4. TRAFFIC CONDITIONS AND CARGO TRANSPORTATION IN THE STATE OF PIAUÍ

4. TRAFFIC CONDITIONS AND CARGO TRANSPORTATION IN THE STATE OF PIAUÍ

4.1 Transportation in the State of Piauí

The state of Piauí is one of the largest Northeastern states. Having the most natural resources available it can create conditions and opportunities to change this large potential into development. Despite the potential, the state of Piauí relies a lot for its provisions and living necessities on other states with the help of transporting services, such as trucks, railways, etc.

Teresina, its capital, is placed on the right margin of the Parnaíba river, at the confluence with the Poti river, a convenient location because it comprehends one of the biggest highway and railway junctions with also airplane, metro and small ferry boat services. However finding a good transportation mode in the South-West region of State, especially in areas away from the principal roads, is difficult.

Piauí has no ports facing to the Ocean, and therefore the gate ways for imports and exports are at Fortaleza, Itaqui, Recife, Salvador and other principal ports. Roads connect Teresina and other cities to all ports in order to transfer cargoes. Railroads connect Teresina to Itaqui and Fortaleza.

There are four bridges across the Parnaíba river. One exists at Parnaíba city and two exist at Teresina city, with the remaining one at Floriano city. Truck transportation from Piauí to Maranhão or beyond Maranhão has to be made via these bridges.

Piauí is rich in natural resources and there are factories to process agricultural products. The problem, however, is that delays in the development of the Southwest have caused difficulties in increasing their cropping area and harvest, because of the poor transporting methods. Before the construction of the dam, there was river transport to carry these goods.

Accordingly, the Parnaiba river basin can be divided into three zones considering the present traffic conditions (see Figs 4.1.1 and 4.1.2 for the present conditions of the traffic network in the State of Piauí and the zoning of the river, respectively).

Zone-1, from Luiz Correia to Teresina : This is one of the most developed area and all kinds of transportation modes are concentrated - railway, road and river navigation will compete with each other.

Zone-2, from Teresina to Floriano : Road transports will compete with transport by river navigation.

Zone-3, from Floriano to Santa Filomena : There is poor access to the upper region from Floriano. There is the possibility to make access to Carajas by railway through the Balsas.

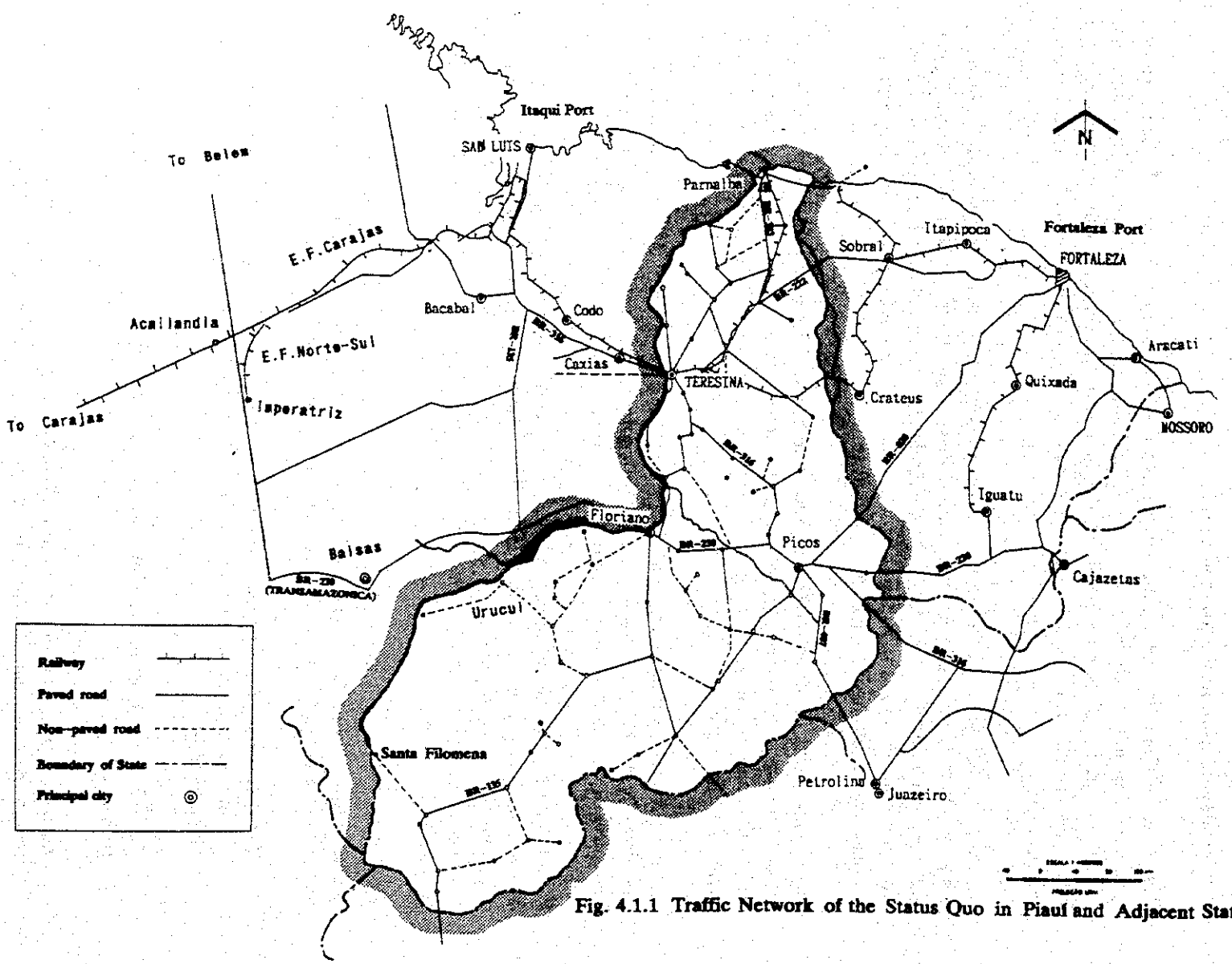
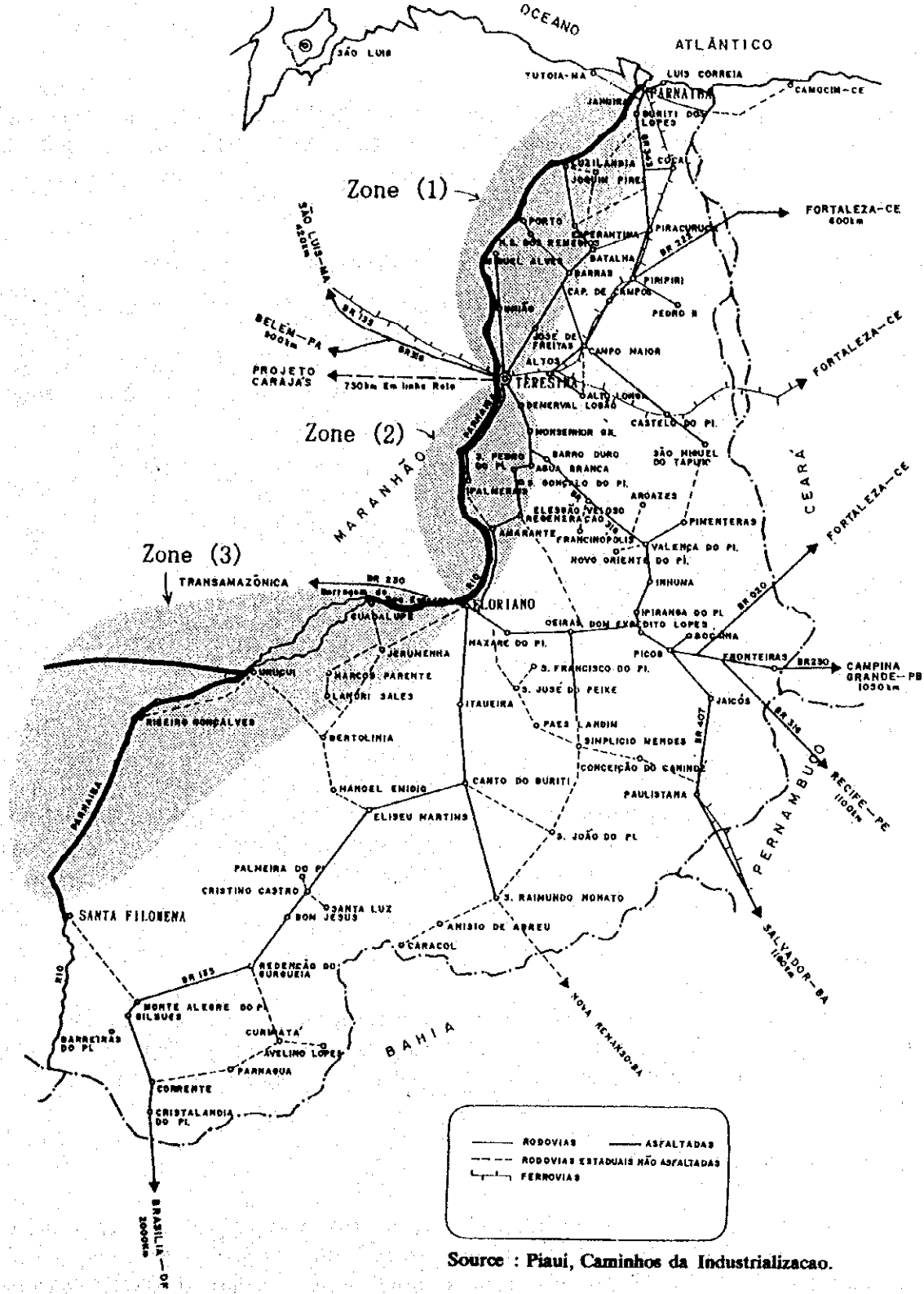


Fig. 4.1.1 Traffic Network of the Status Quo in Piauí and Adjacent State



Source : Piauí, Caminhos da Industrializacao.

Fig. 4.1.2 Outline of Transportation in the State of Piauí

4.2 Outline of Each Transport Mode

(1) Railway Transport

The railway system is operated by Rede Ferroviaria Federal SA (RFFSA) which divides it's 12 regions into SR-1 to SR-12 throughout the area of Brazil. The states of Piauí and Maranhão are affiliated with SR-12 and controlled under São Luis. Major commodities treated and passing Teresina are shown in the following Table 4.2.1.

Table 4.2.1 Major Commodities Transported by Railway

Unit : Ton

Commodity	From	To	1989	1990	1991	1992	1993	Freight US$/T-km
Asphalt	Fortaleza	Teresina	-	12,469	17,235	19,963	8,545	0.028
Cement	Ceara, Maranhao	Teresina	45,385	48,420	49,547	30,576	35,623	0.016
Fuel Oil	Fortaleza	Teresina	23,652	24,679	26,127	20,786	23,151	0.034
Petroleum	Fortaleza	Teresina	178,889	189,842	189,950	201,800	179,541	0.037
Ceramics	Teresina	São Luis	14,821	11,030	7,215	917	3,257	0.009
Iron Scrap	Teresina	Fortaleza	358	199	618	850	2,392	0.012
Rice	Maranhão	Fortaleza	11,177	2,193	2,730	-	-	0.016
Pig Iron	Maranhão	Recife	61,711	43,886	54,558	66,629	75,806	0.011
Animal Feed	Maranhão	Fortaleza	4,244	2,958	3,878	1,650	1,650	0.014
Corn	Fortaleza	São Luis	4,548	84	10,368	6,174	1,015	0.014

Source : RFFSA

(2) Road Transport

The roads constitute the main transport alternative in the State. They link all the regions in all directions and connect the farthest cities and settlements, beyond linking Piauí to neighboring States and to the rest of Brazil. All federal roads are paved with asphalt, except for some stretches. From the data, the total length of the paved roads was 240 km in 1970, which was extended to 1,800 km in 1980 and to 2,300 km in 1991.

(3) River Transport

Present river transport on the Parnaíba river basin is carried out for tourism at the delta and for general service between Parnaíba and Luzilandia. River transporting services and slipways for loading and unloading can be observed in major cities along the Parnaíba river basin.

(4) Harbor Transport

Luiz Correia Port located at the mouth of the Igaracu river was planned to be constructed as the Gateway port of the state of Piauí. However, the successive construction was postponed in 1989. The State of Piauí then entrusted INACE (Industrial Naval do Cearra S.A.) with one berth construction for their own use. The construction, however, was again suspended due to the financial problems of INACE. No further construction plan is available at this moment (see Fig. 4.6.1 for the present condition of Luiz Correia Port).

(5) Other Related Transportation

1) Fortaleza Port

Fortaleza port is located in the state of Ceara, about 650 km away from Luiz Correia port. Principal commodities in this area, such as carnauba wax, animal skin, leather, clothes and so on are almost all transported by truck from Piauí to Fortaleza Port and then exported to USA, Europe and Asia. At the same time, major commodities transferred from Fortaleza to Piauí were petroleum products, cement and flour. Petroleum products are transported by rail.

2) Itaqui Port

Itaqui port is located in the municipality of São Luis, capital of Maranhão. The main exported cargo commodities are aluminium ingot (USA, Europe), pig iron (USA, Europe), manganese (Japan, Europe) and Soybean. The port is a terminus of the Carajas Railway described below.

3) Carajas Railway

The Carajas railway that links the mines of Carajas to Maranhão harbor, also transports a small quantity of soy beans produced along the route.

