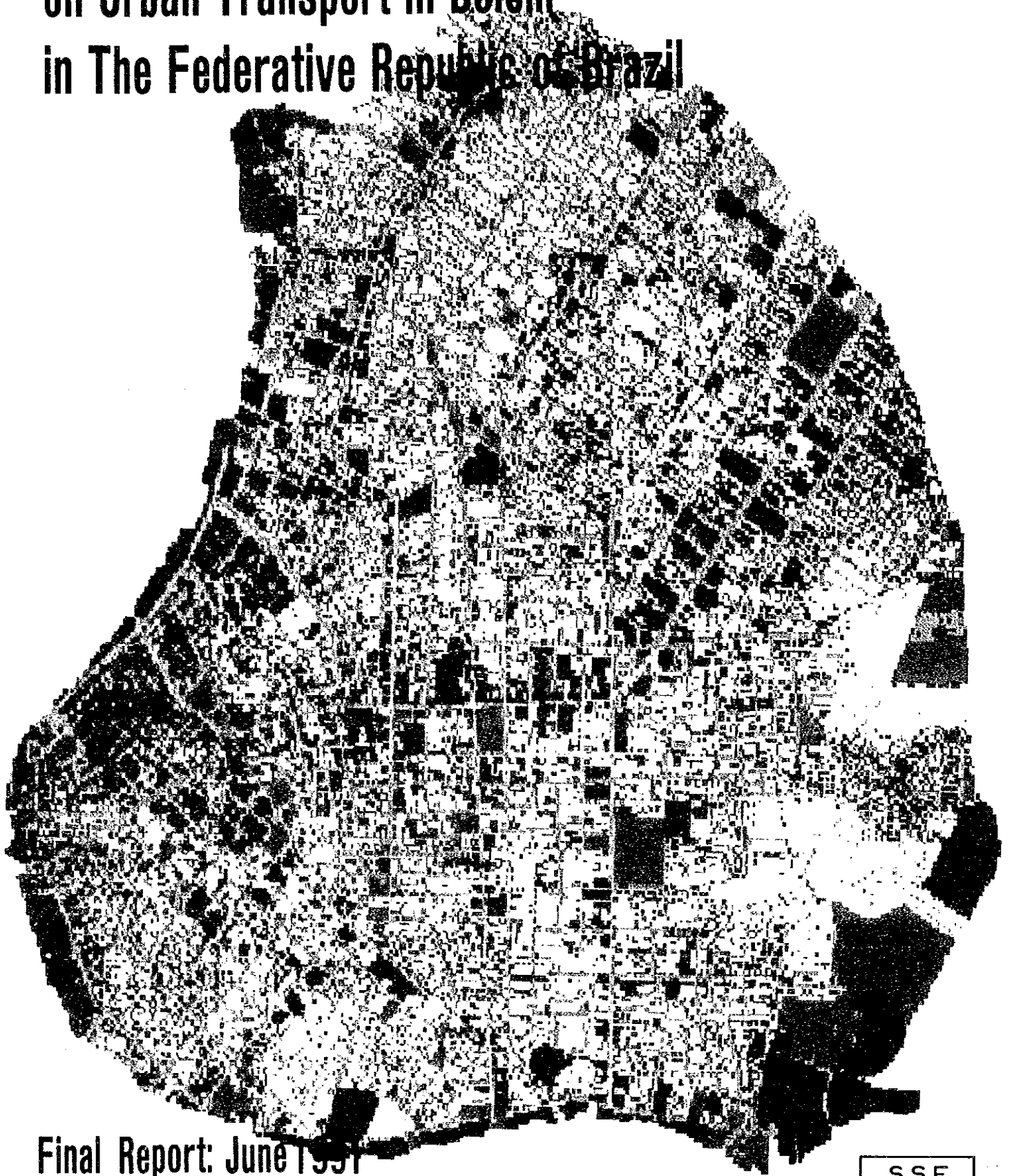


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The Masterplan Study on Urban Transport in Belem in The Federative Republic of Brazil

The Masterplan Study on Urban Transport in Belem in The Federative Republic of Brazil



Final Report: June 1951

Japan International Cooperation Agency

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**The Masterplan Study
on Urban Transport in Belem
in The Federative Republic of Brazil**

Final Report

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Japan International Cooperation Agency

国際協力事業団

22620

PREFACE

In response to a request from the Government of the Federative Republic of Brazil, the Government of Japan decided to conduct a Masterplan Study on Urban Transport in Belem and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to Brazil a study team headed by Mr. Takeo Sato, Chodai Co., Ltd., composed of members from Chodai CO., Ltd. and Yachiyo Engineering Co., Ltd., three times between October 1989 and March 1991.

The team held discussions with the officials concerned of the Government of Brazil, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Federative Republic of Brazil for their close cooperation extended to the team.

June 1991



Kensuke Yanagiya
President
Japan International Cooperation Agency

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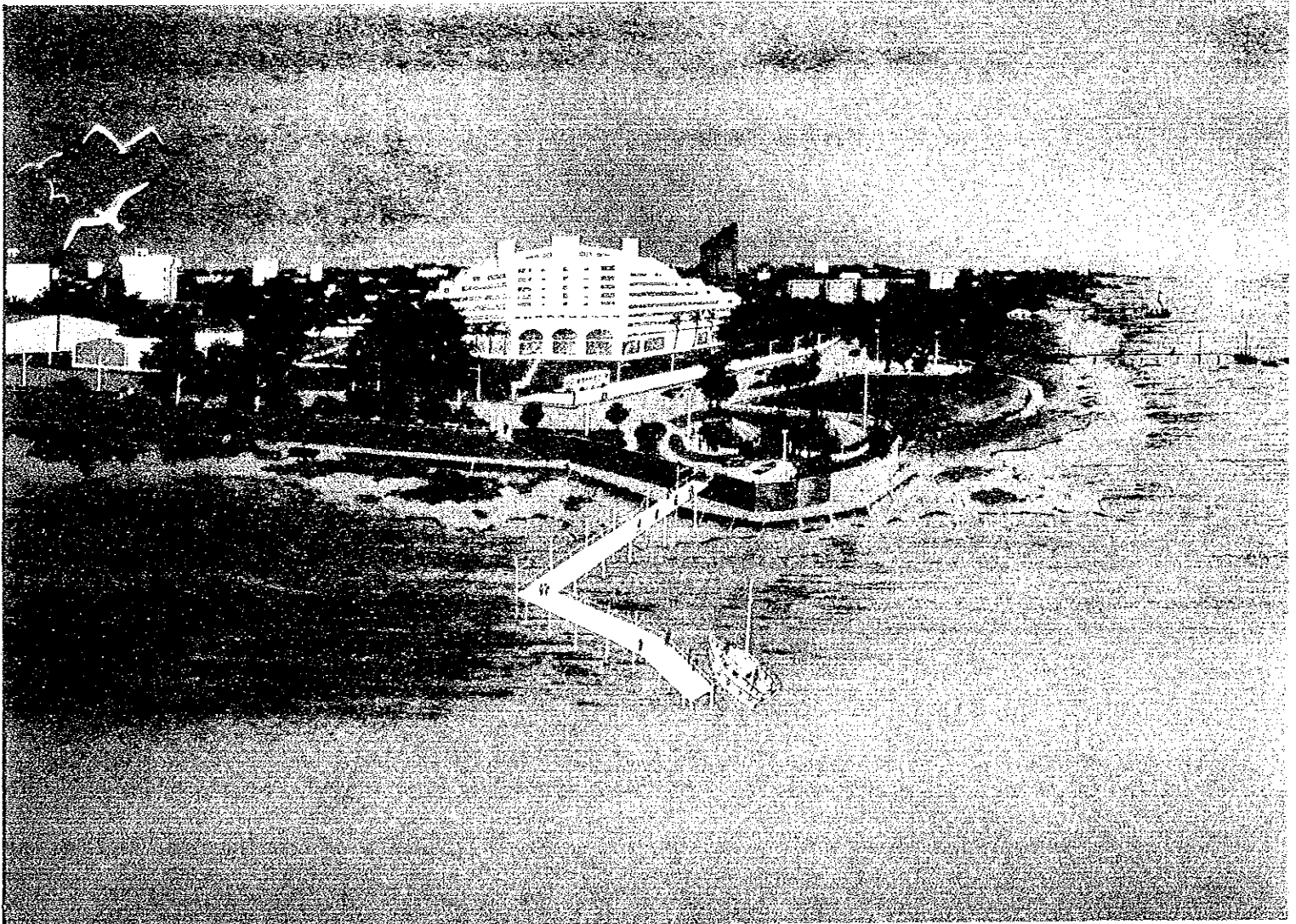
List of Abbreviations

BATRAN	Batalhao de Transito da Policia Militar
B/C	Benefit Cost Ratio
BMA	Belem Metropolitan Area
BMR	Belem Metropolitan Region
BTN	Bonus Tesouro Nacional
CBD	Central Business District
CR\$	Cruzeiro
DETRAN	Departamento de Transito do Estado do Para
EMTU	Empresa Metropolitana Transportes Urbanos
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Products
GRP	Gross Regional Products
IBGE	Instituto Brasileira de Geografia Economica
IBRD	International Bank for Reconstruction and Development
IDESP	Instituto de Desenvolvimento Economico-Social do Para
IMF	International Money Fund
IRR	Internal Rate of Return
IZ	Integrated Zone
JICA	Japan International Corporation Agency
NCZ\$	Cruzado Novo
NPV	Net Present Value
OD	Origin and Destination
PT	Person Trip
SEPLAN	Secretaria de Planejamento do Estado do Para
SETRAN	Secretaria de Transporte do Estado do Para
SM	Minimum Salary
VOC	Vehicle Operation Cost

1. Introduction

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Icoaraci Riverside Park ▼



1.1 Background

1. Belem, the largest metropolis in Amazon area, is the capital of Para state, about 1600 km north of Brasilia. Its development was brought about by the advantageous location of the gate port of the Amazon basin, situated about 130 km upstream from Atlantic Ocean. The Belem Metropolitan Region (BMR) consists of Municipalities of Belem, Ananindeua, Benevides and Barcarena.

2. Due to the influx of a large number of immigrants to the Region, its population has been growing at an average high of about 3.4 % annually for the past several decades. It is expected to grow from 1.4 million in 1990 to about 2.4 million in the year 2010.

3. The economic growth of Para State which includes Belem Metropolitan Region, has been stagnant in recent years, due to the country-wide economic recession. GRP(Gross Regional Products) growth rate from 1979 to 1989 was 6.44 % per annum, however, from 1987 to 1989 the GRP was only 3.32 % per annum. Due to the economic recession of the Region, the vehicle ownership of the Region increased slightly from some 67.7 vehicles per thousand persons in 1980 to 71.2 vehicles per thousand persons in 1989.

4. Urban area in Belem Metropolitan Region (BMR) has been expanding rapidly in accordance with the population growth of the BMR. The Central Area, namely the Belem District, which has been developing since the early seventeenth century, has the major business, commercial and government administrative functions, as well as the residential one. This District is surrounded by rivers (south and west) and the Institutional belt (military and government use, north and east).

5. High income people are concentrated in the limited area of the Belem District with the high rise buildings and dense population. On the other hand, low income people live outside the Institutional belt. The huge area along Augusto Montenegro Rd. and National Road BR-316 have been developing in response to the residential demand of those people for the past two decades.

6. Due to the high growth in population and vehicle number, the traffic demand has grown rapidly. The main traffic corridors in the urbanized area of the Region suffer from congested traffic, due of the excessive concentration of the urban functions into the Central Area, insufficient number of the traffic corridors and the reduced traffic capacity of the streets due to car parking and/or bus operations for passenger movements.

7. The bus transport, which is the major transport mode for person trips, has developed in terms of service area and number of bus operations in response to the expansion of the urbanized area. Buses are operated by nineteen (19) private companies mostly serving to the Central Business District (CBD), located at south-west corner of the Belem District.

8. There are some seventy (70) bus routes covering the urban area of the Region. These routes concentrate into a few traffic corridors for revenue reason and/or road network condition. There are few spaces on the streets for bus operation, such as bus stop bay and the exclusive lane. The bus operation network does not sufficiently cover the newly developed area, especially the one outside the Institutional belt. People are forced to commute and/or to travel by poor transport means every day.

9. In view of above problems, it is imperative to improve the urban transport system in Belem Metropolitan Region. To carry out the above program effectively, it is necessary to establish a master urban transport plan including a future land use plan for the Region.

10. With above objectives in mind, the Government of Brazil requested the Government of Japan for assistance to conduct the Masterplan Study on Urban Transport in Belem in 1988. In response to this request, the Government of Japan through its implementing Agency, the Japan International Cooperation Agency (JICA) began to carry out this study jointly with the Government of Brazil since November, 1989.

1.2 Objectives of the Study

11. The objectives of the Study is to formulate a transport masterplan including transport policies, a development plan and program for the short and long terms, and a future land use plan in the Study Area, that will effectively serve the present and future transport demands and contribute to urban development in the Belem Metropolitan Region.

1.3 Study Area

12. The Study Area covers the present and future urbanized area of the Municipalities of Belem and Ananindeua, shown in Figure 1.3-1. Although Belem Metropolitan Region includes also the Municipalities of Benevides and Barcarena, the Study Area did not cover these area due to the following reasons:

a. The main objective is to develop master plan of the urban transportation which will cope with the major transport problems for the present as well as for the future in Belem Metropolitan Region.

b. Municipalities of Barcarena and Benevides are located independently from the Belem urban area. Only a few residents may be commuting to Belem and Ananindeua. Intermunicipal transport plan or river transport plan will address these problems.

c. The population of Municipalities of Barcarena and Benevides is in the range of thousands and is not expected to grow so rapidly. Such urban areas are expected to be independent from the Study Area.

d. Ananindeua has already become a contiguous urban area with Belem, therefore, it cannot be studied separately.

1.4 Study Organization

13. The Study is being carried out in Brazil jointly by JICA and the Government of Brazil in coordination with other agencies. The organizations involved in the Study are shown in Figure 1.4-1.

