CHAPTER 2

STUDY AREA

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2.1 Natural Conditions

2.1.1 Topography and Geology

(1) Topography

The RMR is located on the eastern margin of the State of Pernambuco. It covers the fluvial flat plain along the coast and plateau and hilly areas inland. The flat plain has an altitude of 5 – 6 m and has many coves and swamps. The flat plain extends about 5 km to the west and abruptly gives way to a plateau and hilly areas with an altitude of 100 to 150 m. The plateau is relatively hilly and dissected by rivers. The highest point in the RMR is the Mt. Urugu in its southwestern margin and the peak has an altitude of 424 m according to the 1:10,000 topographic map. However most of the other parts are not higher than 200 m. The recent urbanization accompanying large-scale reclamation and landfill has obscured the original topography of the flat plain.

(2) Geology

The geology of the RMR is roughly classified into three different units. They are Precambrian basement rocks, Cretaceous sedimentary rocks and tertiary to quaternary sediments. The Precambrian basement rocks underlay all the other geological units and are widely exposed in the southwestern part. They are hard crystalline granites and granodiorites.

Along the Capibaribe River there is a major geological break called the Pernambuco lineament. The Cretaceous sedimentary rocks show contrasting characteristics between the north and south of the Pernambuco lineament. In the north the components are mostly well-consolidated sandstones and mudstones, of which some are calcarious. On the other hand, in the south there are volcanic rocks such as basalts and trakytes along with small amount of granite, sandstone and conglomerates. These rocks are consolidated, however some of the sandstone is feldspathic and subjects to weathering.

The Tertiary sedimentary rocks are widely distributed in the north west of the RMR and they are sandstones with calcarious cement. To the south of the Pernambuco lineament, the tertiary rocks have only a limited distribution and they are sandstones with fragments of volcanic rocks.

Quaternary sediments are those of unconsolidated sands and mud of fluvial and marine origins. They are distributed along the river courses and lowlands between the river courses. Near the river mouths, the sediment is characterized by fine silt and mud with a high content

of organic matter. A peculiar sandstone with calcareous cement of this age is unusually consolidated and resistant to erosion and forms a barrier reef along the shore.
Permeability of the norther region is high and the Beberibe aquifer has a large capacity of the groundwater.

2.1.2 Meteorology and Hydrology

(1) Temperature

The average values of monthly maximum, mean and minimum temperatures at Recife (Curado Station) from 1961 to 1990 are shown as follows:

Maximum: 30.7 °C in April to 27.3 °C in July
Mean: 26.6 °C in February to 23.9 °C in August
Minimum: 22.7 °C in March to 20.6 °C in August

(2) Humidity

The monthly mean humidity (1961 to 1990) in Recife ranges from 73 % in January to 85 % in May to August.

(3) Rainfall

The geographical variation of mean annual rainfall in the RMR is as follows (refer to Fig. 2.1-1):

- Along the coast, 2600 mm in the north, 2000 mm in the central part and 2200 mm in the southern part,
- In the western hilly areas, 1200 mm in the central part and 2000 mm both in the northern and the southern parts.

The mean monthly rainfall in Recife is 47.8 mm in November to 389.6 mm in June. The maximum daily rainfall during the period from 1961 to 1990 was 235 mm in May (24/5/1986) and 383 mm in August (14/8/1990) as shown in Fig. 2.1-2.

2.1.3 River System

The rivers in the RMR are: Arataca at the northern boundary, Jaguaribe, Botafogo, Igarassu, Timbo, Paratibe, Beberibe, Capibaribe, Tejipio, Jaboatao, Pirapama, Ipojuca, and Sibiro at the southern boundary as shown in Fig. 2.1-3. Major river basins related to PQA are Beberibe (82 km^2), Capibaribe (7,445 km^2), Jaboatao/Pirapama (442 km^2) and Ipojuca (3,479 km^2), where most of the urban areas are located.

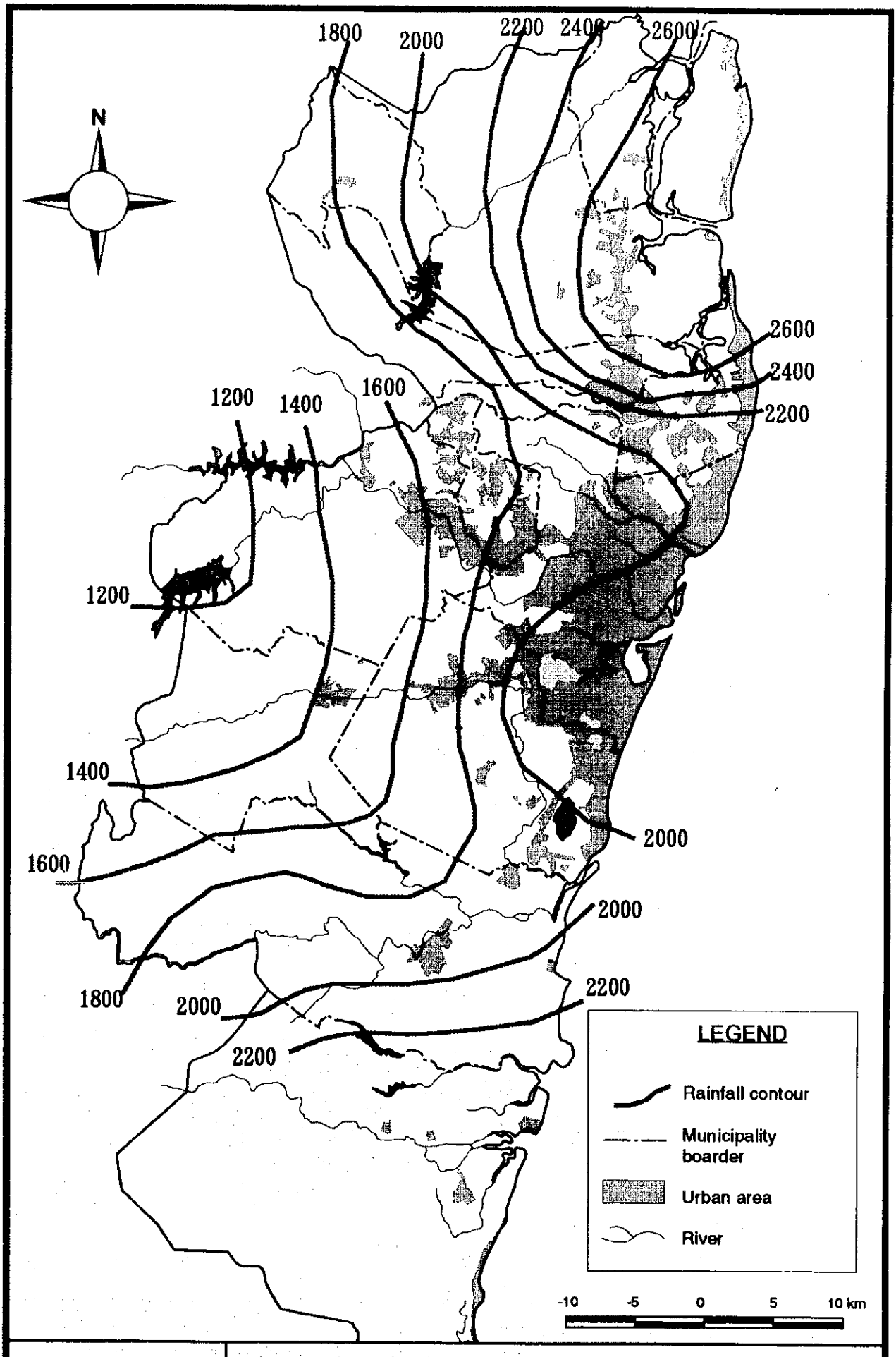
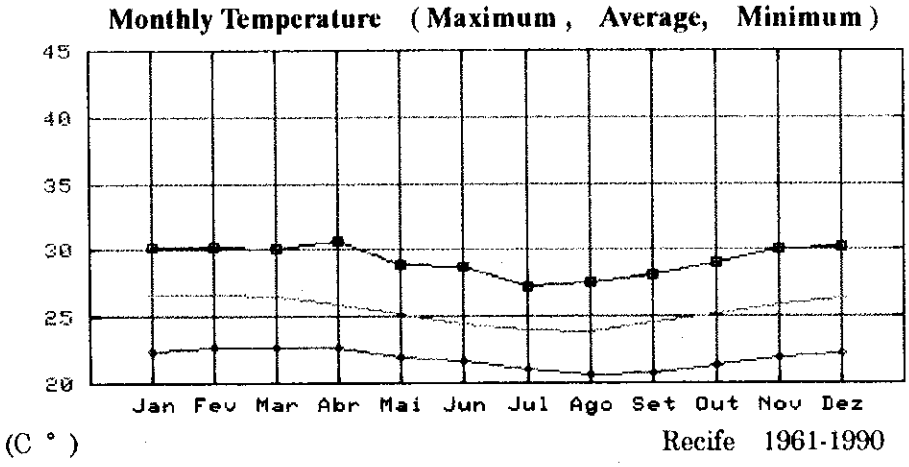
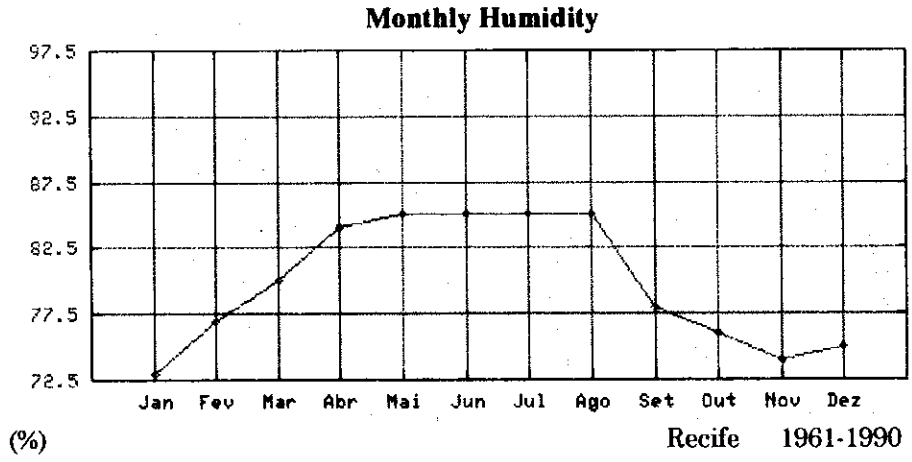


Fig. 2.1 - 1 Average Annual Rainfall in RMR

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR





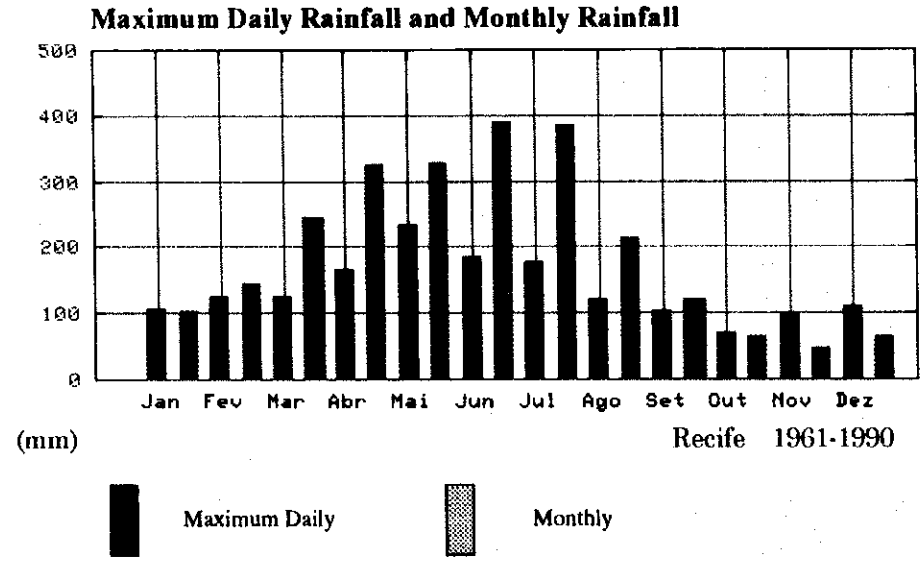


Fig. 2.1-2	Climate of RMR (Recife)

