Japan International Cooperation Agency (JICA)
The Government of State of Para
The Federative Republic of Brazil

The Feasibility Study On The Improvement of Transport System In The Metropolitan Area of Belem In The Federative Republic of Brazil

Final Report (Main Report)

October 2003

Chodai Co., Ltd
In Association With
Yachiyo Engineering Co., Ltd

Exchange Rates: June 2003

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US$ 1.00 = ¥120

Preface

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

JICA selected and dispatched a study team headed by Mr. Kenichi Sekine of Chodai Co., Ltd., to Brazil, three times between May 2002 and August 2003. In addition, JICA set up an advisory committee headed by Dr. Koshi Yamamoto, Professor, University of Nagoya Institute of Technology between May 2002 and August 2003, which examined the study from specialist and technical points of view.

The Team held discussions with the officials concerned of the Government of the Federative Republic of Brazil, and conducted a field survey at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, 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.

October 2003

Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

Letter of Transmittal

October 2003

Mr. Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

Dear Sir.

It is a great honor for me to submit herewith the final reports of the Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem in the Federative Republic of Brazil.

A study team, which consists of Chodai Co., LTD. and Yachiyo Engineering Co., LTD. and headed by myself, conducted field surveys, data analysis and planning works of feasibility study in Belem based on the terms of references instructed by the Japan International Cooperation Agency (JICA) from May 2002 to August 2003.

The study team held thorough discussions and investigations with officials concerned of the Government of the Federative Republic of Brazil, accordingly, various traffic surveys, present condition analysis, preliminary engineering design, conduct of environmental impact assessment, preparation of implementation program and project evaluation. The results were collected in the final reports, main and summary reports.

On behalf of the team I wish to express my heartfelt appreciation to the Officials concerned of the Government of the Federative Republic of Brazil for their warm friendship and cooperation extended to us during our stay in Brazil.

Also, I wish to express my sincere appreciation to JICA, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, the Embassy of Japan in Brazil and other concerned government authorities for their valuable advice and cooperation given to us in the course of the site surveys and preparation of the final reports.

Yours Faithfully,

Kenichi Sekine

Team Leader

The Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem in the Federative Republic of Brazil

The Feasibility Study
on the Improvement of Transport System
in the Metropolitan Area of Belem

Study Duration: May 2002 – October 2003
Requesting Organization: Para State

Outline of the Study

1. STUDY BACKGROUND

In 2000, the Government of the Federative Republic of Brazil (hereinafter referred to as "GOB") requested the Government of Japan (hereinafter referred to as "GOJ") for assistance to carry out "the Update of Master Plan for Urban Transport in the Metropolitan Area of Belem" (hereinafter referred to as "PDTU2001") and the study was completed in 2001 by joint efforts of the Brazilian and the Japanese study team.

PDTU2001 recommended a new bus system and a number of road projects as high priority projects, by noting the importance of strengthening the public transport system and the urban road network in the Belem Metropolitan area (BMA). The further study of the proposed bus system and road projects is essential to put the Master Plan into effect. Therefore, the GOB requested assistance from the GOJ for the conduct of the Study related to PDTU2001.

The GOJ has decided to conduct the "Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem" (hereinafter referred to as "the Study") following PDTU2001. The Study was commenced in May 2002 and will complete in October 2003.

2. STUDY OBJECTIVES

The objectives of the Study are as follows:

1) To undertake feasibility study on the improvement of transport system, which contains the road projects and the bus system project, both of which are necessary to mitigate the inefficiency of the present transport system in the Metropolitan Area of Belem, and,
2) To pursue technology transfer to Brazilian counterparts in the course of the implementation of the Study.

3. STUDY AREAS

The Study covers the bus system and road projects in the Metropolitan Area of Belem. The bus system project is composed of road infrastructure, integrated bus terminals and bus operation system.

As for the road project, five (5) roads are included as a study road: Av. Primeiro de Dezembro, Av. Independencia, Av. Pedro Miranda, Rua da Marinha, and Link road of Cidade Nova to Av. Primeiro de Dezembro.

The year 2012 is defined as the target year for feasibility study.

4. STUDY DURATION

The Study was commenced in May 2002 and will complete in October 2003.

5. OUTLINE OF STUDY

(1) Bus Operation System

The trunk bus operation consists of three system components: namely, (i) trunk bus system, (ii) feeder bus system and (iii) conventional bus system. Taking into account the different busway facilities conditions, the proposed trunk bus system runs on three types of busways: viz., (i) trunk busways, (ii) exclusive trunk busways and (iii) trunk bus priority lanes. A feeder bus system is provided for relatively short rides to collect passengers to each trunk bus terminal with integrated transfer. The trunk bus system replaces 61 conventional bus lines, and the remaining 104 bus lines continue their conventional service.

(2) Integrated Bus System

The present study proposes eight new bus terminals for trunk bus operation. Each terminal provides integrated transfers between feeder and trunk bus lines. In this proposal, conventional bus lines will not be integrated with the trunk bus system. Accordingly, eight bus terminals will be so structured to segregate the integrated feeder and trunk bus services from the conventional bus lines and other private transport means. Passengers of conventional bus lines can transfer to trunk bus lines at trunk bus stops but they have to pay the fare again. Passengers of a trunk bus line also have to pay the fare whey they transfer to another trunk bus line (A bus zone to/from B bus zone) at a trunk bus stop.

(3) Bus Infrastructure

In order to ensure the smooth and effective operation of the trunk bus service, the study proposes the following infrastructure development. Table 1 shows the project dimension such as type of busway, length, and number of lanes.

1) *Two-way trunk busways* are constructed on the central part of three existing trunk roads, namely, Rodovia BR-316, Avenida Almirante Barroso and Rodovia Augusto Montenegro. In conjunction, the available roadways, bikeways and sidewalks of the three roads are structurally improved.
2) Avenida Independencia, two-way four-lane road now under construction, is widened to a six-lane road with *the two-way exclusive trunk bus lanes* provided on its median.
3) Along a number of roads within Belem and Icoaraci Cities and Rodovia Mario Covas in Cidade Nova, an outermost lane on each side is improved as *trunk bus priority lane*, marked by colored asphalt concrete pavement.
4) Avenidas Pedro Cabral and Senador Lemos, currently serving two-way traffic with dual carriageway, are converted to one-way roads with three lanes, with the remaining lane improved as trunk bus priority lane, similarly marked by colored asphalt concrete pavement.
5) Integrated bus terminals are newly constructed at eight locations.
6) New bus stops are constructed along trunk busways and exclusive trunk bus lanes.

(4) Road Projects

Four (4) road projects are planned in the study, which are: new construction of Av. Independencia (Para State is now constructing the suburban segment and is planning the

Centro accessing segment in this study), extension and new construction of Primeiro de Dezembro, and improvement of Rua Yamada and Rua da Marinha.

Road design of the road projects is examined taking into account the conservation of natural and social environment. The adjustment of construction year of trunk bus and road projects in the implementation plan is made from the viewpoint of the travel demand on both road and trunk bus facilities.

From the viewpoints of the bus travel demand, the implementation of the Centro accessing segment of Avenida Independencia by 2010 is indispensable. Primeiro de Dezembro should be constructed by 2010 as well as that of Avenida Independencia. On the other hand, road constructions on Rua Yamada and Rua da Marinha will be recommended in 2012 as a middle term project. Table 2 shows the project dimension such as road length and number of lanes.