4.3 Transport Costs

CESP in São Paulo shows river transportation costs on the Tiete river and the Parnaíba river. Comparative transportation costs of waterway, railway and highway are US$ 0.012 ton-km, US$ 0.025 to 0.036 ton-km and US$ 0.030 to 0.050 ton-km in the Tiete river, respectively. The transfer cost is US$ 2.0/ton. Table 4.10.2 shows the comparative transportation costs of waterway, railway and highway. Transfer costs in Table 4.10.2 were obtained from CESP.

Table 4.10.2 Transport Cost Comparative Table (Agricultural Products)

Unit : US$/ton-km
Unit for transfer: US$/ton

Location	Products	Waterway	Railway	Highway	Transfer
Piauí	Rice	-	0.016	0.008 - 0.061	-
	Flour	-	-	0.012	-
	Fejon	-	-	0.013	-
	Corn	-	0.014	-	-
Tiete	Average	0.012	0.031	0.040	2

Souce : JICA Study Team

4.4 Necessity and Condition of River Transportation

(1) Geographically, the State of Piauí lays North-South along a long narrow corridor, while the major highways run East-West and make no contribution to the southwest regions of the State. Resuming of river transportation is necessary for the improvement of the upper Parnaíba region.

(2) Resuming of river transportation would be useful for the development of the upper Parnaíba region because there is no good access to the upper Parnaíba region from Floriano. It would supply cheap transportation by carrying agricultural products downstream from the upper region, while fertilizers, feeds and salt would be carried upstream.

(3) Transport methods in most of the enterprises are fixed. To attract cargo demands, river transport is required to be cheap, safe and reliable.

5. AGRICULTURAL CONDITIONS IN THE STATE OF PIAUÍ

5 AGRICULTURAL CONDITIONS IN THE STATE OF PIAUÍ

5.1 General

The agricultural sector plays an important role in the Piauí state economy, contributing with 19 % to the gross domestic product (GDP) and employing 60 % of the total labor force. However its relative contribution to the GDP has declined in the last decade dropping from 23.5 % in 1970 to 19.0 % in 1987, whereas the service and the industrial sectors contributed with 57.6 % and 23.4 % respectively in the latter year. The State Government still places a high priority on the agricultural sector, on which the majority of the state's large rural population depends as the main source of employment, income and livelihood. Taking into account its agricultural potential, water resources, land potential for agricultural use and labor force, the Piauí state has planned to promote the economy of rural areas through agricultural development.

Among the temporary cultures - the most significant in economic terms - there are six outstanding agricultural products: rice, beans, cotton, corn, cassava and sugar cane, and recently, soybeans. Among the features of the State's agriculture it can be mentioned that it depends largely on small scale agriculture, has very low productivity and is mainly carried out in the form of subsistence agriculture. Thus, it is possible to increase agricultural production through the improvement of agricultural techniques.

5.2 Government's Agricultural Sector Development Policy

The State Government development strategy stresses rural and regional development, aiming at the promotion of the State's social and economic development, through economic growth, creation of employment, reduction of the illiteracy level, improvement of health, education and sewage services. In the agricultural sector the main objective is to achieve regional development, especially in the south and southwest parts of the State considering their meagre agriculture and their natural potential. Specific objectives in this sector are: to incorporate 400,000 ha defined by the State's land to the productive land, to extend temporary cultivation agriculture and promote perennial cultures on the Southwest of the State, to establish an agro-industrial complex in the Gurgueia-Floriano region, considering the existing agricultural potential associated with the irrigation project, and to enlarge essential physical infrastructure for development (roads, energy, communications and silo).

In the State of Piauí, there is about 117 million ha of potential area for the development, of which only 11.7 million ha has been developed. As the southern area of the upper Parnaíba is not well developed, the state government has adopted policies of investments in agricultural activity, tax exemption, financial support for electricity consumption, etc., all to promote the agriculture development in the private sectors. Even with such strategic policies by the State Government, the area has so far suffered from a lack of road networks making transport difficult and increasing relevant costs. As a consequence, growth in agricultural productivity has been restricted both in terms of its quantity and efficiency.

5.3 Agricultural Sector Performance

Agriculture carried out in the State of Piauí consists mostly of subsistence agriculture; main crops are rice, corn, beans, cassava and cotton. The farming area in the State of Piauí is indicated in the Table 5.3.2. However, recently, the production of rice and soybean, which is carried out by enterprises, has increased, especially in the upper stream portion of the Parnaíba river.

The soybean production in the State began in 1988, increased to 10,409 tons in 1994 and continues growing. The southwest part of the State presents itself as a rice producer, especially Ribeiro Gonçalves city, with 34,263 tons and Urucui with 25,150 tons. The larger production is the result of the Tax policy applied by the State Government, through which large agricultural and cattle raising projects were implanted. Rice cultivation has been carried out under seasonal planting, with results better than expected. Having been diagnosed as such productive activities, the area still has some burden from the lack of road transport. A great leap in the productivity is expected by provision of sufficient transport facilities, and in particular by road networks.

Table 5.3.2 Cultivated Area

(Unit : 1,000 ha)

Culture	1985	1986	1987	1988	1989	1990	1991
Corn	363.4	444.2	363.8	455.7	428.3	394.7	418.2
Beans	277.9	316.3	261.0	337.2	276.1	270.0	282.6
Beans	16.5	15.5	12.1	15.2	13.5	14.6	11.5
Rice	198.6	240.1	209.6	249.0	238.2	221.1	258.2
Paddy	11.5	12.5	12.6	14.2	14.5	14.2	15.1
Cassava	66.9	120.7	157.7	137.1	142.3	166.4	159.7
Cotton	212.0	218.8	197.6	204.3	183.0	140.0	109.6

(Source: State Secretary of Agriculture, Piauí)

5.4 Characteristics of the Agricultural Sector

At present, the cropping area of the State of Piauí is about 11,828,000 ha exploited by about 270,000 families. The agriculture of the Stateof Piauí is classified into two types; subsistence agriculture, predominating in the lower reach of the Parnaíba river and entrepreneurial type in the upper area. Entrepreneurial agriculture was introduced recently because of the State incentive policy, natural conditions and reasonable land price. However, due to the lack of transportation facilities, the agricultural land expansion is stagnating.

5.5 Estimation of Agricultural Production Volume

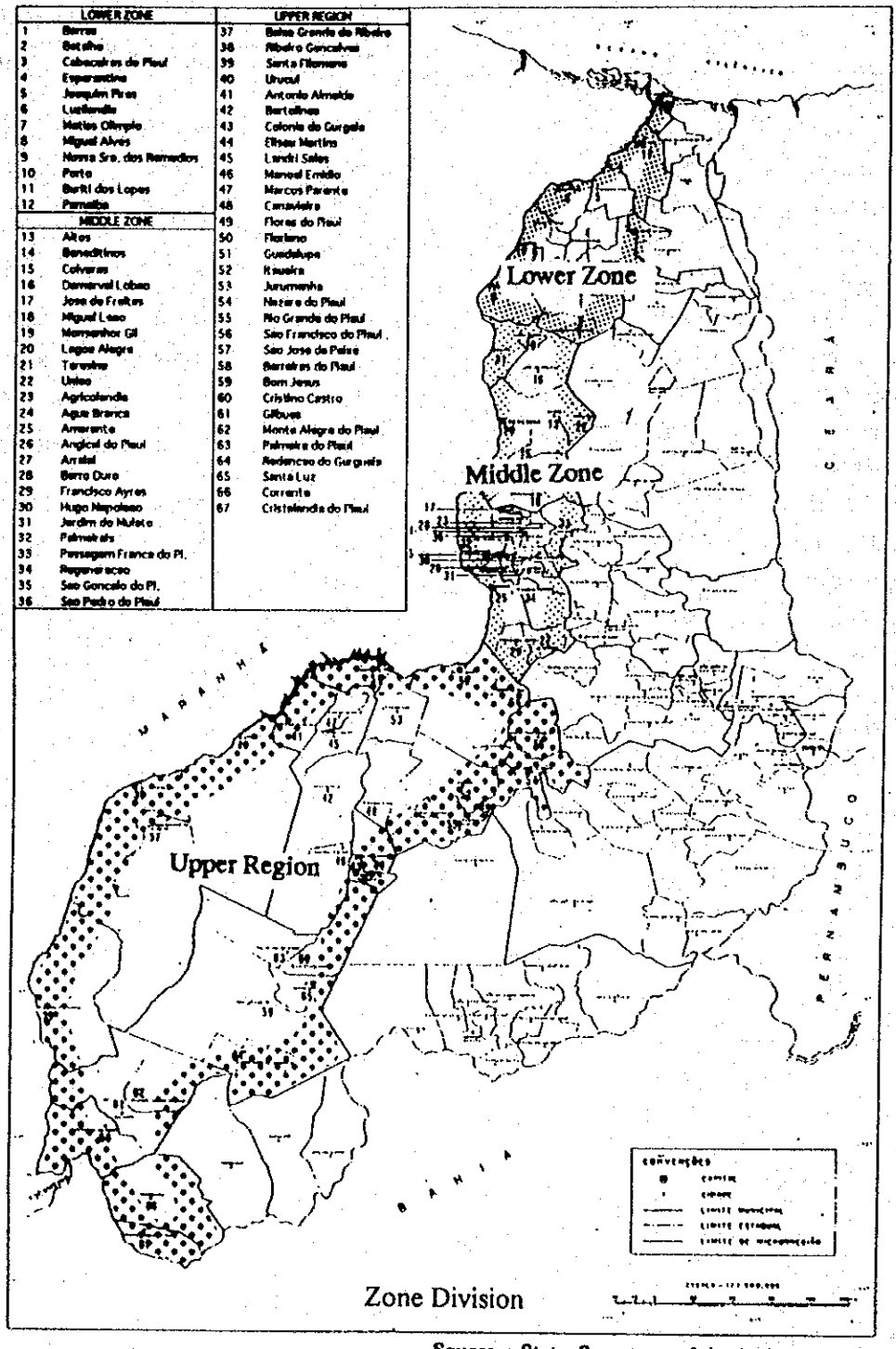
Estimated production volumes in the Parnaíba basin that were provided by the State Government are shown in Table 5.5.1. (See Fig.5.5.1 for divisional zoning.) Projected annual growth rates for each crop are 12.7 % for rice, 14.0 % for corn, 15.9 % for Feijão beans and 26.9 % for Soybeans.

Table 5.5.1 Estimated Production Volume

Unit : Ton

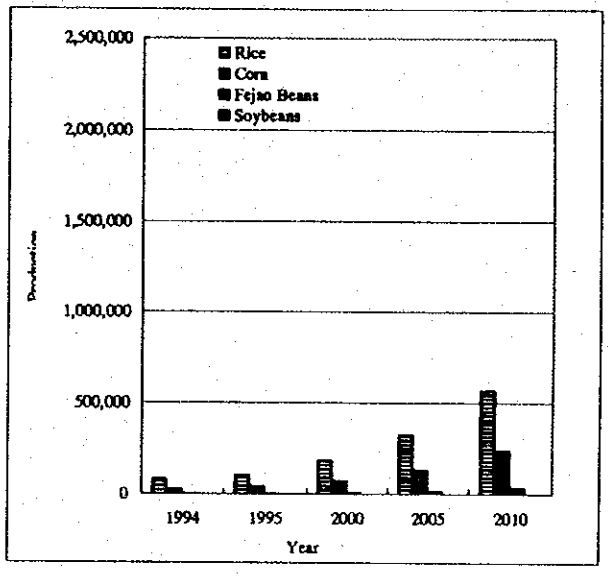
	1994	1995	2000	2005	2010
Rice					
Lower Zone	81,737	101,255	185,579	325,693	567,716
Middle Zone	74,526	92,323	169,208	296,959	517,628
Upper Zone	147,380	182,575	334,627	587,271	1,023,673
TOTAL	303,643	376,153	689,414	1,209,923	2,109,017
Corn					
Lower Zone	29,754	41,259	74,006	134,616	240,694
Middle Zone	30,567	42,390	76,036	138,309	247,295
Upper Zone	76,253	105,739	189,665	345,000	616,825
TOTAL	136,574	189,388	339,707	617,925	1,104,814
Feijão Beans					
Lower Zone	3,093	3,748	9,561	17,918	32,919
Middle Zone	3,003	3,641	9,286	17,403	31,972
Upper Zone	7,727	9,370	23,903	44,801	82,309
TOTAL	13,823	16,759	42,750	80,122	147,200
Soybeans					
Upper Zone	10,409	22,840	94,226	234,434	471,516
TOTAL	10,409	22,840	94,226	234,434	471,516

(Source: State Secretary of Agriculture, Piaui)