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

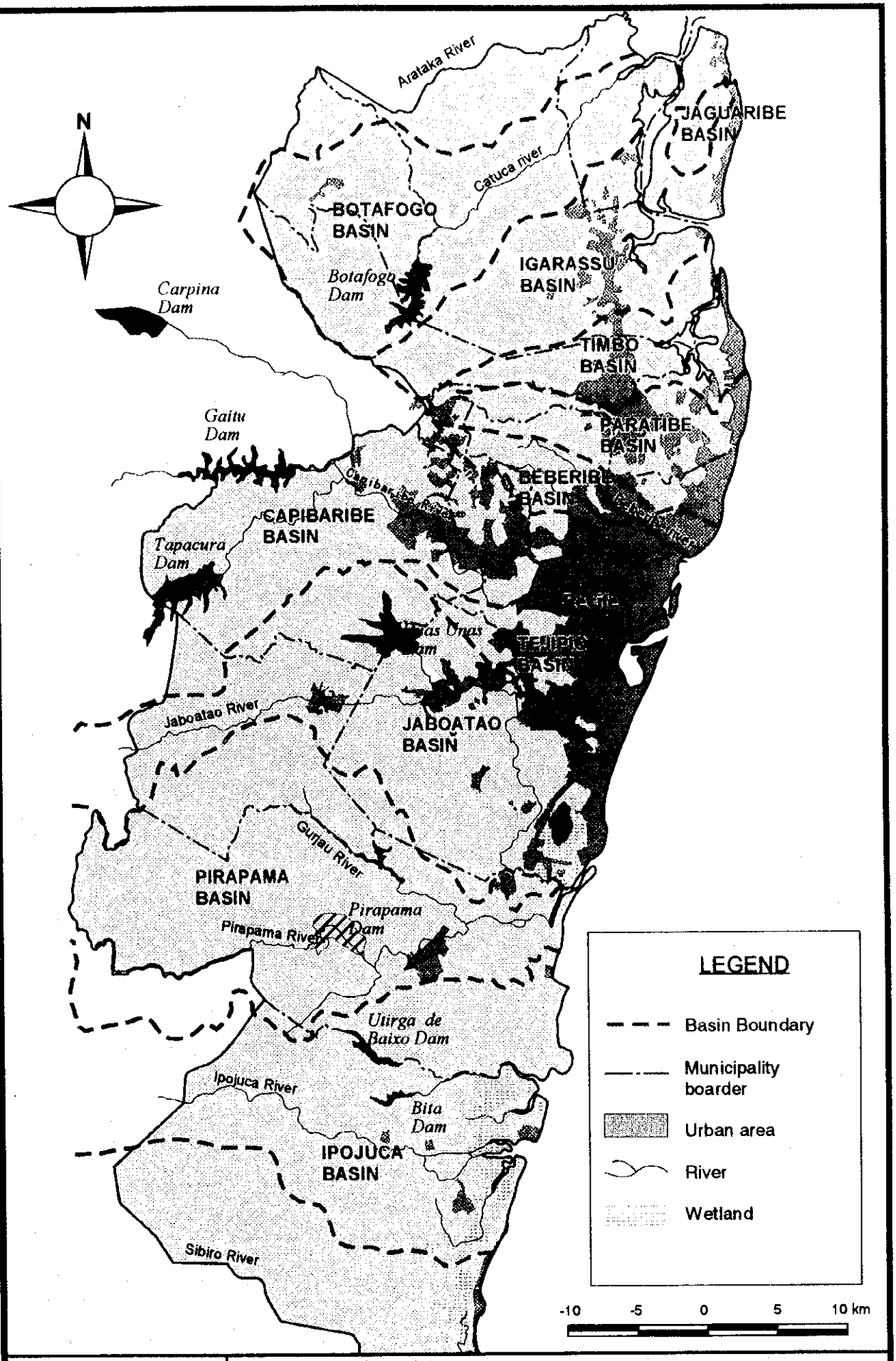


Fig. 2.1-3 River System in RMR

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

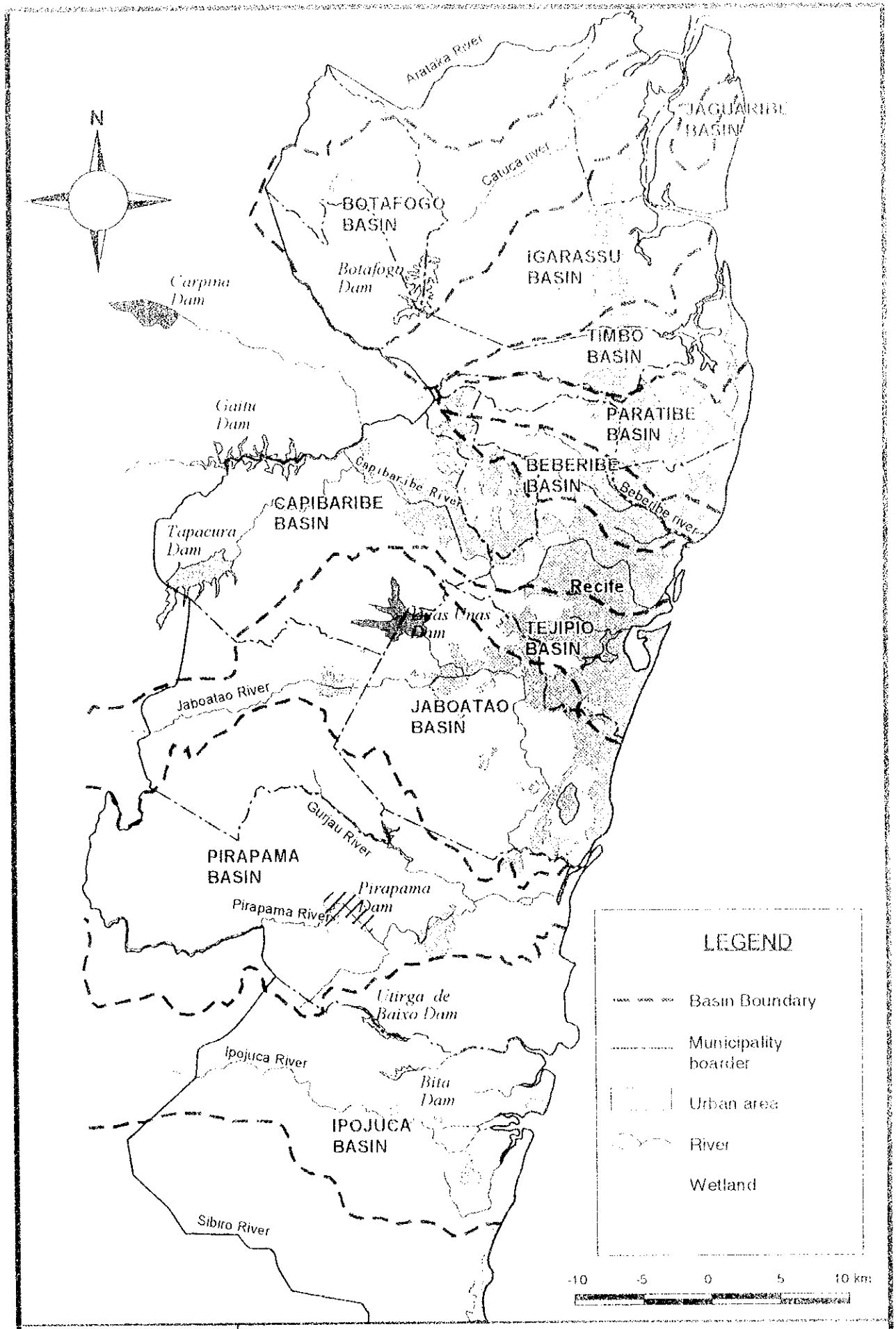


Fig. 2.1-3 River System in RMR

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

2.2 Socio-Economy

2.2.1 Administration

The Federative Republic of Brazil consists of five Major Regions, namely; the North, Northeast, Southwest, South and Central West. Administratively comprises 27 Federative Units, which are constitute as follows: 7 Units in the North Region, 9 Units in the Northeast, 4 Units in the Southwest, 3 Units in South and 4 Units in the Central West. These Federative Units are called States. The States are further divided into Municipalities, the Municipalities into Districts. As of the end of August 1997, there were 5,507 Municipalities and 9,516 Districts.

The State of Pernambuco, including the Study area, is located at the eastern end of Northeast Region. It consists of 185 Municipalities and 382 Districts. The Recife Metropolitan Region (RMR) is located at the eastern end of the State. The RMR was established in the Federal Law (Law No.14, 8th of June 1973), and confirmed in the State Law (1st of January 1994) under the 1988 Federal Constitution. It comprises 14 Municipalities and 27 Districts. The Municipality of Recife is the capital of the State. The respective municipalities are composed of the following number of Districts.

Municipalities and Districts

Name of Municipality	Number of Districts	Name of Municipality	Number of Districts
Abreu e Lima	1	Itapissuma	1
Araçoiaba	1	Jaboatão dos Guararapes	3
Cabo de Santo Agostinho	4	Moreno	1
Camaragibe	1	Olinda	1
Igarassu	3	Paulista	4
Ipojuca	3	Recife	1
Itamaracá	1	São Lourenço da Mata	2

Source: Contagem da População 1996, 1997, IBGE

2.2.2 Population and Labor Force

(1) Population

According to the diagonal census of population in 1996 by Brazilian Institute of Geography and Statistics Foundation (IBGE), Brazil had a population of 157 million. The population was increased by 10.2 million compared with the 1991 census, as shown in Table 2.2-1. During these five years, the average growth rate was 1.4% per annum. Since the average growth rate during the 1980's was 1.9%, it dropped down 0.5 point.

In the State of Pernambuco, the population in 1996 was 7.40 million or 4.7% of the national population. The average growth rate between 1991 and 1996 was 0.7% per annum. This growth rate was smaller than that of the country. Supposing the national growth rate was a natural growth rate in the country, the considerable number of the population in the State of Pernambuco moved to other states at a higher pace.

The population growth trend of the RMR comprising 14 municipalities was tabulated in Table 2.2-1. The average growth rate between 1991 and 1996 was 1.3% per annum. This rate was 0.6 point higher than the state average rate. Accordingly, a considerable number of the rural population is assumed to have migrated into the RMR.

Among the14 municipalities, Recife Municipality is the largest in terms of population, and functions as the center of the RMR. Its population was 1.35 million in 1996, accounting for 43.3% of the RMR population. The five largest municipalities in terms of population are Recife, Olinda, Jaboatão dos Guararapes, Paulista and Camaragibe and they form a core of the RMR in terms of their socio-economic activities in the RMR. These core municipalities account for 2.57 million or 83% of the RMR population.

The urban population of the 14 municipalities is also tabulated in Table 2.2-1. The total urban population of the RMR was 2.94 million in 1996, accounting for 94% of the total population. The growth rate between 1991 and 1996 was 1.3%. The growth rates of the core Municipalities of Recife and Olinda were 0.7% and 0.5%, smaller than the rate of the RMR. On the other hand, the surrounding municipalities recorded higher growth rates than that of the RMR. This means that the increased population during this period was absorbed in these surrounding municipalities.

The population density in the municipal areas of the RMR was calculated at 11.2 persons/ha in 1996. The densities of the respective municipalities ranged from the largest at 85.2 persons/ha in Olinda to the smallest at 1.3 persons/ha in Araçoiaba, as shown in the table below. In addition to Olinda, the other four municipalities recorded a high population density of more than 20 persons/ha.

Population and Population Density by Municipality (1996)

Municipality	Total Population (1000)	Municipal Area (km^2)	Population Density (Persons per ha)
Abreu e Lima	80.8	129.1	6.3
Araçoiaba	12.0	96.9	1.2
Cabo de Santo Agostinho	140.8	448.4	3.1
Camaragibe	111.1	48.3	23.0
Igarassu	73.0	304.2	2.4
Ipojuca	48.5	514.8	0.9
Itamaracá	13.8	65.4	2.1
Itapissuma	19.2	74.3	2.6
Jaboatão dos Guararapes	530.0	257.3	20.6
Moreno	40.0	192.1	2.1
Olinda	349.4	38.1	91.7
Paulista	233.6	102.3	22.8
Recife	1,346.0	218.7	61.5
São Lourenço da Mata	89.8	264.4	3.4
RMR	3,088.0	2,754.3	11.2

Source: Censo Demografico 1996, Numero 14 Pernambuco, IBGE

The population density in the urbanized areas of the RMR was calculated at 97 persons/ha on average in 1996. The density of the respective Municipalities ranged from the largest at 139 persons/ha in Olinda to the smallest at 18 persons/ha in Itamaracá. In addition to Olinda, the following four Municipalities recorded a high population density of more than 100 persons/ha: Recife, Araçoiaba, Jaboatão dos Guararapes, and Cabo de Santo Agostinho. The five core municipalities, i.e., Olinda, Recife, Paulista, Camaragibe and Jaboatão dos Guararapes, accounted for 2.49 million people or 85% of the total urban population in their urbanized areas. The table below shows the urban population density of the respective municipalities.

Urban Population and Population Density by Municipality (1996)

Municipality	Urban Population (1000)	Urbanized Area (ha)	Urban Density (Persons per ha)
Abreu e Lima	72.7	1,092	66.6
Araçoiaba	9.3	83	112.0
Cabo de Santo Agostinho	125.0	1,186	105.4
Camaragibe	111.1	2,267	49.0
Igarassu	55.9	1,125	49.7
Ipojuca	30.4	885	34.4
Itamaracá	11.2	620	18.1
Itapissuma	16.1	175	90.9
Jaboatão dos Guararapes	457.7	4,230	108.2
Moreno	32.1	415	77.3
Olinda	349.4	2,520	138.6
Paulista	229.5	3,012	76.2
Recife	1,346.0	10,852	124.0
São Lourenço da Mata	78.8	1,687	46.7
RMR	2,925.2	30,150	97.0

Source: Censo Demografico 1996, Numero 14 Pernambuco, IBGE

The average family size in the RMR was calculated at 3.5 on average in 1997. It was smaller than that of the average size (3.8) in the state. The family size in rural areas was 4.2, larger than that of the state average. The table below shows the average family sizes in the respective areas.

Family Sizes

Area	Total Population (1000)	Number of Households (1000)	Average Family Size (Persons)
Brazil *	157,070	42,728	3.7
Urban *	123,077	34,728	3.5
Rural *	33,993	7,990	4.3
Pernambuco State	7,480	1,994	3.8
Urban	5,697	1,567	3.6
Rural	1,784	427	4.2
RMR	3,089	874	3.5

Source: Anuário Estatístico do Brasil 1997, 1998, IBGE
Pesquisa Nacional pr Amostra de Domicílios 1997, Vol 19 Pernambuco, IBGE
Note: * Data in 1996

(2) Labor Force

In the 1996 census year, the labor force in Brazil registered 73.1 million. This accounted for 57.7% of the total working age population (123.6 million), i.e., 10 years old and older. Of this number, 68.0 million or 93.0% were employed. Thus, an unemployment rate was 7.0% nationwide. In the Northeast Region, the labor force was 20.4 million in the same year. This accounted for 57.8% of the total working age population (35.3 million). Of this number, 19.2 million or 94.1% were employed. Then, the unemployment rate was 5.9%, lower than the national rate.

In the State of Pernambuco, the labor force was recorded at 3.39 million in 1997. This accounted for 57.5% of the total working age population (5.89 million). Of the total number, 3.10 million people or 91.4% were employed. Thus, an unemployment rate was 8.6% in the state. In the RMR, the labor force was recorded at 1.34 million in the same year. The labor force accounted for 40% of the total labor force in the state, which was slightly smaller than the rate of population (43%). This labor force in the RMR accounted for 53.4% of the total working age population (2.51 million). Of the total labor force, 1.16 million or 86.6% were employed. Thus, the unemployment rate was 13.4% in the state.

In 1997, the agricultural sector absorbed the greatest portion of manpower resources in the state. It accounted for 31.7% of the total employment. In the RMR, on the other hand, the agricultural sector absorbed only 3.7% of the labor force, as shown in the table below. The manufacturing sector employed 7.6% only in the state. Even in the RMR, it absorbed only 8.4%.

Yet, the service sector, including seven sub-sectors such as trade, hotels and restaurants, etc. in the table, absorbed 54% of the total employment in the state. In the RMR, this rate reached 79%. Among the service sub-sectors, accommodation and catering absorbed 29% and the trading sub-sector, 20%. Thus, the labor force in the RMR is characterized by the employment in the service sector.

Employment in Pernambuco and RMR

Economic Sector	Number of Employment (1000)		Percentage Distribution (%)	
	Pernambuco	RMR	Pernambuco	RMR
Agriculture	981.2	43.3	31.7	3.7
Industry	446.7	202.3	14.4	17.4
Manufacturing	235.2.	97.2	7.6	8.4
Construction	182.6	91.8	5.9	7.9
Other Industries	28.9	13.3	0.9	1.1
Services	1,669.8	918.1	53.9	78.9
Trade	460.0	230.3	14.8	19.8
Hotels & Restaurants	583.8	332.5	18.8	28.6
Auxiliary Services	68.7	51.6	2.2	4.4
Transportation & Communication	125.4	67.3	4.0	5.8
Social Services	239.6	130.8	7.7	11.2
Public Services	141.3	74.5	4.6	6.4
Other Activities	51.1	31.0	1.6	2.7
Total	3,097.7	1,163.7	100.0	100.0

Source: Pesquisa Nacional por Amostra de Domicílios 1997, Vol.19 Pernambuco, 1998, IBGE

An average monthly income was distributed as estimated at 2.1 times the minimum wage in the state in 1997. In the RMR, it was estimated at 3.2 times of the minimum wage. These average wages are equivalent to approximately R$ 287/month in the state and R$ 435/month in the RMR. The distribution of the monthly wages is shown in the table below. The mean wages of the state and the RMR were between ½ to 1 minimum wage and 1 to 2 minimum wages, respectively. The percentage of workers with an income of up to 3 minimum wages (R$408/month) accounted for 82% of the total workers in the state and 71% in the RMR.

Monthly Wages in Pernambuco and RMR

Income Range	Number of Workers (1000)		Distribution (%)	
	Pernambuco	RMR	Pernambuco	RMR
Up to ½ Minimum Wage*1	287.4	68.7	9.3	5.9
½ to 1 Minimum Wage*1	671.7	226.3	21.7	19.4
1 to 2 Minimum Wage*1	687.7	304.0	22.2	26.1
2 to 3 Minimum Wage*1	262.1	150.7	8.5	13.0
3 to 5 Minimum Wage*1	261.6	142.2	8.4	12.2
5 to 10 Minimum Wage*1	150.4	93.3	4.9	8.0
10 to 20 Minimum Wage*1	64.0	42.5	2.1	3.7
More Than 20 Minimum Wage	33.4	24.4	1.1	2.1
No Income *2	619.9	70.2	20.0	6.0
No Answer	59.5	41.4	1.9	3.6
Total	3,097.7	1,163.7	100.0	100.0

Source: Pesquisa Nacional por Amostra de Domicílios 1997, Vol.19 Pernambuco, 1998, IBGE
Note: *1 A minimum wage is stipulated as R$136 in 1999.
*2 Including workers who received social benefits only.

2.2.3 National Economy

(1) National Account

The Gross Domestic Product (GDP) in Brazil was R$864 billion in 1997, as shown in Table 2.2-2. The table shows the GDP broken down into Gross Value Added (GVA) of the main economic sectors. They are summarized as follows:

- R$ 66 billion or 7.7% of GDP for the agricultural sector,
- R$ 326 billion or 37.8% for the industrial sector, and
- R$ 471 billion or 54.5% by services' sector.

Per capita GDP was calculated at R$ 5,413, equivalent to US$ 4,850.

The Gross Regional Domestic Product (GRDP) in the State of Pernambuco was R$ 23.3 billion in 1997, as shown in Table 2.2-3. It accounted for 2.7% of the national GDP. The GVA of the main sectors was shown in the same table. They were broken down as follows:

- R$ 2.14 billion or 9.2% of GRDP for the agricultural sector,
- R$ 7.67 billion or 33.0% of GRDP for the industrial sector and
- R$ 13.46 billion or 57.9% of GRDP by the services' sector.

The Per capita GRDP in Pernambuco was R$ 3,115 (equivalent to US$ 2,790) in 1997, as shown in Table 2.2-3. It was only 58% of the national per capita GDP. The GRDP for the RMR is not estimated by any agency concerned. In this current study, therefore, it is

represented by the GRDP of the state. Similarly, the GRDP in the project sites is considered to be R$ 3,115 the same as in 1997.

Between 1994 and 1997, the GDP increased from R$ 779 billion to R$ 864 billion in real terms, i.e., at average growth rate of 3.5% per annum. The GRDP in Pernambuco grew at a rate of 4.2% per annum on average for the same period, which was higher than the growth rate of the country. Thus, the share of the region in the country increased during this period.

In terms of average annual growth between 1994 and 1997, both per capita GDP and per capita GRDP of Pernambuco were calculated as 2.1% and 3.5%, respectively. The economy of the state grew at a higher pace than the national economy, so the disparity between the state and the nation was reduced during this period.

(2) Foreign Trade

Brazil's external trade balance has shown an increase in the deficit since 1995. The major traditional commodity exports such as coffee, and mineral ores have contributed to the national trading performance for a long time. These exports amounted to US$ 47.8 billion in 1996 and US$ 53.0 billion in 1997 at FOB value. In 1996, the top five exports comprised the following commodities:

(1) soybeans, accounting for US$ 4.5 billion or 25%;
(2) mineral ores, US$ 2.9 billion or 16%;
(3) coffee, US$ 2.1 billion or 12%;
(4) meat, US$ 1.5 billion or 8%; and
(5) sugar, US$ 1.5 billion or 8%.

In addition, manufactured products have contributed more than the traditional ones, but their performance has not grown at the expected rate. These exports amounted to US$ 29.7 billion. The top five products are the following:

(1) fabricated metal products, accounting for US$ 6.3 billion or 21%;
(2) transportation equipment, US$ 4.8 billion or 16%;
(3) chemical products, US$ 3.5 billion or 12%;
(4) machines and mechanical instruments, US$ 3.2 billion or 11%; and
(5) paper and cellulose, US$ 1.9 billion or 7%.

Foreign Trade in Brazil

(Unit: US$ billion)

	1994	1995	1996	1997
Merchandise Export (FOB)	43.55	46.51	47.75	52.99
Merchandise Import (CIF)	35.51	53.83	56.75	64.99
Trade Balance	8.04	-7.32	-9.00	-12.00

The imports amounted to US$ 56.8 billion in 1996 and US$ 65.0 billion in 1997 at CIF value. In 1996, the major import items were the following:

(1) consumer goods, accounting for 17% of the total imports;
(2) raw materials, 33%;
(3) petroleum and derivatives, 12%; and
(4) capital goods, 38%.