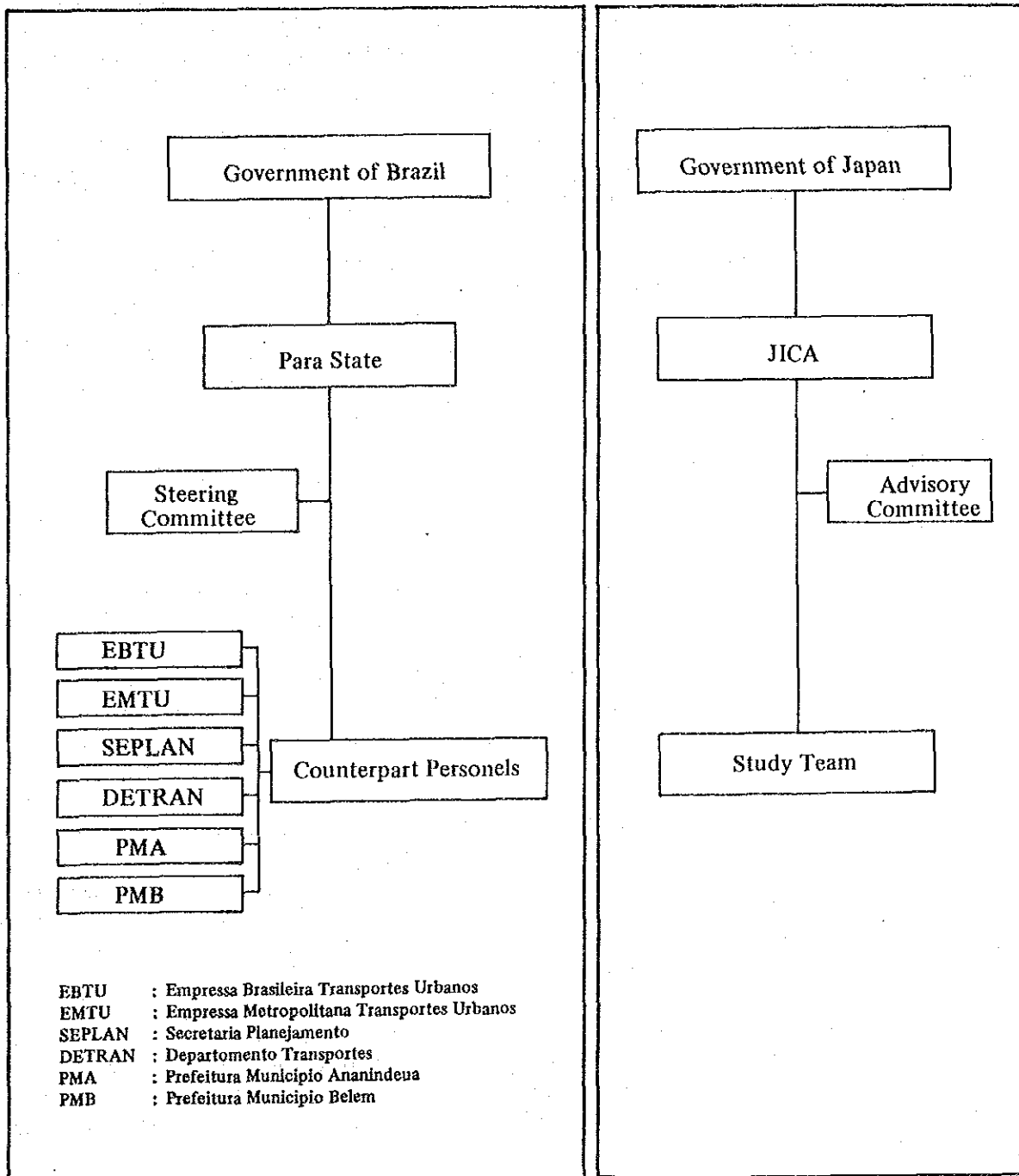


Figure 1.4-1 Study Organization

1.5 Study Flow

14. In order to accomplish the objectives of the Study, the various components of the Study have been conducted through the following four steps.

15. Step 1 involves the survey of the existing condition and data collection. A number of various surveys on the existing conditions related to the Study were carried out during the period from December 1989 to April 1990. The main survey items were as follows;

- a. Person Trip Survey and its related surveys including Cordon Line Survey and Screen Line Survey,
- b. Public Transport Survey including bus company survey, bus passenger survey and bus route survey,
- c. Surveys for traffic management such as traffic volume counting, travel time survey, parking survey, traffic accidents survey, etc.
- d. Road inventory survey,
- e. Land use survey, and
- f. Socioeconomic survey including economic activities, population growth trend, transportation, etc.

16. The above survey results were compiled and analyzed to understand the existing conditions of the urban transport, the socioeconomic activities and land use pattern in the Study Area.

17. Step 2 is the analysis of existing conditions. On the basis of the survey results, the existing problems on the urban transport and urban structure in the Study Area were identified. At the same time, socioeconomic framework in future was projected and the future land use plan prepared. In addition, the future transport demand was forecasted based on the future land use and future socioeconomic framework.

18. Step 3 is the development of alternative transport plans. In order to meet the future traffic demand, the alternative road network plans were formulated and roughly evaluated by calculating the project cost and effect of each alternative on the traffic flow.

19. In addition to the road network plan, a public transport network plan for bus transportation was prepared, for

the short and long term plans. It includes the introduction of trunk bus operation and zone bus operation systems.

20. Traffic management improvement plan was also prepared. It includes the improvement of signal control system, intersection improvement, traffic corridor readjustment due to the introduction of trunk bus system, parking system improvement, etc.

21. Step 4 is the preparation of Masterplan and implementation plan. Based on the findings emerging from the evaluation of the results in Step 3, the transport master plan network will be formulated and economically evaluated by setting up the investment schedule of each project.

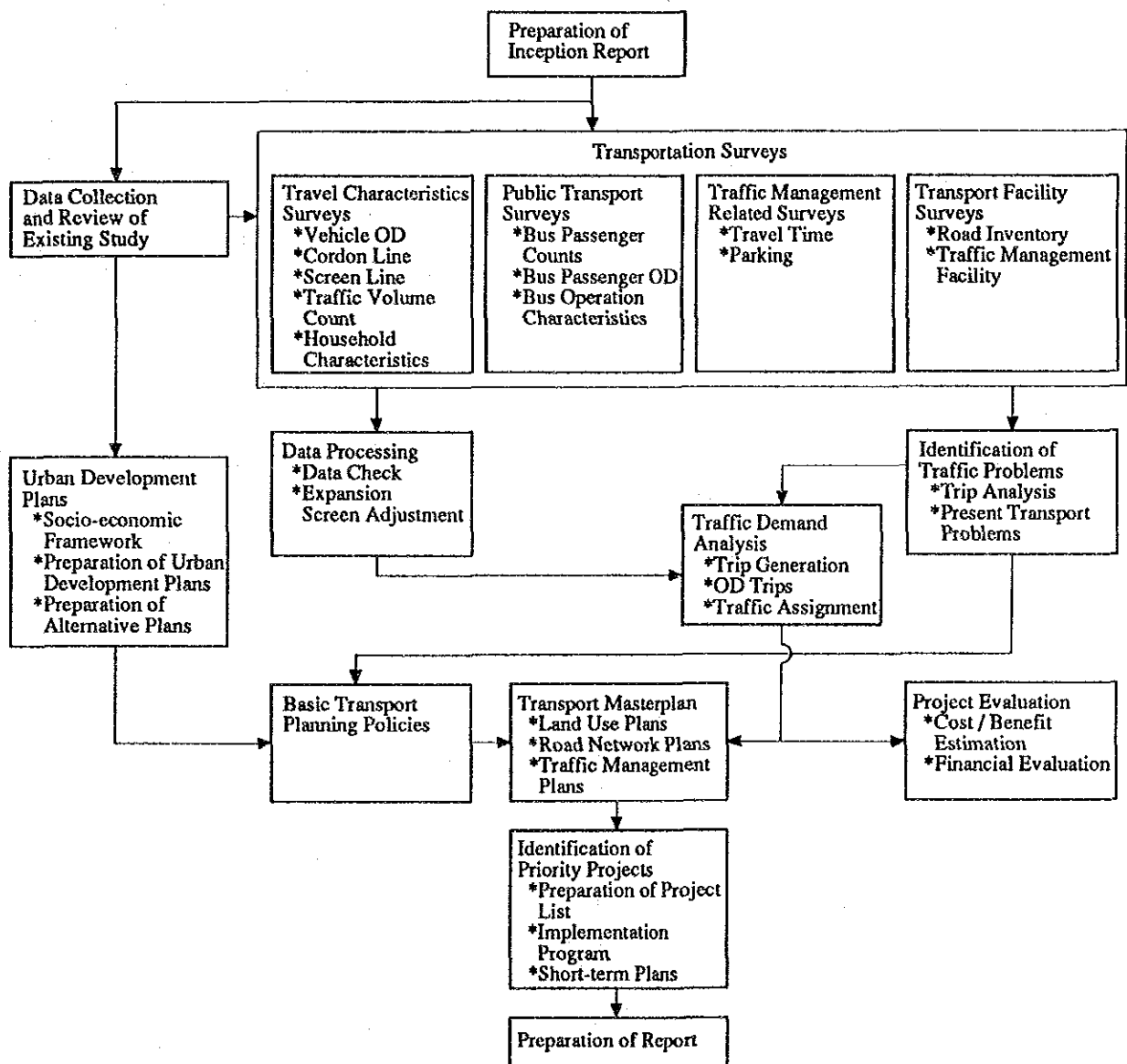


Figure 1.5-1 Study Flow

2. Socioeconomic Trend

2.1	Population	9
2.2	Gross Regional Product (GDP)	14
2.3	Employment	17
2.4	Household Income	19
2.5	Car Ownership	20

Local Market ▼



2.1 Population

2.1.1 Population Growth Trend of Study Area

22. As shown in Table 2.1-1 the population of the Study Area has increased from 996 thousands in 1980 to 1,419 thousands in 1990 at an annual increase rate of 3.6 % on the average. This value is 0.7 percent lower than that of 4.3 % in 1970s.

Table 2.1-1 Population Growth of Study Area

Year	Pop.(thousand)	Annual Increase Rate(%)
1) 1980	996	
2) 1990	1,419	3.61

Source: 1) Enumeration from 1980 Census Tracts Data
(The value is about 3 thousand persons smaller than the official summed value of 999 thousand for the municipalities of Belem and Ananindeua. These persons are considered to have been in the islands outside of the Study Area.)
2) Result of household data by PT Survey (April, 1990)

23. Using the natural increase data obtained from the Foundation of Public Health Services of Para (Fundacao de Servicos de Saude Publica do Para - FSESP), the natural increase rates and the net in-migration rates are estimated for the past ten years (see Table 2.1-2). The annual natural increase rate has shown a declining tendency from 2.81 % in 1980/81 to 1.86 % in 1989/90. Compared with the estimated population increase rates of Brazil (These values are considered to be nearly the national average of natural increase rate.), the natural increase rate of the Study Area has experienced a rapid drop and in recent years it came down to a level below the natural average (refer to Table 2.1-3).

24. The net in-migration rate has been fluctuating between 1.0 and 1.5 % per annum. No clear trend of change can be observed, but in recent years it seems that the rate has ranged at a level of 1.4 to 1.5 % and the annual in-migration is nearly 20 thousand persons larger than the out-migration.

Table 2.1-2 Estimation of Natural Increase Rates and Net In-migration Rates, 1980 - 1990

Year	Population 1)		Natural Increase 2)		Net-migration 3)	
	Number	Increase Rate (%)	Number	Increase Rate (%)	Number	Increase Rate (%)
1980	995,891	3.93	27,960	2.81	11,173	1.12
1981	1,035,024	3.83	30,276	2.93	9,365	0.90
1982	1,074,665	3.77	30,281	2.82	10,180	0.95
1983	1,115,126	3.70	27,861	2.50	13,399	1.20
1984	1,156,386	3.64	26,346	2.28	15,689	1.36
1985	1,198,421	3.57	25,424	2.12	17,360	1.45
1986	1,241,204	3.51	24,038	1.94	19,466	1.57
1987	1,284,708	3.44	25,610	1.99	18,584	1.45
1988	1,328,902	3.38	25,540	1.92	19,311	1.45
1989	1,373,753	3.31	25,598	1.86	19,873	1.45
1990	1,419,224					

- Note: 1) Estimated for each year based on the assumption that the population increase rate has gradually slowed down.
 2) Between 1980 and 1988, the data from FSESP are adjusted according to the difference of the total population in 1980 between the Study Area (996 thousand) and Belem/Ananindeua (999 thousand). Between 1988 and 1990, the natural increase rates are estimated by using a model reflecting the past declining tendency and the numbers are obtained by applying these natural increase rates.
 3) Calculated by subtracting the number of natural increase from the total population increase.

Table 2.1-3 Estimated Population Increase Rate of Brazil and Natural Increase Rate of the Study Area

	Population Increase 1) Rate of Brazil	Natural Increase Rate of Study Area
1980/81	2.29	2.81
1984/85	2.19	2.28
1989/90	2.01	1.86

Source: 1) IBGE

2.1.2 Characteristics by Zone

25. Table 2.1-4 shows the population distribution by Integrated Zone (hereinafter referred to IZ) in 1990 and its change during the period 1980-90. In 1990, 50% of the total population is located in the central area which covers only 6% of whole area.

26. The central area, which is composed of IZs of Centro, Guama, Sacramento and Marco has an average population density of about 200 persons per hector. This area shows a saturated situation and the annual increase rate is only 1.2% on the average.

27. The Transition areas of IZ of Marambaia and IZ of Aeroporto seem to be able to accommodate more population, but because of the existence of the vast institutional area the real population density is already at a high level (refer to Table 3.4-4). IZ of Embrapa is a special zone composed of EMBRAPA, COSAMPA, CEASA and FCAP.

Table 2.1-4 Population by Integrated Zone, 1980-1990

Integrated Zone (No.)	Covered Area (km ²)	Population		Population Density (90,p/ha)	80-90 G.R.p/a (%)
		1980	1990		
Central area					
Centro (1)	8.23	135,834	143,648	174.5	0.56
Guama (2)	10.93	184,870	231,901	212.2	2.29
Sacramento (3)	10.10	182,917	203,860	201.8	1.09
Marco (4)	7.87	128,111	133,184	169.2	0.39
Subtotal	37.13	631,732	712,593	191.9	1.21
Transition area					
Marambaia (5)	16.68	125,064	154,940	92.9	2.17
Aeroporto (6)	13.57	30,431	50,560	37.3	5.21
Embrapa (7)	18.41	671	318	0.2	-7.20
Subtotal	48.66	156,166	205,818	42.3	2.80
Expansion area					
Guanabara (8)	8.72	32,818	63,990	73.4	6.91
Bengui (9)	24.03	35,015	106,046	44.1	11.72
Pratinha (10)	8.14	6,641	20,452	25.1	11.91
Icoaraci (11)	36.76	64,338	96,610	26.3	4.15
Cidade Nova (12)	40.05	23,499	113,784	28.4	17.09
J. Seffer (13)	24.18	9,773	29,982	12.4	11.86
Ananindeua (14)	30.39	15,925	52,748	17.4	12.72
Aura (15)	53.58	4,227	495	0.1	-19.30
Subtotal	225.85	192,236	484,107	21.4	9.68
Islands					
Outeiro (16)	31.82	2,085	4,914	1.5	8.95
Ilhas (17)	63.20	0	0	0.0	
Mosqueiro (18)	220.85	13,672	11,792	0.5	-1.47
Subtotal	315.87	15,757	16,706	0.5	0.59
Total	627.51	995,891	1,419,224	22.6	3.61

28. The Expansion area has a population of 484 thousands, which is about one third of the total population of the Study Area. The population increase rate during the past ten years registered a high 9.7% per annum. The population density is still at a low level and it is expected that the area will absorb a more people in the coming years.