(5) Project Cost and Financial Resource

The total investment of the trunk bus and road projects as shown in Table 1 and Table 2 is estimated at US$261 million, of which US$163.0 million, equivalent to 62% of the total, is estimated for the trunk bus projects and US$98.5 million is for the road projects. The investment of the trunk bus projects will peak in 2006 when the busways are constructed. Its cost is approximately US$82 million. The economic viability of the project is very high showing 28.0 % of E-IRR and R$495 million of NPV. If evaluating the trunk bus system project alone, the economic E-IRR is 17.0%. The E-IRR of the entire road project is extremely high at 41%. As for financial analysis, the project F-IRR is very high at 40.9% and Equity IRR is 20.3%

Comparatively, these investments apparently exceed the budget of infrastructure in Para State. For an early implementation stage of the projects, certain financial resources should be identified as soon as possible.

Table 1 Recommended Trunk Bus Project

No.	Project Name	Type of Busway	Project Length (km)	No. of Bus Lane (/direction)	Project Cost (1000US$)
1. Busway Projects					
1)	Av. Almirante Barroso	Trunk Busway	6.000	2	17,885
2)	Rodovia BR-316	Trunk Busway	10.750	2	32,438
3)	Rodovia August Montenegro	Trunk Busway	13.635	2	34,651
4)	Av. Independencia on the Suburban Segment	Exclusive Trunk Bus Lane	12.344	2	24,241
5)	Av. Independencia on the central accessing Segment	Exclusive Trunk Bus Lane	7.235	2	21,550
6)	Bus Priority Road from Icoaraci Bus Terminal to Rodovia Augusto Montenegro	Trunk Bus Priority Lane	3.270	2	496
7)	Bus Priority Road from Sao Braz Bus Terminal into Centro	Trunk Bus Priority Lane	9.800	2	2,142
8)	Bus Priority Road on Avenida Pedro Cabral and Senador Lemos	Trunk Bus Priority Lane	7.800	2	11,855
9)	Rodovia Mario Covas in Cidade Nova	Trunk Bus Priority Lane	3.550	2	1,224
	Sub-Total		74.384		146,482
2. Integrated Bus Terminals			Area m2		
1)	Terminal A: Icoaraci	Bus Terminal	11,480		1,454
2)	Terminal B: Tapana	Bus Terminal	15,540		2,091
3)	Terminal C: Mangueirao	Bus Terminal	15,540		2,010
4)	Terminal D: Coqueiro	Bus Terminal	18,768		2,294
5)	Terminal E: Aguas Lindas	Bus Terminal	9,680		1,238
6)	Terminal F: Marituba	Bus Terminal	16,770		2,187
7)	Terminal G: Independencia 1	Bus Terminal	10,560		1,117
8)	Terminal H: Independencia 2	Bus Terminal	10,560		1,071
	Sub-Total				13,462
			Number		
3. Bus Facilities (Bus Stops)		Bus Stop	45		3,023
		Bus Shelter	82		
		Sao Braz Terminal Rehabilitaion	1		
4. Total Cost of Trunk Bus System Project					162,967

Table 2 Recommended Road Project

No.	Project Name	Project Length (km)	No. of Lane (/direction)	Project Cost (1000US$)	Remarks
1)	Av. Independencia on the Suburban Segment	12.344	4	39,360	Constructing by Para State
2)	Av. Independencia on the central accessing Segment	7.235	4	37,276	Planning by Para State
3)	Av. Primeiro de Dezembro/Rodovia Mario Covas Extension	10.077	4	51,795	New construction road
4)	Rua Yamada	10.000	4	32,655	Road Improvement
5)	Rua da Marinha	4.555	4	14,051	Road Improvement
Sub-Total excluding Av. Independencia		24.632		98,501	Only Stury Projects
Total		44.211		175,137	

(6) Benefits to Environmental Conservation

1) Environmental Conservation

The trunk bus system uses the available road space of the existing trunk roads. Because the widening of road space is not required, the proposed system is unlikely to do additional damage to the current situation of the surrounding environment. Nonetheless, it is necessary to take sufficient environmental conservation measures both during and after the construction.

2) Reduced Emission of Nitrogen Oxides (NO_X)

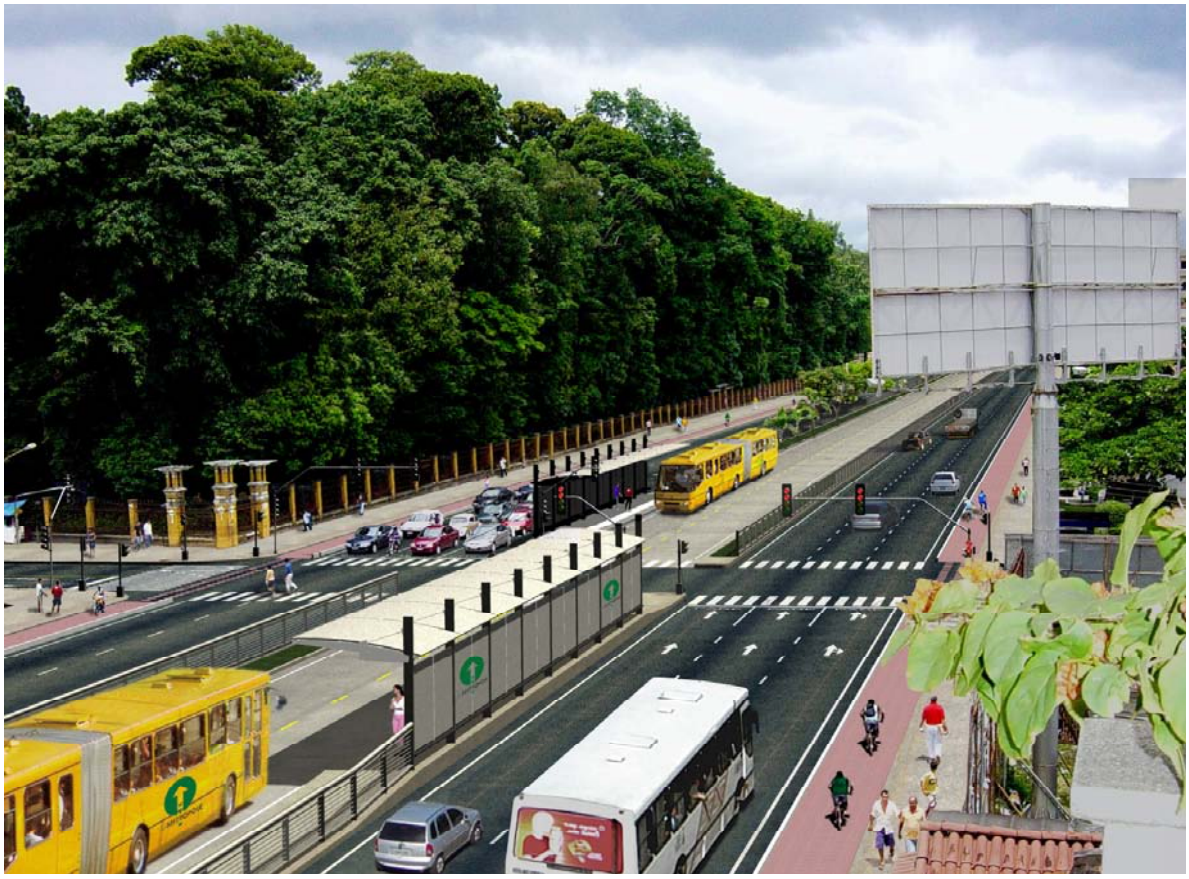
The level of air pollution by NO_X, CO, PM-10 and SO_2 in the study area is currently better than the national environmental standards. However, the situation is sure to deteriorate in the foreseeable future. Without the trunk bus system, the daily emission of NO_X will rise to 12.6 tons in 2007 and 18.5 tons in 2012. With the system, the NO_X emission will be 11.2 and 14.9 tons respectively, lower by 10% and 20% relative to the "without" situation. The introduction of the trunk bus system will be effective to keep the air pollution by NO_X in check.