Brazil has been running a deficit on its current transactions. In particular, it has consecutively recorded a deficit on the service trade, as shown in the balance of payment table below. Borrowing overseas, from official and private sources mainly financed the deficit. This activity has accelerated the worsening current deficit. The deficit is said to be partly offset by tourism.

In 1997, the current transaction recorded a high level deficit of $ 33.4 billion. Although it was only US$ 1.7 billion in 1994, it jumped to US$ 18.0 billion the following year because the merchandize trade went into deficit. In 1996 the trade gap worsened further due to the outflow of interest and other services. The net result of current transaction was US$ 24.4 billion. These deficits were cancelled by the increase of direct foreign investment. Accordingly, an overall balance recorded until 1996. In 1997, the capital balance declined to US$ 26.8 billion, so the overall balance went into a deficit of US$ 7.8 billion.

Trade Balance

(Unit: US$ billion)

Item	1994	1995	1996	1997
Trade Balance	10.47	-3.35	-5.54	-8.37
Merchandise Export (FOB)	43.55	46.51	47.75	52.99
Merchandise Import (FOB)	33.08	49.86	53.29	61.36
Services' Balance	-14.74	-18.59	-21.71	-27.29
Interest	-6.34	-8.16	-9.84	-10.39
Other Services	-8.40	-10.43	-11.87	-16.90
Net Transfer	2.59	3.97	2.90	2.22
Current Transactions	-1.69	-17.97	-24.35	-33.44
Capital Balance	14.29	29.36	32.39	26.76
Errors and Omissions	0.33	2.09	0.97	-1.13
Balance of Payment	12.94	13.48	9.02	-7.81

(3) Inflation, Prices and Foreign Exchange Rates

Table 2.2-4 shows price indices of the country and in Recife from the year 1994 to 1999 covering not only consumer prices (INPC) but also wholesale prices. The price index of construction in the country is also indicated in the table. The INPC in Recife increased to 180.6 (base: December 1994=100) in November 1999, up by about 80% in the past five years. Annual price increase rates of the national average and Recife are also shown in the table. In Recife, the rate of increase was 3.6% in 1998 and 8.1% in 1999. However, the rate of increase has stabilized gradually in 1999. On the other hand, the wholesale price index jumped up to 27.5% in 1999 because of the devaluation of the Real(R$).

The table shows the foreign exchange rate of R$ per US$ from 1994 to 1999 at the end of each period. The value of the Real dropped from R$ 0.98 per US$ 1.0 at the end of 1995 to R$ 1.79 at the end of 1999.

(4) Foreign Assistance and Debt

Gross receipts of official development assistance (ODA) from the bilateral and multilateral agencies aggregated to US$ 43.0 billion in total between 1993 and 1997 and averaged US$ 8.6 billion per year. The receipts increased year by year, although the total receipt in 1994 recorded minus US$ 3.2 billion. In 1997, the total receipts amounted to US$ 20.3 billion, accounting for approximately 6% of the annual revenue. The total receipts from bilateral assistance were US$ 18.5 billion in the same year. The top three donors in the same year were as follows: (1) US$ 13.5 billion from United States; US$ 1.9 billion from Japan; and US$ 1.5 billion form Netherlands. The record of ODA to Brazil is summarized in Table 2.2-5.

In 1997, the total external debt was US$ 194 billion. It accounted for 930% of GDP (US$ 20.8 billion in 1997). The outstanding of long-term debt was US$ 158 billion in the same year. The total debt-service was US$ 38 million, comprising US$ 27 million of principal repayment and US$ 11 million of interest payment. Thus, the debt service ratio (DSR) was increased rapidly from 24 % in 1993 to 57 % in 1996. The detailed figures are listed in Table 2.2-6.

2.2.4 Regional Economy

(1) Economic Structure

In the State of Pernambuco, the services sector recorded the highest value in terms of GRDP among the major economic sectors in 1997. It accounted for 57.9% of the total as shown in

the table below. The industrial sector is in second position, accounting for 33.0%. The agricultural sector accounted for only 9.2%. On the other hand, the agricultural sector absorbed 31.7% of the labor force in spite of the lowest economic performance. The industrial sector absorbed only 14.4% of the labor force but made a 33.0% contributed to the total GRDP. The services' sector absorbed 53.9% of labor force.

GRDP and Labor Force (1997)

Economic Sector	GRDP in 1997	Labor Force 1997	
		Pernambuco	RMR
Agriculture	9.2%	31.7%	3.7%
Industry	33.0%	14.4%	17.4%
Services	57.9%	53.9%	78.9%
Total	100.0%	100.0%	100.0%

In the RMR, the agricultural sector absorbed only 3.7% of the labor force. The services sector had the largest labor force of 78.9%. Thus, the economy in the RMR is said to specialize in the services industry.

(2) Agricultural Production

Agricultural activities take place mostly in rural areas in the state. The agricultural production in the RMR is mainly from small-sized intensive farming in the suburbs of the central urban areas, although sugar cane fields are still spread throughout the surrounding municipalities. In 1991, the top five crops in terms of production value were sugar cane, cassava, tomato, feijão bean and banana, as shown in the table below.

Agricultural Production in Pernambuco (1991)

Crop	Cultivated Area (1000 ha)	Production (1000 tons)	Value (Cr$ Million)
Sugar Cane	467	23,505	172.9
Cassava	112	1,126	30.7
Tomato	10	324	20.5
Feijão Bean	300	98	16.6
Banana	31	39	14.0

Source: Anuario Estatistico de Pernambuco, 1992, CONDEPE

(3) Industrial Production

The industrial sector achieved around one-third of the GRDP in the state. Within the industrial sector, manufacturing sub-sector had the largest share, accounting for 51 %. Among many manufacturing industries, the leading is the food industry. Its value added attained R$ 1.1 billion in 1997, accounting for 29 % of the entire manufacturing performance.

Industrial Production in Pernambuco (1997)

Type of Industry	Gross Value Added (R$ Million)	Percentage Share (%)
Food Industry	1,104	28.5
Beverage	469	12.1
Metal fabrication	459	11.8
Chemical Products	311	8.0
Non-metallic Products	280	7.2
Others	1,257	32.4
Total	3,880	100.0

Source: Gross Regional Domestic Product Information, Dec. 1999, FIEPE & CONDEPE

Next to the food industry, the following types of industry attained high production levels in the state in 1997: beverages, metal fabrication, chemical products and non-metallic products.

(4) Tourism

Tourism is expected to be the leading industry in the State of Pernambuco. Under the "PRODETUR II" development program, the state government emphasizes the promotion of the tourism industry. In fact, the number of tourists is increasing year by year. In 1998, 1.76 million tourists visited the state. Among these tourists, 0.88 million people stayed at hotels or other commercial accommodations. The total revenue from tourism was estimated at US$ 534 million in the state.

In the RMR, 1.14 million tourists arrived and 0.42 million stayed in commercial accommodations. Of these tourists, 93% were Brazilian and only 7% were from abroad. Their expenses were estimated at US$ 347 million. Detail of these tourists is given in the table below.

(Performance in RMR in 1998)

Item	Local Tourist	Foreign Tourist	Total
Number of Visitors (1000)	1,064	78	1,142
Number of Tourists Lodged (1000)	-	-	422
Average Length of Staying (days)	8.6	10.8	9.0
Average Daily Expense (US$)	33.2	51.4	34.7
Total Expenses (US$ Million)	303.7	43.7	347.4

Source: Tourism in Pernambuco: Selected Indicators, 1999, Secretary of Economic Development, Tourism and Sports

The major purposes of Brazilian travelers are (1) business; (2) sightseeing and (3) visit to parents and friends as shown in the table below. For foreign travelers, the main purpose is sightseeing, accounting for 57% of the total. National sightseers except those on one-day trip stayed at hotels or other accommodations for an average of 7.2 days. The figure is 7.6 days for foreign tourists.

(Performance in RMR in 1997/1998)

Purpose of Travel	Distribution of Purposes (%)		Period of Staying (days)	
	Local	Foreign	Local	Foreign
Sightseeing	28	57	7.2	7.6
Visit to Parents and Friends	25	14	12.6	24.0
Conference	5	3	7.4	4.9
Business	37	25	8.1	9.9
Health Care	4	0	9.3	0.0
Religion	1	1	5.8	1.5

Source: Macroestrantegia turistica para o Estado de Pernambuco, Aug. 1999, GEP

In a questionnaire survey of tourists, urban infrastructures for tourists in the state was evaluated. In terms of security, 55% of the respondents evaluated it as excellent or good. Regarding airport facilities, 79% evaluated them as excellent or good. On the other hand, 62% evaluated public cleanliness in towns as fair (35% of fair and 27% of poor). The tourists seem to perceive urban cleanliness as tourist attraction.

(5) Infrastructure

The following table shows the coverage of basic public services in the state in 1996. Water supply services cover nearly 4.9 million people and 173 districts. There are 184 water treatment stations (ETA) and 19 laboratories in the state. In the RMR, the four largest ETAs had a nominal treatment capacity of 8.1 m^3/sec in 1996. Water supply and sewerage services are managed by COMPESA.

(Unit: % of residences covered with services)

Infrastructure	Urban Area	Rural Area	Total
Water Supply	90.1	7.1	71.9
Sewerage Services	33.8	1.5	26.7
Refuse Collection	63.5	3.5	50.3
Electricity	99.4	65.2	91.9
Telephone	15.8	0.9	12.5

Source: Pernambuco, Basic Information, 1997, Secretary of Economic Development, Tourism and Sports

The electricity system serves most of the population in the state, as shown in the table above. The system is managed as follows: generation systems by Hydroelectric Company of São Francisco (CHESF) and transmission and distribution systems by the Electricity Company of Pernambuco (CELPE).

(6) Household Economy

Family income and expenditure can roughly describe living conditions of the people. The data on average household expenditure in Recife is presented in Table 2.2-7. The average expenditure was R$ 922 per month in 1995/96.

The average expense on housing was R$ 195 per month or 21% of total family expenditure. This expense includes housing cost and utility costs. Of the total the utilities expense accounted for R$ 63 or 7%. This included electricity, gas, telephone and water as well as sewerage services. It is difficult to segregate the expense for sewerage service because of lack of data. If the expense for sewerage service was one-fifth of the utility expense, the amount would be R$ 13 per month.

The average expense for health care was R$ 69 per month or 7 % of the total family expenditure. The largest among health care items was an expense for insurance, although low-income families do not pay for this item as shown in the table. The second largest expense was for medicines: R$ 20 per month on average. Even low-income families paid for not small amount of this item. This means that the expense for medicines could be a heavy burden for low-income families.

While some data on family expenditure is available, the average family income is not clear. If family income is estimated through weighted average of income distribution in the table, the average family income will be around 8 minimum wages. Since the minimum wage was R$ 100 in 1995/96, the average family income was R$ 800 per month, which is smaller than the average family expenditure.

The Engel coefficient, which is the percentage of total income spent on food, is said to be an indicator of standard of living. Lower income families have a high coefficient. The coefficient based on the average figures in Recife was calculated at 26 %. Families with and income of 5 and 6 minimum wages had a coefficient of 40 %. These families may be classified as of low-income.

(7) Public Health Conditions

The public health system covers all the people in Brazil under the Unified Health System (Sistema Único de Saúde: SUS), since the new constitution 1988 prescribed that health is a right of the people. Under the SUS, Brazilian people can get in principle free medical care in specified private hospitals as well as in public hospitals. In the State of Pernambuco, the public health system is managed under 11 regional health management units (Diretorias Regionais de Saúde: DIRES). The RMR belongs to DIRES I. The DIRES I includes four municipalities as well as the 14 municipalities of the RMR.

In DIRES I, Secretary of Health started to record statistics of the incidence of diseases after 1989, though its statistical system is not quite complete yet. Based on the statistics, the

incidence of water borne diseases for the past four years is listed in the table below. Some diseases were not reported for a specific reason. For example, cholera was prevalent in 1996 and 1997, so its information was gathered in a particular section at that period. Thus, the number of cases was not reported to the statistical center. Diarrhea is so common that the cases are not always notified to the statistical information center. Therefore, the actual number of diarrhea cases could be much more than the figure in the table. Leptospirosis usually occurs in quite limited areas and does not spread out to other areas.

Water Borne Diseases	Number of Cases *1				Incidence (per 100,000)			
	1996	1997	1998	1999*2	1996	1997	1998	1999
Cholera *3	-	-	6	582	-	-	0.17	15.95
Diarrhea *4	88	1,665	548	1,283	-	-	15.32	35.15
Schistosomiasis	40	219	460	397	-	-	12.86	10.88
Typhoid Fever	2	-	4	9	-	-	0.11	0.25
Hepatitis *5	449	590	590	580	-	-	16.50	15.89
Leptospirosis	340	228	116	34	-	-	3.24	0.93
All Diseases	-	-	32,789	22,780	-	-	917.00*6	624.00*6

Source: DIRES I, State Secretary of Health

Note: *1 the number was confirmed by medical doctors in hospitals.
*2 The number includes incidence until November.
*3 the cases of cholera were not reported in 1996 and 1997.
*4 the number of diarrhea cases is considered as much more than the notified.
*5 Types A, B and C are included in the figures. Only type A is related to sewerage.
*6 the morbidity was estimated on the basis of population in DIRES I.

In the Municipality of Recife, the municipal secretariat of health reported the incidence of cholera and diarrhea between 1995 and 1998. The number of cases of each disease is shown in the table below.

Item	Cholera				Diarrhea			
	1995	1996	1997	1998	1995	1996	1997	1998
Number of Cases	38	14	27	37	153	138	132	122
·Up to 10 Years Old	5	4	8	21	91	69	40	41
·10 Years Old and Over	33	10	20	16	62	69	92	81
Incidence (per 100,000)	2.85	1.04	2.00	2.73	11.47	10.25	9.77	9.00

The incidence of these diseases seems to be lower than that of DIRES I. This may be because the sanitary conditions in the Municipality of Recife are better than overall conditions in DIRES I. In the case of cholera, the number of cases in the working age bracket (10 years old and over) was larger than 10 years old in 1995. However, this tendency was reversed in 1998. Meanwhile, diarrhea showed the opposite trend as shown in the table.

According to a master thesis on "Mortalidade Infantil e Condicao de Vida: Uma Analise da Desigualdade Espacial no Recife", 1998, Maria J.Bezerra Guimaraes at Pernambuco State University, the infant death rate is affected by living conditions in the neighborhoods. The thesis presented a factor analysis regarding infant deaths in four different economic clusters in

the Municipality of Recife. It concluded that the risk of dying during the first year of life of perinatal disorder, bronchopneumonia and gastro-enteritis was 42 %, 61 % and 274 % higher in the cluster of low level living conditions than that in the cluster of high level living conditions. In the same way, living conditions in neighborhood might influence mortality rates.

2.2.5 Land Use

The RMR was established in 1973 based on the Complementary. In 1976, FIDEM prepared the first metropolitan development plan of the RMR. The RMR had a population of 3.1 million (in 1996) in the total area of 2,766 km^2. Of the whole RMR, the urbanized areas account for 302 km^2 or 11%. The urbanised areas are located predominantly in the coastal strip, including the estuary of the Capibaribe, Beberibe and Tejipió Rivers. The Island of Recife and the port, sites of the foundation of the city, are located at the estuary of the rivers. The metropolitan is characterized by the conurbation of Recife with the bordering municipalities and of these with other ones. It functions interdependently and needs an integrated conception of urban planning and politics, transport and sanitation.

Among 14 municipalities, the Municipality of Recife has the largest urbanised area of 109 km^2, as shown in the table below. The five core municipalities, i.e., Recife, Olinda, Paulista, Camaragibe and Jaboatão dos Guararapes, have urbanized areas of 229 km^2.

Municipality	Municipal Area (km^2)	Urbanized Area (km^2)	Rate of Urbanized Area (%)
Abreu e Lima	138	10.9	7.9
Araçoiaba	90	0.8	0.9
Cabo de Santo Agostinho	445	11.9	2.7
Camaragibe	51	22.7	44.5
Igarassu	300	11.3	3.8
Ipojuca	527	8.9	1.7
Itamaracá	67	6.2	9.2
Itapissuma	75	1.7	2.3
Jaboatão dos Guararapes	259	42.3	16.3
Moreno	193	4.2	2.2
Olinda	41	25.2	61.5
Paulista	99	30.1	30.4
Recife	218	108.5	49.8
São Lourenço da Mata	263	16.9	6.4
RMR	2,766	301.6	10.9

Besides the urbanised areas, the area of the RMR is characterised by two different kinds of occupation. The cultivated areas are characterised by the predominance of sugar cane plantations, which are located in portions to the north, the west and the south of the RMR.

Even in the core municipalities, the cultivated areas exist in suburban zones outside of the urbanized areas. Of the surrounding municipalities, Ipojuca occupies the largest territory, with 527 km^2. It has the least-urbanized areas of all, with a degree of urbanization of 1.7%. In other words, great part of the population of the town lives on rural activities, above all, on the sugar cane plantations. Cabo de Santo Agostinho, Moreno and Igarassú follow the same pattern.

The forestlands are dispersed throughout residual zones in the RMR. The forestlands are mostly located in the surrounding municipalities as protection zones for water resources catchments under State Law No.9860 in 1986.

2.2.6 Development Plans

(1) Federal Development Plan 2000-2003

"Plano Plurianual 2000-2003 (Multi-year Development Plan 2000-2003)" presents the national development policy to support medium-term economic growth in the country. The plan proposes the macro-economic goals and target figures. These are essential information to project a socio-economic framework for the current study. The targets of GDP growths for the period are proposed as follows. In this study these target figures are adopted to construct a future framework, although the projection period of the plan is only until 2003.