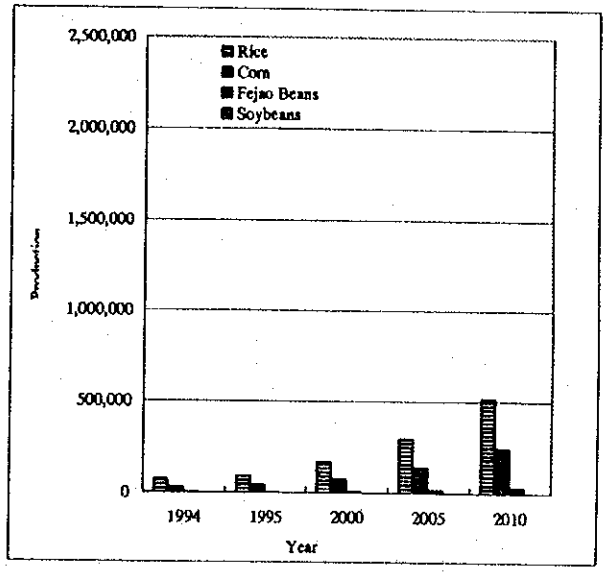


Source : State Secretary of Agriculture, Piaui

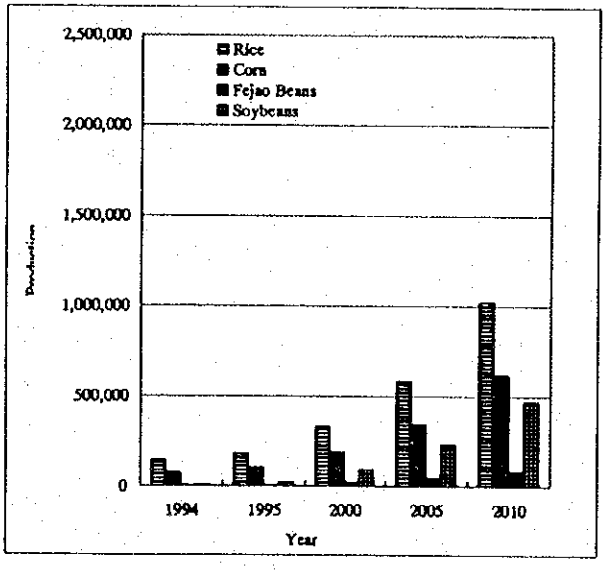
Fig. 5.5.1 Zone Division



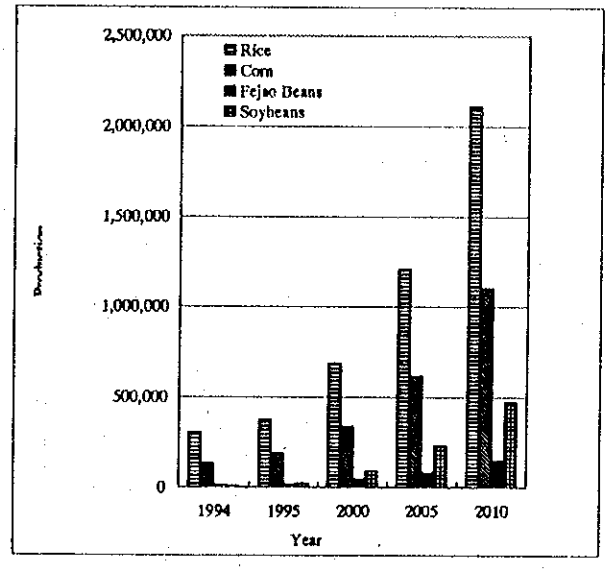
Lower Zone - Estimated Production



Middle Zone - Estimated Production



Upper Zone - Estimated Production



Parnaí ba River - Estimated Production Volume

Source : State Secretary of Agriculture, Piaui

Fig. 5.5.2 Estimated Production

6. DEMAND FORECAST

6. DEMAND FORECAST

6.1 Peculiarities of the Brazilian Economy

When the civil government assumed power in 1985, the economy was in a state of collapse due to a foreign investment crisis brought by the former military government's excessive growth policies in disregard of international economic realities during its final stages. Price inflation, which the citizens had lived with until then, was also running rampant. In order to solve these problems, the focus of economic policies since 1985 has shifted diametrically from development-oriented to stability-oriented, as each of the administrations holding the power--the Sarney Administration (1985-1989), the Collor Administration (1990-1992) and the interim administration of Acting President Franco (1992-Present)--have embarked on bold courses of comprehensive economic policies intended primarily to control inflation.

The measures implemented by these administrations in a process of trial and error include price policies, wage policies, issuing new denominations of currency as a banking and foreign exchange policy, administrative reforms and tax reforms. On some occasions they have even resorted to the drastic measure of freezing citizens' bank accounts to curb inflation and induce stable growth.

As shown in Table 6.1.1, economic plans were enacted at a bewildering pace. The plans provided some short-term symptomatic relief, but they fell short of accomplishing their intended results. As of mid 1994, the inability to attain monetary stability remains a prevailing characteristic of the Brazilian economy, as Table 6.1.2 illustrates.

Table 6.1.1 Economic Stability Plans Since Civil Government was Established

Policy's Common Name	Date of Enactment
Sarney Administration	
(1) Cruzado Plan	February 28, 1986
Second Cruzado Plan (Moratorium Proclamation)	November 21, 1986 (February 20, 1987)
(2) Bressel Plan	June 12, 1987
(3) Summer Plan	December 4, 1988
Collor Administration	
(4) Collor Plan	March 16, 1990
Second Collor Plan	January 31, 1991
Franco Interim Administration	
(5) Real Plan	July 1, 1994

Source: Encyclopedia of Brazil's Economy

Table 6.1.2 The Brazilian Economy's Rate of Price Inflation

unit : (%)

1988	1989	1990	1991	1992	1993
993	1,864	1,585	475	1,200*	2,700*

Source: Encyclopedia of Brazil's Economy *Estimated Values by JICA Study Team

The extreme rates of price inflation shown above have inevitably influenced commercial activities. In other words, in setting the market price for a product, it becomes an essential factor to consider the required period until the sale, in addition to such factors as production cost, distribution cost and profit margin. This leads to an abnormal situation, where the time element becomes dominant overall in the sale, and disregard of the optimal value of distribution costs following the theory on economy of transport. This abnormal situation currently prevails in Brazil and it is exerting a significant influence on the allocation of cargoes among the means of transport in the domestic distribution system.

In addition to contradicting the economic theory that producers seek to maximize profit margin by minimizing distribution costs, this situation also results in a difficulty in determining theoretical values for the optimal allocation of cargoes among the different means of transport in product distribution.

6.2 Scenario of the River Transport

Conceivable river transport scenarios are shown in Fig. 6.2.1 through 6.2.3. Scenario 1 is a coherent navigation plan from Santa Filomena, located in the far upstream region to the port of Luiz Correia, located at the river's mouth. Scenario 2 contemplates the transport from Santa Filomena to Teresina, which is the state capital and the largest consumer market. Scenario 3 is the plan from Santa Filomena to Floriano, where existing roads will be used to transport cargoes.

6.3 Demand Forecast Method

(1) General

As previously stated in 6.1, the peculiarities of cargo allocation among the modes of transport in the domestic distribution system make it very difficult to apply general analysis methods based on theory of the economy. Consequently, the analytical approach was inclined to a cumulative forecasting method based on the present and future conditions of the transport infrastructure in each zone of the river and its surrounding coastal region.

The agricultural products potentially expected in the Balsas river basin region in the future, particularly soya beans as a prospective candidate for an export product, should be transported by land to Carolina and to Inperatriz for a time. Even in a longer term future, they will be better exported from Itaqui by the Carajas Railway via the North-South Railway, rather than by the navigation in the Balsas river. Establishment of this transport route will not only make the Carajas Railway, whose construction required a massive investment of capital, more economically viable, but also be economically beneficial from the national point of view.

(2) Products to be Transported by the River Transport

The products of Piauí expected in the future, are the agricultural ones as predicted in Chapter 5. Large scale agricultural development is especially anticipated for the southwest part of the state, a coastal region of the Parnaíba river.

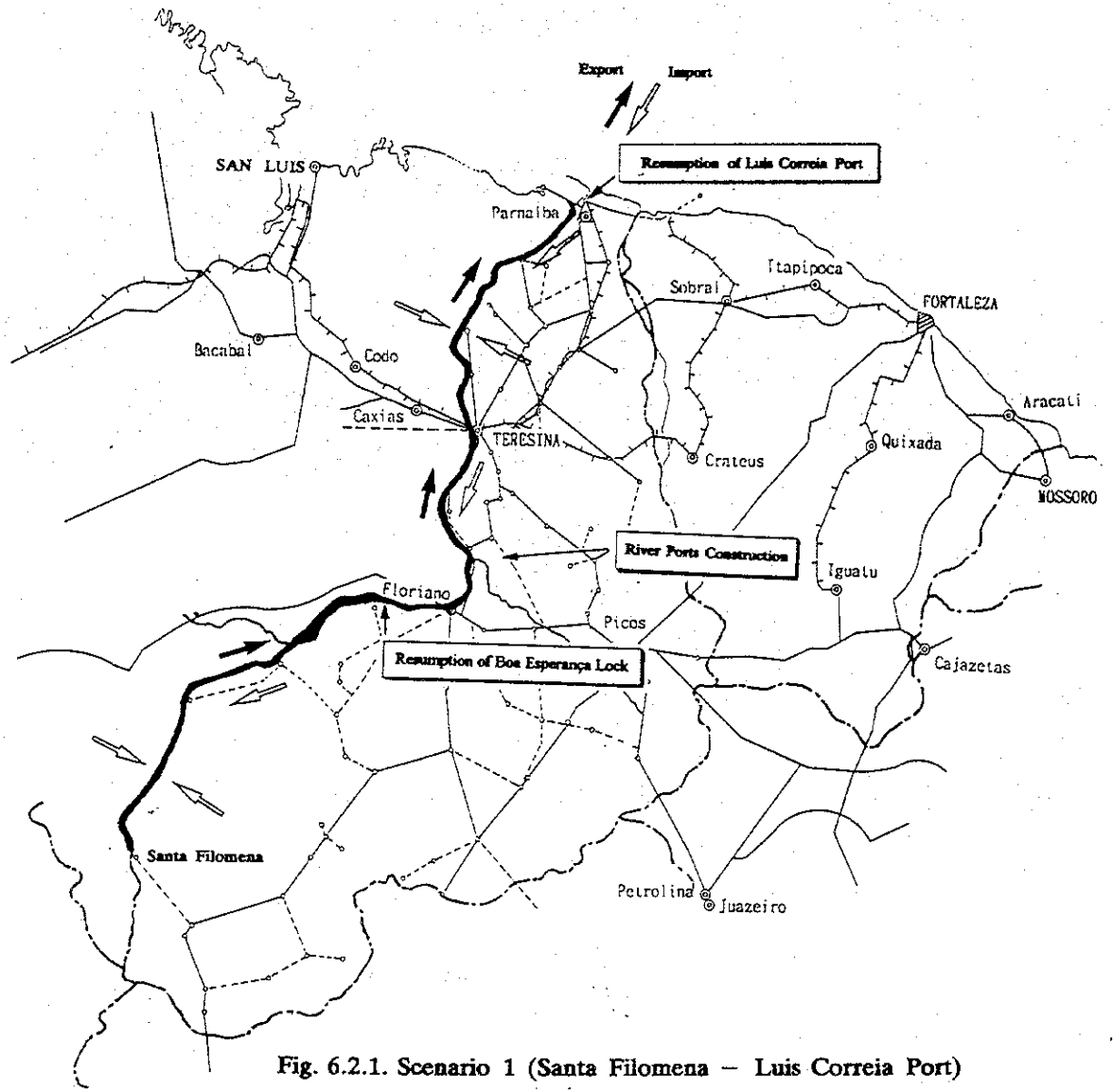


Fig. 6.2.1. Scenario 1 (Santa Filomena – Luis Correia Port)

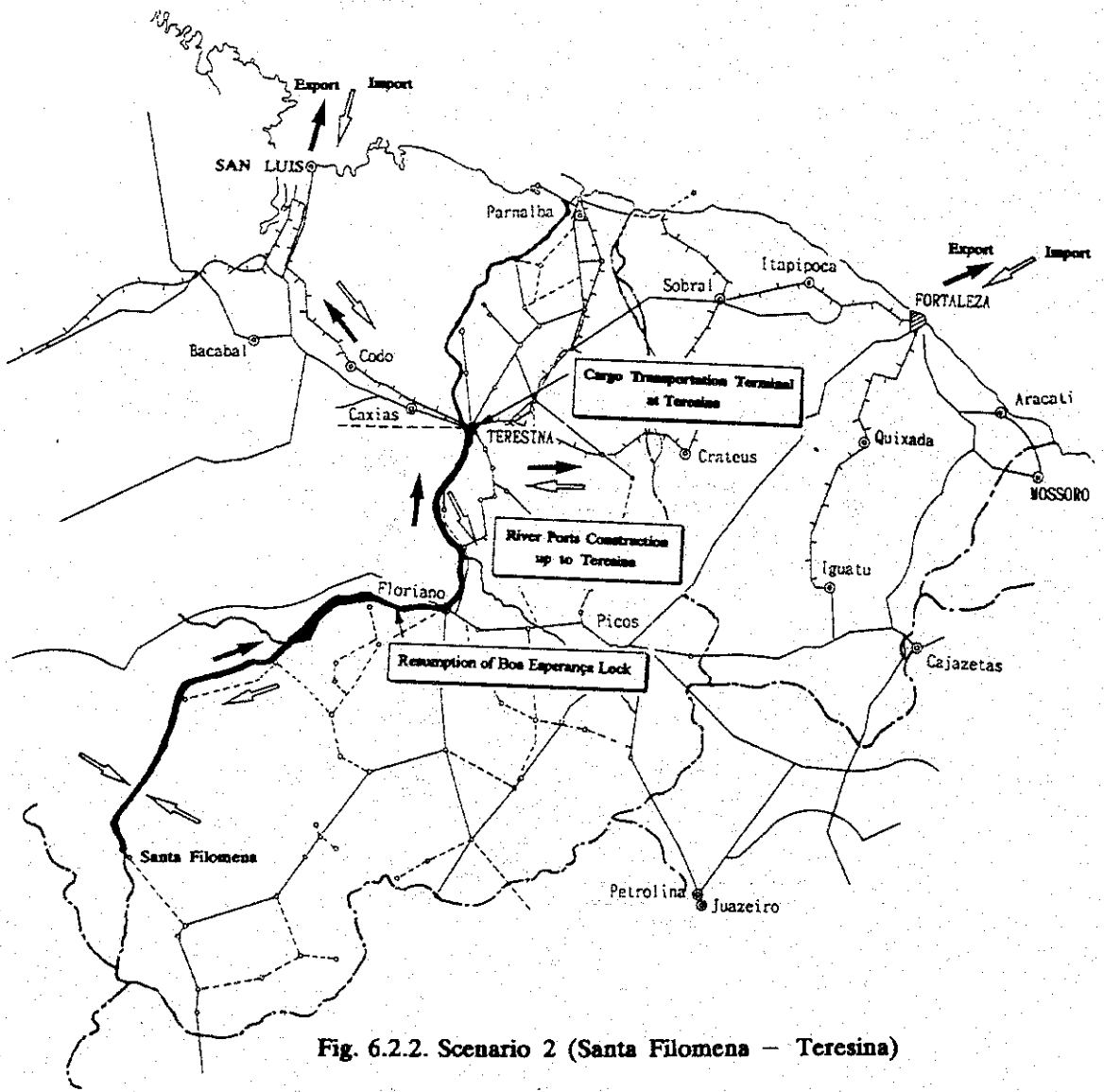


Fig. 6.2.2. Scenario 2 (Santa Filomena – Teresina)