29. The Islands are composed of Outeiro Island (IZ 16), Mosqueiro Island (IZ 18) and several islands belonging to the municipality of Ananindeua (IZ 17). No one lives in Ilhas, which is a low-lying wet land. Population of Outeiro is small but increased at a considerably high rate. On the other hand, Mosqueiro (IZ 18) registered a slight decline.

2.1.3 Demographic Structure in 1990

(1) Age-sex Composition

30. Of the total population of 1,419 thousand, 670 thousand are males and 749 thousand are females. The number of male population per 100 females (sex-ratio) is 89.5. According to the 1980 Census sex-ratio of Belem Metropolitan Region was 91.5. Such low sex-ratio reflects migration of females to the Study Area for better opportunities especially in services.

31. The age-sex composition is shown in Figure 2.1-1. Males exceed females in 0-4 and 5-9 years age-groups. In all other age-groups, however, there is an excess of females over males. As for the age structure, the compositions of the age-groups 10-14 and 15-19 years are high (12.3% and 13.1%, respectively).

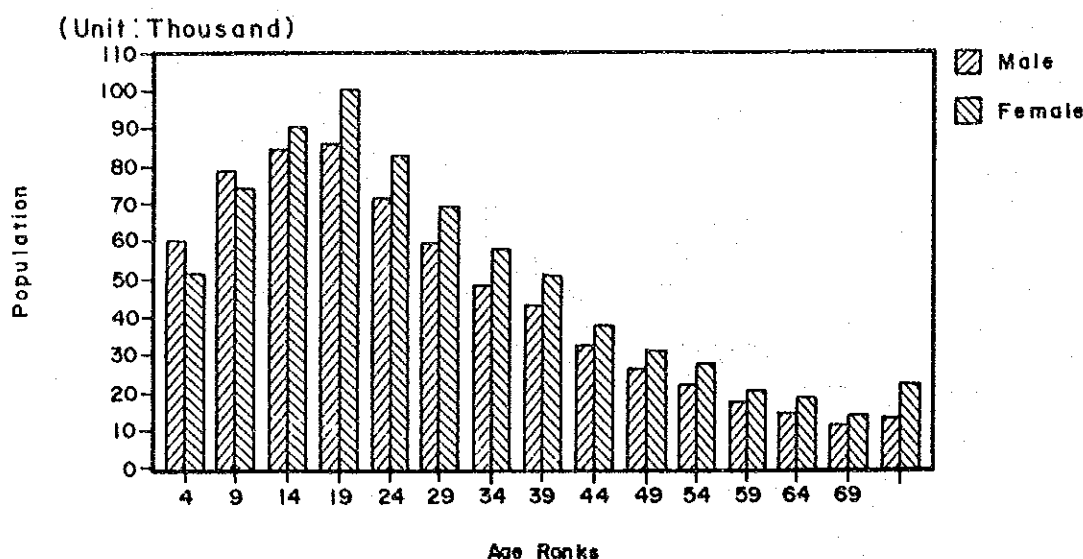


Figure 2.1-1 Population by Sex and by Age-group

(2) Economic Participation

32. The economically active population (labor force) is 541 thousands. The population not in labor force comprises of 414 thousand students, 200 thousand housewives and 264 thousand others (refer to Table 2.1-5).

Table 2.1-5 Economic Participation

Economic Category	Number	Percent
Economically Active	541,000	38.1
Employed	494,000	34.8
Unemployed	47,000	3.3
Not Economically Active	878,000	61.9
Students	414,000	29.2
Housewives	200,000	14.1
Others	264,000	18.6
Total	1,419,000	100.0

2.2 Gross Regional Product (GDP)

2.2.1 Economic Growth of Brazil and Para

33. The Brazilian economy suffered from a series of difficulties in 1980s. The annual average growth rate of GDP was only about 2.2 % during the past ten years, extremely lower than that of 8.6 % in 1970s. This slow growth is due to the significant fall in investment, resulting from the exhaustion of the capital of foreign debt in the public sector and the bankruptcy of the funding pattern for investments based on the foreign debts (refer to Table 2.2-1).

34. The State of Para is typical frontier area of the national economy. The investments in the sectors of energy and mining have attracted the surplus population of the rest of the country and contributed to a relatively high economic growth.

Table 2.2-1 Annual Growth Rate of GDP
and GRP of Para (%)

Year	GDP(Brazil) 1)		GRP(Para) 2)	
1981	-4.4		-1.3	
1982	0.6		7.3	
1983	-3.5		-2.7	
1984	5.1		5.9	
1985	8.3	1.1	3.8	2.5
1986	7.5		17.1	
1987	3.6		2.1	
1988	0.0		5.0	
1989	3.3	3.6	2.9	6.6
1980-1989	2.2		4.3	

Source: 1) IBGE, 2) IDESP

2.2.2 Estimation of GRP of the Study Area in 1989

35. There are no published data of GRP of the Study Area. However, it can be estimated by using the data obtained from the economic censuses.

36. Tables 2.2-2 and 2.2-3 show the production amounts and shares of main economic activities of the Study Area in 1975 and 1980, respectively.

Table 2.2-2 Production Amount and Share of Economic Activities of the Study Area, 1975 (unit: Cr\$ 1000, %)

Area	Agriculture Livestock(A)		Manufacturing Industry(B)		Commerce & Services(C)	
	Amount	%	Amount	%	Amount	%
Para	1,918,562	100.0	1,699,018	100.0	8,411,732	100.0
Study Area	19,190	1.0	1,124,432	66.2	6,086,245	72.4
Belem	10,380	0.5	1,032,394	60.8	5,903,734	70.2
Ananindeua	8,810	0.5	92,038	5.4	182,511	2.2

Source: IBGE (Censos Economicos, 1975)

Table 2.2-3 Production Amount and Share of Economic Activities of the Study Area, 1980 (unit: Cr\$ 1000, %)

Area	Agriculture Livestock(A)		Manufacturing Industry(B)		Commerce & Services(C)	
	Amount	%	Amount	%	Amount	%
Para	36,108,070	100.0	33,057,613	100.0	158,111,954	100.0
Study Area	330,307	0.9	14,812,336	44.8	98,920,530	62.6
Belem	158,001	0.4	12,877,031	39.0	93,880,187	59.4
Ananindeua	172,306	0.5	1,935,305	5.8	5,040,343	3.2

Source: IBGE (Censos Economicos, 1980)

37. Assuming that the shares of A, B, and C are those of the primary, the secondary and the tertiary sectors respectively, GRP of the Study Area are estimated for 1975 and 1980 (refer to Table 2.2-4).

Table 2.2-4 Estimated GRP of the Study Area, 1975 & 1980 (thousand US\$, 1989 prices, %)

Sector	Para			Study Area			Elasticity
	1975	1980	Annual Growth Rate	1975	1980	Annual Growth Rate	
	Primary	459,431	1,006,453	17.0	4,594	9,058	
Secondary	724,281	1,647,618	17.9	479,474	738,133	9.0	0.503
Tertiary	1,560,778	3,055,387	14.4	1,130,003	1,912,672	11.1	0.771
Total	2,744,490	5,709,458	15.8	1,614,071	2,659,863	10.5	0.665

Note: 1) Exchange rates between Cruzeiro and US dollar are based on the annual average of the monthly average rates published by Fundacao Getulio Vargas:

1975, Cr\$/US\$ = 8.126

1980, Cr\$/US\$ = 52.699

2) 1989 prices are calculated by using the following consumer price indices of the United States:

1975 = 100, 1980 = 153.1

1980 = 100, 1985 = 132.7

1985 = 100, 1989 = 114.65

38. For estimating GRP in 1989, the following considerations are made for each sector:

(1) Primary Sector

39. Due to rapid urbanization, agricultural lands are decreasing in the Study Area. The elasticity in 1980-89 should be lower than 0.853 in 1975-80. 0.7 is adopted as the elasticity in 1980-1989.

(2) Secondary Sector

40. Large scale industrial projects, for example like ALBRAS, were implemented outside the Study Area during the period. On the other hand, no significant industrial developments were founded inside. The elasticity in 1980-89 should be lower than 0.503 in 1975-80. 0.4 is adopted as the elasticity in 1980-89.

(3) Tertiary Sector

41. The economic impact of Para on the Study Area is assumed to be almost the same as in 1975-80. The elasticity of 0.771 in 1975-80 is adopted as that in 1980-89.

42. Using the data from IDESP for the period between 1980 and 1987 and the Study Team estimates for 1988 and 1989, the annual average growth rates of Para during the period were: primary sector 2.67 %, secondary sector 7.16 % and tertiary sector 3.64 %. Applying the sector elasticity to the growth rates, GRP of the Study Area in 1989 is estimated as shown in Table 2.2-5:

Table 2.2-5 Estimated GRP of the Study Area
in 1989 (US\$ 1000, %)

Sector	Amount	Percentage
Primary	10,702	0.3
Secondary	951,378	27.8
Tertiary	2,454,476	71.8
Total	3,416,556	100.0

Compared with the estimated population of 1,374 thousand in 1989, the per capita GRP is estimated at US\$ 2,487.

2.3 Employment

2.3.1 Labor Force and Employment in 1990

43. As described in section 2.1.3 labor force in 1990 is 541 thousand persons, of which 494 thousand persons are employed and 47 thousand persons are unemployed. This means that the crude activity rate (ratio of labor force to total population) is 38.1 % and the unemployment rate is 8.6 %. Of 494 thousands employed population, 485 thousand persons work inside the Study Area (refer to Table 2.3-1).

Table 2.3-1 Employed Population Working in the Study Area and its Ratio by Sector, 1990

Sector	Resident Employed Population (A)	Working in Study Area (B)	Working Outside	(B)/(A)
Primary	7,027	5,964	1,063	0.849
Secondary	79,681	77,731	1,950	0.976
Tertiary	407,076	400,825	6,251	0.985
Total	493,784	484,520	9,264	0.981

44. Compared with the 1980 Census results, the numbers of employed persons in the primary and secondary sectors scarcely changed while that in the tertiary sector increased by 76 percent (refer to Table 2.3-2).

Table 2.3-2 Employed Population by Sector in 1980 and Change between 1980 and 1990

Sector	1980	1990/1980
Primary	6,389	1.10
Secondary	81,078	0.98
Tertiary	230,938	1.76
Total	318,405	1.55

Source: 1980 Census

2.3.2 Characteristics by Zone

45. The distribution of employed population is shown in Table 2.3-3, enumerated at residence and working place.

46. Centro has a high concentration of more than 30 % of the total employment. The relationship between the work place base to residence base expresses the zone characteristics of socioeconomic activity. Thus, if the ratio is over 1.00, the zone attracts

more persons from residence base to the work base. In the central area, Centro and Marco are composed of a commercial and business belt while Guama and Sacramento have characteristics of residential area. The transition area is a mixture of institutional and residential zones. The extraordinary high ratio of 52.55 of Embrapa reflects the existence of EMBRAPA and other institutions.

47. Rapid residential developments are proceeding in the expansion area and the ratios above mentioned are very low as a whole. However Pratinha and Ananindeua show the ratio over 1.00. The former is the industrial zone attracting workers from surrounding areas and latter includes the town center of Ananindeua. The island area is considered to be relatively independent but seems to attract some workers in the tertiary sector as the recreational zone.

Table 2.3-3 Distribution of Residence and Work Place of Employed Population

Integrated Zone	Residence base	Work place Number	base %	Work place to residence ratio
Central area				
Centro	52,674	152,235	30.9	2.89
Guama	80,479	42,215	8.5	0.52
Sacramento	71,981	56,795	11.5	0.79
Marco	48,358	67,740	12.7	1.30
Subtotal	253,497	314,085	63.6	1.24
Transition are				
Marambaia	54,378	39,213	7.9	0.72
Aeroporto	15,951	12,588	2.5	0.79
Embrapa	89	4,677	0.9	52.55
Subtotal	70,418	56,478	11.4	0.80
Expansion area				
Guanabara	20,056	17,911	3.6	0.89
Bengui	35,958	15,232	3.1	0.42
Pratinha	6,448	8,031	1.6	1.25
Icoaraci	37,094	29,028	5.9	0.78
Cidade Nova	38,858	14,101	2.9	0.36
Julia Seffer	9,672	4,400	0.9	0.45
Ananindeua	15,877	18,220	3.7	1.15
Aura	99	110	0.0	1.11
Subtotal	164,062	107,033	21.7	0.65
Islands				
Outeiro	1,884	2,698	0.5	1.43
Ilhas	0	14	0.0	
Mosqueiro	3,923	4,212	0.9	1.07
Subtotal	5,807	6,924	1.4	1.19
Study Area	493,784	484,520	98.1	0.98
Outside	0	9,264	1.9	
Total	493,784	493,784	100.0	1.00

2.4 Household Income

48. The number of households by monthly income level is shown in Figure 2.4-1. Most households earn between 5,000 and 30,000 NCZ per month (as of March 1990).

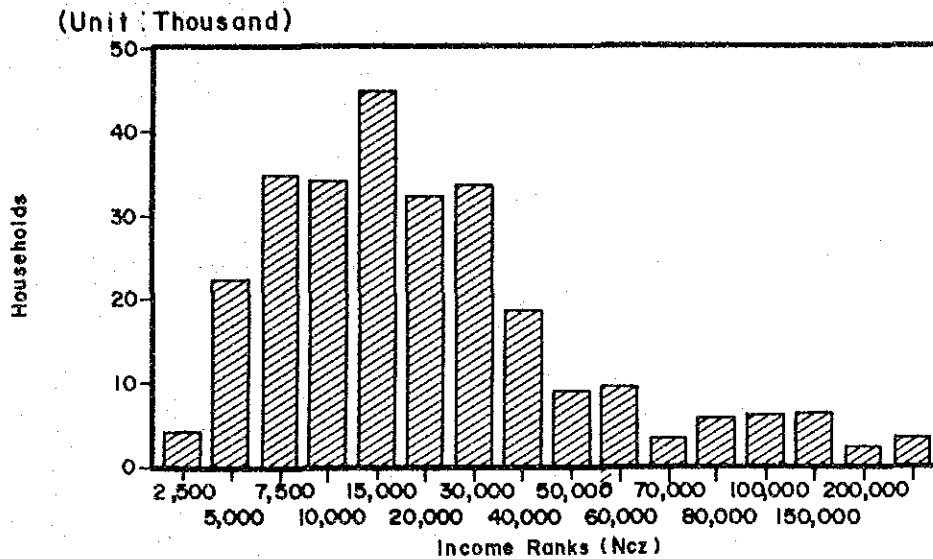


Figure 2.4-1 Monthly Income Distribution

49. All of the households are equally divided into five groups (i.e., monthly income quintile groups) after being arranged in order of monthly income, and are referred to as Groups I, II, III, IV and V in order from the lowest income group to the highest.

50. The ratio of the total income earned by each quintile group to the whole regional income distributed is shown in Table 2.4-1. The fifth group earns 62.6 % while the first group receives only 3.3 %. The fourth group earns 17.6 % which is near the percentage of number of households (20 %).