Item	2000	2001	2002	2003
GDP Growth Rate (%)	4.0	4.5	5.0	5.0

Source: Plan Plurianual 2000-2003, Orçamentos da União 2000, 1999, GOB

The actual GDP growth rate during four years from 1994 to 1997 was 4.6 % on average. The target growth seems to be high as compared with what was actually achieved. The plan expects economic conditions in and out of the country to improve after the economic stagnation in these years.

(2) State Development Plan 2000-2003

The state government plan 2000-2003, "Projeto de Lei do Plano Plurianual 2000-2003, Governo de Pernambuco", is still under preparation, although its draft has been submitted to the state parliament. The plan proposes medium-term budgets for sectors related to the government policy. However, it does not propose a goal for economic growth during the planning period.

Table 2.2-1 Census Population in Brazil, Pernambuco, RMR and Municipalities Involved: 1970, 1980, 1991 and 1996

Area	Census Population				Census Urban Population				Census Rural Populatiopn			
	1970	1980	1991	1996	1970	1980	1991	1996	1970	1980	1991	1996
Population												
I. Brazil	93,139,037	119,002,706	146,825,475	157,070,163	52,084,984	80,436,409	110,990,990	123,076,831	41,054,053	38,566,297	35,834,485	33,993,332
II. Pernambuco State	5,160,640	6,141,993	7,127,855	7,399,071	2,810,843	3,783,264	5,051,654	5,476,855	2,349,797	2,358,729	2,076,201	1.922.216
III. RMR	1,832,306	2,407,179	2,920,007	3,099,956	1,663,585	2,154,874	2,757,088	2,935,401	168,721	252,305	162,919	164,555
1. Abreu e Lima	26,065	47,058	77,035	80,828	23,083	41,369	70,548	72,679	2,982	5,689	6,487	8,149
2. Araçoiaba	8,669	8,881	10,640	11,989	3,546	6,300	9,077	10,227	5,123	2,581	1,563	1,762
3. Cabo de Santo Agostinho	75,829	104,157	127,036	140,764	40,284	81,901	109,763	125,055	35,545	22,256	17,273	15,709
4. Camaragibe	46,671	87,710	99,407	111,119	41,196	66,992	99,407	111,119	5,475	20,718	0	0
5. Igarassu	37,370	51,843	69,197	85,051	24,198	42,228	50,740	65,163	13,172	9,615	18,457	19,888
6. Ipojuca	35,851	39,456	45,424	48,479	10,003	16,925	25,168	30,428	25,848	22,531	20,256	18.051
7. Itamaracá	7,117	8,256	11,606	13,799	4,087	6,501	8,580	11,210	3,030	1,755	3,026	2,589
8. Itapissuma	9,040	12,521	16,408	19,186	7,193	10,128	14,101	16,077	1,847	2,393	2,307	3,109
9. Jaboatão dos Guararapes	200,975	330,414	487.119	529,966	185,833	290,509	419,479	457,664	15,142	39,905	67,640	72,302
10. Moreno	31,204	34,943	39,132	39,962	17,681	26,229	31,571	32,063	13,523	8,714	7,561	7,899
11. Olinda	196,342	282,203	341,394	349,380	187,428	266,751	341,394	349,380	8,914	15,452	0	0
12. Paulista	43,994	118,689	211,491	233,634	39,401	55,269	207,708	229,515	4,593	63,420	3,783	4,119
13. Recife	1,060,329	1,203,899	1,298,229	1,346,045	1,046,413	1,183,391	1,298,229	1,346,045	13,916	20,508	0	0
14. São Lourenço da Mata	52,850	77,149	85,889	89,754	33,239	60,381	71,323	78,776	19,611	16,768	14,566	10,978
Average Annual Growth Rate (%)	-	'70/'80	'80/'91	'91/96	-	'70/'80	'80/'91	'91/96	-	'70/'80	'80/'91	'91/96
I. Brazil	-	2.5	1.9	1.4	-	4.4	3.0	2.1	-	-0.6	-0.7	-1.0
II. Pernambuco State	-	1.8	1.4	0.7	-	3.0	2.7	1.6	-	0.0	-1.2	-1.5
III. RMR	-	2.8	1.8	1.2	-	2.6	2.3	1.3	-	4.1	-3.9	0.2
1. Abreu e Lima	-	6.1	4.6	1.0	-	6.0	5.0	0.6	-	6.7	1.2	4.7
2. Araçoiaba	-	0.2	1.7	2.4	-	5.9	3.4	2.4	-	-6.6	-4.5	2.4
3. Cabo de Santo Agostinho	-	3.2	1.8	2.1	-	7.4	2.7	2.6	-	-4.6	-2.3	-1.9
4. Camaragibe	-	6.5	1.1	2.3	-	5.0	3.7	2.3	-	14.2	-	-
5. Igarassu	-	3.3	2.7	4.2	-	5.7	1.7	5.1	-	-3.1	6.1	1.5
6. Ipojuca	-	1.0	1.3	1.3	-	5.4	3.7	3.9	-	-1.4	-1.0	-2.3
7. Itamaracá	-	1.5	3.1	3.5	-	4.8	2.6	5.5	-	-5.3	5.1	-3.1
8. Itapissuma	-	3.3	2.5	3.2	-	3.5	3.1	2.7	-	2.6	-0.3	6.1
9. Jaboatão dos Guararapes	-	5.1	3.6	1.7	-	4.6	3.4	1.8	-	10.2	4.9	1.3
10. Moreno	-	1.1	1.0	0.4	-	4.0	1.7	0.3	-	-4.3	-1.3	0.9
11. Olinda	-	3.7	1.7	0.5	-	3.6	2.3	0.5	-	5.7	-	-
12. Paulista	-	10.4	5.4	2.0	-	3.4	12.8	2.0	-	30.0	-22.6	1.7
13. Recife	-	1.3	0.7	0.7	-	1.2	0.8	0.7	-	4.0	-	-
14. São Lourenço da Mata	-	3.9	1.0	0.9	-	6.2	1.5	2.0	-	-1.6	-1.3	-5.5

Source: (1) Annuario Estatistico do Brasil, 1997, IBGE
(2) Censo Demografico de Pernambuco - 1980 e 1991, IBGE

Table 2.2-2 Gross Domestic Product by Economic Sectors in Brazil: 1994-1997

Economic Sector	1994	1995	1996	1997
Gross Domestic Product at Current Prices (Unit: R$ Billion)				
1. Agriculture	34.0	55.1	63.2	66.4
2. Industry	135.8	240.3	292.1	326.6
1) Mining & Quarring	4.4	6.6	7.6	9.0
2) Manufacturing	92.9	158.4	187.6	202.9
3) Construction	27.4	56.0	70.1	84.3
4) Elec. Gas & Water	11.1	19.4	26.7	30.4
3. Services	179.4	351.3	423.6	471.1
1) Commerce	29.0	62.0	65.0	68.0
2) Hotel & Restaurant	6.3	12.8	15.3	15.6
3) Transportation & Communication	12.9	21.4	30.9	34.9
4) Finance, Real Estate, etc.	71.4	124.3	151.4	179.1
5) Public Services	45.5	99.9	121.3	128.7
6) Other Services	14.3	31.0	39.6	44.8
6. GDP at Market Prices	349.2	646.2	778.9	864.1
in US$ Billion*1	412.8	658.0	749.6	774.3
8. GDP per Capita (R$)	2,280	4,160	4,946	5,413
in US$	2,695	4,237	4,760	4,850
Gross Domestic Product at 1997 Constant Prices (Unit: R$ Billion)				
1. GDP at Market Prices	778.8	811.7	834.1	864.1
Real Growth Rate (%)	5.9	4.2	2.8	3.6
2. GDP per capita	5,086	5,226	5,296	5,413
Real Growth Rate (%)	4.3	2.8	1.4	2.2
Percentage Distribution (%)				
1. Agriculture	9.74	8.53	8.12	7.68
2. Industry	38.88	37.19	37.50	37.80
1) Mining & Quarring	1.27	1.02	0.98	1.04
2) Manufacturing	26.59	24.51	24.09	23.48
3) Construction	7.84	8.66	9.00	9.76
4) Elec. Gas & Water	3.18	3.00	3.43	3.52
3. Services	51.38	54.37	54.38	54.52
1) Commerce	8.31	9.60	8.35	7.87
2) Hotel & Restaurant	1.80	1.98	1.96	1.80
3) Transportation & Communication	3.70	3.31	3.97	4.04
4) Finance, Real Estate, etc.	20.44	19.23	19.44	20.73
5) Public Services	13.03	15.46	15.57	14.89
6) Other Services	4.10	4.79	5.09	5.19
4. GDP at Market Prices	100.00	100.09	100.00	100.00

Source: Contas Nacionais Numero 3, Contas Regionais do Brasil 1985-1997, March 1999, IBGE

Note: *1 The following exchage rates were applied, which were at the end of year.

Year	1994	1995	1996	1997
R$ per US$	0.846	0.982	1.039	1.116

Table 2.2-3 Gross Regional Domestic Product in Pernambuco State: 1994-1997

Economic Sector	1994	1995	1996	1997
Gross Regional Domestic Product at Current Prices (Unit: R$ Billion)				
1. Agriculture	0.92	1.81	2.30	2.14
2. Industry	3.09	5.57	6.41	7.67
1) Mining & Quarring	0.01	0.02	0.03	0.03
2) Manufacturing	1.77	3.32	3.63	3.88
3) Construction	1.09	1.90	2.34	3.22
4) Elec. Gas & Water	0.23	0.33	0.41	0.54
3. Services	5.03	10.09	12.68	13.46
1) Commerce	1.20	2.55	2.80	2.82
2) Hotel & Restaurant	0.35	0.66	0.86	0.90
3) Transportation & Communication	0.28	0.44	0.79	0.93
4) Finance, Real Estate, etc.	1.23	2.18	2.92	3.26
5) Public Services	1.49	3.29	4.05	4.11
6) Other Services	0.47	0.96	1.26	1.44
6. GRDP at Market Prices	9.04	17.46	21.39	23.26
in US$ Billion*1	10.68	17.78	20.59	20.84
7. GRDP per Capita (R$)	1,239	2,375	2,887	3,115
in US$	1,465	2,419	2,779	2,791
Gross Regional Domestic Product at 1997 Constant Prices				
1. GRDP at Market Prices (R$ Billion)	20.54	21.78	22.50	23.26
Real Growth Rate (%)	7.7	6.0	3.3	3.4
2. GRDP per Capita (R$)	2,832	2,974	3,042	3,115
Real Growth Rate (%)	6.7	5.0	2.3	2.4
Percentage Distribution (%)				
1. Agriculture	10.22	10.34	10.77	9.18
2. Industry	34.16	31.89	29.95	32.97
1) Mining & Quarring	0.07	0.10	0.12	0.12
2) Manufacturing	19.55	18.99	16.98	16.68
3) Construction	12.03	10.90	10.92	13.84
4) Elec. Gas & Water	2.51	1.90	1.93	2.33
3. Services	55.62	57.77	59.28	57.85
1) Commerce	13.28	14.58	13.11	12.12
2) Hotel & Restaurant	3.88	3.80	4.02	3.86
3) Transportation & Communication	3.14	2.54	3.67	3.99
4) Finance, Real Estate, etc.	13.58	12.47	13.65	14.02
5) Public Services	16.53	18.86	18.94	17.66
6) Other Services	5.21	5.52	5.89	6.20
4. GDP at Market Prices	100.00	100.00	100.00	100.00

Source: Contas Nacionais Numero 3, Contas Regionais do Brasil 1985-1997, 1999, IBGE
Information and data presented by CONDEPE and FIEPE

Note: *1 The following exchage rates were applied, which were at the end of year.

Year	1994	1995	1996	1997
R$ per US$	0.846	0.982	1.039	1.116

Table 2.2-4 Consumer and Wholesale Price Indices and Foreign Exchange: 1994-1999

Year	Month	National Consumer Price Index: INPC(Base: Dec. 1994 = 100)					Wholesale Price Index (Base: Aug. 1994=100)	Price Index of Construction (Base: Aug. 1994=100)			Foreign Exchange Rate (Reals/US$)	
		Brazil				Recife						
		All Items	food & Beverages	Housing	Health & Pers. Care	All Items		Total	Materials	Labor	Official Rate	Parallel Rate
1994	Dec.	100.0	100.0	100.0	100.0	100.0	100.0	105.5	104.2	107.1	-	-
1995	Dec.	122.0	108.4	166.3	128.5	121.6	115.1	138.7	124.3	156.5	0.9820	1.0000
1996	Dec.	133.1	110.8	209.6	145.1	132.1	115.0	151.9	129.9	181.5	1.0390	1.1200
1997	Dec.	138.9	112.3	226.8	154.3	134.7	123.9	162.3	135.2	199.8	1.1160	1.2200
1998	Dec.	142.3	115.8	232.6	162.9	139.6	134.6	-	-	-	1.2080	1.2900
1999	Jan.	143.3	116.8	232.8	163.7	140.5	136.8	-	-	-	1.9832	2.0000
	Feb.	145.1	120.2	233.7	165.0	142.9	146.3	-	-	-	2.0648	1.9800
	Mar.	147.0	122.7	235.7	167.9	144.1	150.5	-	-	-	1.7220	1.7800
	Apr.	147.7	122.1	237.4	170.9	144.8	150.0	-	-	-	1.6607	1.7200
	May	147.7	120.7	237.9	173.6	144.3	148.7	-	-	-	1.7240	1.7300
	Jun.	147.8	119.1	239.5	174.9	145.1	150.8	-	-	-	1.7695	1.8200
	Jul.	148.9	118.6	242.5	175.9	146.0	153.8	-	-	-	1.7892	1.8550
	Aug.	149.8	118.7	244.7	178.0	146.8	157.1	-	-	-	1.9159	1.9800
	Sep.	150.3	119.2	245.4	179.3	147.5	160.7	-	-	-	1.9223	1.9800
	Oct.	151.8	121.7	245.4	180.1	148.8	164.9	-	-	-	1.9530	2.0200
	Nov.	153.2	123.7	246.2	180.6	149.9	-	-	-	-	1.9227	2.0200
	Dec.	-	-	-	-	-	-	-	-	-	1.7890	1.9500

		Annual Increase Rate of INPC (%)					Annual Increase Rate (%)	Annual Increase Rate of Construction (%)			Annual Increase of Foreign Exchage Rate	
		Brazil				Recife						
		All Items	food & Beverages	Housing	Health & Pers. Care	All Items		Total	Materials	Labor	(%)	(%)
1995	Dec.	22.0	8.4	66.3	28.5	21.6	15.1	31.5	46.1	19.4	-	-
1996	Dec.	9.1	2.2	26.0	12.9	8.6	-0.1	9.6	16.0	4.5	5.8	12.0
1997	Dec.	4.3	1.3	8.2	6.3	2.0	7.8	6.8	10.1	4.1	7.4	8.9
1998	Dec.	2.5	3.1	2.5	5.6	3.6	8.6	-	-	-	8.2	5.7
1999	Nov.	8.4	7.5	6.4	11.9	8.1	27.5	-	-	-	48.1	51.2
Average(94-99)		9.3	4.5	21.9	13.1	8.8	11.8	-	-	-	17.4	19.5

Source: (1) Anuario Estatistico do Brasil 1997, 1998, IBGE
(2) Brazil em Numeros, Vol.6 - 1998, IBGE
(3) Banco Central do Brasil
(4) "Conjuntura Estatistica" by FGV

Table 2.2-5 Official Development Assistance: 1992-1997

(Unit: US$ Million)

Item	1993	1994	1995	1996	1997
Bilateral	**4,337**	**-2,978**	**9,393**	**11,233**	**18,547**
1. United States	3,640	6,375	6,124	5,731	13,460
2. Japan	-175	-7,439	575	2,746	1,908
3. Netherlands	260	-89	201	158	1,489
4. Germany	497	886	1,812	516	1,292
5. Italy	-69	166	651	240	1,234
6. France	-117	-2,885	-753	788	1,219
7. United Kingdom	70	440	807	1,103	943
8. Spain	1	20	57	539	612
9. Portugal	-1	2	34	322	495
10. Belgium	8	21	-163	-1,026	-4,618
11. Others	223	-475	48	116	513
Multilateral	**-566**	**-246**	**-19**	**1,650**	**1,710**
1. Interamerical Development Bank	83	280	136	494	1,051
2. World Bank	-808	-706	-539	278	368
3. UN Development Programme	41	85	97	123	201
4. Others	118	95	287	754	90
Total	**3,771**	**-3,225**	**9,374**	**12,882**	**20,257**

Source: Geographical Distribution of Financial Flows to Aid Recipients, Disbursements Commitments Country Indicators 1993-1997, OECD Development Assistance Committee

Note: Official development assistance is defined as grants and loans, with at least a 25% grant element, administered with the aim of promoting economic and social development.
Figures indicate net amounts.