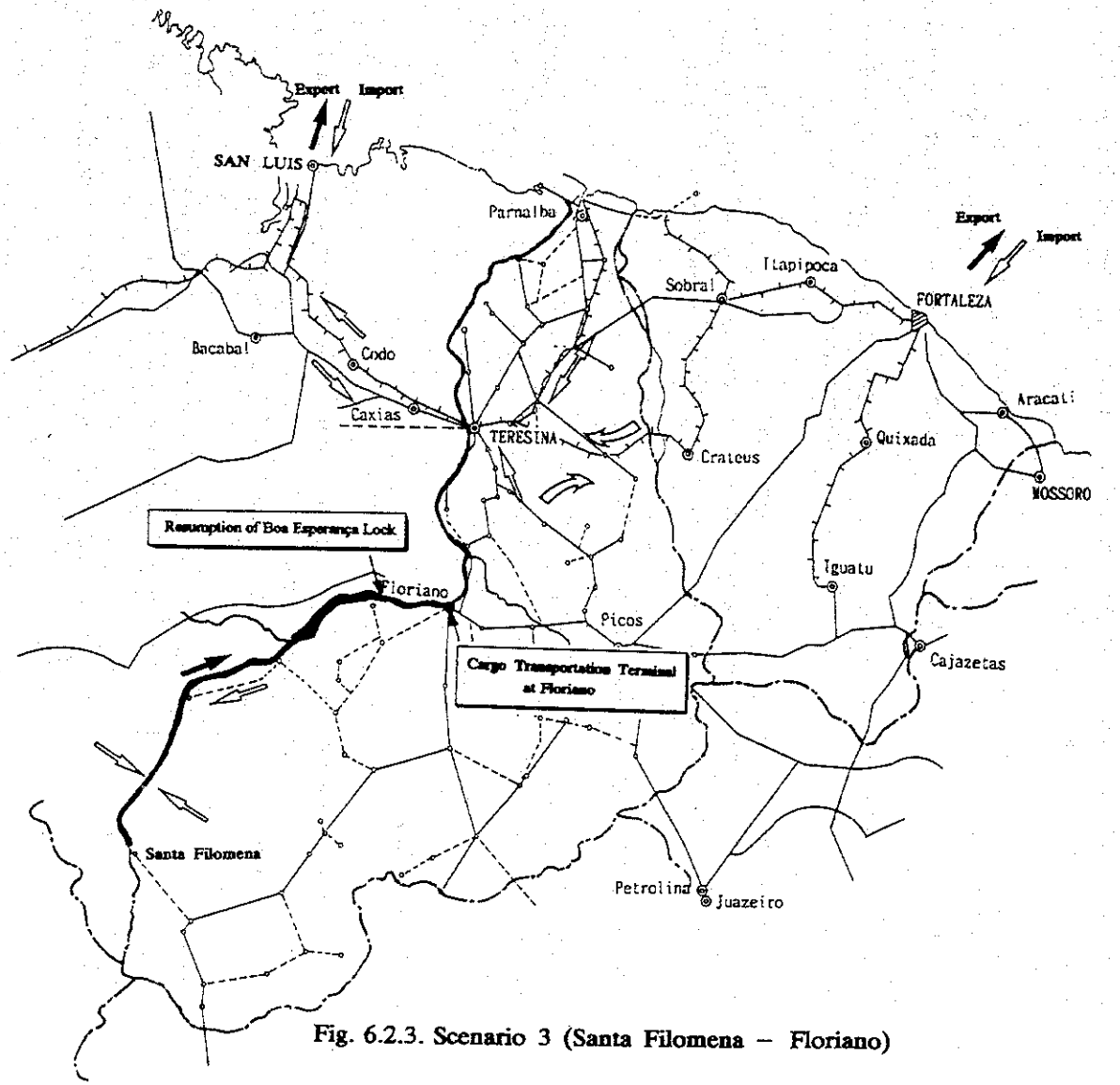


Fig. 6.2.3. Scenario 3 (Santa Filomena – Floriano)

It will also be essential to transport household commodities for people working with the agricultural sector as well as various goods necessary to increase the productivity in the development process.

Considering the above situation, it was decided to conduct the demand forecast for the products listed below in each of the three zones:

1) The zone downstream from Teresina	: Agricultural products and salt
2) The zone from Teresina to Floriano	: Agricultural products, household commodities for the upstream region and salt
3) The zone upstream from Floriano	: Agricultural products and household commodities

(Note: For the downstream region from Floriano, the effects of inflation on goods other than agricultural products are comparatively slight. Salt, whose transport costs make up a high percentage of its price, was the only one of these products included in the forecast.)

(3) Prior Conditions for the Demand Forecast

The conditions assumed for the demand forecast are listed hereunder. Unless the conditions are satisfied or if an alteration in the basic figures exists, the demand forecast in this study will lose its reality.

1) Basic Conditions

a. A regular time table of river transport will be maintained to keep its punctuality, and the safety during maneuvering shall be secured.
b. There shall be a consistent transport system from the upstream region all the way to Teresina or Floriano.
c. Each river port considered as a key shipping point shall have appropriate collection facilities and equipment for loading and unloading to accommodate the volume of cargoes.
d. The main network roads in the upstream region shall not expand beyond their current state.

2) Conditions for the Transport of Agricultural Products

a. The forecast for the agricultural products in the year 2010 will be materialized.
b. The development plan of agro-industry centers shall be achieved as per the state's policies. Especially the following issues are essential:
    - Rice processing complexes shall be operated in the downstream (in Parnaíba city as the central processing location) and in the midstream (in Teresina city as the central location) regions.

- Corn and soybean processing centers shall be established in the upstream region (in Floriano city as the central location). Other currently operational agro-industry factories shall be established.

- It is recommend to establish a rice processing center at Floriano taking into account the present increasing trend of rice production in the upstream regions.

3) Conditions for Distribution of Products Necessary for Daily Living and Production

a. No significant changes will occur that might affect the results of the analysis from the present status of product distribution.
b. The commercial base in Floriano City will expand.

6.4 Demand Forecast In Volume (Potential Demand Volume)

The potential maximum demand in the transport volumes is predicted in Table 6.4. In the prediction, the maximum annual volume of 978,800 tons is found between Guadalupe and Floriano.

Tables 6.4.1, 6.4.2 and 6.4.3 show a demand forecast in volumes among respective river ports. It should be noted that the forecast discussed herein is of a potential demand. To formulate the final volumes as the forecast, it is necessary to conduct further analyses taking into account of the acceptable maximum annual transport volumes among respective river ports.

Table 6.4 Predicted Maximum Demand in the Transport Volume in each Zone

Unit : ton

Year	Direction	Zone 1 Parnaíba ~Teresina	Zone 2 Teresina ~Floriano	Zone 3 Floriano ~Santa Filomena
2000	upward	22,000	58,100	103,800
	downward	37,800	217,000	271,500
2005	upward	38,700	97,900	155,850
	downward	97,360	432,930	530,500
2010	upward	56,700	150,300	208,800
	downward	167,000	796,400	978,800

Source : JICA Study Team

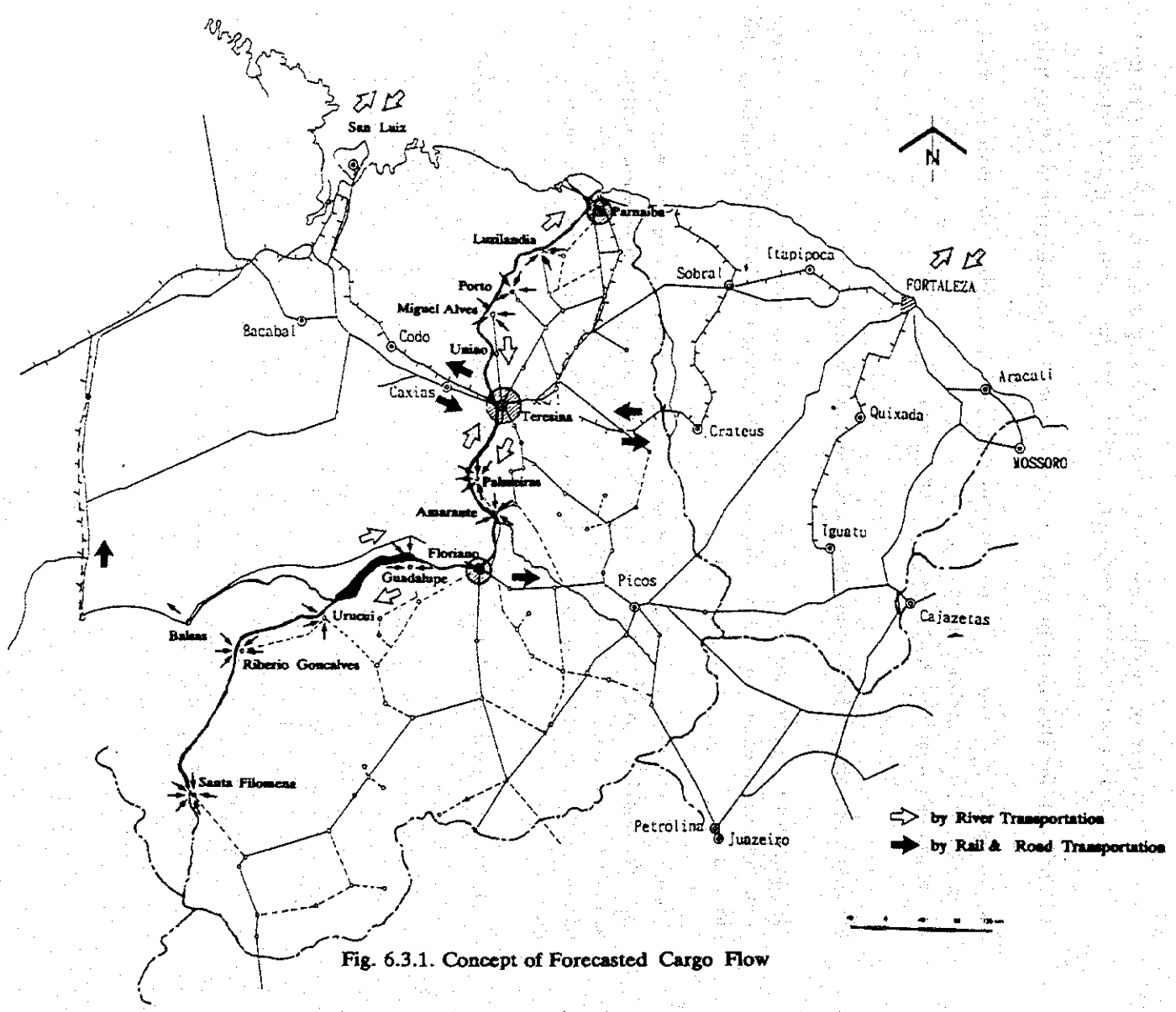


Fig. 6.3.1. Concept of Forecasted Cargo Flow

Table 6.4.1 Transition of Demand Volume (Agricultural Products)

Part of Up Stream Region(St.Filomena ~ Floriano)

Unit : t / year

		St.Filomena ~	R.Goncalves ~	Urcui ~	Gudalupe ~	Floriano
2000	→	23,100	119,400	231,900	271,500	
	←	0	800	4,000	4,000	
2005	→	40,420	239,120	456,870	530,500	
	←	0	1,400	7,000	7,000	
2010	→	72,950	435,950	846,650	978,800	
	←	0	2,000	10,000	10,000	

Part of Mid-Stream Region (Floriano ~ Uniao)

		Floriano ~	Amarante ~	Palmeiras ~	Teresina ~	Uniao
2000	→	191,300	204,500	217,000	0	
	←	21,400	14,400	12,800	20,000	
2005	→	287,680	410,230	432,930	0	
	←	38,300	25,900	22,900	35,000	
2010	→	724,500	761,400	796,400	0	
	←	67,700	45,200	40,200	56,700	

