | 224.00 | - | - | - | - | 0.00 | 224.00 |
| 0012 | Talkha Bridge | - | - | 0.00 | 2.50 | - | - | - | 2.50 | 2.50 |
| 0013 | Samannud-EL Mehala EL Kubra | - | 6.50 | 6.50 | - | - | - | - | 0.00 | 6.50 |
| 0016 | Shibin EL Kom-Quweisna | - | - | 0.00 | - | 11.00 | - | - | 11.00 | 11.00 |
| 0018 | Rashid-Abu Quer-Alex | - | - | 0.00 | 24.00 | - | - | 33.00 | 57.00 | 57.00 |
| 0022 | Cairo-EL Fayoum-Beni Suef | - | 91.00 | 91.00 | 44.00 | - | - | - | 44.00 | 135.00 |
| 0023 | EL Mehala-Tanta | - | 33.00 | 33.00 | - | - | - | - | 0.00 | 33.00 |
| 0033 | Cairo-Suez | - | 133.50 | 133.50 | - | - | - | - | 0.00 | 133.50 |
| 0039 | Belbies-Haikestep | - | 32.00 | 32.00 | - | - | - | - | 0.00 | 32.00 |
| 0044 | Port Said-Suez-Bernice | - | 73.90 | 73.90 | 597.90 | - | - | 286.00 | 883.90 | 957.80 |
| 0045 | EL Mehala EL Kubra-Kafr EL Sheikh | - | - | 0.00 | - | - | - | 26.00 | 26.00 | 26.00 |
| 0054 | Cairo-EL Saf-EL Menya-Asuit | - | - | 0.00 | 375.00 | - | - | - | 375.00 | 375.00 |
| 0054 | ELKorimat-EL Zaafarana | - | - | 0.00 | - | - | - | 167.00 | 167.00 | 167.00 |
| 0055 | Alex-Matrouh-EL Saloum | - | 514.00 | 514.00 | 43.00 | - | - | - | 43.00 | 557.00 |
| 0066 | EL Qantara Sharq-EL Tor-Taba | - | - | 0.00 | 539.00 | - | - | 231.00 | 770.00 | 770.00 |
| 0071 | Beni Suef Bridge | - | - | 0.00 | 1.00 | - | - | - | 1.00 | 1.00 |
| 0077 | Qena-Safaga | - | - | 0.00 | 169.00 | - | - | - | 169.00 | 169.00 |
| 0088 | Qift-EL Quseir | - | - | 0.00 | - | - | - | 180.00 | 180.00 | 180.00 |
| 0099 | Idfu-Mersa Alam | - | - | 0.00 | 3.00 | - | - | 225.00 | 228.00 | 228.00 |
| 0101 | Cairo-Ismailiya(Desert) | - | 121.00 | 121.00 | - | - | - | - | 0.00 | 121.00 |
| 0103 | El Maadi-Ain Sokhna | - | - | 0.00 | 165.00 | - | - | - | 165.00 | 165.00 |
| 0109 | Damietta-Port Said | - | 51.00 | 51.00 | - | - | - | - | 0.00 | 51.00 |
| 0329 | Qanater Asuit | - | - | 0.00 | - | - | - | 2.50 | 2.50 | 2.50 |
| 0910 | EL Shat Conn.-Nakhl-Taba | - | - | 0.00 | 258.00 | - | - | - | 258.00 | 258.00 |
| 0931 | New Valley-EL Dakhla | - | - | 0.00 | 189.00 | - | - | - | 189.00 | 189.00 |
| 0932 | EL Sh. Fadl-Ras Gharib | - | - | 0.00 | 240.00 | - | - | - | 240.00 | 240.00 |
| 0933 | EL Menya Bridge | - | - | 0.00 | 2.50 | - | - | - | 2.50 | 2.50 |
| 0937 | EL Taref-Nag Hammadi | - | - | 0.00 | 10.50 | - | - | - | 10.50 | 10.50 |
| 0938 | Luxor-Luxor Air Port | - | - | 0.00 | 7.00 | - | - | - | 7.00 | 7.00 |
| 0941 | Aswan-Wadi Halfa | - | - | 0.00 | 339.00 | - | - | 6.00 | 345.00 | 345.00 |
| 0955 | Ring Road | 55.00 | - | 55.00 | - | - | - | - | 0.00 | 55.00 |
| Total | | 138.50 | 1512.40 | 1650.90 | 4661.70 | 11.00 | 0.00 | 1260.00 | 5932.70 | 7583.60 |

## 14.3 Level of Service for the 1992 Base Year Inter City Highway Network.

### 14.3.1 1992 Base Year Network in 1992

After calibrating the link free flow speeds in 1992 inter city highway network based on average daily traffic volume by vehicle type actually counted on cordon line stations, the 1992 OD matrix has been assigned to the network.

The resulted loaded highway network of this assignment run is presented graphically in Fig. 14-3-1. The V/C ratios of all the links have been scanned to identify the links having critical traffic volumes, i.e. traffic volumes almost reaching the link capacity. Fig. 14-3-2 presents the links having an overloading equal or more than 0.55, 0.70, 0.85 & 1.00 respectively.

The maximum V/C ratio in 1992 is 0.92 and occurs on the 2-lane two-way non-divided link Sharkawia (Mansoura)-Sandoub (from node 1254 to node 1248) on route number 5 east of Damietta branch of the river Nile. The links having the maximum traffic volumes on each route, together with the corresponding V/C ratios, are given in Table 14-3-1. The heaviest loaded routes are:

- Cairo/Alexandria agriculture (route No.1)
- Cairo / Alexandria desert (route No.11)
- Benha / Mansoura (route No.5)
- Cairo / Belbes (route No.39) / Zagazig / Mansoura (route No.10)
- Cairo / Ismailia (route No.101)
- Cairo / Suez (route No.33)
- Cairo / Upper Egypt agriculture highway (route No.2)