3) Reduced Emission of Carbon Dioxide (CO_2)

Without the trunk bus system, the daily emission of CO_2 is estimated to reach 1,590 tons in 2007 and 2,850 tons in 2012. With the system, the daily emission will be 1,380 and 2,110 tons, lower by 13 and 26% respectively relative to the "without" situation. The trunk bus system will serve sizably to curtail the CO_2 emission, the major cause of global warming.

4) Expropriation Program

Based on the basic design of the proposed road and bus system project, the number of house to be expropriated was estimated, and it was found that approximately 1,818 houses must be expropriated within this project. Among of them, 601 families will move into resettlement sites. Within this project, the Government of Para State will prepare nine resettlement sites around the project area.



Photomontage for Trunk Busway on Avenida Almirante Barroso

Photomontage for Trunk Busway on Rodovia BR-316

Photomontage for Trunk Busway on Rodovia Augusto Montenegro

Photomontage for Exclusive Trunk Bus Lane on Avenida Independencia

Photomontage for Trunk Bus Priority Lane in Central Area

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AGR:	Goiania Agency of Regulation, Control and Supervising of Public Services
AMPPPC:	Municipality Agency of Preservation and Protection
ABNT:	Brazilian Association of Technical Rules
APA:	Environmental Protected Reserves
APEG:	Ecological Research Area of GUAMA
ARCON:	State Agency of Regulation and Control of Public Services
BMA:	Belem Metropolitan Area
CDTC:	Deliberative Chamber of Public Transports of Goiania
CMTC:	Metropolitan Company of Public Transport
COHAB:	Para State Habitation Company
CONAMA:	National Concierge of Environmental
CONAMAZ:	National Council of the Amazon Region
CONERC:	Council State of Regulation and Public Services Control
CONSEMA:	Council State of Environment
CONTRAN:	National Transit Council
COSANPA:	Para State Sanitation Company
CTBel:	Transport Company of Belem Municipality
DEMUTRAN:	Municipality Department of Transports and Traffic
DPHAC:	Department of Historical, Architectural and Cultural Heritage Conservation
DETRAN:	State of Para Department of Transit
DNIT:	National Department of Road Transport Infrastrutucture
IEE:	Initial Environmental Examination
EBTU:	Urban Transports Brazilian Enterprise
EIA:	Environmental Impact Study
EMTU:	Urban Transports Metropolitan Municipality
FADESP:	Foundation of Support and Develop for the Research
FUMBEL:	Belem Cultural Heritage Foundation
FUNVERDE:	Belem Green Area and Park Foundation
GETRANS:	Executive Group of Management of Metropolitan Network of Public Transports
GETRAT:	Special Study Group for Decreasing
IBAMA:	Brazilian Institute of Environmental and Renewalbe natural Resources
IPHAN:	National Institute of Historical/Architectural and Cultural Heritage
IPPUC:	Institute of Urban Survey and Planning of Curitiba
JICA:	Japan International Cooperation Agency
LI:	License for Installation
LO:	License for Operation
LP:	Preliminary License
OD:	Origin and Destination
PDTU:	Master Plan Study on Urban Transport in Belem
PEA:	Environmental Egineering Desing Report
PROCONVE:	Brazilian Program of Pollution Control
PROSANEAR:	Sanitation Program for Low-income People
RCA:	Environmental Control Report
RMG:	Goiania Metropolitan Area
SAAEBE:	Belem Water and Siwerage Autonomous Service
SECTAM:	Executive Secretariat of Science, Techonology and Environmental
SECULT:	Executive Secretariat of Culture

SEGUP:	Executive Secretariat of Public Security
SESMA:	Secretariat of Health and Environment of Belem Municipality
SETRAN:	Executive Secretariat of Transports
SETRANSBEL:	Syndicate of Transport Companies of Belem
SISNAMA:	National System of Environment
SISP:	Integrated System of Public Security
SMT:	Municipality Secretary of Transport and Circulation
TELEMAR:	Tele North East Participations S.A
UFPA:	Federal University of Para
URBS:	Transport Company of Curitiba

CONCLUSION AND RECOMMENDATIONS

CONCLUSION AND RECOMMENDATIONS

(1) Necessity of the Projects

The PDTU2001 was conducted by joint efforts of the Brazilian and the Japanese study team over a period of one year from 2000 to 2001, and the various projects were recommended to improve the traffic congestion and maintain sound activities in BMA. Following the PDTU2001, the Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem, which were recommended by the PDTU2001 as the high priority projects as well as the urgent implementation projects, were conducted. As the implementation of projects recommended under the Study will contribute to the followings, it is necessary to implement these projects as soon as possible:

1) To mitigate and to reduce traffic congestion;
2) To contribute in setting up to maintain the trunk bus system, and to ensure efficiency of bus operation system;
3) To contribute to the social and natural environment by reducing air pollution; and
4) To increase economic and social activities.

(2) Bus Operation System (see Table 1)

The trunk bus operation consists of three system components: namely, (i) trunk bus system, (ii) feeder bus system and (iii) conventional bus system. Taking into account the different busway facilities conditions, the proposed trunk bus system runs on three types of busways: viz., (i) trunk busways, (ii) exclusive trunk busways and (iii) trunk bus priority lanes. A feeder bus system is provided for relatively short rides to collect passengers to each trunk bus terminal with integrated transfer. The trunk bus system replaces 61 conventional bus lines, and the remaining 104 bus lines continue their conventional service.

(3) Integrated Bus System

The present study proposes eight new bus terminals for trunk bus operation. Each terminal provides integrated transfers between feeder and trunk bus lines. In this proposal, conventional bus lines will not be integrated with the trunk bus system. Accordingly, eight bus terminals will be so structured to segregate the integrated feeder and trunk bus services from the conventional bus lines and other private transport means. Passengers of conventional bus lines can transfer to trunk bus lines at trunk bus stops but they have to pay the fare again. Passengers of a trunk bus line also have to pay the fare whey they transfer to another trunk bus line (A bus zone to/from B bus zone) at a trunk bus stop.

(4) Bus Infrastructure (see Table 1)

In order to ensure the smooth and effective operation of the trunk bus service, the present study proposes the following infrastructural development.

1) Two-way trunk busways are constructed on the central part of three existing trunk roads, namely, Rodovia BR-316, Avenida Almirante Barroso and Rodovia Augusto Montenegro. In conjunction, the available roadways, bikeways and sidewalks of the three roads are structurally improved.
2) Avenida Independencia, two-way four-lane road now under construction, is widened to a six-lane road with the two-way exclusive trunk bus lanes provided on its median.

3) Along a number of roads within Belem and Icoaraci Cities and Rodovia Mario Covas in Ciudade Nova, an outermost lane on each side is improved as trunk bus priority lane, marked by colored asphalt concrete pavement.