Table 2.2-.6 External Debt: 1992-1997

(Unit: US$ Billion)

Item	1993	1994	1995	1996	1997
Total External Debt	**143.8**	**151.2**	**159.0**	**179.5**	**193.7**
1. Long Term Debt	112.9	119.6	128.4	144.0	157.6
2. Use of IMF Credit	0.3	0.2	0.1	0.1	0.0
3. Short Term Debt	30.6	31.4	30.5	35.4	36.1
Debt Outstanding of Long Term Debt	**112.9**	**119.6**	**128.4**	**144.0**	**157.6**
1. Public and Publicly Guaranteed	92.0	94.9	97.6	95.0	86.7
a. Official Creditors	30.0	29.4	28.4	26.5	23.3
- Multilateral	9.5	9.4	9.4	9.4	10.1
- Bilateral	20.6	20.0	19.1	17.1	13.2
b. Private Creditors	62.0	65.5	69.1	68.5	63.4
- Bonds	11.6	53.6	54.6	56.1	50.7
- Commercial Banks	45.0	6.8	9.7	8.7	9.9
- Others	5.4	5.2	4.8	3.6	2.9
2. Private Non-guaranteed	20.9	24.7	30.8	49.0	70.8
Total Debt Service	**11.2**	**16.2**	**21.7**	**25.1**	**38.1**
1. Principal Repayment	6.8	9.6	10.9	14.4	26.5
a. Long Term Debt	6.3	9.4	10.9	14.4	26.5
b. IMF Repurchases	0.5	0.1	0.0	0.1	0.0
2. Interest Payments	4.4	6.6	10.8	10.6	11.6
a. Long Term Debt	3.2	5.1	9.0	8.8	10.2
b. IMF Charges	0.0	0.0	0.0	0.0	0.0
c. Short Term Debt	1.2	1.5	1.8	1.9	1.4
Ratios (%)					
1. Total External Debt/GNP	33.6	28.1	22.9	23.5	24.1
2. Debt Service Ratio *1	24.4	30.6	36.8	42.3	57.4

Source: Global Development Finance 1998, March 1999, World Bank

Note: Long term debt is defined as having original maturity of more than one year.
*1 Debt service as a percentage of earnings from exports of goods and service.

Table 2.2-7 Average Annual Household Expenditure by Expenditure Item in Recife: 1995/96

(Unit: R$)

Item	Entire Families	Monthly Family Income Class (Ratio to Minimum Wage)									
		Less than 2	2 to 3	3 to 5	5 to 6	6 to 8	8 to 10	10 to 15	15 to 20	20 to 30	30 and Over
Gross Expenditure	922.74	246.69	359.68	514.42	683.07	774.62	952.70	1,291.18	1,732.63	2,360.86	4,559.97
I. Current Expenditure	807.44	230.06	344.17	476.43	648.38	731.36	866.89	1143.78	1507.47	1999.34	3669.61
A. Expenditure for Consumption	738.15	225.01	334.23	452.69	608.62	691.68	805.51	1,063.35	1,379.90	1,789.53	3,142.00
1. Food and Beverages	209.43	96.26	137.67	174.61	220.27	234.83	214.26	294.24	299.94	377.32	601.31
2. Housing and Utilities	194.56	54.76	77.91	105.34	137.45	167.25	223.00	277.56	376.71	480.03	935.68
a. Housing Rent	36.50	10.73	14.94	16.08	15.46	31.67	40.79	61.02	75.58	95.66	174.54
b. Utilities	63.48	13.37	16.42	29.67	50.02	47.98	54.74	90.09	128.89	164.13	369.01
c. Furnishing	94.58	30.66	46.55	59.59	71.97	87.60	127.47	126.45	172.24	220.24	392.13
3. Clothing and Foot Wear	53.08	14.73	24.72	36.76	51.94	56.21	69.16	86.70	100.41	115.15	187.84
4. Transport	86.57	21.26	36.34	53.93	54.11	75.04	98.72	119.92	167.95	234.61	398.99
5. Personal Care	17.85	5.72	9.78	14.05	17.30	19.19	23.37	28.86	33.85	31.89	56.76
6. Health Care	68.70	11.56	16.29	24.71	48.24	52.66	69.05	105.77	167.39	212.25	377.13
a. Medicines	19.89	8.35	10.51	15.12	22.30	23.06	25.79	28.64	37.21	44.09	50.46
b. Insurance	30.09	0.86	2.42	5.06	13.12	17.38	28.12	51.68	87.36	111.34	197.87
c. Medical Consultation	1.21	0.16	0.21	0.48	0.50	0.43	1.77	2.64	2.88	2.63	7.37
d. Hospitalization	2.53	-	-	-	-	0.26	0.67	1.12	1.48	0.41	38.05
e. Others	14.98	2.19	3.15	4.05	12.32	11.53	12.70	21.69	38.46	53.78	83.38
7. Education	38.81	6.81	6.10	15.92	28.71	26.17	41.89	60.66	101.33	126.59	203.69
8. Recreation and Culture	22.12	3.04	4.18	7.07	20.09	15.14	21.65	32.31	44.19	86.84	123.09
9. Tobacco	9.23	4.74	8.52	6.96	8.00	11.81	11.17	10.95	14.05	19.98	18.85
10. Personal Services	11.53	2.72	5.42	6.31	10.10	11.82	14.00	17.09	20.03	28.38	51.15
11. Other Consumption	26.27	3.41	7.30	7.03	12.41	21.56	19.24	29.29	54.05	76.49	187.51
B. Other Expenditure	69.29	5.05	9.94	23.74	39.76	39.68	61.38	80.43	127.57	209.81	527.61
II. Increment of Assets	103.03	15.60	13.93	31.59	28.03	38.32	78.74	137.07	196.34	325.84	795.22
III. Repayment of Debts	12.27	1.03	1.58	6.40	6.66	4.94	7.07	10.33	28.82	35.68	95.14
Number of Families	715,938	184,972	96,624	130,097	40,027	66,053	35,024	56,535	29,830	33,339	43,437
Average Family Size	4.06	3.56	3.93	4.40	4.27	4.53	4.30	4.32	4.13	3.94	4.04

Source: Pesquisa de Orcamentos Familiares 1995-1996, Vol 1 Despesas, Recebimentos e Caracteristicas das Familias, Domicilios, Pessoas e Locais de Compra, 1999, IBC
Note: A minimum wage is stipulated as R$136 in 1999.

2.3 Poverty Area

2.3.1 General

In the RMR there are a large number of poverty areas, formerly called "slum", that present various problems. Although there is no accurate information about the population living in the poverty areas of the RMR, some sources estimate this population at more than 40% of the whole RMR population.

The common features of these settlements are the precarious basic infrastructure (especially drainage and sewerage facilities, solid waste collection, etc.), a high population density, a low sanitary level, and/or sometimes vulnerability to natural disasters such as landslides and floods.

Some of these settlements have been specified as ZEIS (Special Zones of Social Interest); a legal classification specified in the Brazilian National Constitution of 1988, introduced in some municipalities through special laws. Once a poverty area becomes a ZEIS, the settlement may undergo urbanization and an ownership registration process, supported by the respective municipal government. A questionnaire survey on resident's awareness in the RMR was conducted during the Study.

2.3.2 Distribution of Poverty Areas within the RMR

(1) Poverty Areas in Recife

At present, the poverty areas are scattered all over the urban area of the RMR. Some of these poverty areas are more than 50 years old. Currently, due to the level of organization of their communities, these areas have some basic infrastructure such as water supply, electricity, paved roads and flights of steps. Nevertheless, there are still many areas in which living conditions are very precarious.

In 1988, the Pernambuco State Secretariat of Housing, Sanitation and Civil Works carried out the first mapping of Recife poverty areas, and identified approximately. 500 of them, occupying around 15% of the city area.

There are neither recent nor accurate figures for the population living in these poverty areas at present. If we only consider the ZEIS, the information available on them gives a total population of approximately 800,000, in 66 ZEIS, in 1999. Considering the population estimate carried out by FIDEM for Recife in the year 2000 (1,385,563), the ZEIS population accounts for approximately 58%. Therefore, the total population of poverty areas (ZEIS or non-ZEIS) is assumed to be more than 60% of the total population of Recife City.

(2) Poverty Areas in Olinda

During the 1960's, Olinda underwent a fast population growth. In same period, eight (8) major low-cost housing projects were executed by the government (COHAB) or by private companies, within the national housing policy for low-income populations. Olinda is only 8 km from the center of Recife and thus has plays an important role as a dormitory town.

At present, due to the lack of a housing policy, no more major low-cost housing projects are underway. As a result the low-income population was forced to occupy the hilly areas and flat and/or flood hazard areas, as well as other illegal areas, following the same pattern as in Recife. Currently there exist sixty (60) poverty areas in Olinda (1995).

In 1995, the Municipal Secretariat of Planning and Environment carried out a study in which they defined "homogeneous areas" according to housing and physical/environmental standards. According to this study, 34.3% (categories IV and V) of the population lived in precarious areas in terms of infrastructure and hazardous conditions as shown in the following table. According to the same source, 79.4% of the urban population had an average household income of 3.3 MW (3.3 times the minimum wage) or less.

Homogeneous Areas in Olinda

Category	CHARACTERISTICS		% of the total pop.	Average Household Income
	HOUSING STANDARD	PHYSICAL/ENVIRONMENTAL CONDITIONS		
I	Predominance of medium and high construction standards, with some apartment blocks, legal property land, lots with an average size of 360 m^2.	Predominantly flat topography located close to the coast, with regular water supply, with connection to sewerage or with cesspit, regular garbage collection, and good access.	17.8	9.3 MW
II	Large housing projects, 1 or 2 story masonry houses in 200 m^2 lots, or low-cost apartment buildings.	Predominantly flat topography, with regular water supply, with connection to sewerage, unsatisfactory garbage collection, and good access.	25.8	3.3 MW
III	Predominance of low and medium construction standards, legal property land, lots with an average size of 200 m^2.	Flat topography, drainage problems in the streets, regular water supply, cesspit, unsatisfactory garbage collection, and reasonably good access.	19.3	2.1 MW
IV	High concentration of low construction standard dwellings, masonry or mud walls, irregular shaped lots due to steep topography, lots with an average size less than 200 m^2.	Steep topography, landslide problems, irregular water supply, precarious sewage collection (if any), unsatisfactory garbage collection, and precarious access.	21.3	1.3 MW
V	High-density areas, illegal occupation of areas improper for housing, minimum size lots, construction standard varying from consolidated (masonry) to precarious (perishable materials such as plastic, pieces of wood, canvas, etc.).	Located in landslide or flood hazard areas, totally destitute of infrastructure, very precarious access.	13.0	0.9 MW
RURAL AREA			2.8	

Source: PQA, Diagnóstico das Áreas Pobres Prioritárias, FADE / UFPE, 1997.
Note: MW = Minimum Wage (R$ 136, as for Dec. 1999).

In recent talks with officials of this Secretariat, the Study Team was informed that the number of poverty areas (60) was the same as before. However, their population had increased considerably. The population is counted only when some projects are to be carried out such as in the Maruim Island poverty area. There, the Secretariat of Civil Works and Urban Services is implementing a project in which some of the settlements along the Beberibe River are going to be removed and the remaining residents will be provided with improved infrastructure such as drainage and sewerage facilities.

(3) Poverty Areas in Jaboatão dos Guararapes

The population growth rate in Jaboatão is closely related to the migratory process within the RMR, especially to that of the last decade (1980's). During this period, several large popular housing projects were implemented by COHAB in Jaboatão. Concerning the poverty areas, according to the document "Estudos Realizados na Bacia da Lagoa Olho D'Água, Vol. I" (Dec/99), carried out by the municipal government, revealed the existence of 54 poverty areas and the number of residents is estimated to be approximately 70 % of the total population.

It is the District of Prazeres that has the highest number of poverty areas. The service industry is booming there, mainly in the coastal areas. In recent years, three (3) luxury hotels and a large shopping center have been constructed in this district.

Probably due to the attraction of these services, the majority of the new poverty areas are located in the District of Prazeres. However, the occupation of this district by the poor population is not a new event. The oldest settlements, legalized as ZEIS, almost 30 years old, are mainly located within the Olho d'Agua Lagoon basin in the District of Prazeres, in flat and flood hazard areas. The population of these ZEIS within the lagoon basin is approximately 87,780 distributed in 28 communities (except the ZEIS Moenda de Bronze that is located in the district of Jaboatão – old center). According to the EMDEJA (Jaboatão Development Company) the population living in non ZEIS could be almost equal to the ZEIS population in the basin of the Olho d'Agua Lagoon.

(4) Poverty Areas in Camaragibe

The municipality of Camaragibe was created by becoming independent from the municipality of São Lourenço da Mata in 1982. It has a territory of 52.9 km^2.

According to the "Diagnosis of Priority Poverty Areas – PQA (1997)", only 3 % of the population was served with a sewerage system of the condominial type. The rest utilized ordinary cesspits with improper lining or they simply discharged the sewage directly into the

drainage system. Water supply services covered only 35% of the population. The rest of the population utilized deep wells, which were not properly constructed and subject to contamination from the cesspits. The coverage of solid waste collection services was 72%.

According to the Camaragibe Civil Defense Coordinator, the hilly area of the municipality has an area of 4.3 km^2 (8.13 % of the municipality area). There were 3,400 and 1,800 families living in permanent and imminent landslide areas, respectively, in 1997, but not all the families living in hilly areas are subject to the hazard of landslides.

There are cases in which residents legally purchased their lands. However, these legally purchased housing lots were located in improper areas and thus they also have the same problems as the poverty areas. According to Camaragibe officials, the population living in both formal and informal (poverty) areas subject to the above conditions commonly have an average household income of 2 MW.

2.3.3 ZEIS (Special Zones of Social Interest)

In the 80's, a new legal instrument was incorporated in the Land Use and Occupation Laws of some municipalities. This is the ZEIS and represents the formal acknowledgement of the poverty areas by the government as an actual and permanent occupation of urban land by poor people to assure their dwelling rights.

As mentioned before, once an area becomes a ZEIS, the settlement can officially undergo an urbanization and ownership registration process, supported by the respective municipal governments. Not every poverty area fulfills the conditions necessary to become a ZEIS. For example, those settlements located along the rivers or canals ("non aedificandi" areas), where the government plans to construct an avenue, cannot become ZEIS.

The fact of becoming a ZEIS does not mean that the settlement is automatically to be supplied with all basic infrastructures and that the land ownership problem will be solved. Concerning the infrastructure, the main constraint is lack of funds at the municipal level. As for land ownership, there are basically two cases: publicly owned land and privately owned land. If the property is located in the publicly owned land, the municipal government can grant the dweller a concession for the use of the land for a certain period, e.g. 100 years. This concession is called CDRU (Concession of Actual Use Right).

In the case where the residents are living on private land for more than 5 years, during which time the land owner does not start a lawsuit against the residents, the residents obtain the right to continue to live there and become legal owners, according to the "Usucapião" Law

(provided for the National Constitution). However, this legalization process may take a long time.

Whatever the case is, the residents are represented in a Forum of PREZEIS or ZEIS in which they can decide jointly with the municipal officials the procedures to be taken.

The Regularization Plan of the ZEIS (PREZEIS) of *Recife* was created through Municipal Law no. 14.947 (March 1987). In 1997, there had already been 66 ZEIS instituted in Recife (Table 2.3-1), of which 25% were located in hilly areas.

In Jaboatao the ZEIS were instituted by Municipal Law No. 114 (1991). In 1991 there were 15 ZEIS encompassing 29 poverty areas (Table 2.3-2).

In *Olinda*, a study is being carried out by the local government to form a basis for the creation of a municipal law of ZEIS, an instrument that is included in the newly approved Urban Development Master Plan of Olinda. However, there are no ZEIS in this municipality at present.

In *Camaragibe*, the Municipal Law No. 063 concerning Land Ownership Regularization was approved in June 1999. This law provides for the creation of ZEIS. Up to the present only one poverty-area has been legalized as a ZEIS, the Carmelita settlement dating back to 1950. Since the approval of the law, many communities are calling for their legalization as ZEIS. These areas are to be inspected and the municipal government will evaluate the possibility of legalizing them as ZEIS.

2.3.4 Sanitary Conditions of Poverty Areas

The long term spontaneous occupations and some recently organized occupations have somehow managed to be provided with some basic infrastructure such as water supply, electricity, solid waste collection, but very little sewerage or drainage facilities. However, some other areas still remain in a very poor situation as shown in the following studies.

According to the study carried out by GEPE/UN-Habitat (1996), mentioned in the PQA (RE-1), in 50 poverty areas in the RMR (40 in Recife, 4 in Jaboatão, 2 in Olinda, and 2 in Camaragibe), the sanitation conditions concerning water supply, sewerage, and solid waste collection were as follows;

Water Supply Existence	Yes	No	No answer
	75.8 %	8.2 %	16.0 %

Water Supply System Type	Internal plumbing with water tank	Internal plumbing without water tank	Source outside the house	Others
	23.0%	25.6%	40.2%	11.2%

Sewerage System Type	Public pipeline	Condominial pipeline	Connection to drainage system	Cesspit	Stream	Gutters on streets	Others and no answer
	6.0%	1.0%	8.1%	33.5%	12.4%	18.5%	20.5%

Solid Waste Disposal	Burned	Dumped on waste land	Dumped in stream	Separated - Recycled	Others
	13.3%	41.0%	30.0%	0.5%	15.2%

Source: GEPE/UN-Habitat, 1996.

The sanitation conditions of the poverty areas described in the study were very poor. Although 75.8 % of the households in the previous study have COMPESA water supply, only 48.6% of them have internal plumbing with or without an internal water tank. The others have to get water from public water taps supplied by COMPESA or other sources. As for sewage, the largest segment of households discharge the sewage in ordinary cesspits (33.5%). Only 1.0% of them has Condominial sewerage systems. Concerning solid waste, 71.0% dump their solid wastes either on wet land or into watercourses. Consequently, these areas present some cases of water borne and water related diseases such as filariasis, elephantiasis, meningitis, hepatitis, cholera, leptospirosis, and dengue fever.