Part of Down Stream Region (Uniao ~ Luiz Correia)

		Uniao ~	Miguel Alves ~	Ponto ~	Lugiandia ~	Paranaiba ~ Luis Correia
2000	→	0	8,600	16,600	37,800	
	←	10,000	0	0	0	
2005	→	0	15,600	29,660	97,360	
	←	17,000	0	0	0	
2010	→	0	26,900	52,700	167,000	
	←	25,000	0	0	0	

Table 6.4.2 Transition of Demand Volume (Commodities)

Part of Up Stream Region (St.Filomena ~ Floriano)

Unit : t / year

		St.Filomena	~ R.Goncalves	~ Urcui	~ Gudalupe	~ Floriano
2000	→	0	0	0	0	
	←	7,600	35,400	80,000	99,200	
2005	→	0	0	0	0	
	←	10,000	51,900	120,000	148,500	
2010	→	0	0	0	0	
	←	12,600	68,700	160,600	198,800	

Part of Mid-Stream Region (Floriano ~ Uniao)

		Floriano	~ Amarante	~ Palmeiras	~ Teresina	~ Uniao
2000	→	0	0	0	0	
	←	36,300	36,300	36,300	0	
2005	→	0	0	0	9,700	
	←	59,400	59,400	0	0	
2010	→	0	0	0	11,000	
	←	82,600	82,600	0	0	

Part of Down Stream Region(Uniao ~ Luiz Correia)

		Uniao	~ Miguel Alves	~ Ponto	~ Lugiandia	~ Paranaiba	~ Luis Correia
2000	→	4,400	1,480	0	0	0	
	←	1,200	1,940	2,350	2,350	0	
2005	→	4,950	1,680	0	0	0	
	←	1,300	2,190	2,650	2,650	0	
2010	→	5,600	1,900	0	0	0	
	←	1,480	2,480	3,000	3,000	0	

Table 6.4.3 Transition of Demand Volume (All Cargo)

Part of Up Stream Region(St.Filomena ~ Floriano)

Unit : t / year

		St.Filomena	~ R.Goncalves	~ Urcui	~ Gudalupe	~ Floriano
2000	→	23,100	119,400	231,900	271,500	
	←	8,400	37,200	84,800	103,800	
2005	→	40,420	239,120	456,870	530,500	
	←	11,050	53,450	127,850	155,850	
2010	→	72,950	435,950	846,650	978,800	
	←	12,700	70,700	170,600	208,800	

Part of Mid-Stream Region (Floriano ~ Uniao)

		Floriano	~ Amarante	~ Palmeiras	~ Teresina	~ Uniao
2000	→	191,300	204,500	217,000	0	
	←	58,100	51,100	49,500	20,000	
2005	→	387,680	410,230	432,930	0	
	←	97,900	85,500	82,500	35,000	
2010	→	724,500	761,400	796,400	0	
	←	150,300	127,800	122,800	56,700	

Part of Down Stream Region(Uniao ~ Luiz Correia)

		Uniao	~ Miguel Alves	~ Ponto	~ Lugiandia	~ Paranaiba	~ Luis Correia
2000	→	0	8,600	16,600	37,800		
	←	11,200	2,000	2,400	2,400		
2005	→	0	15,600	29,660	97,360		
	←	18,250	2,250	2,700	2,700		
2010	→	0	26,500	52,700	167,000		
	←	26,500	2,500	3,000	3,000		

6.5 Share of Water Transport for Agricultural Products in the Upstream Region

Share of the potential cargo demand in the navigation for agricultural products in the upstream region is around 43 % as shown in Table 6.5.1.

Table 6.5.1 Navigable Cargo Ratio (Potential Demand Volume)

Unit : ton

Products		2000	2003	2005	2010
Rice	Projected Product Volume	334,627	486,200	587,271	1,023,673
	Navigable Cargo Volume	165,500	240,860	291,100	506,700
Corn	Projected Product Volume	189,665	282,900	345,000	616,825
	Navigable Cargo Volume	26,300	39,260	47,900	88,200
Fejon Beans	Projected Product Volume	23,909	36,404	44,801	82,309
	Navigable Cargo Volume	4,200	6,330	7,750	15,050
Soy Beans	Projected Product Volume	94,226	178,300	234,434	471,516
	Navigable Cargo Volume	72,300	135,900	178,300	361,500
Total	Projected Product Volume	642,427	983,804	1,211,506	2,194,323
	Navigable Cargo Volume	268,300 (3,800)	422,350 (5,450)	525,050 (6,550)	971,450 (9,450)

Note : Numbers in ( ) shows Nuts and Fruits

Navigable cargo volumes in Table 6.5.1 are projected by the method of a gravity model which is commonly used in traffic analysis. The respective transport cargo volumes calculated from each agricultural production area to each river port along the Parnaíba river and to other major cities are based on the inverse proportion of the time distance factor for each route.

7. NAVIGABLE SHIP AND MAXIMUM TRANSPORT CAPACITY OF THE PARNAÍBA RIVER

7 NAVIGABLE SHIP AND MAXIMUM TRANSPORT CAPACITY OF THE PARNAÍBA RIVER

7.1 Navigable Ship Size of the Parnaíba River

(1) Conditions of Each Zone

Zone-1 : In this zone, the river has its sufficient width but several difficulties in river navigation are observed such as many sand bars, shallow depth in the dry season at Luzilandia and sharp curves in the Igaracu river. To overcome the difficulties, adequate navigation aids and the excellent maneuverability of ships are required.

Zone-2 : The river shows a relatively stable width and depth in this zone though it has some sharp curves, narrow channels and sand bars. Suitable navigation aids and some improvements in the channel are therefore essential for a ship's safe navigation.

Zone-3 : The river in this zone has sufficient depth but some difficulties for ship navigation are found such as many narrow channels with rocky riverbanks, high velocity of flow and a few shallow areas near Santa Filomena. Boa Esperança Lock and the waterway between the two locks have a principal importance and should be repaired and completed for safer navigation. Suitable navigation aids and some improvements in the channel are also essential in this zone.

In addition to the above, it is necessary for each zone to provide supplying facilities of fuel oil, fresh water and provisions, mooring and anchorage spaces and necessary fittings, loading and unloading facilities, and some assistance and rescue systems for safety precautions.

(2) Dimensions of Navigable Ship

The following three systems are typical and applicable for the Parnaíba river navigation (see Table 7.1.1 and Fig.7.1.1).

Case 1 : Self-propulsive cargo ship (lock passable type)
Case 2 : Larger sized self-propulsive cargo ship
Case 3 : Pusher and barge system (Pusher plus single or plural barges)

All ships or barge systems should have a navigation speed of around 8.0 knots in both terms of effective transporting capability and of economical fuel consumption. The size of ships and barges except large sized vessels must be within the limits of the Boa Esperança Lock as 47 m in length and 11 m in breadth with some margins for the safe maneuvering. The maximum draft of ship is restricted to 2.3m by water level in Boa Esperança Locks. Downstream of the Locks, much larger vessels or multiple barges in a unit are applicable.

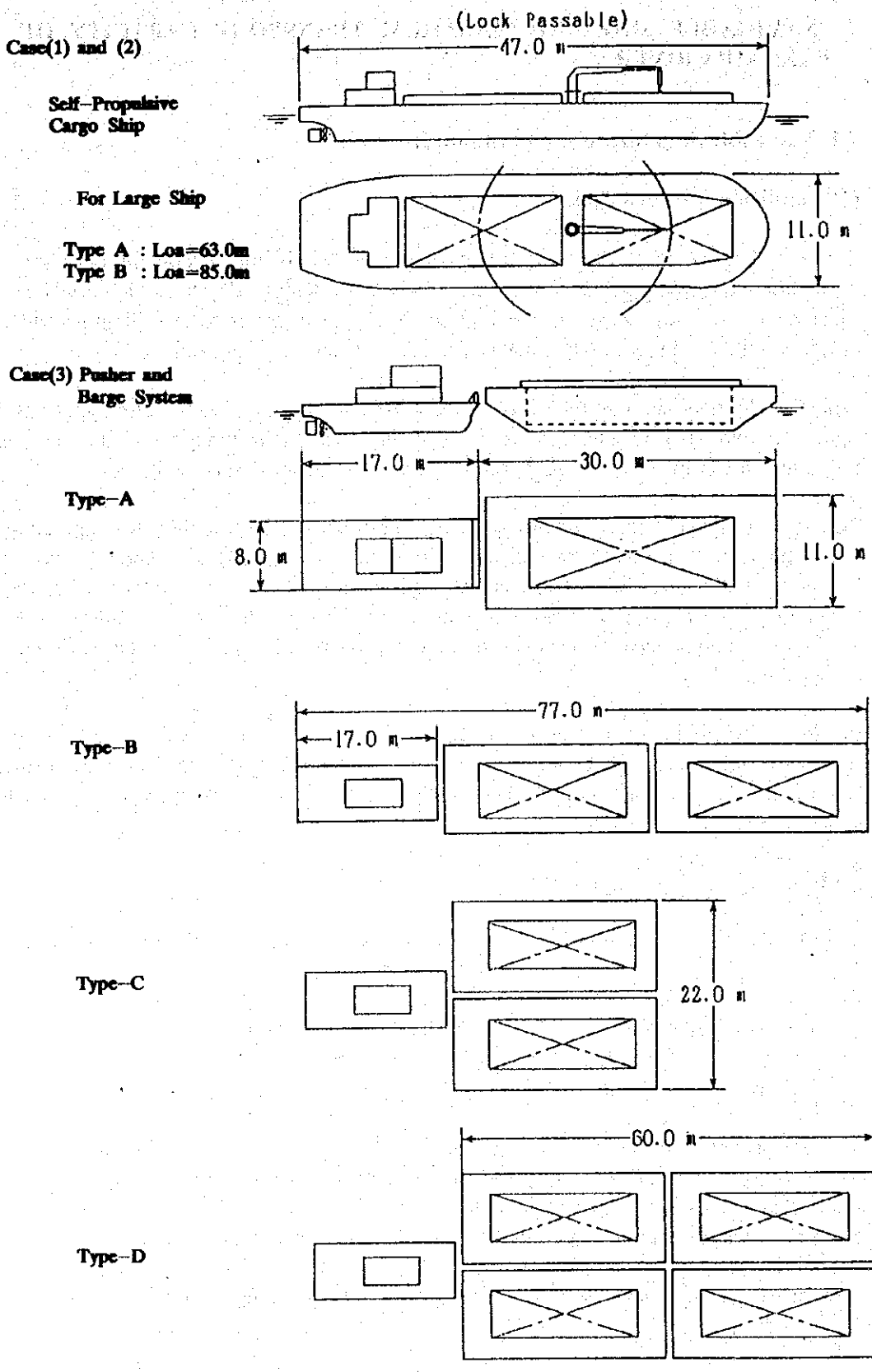


Fig. 7.1.1 Type of Navigable Ship

Table 7.1.1 Dimension and Capacity of Barge System

	Case 1	Case 2		Case 3			
		A	B	A	B	C	D
Length overall LOA (m)	47.0	63.0	85.0	47.0	77.0	47.0	77.0
Length p.p. (m)	45.0	60.0	80.0	-	-	-	-
Breadth of system (m)	11.0	15.0	20.0	11.0	11.0	22.0	22.0
Depth (m)	3.5	4.0	4.5	3.0	3.0	3.0	3.0
Maximum Draft (m)	3.0	3.5	4.0	2.5	2.5	2.5	2.5
Speed (knot)	8.0	8.0	8.0	8.0	7.0	6.0	4.0

With considerations on the piloting difficulties in winding or narrow zones in the channel and on the capacity of propulsion under high velocity flow, the applicability and suitability of ship type for each zone is studied as follows.

Zone-1 : Basically all types of ship stipulated above are applicable in this zone.

Zone-2 : The width of the river is less than Zone-1 and the river has some projecting rocks and sharp curves so that only type A (63 m length) for large cargo ships and type A and B in case 3 for barge systems are to be recommendable in view of safe navigation.

Zone-3 : A lock passable cargo ship and a barge system are both applicable though the size of ships for this zone is basically restricted by dimensions of Boa Esperança Locks.

After the investigations above, the navigable ship sizes for each zone are summarized below.

Table 7.1.2 Summary of Navigable Ship Size

SHIP SIZE & TYPE		Zone-1	Zone-2	Zone-3
(1) Self Propulsive Ship (Lock passable)		x	x	x
(2) Self Propulsive Ship (Large Sized)	Type A	x	x	-
	Type B	x	-	-
(3) Pusher and Barges	Type-A	x	x	-
	Type-B	x	x	-
	Type-C	x	-	-
	Type-D	x	-	-

x : Applicable
- : Not applicable

7.2 Vessel Types and Capacity

(1) Suitable Ship Type and Size

As studied above, a pusher and a barge system are both applicable in Zone-1 and Zone-2. However the barge system is not recommendable for its piloting difficulties in winding areas, for its steering sensitivity in shallower water and its principal instability under faster flow.

On the other hand, large sized cargo ships are also applicable in Zone-1 and Zone-2 and these can be navigable in narrow channels and shallow water. They are, however, not recommendable for they cannot pass through the locks and would be required cargo transfer to the other passable ships before or after entering Boa Esperança Lock. In addition, the ship could not enjoy her large capacity under a full draft in the shallow water around Zone-1. In view of such points for flexible navigation, lock passable sized cargo ships are much more suitable and convenient as a whole.