Table 2.4-1 Average Monthly Income and Composition of Income Distribution by Quintile Groups

Monthly Income Quintile Group	Average Monthly Income (NCZ)	Composition of Income Distributed (%)
I	5,093	3.3
II	9,507	6.2
III	15,606	10.3
IV	26,707	17.6
V	95,252	62.6
Total	30,433	100.0

2.5 Car Ownership

51. The total number of cars is approximately 69,000 vehicles. On the other hand, the figure for motorcycle (4,800) is much lower than that of cars as shown in Table 2.5-1. The percentage of motorized households who own a car is 19 %. Company and government owned vehicles, however, are not included in those figures. Additionally, some of the vehicles owned by companies or government are privately used. Therefore, the figure indicated before seems to be lower than that in actual use.

Table 2.5-1 Motorized Households and Car Ownership

Block No.	Non-Motorized	Number of Households			Number of Vehicles			Average Household Income
		Motorized Households	Total	Motorized Ratio	Car	M/C	Total	
1	20,180	13,628	33,808	0.403	17,223	921	18,144	58,407
2	41,981	5,908	47,889	0.123	7,368	622	7,990	20,101
3	35,739	7,875	43,614	0.181	9,737	466	10,203	38,550
4	21,117	8,679	29,796	0.291	10,682	622	11,304	38,915
5	24,965	6,349	31,314	0.203	7,220	458	7,678	29,494
6	8,887	813	9,700	0.084	909	123	1,032	18,491
7	21	44	65	0.677	62	0	62	45,479
8	12,153	1,956	14,109	0.139	2,381	176	2,557	24,164
9	19,837	3,070	22,907	0.134	3,530	312	3,842	23,629
10	3,809	121	3,930	0.031	202	0	202	13,048
11	16,434	2,136	18,570	0.115	2,811	399	3,210	20,719
12	21,226	3,565	24,791	0.144	4,036	291	4,327	22,464
13	5,381	718	6,099	0.118	859	28	887	23,285
14	10,960	826	11,786	0.070	1,220	286	1,506	13,539
15	72	18	90	0.200	18	0	18	12,656
16	1,061	110	1,171	0.094	164	28	192	13,907
17	0	0	0	0.000	0	0	0	0
18	2,574	228	2,802	0.081	276	55	331	12,755
Total	246,397	56,044	302,441	0.185	68,798	4,787	73,585	29,939

Note : Motorized household is of car owner (excluding M/C)

52. The relationship between households income level and car ownership is shown in Figure 2.5-1. The accumulative percentage of car ownership categorized into non-car, one car, multiple cars and motorcycle by household income level is shown in Figure 2.5-2 and the percentage of ownership for the income level according to the same category is shown in Figure 2.5-3. As seen from these Figures, the composition rate of non-motorized households decrease, while motorized households increase for the increase of income level.

53. This kind of relationship is also found in Figure 2.5-4, which shows the average household income level against the motorized household ratio by the integrated zone. According to this Figure, in the central area where the average household income level is more than 30,000 NCZ, the car ownership become high level.

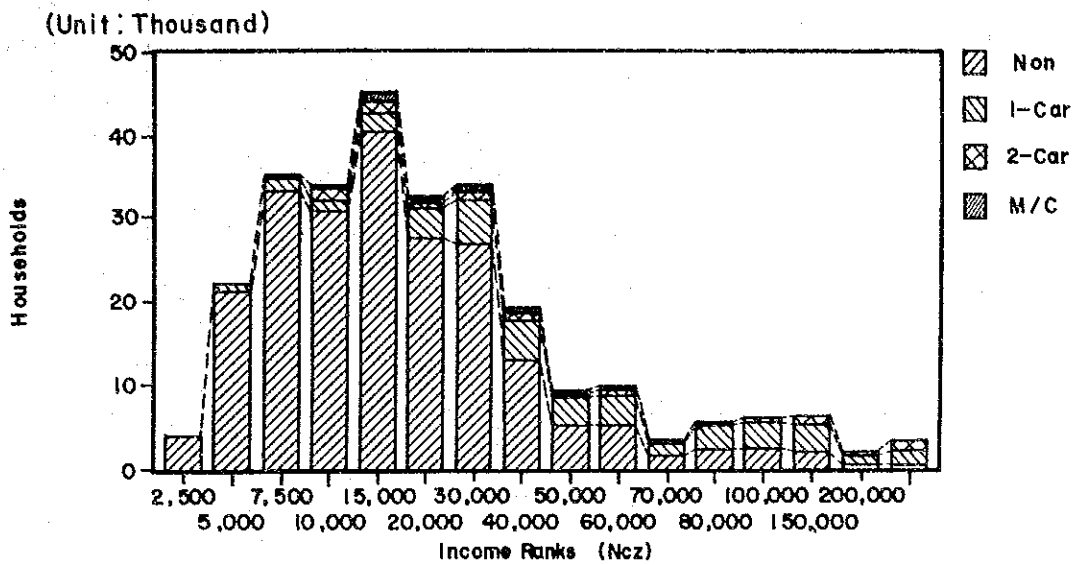


Figure 2.5-1 Motorized Households by Income Level

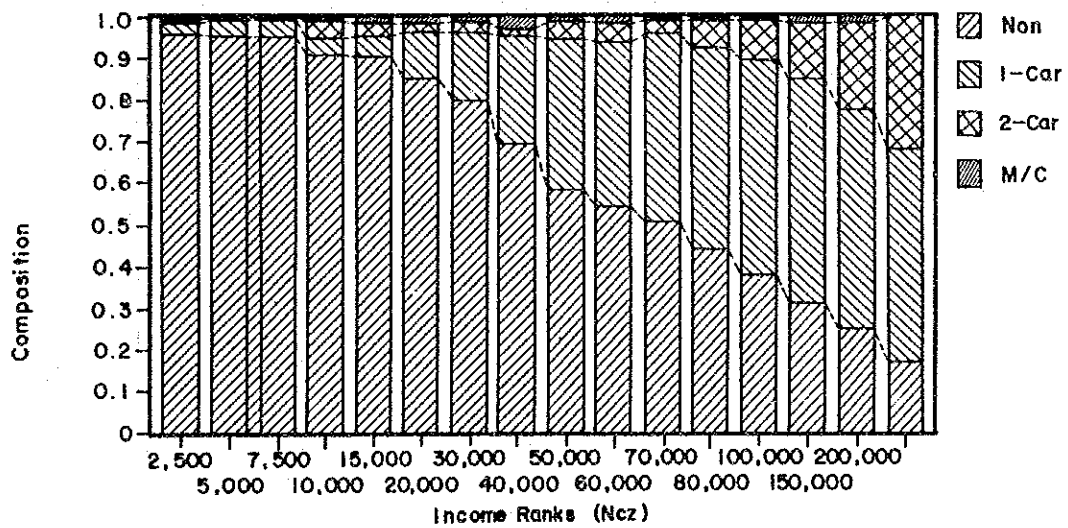


Figure 2.5-2 Accumulative Percentage of Car Ownership

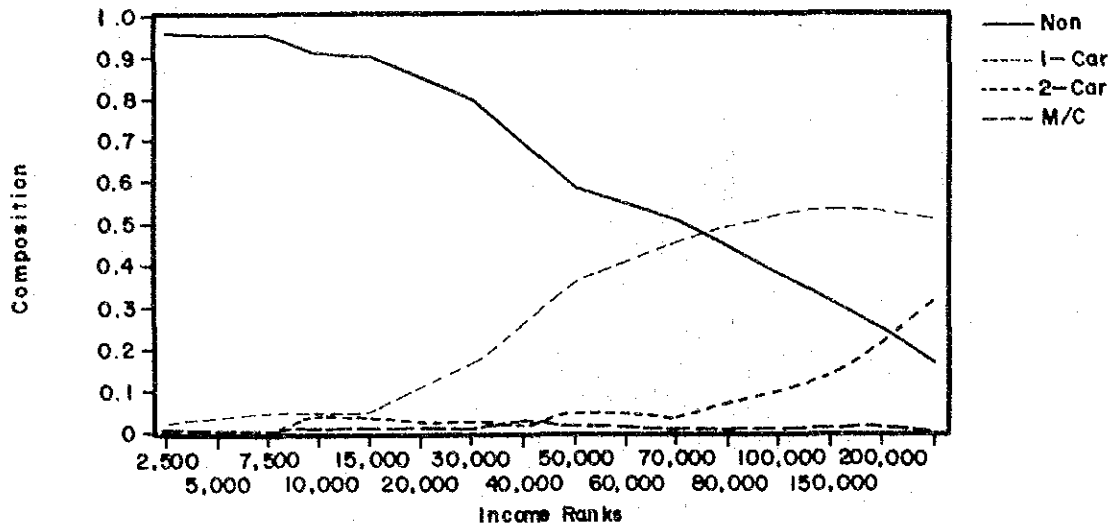


Figure 2.5-3 Car Ownership Ratio by Income Level

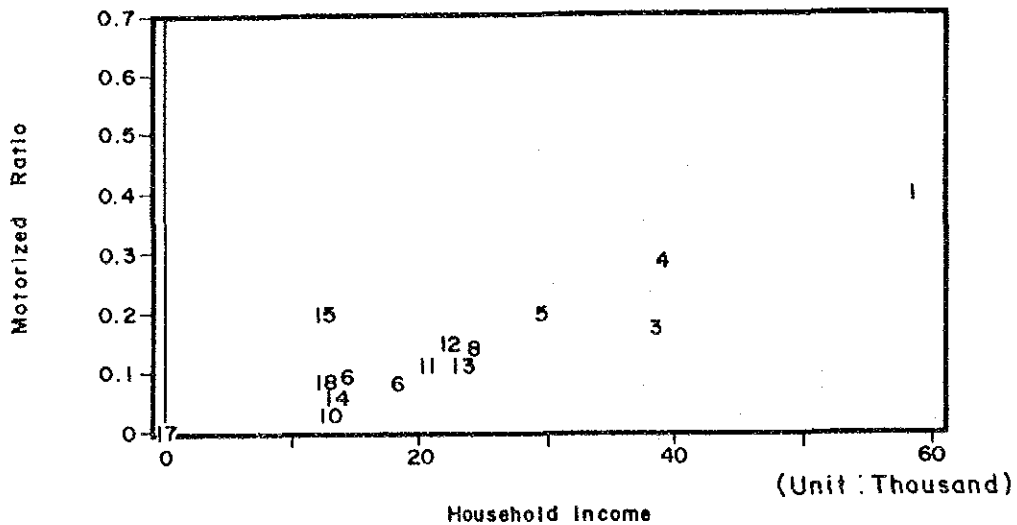
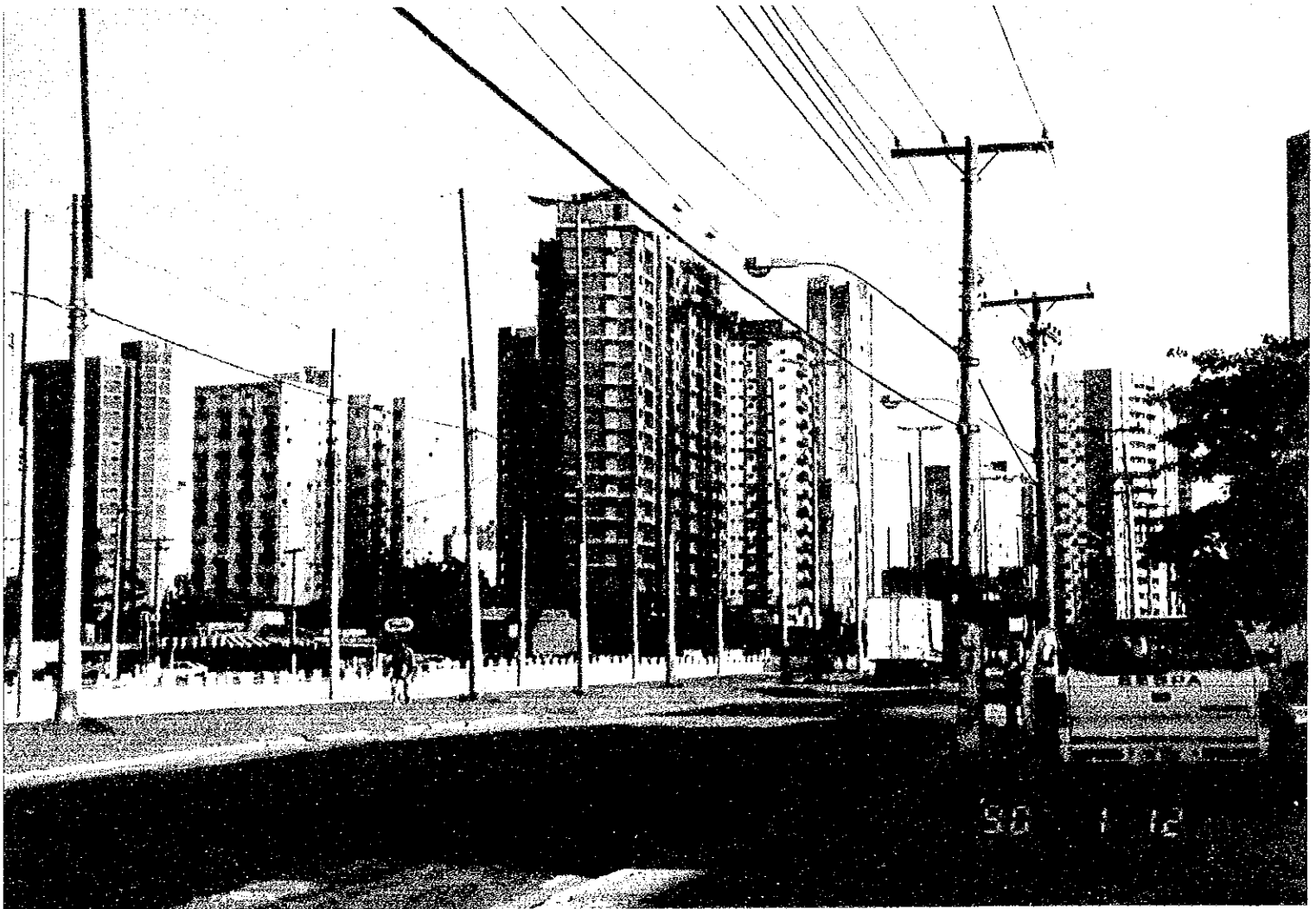


Figure 2.5-4 Relation Between Car Ownership and Income Level

3. Existing Land Use

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Verticalization in Central Area ▼



3.1 Historical Background of the Study Area

3.1.1 History of Belem

54. Belem was founded in January 6th 1616, by Francisco Caldeira Castelo Branco, the Captain of Rio Grande do Norte, who left the State of Maranhao controlling an expedition of 200 men in three caravels to settle the core of the city in an area nowadays called "Forte do Castelo" (Castelo Fort). The place, was selected because it offered excellent shelter to navigation, provided access to the whole Amazon and strategically dominated all the fluvial trails susceptible to threats from French, English and Dutch pirates invasion.