According to another study, in Olinda, in 1992, the infectious and parasitic diseases occurring in the areas located within category V (worst conditions) of the homogeneous groups (Table 2.3-3) were the cause of a mortality rate 12.8 times higher than in the areas located within category I (best conditions).[1]

2.3.5 Recommendations of the PQA on Poverty Areas

The "Diagnóstico das Áreas Pobres Prioritárias" (Diagnosis of Priority Poverty Areas) aimed to select and rank the Priority Poverty Areas to be supplied with investments from the PQA. The basic eligibility criteria were based on the following items: (1) Income level; (2) Existing urban infrastructure conditions; (3) Level of environmental damage; (4) Existence of community organization; (5) Land ownership status; (6) Viable cost-benefit relationship.

[1] Guimarães, M. J. B., *"Mortalidade Infantil e Condição de Vida: Uma análise da desigualdade espacial no Recife, 1998"*, thesis for Master's Degree presented for the IMIP (Institute of Motherly and Infant of Pernambuco) Master Course.

(1) Study Units

Since the study focused on water quality and environment, the study units were based on run-off basins and sub-basins. The Collection Units established for the Recife sewerage project were utilized. For the other three- (3) municipalities (Jaboatão dos Guararapes, Camaragibe and Olinda), the study units are also based on the Collection Units, adopting the same criteria.

Study Area of the "Diagnosis of Priority Poverty Areas" – PQA

Municipality	No. of Collection Units	Area (ha)	Population
TOTAL	**84**	**7,750**	**740,500**
Recife		4,600	480,000
Capibaribe river basin	15	2,600	290,000
Beberibe river basin	28	2,000	190,000
Olinda			
Beberibe river basin	20	1,460	164,000
Camaragibe			
Capibaribe river basin	21	1,690	96,500
Jaboatão dos Guararapes	In the basins for the Olho D'água Lake, the Collection Unit division study was carried out. However, as a conclusion, it was observed that the area presents a general problem of macro-drainage, which demands a structural solution, without which it is not possible to achieve efficient results with the implementation of urban infrastructure.		

(2) Priority Poverty Areas

Based on the existing information and field surveys, a matrix of data was prepared and the priority areas were ranked. The matrix was made up of 20 columns to be filled up with the eligibility criteria items. To each item, points were attributed. The total points defined the priority areas.

In order to estimate the investment cost for infrastructure works to be carried out in each of the studied the Collection Units, the costs for each type of measures were estimated. Also for this purpose, typical situations were grouped as follows:

- Hills with little infrastructure requiring the removal of houses in precarious conditions (up to 20 % of the total number of houses);
- Hills with infrastructure without requiring the removal of houses in precarious conditions;
- Plain with little infrastructure in flood hazard area requiring the removal of houses in precarious conditions (up to 20 % of the total number of houses);
- Plain with little infrastructure, no flood hazard area, requiring the removal of houses in precarious conditions (up to 10 % of the total number of houses);
- Plain with infrastructure and no need to remove houses.

The items for cost estimation were defined as follows:

⇒ Preliminary works, provisional facilities, re-routing of pipelines, topographic surveys, demolitions, removals, security and signage of the works;
⇒ Earth works, stabilization and recuperation of slopes; macro and micro-drainage works;
⇒ Paving of streets and sidewalks, construction of flights and steps;
⇒ Sewerage service installation, including collectors, trunk pipelines, pressure pipeline, household connection, improvement of internal (inside the house) connections; extension of water supply pipelines;
⇒ Re-settlement of population, including the construction of dwellings and infrastructure;
⇒ Studies, designs and civil works management;
⇒ Costs of social worker.

A summary of the highest priority areas and the necessary investment is presented in the following table.

Priority No.1 Poverty Areas for Investment of the PQA

Municipality	Area	Topography	Total Cost of Intervention (US$)	US$ per Family
Olinda	Surroundings of Passarinho	Hilly	50,000,000	2,750
Recife	Surroundings of Vasco da Gama, Dois Unidos, Nova Descoberta, and Passarinho	Hilly	21,200,000	1,110
Camaragibe	Surroundings of Tabatinga.	Hilly	11,800,000	2,000
Olinda	Areas such as Cabo Gato, Varadouro, Santa Teresa	Flat	5,300,000	2,000
Recife	Surroundings of Bairro do Arruda, Beberibe, Fundão, and areas such as Bomba Grande, and Várzea	Flat	4,300,000	1,100
TOTAL			**92,600,000**	

2.3.6 Other Related Existing Projects and Programs

(1) Pro-Metrópole (Project of Infrastructure in Low Income Areas of the RMR)

The Project Study is at present in stage of preparation. The German Society for Technical Cooperation (GTZ) (private portion) is carrying out the study with the financial support of the World Bank.

A preliminary cost estimation of the Project suggests a total investment of US$ 200 millions, to be partially financed by the World Bank and partially by Federal, State, and the Municipal funds. The Program has three components: A – Local Infrastructure in Low Income Areas, B – Metropolitan Infrastructure, and C – Institutional and Social Studies and Development Actions.

Component A: Including the construction or improvement of water supply, sewerage and drainage systems in areas where the low income population live, as well as other improvement works.

Component B: Including the installation and/or improvement of metropolitan infrastructure such as sewage treatment plants to complement the existing infrastructure.

Component C: Divided into three sub-components:

- C1: Studies and Projects (strategy for the combat of urban poverty, basic-infrastructure in low income areas, solid waste management plan, etc.);
- C2: Institutional Development (training and development of relevant institutions); and
- C3: Economic and Social Development (support to community organizations, environmental education, etc.).

The Beberibe River basin has been selected as the priority area of implementation. Within this area, two Pilot Projects (Passarinho in Olinda and Campo Grande in Recife) are now under preparation including the detailed design (D/D) of infrastructure.

(2) Habitar Brasil/IDB Program

This Program is one of the components of the Habitar Brazil program of the Federal Government. The program is already being implemented with national funds. The Habitar Brasil/IDB Program aims at, among other things, financing improvement projects for poverty areas such as urbanization, relocation of families, legalization of land ownership, etc.

The Program's total cost is R$ 417 million, for the whole country, of which 60% is financed by the IDB and 40% by local counterparts. In the RMR, two areas were selected for the program evaluation project: the communities, "Dancing Days" and "Sítio Grande", in the municipality of Recife. In these two projects, some of the items to be financed are as follows:

For Dancing Days (R$ 1,509,923):
Condominial sewerage system, basic collection pipes, and household connections for sewage; extension of water supply system; micro-drainage and paving of main streets,

For Sitio Grande (R$ 3,913,496):
Macro-drainage works including 300 m each of canal improvement and road paving.

(3) Pro-Renda (Pro-Income, German Society of Technical Cooperation – GTZ)

The main objective of this Program is to achieve the sustainable improvement of living conditions in some selected areas. For this purpose, the Program proposes the improved coverage of public services (basic infrastructure) for low income users, among other measures (preparation and application of construction standards for self-build dwellings, support in accessing the labor force market, strengthening of community organizations, etc.).

For the State of Pernambuco, the Program will be implemented all in the ZEIS of Recife City. The target-population is that with an average household income of US$ 300 (approx. 3 to 4 MW, as for Dec/99). The implementation period of the Program is 10 years, and the total cost is R$ 20 million.

(4) Pro-Infra (Caixa Econômica Federal)

This Program aims at improving the hazardous and unhealthy conditions of areas where the low-income population live. The funds come from the Federal Government through a federal public bank (Caixa Econômica Federal). A summary of the measures and investments of the program is given in the following table.

Actions and Investments of PRO-INFRA in Low Income Areas

(Unit: R$ 1.00)

	Municipality	Project	Total Cost	Total Loan	Remarks
1	RECIFE	Jordão Canal	6,000,000	6,000,000	Completed
2	RECIFE	Mangueira	1,200,000	1,200,000	Completed
3	RECIFE	Recife Hills (Morros do Recife)	5,500,000	5,500,000	Completed
4	JABOATÃO	Jaboatão	5,615,000	5,615,000	Completed
5	OLINDA	Coast of Olinda	2,500,000	2,500,000	Completed
6	CABO	Cabo	417,000	417,000	Awaiting final financial approval
7	RECIFE	Vasco da Gama	1,800,000	1,800,000	Civil works in progress
8	RECIFE	Joana Bezerra	8,760,000	8,760,000	Civil works in progress
9	RECIFE	Morros Recife 2	6,240,000	6,240,000	Civil works in progress
10	OLINDA	Lining – Bultrins	150,000	150,000	Analysis of bidding documents
11	OLINDA	Urbanization – Bultrins PE 15	1,770,100	1,770,100	Invoicing
12	JABOATÃO	Setúbal	3,600,000	3,600,000	Civil works in progress
13	SÃO LOURENÇO	Nova Tiúma	76,800	76,800	Technical analysis
14	RECIFE	Morros Recife	4,800,000	4,800,000	Technical analysis
15	RECIFE	Terceira Perimetral	3,250,179	3,250,179	Technical analysis
16	RECIFE	Joana Bezerra	4,825,890	4,825,890	Detailed design
17	RECIFE	Joaquim Nabuco / Dom Bosco	1,602,691	1,602,691	Technical analysis
18	CAMARAGIBE	Vila da Fábrica	120,000	120,000	Technical analysis
19	OLINDA	Bultrins Fragoso	102,981	102,981	Civil works in progress
20	JABOATÃO	Canal Setúba II	3,750,000	3,750,000	Civil works in progress
		TOTAL	**62,080,641**	**62,080,641**	

Source: Caixa Econômica Federal – CEF

(5) Pro-Moradia (Housing) - CEF

This Program aims at improving the living conditions of the low-income population living in unhealthy areas. This is a nationwide program that utilizes the resources of a Federal Fund (FGTS). In the RMR, the Program will benefit the following projects:

Projects Benefited by the PRO-MORADIA Program in the RMR

	Municipality	Project	Total Cost (R$)	Total Loan (R$)	Remarks
1	OLINDA	Infrastructure Sapucaia / Santa Rita	1,053,257	947,931	Completed
2	OLINDA	Infrastructure Cidade Tabajara	1,120,092	1,008,083	Completed
3	OLINDA	Infrastructure Águas Compridas	1,265,209	1,138,688	Completed
TOTAL			3,438,558	3,094,702	

(6) "Movimento Viva o Morro" Program (Program for the Urban Structuring of the Hills of Recife Metropolitan Region)

This program was proposed by the Metropolitan Chamber of the Environment and Sanitation (CMMAS) in response to the request of the mayor of Camaragibe, in April 1997, for the discussion of common problems concerning hill occupation in the municipalities of the RMR.

In July 1999, a commission was set up to structure the program. As a result, a 5-year Work Plan (1999-2003) was prepared. This Plan is divided into 5 (five) stages as follows;

I - Organization of tasks,
II - Background studies for formulation of a proposal for the urban structuring of the RMR hills,
III- Production of information and implementation of Pilot Projects,
IV- Elaboration and approval of the Program for the Urban Structuring of the RMR Hills, and
V - Implementation of the Program of Structural measures in the RMR Hills.

The target area of the Plan is the RMR hills divided into four categories: hills occupied by poor communities, hills under occupation densification pressure, hills under occupation expansion pressure, and hills not yet occupied but susceptible to occupation.

The Table 2.3-3 presents some information about the occupation of hills and the hazardous conditions in the municipalities of the RMR.

Information on the Conditions of Hills located in the Urban Areas of the RMR Municipalities - 1997

		Population	Population on the hills	%	Municipal Area (km2)	Hilly Area (km2)	%	Density on the hills (inhab./km2)	Popul. in permanent hazardous conditions (*)	Popul. in iminent hazardous conditions (*)
RMR (Recife Metropolitan Area)										
1	Abreu e Lima	NI	NI	NI	NI	NI	NI	NI	NI	NI
2	Araçoiabu	Not included in the Program								
3	Cabo de Santo Agostinho	137,295	38,869	28.3	445.0	5.30	1.2	7,334	15,548	8,505
4	Camaragibe	114,039	38,013	33.3	52.9	4.30	8.1	8,840	15,300	8,100
5	Igarassú	73,556	3,000	4.1	299.0	2.00	0.7	1,500	1,575	450
6	Ipojuca	48,576	15,000	30.9	527.0	4.00	0.8	3,750	3,753	
7	Itamaraca	13,807	1,625	11.8	67.0	0.98	1.5	1,658	324	
8	Itapissuma	Not included in the Program								
9	Jaboatão dos Guararapes	537,766	82,340	15.3	259.0	43.30	16.7	1,902	23,868	14,918
10	Moreno	39,957	12,149	30.4	189.0	0.60	0.3	20,248	4,860	17,456
11	Olinda	355,741	109,825	30.9	40.8	4.68	11.5	23,467	35,370	3,474
12	Paulista	233,634	75,000	32.1	97.2	30.00	30.9	2,500	1,350	203
13	Recife	1,342,877	380,000	28.3	218.0	39.00	17.9	9,744	151,650	23,850
14	São Lourenço da Mata	NI	NI	NI	NI	NI	NI	NI	NI	NI

Note: NI = Not Informed

(*) This information shall be revised by each municipality utilizing a common criteria

2.3.7 Residents Awareness Survey

(1) Sampling criteria

The survey that covered all the fourteen (14) municipalities of the RMR, was carried out from November through December 1999. The population of each area determined the number of samples taken, and the proportion of the samples with sewerage corresponded to municipal figures.

Sampling

Municipality	Urban Population (1998)	Urban Households			Sample		
		Total (1998)*	With Sewerage**	% with Sewerage	Total	Without Sewerage	With Sewerage
RMR	2,999,265	749,816	123,446	16.46	605	509	96
1 Abreu e Lima	74,040	18,510	304	1.64	19	18	1
2 Araçoiaba	9,710	2,428	0	0.00	4	4	0
3 Cabo de Santo Agostinho	130,866	32,716	192	0.59	35	33	2
4 Camaragibe	116,503	29,126	507	1.74	31	29	2
5 Igarassú	58,433	14,608	200	1.37	15	14	1
6 Ipojuca	31,855	7,964	0	0.00	12	12	0
7 Itamaracá	11,754	2,939	0	0.00	4	4	0
8 Itapissuma	16,805	4,201	0	0.00	6	6	0
9 Jaboatão dos Guararapes	475,438	118,860	20,009	16.83	86	71	15
10 Moreno	32,670	8,167	0	0.00	15	15	0
11 Olinda	353,051	88,263	21,667	24.55	64	48	16
12 Paulista	239,854	59,964	32,851	54.78	44	20	24
13 Recife	1,368,029	342,007	45,336	13.26	247	217	30
14 São Lourenço da Mata	80,255	20,064	2,380	11.86	23	20	3

Sources: IBGE; Compesa

Note: * Estimated Data, ** Data supplied by COMPESA

(2) Major issues from the Residents Awareness Survey

The complete analysis of the results of the residents Awareness Survey can be consulted in the Supporting Report E (E.2 "Report on the Results of the Residents awareness survey"). However, the major issues arose from this analysis are now summarized as follows:

(1) The Recife Metropolitan Region presents different types of "living environment". The so-called "Poverty Areas" (former slums, organized occupations, and slums) represent 31.4% of the sample universe. The different types of "living environment" also present different degrees of urban infrastructure.

(2) As for the topographic conditions, it is identified that households in flat areas are at a high risk of flooding. This is especially serious for the households in "occupations" and "slums".

(3) The unemployment rate is very high in the RMR and it is particularly high in the "slums".

(4) The majority of households receive a monthly income of less than 3 Minimum Wages (approx. US$ 230).

(5) The survey revealed an optimistic view on the Solid Waste issue. However, our knowledge of actual facts, particularly in relation to the presence of solid waste in the stormwater drainage system, leads us to conclude that a deeper understanding of the issue may be necessary.

(6) As for the Water Supply issue, the survey brought to light the water shortage problem (COMPESA water), and the trend of using alternative sources (wells and tank trucks). It also showed that the majority of the households pay no more than R$ 20/month for water (88.2%), and consume no more than 20 m^3/month (92.7%).

(7) In terms of the Sewerage System, we could observe the following facts:
- For the RMR, COMPESA services in "occupations" and "slums" are particularly low.
- The most common alternative for sewage disposal in "urbanized" areas and "former slums" is the septic tank. On the other hand, for "occupations" and "slums" the most common alternative is the direct "discharge into the gutters along streets, water streams, etc."
- With regard to the municipalities, there are different situations with the predominance of one or another type of sewerage system. However, in the RMR as a whole, a

predominance of septic tank utilization alone or combination with another system is identified. Nevertheless, the alternative in which sewage with no treatment is discharged into a stream is also very common.

- To sum up, the results of the "Residents Awareness Survey" lead us to conclude that:
  - There is a lack of residents' awareness about the real problems caused by a deteriorated sewerage system. Meanwhile, they are concerned about conditions of hygiene and flood occurrences in their neighborhood.
  - Despite the widespread use of septic tanks as pointed out in shown in clause (7), they are poorly maintained. This fact, together with the high percentage of households discharging their sewage directly into watercourses, suggests that urgent measures to enhance the sewerage system should be taken.
  - Although, the survey has shown a strong desire of the residents to have both the sewerage and stormwater drainage systems expanded, the majority of them are not willing to contribute to the construction of the system. The main reason for not contributing is that they think the provision of this type of urban infrastructure intervention is a "Government Duty" (56.0%).