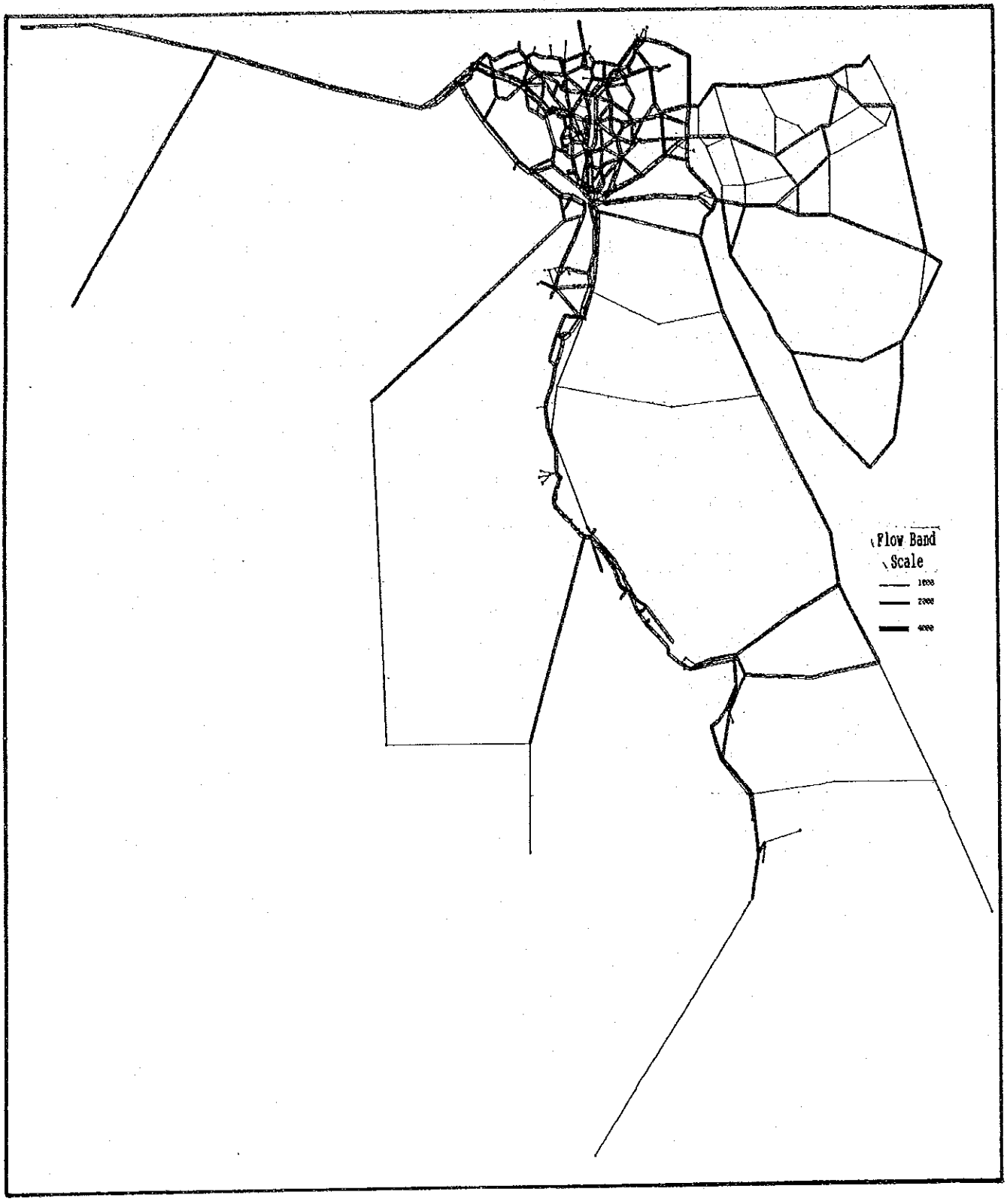



Fig. 14-3-1 Highway Link Overloading, 1992.
a) All Egypt

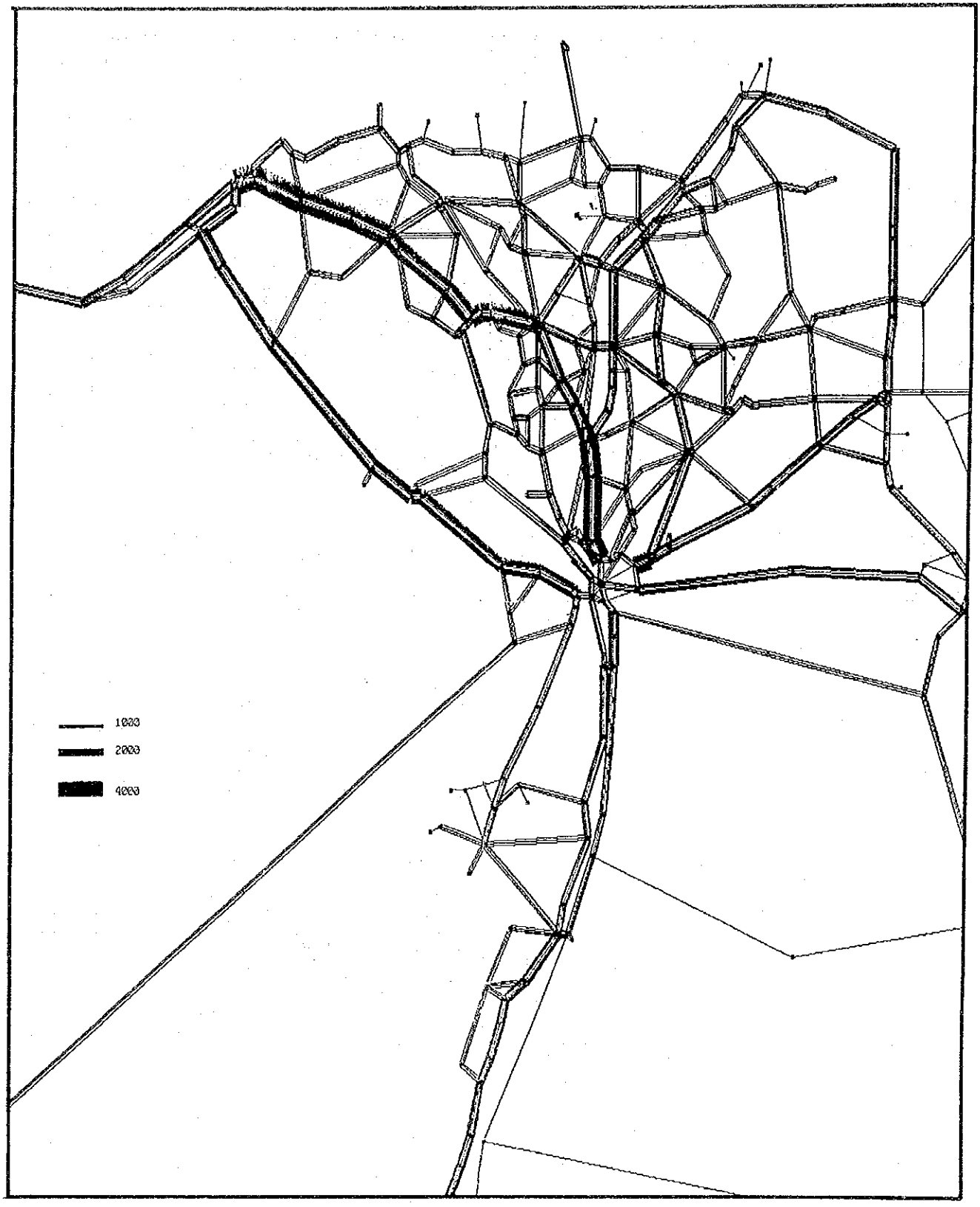



Fig. 14-3-1 Highway Link Overloading, 1992.
b) Lower Egypt

# Table 14-3-1 The 1992 Base Year Route Maximum CPU'S Volume and V/C Ratio

| RT_COD. | LK_COD. | INNODE | OUTNODE | LINK_NAME | PCU'S | CAPACITY | V/C RATIO |
|---|---|---|---|---|---|---|---|
| 0001 | 000118 | 237 | 1810 | ALEX. KM8 TO KAFR EL DAWAR | 2787 | 3220 | 87.00% |
| 0002 | 000209 | 2203 | 2205 | BENI SUEF TO BEBA | 1601 | 2208 | 73.00% |
| 0003 | 000305 | 1354 | 1353 | EL-ABASSA TO EL-DAHRIA | 810 | 1788 | 45.00% |
| 0004 | 000401 | 1402 | 1761 | QANA.EL KHA. TO EZB. ABU YOUS | 1232 | 1920 | 64.00% |
| 0005 | 000507 | 1248 | 1254 | SHARKAWIA(MANS.) TO SANDOUB | 2029 | 2208 | 92.00% |
| 0006 | 000612 | 1309 | 1310 | ABU KEBIR TO FAQOUS | 829 | 2208 | 38.00% |
| 0007 | 000717 | 1880 | 1866 | DESAUQ BR. TO DAMANHOUR | 1182 | 2209 | 54.00% |
| 0008 | 000801 | 1601 | 1745 | ZIFTA TO BENHA BR. | 581 | 2208 | 26.00% |
| 0009 | 000906 | 1603 | 1602 | TANTA TO SANTA | 1278 | 1788 | 71.00% |
| 0010 | 001002 | 1304 | 1302 | ZAGAZIG TO BELBES | 1639 | 2208 | 74.00% |
| 0011 | 001107 | 1856 | 1881 | M.EL-MATROUH TO SADAT CITY ENT | 1530 | 3220 | 48.00% |
| 0012 | 001202 | 1204 | 1208 | TALKHA BR. | 963 | 2208 | 44.00% |
| 0013 | 001302 | 1309 | 1308 | ABU KEBIR TO KAFR SAQR | 621 | 1788 | 35.00% |
| 0014 | 001404 | 1302 | 1314 | BELBIES TO MASHTOUL EL SOUQ | 235 | 1788 | 13.00% |
| 0015 | 001503 | 1303 | 1405 | MINYA EL QAMH TO SH.EL QANATER | 357 | 1788 | 20.00% |
| 0016 | 001601 | 1706 | 1707 | SHEBIN EL KOM TO QUESNA | 499 | 2118 | 24.00% |
| 0017 | 001701 | 1858 | 1803 | EL-TAMPKIA/KHA. TO KOM HAMADA | 1178 | 1788 | 66.00% |
| 0018 | 001803 | 250 | 1815 | L.B.ALEX TO EDCO | 791 | 1788 | 44.00% |
| 0019 | 001901 | 2103 | 2102 | GIZA TO IMBABA | 601 | 2208 | 27.00% |
| 0020 | 002006 | 1883 | 1849 | EDFINA TO EL BOUSILY | 657 | 1788 | 37.00% |
| 0021 | 002101 | 1503 | 1605 | DESOOQ TO BASTUN | 419 | 1788 | 23.00% |
| 0022 | 002207 | 2203 | 2303 | BENI SUEF TO FAYOUM | 445 | 2208 | 20.00% |
| 0023 | 002304 | 1541 | 1574 | KAFR EL GARAIDA TO TOLOMBAT 4 | 352 | 1788 | 20.00% |
| 0024 | 002403 | 1708 | 1639 | BERKET EL SABE TO HAMOUN | 233 | 1788 | 13.00% |
| 0025 | 002505 | 1771 | 1703 | GHAMREEN TO MINOUF | 222 | 1788 | 12.00% |
| 0026 | 002602 | 1584 | 1502 | EL SHEEN TO QELLIN | 448 | 1788 | 25.00% |
| 0029 | 002901 | 1811 | 1810 | ABU EL MATAMEER TO KAFR EL DAW | 231 | 1744 | 13.00% |
| 0030 | 003001 | 1942 | 1312 | EL-FERDAN TO EL-SALHIA | 324 | 2208 | 15.00% |
| 0031 | 003101 | 1308 | 1317 | KAFR SAQR TO AWLAD SAQR | 281 | 1788 | 16.00% |
| 0032 | 003203 | 1311 | 1312 | EL KESANTA TO EL SALHIA | 453 | 1920 | 24.00% |
| 0033 | 003304 | 400 | 433 | SUEZ TO KM 109 CAIRO/SUEZ | 751 | 3220 | 23.00% |
| 0034 | 003401 | 1813 | 1804 | SHUBRAKHIT TO ITAY EL BAROUD | 234 | 1788 | 13.00% |
| 0038 | 003801 | 1208 | 1209 | TALKHA TO BELKAS | 223 | 2208 | 10.00% |
| 0039 | 003902 | 5139 | 1302 | HAIKESTEP TO BELBES | 982 | 3220 | 30.00% |
| 0040 | 004001 | 1847 | 1858 | EL-TAMPIAIA TO EL-TAMY. EL-KHA | 1095 | 2140 | 51.00% |
| 0041 | 004102 | 1743 | 1708 | BABEL TO BERKET EL SABA | 377 | 1788 | 21.00% |
| 0042 | 004201 | 1741 | 1701 | SENYRES TO ASHMOUN | 793 | 2118 | 37.00% |
| 0043 | 004301 | 1646 | 1605 | TANTA(2) TO FASTUN | 547 | 1788 | 31.00% |
| 0044 | 004411 | 1946 | 1904 | ABU SOLTAN TO FAIED | 975 | 2208 | 44.00% |
| 0045 | 004501 | 1501 | 1607 | KAFR EL SHEIEH TO MEHALLA EL K | 185 | 1788 | 10.00% |
| 0046 | 004602 | 2303 | 2305 | FAYOUM TO ITSA | 142 | 1788 | 8.00% |
| 0048 | 004802 | 2302 | 2301 | SENNOURES TO TAMIA | 73 | 1744 | 4.00% |
| 0049 | 004901 | 2303 | 2304 | FAYOUM TO ABSHAWAI | 194 | 1788 | 11.00% |
| 0052 | 005201 | 1810 | 260 | K.EL DAWAR TO KM20 ALX./RASHID | 12 | 1744 | 1.00% |
| 0053 | 005303 | 2206 | 2205 | SUMUSTA TO BEBA | 48 | 1788 | 3.00% |
| 0054 | 005406 | 2108 | 2101 | ASYUT TO SAFT | 853 | 2208 | 39.00% |