4) Avenidas Pedro Cabral and Senador Lemos, currently serving two-way traffic with dual carriageway, are converted to one-way roads with three lanes, with the remaining lane improved as trunk bus priority lane, similarly marked by colored asphalt concrete pavement.

5) Integrated bus terminals are newly constructed at eight locations.

6) New bus stops are constructed along trunk busways and exclusive trunk bus lanes.

Table 1 shows the recommended trunk bus projects.

Table 1 Recommended Trunk Bus Project

No.	Project Name	Type of Busway	Project Length (km)	No. of Bus Lane (/direction)	Project Cost (1000US$)
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9)	Rodovia Mario Covas in Cidade Nova	Trunk Bus Priority Lane	3.550	2	1,225
	Sub-Total		74.384		146,486
2. Integrated Bus Terminals			Area m2		
1)	Terminal A: Icoaraci	Bus Terminal	11,480		1,454
2)	Terminal B: Tapana	Bus Terminal	15,540		2,092
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8)	Terminal H: Independencia 2	Bus Terminal	10,560		1,072
	Sub-Total				13,467
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3. Bus Facilities (Bus Stops)		Bus Stop	45		3,023
		Bus Shelter	82		
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4. Total Cost of Trunk Bus System Project					162,976

(5) Road Projects

Four (4) road projects are planned in the study, which are: new construction of Av. Independencia (Para State is now constructing the suburban segment and is planning the Centro accessing segment in this study), extension and new construction of Primeiro de Dezembro, and improvement of Rua Yamada and Rua da Marinha.

Road design of the road projects is examined taking into account the conservation of natural and social environment. The adjustment of construction year of trunk bus and road projects in the implementation plan is made from the viewpoint of the travel demand on both road and trunk bus facilities.

The route of Av. Independencia is planed to skirt around the Parque Presidente Medici (natural conservative park) because the original route passes through the park. In the plan of Primeiro de Dezembro, the household waste water from the northern residential areas from seeping into the reservoir is partly checked to protect the natural environment around

the reservoir on the south. Rua da Marinha runs next to the nature conservation area (Parque Presidente Medici). Therefore, to take environmental precaution in the road structure, an elevated road instead of ordinary embankment is proposed to allow free mobility of small wild animals.

From the viewpoints of the bus travel demand, the implementation of the Centro accessing segment of Avenida Independencia by 2010 is indispensable. Primeiro de Dezembro should be constructed by 2010 as well as that of Avenida Independencia. On the other hand, road constructions on Rua Yamada and Rua da Marinha will be recommended in 2012 as a middle term project.

Table 2 shows the recommended road projects.

Table 2 Recommended Road Project

No.	Project Name	Project Length (km)	No. of Lane (/direction)	Project Cost (1000US$)	Remarks
1)	Av. Independencia on the Suburban Segment	12.344	4	39,360	Constructing by Para State
2)	Av. Independencia on the central accessing Segment	7.235	4	37,276	Planning by Para State
3)	Av. Primeiro de Dezembro/Rodovia Mario Covas Extension	10.077	4	51,796	New construction road
4)	Rua Yamada	10.000	4	32,655	Road Improvement
5)	Rua da Marinha	4.555	4	14,052	Road Improvement
Sub-Total excluding Av. Independencia		24.632		98,503	Only Study Projects
Total		44.211		175,139	

(6) Project Cost and Financial Resource

The total investment of the trunk bus and road projects is estimated at US$261 million, of which US$163.0 million, equivalent to 62% of the total, is estimated for the trunk bus projects and US$98.5 million is for the road projects. The investment of the trunk bus projects will peak in 2006 when the busways are constructed. Its cost is approximately US$82 million. Comparatively, these investments apparently exceed the budget of infrastructure in Para State. For an early implementation stage of the projects, certain financial resources should be identified as soon as possible.

(7) Further Studies

The Government of Para State is to officially implement the 4-year Metropolitan Integration Program (2004 - 2007) after the Council of Para State will approve this program. This four-year program includes the trunk bus system and road projects proposed in this feasibility study. The on-going project of Avenida Independencia planned and supervised by the Para State, which will be very important component for the proposed trunk bus system, is also to be approved and be integrated formally in this program.

In order to proceed the proposed project in this 4-year program further, several works must be done at the next project stage. Among of them, the priority of the detailed design of following project components such as,

1) Trunk busway on Rodovia BR-316, Avenida Almirante Barroso and Rodovia Augusto Montenegro
2) Exclusive trunk bus lanes on Avenida Independencia

3) Trunk bus priority along a number of roads within Belem and Icoaraci Cities and Avenida Mario Covas in Cidade Nova

4) Integrated bus terminals and Bus stop facilities

is quite high and those tasks shall be initiated immediately after the completion of the feasibility study of this proposed project.

To proceed those tasks and keep the momentum developed since PDTU1991, further interaction and cooperation between Brazilian and Japanese sides must be required, and there are several areas that the Japanese side can make technical assistance for the Brazilian side as did in this feasibility study. Among of them, the area of the future traffic demand analysis in Brazil is still at the rudimentary stage and need more time, experiences and human resources to develop further. So, it is strongly recommended to dispatch the technical adviser of the trunk bus system, in particular, traffic demand analyst as well as other relevant area for the deep-understanding of this project.

CHAPTER 1
Introduction

1. INTRODUCTION

1.1. BACKGROUND OF THE STUDY

The "Master Plan Study on Urban Transport in Belem" (hereinafter referred to as "PDTU1991") was carried out by JICA in 1991, but the proposed projects were not implemented on schedule because of the reorganization in the executing agencies such as EBTU and EMTU. In the mean time, the Belem metropolitan area (BMA) has been increasingly vexed by acute urban transport problems caused by the inadequate supply of transport facilities in the midst of rapid population growth. Heavy traffic congestions on the roads in the BMA have been aggravated by the increased car ownerships and the delayed implementation of the PDTU1991-proposed projects.

Recently, a number of urgent measures have been proposed and implemented: namely, an extension of Av. Primeiro de Dezembro, the grade separated intersection on Av. Almirante Barroso and other road improvement projects. However, the effects of those projects will be limited in the absence of a comprehensive urban transport master plan. In 2000, the Government of the Federative Republic of Brazil (hereinafter referred to as "GOB") requested the Government of Japan (hereinafter referred to as "GOJ") for assistance to carry out "the Update of Master Plan for Urban Transport in the Metropolitan Area of Belem" (hereinafter referred to as "PDTU2001") and the study was completed in 2001 by joint efforts of the Brazilian and the Japanese study team.

PDTU2001 recommended a new bus system and a number of road projects as high priority projects, by noting the importance of strengthening the public transport system and the urban road network in the BMA. The further study of the proposed bus system and road projects is essential to put the Master Plan into effect. Therefore, the GOB requested assistance from the GOJ for the conduct of the Study related to PDTU2001, as a technical cooperation programs of the GOJ.

In response to the request from the GOB, the GOJ has decided to conduct the "Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem" (hereinafter referred to as "the Study"), in accordance with the Basic Agreement on Technical Cooperation between the GOJ and the GOB signed on September 22, 1970 (hereinafter referred to as "the Agreement").

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the GOJ, will undertake the Study in close relationship with the authorities concerned of the GOB.