Table 2.3-1 Special Zones of Social Interest (ZEIS) in Recife

No.	Name	Population	Area (ha)	Population Density (inhab/ha)
1	Cavaleiro (*)	21,950	56.50	388.50
2	Tejipió (*)	5,283	13.60	388.46
3	Areias (*)	10,876	28.00	388.43
4	Barro	10,963	28.22	388.48
5	Capuã	3,185	8.20	388.41
6	Vila Redenção	1,400	5.34	262.17
7	Caçote	12,500	37.10	336.93
8	Mangueira	26,223	67.50	388.49
9	Vietnã	2,991	7.70	388.44
10	Torrões	35,936	92.50	388.50
11	Casa Amarela (*)	347,707	895.00	388.50
12	Alto do Mandu / Alto Santa Isabel (*)	26,884	69.20	388.50
13	Afogados	4,270	34.00	125.59
14	Mustardinha (former Jiquiá Remédios)	12,500	51.44	243.00
15	Novo Prado	2,292	5.90	388.47
16	Prado	3,500	10.13	345.51
17	Sítio do Berardo	7,800	13.50	577.78
18	Dois Unidos (*)	13,341	34.34	388.50
19	Coque	20,000	76.30	262.12
20	Linha do Tiro (*)	24,242	62.40	388.49
21	Pina	26,000	68.68	378.57
22	Fundão de Fora	10,477	26.97	388.47
23	Brasília Teimosa	25,000	72.70	343.88
24	Santo Amaro	14,549	37.45	388.49
25	Coelhos	6,885	25.10	274.30
26	Entra-Apulso	5,480	8.33	657.86
27	João de Barros	1,182	1.80	656.67
28	Rua do Rio / Iraque	1,080	18.43	58.60
29	Borborema	2,150	4.60	467.39
30	Sítio do Cardoso	12,000	14.57	823.61
31	Beirinha - Mangue Seco	1,600	10.70	149.53
32	Ibura-Jordão	20,000	149.00	134.23
33	Coronel Fabriciano	430	0.80	537.50
SUBTOTAL		**720,676**		

No.	Name	Population	Area (ha)	Population Density (inhab/ha)
34	Jardim Uchôa	1,500	8.80	170.45
35	Mangueira da Torre	858	1.70	504.71
36	Sítio Grande	15,000	66.50	225.56
37	Campo Grande	12,000	106.50	112.68
38	Aritana	1,000	1.00	1,000.00
39	Campo do Banco	4,400	13.00	338.46
40	Vila Esperança / Cabocó	750	4.06	184.73
41	Vila Felicidade	3,000	6.40	468.75
42	Vila São João	2,000	4.52	442.48
43	Poço da Panela	611	2.51	243.43
44	Vila Inaldo Martins	320	0.46	695.65
45	Planeta dos Macacos (*)	7,280	27.63	263.48
46	Ilha do Destino	1,600	7.40	216.22
47	Vila do Vintém	270	0.32	843.75
48	Tamarineira	650	1.57	414.01
49	Greve Geral (*)	760	1.51	503.31
50	UR-5 / Três Carneiro (*)		115.66	0.00
51	Ilha do Joaneiro	4,000	13.24	302.11
52	Sítio Wanderley	6,000	6.16	974.03
53	Rosa Selvagem (*)	6,200	49.69	124.77
54	Vila União		4.86	
55	Ilha de Deus	1,275	15.30	83.33
56	Vila Arraes	1,600	8.05	198.76
57	Carangueijo / Tabaiares	2,800	7.36	380.43
58	Campo do Vila	1,400	1.34	1,044.78
59	Alto da Jaqueira (*)		37.21	
60	Brasilit		13.46	
61	Vila do Siri		1.75	
62	Jardim São Paulo I (Rua Souza)		2.01	
63	Jardim São Paulo II (A Baixa)		2.20	
64	Apipucos	1,200	6.00	200.00
65	Vila Macionila / Mussum	224	1.36	164.71
66	Coqueiral de Boa Viagem			
SUBTOTAL		**76,698**		

TOTAL POPULATION (partial)	**797,374**

Source: Department of Urbanization, Urban Planning Directorship, URB - Recife City Urbanization Company, 1999

(*) Hilly areas

Table 2.3-2 Special Zones of Social Interest (ZEIS) in Jaboatao dos Guararapes

No.	Name	No. of Families	Estimated Population	Area (ha)	Density (inhab/ha)	Years of Occupation	Water Supply	Location of Final Sewage Discharge
1	Aritana	800	3,200	3.70	864.86	29	COMPESA	Cesspit/Canal
2	Areal*	500	2,000	28.90	380.62	27	COMPESA	Cesspit/Canal
3	Asa Branca	180	720	1.19	605.04	27	COMPESA	Setúbal Canal
4	Bom Pastor	650	2,600	3.23	804.95	27	COMPESA	Setúbal Canal
5	Briga de Galo	460	1,840	2.80	657.14	32	COMPESA	Carolinas Canal
6	Buenos Aires**	1,000	4,000	19.10	209.42	27	COMPESA	Olho D'Agua Lake
7	Carolinas	1,000	4,000	9.00	444.44	32	COMPESA	Treatment Station (ETE)
8	Dom Helder	460	1,840	13.80	133.33	13	COMPESA	Cesspit/Canal
9	Jardim América**	200	800	19.10	209.42	27	COMPESA	Olho D'Agua Lake
10	Jardim Copacabana	1,100	4,400	10.00	440.00	27	COMPESA	Setúbal Canal
11	Jardim Piedade	1,400	5,600	54.20	103.32	11	COMPESA	Setúbal Canal
12	Jardim Prazeres*	1,600	6,400	28.90	380.62	29	COMPESA	Olho D'Agua Lake
13	João de Deus	1,000	4,000	12.60	317.46	22	COMPESA (50%)	Olho D'Agua Lake
14	Lagoa das Garças	835	3,340	31.92	104.64	13	Illegal Connections	Cesspool/Olho D'Agua Lake
15	Massaranduba	1,200	4,800	7.50	640.00	27	COMPESA	Canal/Cesspit
16	Moenda de Bronze	250	1,000	11.22	89.13	16	COMPESA	Jaboatão river/Cesspit
17	N. Sra. do Carmo	800	3,200	8.10	395.06	27	COMPESA	Setúbal Canal/Cesspit
18	Nova Divinéia	1,200	4,800	19.60	244.90	21	COMPESA	Setúbal Canal
19	Nova Jerusalém	200	800	2.10	380.95	27	COMPESA	Carolinas Canal
20	Pau Seco*	650	2,600	28.90	380.62	29	COMPESA	Olho D'Agua Lake
21	Perpétuo Socorro	300	1,200	NI	NI	11	COMPESA	Olho D'Agua Lake
22	Santa Fé	360	1,440	1.00	1,440.00	19	COMPESA	ETE Vera Lúcia
23	Santa Felicidade	1,000	4,000	NI	NI	13	Illegal Connections	to wetland
24	Sotave	1,400	5,600	6.70	835.82	13	COMPESA	Olho D'Agua Lake
25	Tancredo Neves	150	600	3.20	187.50	17	COMPESA	Setúbal Canal
26	Ticta	650	2,600	2.06	1,262.14	9	COMPESA	ETE Vera Lúcia
27	Vaquejada	1,000	4,000	17.50	228.57	17	COMPESA	Setúbal Canal
28	Vera Lúcia	500	2,000	7.30	273.97	15	COMPESA	Vera Lúcia Canal
29	Vietnã	1,350	5,400	21.00	257.14	28	COMPESA	Setúbal Canal
TOTAL		22,195	88,780					

Source: Executive Coordination of Special Zones of Social Interest (CEZEIS), Municipal Secretariat of Labor and Social Action, 1999

NI = No Information

Note: * Areal, Jardim Prazeres and Pau Seco are located in the same area of 28.90 ha

** Buenos Aires and Jardim América are located in the same area of 19.10 ha

Table 2.3-3 Information on the Conditions of Hills in the Urban Areas of the RMR Municipalities - 1997

		Population	Population in the hills	%	Municipal Area (km^2)	Hilly Area (km^2)	%	Density in the hills (inhab./km^2)	Popul. in permanently hazardous conditions (*)	Popul. in imminently hazardous conditions (*)
RMR (Recife Metropolitan Area)										
1	Abreu e Lima	NI	NI	NI	NI	NI	NI	NI	NI	NI
2	Araçoiaba	Not included in the Program								
3	Cabo de Santo Agostinho	137,295	38,869	28.3	445.0	5.30	1.2	7,334	0	0
4	Camaragibe	114,039	38,013	33.3	52.9	4.30	8.1	8,840	0	0
5	Igarassú	73,556	3,000	4.1	299.0	2.00	0.7	1,500	0	0
6	Ipojuca	48,576	15,000	30.9	527.0	4.00	0.8	3,750	0	
7	Itamaraca	13,807	1,625	11.8	67.0	0.98	1.5	1,658	0	
8	Itapissuma	Not included in the Program								
9	Jaboatão dos Guararapes	537,766	82,340	15.3	259.0	43.30	16.7	1,902	0	0
10	Moreno	39,957	12,149	30.4	189.0	0.60	0.3	20,248	0	0
11	Olinda	355,741	109,825	30.9	40.8	4.68	11.5	23,467	0	0
12	Paulista	233,634	75,000	32.1	97.2	30.00	30.9	2,500	0	0
13	Recife	1,342,877	380,000	28.3	218.0	39.00	17.9	9,744	0	0
14	São Lourenço da Mata	NI	NI	NI	NI	NI	NI	NI	NI	NI

Note: NI = Not Informed

(*) This information will be revised by each municipality utilizing standard criteria

2.4 Water Resources

2.4.1 Surface Water and Water Supply System

The resources for water supply to the RMR are from the reservoirs, rivers and groundwater as shown in Table 2.4-1. The total volume of water supply is 10.61 m^3/s consisting of surface water (8.81m^3/s), and groundwater (1.80 m^3/s). These resources made use of the following two water supply systems:

1) Integrated system : Large-scale supply systems (10.28m^3/s),
2) Independent system: Small-scale and isolated supply systems (0.33m^3/s).

The independent systems mostly depend on groundwater.

A study on the water resources in the RMR and the surrounding regions conducted by Federal University of Pernambuco (UFPE) suggests that the RMR has sufficient natural water resource in terms of amount of rainfall in its catchment area. However, the RMR is experiencing a water shortage due to a large loss of water in the existing water supply system (about 48 %) and a shortfall in the existing water purification capacity (only 49 % of the target in 1995).

The multi-purpose dams that serving the RMR are shown in the following table:

Dams Serving the RMR

Name of Dam	Catchment Area (km^2)	Operated from (year)	Storage Capacity (million m^3)	
			Flood Control	Water Supply
Tapacura	369.0	1974/1987	In the future	66/94.2
Duas Unas	75.0	1977		24.2
Goita	404.0	1978	125.0	27.0
Carpina	6,000.0	1978	270.0	30.0
Varzea Do Una	37.5	1994		11.6
Botafogo	88.0	1985		27.6
Gurjau	13.9	1918		3.2
Bita	20.6	1980		2.8
Utinga	14.7	1980		10.4

There are several water resources development programs. With the completion of ongoing construction and repair work of dams, the RMR will be able to supply enough water until 2040 to meet the demand. On going dam projects are as follows:

1) Pirapama Reservoir: 5.64 m^3/s, once its construction is complete.
2) Sao Bras Reservoir: 1.10m^3/s, under study,

3) Jaboatao Reservoir: $0.92m^3/s$, under study,

4) Ipojuca Reservoir: large potential in the southern area especially for Suape, under study.

2.4.2 Groundwater

COMPESA has been using the groundwater in the RMR since the 70´s while other private businesses have been sinking deep wells for their own use. At first the production of groundwater was relatively easy because the groundwater was confined and extracted as flowing wells. However during the past 25 years, the groundwater level in the RMR has dropped considerably due to the excessive extraction.

The RMR is geologically divided into two blocks by the Pernambuco lineament. The geological differences between the sedimentary basins of the two blocks resulted in contrasting hydrogeological characteristics of the two basins as summarized below.

Northern block: The Pernambuco-Paraiba Sedimentary basin is made up of sedimentary rocks of the Beberibe formation and has a large groundwater potential; 10 times greater than in the southern block with a production capacity of 3.0 to $7.0m^3/h/m$.

Southern block: The Volcano-sedimentary basin of Cabo is made of sedimentary rocks with volcanic rocks of Ipojuca formation. The presence of Ipojuca formation greatly reduces the groundwater potential of this block because it is impermeable.

The northern basin has much greater groundwater potential. This is because the components of the basin are mostly coarse sedimentary rocks of the Beberibe formation. This provides favorable conditions for groundwater storage that leads to the formation of the Beberibe aquifer. In the area where the formation appears at the ground, it forms an unconfined aquifer. In the other areas where there is an overlying stratum, the formation forms a rather confined aquifer.

Since COMPESA started using the groundwater in the northern block, lowering of groundwater tables locally and consequently seawater intrusion have been observed. However, the use of groundwater has been kept increasing and the completion of the COMPESA water supply system in the late 70's further accelerated the production.

Although COMPESA utilizes surface water at present, its supply capacity does not meet the demand and many private businesses and apartment blocks rely on groundwater.

At present COMPESA has 48 groundwater supply systems in 7 towns in the RMR; Recife, Olinda, Paulista, Abreu e Lima, Igarassu, Itapissuma and Itamaraca as well as the coastal regions of Goiana and Sirinhaem.

The wells have depths from 150 to 350m with an average depth of 200 to 250m. In October 1999 COMPESA produced 6,768 l/s of which 4792 l/s (70%) was from the surface water and the rest (30%) was from the groundwater. In a year of normal rainfall, the ratio is 85 to 15. However, in a drought year with the introduction of group of wells for emergency use, the ratio rose to 64 to 36.

COMPESA is making efforts to utilize the groundwater resources more effectively by establishing technical specifications for well construction and by controlling the amount of production from the wells.

However, there are many private wells that are outside the jurisdiction of COMPESA. The production from these wells is necessary to be authorized and controlled by the CPRH. However, a lot of businesses and households sink their own wells without getting permission from the CPRH. Therefore it is not clear that how much volume of groundwater is extracted by these clandestine private wells.

It seems that the continuous shortage of water is spurring on this trend of drilling private wells. People can get only a limited supply of water from the COMPESA systems, which forces them to depend on other water sources such as private wells and water trucks. As of July 2000, the households in Recife were supplied with COMPESA water only every couple of days.

Table 2.4 - 1 Water Resources in the RMR

<INTEGRATED SYSTEMS>

Sector	System / Water Catchment Area	Discharge normally used (m^3/s)
North	Botafogo	1.75
	- Catucá Dam	
	- Conga River	
	- Tabatinga River	
	- Pilão River	
	- Cumbe River	
	Monjope	1.00
	- Utinga River	
	- Pitanga River	
	- Paratibe River	
	Beberibe	0.55
	- River Beberibe	
	Dois Irmãos	0.16
	- Prato and do Meio Reservoirs	
	Beberibe Aquifer	1.50
	- Subterranean water	
West	Tapacurá	4,00
	- Tapacurá Dam	
	- Duas Unas Dam	
	- River Capibaribe - Tiúma	
	- River Capibaribe – Castelo	
	- Várzea do Una Dam(*)	(0.54)
	Jangadinha	0.03
	- Jangadinha Dam	
South	Gurjau	0.89
	- Gurjau Dam	
	Suape (Transference)	0.40
	- Bita and Utinga Dams	
	Total	10.28

- Tends to be an independent system

<INDEPENDENT SYSTEMS>

Sector	System / Water Catchment Area	Discharge normally used (m^3/s)
North	Itamaracá	0.10
	- Wells	
	Araçoiaba	0.02
	- Floreta Stream	
	Itapissuma	0.03
	- Wells	
	Nova Cruz	0.16
	- Wells	
	Beberibe Aquifer	0.01
	- Subterranean water	
West	Bonança	0.01
	- Jaboatão River	
	Moreno	0.08
	- Jaboatão River	
	Nossa Senhora da Luz	0.01
	- Queira Deus Reservoir	
	- Wells	
South	Jussaral	0.01
	- Spring	
	Nossa Senhora do O	0.01
	- Suape System	
	Camela	0.01
	- São Pedro Stream	
	Charneca	0.02
	- Sebastopol Stream	
	Ipojuca	0.02
	- 3 Passagens Stream	
	Total	0.33

2.5 Flood Areas in the RMR

The delta area of the Capibaribe River underwent severe flooding until 1977. However, two dams (Carpina and Goita) were constructed and operated since 1978 for flood control and the Capibaribe River section upstream of the National Road No.101 was improved. Accordingly no significant flooding from the river has occurred for the past 22 years. Because of the large storage capacity of 395 million m^3 and the large drainage area of 6,400 km^2 for flood control by the dams, the Carpina Dam gate was opened only once in the 1990 flood. The river section downstream of the National Road No.101 has not been improved yet because it is located in a densely populated urban area.

Since 1978, flooding has been caused by storm rains in the catchment downstream of the dams, and limited to the lowlands in the municipalities of Jaboatao, Recife and Olinda. The Study Team conducted a survey on flood conditions and added the survey results to the flood areas shown in the PQA-RD. Critical flood areas after 1978 are shown by river basin in Figs. 2.5-1(1/4)-(4/4). There are many informal settlements or slums along the riverbanks and their occupants should be relocated.

The current situation of the critical flood areas is as follows.