| 0055 | 005501 | 232 | 200 | MATROUH CON. TO ALEX. | 932 | 3220 | 29.00% |
| 0056 | 005601 | 2240 | 2206 | SIDS TO SUMUSTA | 8 | 1788 | 0.45% |
| 0057 | 005702 | 2542 | 2508 | QANATER ASTUT TO EL-SAHEL | 39 | 2208 | 2.00% |
| 0059 | 005901 | 2401 | 2402 | MAGHAGHA TO EL IDWA | 2 | 1788 | 0.11% |
| 0066 | 006605 | 435 | 3503 | EL SHATT TO RAS SEDER | 58 | 2208 | 3.00% |
| 0071 | 007102 | 2203 | 2239 | BENI SUEF BR. | 660 | 2208 | 30.00% |
| 0072 | 007203 | 1671 | 1607 | EL AYIDIA TO EL MAHALLA EL KU. | 372 | 2208 | 17.00% |
| 0073 | 007302 | 1244 | 1508 | TITRA TO BIYALA | 151 | 1788 | 8.00% |
| 0077 | 007703 | 3103 | 3139 | SAFAGA TO D.B.QENA-SAFAGA | 92 | 2208 | 4.00% |
| 0082 | 008202 | 1674 | 1604 | EDSHAT TO KAFR EL ZAYAT | 93 | 1788 | 5.00% |
| 0088 | 008802 | 3104 | 3140 | QUSEIR TO D.B.QIFT-QUSEIR | 23 | 1788 | 1.00% |
| 0099 | 009901 | 2801 | 2835 | IDFU BR. | 180 | 2208 | 8.00% |
| 0101 | 010102 | 5139 | 5138 | HAIKESTEP TO CAIRO/ISH. | 1818 | 6100 | 30.00% |
| 0103 | 010302 | 5141 | 454 | EL-KATAMIA TO EL-AIN EL-SOKHNA | 32 | 2208 | 1.00% |
| 0107 | 010701 | 1312 | 1937 | EL SALHIA TO EL KASASEN | 386 | 2208 | 17.00% |
| 0109 | 010902 | 300 | 1145 | PORT SAID TO EL DEEBA | 513 | 3220 | 16.00% |
| 0144 | 014401 | 1510 | 1509 | EL REYAD TO EL RAHOUL | 461 | 1788 | 26.00% |
| 0168 | 016801 | 1509 | 1549 | EL RAHOUL TO EBSHAN | 31 | 1788 | 2.00% |
| 0184 | 018401 | 1810 | 1859 | KAFR EL DAWAR TO MENIT EL-SAID | 171 | 1744 | 10.00% |
| 0194 | 019401 | 1602 | 1676 | EL SANTA TO SONBAT | 58 | 1788 | 3.00% |
| 0320 | 032003 | 2605 | 2642 | SOHAG BR. | 46 | 2208 | 2.00% |
| 0329 | 032901 | 2504 | 2542 | QANATER ASTUT | 96 | 1744 | 6.00% |
| 0490 | 049001 | 2604 | 2646 | GIRGINA TO BANAWEET | 7 | 1920 | 0.36% |
| 0712 | 071202 | 1248 | 1205 | SHARKAWIA(MANS.) TO DEKERNES | 703 | 1788 | 39.00% |
| 0747 | 074701 | 1211 | 1104 | MENIET EL NASR TO EL BARQA | 125 | 1788 | 7.00% |
| 0752 | 075201 | 1501 | 1510 | KAFR EL SHEIKH TO EL REYAD | 154 | 1788 | 9.00% |
| 0782 | 078201 | 1251 | 1104 | EL TANRI TO EL BARQA | 21 | 1788 | 1.00% |
| 0910 | 091002 | 431 | 435 | AHMED HAMDI TUNN. TO EL-SHATT | 143 | 2208 | 6.00% |
| 0912 | 091202 | 3403 | 3439 | EL HASANA TO BEIR TEMADA | 69 | 1788 | 4.00% |
| 0913 | 091305 | 3454 | 3439 | EL MAYELA TO BEIR TEMADA | 5 | 2118 | 0.24% |
| 0914 | 091401 | 3401 | 3444 | EL ARISH TO BEIR LAHFEN | 65 | 2208 | 3.00% |
| 0915 | 091504 | 452 | 3503 | KELTA TO RAS SEDR | 4 | 1788 | 0.22% |
| 0916 | 091601 | 3543 | 3505 | KFAREK EL TOR TO SAINT KATRIN | 9 | 1788 | 1.00% |
| 0917 | 091701 | 3449 | 3403 | MAFAREQ 156 ISH. TO EL HOSHA | 70 | 1788 | 4.00% |
| 0918 | 091802 | 3442 | 3455 | EL AOGA TO RAS EL NAQAB | 2 | 2208 | 0.09% |
| 0923 | 092301 | 1944 | 1951 | K112 CA./ISH TO ISH/SOK RD.ENT | 752 | 2208 | 34.00% |
| 0931 | 093102 | 2151 | 2106 | 6OCT.CON. TO BAHARIA OASIS | 31 | 2208 | 1.00% |
| 0934 | 093401 | 2609 | 2645 | EL MINSHAH TO MINSHAH CON. | 35 | 2140 | 2.00% |
| 0936 | 093601 | 2710 | 2758 | FARSHUT TO FARSHUT CON. | 13 | 2208 | 1.00% |
| 0937 | 093702 | 2743 | 2702 | NAG HAMADI BR. | 127 | 2208 | 6.00% |
| 0938 | 093801 | 2707 | 2748 | LUXOR FERRY | 71 | 1556 | 5.00% |
| 0940 | 094004 | 2803 | 2848 | NASSER TO NASSER CON. | 11 | 1744 | 1.00% |
| 0951 | 095101 | 1313 | 1360 | OBOUR CITY TO KM25 C\ISH.DES. | 61 | 2208 | 3.00% |
| 0952 | 095201 | 1401 | 1447 | SHUBRA EL KHEIMA TO SHARKAWIA | 1028 | 1788 | 57.00% |
| 0953 | 095303 | 2107 | 2152 | 6TH OCTOBER TO KM25 CAI\ALEX.D | 23 | 2208 | 1.00% |
| 0955 | 095501 | 5136 | 1401 | MOSTORD TO SHUBRA EL KHEIMSA | 156 | 4700 | 3.00% |
| 0956 | 095601 | 2144 | 2160 | EL MARASIK BR. | 1054 | 1788 | 59.00% |
| 0961 | 096101 | 1706 | 1770 | SHIBIN EL KOM TO SHAMOUFA | 164 | 1788 | 9.00% |
| 0971 | 097102 | 1315 | 1306 | EL IBRAHIMIA TO DIARB NIGM | 349 | 1788 | 20.00% |
| 0972 | 097201 | 1270 | 1271 | KEEF ABU KHALID TO SUNREGT KU. | 9 | 2208 | 0.41% |
| 0981 | 098101 | 1859 | 1801 | KAFR DAWOOD TO SADAT CITY | 75 | 2140 | 4.00% |
| 0982 | 098201 | 1802 | 1856 | WADI EL NATROUN TO W.NAT.CON. | 92 | 2208 | 4.00% |