55. In 1650, after the period of pirates and natives invasion, the city, which already counted a population of 80 inhabitants excluding the natives, clerics and soldiers, was called "Nossa Senhora de Belem do Grao Para" (Saint Belem of Great Para), under a captaincy forum granted by Felipe II, the King of Spain. It was in this period that the first streets were opened, all of them parallel to the river with cross trails towards the inland.

56. In the 18th century, the city started to develop toward the forest, and further from the coast. In 1720 the Diocese of Para was established throughout Apostolic Bulls. The city population at the time was 6,574 inhabitants. At the end of 1799 Belem counted 1,003 houses and 10,620 inhabitants.

57. Until the middle of 19th century, isolated from the rest of the country, Belem kept a major contact with Portugal, and did not participate in the process which led to the Independence of Brazil in 1822. Only in August 15th 1823, after a period of fighting, the state of Para joined in the Independence, suffering from intervention of the Imperial Government. During this period the city population was 12,476 inhabitants.

58. The "Cabanagem", local revolution which occurred from 1835 to 1840 affected all the State of Para. In 1850, with a population of 40,980 inhabitants and with the opening of the Amazon River to international navigation, a period of growth was initiated in the region. This was accelerated by the rubber economic boom. The census from August 1st 1872 indicated a population of 84,867 inhabitants, and in November 16th 1884 the Republic was proclaimed in Para.

59. The republican administration of Antonio Lemos, from 1897 to 1911, initiated the golden years of Belem with good planning, beautifying the city and making it grow so much that it became the biggest commercial supply station from the Amazon Region. The street pavement was changed from wood to granite. New streets were opened and/or enlarged, the small plazas were changed into public squares which remain in perfect condition until today. Tree planting plan was adopted for the city, and the streets and cross streets were opened in Marco area. Public lighting by electricity was introduced in Belem, as well as the electric street-car services (refer to Table 3.1-1).

Table 3.1-1 Evolution of Population (unit: persons)

Years	Belem	Ananindeua
1649	80	-
1720	6,574	-
1799	10,620	-
1823	12,476	-
1872	84,867	-
1900	120,000	-
1920	162,769	5,387
1940	191,741	3,695
1950	254,949	6,743
1960	399,222	12,275
1970	633,374	22,527
1980	933,287	65,878

Sources: 1649 to 1900 = Magazine of municipalities; IBGE
1920 to 1980 = IBGE data

60. The political fall of Antonio Lemos, after the rubber ruin and the beginning of the 1st World War, paralyzed Belem until the 1940s. After opening of Belem/Brasilia Road (BR-316 and BR-010) in 1960s, Belem was connected with many cities of other regions. And by the road network connection of the city with the rest of the country, a new stage of growth started in the city, as well as several changes in its urban structure.

3.1.2 History of Ananindeua

61. The land where the municipality of Ananindeua is located nowadays was part of Belem Municipality until 1943. The origin of the place as an urban agglomeration came from the middle of the 19th century, when trains from Belem/Braganca Railroad started to make stops between trips. Later the place became a village and afterwards a district from Belem Municipality. The name Ananindeua originated from the great number of trees called "Anani", which existed at the time. Its recent population growth is mostly due to the occupancy of estates and lots along the National Highway BR-316 in its area (refer to Table 3.1-1).

3.1.3 Urban Evolution

62. The "Castelo Fort", whose construction was started in January 12th 1616, constitutes the initial point of the regional occupancy. Belem developed after the Fort. Its pioneer nucleus corresponding to the actual "Cidade Velha" area, characterize its first stage of occupancy. At that time, the boundary of the city occupancy was set at 1 league (old unit of the distance in Portugal = 6.6km) from the Castelo Fort, nowadays called "1st Patrimonial League".

63. In a second stage of urban evolution during 1627 to 1676, and with the opening of the routes presently called 15 de Novembro and Gaspar Viana, the city expanded towards the Guajara Bay until the boundary of the area currently called "Reduto". After the opening of this expansion axle, other cross and parallel routes to the same axle were opened resulting a new space nowadays called "Comercio" area. During this period the city population is assumed at less than 5,000 inhabitants.

64. Later, Belem started to expand to the East, following the course of Guama River. During this period an axle was established towards the inland, which is now identified as Nazare Avenue. This axle follows the main large spine of the city, which is formed by high land, safer from floods. The present Av. Almirante Barroso constitutes a natural continuation of this axle, which always stands along the main large spine, without posing great physical difficulty to the urban expansion. During this period the city population was 10,620 inhabitants at 1799, and 12,476 at 1823.

65. In the first half of 20th century, Belem had already reached the boundary of the "1st Patrimonial League", which today corresponds to Av. Dr. Freitas. By the end of 1950 the city had already occupied all the good highland, which was safer from floods. But the tendency of growth towards the inland still remained. From this period, huge land areas located beyond the 1st Patrimonial League were ceded for the benefit of several governmental and military institutions, which made it difficult to expand towards the inland. During this period the city population rapidly increased from 120 thousand inhabitants in 1900 to 400 thousands in 1960.

66. In the 1960s the growth tendency was registered over swampy lowland, by the expansion along the axle of Av. Almirante Barroso towards the inland, and the start of vertical expansion in the central area and in its slums. In this period Belem/Brasilia Road was opened, and the city population, both Belem and Ananindeua reached 650 thousand inhabitants.

67. In the 1970s the tendency of growth towards Ananindeua Municipality was emphasized and the interconnection with Belem Municipality occurred along the Route BR-316. It was also observed that the expansion covering lots and estates covered swampy areas and rural areas, located beyond the 1st Patrimonial League. By the end of this decade, the city population reached to 1 million inhabitants.

68. In 1980's decade over 30 residential estates called "conjuntos habitacionais" were developed including "Complex of Cidade Nova", along the secondary roads of August Montenegro, Coqueiro and 40 Horas. In 1990, the population reached 1.4 millions inhabitants (refer to Figure 3.1-1).

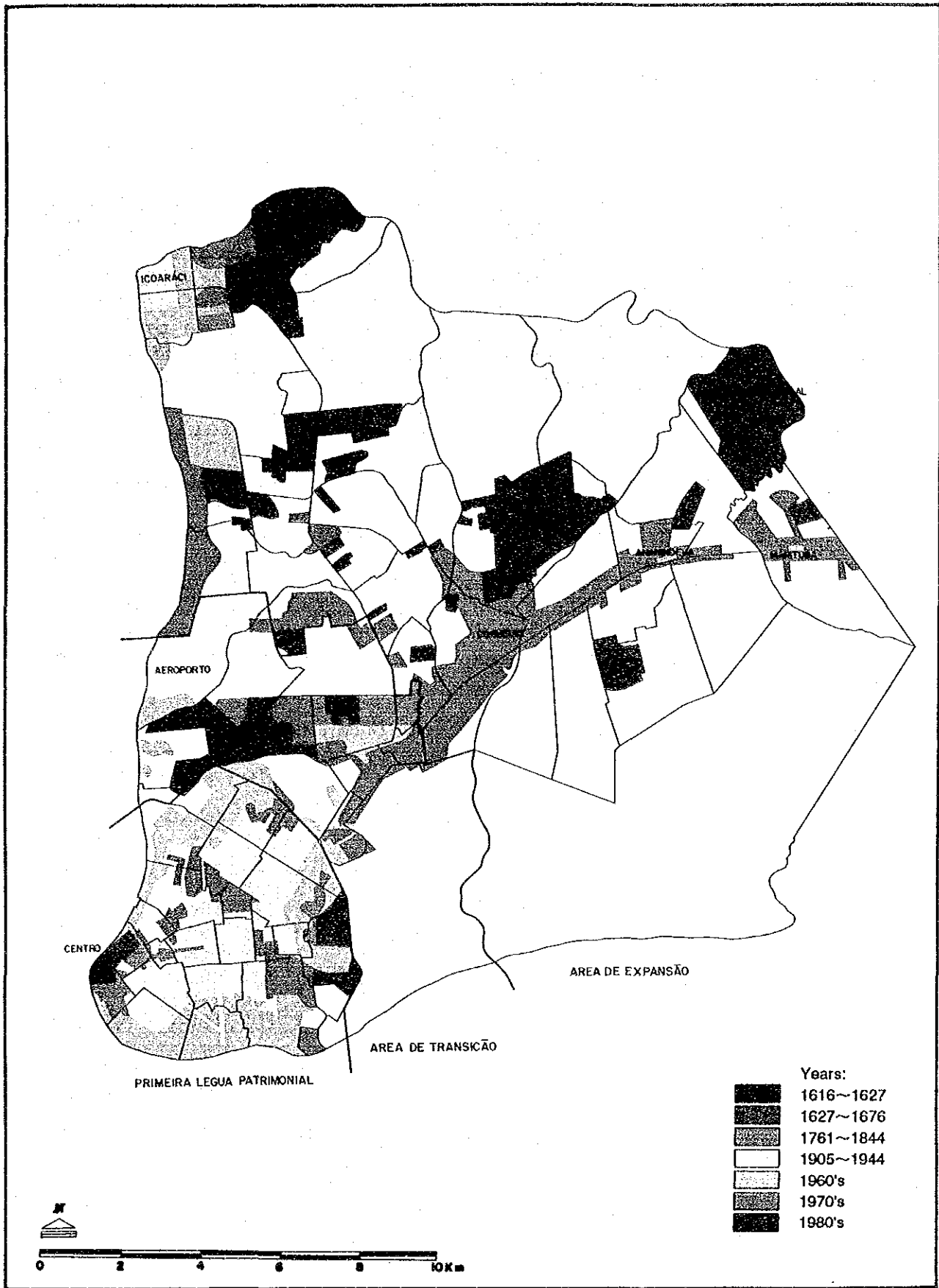


Figure 3.1-1 Urban Evolution of BMR (1616-1990)

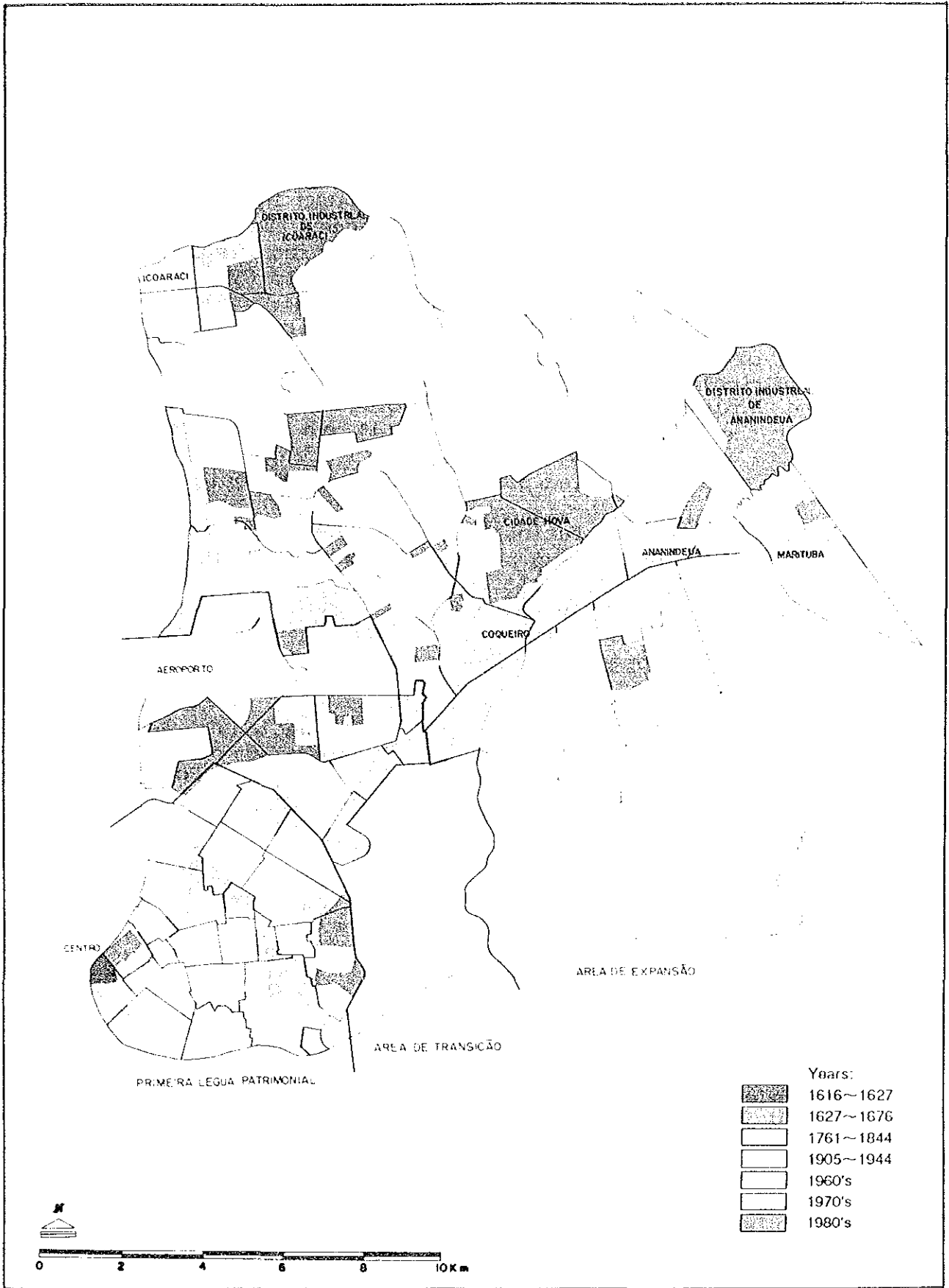


Figure 3.1-1 Urban Evolution of BMR (1616-1990)

3.2 Physical Situation of the Study Area

3.2.1 Urban Scale of the Study Area

69. Belem Metropolitan Region was created by "Complementary Law No. 14" from June 8th 1973 in concomitance with the Metropolitan Regions of Sao Paulo, Bello Horizonte, Porto Alegre, Recife, Salvador, Curitiba and Fortaleza (refer to Table 3.2-1). On July 1st 1974 the Metropolitan Region of Rio de Janeiro was created by the "Complementary Law No.20". That aimed to create an organization capable of making an urban development plan, which would link several municipalities subjected to the same problems and solutions. The ordinary service of metropolitan interest defined by Item No.5 of the "Complementary Law No. 14" are the following:

- a. the integrated plan of the economic and social development
- b. the basic sanitation which includes water supply and drainage network and public cleaning service;
- c. the usage of metropolitan land;
- d. the transportation and network system; and
- e. production and distribution of fuel gas supply system in the developed urban centers comprising more than one municipality.

Table 3.2-1 Profile of the Metropolitan Regions

Name	Number of municipalities	Area (km ²)	Population 1985	Pop. density (psn/km ²)
1. M.R. Sao Paulo	37	7,951	15,221,267	1,914.4
2. M.R. Rio de Janeiro	14	6,464	10,190,384	1,576.5
3. M.R. Bello Horizonte	14	3,670	3,056,498	832.8
4. M.R. Porto Alegre	14	5,806	2,595,886	447.1
5. M.R. Recife	9	2,201	2,494,744	1,133.5
6. M.R. Salvador	8	2,183	2,093,856	959.2
7. M.R. Fortaleza	6	3,483	1,934,581	555.4
8. M.R. Curitiba	14	8,763	1,767,720	201.7
9. M.R. BELEM	2	1,221	1,207,150	988.7
Total	118	41,742	40,562,086	971.7

Source: IBGE

Note : M.R.BELEM includes the pop. of Belem and Ananindeua.