It concludes that the ships to be in service in all zones of the Parnaíba river should be the type of self-propulsive, lock passable sized cargo ships. (See Fig.7.2.1 for its general arrangement.) The corresponding dimensions are depicted below.

Length o.a. :	Loa =	47.0m
Length p.p. :	Lpp =	45.0m
Breadth :	B =	11.0m
Depth :	D =	3.5m
Max. Draft :	d =	3.0m
Cargo Hold Capacity :		1,300 M3
Speed :		8.0 knots

The ship shall also be equipped with the following:

1) Twin main engines, twin screw system and twin rudders for excellent turning performance.
2) Very low height of navigation bridge and collapsible mast to pass Boa Esperança locks.
3) Specially reinforced structure for the bow, bottom and side construction against the grounding or collisions anticipated.
4) Radio equipment for ship to ship and ship to shore communication for safe navigation and emergencies.

(2) Allowable Cargo Capacity at Each Ship's Draft

Based on the above ship size recommended, the ship's carrying capacity for each draft is estimated as shown in Table 7.2.1.

Table 7.2.1 Loadable Cargo Volume by Ship's Draft

Draft(m)	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
Q'ty (ton)	50	90	120	160	200	240	290	330	370	410	450

Draft (m)	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
Q'ty (ton)	490	540	580	620	660	710	750	800	840	890	930

Source : JICA Study Team

7.3 Maximum Transport Capacity of the Parnaíba River

The transport capacity of the Parnaíba river is restricted by the existence of the Boa Esperança Locks and by the water depth. The maximum annual transporting capacity was

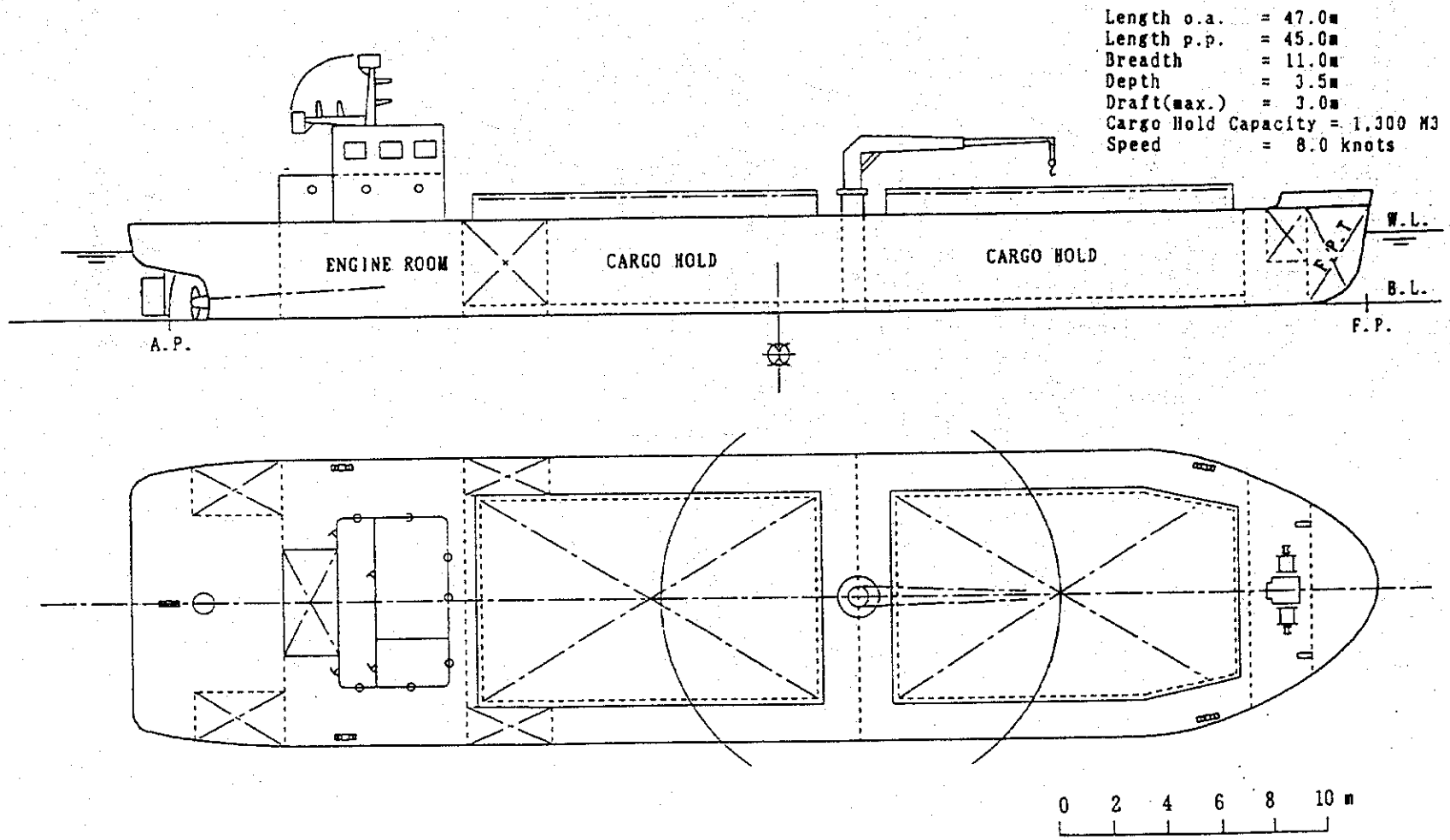


Fig. 7.2.1 General Arrangement

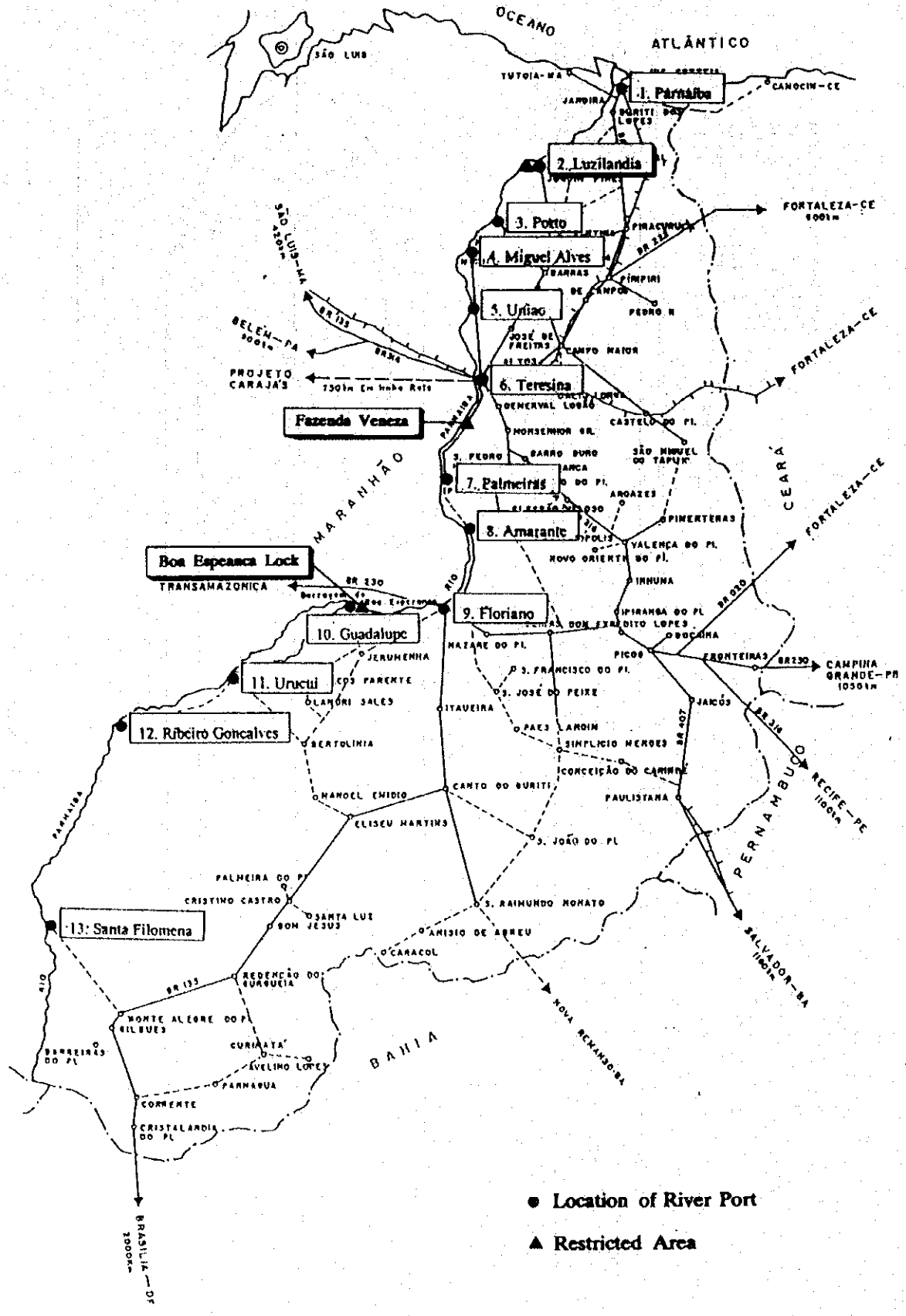


Fig. 7.3.1 Location of River Ports, Lock and Area Restricted by Water Depth

evaluated for each scenario previously presented, under the assumption of daily operating hours of the lock as 12, 18 and 24 hrs (see Figs.7.3.1 and 7.3.2). The conditions set for the evaluation in each scenario are as follows:

Scenario 1 : Transport between Santa Filomena and Parnaíba - The restriction is imposed by the water depth at the locks in the rainy season and by that in between Fazenda Veneza and Luzilandia in the dry season.
Scenario 2 : Transport between Ribeiro Goncalves and Teresina - The water depth is the key at the locks in the rainy season and also at Fazenda Veneza in the dry season.
Scenario 3 : Transport between Ribeiro Goncalves and Floriano - The water depth is the key at the locks in the rainy season and also at Urucui in the dry season.
Scenario 4 : Transport up to Teresina in the rainy season and to Floriano in dry season - The same conditions as in Scenario 3.

Table 7.3.1 Transport Capacity of the Parnaiba River

Unit : ton

Lock Operation Hours		Case 1 12 hours	Case 2 18 hours	Case 3 24 hours
Passable Ships/day	Downward	5 ships	7 ships	10ships
	Upward	5 ships	7ships	10 ships
Santa Filomena	Downward	423,600	593,040	847,200
	Upward	423,600	593,040	847,200
Parnaíba	Total	847,200	1,186,080	1,694,400
Ribeiro Goncalves	Downward	526,800	737,520	1,053,600
	Upward	526,800	737,520	1,053,600
Teresina	Total	1,053,600	1,475,040	2,107,200
Ribeiro Goncalves	Downward	782,400	1,095,360	1,564,800
	Upward	782,400	1,095,360	1,564,800
Floriano	Total	1,564,800	2,190,720	3,129,600
Locks	Downward	892,800	1,249,920	1,785,600
	Upward	892,800	1,249,920	1,785,600
	Total	1,785,600	2,499,840	3,571,200

Source : JICA Study Team

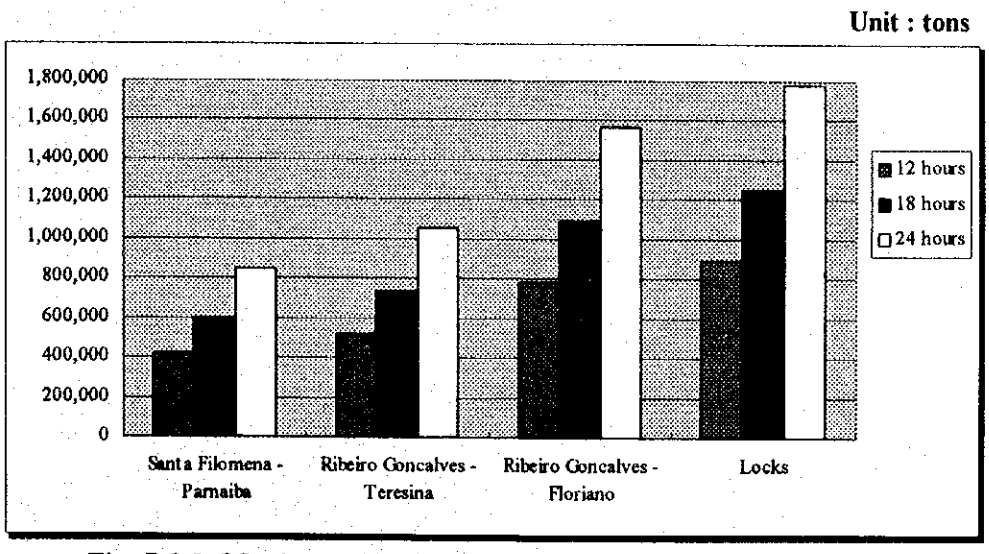


Fig. 7.3.2 Maximum Transport Capacity of the Parnaíba River

The most applicable operation hours of the lock will be 18 hours because of the following reasons.

1) The maximum transport capacity in the case of 12 hours operation is too small considering the demand forecast.
2) In the case of 24 hours operation, congestion of ships will occur in the waiting area for the daytime navigation.
3) The half-night operation has been carried out on the Tiete river.