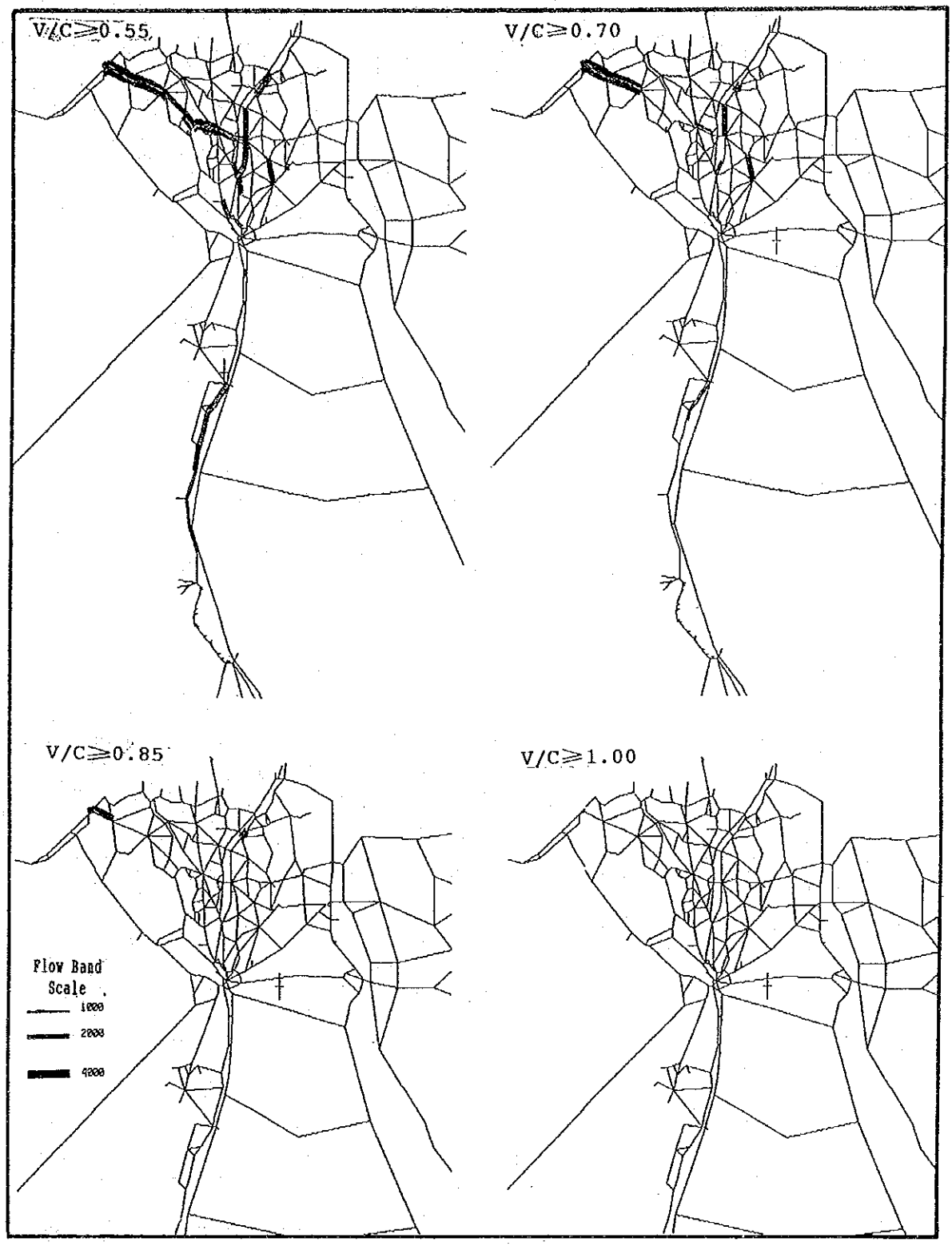



Fig. 14-3-2 Highway Link Overloading ,1992.

An overall evaluation of the loaded highway network has been carried out and is given in Table 14-3-2. The total links PCU-Km and PCU-Hr during the peak hour are 4.959 million and 77.056 thousands respectively. This yields an average running speed during the peak hour for all vehicle types equal to 64.35 km/hr. The total number of PCU trips assigned to the network was 44,340. Dividing the total PCU-Km and total PCU-Hr by the total number of PCU trips yield an average trip length equals 111.8Km and an average trip time equals 103.2 minutes in 1992.

Table 14-3-2 PCU-Km and PCU-Hr in the Base Year 1992 Network

| Level of Service | V/C Range | PCU-Km | (%) | Cum.(%) | PCU-Hours | (%) | Cum.(%) | Speed Km/Hr |
|---|---|---|---|---|---|---|---|---|
| A | 0.00-0.40 | 2,925,664 | 59.0 | 59.0 | 42,724 | 55.4 | 55.4 | 68.48 |
| B | 0.40-0.55 | 1,090,926 | 22.0 | 81.0 | 16,785 | 21.8 | 77.2 | 65.00 |
| C | 0.55-0.70 | 495,875 | 10.0 | 91.0 | 8,392 | 10.9 | 88.1 | 59.09 |
| D | 0.70-0.85 | 347,113 | 7.0 | 98.0 | 6,866 | 8.9 | 97.0 | 50.55 |
| E | 0.85-1.00 | 99,175 | 2.0 | 100.0 | 2,289 | 3.0 | 100.0 | 43.33 |
| Total | | 4,958,753 | | | 77,056 | | | 64.35 |

The 1992 network level of services, expressed as the percentages of the total network operating under different ranges of V/C, have been calculated and are as given also in Table 14-3-2. 59% of the distances covered on the network is running with a level of service A (V/C range is less than 0.40) i.e. almost with free running speeds, 22% with a level of service B (V/C equal 0.40-0.55), 10% with level of service C, and 7% with level of service D. Level of service F means that V/C ratio equals 1.0 or more, and that the links having V/C more than 1.0 will be subject to long queues and frequent stopping. The table shows also the percentages in PCU-Hr of the network operating with the same V/C ranges.