The Preparatory Study Team was dispatched in January 2002, and after discussions with officials of the GOB, the Scope of Work for the Study was agreed upon between both sides, and signed on January 21, 2002.

JICA organized the Study Team to conduct the Study. The Study Team will work in close cooperation with the Brazilian counterpart team in accordance with the agreed upon Scope of Work and the contents of this Inception Report.

1.2. STUDY OBJECTIVES

The objectives of the Study are as follows:

1) To undertake feasibility study on the improvement of transport system, which contains the road projects and the bus system project, both of which are necessary to

mitigate the inefficiency of the present transport system in the Metropolitan Area of Belem, and,

2) To pursue technology transfer to Brazilian counterparts in the course of the implementation of the Study.

1.3. STUDY AREAS

The Study covers the following projects in the Metropolitan Area of Belem, shown in Figure 1.4-1.

(1) Bus System Project

1) Road infrastructure

a) Marituba - Sao Braz,

b) Icoaraci – Entroncamento,

c) BR-316 – Cidade Nova,

d) Central Area, and

e) Binary Av. Pedro Alvares Cabral and Av. Senador Lemos

2) Integration terminals

a) Terminal Marituba,

b) Terminal Cidade Nova,

c) Terminal Icoaraci, and

d) Terminal Sao Braz (Renovation).

3) Operation system

a) Re-organization of bus network by the introduction of trunk routes,

b) Electronic ticket system, and

c) New tariff system.

(2) Road Projects

a) Av. 1^{o} de Dezembro,

b) Av. Independencia,

c) Av. Pedro Miranda,

d) Rua da Marinha, and

e) Link road of Cidade Nova to Av. 1^{o} de Dezembro.

1.4. TARGET YEAR

The year 2012 is defined as the target year for feasibility study.

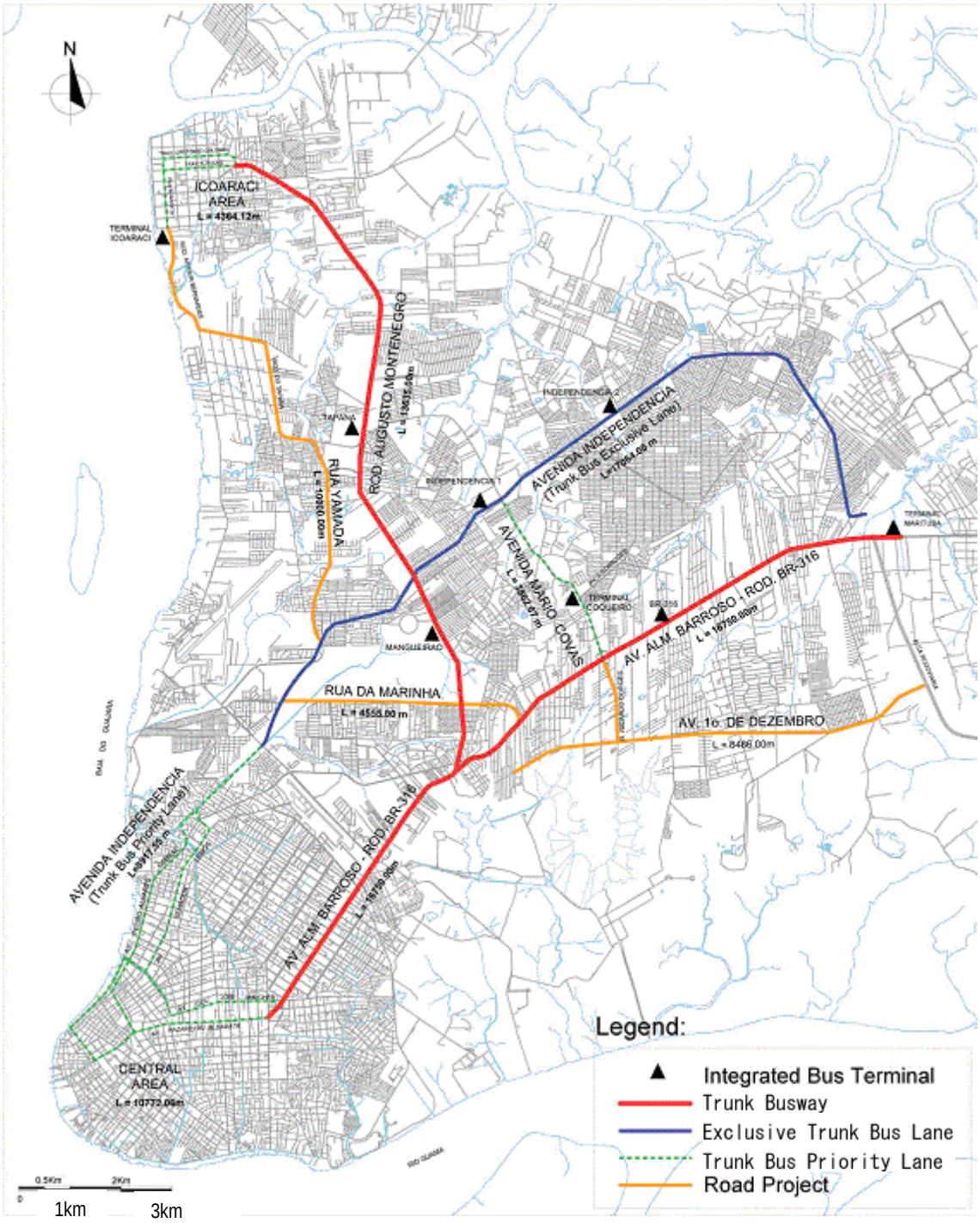


Figure 1.4-1 Study Area and Study Projects

1.5. SCOPE OF STUDY

Major activities of the Study are divided into four (4) stages. Major study items of each stage are described below. The study flow is schematically shown in Figure 1.6-1.

(1) First Stage of the Study (Working in Brazil)

The first stage of the study will be carried out in Brazil from May to August 2002. Major study items are listed below.

1) Collection and Review of Existing Data and Information
2) Supplemental Traffic Survey
3) Existing Public Transport Survey
4) Topographic and Road Inventory Survey
5) Natural Environmental Condition Survey
6) Social Environmental Condition Survey
7) Initial Environmental Examination (IEE)
8) Environmental Impact Assessment (EIA)
9) Future Traffic and Transport Demand Forecast

(2) Second Stage of the Study (Working in Brazil)

The second stage of the Study will be conducted in Brazil from September to January 2003. Major study items are listed below.

10) Planning Policies and Strategies
11) Public Transport System
12) Basic Conceptual Plan
13) Traffic Management
14) Preliminary Engineering Design
15) Issues of Existing Public Transport Organization
16) Project's Cost Estimate
17) Presentation of Interim Report and Opening of Workshop (1)

(3) Third Stage of the Study (Working in Brazil)

The third stage of the Study will be carried out in Brazil from May to July 2003. Major study items are listed below,

18) Environmental License Approval
19) Project Evaluation
20) Implementation Program
21) Recommendation of Public Transport Organization
22) Conclusion and Recommendation
23) Presentation of Draft Final Report and Opening of Workshop (2)

(4) Fourth Stage of the Study (Working in Japan)

The fourth stage of the Study will be conducted in Japan from August to September 2003. Major work items include the preparation of the Final Report after receiving the comments on the Draft Final Report from the Brazilian side.