Consequently, the maximum transport capacity of the river shall be as per Table 7.3.9.

Table 7.3.9 Maximum Transport Capacity

Unit : tons/year

Case	Downward	Upward	Total
Santa Filomena - Parnaíba	593,040	593,040	1,186,080
Ribeiro Goncalves - Teresina	737,520	737,520	1,475,040
Ribeiro Goncalves - Floriano	1,095,360	1,095,360	2,190,720
Lock Passage	1,249,920	1,249,920	2,499,840

Source : JICA Study Team

(1) Conditions

1) Number of Vessels Passable at the Locks

From the maximum water depth at the locks at 2.5 m, the maximum draft of passable vessels is assumed as 2.3 m and the resulting loading capacity is set to 620 ton/vesssel. The time required for the passage is estimated at around 2.5 hrs. incorporating one each vessel in the downward and upward direction. For example in a case of 18 hrs. operation, 14 vessels/day can go through the lock (see Table 7.3.2).

Table 7.3.2 Number of Ships Passing the Locks

	Direction	Case 1	Case 2	Case 3
Lock Operation Hours (hr)		12	18	24
Number of Ships Passable the Locks per Day	Downward	5	7	10
	Upward	5	7	10
	Total	10	14	20
Number of Ships Passable the Locks per Month	Downward	120	168	240
	Upward	120	168	240
	Total	240	336	480

Source : JICA Study Team

2) Depth of Waterway, Draft of Vessel and Cargo Volume

Table 7.3.3 Waterway Depth - Draft - Cargo Volume

	Zone 1			Zone 2			Zone 3		
	Depth (m)	Draft (m)	Cargo Volume (t)	Depth (m)	Draft (m)	Cargo Volume (t)	Depth (m)	Draft (m)	Cargo Volume (t)
Jan	2.7	2.4	660	2.8	2.5	710	1.9	1.6	330
Feb	2.8	2.5	710	3.1	2.8	840	2.1	1.8	410
Mar	3.3	3.0	930	3.2	2.9	890	2.0	1.7	370
Apr	3.1	2.8	840	2.7	2.4	660	1.9	1.6	330
May	2.1	1.8	410	1.8	1.5	290	1.6	1.3	200
Jun	1.6	1.3	200	1.5	1.2	160	1.5	1.2	160
Jul	1.3	1.0	90	1.5	1.2	160	1.5	1.2	160
Aug	1.2	0.9	50	1.5	1.2	160	1.5	1.2	160
Sep	1.2	0.9	50	1.5	1.2	160	1.4	1.1	120
Oct	1.3	1.0	90	1.6	1.3	200	1.5	1.2	160
Nov	1.4	1.1	120	2.0	1.7	370	1.6	1.3	200
Dec	1.6	1.3	200	2.1	1.8	410	1.7	1.4	240

Source : JICA Study Team

3) Daytime Navigation

Considering the difficulties involved with night navigation due to the nature of the river such as shallow waters, narrow channels, rapid water flow and curved passages, daytime navigation shall be recommended.

(2) Estimation of Maximum Transport Capacity

Monthly and Annual Transport Capacities for each scenario are all shown in Tables 7.3.5, 7.3.6 and 7.3.7.

Table 7.3.5 Monthly and Annual Transport Capacity
(Transportation between Santa Filomena and Parnaiba)

Month	Min. Water Depth (Point)	Draft (m)	Loadable Cargo Volume/ship (ton)	Montly Transport Capacity Lock Operation Hour		
				12 hr (120 ships)	18 hr (168 ships)	24 hr (240 ships)
Jan	2.5 m (Lock)	2.3	620	74,400	104,160	148,800
Feb	2.5 (lock)	2.3	620	74,400	104,160	148,800
Mar	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Apr	2.5 (Lock)	2.3	620	74,400	104,160	148,800
May	1.8 (F. Veneza)	1.5	290	34,800	48,720	69,600
Jun	1.5 (F. Veneza)	1.2	160	19,200	26,880	38,400
Jul	1.3 (Luzilandia)	1.0	90	10,800	15,120	21,600
Aug	1.2 (Luzilandia)	0.9	50	6,000	8,400	12,000
Sep	1.2 (Luzilandia)	0.9	50	6,000	8,400	12,000
Oct	1.3 (Luzilandia)	1.0	90	10,800	15,120	21,600
Nov	1.4 (Luzilandia)	1.1	120	14,400	20,160	28,800
Dec	1.6 (Luzilandia)	1.3	200	24,000	33,600	48,000
Annual Transport Capacity		Downward		423,600	593,040	847,200
		Upward		423,600	593,040	847,200
		Total		847,200	1186,080	1,694,400

Table 7.3.6 Monthly and Annual Transport Capacity
(Transportation between Ribeiro Goncalves and Teresina)

Month	Min. Depth (Point)	Draft (m)	Loadable Cargo Volume/ship (ton)	Montly Transport Capacity Lock Operation Hour 12 hr (120 ships)	18 hr (168 ships)	24 hr (240 ships)
Jan	2.5 m (Lock)	2.3	620	74,400	104,160	148,800
Feb	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Mar	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Apr	2.5 (Lock)	2.3	620	74,400	104,160	148,800
May	1.8 (F. Veneza)	1.5	290	34,800	48,720	69,600
Jun	1.5 (F. Veneza)	1.2	160	19,200	26,880	38,400
Jul	1.5 (F. Veneza)	1.2	160	19,200	26,880	38,400
Aug	1.5 (F. Veneza)	1.2	160	19,200	26,880	38,400
Sep	1.5 (F. Veneza)	1.2	160	19,200	26,880	38,400
Oct	1.6 (F. Veneza)	1.3	200	24,000	33,600	48,000
Nov	2.0 (F. Veneza)	1.7	370	44,400	62,160	88,800
Dec	2.1 (F. Veneza)	1.8	410	49,200	68,880	98,400
Annual Transport Capacity		Downward		526,800	737,520	1,053,600
		Upward		526,800	737,520	1,053,600
		Total		1,053,600	1,475,040	2,107,200

Source : JICA Study Team

Table 7.3.7 Monthly and Annual Transport Capacity
(Transportation between Ribeiro Goncalves and Floriano)

Month	Min. Depth (Point)	Draft (m)	Loadable Cargo Volume/ship (ton)	Montly Transport Capacity (ton) Lock Operation Hour 12 hr (120 ships)	18 hr (168 ships)	24 hr (240 ships)
Jan	2.5 m (Lock)	2.3	620	74,400	104,160	148,800
Feb	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Mar	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Apr	2.5 (Lock)	2.3	620	74,400	104,160	148,800
May	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Jun	2.4 (Urucui)	2.1	540	64,800	90,720	129,600
Jul	2.2 (Urucui)	1.9	450	54,000	75,600	108,000
Aug	2.1 (Urucui)	1.8	410	49,200	68,880	98,400
Sep	2.0 (Urucui)	1.7	370	44,400	62,160	88,800
Oct	2.1 (Urucui)	1.8	410	49,200	68,880	98,400
Nov	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Dec	2.5 (Lock)	2.3	620	74,400	104,160	148,800
Annual Transport Capacity		Downward		782,400	1,095,360	1,564,800
		Upward		782,400	1,095,360	1,564,800
		Total		1,564,800	2,190,720	3,129,600

Source : JICA Study Team

8. CARGO TRANSPORTATION PLANNING

8. CARGO TRANSPORTATION PLANNING

8.1 Allowable Maximum Volume and Potential Demand in River Transport

The allowable maximum transport volume estimated in accordance with result of investigation on the natural conditions and on various conditions related to the navigation in Chapter 7 is as follows:

Up and mid-stream area (St. Filomena - Teresina)	: 737,520 tons/year
Down-stream area (Miguel Alves - Parnaíba)	: 593,040 tons/year

On the other hand, the potential transport demand in cargo volumes among the ports in 2005 and 2010 according to the overall forecast discussed in Chapter 6 is as follows.

Year 2005

Up and mid-stream area (Guadalupe - Floriano)	: 530,500 tons/year
Down stream area (Luzilandia - Parnaíba)	: 97,360 tons/year

Year 2010

Up and mid-stream area (Guadalupe - Floriano)	: 978,800 tons/year
Down stream (Ludiandia - Parnaíba)	: 167,000 tons/year

As shown above, the potential demand of cargo will be within the allowable maximum transport volume in 2005. However, in the year 2010, it will surpass the allowable limit in the up and mid-stream areas.

8.2 Maximum Transporting Volume

The allowable maximum cargo volume in the Parnaíba river is estimated based on the forecast of transport volume, which is within the limit of allowable maximum transport volume.

However, the cargoes to be reviewed are only the agricultural products transported from the upstream to the midstream area. It is not necessary to review the volume of materials for production and household goods, as these are within the range of allowable limits.

With regard to revision of the transport volume forecast, the following points are adopted taking into account the relevant characteristics of transport demand in exporting cargoes.

1) Soybeans are regarded as prior agricultural products, since they require a specific shipping season (February - May).

2) Fruits and nuts have also priority, as they are possible exporting products and their freshness is of essential importance.

3) As demand for rice within the relevant regions is limited and it is an agricultural product to be distributed to other regions, it is assumed that an excessive production volume over the allowable transport capacity for river navigation will be transported by land to the southern part of the country and the allowable volume is adjusted mainly from the volume of rice.

4) As most corn and fejon are assumed to be distributed for the region's demand or for other regions after being processed by the Agro-industry Center located in the region, an excessive volume of production over the allowable transport volume for river navigation is assumed to be distributed within the region or a part is assumed to be transported to other regions after the processing.

8.3 Cargo Transport Volumes in Each Scenario

Four scenarios were examined based on the potential demand volume, i.e., the allowable maximum cargo volume for river navigation as determined in the previous chapter. The transport capacity of the Parnaíba river and alternatives in the river navigation plan are examined by assuming the following scenarios:

Scenario 1 : Plan to operate the whole section between Santa Filomena and Parnaíba.
Scenario 2 : Plan to operate the section between Santa Filomena and Teresina.
Scenario 3 : Plan to operate the section between Santa Filomena and Floriano.
Scenario 4 : Plan to operate the section between Santa Filomena and Teresina during rainy season based on Scenario 3.

Figs. 8.3.1 to 8.3.4 show the respective cargo transport volumes for river transport in the above scenarios. Table 8.3.1 shows the outline of each scenario:

Table 8.3.1 Outline of Each Scenario

Particulars	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Service Section (from St. Filomena to)	Parnaíba	Teresina	Floriano	Rainy Season : Teresina Dry Season : Floriano
Transport Character (Restriction Factors)	Lock and water depth at Fazenda Veneza Luzilandia	Lock and water depth at Fazenda Veneza	Lock	Lock
Maximum Cargo Transport Volume (Lock operation : 18 hr)	593,040 t/yr.	737,520 t/yr.	1,095,360 t/yr.	1,095,360 t/yr.
Required Nos. of Vessels (in 2010)	53 units	46 units	31 units	40 units
Problem	Initial investment is too large for it's transport volume. Cost of O&M is too large.	As plan matches with existing infrastructures. Plan is desirable.	There is a difficulty of land transport from Floriano.	Compromised plan supplementing a drawback of Scenario 3

Note : Required number of vessel in each scenario is estimated in Chapter 9.