The level of service based on the volume over capacity ratio of the Egyptian inter city highway network is very good. A highway master plan development strategy should have this level of service in the future.

### 14.3.2 1992 Base Year Network in 2012 Do-Nothing Case

To estimate the drop of the level of service of the highway network accompanying the Do-Nothing case till the year 2012, i.e. to estimate the drop of the level of service, assuming that no additional capacity will be added to the highway network till the year 2012, an assignment run has been carried out using the 1992 highway network together with the 2012 OD matrix.

Table 14-3-3 presents the maximum link volumes on each of the routes of the inter city highway network obtained from the 2012 Do-Nothing assignment run. Most of the links having the higher traffic volumes have also a V/C percentages exceeding 100 i.e. having the worst level of service (level of service F). Some of these links are divided one-way links like Alex/Kafr El-Dawar, and the others are 2-lane two-way links like Zagazig/Belbes, Bani Mazar/ Maghagha, and Meet Ghamr/Zifta.

Fig. 14-3-2 presents the links having V/C ratios equal or more than 1.0, 0.85, 0.7, and 0.55 (equivalent to level of services F, E, D, and C respectively). The following roads show very high congestion (V/C more than 0.85).

- Cairo/Alexandria desert and agriculture roads,
- Cairo/Belbes/Zagazig/Mansoura, and
- the northern part of the upper Egypt road,

An evaluation of the 1992 network loaded with the 2012 total PCU'S predicted OD matrix has been carried out and is given in Table 14-3-4. The table shows that the total PCU-Km equals 14.4 million and the total PCU-Hr equals 318.8 thousands. Only 23% of the vehicles are running with level of service A + B while 45% are running with the worst level of services E + F. The average running speed for the level of service A equals 68.0 Km/Hr while that for level of service E+F equals 36.4 Km/Hr. Dividing the total PCU-Km by the total PCU-Hr yields the average running speed of 45.33 Km/Hr for all the vehicles running on the whole network. Dividing the total PCU-Km and the total PCU-Hr by the total number of the PCU'S trips (which equals 104,970 in the 2012 OD matrix) yields an average trip length equals 137.7 Km and an average trip time equals 182.5 Mins.