(1) Jaboatao dos Guararapes

Flood areas are located around the Olho d'Agua Lagoon, which has an area of 3.75 km^2 with a drainage basin area of 33.75 km^2. The yearly maximum water level of the lagoon ranges from 0.94 m to 1.68 m (October 1990). There are two major channels, the Canal de Setubal and the Canal Corolinas, flowing into the lagoon which drain into the Jaboatao River by way of the Canal Olho D'Agua. These channels are not lined (earth channels).

The areas lower than about 2.0 m above mean sea level (m.s.l) with poor drainage are prone to flooding. However, most of the areas around the lagoon are higher than 2.0 m because of reclamation. The PQA proposed to improve parts of the Canal de Setubal and other channels. The Municipality has a plan to improve the canals of Setubal and Olho D'Agua and create a new channel of 40m wide, linking the two canals and bypassing the lagoon.

(2) Recife

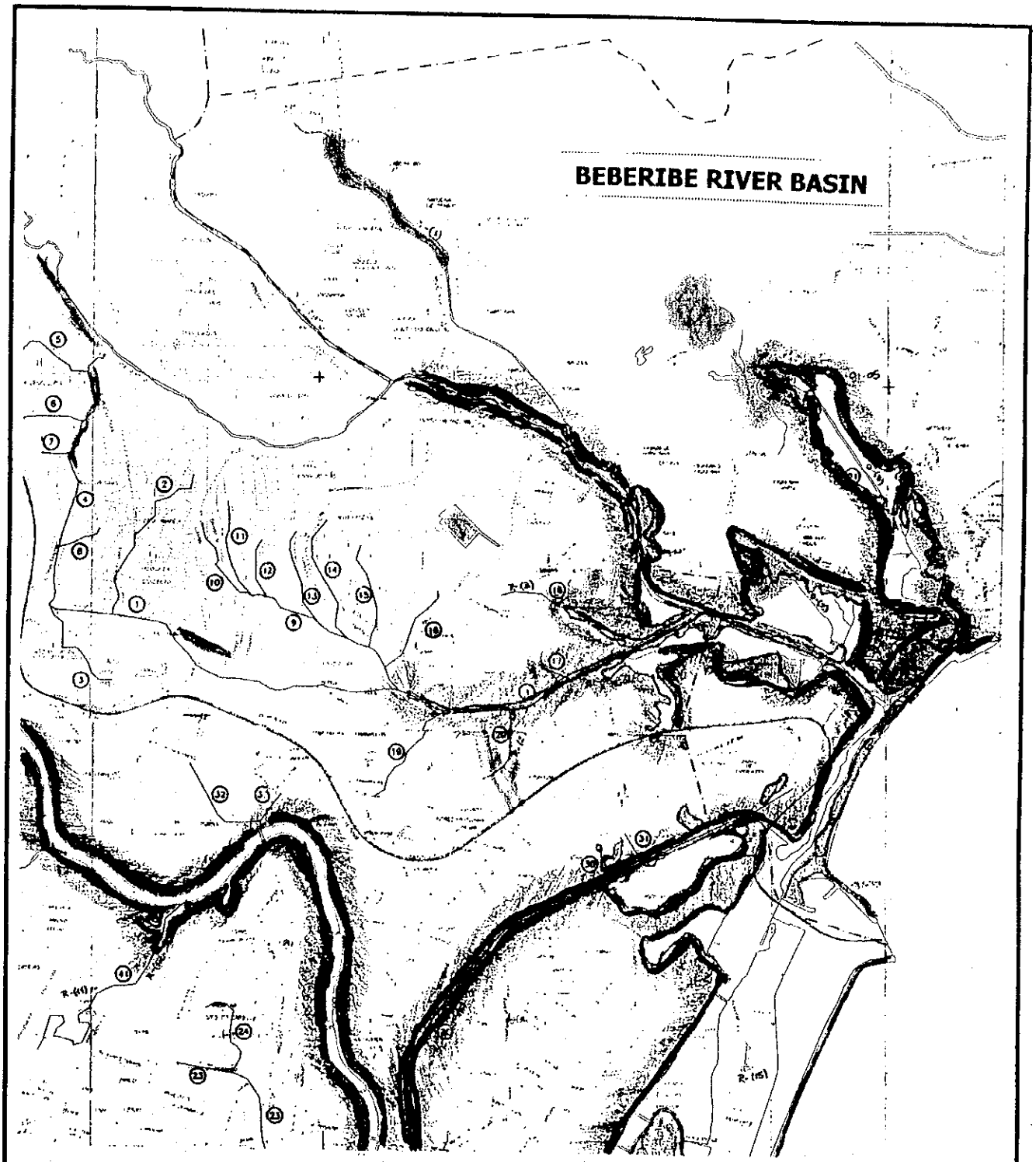
The Municipality of Recife has conducted some drainage improvement works; thereby solving, major flood problems. The remaining flood problems are small scale and of short

duration. There are about seventy (70) locations on and around roads identified as flood

prone, due mainly to poor drainage. These locations should be improved by providing road surface drainage facilities and proper municipal maintenance activities (such as cleaning).

(3) Olinda City

The critical flood areas are located along the Beberibe River and its tributary, the Canal da Malaria. The areas are lower than the surrounding areas due to the estuary topography and the existing hollows of old mining sites. The Municipality of Olinda intends to redevelop the coastal wetland by relocation and also to improve the upper part of the Rio Doce.



LEGEND

Flooded Area

Ground Hight Less than 2.0 m

scale : 1 / 50,000

0 1 2 2,5Km

Fig. 2.5-1(1/4)	Flooded Areas(After 1978) - Beberibe River Basin

THE STUDY ON STORM WATER DRAINAGE AND SEWERAGE MANEGEMENT PLAN FOR RMR

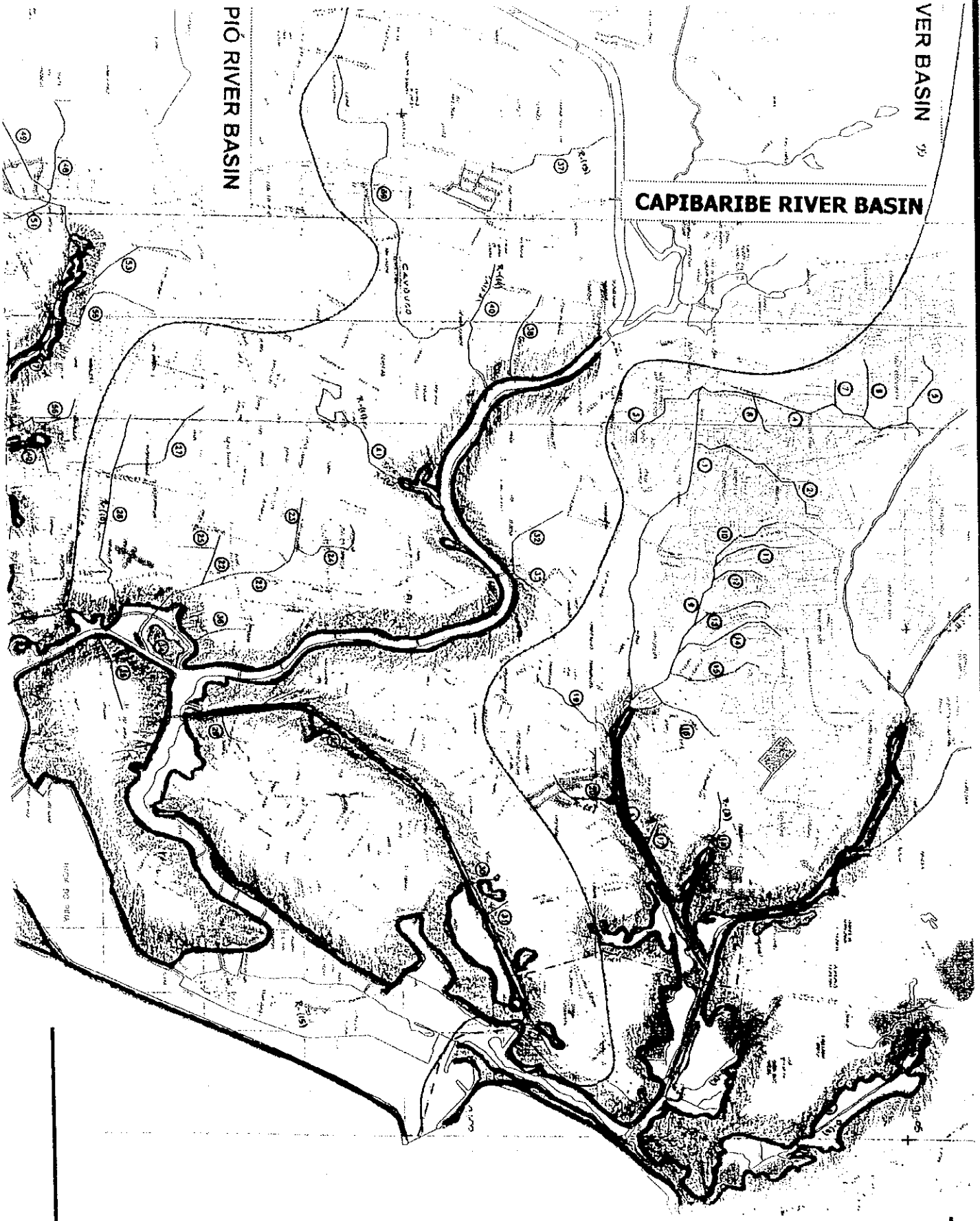


Fig. 2.5-1(2/4) Flooded Areas(After 1978) - Capibaribe River Basin

THE STUDY ON STORM WATER DRAINAGE AND SEWERAGE MANEGEMENT PLAN FOR RMR

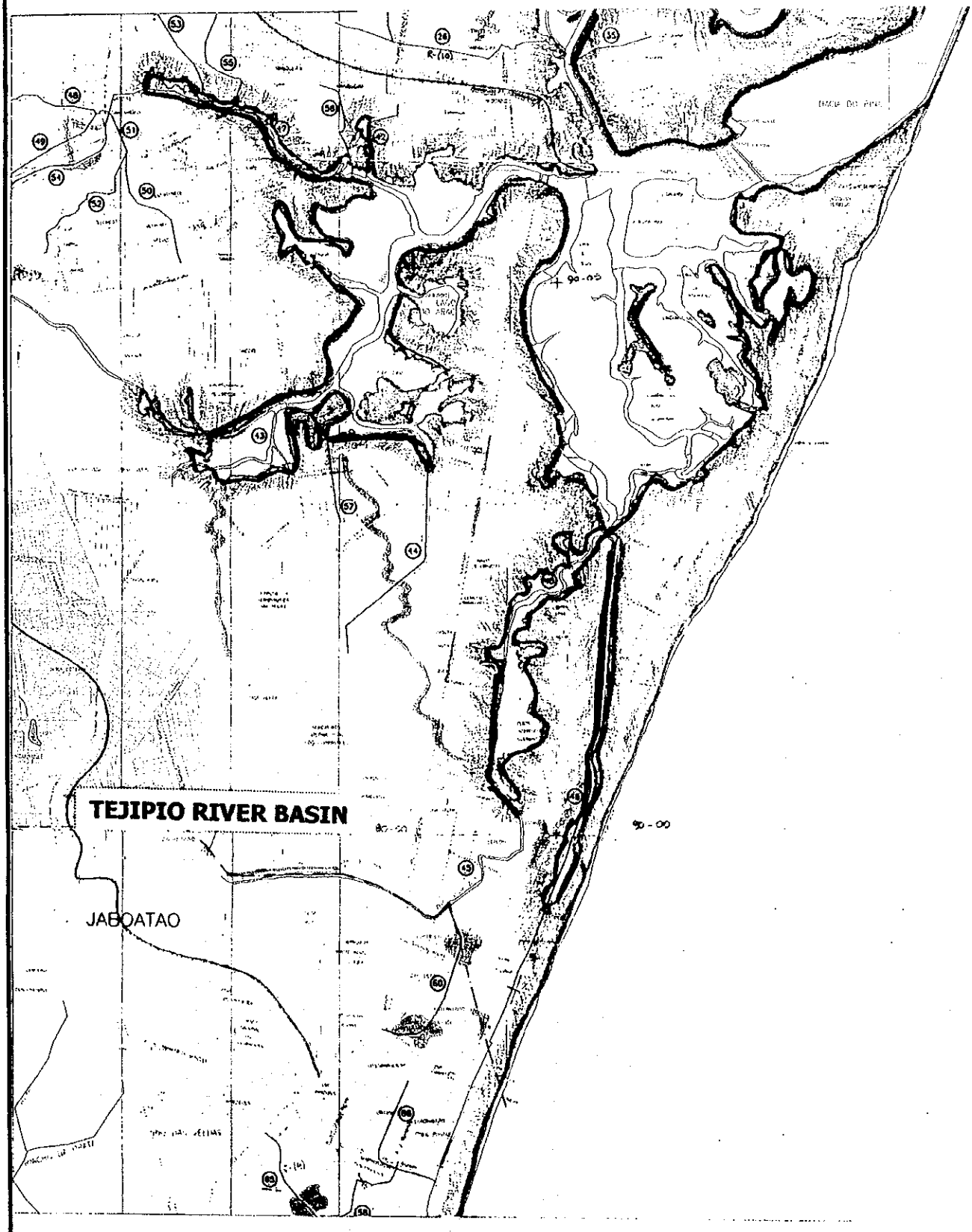


Fig. 2.5-1(3/4)	Flooded Areas(After 1978) - Tejipio River Basin

THE STUDY ON STORM WATER DRAINAGE AND SEWERAGE MANEGEMENT PLAN FOR RMR

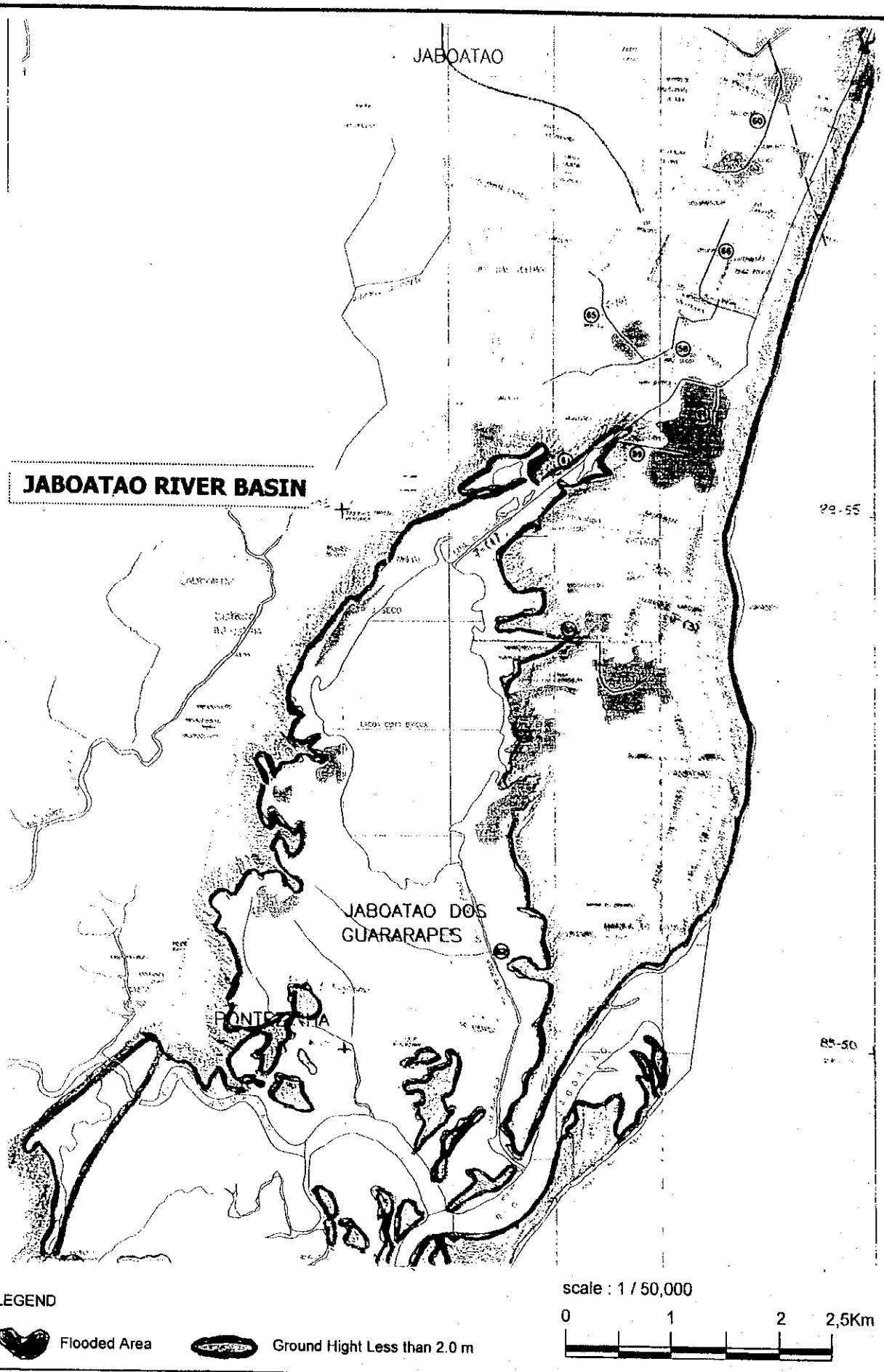


Fig. 2.5-1(4/4) Flooded Areas(After 1978) - Jaboatao River Basin

THE STUDY ON STORM WATER DRAINAGE AND SEWERAGE MANEGEMENT PLAN FOR RMR