1.6. PROGRESS OF THE STUDY

The major events associated with the Study are as follows;

(1) Submitting the Inception Report

A Steering Committee Meeting was held on May 14, 2002 at the conference room of COHAB in Para State. Attendances were the member of JICA Advisory Committee, the

JICA Study Team, and the member of Steering Committee. The JICA Study Team submitted the Inception Report to the Brazilian side. After the discussion, the contents of the Inception Report were accepted.

(2) Progress Report

The Steering Committee Meeting was held on October 9, 2002 at the conference room of State Special Secretariat of Regional Integration (SEIR) in Para State. Attendances were the member of JICA Advisory Committee, the JICA Study Team, and the member of Steering Committee. The Progress Report covering the results of data collection and its analysis was submitted to the Brazilian side.

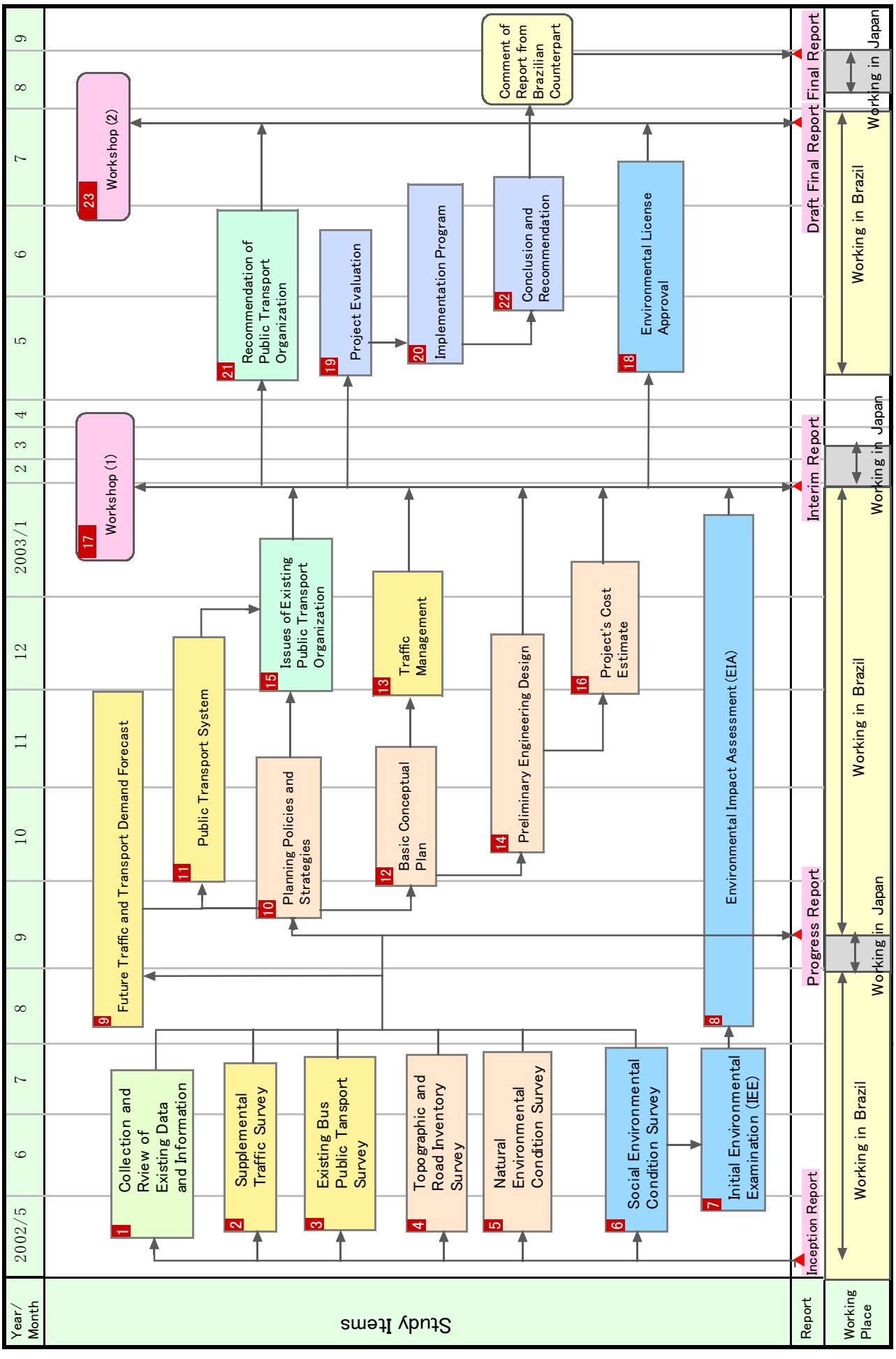
(3) Interim Report

The Steering Committee Meeting was held on January 21, 2003 at the conference room of SEIR in Para State. Attendances were the member of JICA Advisory Committee, the JICA Study Team, and the member of Steering Committee. The Interim Report covering the results of planning of trunk bus system and road projects, and preliminary engineering design of its planning was submitted to the Brazilian side.

(4) Draft Final Report

The Steering Committee Meeting was held on August 6, 2003 at the conference room of SEIR in Para State. Attendances were the member of the JICA Study Team, and the member of Steering Committee. The Draft Final Report adding the results of construction plan and cost estimate, implementation plan, organization of trunk bus system, economic and financial evaluation, environmental impact assessment and conclusion to the Interim Report was submitted to the Brazilian side.

Figure1.6-1 Study Flow Chart



1.7. ORGANIZATION

JICA organized both the Study Team, headed by Mr. Kenichi Sekine, and the Advisory Committee, chaired by Dr. Koshi Yamamoto, to provide the advice for the Study. The Government of Brazil organized both the Counterpart Team, coordinated by Mr. Paulo de Castro Ribeiro and the Steering Committee, chaired by Mr. José Augusto Soares Affonso, State Special Secretariat of Regional Integration (SEIR) in Para State. The schematic organization chart for the study is shown in Figure 1.7-1.