# Table 14-3-3 Route Maximum PCU's Volumes and V/C Ratios for the 1992 Network Loaded with 2012 Total PCU Matrix

| RT_COD. | LK_COD. | INNODE | OUTNODE | LINK_NAME | PCU'S | CAPACITY | V/C RATIO |
|---|---|---|---|---|---|---|---|
| 0001 | 000119 | 0200 | 0237 | ALEX. TO KM8 ALEX\CAIRO AGR. | 5240 | 3220 | 163.00% |
| 0002 | 000215 | 2403 | 2401 | BENI MASAR TO MAGHAGHA | 3947 | 2208 | 179.00% |
| 0003 | 000304 | 1354 | 1302 | EL-ABASSA TO BELBES | 1534 | 1788 | 86.00% |
| 0004 | 000403 | 1761 | 1741 | BEBET ABU YOUSSEF TO SENTRES | 2877 | 1920 | 150.00% |
| 0005 | 000518 | 1403 | 1447 | QALYUB TO EL-SHARKAWIA | 3037 | 1788 | 170.00% |
| 0006 | 000612 | 1309 | 1310 | ABU KEBIR TO FAQOUS | 1950 | 2208 | 88.00% |
| 0007 | 000717 | 1880 | 1805 | DESAUQ BR. TO DAMANHOUR | 2574 | 2208 | 117.00% |
| 0008 | 000803 | 1676 | 1671 | SOMBAT TO EL ASIUIA | 2942 | 2208 | 133.00% |
| 0009 | 000904 | 1201 | 1601 | MEET GHAMR TO SIFTA | 2761 | 2208 | 125.00% |
| 0010 | 001002 | 1304 | 1302 | ZAGAZIG TO BELBES | 4305 | 2208 | 195.00% |
| 0011 | 001107 | 1856 | 1881 | M.EL-MATROUH TO SADAT CITY ENT | 3679 | 3220 | 114.00% |
| 0012 | 001202 | 1204 | 1208 | TALKHA BR. | 2158 | 2208 | 98.00% |
| 0013 | 001302 | 1309 | 1308 | ABU KEBIR TO KAFR SAQR | 2131 | 1788 | 119.00% |
| 0014 | 001403 | 1305 | 1318 | ABU HAMMAD TO EL QURIN | 902 | 1788 | 50.00% |
| 0015 | 001502 | 1270 | 1303 | MEET ABU KHALID TO MINIA EL QA | 1821 | 1788 | 102.00% |
| 0016 | 001601 | 1706 | 1707 | SHEBIN EL KOM TO QUESNA | 1647 | 2120 | 78.00% |
| 0017 | 001701 | 1858 | 1603 | EL-TAWFEKIA/KHA. TO KOM HAMADA | 1963 | 1788 | 110.00% |
| 0018 | 001801 | 0200 | 0261 | ALIX. TO ALIX. (2) | 2499 | 2208 | 113.00% |
| 0019 | 001901 | 2103 | 2102 | GIZA TO IMBABA | 1382 | 2208 | 63.00% |
| 0020 | 002006 | 1883 | 1849 | EDFINA TO EL BOUSILY | 1653 | 1788 | 92.00% |
| 0021 | 002101 | 1503 | 1505 | DESOUQ TO BASYUN | 1213 | 1788 | 68.00% |
| 0022 | 002208 | 2370 | 2201 | NEW FAYOUM CON. TO BANI SUEF | 1894 | 2208 | 86.00% |
| 0023 | 002306 | 1603 | 1672 | TANTA TO SHABSHIR | 1774 | 3220 | 55.00% |
| 0024 | 002403 | 1708 | 1639 | BERKET EL SABE TO HAMOUN | 938 | 1788 | 52.00% |
| 0025 | 002502 | 1673 | 1705 | KAFR EL SHURAFA TO TALA | 1859 | 1788 | 104.00% |
| 0026 | 002602 | 1644 | 1502 | EL SHEEN TO QELLIN | 1823 | 1788 | 102.00% |
| 0029 | 002901 | 1811 | 1810 | ABU EL MATAMEER TO KAFR EL DAW | 739 | 1744 | 42.00% |
| 0030 | 003001 | 1942 | 1312 | EL-FERDAN TO EL-SALHIA | 904 | 2208 | 41.00% |
| 0031 | 003101 | 1308 | 1317 | KAFR SAQR TO AHLAD SAQR | 1042 | 1788 | 58.00% |
| 0032 | 003201 | 1311 | 1312 | EL HESANYA TO EL SALHIA | 1292 | 1920 | 67.00% |
| 0033 | 003303 | 0433 | 0449 | KM 109 TO KM 69.5 (CAIRO/SUEZ) | 2027 | 3220 | 63.00% |
| 0034 | 003401 | 1813 | 1804 | SHUBRAKHIT TO IYAT EL BAROUD | 647 | 1788 | 36.00% |
| 0038 | 003801 | 1208 | 1209 | TALKHA TO BELKAS | 775 | 2208 | 35.00% |
| 0039 | 003902 | 1302 | 5139 | BELBES TO HAIKESTEP | 3086 | 3220 | 96.00% |
| 0040 | 004008 | 2102 | 1443 | IMBABA TO EL MANASHI | 2278 | 2208 | 103.00% |
| 0041 | 004101 | 1705 | 1743 | TALA TO BASEL | 1505 | 1744 | 86.00% |
| 0042 | 004201 | 1741 | 1701 | SENTRES TO ASEMOUN | 1818 | 2120 | 86.00% |
| 0043 | 004301 | 1646 | 1605 | TANTA(2) TO PASYUN | 1557 | 1788 | 87.00% |
| 0044 | 004411 | 1946 | 1906 | ABU SOLTAN TO FAYED | 1943 | 2208 | 88.00% |
| 0045 | 004501 | 1501 | 1607 | KAFR EL SHEIKH TO MEHALLA EL K | 1322 | 1788 | 74.00% |
| 0046 | 004603 | 2303 | 2305 | FAYOUM TO ITSA | 740 | 1788 | 41.00% |
| 0048 | 004803 | 2302 | 2301 | SENNOURES TO TAMIA | 446 | 1744 | 26.00% |
| 0049 | 004901 | 2303 | 2304 | FAYOUM TO ABSHANAI | 914 | 1788 | 51.00% |
| 0052 | 005202 | 1867 | 1810 | ABIS TO KAFR EL DAWAR | 840 | 1744 | 48.00% |
| 0053 | 005302 | 2206 | 2402 | SUMUSTA TO EL IDWA | 1330 | 1788 | 74.00% |
| 0054 | 005405 | 2108 | 2101 | ATFIH TO SAFF | 3491 | 2208 | 158.00% |
| 0055 | 005516 | 3303 | 0231 | NEW AAMRIYA TO AAMREYA | 1515 | 2208 | 69.00% |
| 0056 | 005601 | 2240 | 2206 | SIDS TO SUMUSTA | 65 | 1788 | 4.00% |
| 0057 | 005702 | 2542 | 2508 | QANATER ASYUT TO EL-SAHEL | 1494 | 2208 | 68.00% |
| 0059 | 005901 | 2401 | 2402 | MAGHAGHA TO EL IDWA | 1300 | 1788 | 73.00% |
| 0066 | 006602 | 1935 | 1954 | EAST NG.6(ISM.EA.) TO B.KEBIYA | 241 | 2208 | 11.00% |
| 0071 | 007101 | 2203 | 2204 | BENI SUEF TO IHNASIA | 1173 | 1788 | 66.00% |
| 0072 | 007203 | 1671 | 1607 | EL ASIUIA TO EL MAHALLA EL KU. | 1550 | 2208 | 70.00% |
| 0073 | 007302 | 1244 | 1508 | TITRA TO BIYALA | 754 | 1788 | 42.00% |
| 0074 | 007401 | 1671 | 1672 | EL ASIUIA TO SHABSHIR | 104 | 1788 | 6.00% |
| 0077 | 007703 | 3103 | 3139 | SAFAGA TO D.B.QENA-SAFAGA | 1754 | 2208 | 79.00% |
| 0082 | 008202 | 1674 | 1604 | KOSMAT TO KAFR EL ZAYAT | 1528 | 1788 | 85.00% |
| 0088 | 008802 | 3104 | 3140 | QUSEIR TO D.B.QIFT-QUSEIR | 58 | 1788 | 3.00% |
| 0099 | 009901 | 2801 | 2835 | IDFU BR. | 226 | 2208 | 10.00% |
| 0101 | 010102 | 5139 | 5138 | HAIKESTEP TO CAIRO/ISM. | 5583 | 6100 | 92.00% |
| 0103 | 010301 | 5142 | 5141 | EL-MAADI TO EL-KAFAMIA | 634 | 2208 | 29.00% |
| 0107 | 010702 | 1937 | 1938 | EL KASASIN TO KM85 CAIR\ISM.D. | 1121 | 2208 | 51.00% |
| 0109 | 010902 | 1145 | 0300 | EL DEFBA TO PORT SAID | 1560 | 3220 | 48.00% |
| 0144 | 014402 | 1547 | 1510 | EL-SHALAKAN TO EL REYAD | 857 | 1788 | 48.00% |
| 0168 | 016801 | 1509 | 1549 | EL HAMOUL TO EBSHAN | 322 | 1788 | 18.00% |
| 0184 | 018401 | 1810 | 1850 | KAFR EL DAWAR TO MENIT EL-SAID | 1255 | 1744 | 72.00% |
| 0194 | 019401 | 1602 | 1676 | EL SANTA TO SOMBAT | 1060 | 1788 | 59.00% |
| 0320 | 032003 | 2606 | 2642 | AKHMIM TO SOHAG BR. | 1261 | 2208 | 57.00% |
| 0329 | 032901 | 2504 | 2542 | QANATER ASYUT | 1244 | 1744 | 71.00% |
| 0490 | 049001 | 2604 | 2646 | GIRGHA TO BANAWEET | 191 | 1920 | 10.00% |
| 0712 | 071202 | 1248 | 1205 | SHARKAWIA(MANS.) TO DEKERNES | 1173 | 1788 | 66.00% |
| 0747 | 074701 | 1211 | 1104 | MENIET EL NASR TO EL SARQA | 263 | 1788 | 15.00% |
| 0752 | 075201 | 1501 | 1510 | KAFR EL SHEIKH TO EL REYAD | 186 | 1788 | 10.00% |
| 0782 | 078201 | 1251 | 1104 | EL TAHRI TO EL SARQA | 39 | 1788 | 2.00% |
| 0910 | 091002 | 0431 | 0435 | AHMED HAMDI TUNN. TO EL-SHATT | 432 | 2208 | 20.00% |
| 0912 | 091202 | 3403 | 3439 | EL HASANA TO BEIR TEMADA | 38 | 1788 | 2.00% |
| 0913 | 091305 | 3454 | 3439 | EL NAKHLA TO BEIR TEMADA | 5 | 2120 | 0.24% |
| 0914 | 091401 | 3401 | 3444 | EL ARISH TO BEIR LAHFEN | 38 | 2208 | 2.00% |
| 0915 | 091504 | 0452 | 3503 | MELIA TO RAS SEDR | 5 | 1788 | 0.28% |
| 0916 | 091602 | 3550 | 3505 | FIRAN OASIS TO SAINTKATRIN | 24 | 1788 | 1.00% |
| 0917 | 091703 | 3449 | 3403 | KAFAREQ 156 ISM. TO EL HOSNA | 76 | 1788 | 4.00% |
| 0918 | 091803 | 3474 | 3455 | SAMANA TO RAS EL NAQAB | 2 | 2208 | 0.09% |
| 0921 | 092102 | 0451 | 0432 | EL SHATT CON. TO K18 SUEZ/ISM. | 97 | 2208 | 4.00% |
| 0927 | 092301 | 1944 | 1951 | K112 CA./ISM TO ISM/SUE RD.ENT | 844 | 2208 | 38.00% |
| 0931 | 093102 | 2151 | 2172 | 6 OCT.CON.TO GIZA\WAHAT 1 | 142 | 2208 | 6.00% |
| 0932 | 093204 | 3138 | 3101 | ABU RADD TO RAS GHARIB | 17 | 2208 | 1.00% |
| 0933 | 093301 | 2406 | 2440 | EL MINIA BR. | 436 | 3220 | 14.00% |
| 0934 | 093401 | 2609 | 2645 | EL MENSHAH TO MINSHAH CON. | 384 | 2142 | 18.00% |
| 0935 | 093502 | 2760 | 2761 | QANATER KAG HAMADI | 700 | 1744 | 40.00% |
| 0936 | 093601 | 2710 | 2758 | FARSHUT TO FARSHUT CON. | 146 | 2208 | 7.00% |
| 0937 | 093702 | 2743 | 2702 | KAG HAMADI BR. | 234 | 2208 | 11.00% |
| 0938 | 093801 | 2707 | 2748 | LUXOR FERRET | 283 | 1568 | 18.00% |
| 0939 | 093901 | 2709 | 2745 | QANATER ISNA | 41 | 1744 | 2.00% |
| 0940 | 094004 | 2803 | 2848 | NASSER TO NASSER CON. | 98 | 1744 | 6.00% |
| 0951 | 095101 | 1313 | 1360 | OBOUR CITY TO KM25 C\ISM.DES. | 2 | 2208 | 0.09% |
| 0952 | 095201 | 1401 | 1447 | SHUBRA EL KHEIMA TO SHARKAWIA | 4824 | 1788 | 270.00% |
| 0953 | 095303 | 2107 | 2152 | 6TH OCTOBER TO KM25 CAI\ALEX.D | 34 | 2208 | 2.00% |
| 0954 | 095402 | 1462 | 1745 | BENHA N.BR. TO BENHA | 6 | 2208 | 0.27% |
| 0955 | 095507 | 2103 | 5145 | GIZA TO MONIEB EAST | 1613 | 4700 | 34.00% |
| 0956 | 095601 | 2144 | 2160 | EL MARAEIK BR. | 809 | 1788 | 45.00% |
| 0959 | 095902 | 5142 | 5158 | EL MAADI TO 15 MAY | 1842 | 3220 | 57.00% |
| 0961 | 096103 | 1770 | 1771 | SHAMOUFA TO GHAMRERN | 219 | 1788 | 12.00% |
| 0971 | 097102 | 1315 | 1306 | EL IBRAHIMIA TO DIARB NIGM | 1068 | 1788 | 60.00% |
| 0972 | 097203 | 1270 | 1271 | MEET ABU KHALID TO SHEREET KU. | 510 | 2208 | 23.00% |
| 0981 | 098101 | 1859 | 1801 | KAFR DAWOOD TO.SADAT CITY | 116 | 2142 | 5.00% |
| 0982 | 098201 | 1802 | 1856 | WADI EL NATROUN TO W.NAT.CON. | 214 | 2208 | 10.00% |