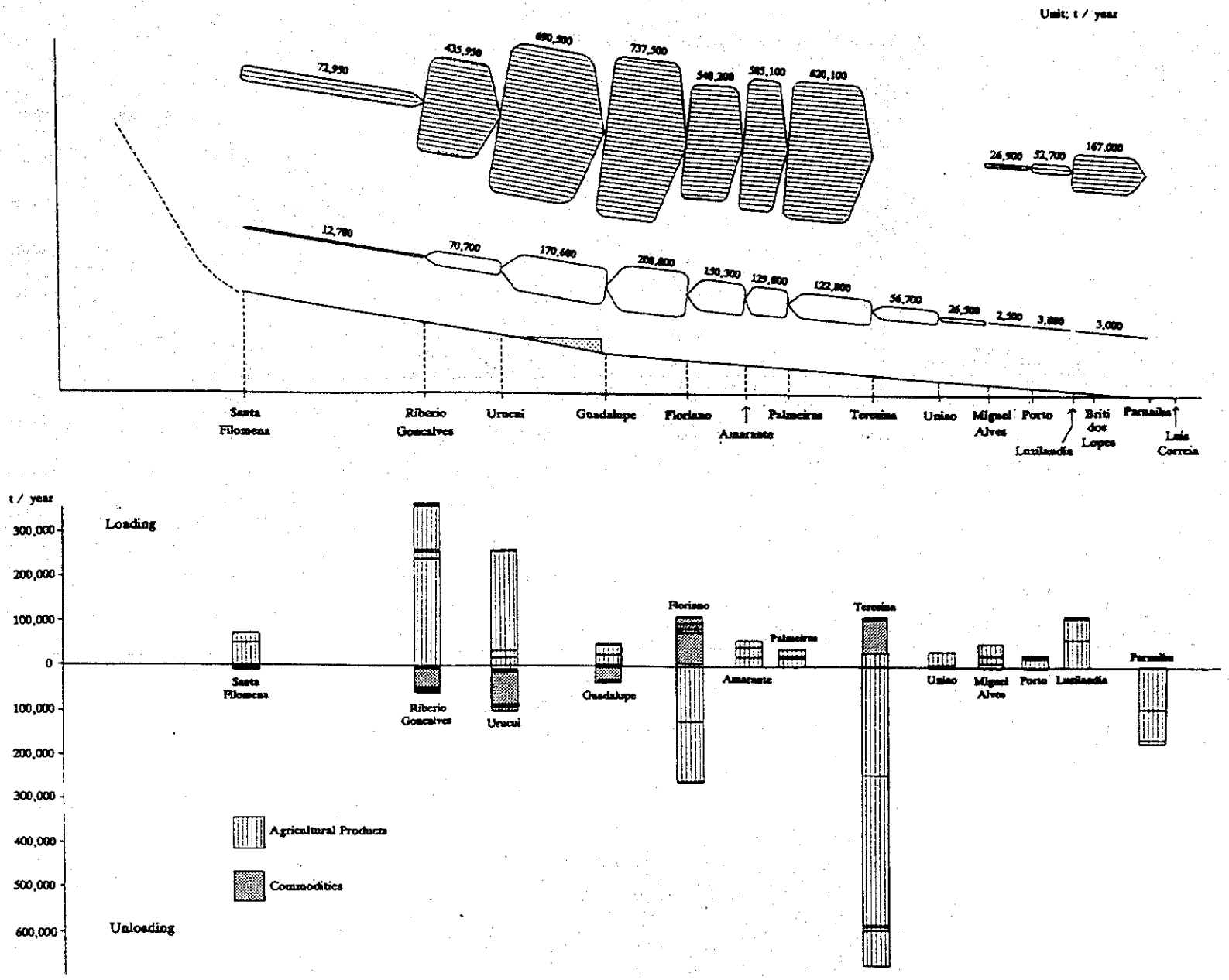


Fig. 8.3.1 Cargo Transport Volume in Scenario 1

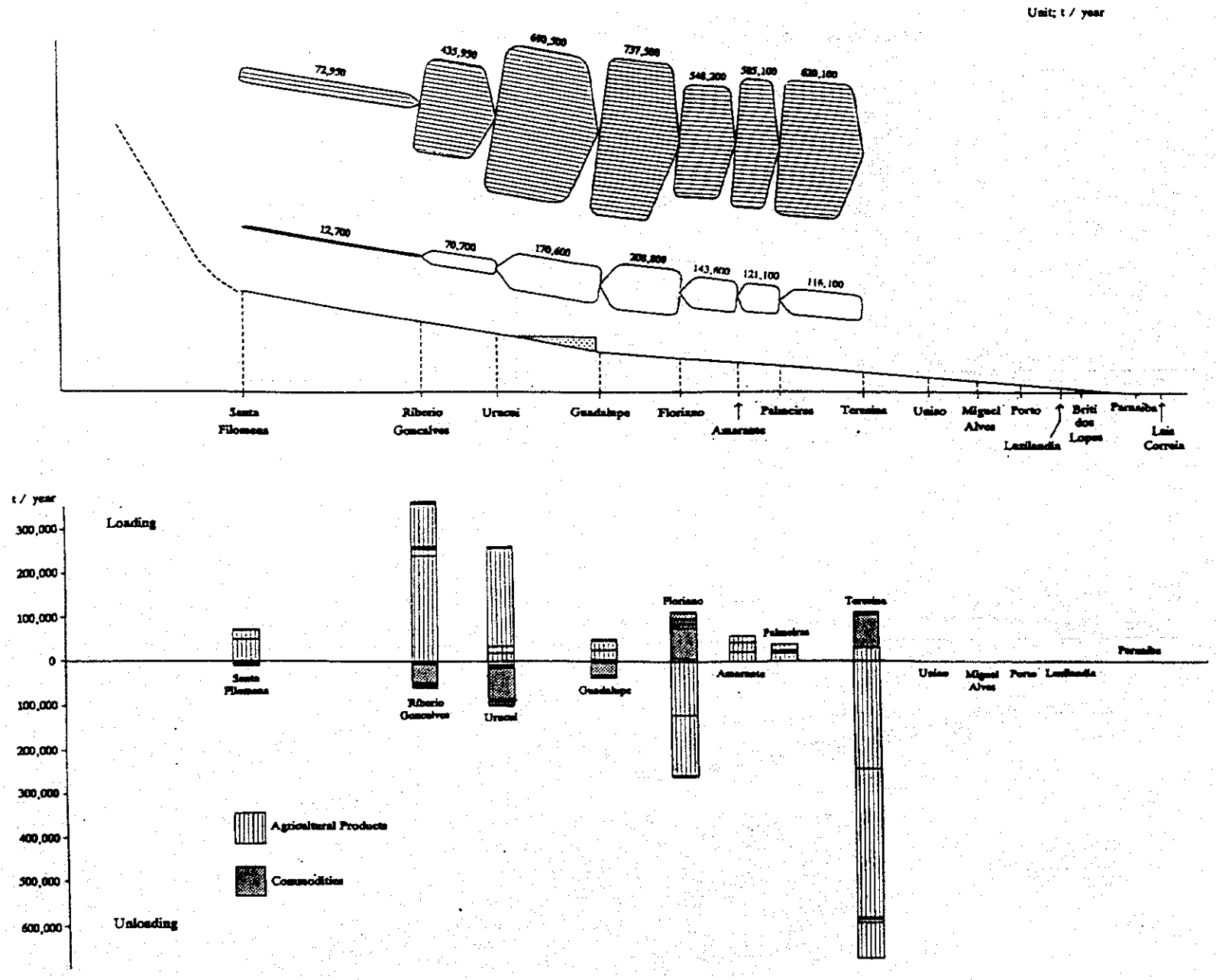


Fig. 8.3.2 Cargo Transport Volume in Scenario 2

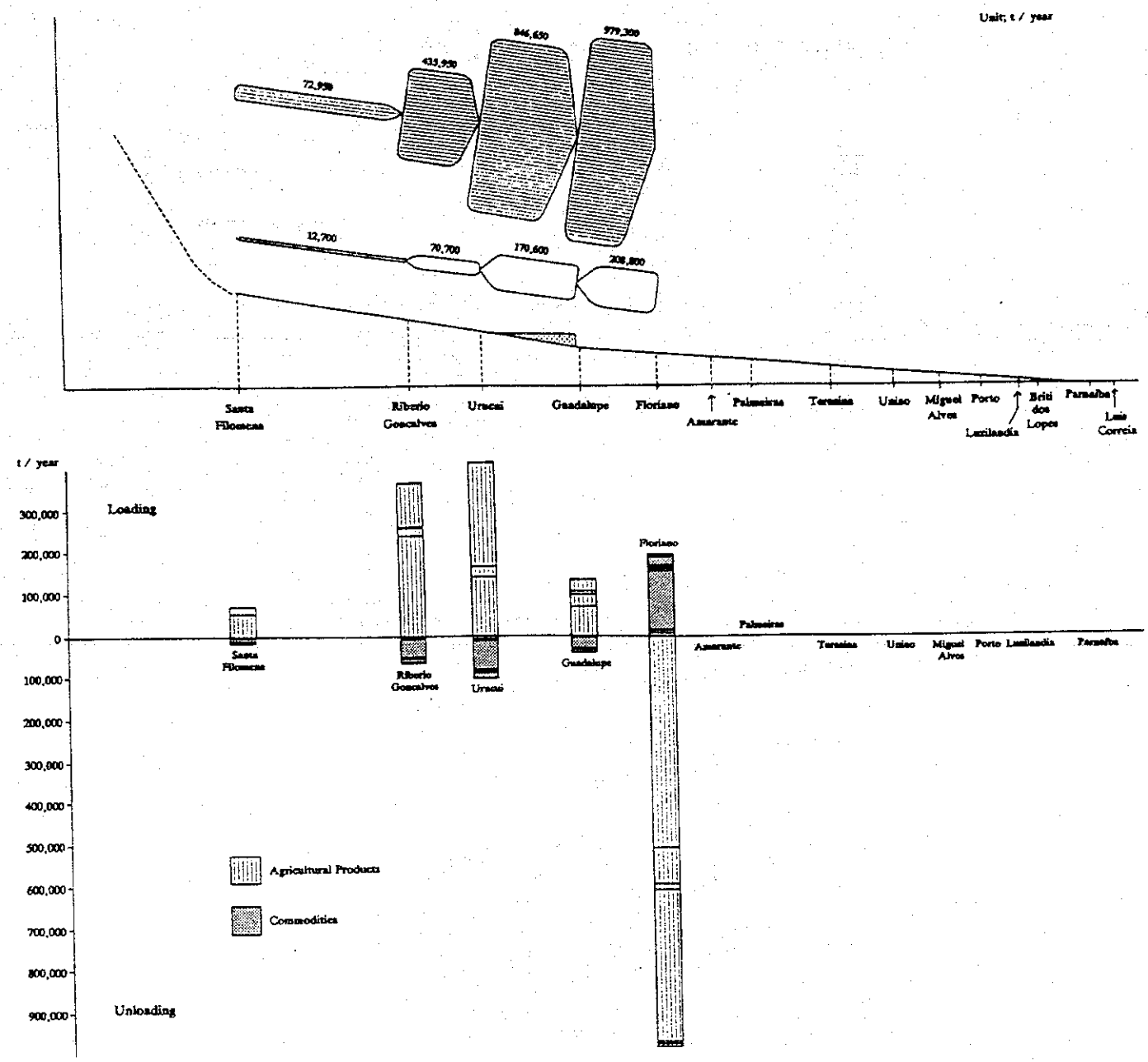


Fig. 8.3.3 Cargo Transport Volume in Scenario 3

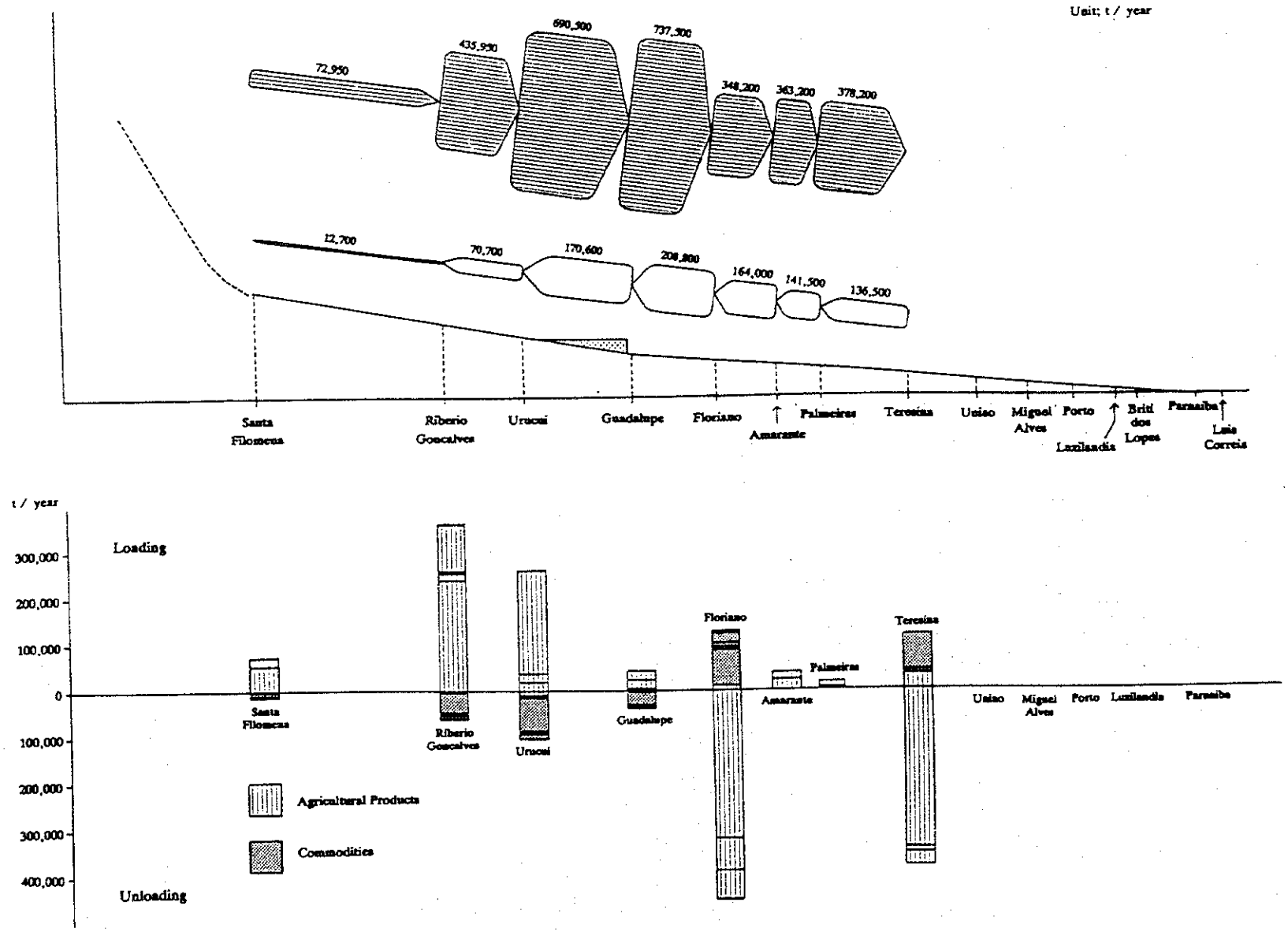


Fig. 8.3.4 Cargo Transport Volume in Scenario 4