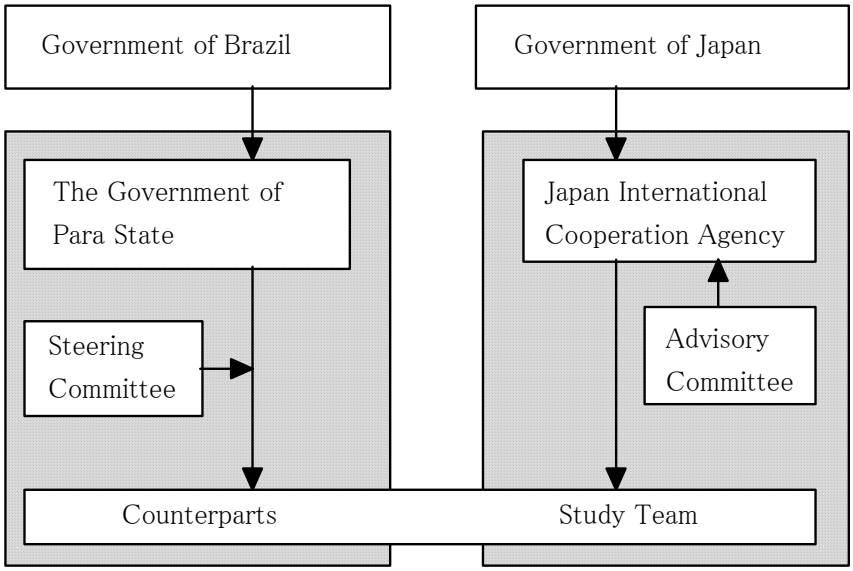


Figure 1.7-1 Organization Chart

1.8. STUDY ORGANIZATION MEMBERS

(1) Members of JICA Study Team

Mr. Kenichi SEKINE:	Team Leader
Mr. Koichi TSUZUKI:	Deputy Team Leader/ Public Transport Planner
Mr. Hisayuki YAMAGUCHI:	Public Transport System Analyst
Mr. Toshihiro HOTTA:	Road Planner
Mr. Masato KOTO:	Traffic Management Planner
Mr. Tetsuo HORIE:	Traffic Demand Analyst/ System Engineer
Mr. Yoshiaki NISHIKATU:	Road Planner
Mr. Masahiko MORI:	Structure Designer
Mr. Naoyuki MINAMI:	Public Transport Facility Designer
Mr. Yasushi HIGA:	Cost Estimate Analyst/ Construction Method
Dr. Takanori HAYASIDA:	Environment Analyst
Mr. Tetsuo WAKUI:	Economist
Mr. Raimundo COSTA:	Public Transport Organization Planer
Mr. Yasutoku NAGASE:	Social Environmental Surveyor
Mr. Hiroshi KUDOU:	Project Coordinator

(2) Members of JICA Advisory Committee

Prof. Dr. Koshi YAMAMOTO: (Leader)	Professor, University of Nagoya Institute of Technology
Mr. Katsuya YAMAMOTO:	Foundation for Riverfront Improvement and Restoration
Mr. Osamu IWATA*:	Ministry of Land Infrastructure and Transport
Mr. Hitoshi YOSHIMURA:	Ministry of Land Infrastructure and Transport

(3) Members of JICA Headquarter

Mr. Toshio HIRAI*:	Director, 1st Development Study Division, Social Development Study Department
Mr. Takeshi NARUSE*:	Director, 1st Development Study Division
Mr. Toshiyuki KUROYANAGI*:	Director, 1st Development Study Division
Mr. Akira NAKAMURA:	Director, 1st Development Study Division
Mr. Satoshi UMENAGA:	Deputy Director, 1st Development Study Division
Mr. Nobuaki KOGUCHI*:	1st Development Study Division
Ms. Momoko HOTTA:	1st Development Study Division

(4) Members of JICA Belem Office

Mr. Katsuhiko HAGA:	Resident Representative
Ms. Chiharu MORITA:	Assistant Resident Representative
Mr. Yasuhiro ONISHI:	Assistant Resident Representative

(5) Members of Steering Committee

Mr. José Augusto Soares Affonso:	Secretary, SEIR
Mr. Paulo Elcídio Chaves Nogueira:	Secretary, SEDURB
Mr. Cicerino Cabral do Nascimento:	Director President, COHAB/PA
Mrs. Suleima Fraiha Pegado:	DETRAN
Mr. Pedro Abílio Torres do Carmo:	SETRAN
Mr. Ronaldo Barata:	ARCON
Mr. Clovis Manoel de Melo Begot:	Vice Mayor, Municipality of Ananindeua
Mr. Gustavo Sampaio Sardinha Pinto:	Secretary of Planning, Municipality of Marituba
Mr. Fernando Luiz Rodrigues Nogueira:	UFPA
Mr. Evaristo Clementino Rezende dos Santos:	UNAMA

(6) Member of Counterpart

Mr. Paulo de Castro Ribeiro:	Coordinator of Counterpart, COHAB/PA
Mrs. Massa Goto:	COHAB/PA
Mr. Carlos Henrique Rodrigues Rocha:	COHAB/PA
Mr. Paulo Maurício Pinho:	SEDURB
Mrs. Lilia Maria Carvalho da Silva Dantas:	DETRAN
Mrs. Maria de Fátima Arnaud Moreira:	SETRAN
Mr. Rui Begot da Rocha:	Municipality of Ananindeua
Mrs. Marta da Penha Ferreira:	Municipality of Marituba
Mrs. Maísa Sales Gama Tobias:	UFPA
Mr. Maurício Melo Ribeiro:	UNAMA

Note: * Predecessor

PART A

EXISTING CONDITIONS OF THE STUDY AREA

CHAPTER 2
Present Conditions In The Study Area

PART-A EXISTING CONDITIONS OF THE STUDY AREA

2. PRESENT CONDITIONS IN THE STUDY AREA

2.1. SOCIO-ECONOMIC CONDITIONS

The study collected and analyzed existing socio-economic data to understand the socio-economic characteristics in the study area since 1990. The population and car ownership in 1990 and 2000 were compared for the macro-traffic zone, which is defined in the Person Trip Survey in PDTU2001. These analyses indicate the trend of urbanization and development in the study area.

(1) Population

Figure 2.1-1 shows the comparison of population between 1990 and 2000 for the macro-traffic zone with a bar graph. The total populations in 1990 and 2000 in the Belem Metropolitan Area (BMA) were 1.4 million and 1.9 million, respectively. The population growth ratio since 1990 was approximately 1.34, equivalent to 3.0% per annum. The regions with higher growth rates are Bengui, Pratinha, Cidade Nova, Julia Seffer and Ananindeua, which are located in suburban areas. The figures range from 1.9 to 2.7 during the decade. On the other hand, the growth rate in the Central Area in Belem, which is the business and commercial district, is as low as 1.06 to 1.10. This indicates that the area developing as a residential area extends to the suburbs in the direction of Ananindeua.

Figure 2.1-2 shows the gross population density in 1996 according to the population census in 1996. As can be seen, the areas with high population density are the Central Area (Primeira.Legua) and newly developed areas such as Cidade Nova, Icoaraci, and Marambaia. Those areas do not coincide with the road development.

(2) Income

Figure 2.1-3 shows the average household income in 2000 for the macro-traffic zone. This information was obtained from the Person Trip Survey conducted in 2000. The macro-zones with higher income are concentrated in the Central Area. The macro-zones with higher than average income in the BMA are Centro, Guama, Sacramento, Marco and Marambaia. In the peripheral area, only Cidade Nova exceeds the average. Higher income corresponds closely with motorized households—families that own a car. The analysis of car ownership in PDTU1991 and PDTU2001 indicates that the higher the average income is, the higher the ratio of motorized households is.

The higher population growth areas are distributed in the suburban area, while higher income households are concentrated in the Central Area. This shows that the public transport passengers inhabit in the suburban area and they commute using buses. The trip length of bus passengers will be longer than that of passenger-car users from the population and income distribution.

Figure 2.1-4 shows the average monthly income per capita in 1991 according to the population census in 1991. As can be seen, inside the Central Area, some areas along Av. Almirante Barroso, Av. Nazare and Av. Governador Jose Malcher indicate high income levels and it shows high-income households dwell along those major roads. However, other areas do not show the relation between road development and income level.