Table 14-3-4 PCU-Km and PCU-Hr in the 1992 Highway Network Loaded with 2012 OD Total PCU Matrix

| Level of Service | V/C Range | PCU-Kilometers | (%) | Cum.(%) | PCU-Hours | (%) | Cum.(%) | Speed Km/Hr |
|---|---|---|---|---|---|---|---|---|
| A | 0.00-0.40 | 1,734,188 | 12.0 | 12.0 | 25,508 | 8.0 | 8.0 | 67.99 |
| B | 0.40-0.55 | 1,589,673 | 11.0 | 23.0 | 25,508 | 8.0 | 16.0 | 62.32 |
| C | 0.55-0.70 | 2,312,252 | 16.0 | 39.0 | 41,450 | 13.0 | 29.0 | 55.78 |
| D | 0.70-0.85 | 2,312,252 | 16.0 | 45.0 | 47,827 | 15.0 | 44.0 | 48.35 |
| E | 0.85-1.00 | 6,503,208 | 45.0 | 100.0 | 178,554 | 56.0 | 100.0 | 36.42 |
| Total | | 14,451,573 | | | 318,847 | | | 45.09 |

Comparing the level of service prevailing in 1992 with that of the Do-nothing alternative, 81% of the vehicles are running with a level of service A and B, compared only to 23% in the 2012 Do-Nothing alternative. The average running speed for 1992 base year for the overall network drops from 65.00 Km/Hr in the year 1992 to 45.32 Km/Hr in the 2012 Do-Nothing alternative. The average trip length and time in 1992 are 111.8 Km and 103.2 Mins compared to 137.7 km and 182.3 Mins in the 2012 Do-Nothing alternative, respectively. The average trip length has increased by 23.1%, while the average trip time has increased by 76.6%. This shows again that the level of service will drop tremendously if the Do-Nothing development alternative is adopted.

## 14.4 Optimum Level of Service for Future Highway Network

### 14.4.1 Theoretical Inter City Highway Network Development Alternatives for the Year 2012.

For the determination of optimum level of service for network improvement which maximizes the net benefit, an assignment run will be carried out for the Do-Nothing case with the network of the year 1992 and the vehicle flow matrices predicted for the year 2012. Upgrading alternatives required to cope with the increase of traffic with four different level of services of;

Alt. 1: Service Level E : Max. V/C of 1.00
Alt. 2: Service Level D : Max. V/C of 0.85
Alt. 3: Service Level C : Max. V/C of 0.70
Alt. 4: Service Level B : Max. V/C of 0.55

have been worked out. These four alternatives correspond to the four highway level of services E, D, C, and B respectively.

In the alternative-1, no link in the inter city highway network will have by the year 2012 a level of service less than E, i.e. a V/C ratio more than 1.00. In the alternative-2, no link in the network will have by the year 2012 a level of service less than D, i.e. a V/C ratio equal or more than 0.85. The alternatives-3 and 4 correspond to the level of services C and B, i.e. no link in 2012 will have a V/C ratio equal or more than 0.70 and 0.55 respectively.

Additional capacities through links upgrading projects to cope with the increase in the 2012 links predicted traffic volumes have been determined for each individual link. This exercise has been carried out for each link whose V/C ratio exceeds the level of service determined for each development alternative.

The alternative corresponding to the lowest level of service i.e. level of service E, has the smallest number of upgrading projects, while the alternative having the highest level of service, i.e. level of service B, has the largest number of upgrading projects.

### 14.4.2 Operational Evaluation for the Inter City Highway Network 2012 Theoretical Development Alternatives

Results of 2012 four assignment runs with the four development alternatives mentioned above, together with the 2012 Do-Nothing and the 1992 base year assignment runs result, are presented in Table 14-4-1.

The differences in the average trip lengths for the alternatives 4 to 1 compared to the Do-Nothing are 5.2, 5.2, 4.5, and 3.2 Km respectively. The increase of the difference with

the lowering of the level of service indicates that some inter city trips are forced for circuiting in the Do-Nothing and the low level of service alternatives.

Table 14-4-1 Results of Assignment Runs for the Base Year 1992 and the Different 2012 Highway Development Alternatives

| Descriptions | Base Year 1992 | Alt-4 | Alt-3 | Alt-2 | Alt-1 | Do-Nothing 2012 |
|---|---|---|---|---|---|---|
| 1 Link Length (Km) | 15,888 | 18,884 | 17,979 | 17,227 | 16,339 | 15,888 |
| 2 Upgrading Project No. | - | 81 | 53 | 41 | 36 | - |
| 3 Upgrading Project Km | - | 3,486.7 | 2,738.0 | 1,810.9 | 1,159.5 | - |
| 4 Peak Hour PCU's Trips | 44,340 | 104,970 | 104,970 | 104,970 | 104,970 | 104,970 |
| 5 Total PCU-Hr | 77,056 | 202,431 | 213,259 | 230,960 | 256,199 | 318,848 |
| 6 Total PCU-Km (x1000) | 4,959 | 13,905 | 13,910 | 13,987 | 14,123 | 14,452 |
| 7 Average Speed Km/Hr | 64.4 | 68.7 | 65.2 | 60.6 | 55.1 | 45.3 |
| 8 Average Tr. Time (Min) | 103.2 | 115.7 | 121.9 | 132.0 | 146.4 | 182.3 |
| 9 Average Tr. Length (Km) | 111.8 | 132.5 | 132.5 | 133.2 | 134.5 | 137.7 |
| 10 Average V/C % | 0.43 | 0.46 | 0.52 | 0.58 | 0.66 | 0.73 |
| 11 Percent of V/C | | | | | | |
| Level of Service A | 59 | 39 | 25 | 19 | 13 | 12 |
| Level of Service B | 22 | 35 | 31 | 22 | 16 | 11 |
| Level of Service C | 10 | 21 | 34 | 29 | 21 | 16 |
| Level of Service D | 7 | 4 | 9 | 23 | 30 | 16 |
| Level of Service E | 2 | 0 | 1 | 6 | 19 | 45 |
| 12 Preliminary Cost (M.LE) | - | 2,208.8 | 1,463.5 | 900.3 | 476.9 | - |

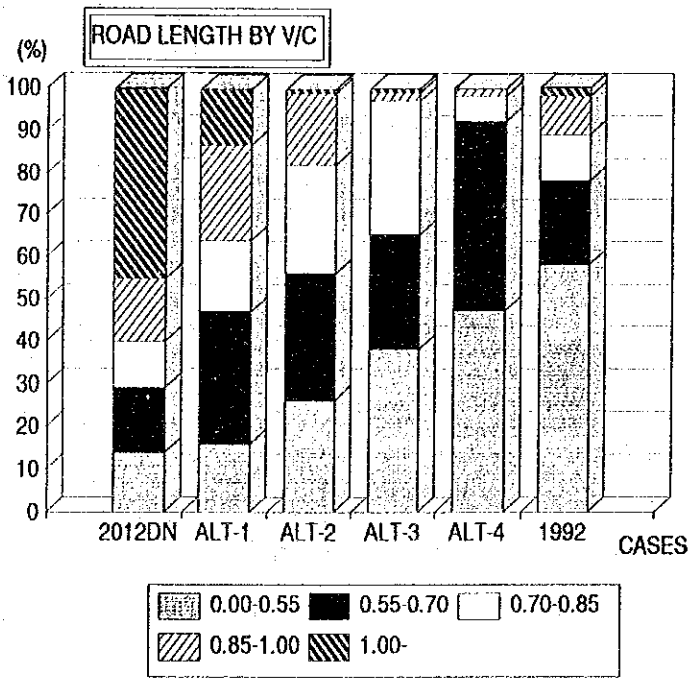



Fig. 14-4-1 Network Length Percent by V/C and Alternatives

The difference in the average speeds are 23.7, 20.2, 15.6, and 10.1 Km/Hr between the four alternatives from 4 to 1 and the Do-Nothing alternatives respectively. The rate of increase in the speed decreases with the raise of the level of service i.e. that the rate of increase of expenditure on highway upgrading is not linearly proportional to the rate of increase of the level of service induced by that expenditure. In other words the same expenditure induces higher improvement in the level of service in congested networks than in lightly loaded networks.