3.2.2 Location of the Study Area

70. The capital city of the State of Para, Belem is situated at latitude 1 28'S and longitude 48 29'W, just on the equator. The Amazon River is divided into two parts by Marajo Island located in the mouth of the river. One is the principle stream to the North, the other is the Para River to the South. Guajara Bay which is the end of Para River forms its western boundary, while the Guama River, which is the tributary to Tocantins River is located at the South boundary.

71. After opening of Belem/Brasilia Road in 1960s, Belem was connected with the principle cities of other regions by road network. The International Airport located in Val-de-Cans connects Belem with several cities directly, including international route to Miami (USA). There are 2 ferry lines between Belem and the other sides of the rivers; Belem (Porto do Sal) to Barcarena (Cafezal), and Icoaraci (Balsa) to Marajo Island (Salvaterra, Soure).

Table 3.2-2 Distance between Major Cities and Belem

Cities	Air route	Land route
Brasilia	1,610 km	2,120 km
Sao Paulo	2,459	2,933
Rio de Janeiro	2,446	3,250
Recife	1,676	2,074
Curitiba	2,684	3,193
Porto Alegre	3,192	3,854
Manaus	1,297	5,298

3.2.3 Natural conditions of the Study Area

72. The Study Area is classified into two parts in accordance with its topographic characteristics, "Continental area" located in its southern part and "Islands area" located in the northern part of the Study Area. The covered area is almost same size, however, the population is concentrated (98.8%) in the Continental area. Islands area counts 10 islands, Mosqueiro (191.1 km²), Outeiro (31.8 km²), Marituba (38.4 km²) and so on.

Table 3.2-3 Land and Population of the Study Area

Land types	Municipalities	Area(km ²)	Population, 1990
Continental:	Belem	203.49 (32.4%)	1,291,726 (91.0%)
	Ananindeua	108.15 (17.3%)	110,792 (7.8%)
	Sub-total	311.64 (49.7%)	1,402,518 (98.8%)
Islands:	Belem	252.67 (40.2%)	16,706 (1.2%)
	Ananindeua	63.20 (10.1%)	0 (-)
	Sub-total	315.87 (50.3%)	16,706 (1.2%)
Total		627.51 (100 %)	1,419,224 (100 %)

73. The Study Area consists of the initial part of the "Bragantina Zone" and the Islands of "Caratateua" and "Mosqueiro", located in the Guajara Bay, at the mouth of Para River. It has a well distributed drainage network which flows either into the Guajara Bay to the North and West or into the Guama River to the South. From the topographic point of view, the landscape of the Study Area is almost uniform. The highest hiposometric quota does not exceed 30 meters, which characterizes its topographic uniformity.

74. As in every part of the Amazon, the Study Area has three different topographic characteristics, represented by levels of "meadows", "terraces" and "tablelands" (low plateaus). Those in general context are regarded as regional prairies, integrating the aspects of domain of Amazon sedimentary lowlands in one of its most typical forms. Therefore, the city did not develop in a defined topographic direction. It does not follows a valley, it is not located in a watershed and it does not surround a mountain. It was developed in a high accident area with strong surface irregularities, which were originally represented as isolated or divided sections among the swampy areas.

75. The lands of the Study Area are part of the great sedimentary basin of the Amazon and because of their origin, situation and constitution, they have the same geomorphologic and geologic characteristics from the referred basin, with some local modification. They are geologically very recent lands. As we get further from the city, from the edge of Guaraja Bay towards the East, the lands become older, from "Holocene" to "Pleistocene" and "Miocene". The Holocene is represented by argil, used by local pottery factories. The Pleistocene corresponds to the area of "Terra Firm", which is the land free from the frequent floods and high tides, hiding the "Barreiras" series, recognized by "Latosolos Amarelos". In these lands belts with "Gres do Para" can be found. This Gres is a ferruginous sandstone material largely used in civil construction.

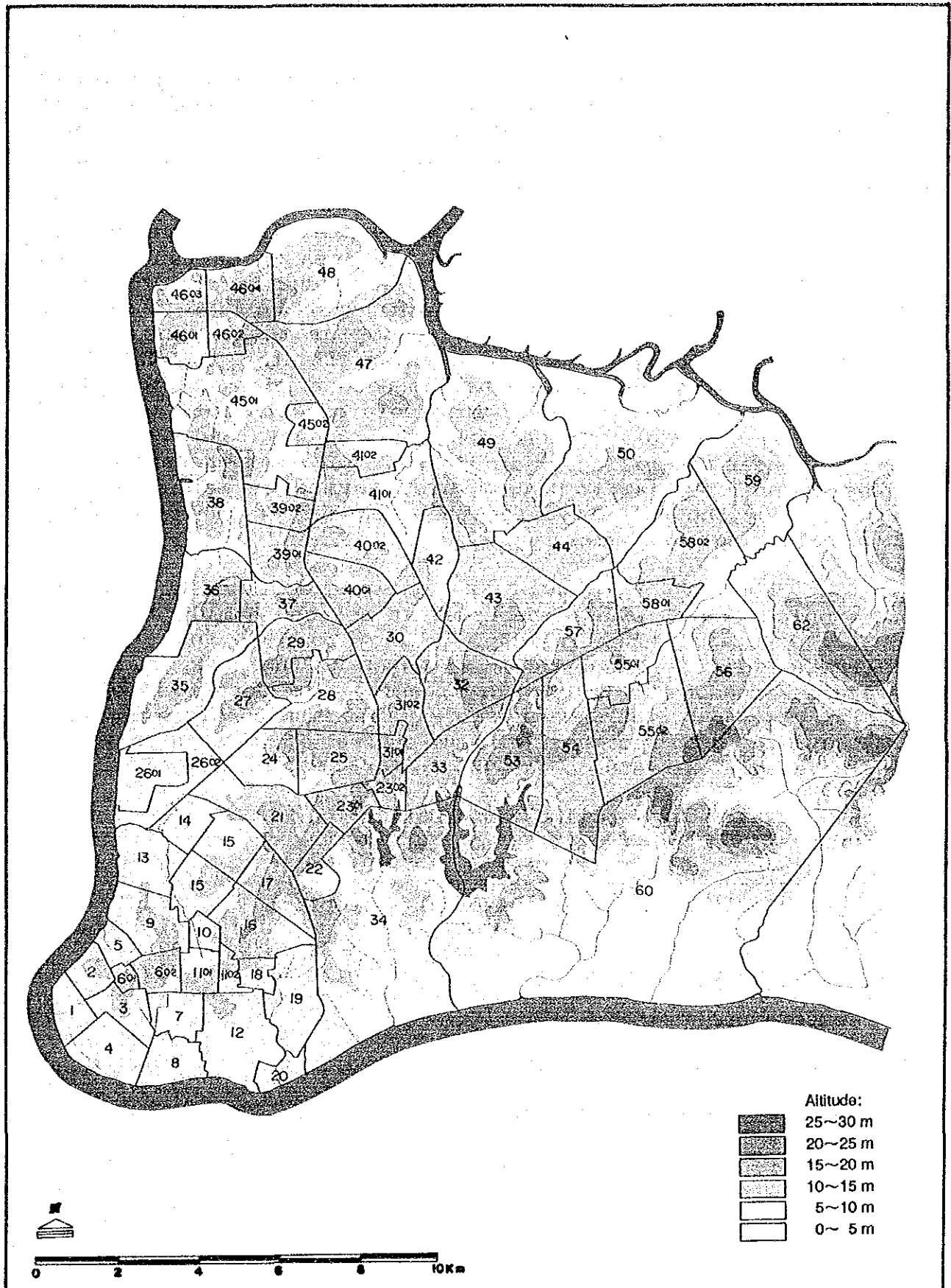


Figure 3.2-1 Land Form

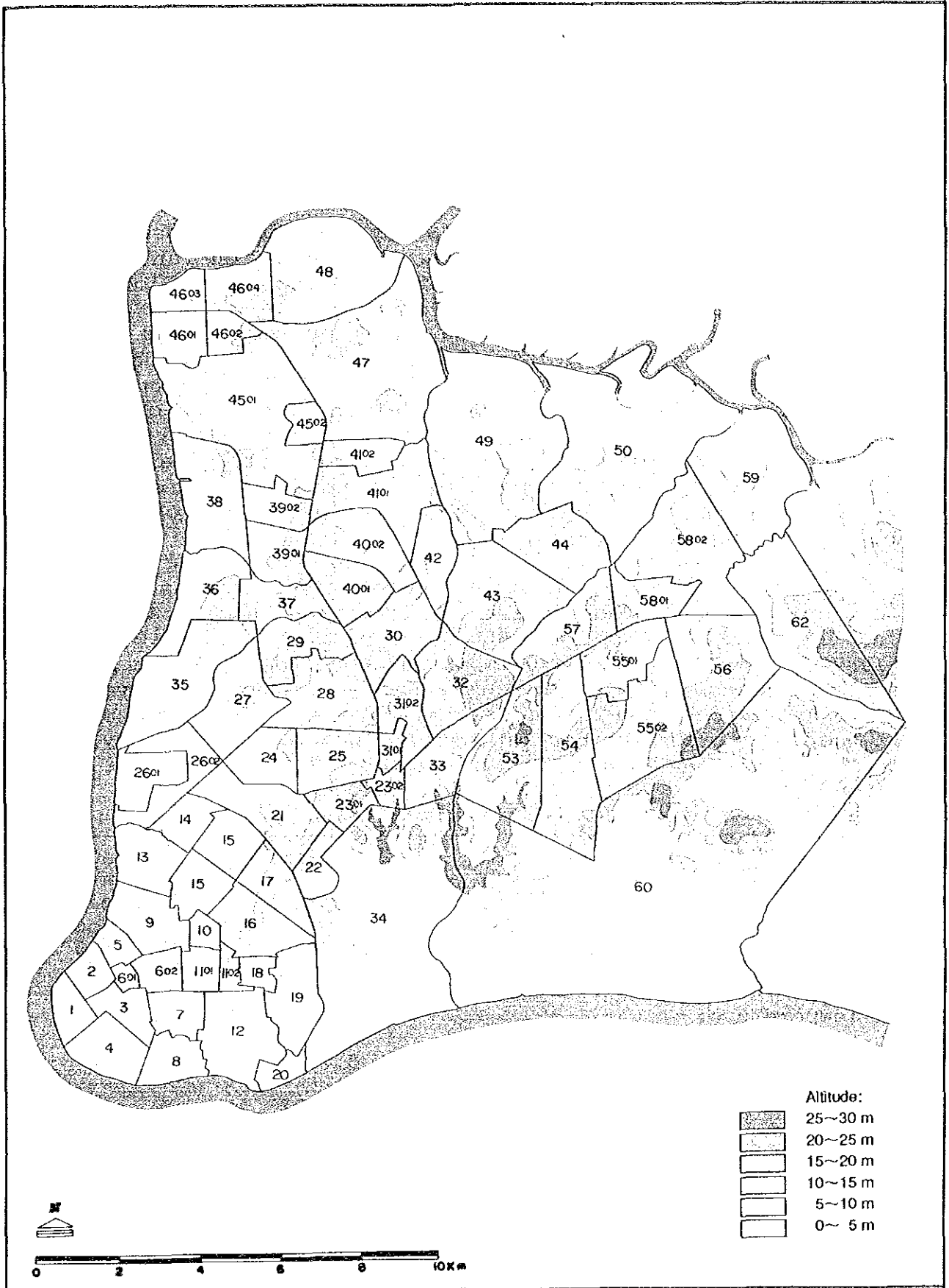


Figure 3.2-1 Land Form

76. The continental part of the Study Area consists of 18 complete hydrographic basins and one incomplete (the basin of Igarape Ananindeuazinho, arm of Maguari River). In the islands area can be identified 15 basins in Mosqueiro Island and another 15 in the other islands.

77. The vegetal cover of the Study Area is represented by two very different types of forest: the ones which run in good land and the meadow ones. This situation is due to its location, (which is in the confluence between Para and Guama rivers), to its expansion towards the "Bragantina Zone" protoform and to the existence of 18 hydrographic basins inside its area. Nowadays, due to the city growth, vegetation has changed a lot, characterized itself by remnant forest areas, intercalated with cuts-over land and areas of small plantation along the roadways and hydroways, especially near the villages. In its slums at West, a narrow belt can be found marginal to the rivers, formed by mangroves and influenced by the salinity from the ocean water, which reaches this area during the summer.

78. Climatic condition of Belem is categorized as "Equatorial tropical zone", whose character is hot and humid. Amount of rainfall counts 3,418 mm in 1985, 3,127 mm in 1986 and 2,632 mm in 1987. Rainfall reached 470 mm in March as the peak (in 1987). There are 2 seasons in Belem: "dry season" from June to November, and "rainy season" from December to May. Maximum absolute temperature was 35.4 °c in December, minimum one was 20.8 °c in July, and annual average was 26.6 °c in 1987 (refer to Table 3.2-4).

Table 3.2-4 Climate and Meteorology

	Belem	Brasilia	Sao Paulo
Type of Climate:	Equatorial tropical	Tropical	Tropical of altitude
Latitude	1°28'03"S	15°30'00"S	23°32'36"S
Altitude	11 m	1,172 m	760 m
Temperature:			
Maximum absolute	35.4 °c	32.6 °c	33.4 °c
Minimum absolute	20.8 °c	8.7 °c	5.2 °c

Source : Annual Statistics of Brazil; 1987

79. As for winds, the North-East are predominant, which are of easy penetration in the Study Area, due to the relieve disposal: the big spines and thalwegs are disposed parallel in the North-East and South-West direction. The North winds act less frequently, as they project themselves over Icoaraci and Val-de-Caes area due to the relieve disposal from the Guajara Bay border (refer to Table 3.2-5).

Table 3.2-5 Meteorological Observation Data of Belem

Month	Temperature (c)			Humidity (%)	Rainfall (mm)	Winds direction	
	Max.	Min.	Average			Dominant	Second
Jan.	30.7	22.7	25.8	92	418.6	NE	SE
Feb.	30.9	22.9	25.8	92	393.3	NE	NW
Mar.	30.2	23.1	25.7	92	470.2	NE	SE
Apr.	31.6	23.2	26.3	90	324.6	NE	NW
May.	32.2	23.0	26.8	86	118.9	SE	NE
Jun.	31.9	23.0	26.6	86	180.3	SE	NE
Jul.	32.0	22.7	26.4	86	164.8	SE	NW
Aug.	32.2	22.8	26.7	85	168.1	SE	NW
Sep.	32.5	22.5	27.0	83	90.0	NE	SE
Oct.	32.7	22.4	27.1	82	82.9	NE	SE
Nov.	33.2	22.5	27.4	80	65.9	NE	SE
Dec.	32.7	22.8	27.2	83	154.7	NE	SE
Average	31.9	22.8	26.6	86	2,632.3 (Total)		

Source: National Meteorological Institute, 1987.

3.3 Land Use Inventory

3.3.1 Area Designation for Land Use Study

80. In accordance with the characteristics of the lands and the historical backgrounds of urban evolution, the Study Area is designated into four (4) parcels as follows: (refer to Table 3.3-1 and Figure 3.3-1).

Table 3.3-1 Principle Characteristics of each Area

Areas	Distance from CF*	Covered area (km ²)	Population 1990 (persons)	Population density (psn/ha)
1. Central area	0-6.6 km	37.13 (5.9)	712,593(50.2)	191.9
2. Transition area	6.6-10 km	48.66 (7.8)	205,818(14.5)	42.3
3. Expansion area	10-20 km	225.85(36.0)	484,107(34.1)	21.4
4. Islands area	Over 20 km	315.87(50.3)	16,706 (1.2)	0.5
Total (Continental area)		311.64(49.7)	1,402,518(98.8)	45.0
Total (Whole Study Area)		627.51(100%)	1,419,224(100%)	22.6

Notes:* The basis of distance is the "Castelo Fort" which is located at western edge of the Cidade Velha. Each area corresponds to the following "Integrated zones":

Central area = No.1 to 4, Transition area = No.5 to 7
Expansion area = No.8 to 14, Island area = No. 16 to 18

81. Central area is the urban area, comprising the greatest conglomeration of business and services, which is the great attraction pole of trips for the rest of the Study Area. Its limit touches a semi-circle of a 6.6 km radius from the "Castelo Fort", corresponding to the 1st Patrimonial League, a line defined as boundary to Belem city area during the end of 19th century. In this area there are 18 traditional wards ("bairros") and its road network structure follows the pattern adopted during the colonization period with narrow sinuous streets to a grid network, organized from the growth axles of the city. This network loses its continuity in swampy areas, becoming an irregular reflection of the difficulty of occupancy in these areas. Even though urban structure is grid in most wards, there are difficulties of physical integration among them due to the hermetic nature of each one, which is consequence of the lack of a directed policy of urban growth in recent periods. This area covers 37.13 km² (5.9% of the Study Area) and 713 thousand inhabitants (50.2% of above) are settled in 1990.

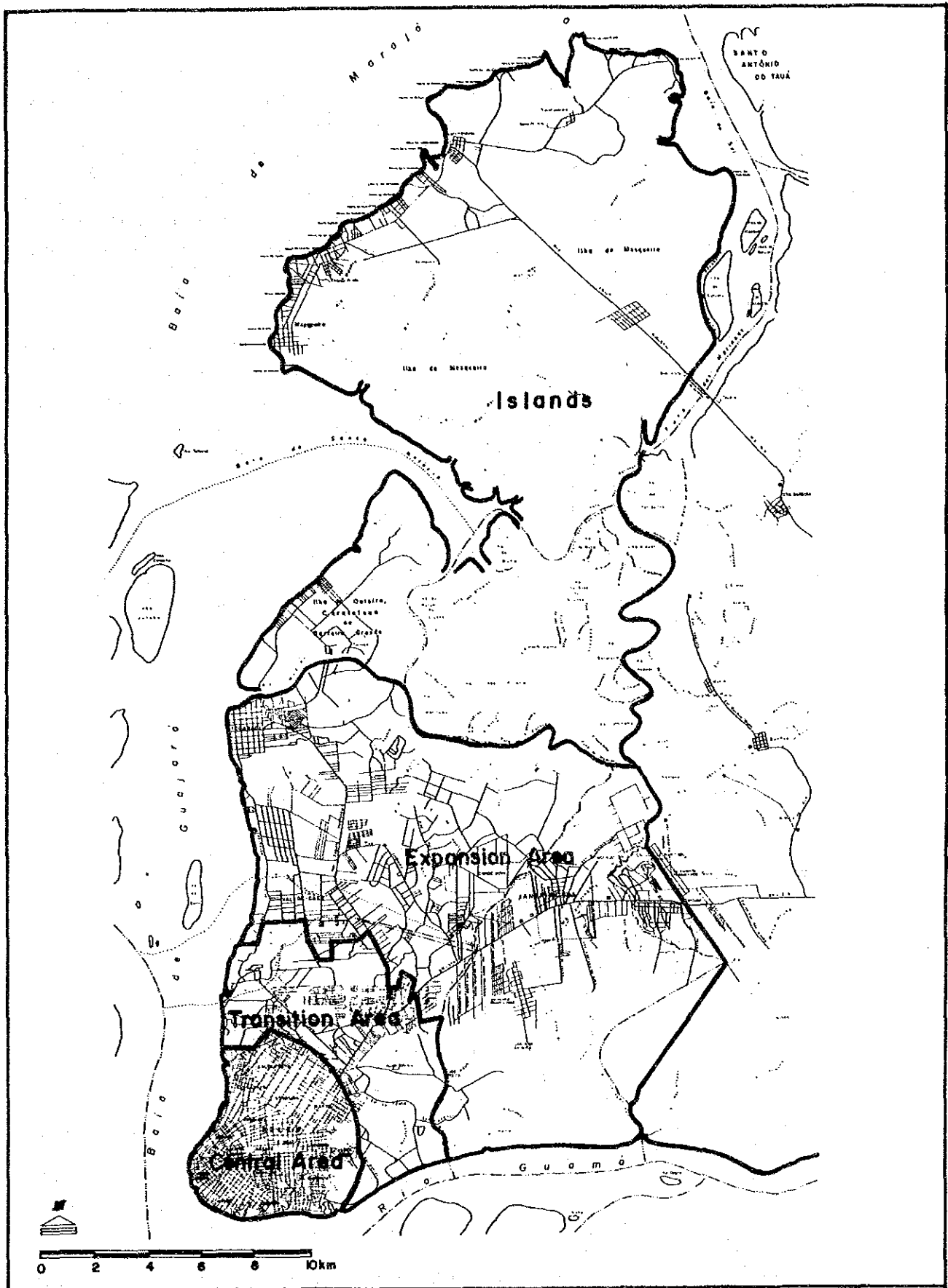


Figure 3.3-1 Area Designated for Land Use Study

82. Transition area is located right after the Central area, and constitutes the immediate expansion from the Central area. It covers the areas of Marambaia, Souza, Atalaia etc. and the first great sized institutional estates, such as airports, military facilities, water reservoir, electric power plant, State research facilities and so on. The inside road network does not show continuity, as inbound and outbound connections are made with the arterial roads that guided the growth of this area. This area covers 48.66 km² (7.8%) and approximately 206 thousand inhabitants (14.5%) are settled in 1990.

83. Expansion area, occupied by great estates and lots, comprise the municipality of Ananindeua and the towns of Icoaraci and Marituba. Its growth is oriented from Route BR-316 and its secondary roads such as "Augusto Montenegro", "Coqueiro" and "40 Horas". This area covers 225.85 km² (36.0%) and 484 thousand inhabitants (34.1%) are settled in 1990.

84. Ten (10) islands including Mosqueiro, Outeiro, Marituba, and so on, are located in the northern part of the Study Area, and they cover 315.87 km² (50.3% of the Study Area), but the population is only 17 thousand inhabitants (1.2%) in 1990. Over 90% of the land is still virgin forest.

3.3.2 Land Use Investigation

85. For the classification system for "General land use survey" scaled on 1:10,000, the following zones are identified:

- a. Consolidated urban zones
- b. Urban zones in formation
- c. Commercial and services zones
- d. Industrial zones
- e. Residential estate zones
- f. Institutional zones
- g. Rural zones

86. For the classification system for "Specific land use survey" scaled on 1:2,000, the following typology was designated.

- a. Site for residentia
Habitat occupied as residence with one or more families.
- b. Site for commercial
Buildings designed for business in general, for both kinds of sales, retail and wholesale, including department stores and big size magazines etc.
- c. Site for services
Buildings where enterprises are located, also including

governmental organization which offer services (such as banks, medical clinics, offices), liberal work-places (lawyers, engineers), travel agencies, schools, gas stations, distributing stations (water, electricity, telephone), etc.

- d. Site for industrial
Buildings for industrial purposes, regardless of size, such as sawmills, graphics, metallurgic, all kinds of factories, etc.
- e. Site for institutional
Buildings for governmental organizations and military institutions
- f. Open space
Parks, squares, cemeteries, parking lots, vacant lots and domiciles.

3.3.3 Results of the General Land Use Survey

87. After execution of the general land use survey, land use map scaled on 1:20,000 was prepared (Refer to Figure 3.3-2). Quantifying of land use was carried out by each designated area. Table 3.3-2 shows the abstract of the work.

Table 3.3-2 Area list of the "General Land Use Survey"(unit: km²)

Zones	Central area	Transition area	Expansion area	Islands area	Total (C)	Total (W)
Consolidated urban zones	35.24	5.69	23.57	5.00	64.50	69.50
Urban zones in formation	-	5.21	43.70	12.00	48.91	60.91
Industrial zones	0.61	-	14.87	0.50	15.48	15.98
Residential estate zones	-	3.58	15.27	-	18.85	18.85
Institutional zones	1.28	34.18	23.26	1.00	58.72	59.72
Rural zones	-	-	105.18	297.37	105.18	402.55
Total	37.13	48.66	225.85	315.87	311.64	627.51

Note: Total(C) = Continental area, Total(W) = Whole Study Area

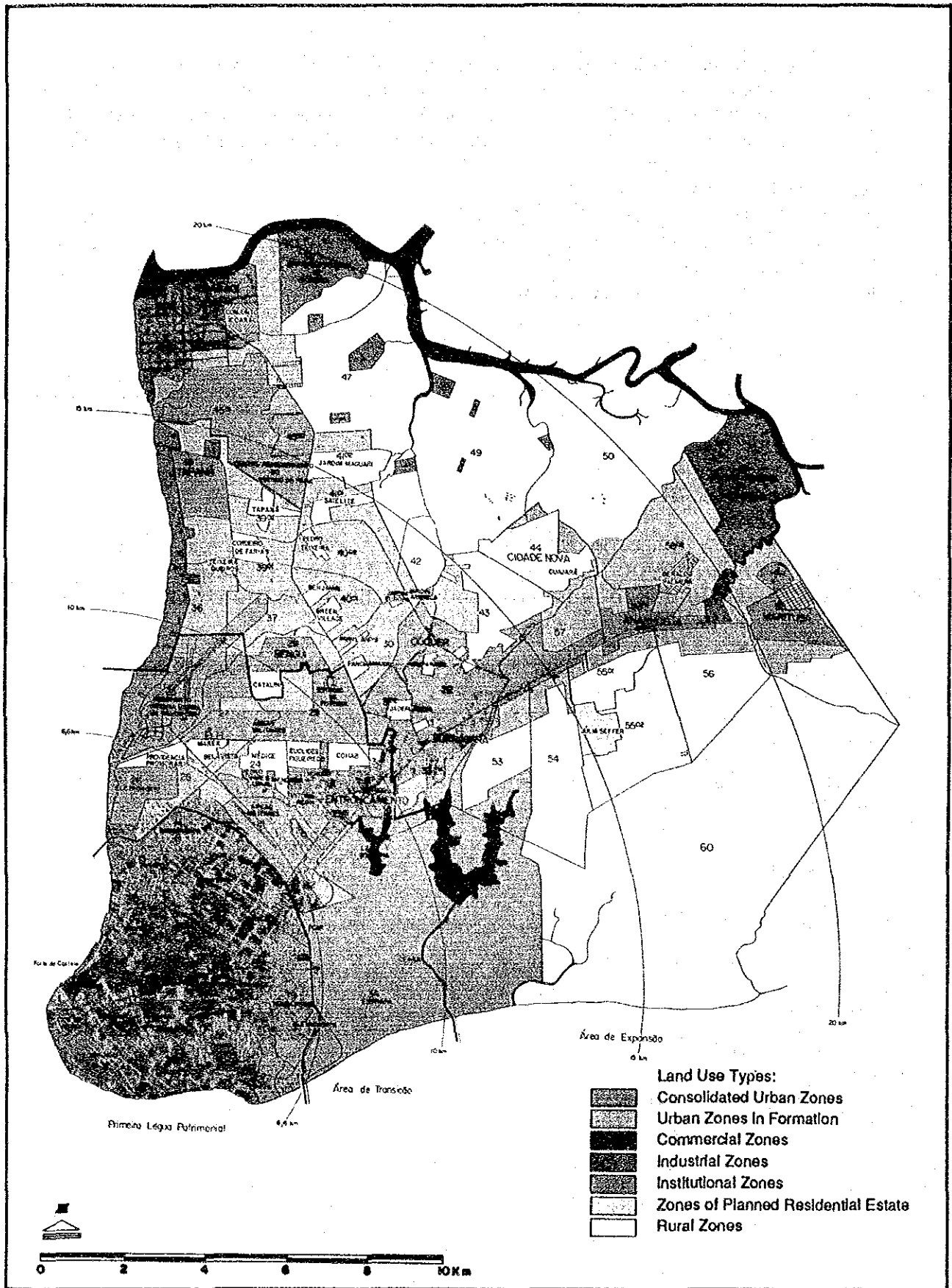


Figure 3.3-2 Existing Land Use (Continental Area)