The percentage of the veh.-Km running with level of service A and B in the 1992 base year is more than that of the alternative-4 which has the highest number of upgrading projects. However, the average network speed by the 2012 alternative-4 equals 68.7 km/hr compared to 65.0 km/hr at the 1992 base year, shows that the alternative-4 has better level of service than that prevailing at the present time, even if the average V/C in the year 1992 is less than that of the level of alternative-4.

Fig. 14-4-1 shows big improvement in the level of service even for the alternative-1 with the least number of upgrading projects. The alternative-1 do not have any link with V/C ratio more than 1.00, and few links with V/C ratio equal or more than 0.85. The overloaded links are mainly along the Cairo/Alex, Cairo/Belbes, and Benha/Mansoura corridors. The alternative-2 has no link with V/C ratio more than 0.85, few links with V/C ratio equal or more than 0.7 and the overloaded corridors are still the same as the alternative-1. The same trend applies to the alternatives-3 and 4, but with higher level of service standards.

### 14.4.2 The Optimum Level of Service for Future Highway Master Plan Development Strategy

#### 1) Total Vehicle Operating Costs for the Different Highway Development Alternatives and VOC saving

The assignment runs give the loaded vehicle numbers in terms of PCU at the peak hour and the final speeds by link, therefore in order to calculate VOC by vehicle classification, the vehicle composition on a link was assumed based on the information of traffic counting. All the inter city highway network links are classified into three categories of;

(a) Primary Desert Road
(b) Primary Agriculture Road, and
(c) Secondary Agriculture road,

and into two further classifications by their locations of;

(a) Lower Egypt and
(b) Upper Egypt.

Totally six categories of vehicle compositions corresponding to the six link types are prepared to calculate the total VOC on the network. Table 14-4-2 shows the resulted VOC and other indices for the alternatives in the year 2012.

Table 14-4-2 Total VOC of 2012 Alternatives

| Case | Net Dist Km | PCUKM 1000PKm | PCUHR 1000PHr | VOC 1000LE | Av.Speed Km/h |
|---|---|---|---|---|---|
| 1.Do Nothing | 23376.0 | 13488.9 | 290.5 | 6659.3 | 58.8 |
| 2.Alt.1(V/C 1.00) | 21986.5 | 13289.4 | 236.3 | 6196.4 | 61.7 |
| 3.Alt.2(V/C 0.85) | 21853.5 | 13103.3 | 214.9 | 5984.0 | 63.8 |
| 4.Alt.3(V/C 0.70) | 21764.5 | 13055.1 | 206.5 | 5910.3 | 64.6 |
| 5.Alt.4(V/C 0.55) | 21844.5 | 13019.2 | 197.0 | 5829.4 | 65.5 |

2) Construction Costs

Table 14-4-3 includes a preliminary cost estimate for the upgrading alternatives based on the length of the route section and the current(1992) prices per kilometer run. In order to avoid the influence by the implementation schedule of each improvement project in this stage, this construction cost will be then converted to a single year investment in the year 2012, by the following formula, assuming the growth rate curve with a rate of 5.1% same as GDP growth rate.

$$CN = TC \times (1+i)^n / (1+\Sigma(1+i)^{n-1}))$$

where CN : annual investment in (n)th year
TC : total investment
i : annual interest rate (5.1%)
n : investment period (20 years)

The cost calculated by this formula is given also in Table 14-4-3 and represents the annual investment in terms of the present value, if all the costs will be invested in accordance with an economic growth rate, and will give the preliminary net benefit in the last year of the study period.

3) The Optimum Level of Service for Future Highway Development Strategy

To calculate annual net VOC saving, the peak hourly VOC is converted to the annual VOC applying 330 working days a year. An assignment run gives only peak hour traffic flow, and no VOC saving comparing to Do Nothing case is expected for off peak hours, so that 4 hours in a working day to generate VOC saving is assumed in the VOC saving calculation.

Table 14-4-3 shows the calculation results. The annual net benefit (Benefit - Cost) of Alt.4 (V/C 0.55) is the highest, however the increment of annual VOC saving between V/C 0.70 case and 0.55 case is smaller than that of V/C 0.85 and 0.70

cases, while the increment of annual investment in these cases is increasing as seen in Fig. 14-4-2. Accordingly the maximum net benefit was calculated by two regression formulas of annual savings and annual investments by V/C ratio, and the maximum net benefit was estimated at 818.3 M.LE at V/C ratio of 0.62, which is defined as the optimum level of service.

Table 14-4-3 2012 Annual Net Benefit of 2012 Alternatives

| CASE | | | VOC | | ANNUAL 4 Hrs | COST | | ANNUAL NET |
|---|---|---|---|---|---|---|---|---|
| NET | OD | V/C | HOURLY (1,000LE) | ANNUAL (MLE) | SAVING (MLE) | TOTAL (MLE) | ANNUAL (MLE) | BENEFIT (MLE) |
| 1992 | 2012 | | 6,659.3 | 8,790.3 | | | | |
| 2012 | 2012 | 1.00 | 6,196.4 | 8,179.2 | 611.0 | 803.6 | 65.0 | 546.0 |
| | 2012 | 0.85 | 5,984.0 | 7,898.9 | 891.4 | 1,517.1 | 122.8 | 768.6 |
| | 2012 | 0.70 | 5,910.3 | 7,801.6 | 988.7 | 2,466.0 | 199.6 | 789.1 |
| | 2012 | 0.55 | 5,829.4 | 7,694.8 | 1,095.5 | 3,721.8 | 301.2 | 794.3 |

Annual Growth Rate of Investment =5.1%
B=-676.30*V/C^2+1321.873 M.LE/YEAR (R2=0.96)
C=V/C^(-2.5161)*73.703 M.LE/YEAR (R2=0.97)
MAX(B-C)=818.3 M.LE at V/C=0.64

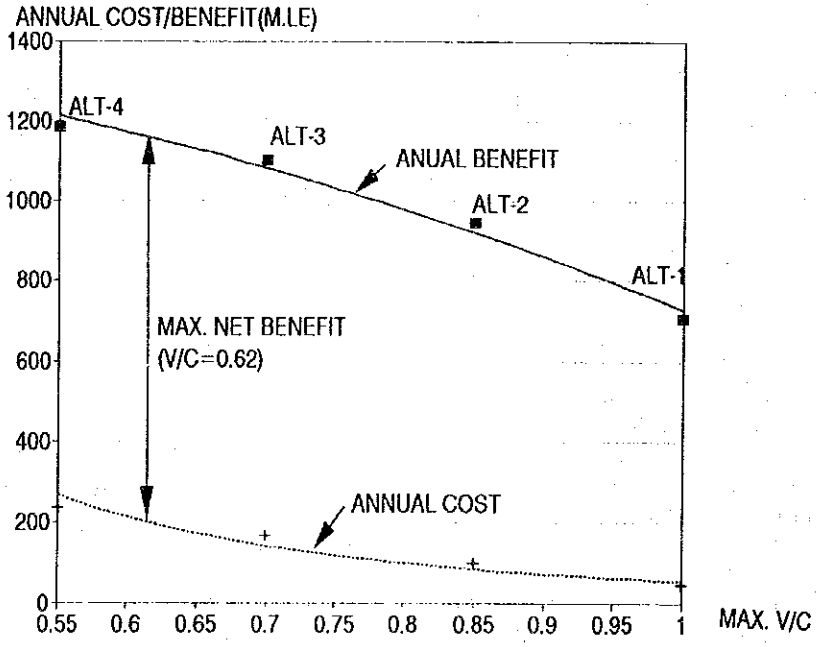



Fig. 14-4-2 Annual VOC Saving and Annual Investment by V/C