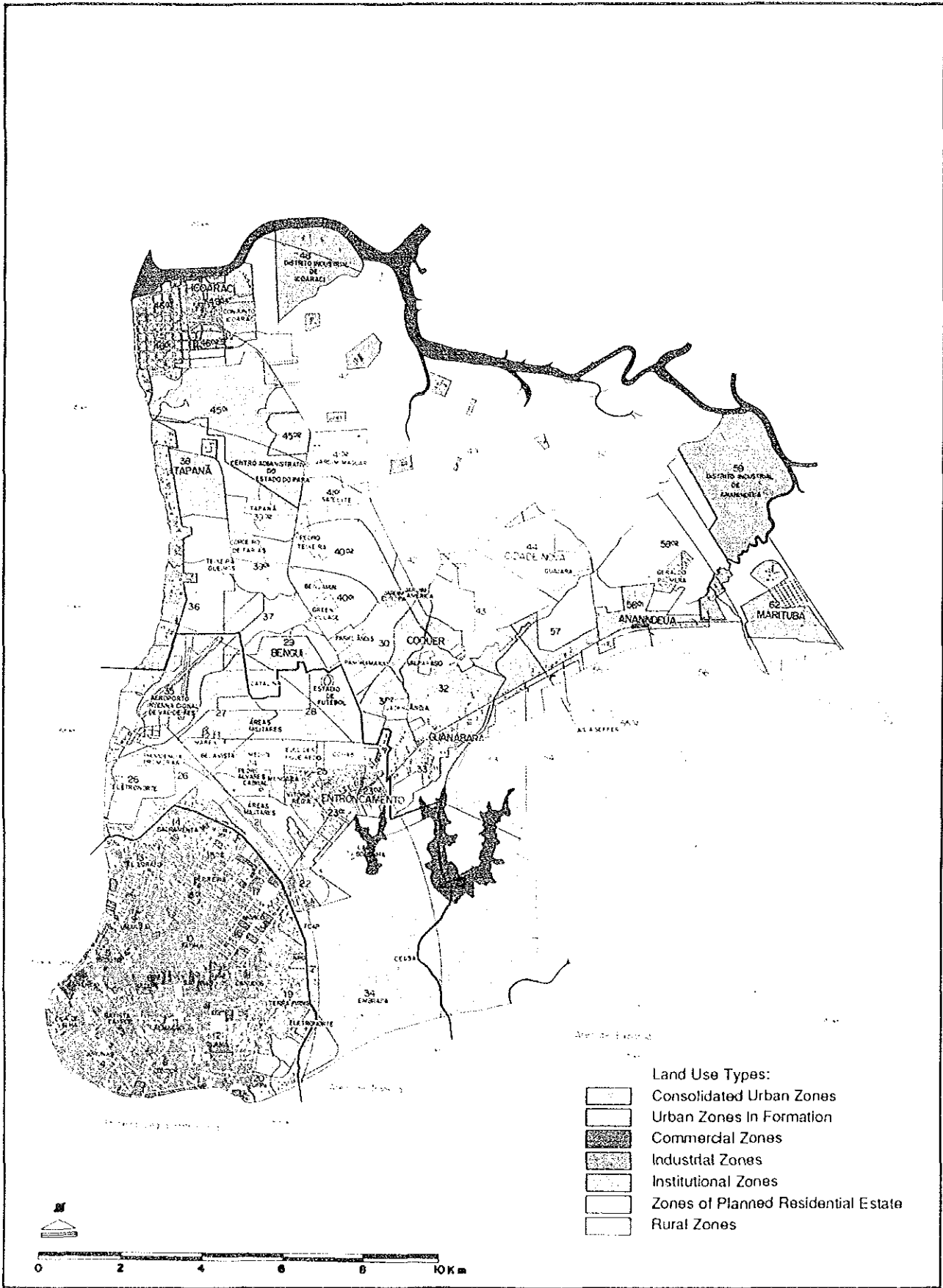


Figure 3.3-2 Existing Land Use (Continental Area)

88. From the composition of land use zones by area, following characters are observed:

- a. Consolidated urban zones constitute 50.7% of the Central area;
- b. Urban zones in formation, Industrial zones and Residential estate zones constitute 71.7%, 93.1% and 81.0% of the Expansion area, respectively;
- c. Institutional zones constitute 57.2% of the Transition area; and
- d. Rural zones constitute 73.9% of the Islands area

3.3.4 Inventory of Principle Land Use

89. A total area of 59.72 km² (9.5% of the Study Area) is occupied for the institutional purposes. Principle areas are as follows:

- FCAP (University of Agrarian Science of Para) and EMBRAPA (Brazilian Organization of Farming and Cattle-raising Survey)..... 16.25 km² (27.2%)
- Military and Airports..... 13.39 km² (22.4%)
- COSANPA (Sanitation Company of Para)... 15.68 km² (26.2%)
- State Administrative Center..... 7.61 km² (12.7%)
- UFPA (Federal University of Para)..... 2.51 km² (4.2%)

90. A total area of 15.98 km² (2.6% of the Study Area) is occupied for industrial purposes. Principle areas are concentrated in the following 3 zones:

- Ananindeua industrial district..... 6.19 km² (38.5%)
- Icoaraci industrial district..... 3.57 km² (22.2%)
- Guajara Bay industrial zone..... 2.46 km² (15.3%)

91. Within the consolidated urban zones, following areas are characterized as the commercial centers of the central and locals: The "Centro" is the oldest and biggest Central Business District (CBD) in Belem, and many kinds of commercial, business, services and institutional facilities are concentrated in this area. On the other hand, local commercial centers are distributed mainly on the axes of Av. Nazare and Route BR-316, such as the commercial centers of "Nazare Avenue", "Sao Braz", "Entroncamento" and "Ananindeua". Other local commercial centers are located at both bairros of "Guama" and "Pedreira", and district center of "Icoaraci" and "Coqueiro".

- Centro commercial center
- Nazare Avenue commercial center

- Sao Braz commercial center
- Pedreira commercial center (Along Av. Pedro Miranda)
- Guama commercial center (Along Av. Jose Bonifacio)
- Entroncamento commercial center
- Ananindeua commercial center
- Coqueiro commercial center
- Icoaraci commercial center

92. The residential estate zones (18.85 km², 3% of the Study Area) are located mainly in the "Expansion area". There are none in "Central area" and "Islands area". Those area are the planned residential estates, so called "Conjuntos Habitacionais". The major ones among of 30 residential sectors are as follows:

(Transition area, 3.58 km ²)	
- Medice.....	1.01 km ²
- Cohab.....	0.70
- Providencia Promorar.....	0.65
- Euclides Figueiredo.....	0.64
- Catalina.....	0.49
- Marex/Bela Vista.....	0.42
(Expansion area, 15.27 km ²)	
- Cidade Nova.....	6.57 km ²
- Jardim Maguari.....	1.52
- Julia Seffer.....	1.16
- Conjunto Icoaraci.....	0.63
- Satelite.....	0.55
- Tapanã.....	0.52
- Cordeiro de Farias.....	0.52
- Geraldo Palmeira.....	0.47
- Pedro Teixeira.....	0.22
- Panorama XXI.....	0.22

3.3.5 Results of the Specific Land Use Survey

93. Table 3.3-3 shows the designation of blocks, in accordance with the character of the land and the historical background of urban evolution. The central area is divided into 3 blocks.

Table 3.3-3 Designation of Blocks

Blocks	Corresponding bairros		
Primary block	-Cidade Velha -Comercio	-Batista Campos -Reduto	-Nazare
Secondary block	-Jurunas -Cremacao	-Condor -Umarizal	-Fatima -Sao Braz
Tertiary block	-Guama -Telegrafo -Sacramenta	-Pedreira -Marco -Canudos	-Terra Firme

94. Table 3.3-4 shows the land use type by each block after calculations based on the site and building survey. The land is classified into 2 categories: "Site area" for the buildings or spaces for specific purposes, and "Road area" for transportation use. In the Central area of Belem, almost 80% of land is being designated as "Site area" and remaining 20% as "Road area".

Table 3.3-4 Area Inventory by Land Use Types (unit: ha)

	Primary block	Secondary block	Tertiary block	Total
Gross area	594.00	1,033.00	2,050.00	3,677.00
Road area	130.48	219.99	409.76	760.23
(Ratio: %)	(22.0)	(21.3)	(20.0)	(20.7)
Site area	463.52	813.01	1,640.24	2,916.77
(Ratio: %)	(78.0)	(78.7)	(80.0)	(79.3)
Land use breakdowns:				
Residential	220.24	559.61	1,070.51	1,850.36
Commercial	61.61	60.62	109.63	231.86
Services	84.61	103.60	187.44	375.65
Industrial	10.65	9.13	29.02	48.80
Institutional	40.89	20.77	40.61	102.27
Open space	45.52	59.28	203.03	307.83

3.4 Land Use Analysis

3.4.1 Urban Evolution of the Study Area

95. The population distribution based on the IBGE and Study Team data is estimated for the purpose of considering the succession of population in each area of the Study Area. Table 3.4-1 shows the number of population from 1940 to 1990 by decades. In 1940 population of Study Area was less than 0.2 millions, but it increased from decade to decade, reaching 1.4 millions in 1990.

Areas	1940	1950	1960	1970	1980	1990
Central area	168,000	215,449	334,961	504,904	645,556	712,593
Trans. area	2,000	14,000	33,000	85,000	150,000	205,818
Expan. area	17,436	22,243	35,484	62,747	203,114	484,107
Islands	8,000	10,000	11,000	13,000	16,753	16,706
Total	195,436	261,692	414,445	665,651	1,015,423	1,419,224

Sources: Years of 1940 to 1980 are determined from IBGE data.

96. Table 3.4-2 shows the succession of population growth ratio by each decade. After urban evolution in Central area up to 1950, Transition area grew up from 1950 to 1980, followed by Expansion area from 1970 until today.

Areas	1940/50	1950/60	1960/70	1970/80	1980/90
Central area	28.2	55.5	50.7	27.9	10.3
Transition area	600.0	135.7	157.6	76.5	37.2
Expansion area	27.6	59.5	76.8	223.7	138.3
Islands	25.0	10.0	18.2	28.9	-0.2
Average	33.9	58.4	60.6	52.5	39.8

97. Table 3.4-3 shows the succession of population allocation by each area. The Central area changed its majority portion from 86.0% to 50.2% during past 50 years. While, Expansion area has been increasing its share from 1970, and it reached 34.1% in 1990.

Table 3.4-3 Succession of Population Allocation (unit: %)

Areas	1940	1950	1960	1970	1980	1990
Central area	86.0	82.3	80.8	75.9	63.6	50.2
Transition area	1.0	5.4	8.0	12.8	14.8	14.5
Expansion area	8.9	8.5	8.5	9.4	20.0	34.1
Islands	4.1	3.8	2.7	1.9	1.6	1.2
Total	100%	100%	100%	100%	100%	100%

98. Table 3.4-4 shows the succession of population density in the same periods. In 1990, population density of Central area reached 192 persons/ha, and Transition area also counts 142 persons/ha in net case. While Expansion area counts only 21.4 persons/ha.

Table 3.4-4 Succession of Population Density (unit: persons/ha)

Area	1940	1950	1960	1970	1980	1990
Central area	45.2	58.0	90.2	136.0	173.9	191.9
Transition area	0.4	2.9	6.8	17.5	30.8	42.3
(Net area)*	(1.2)	(8.3)	(19.5)	(50.1)	(91.6)	(142.1)
Expansion area	0.8	1.0	1.6	2.8	9.0	21.4
Islands	0.3	0.3	0.3	0.4	0.5	0.5
Average	3.1	4.2	6.6	10.6	16.2	22.6

Note: * Net area means the case excluding the institutional zones. Two-third of the transition area is occupied by this purpose.

3.5 Inventory of Development Condition

3.5.1 Development Control Plan of the Belem Municipality

99. The development scheme for urban evolution was planned by Belem Municipality. The "Law of Urban Development of Belem Municipality", law number 7401 dated at 29 January, 1988 refers to the municipality policy of urban development to the future. Its main objectives are as follows:

- a. Direct and control the utilization of municipal urban land;
- b. Supply the basic necessities of the citizens related to the functions of work, residence, entertainment and transportation etc., which offer improvement to the quality of life;
- c. Get rid of the urban center congestion; and
- d. Look after the surrounding heritage and valorize the cultural heritage through the ecology, cultural and landscape protection.

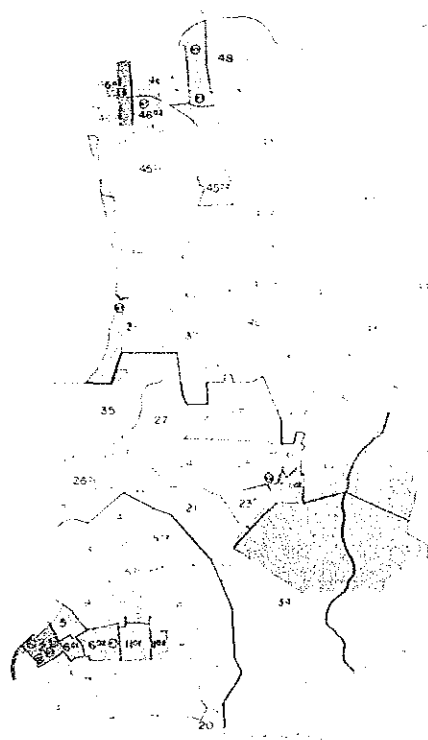
100. The plan mentioned above classifies the land into following 7 zones in accordance with urban activities and the present situation of land utilizations: (refer to Figure 3.5-1)

- a. Commercial and Services zone
- b. Mixed-use zone
- c. Habitational zone
- d. Industrial zone
- e. Special functional zone
- f. Preservation zone
- g. Rural land

101. The "Mixed-use zone" is subdivided into 4 subzones indicated in Table 3.5-1, in accordance with the composition of "Commercial and services", "Industrial" and "Habitational". While "Habitational zone" is subdivided into 7 subzones based on the population density from low to high. (refer to Table 3.5-2)

102. Table 3.5-1 shows the distribution of each designated zone by 4 areas of the Study Area. It's a matter of course the Plan above mentioned covers only the land reverted to Belem Municipality. In this study, the "Zones" are designated in the same manner as the land reverted to Ananindeua Municipality. These are:

- a. Integrated traffic zones along Route BR-316, such as Julia Seffer and Ananindeua excluding Ananindeua Ind., are corresponding to "Habitational zone (H-4)";



Zone Types:

Residential Zones

Population Density (Persons / ha)

0 100 200 300 400 500 600 700

H-1	150	Historical Conservation Area of Cidade Velha
H-2	110 - 170	
H-3	110 - 120	
H-4	150 - 225	
H-5	225 - 300	
H-6	300 - 375	
H-7	375 - 700	

- Commercial and Services Zones
- Mixed-use Zones
- Industrial Zones
- Special Functional Zones
- Preservation Zones
- Rural Land



Figure 3.5-1 Development Scheme

- b. Within the above area, existing municipality's center of Ananindeua (Julia Seffer and Ananindeua of traffic zone) and Marituba are corresponding to "Mixed-use zone (M-2)";
- c. Distrito Industrial Ananindeua is corresponding to "Industrial zone"; and
- d. Aura which is nature land faced to Guama River is corresponding to mainly "Rural zone", including partially both zones of "Special functional" and "Preservation".

Table 3.5-1 Area List of the Development Scheme (unit: Km2)

Zone types	Central area	Trans. area	Expan. area	Islands	Total (km2)	(%)
1. Commercial and services zone	1.09	-	1.03	-	2.12	0.34
2. Mixed-use zone	4.41	1.18	11.29	-	16.88	2.69
Breakdown: M-1	4.41	-	1.11	-	5.52	0.88
M-2	-	1.00	6.09	-	7.09	1.13
M-3	-	-	1.02	-	1.02	0.16
M-4	-	0.18	3.07	-	3.25	0.52
3. Habitational zone	29.78	15.78	121.89	73.13	240.58	38.33
Breakdown: H-1	-	1.80	21.03	17.86	40.69	6.48
H-2.H-3	0.37	-	-	-	0.37	0.06
H-4	16.41	12.50	90.04	55.27	174.22	27.76
H-5	-	1.48	8.56	-	10.04	1.60
H-6	3.34	-	2.26	-	5.60	0.89
H-7	9.66	-	-	-	9.66	1.54
4. Industrial zone	-	-	10.01	-	10.01	1.60
5. Special functional zone	1.85	23.81	16.91	8.37	50.94	8.12
6. Preservation zone	-	7.89	7.69	-	15.58	2.48
7. Rural land	-	-	57.03	234.37	291.40	46.44
Total	37.13	48.66	225.85	315.87	627.51	100%