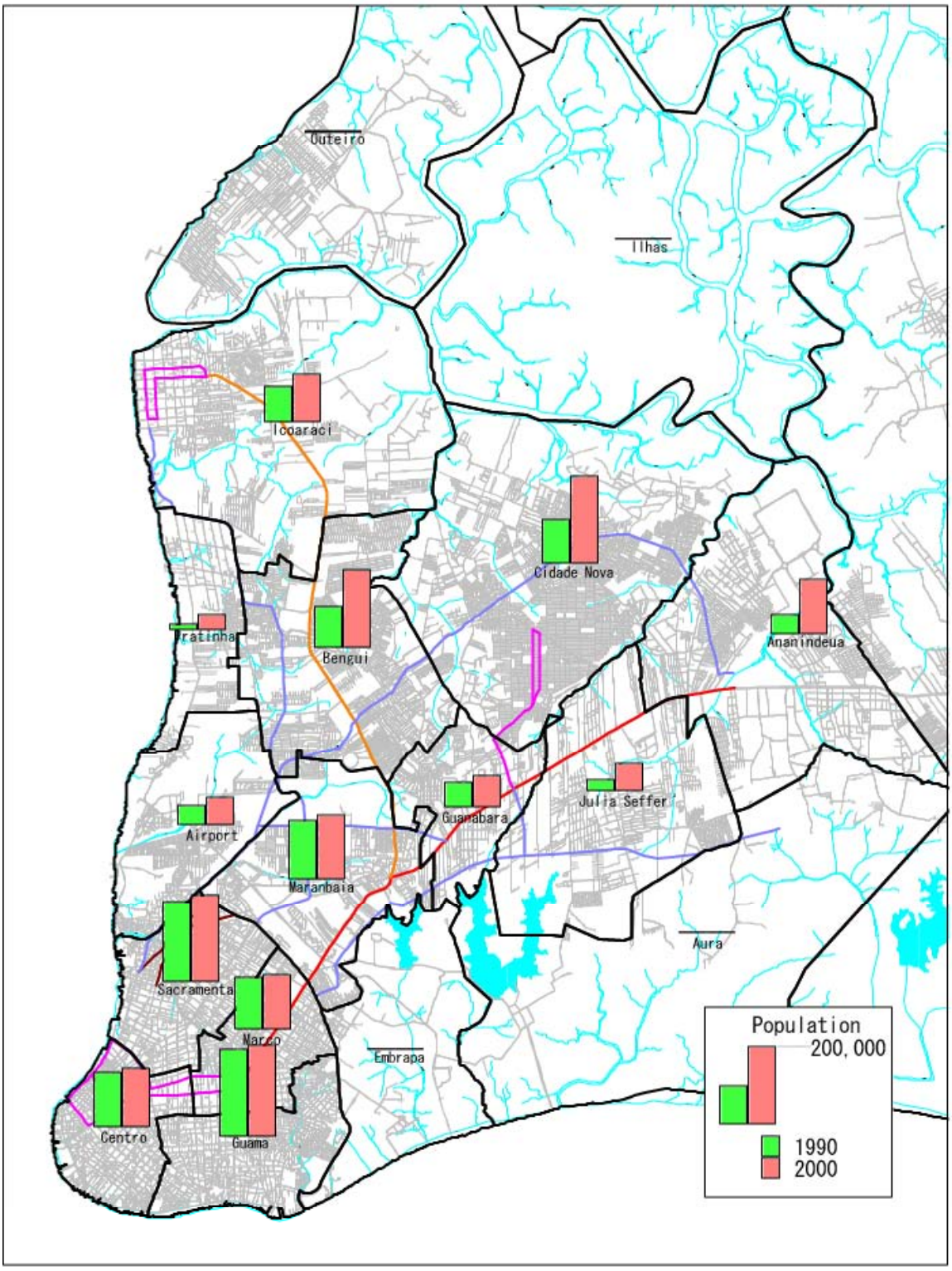


Figure 2.1-1 Comparison of Population Between 1990 and 2000

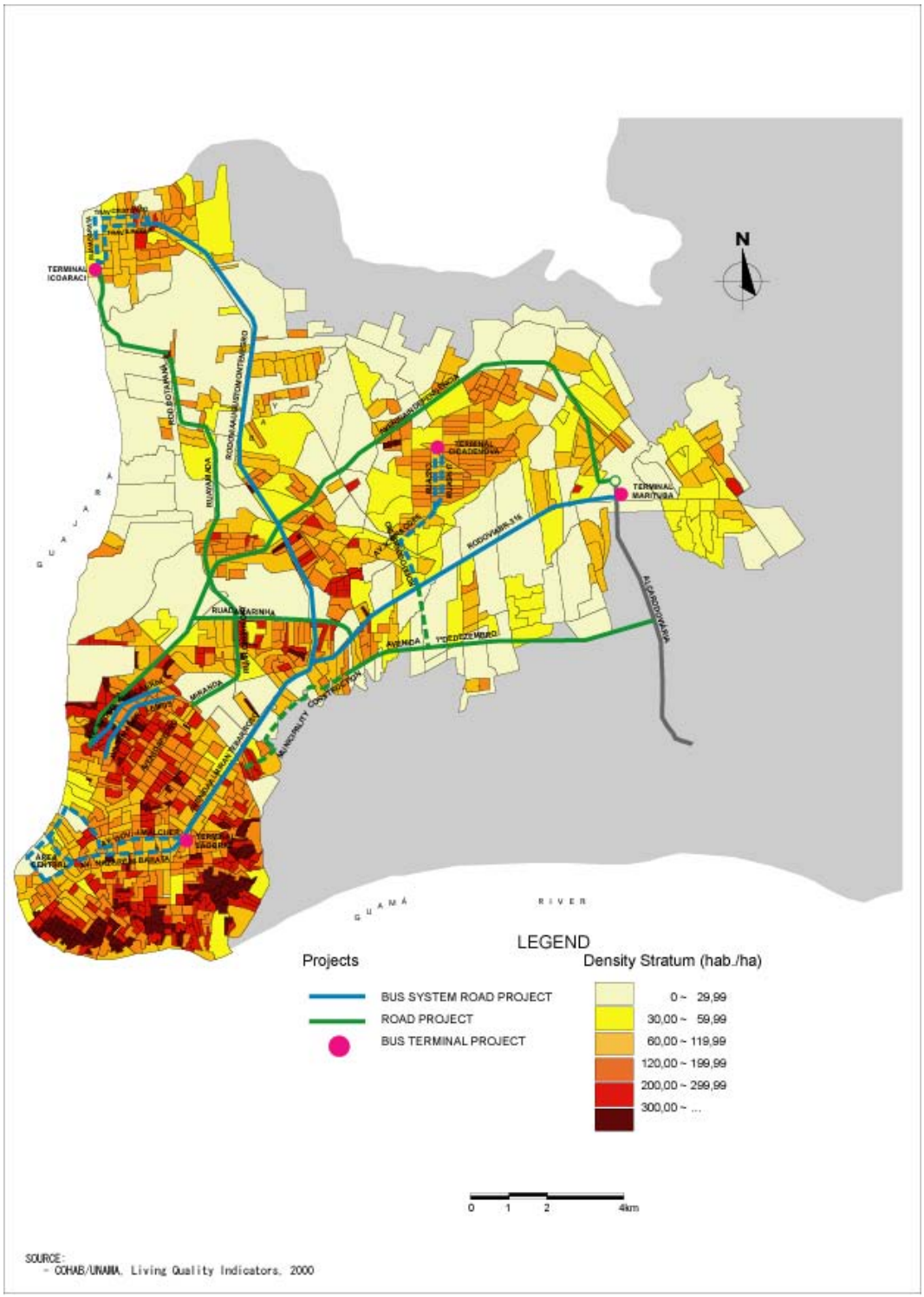


Figure 2.1-2 Gross Population Density in 1996

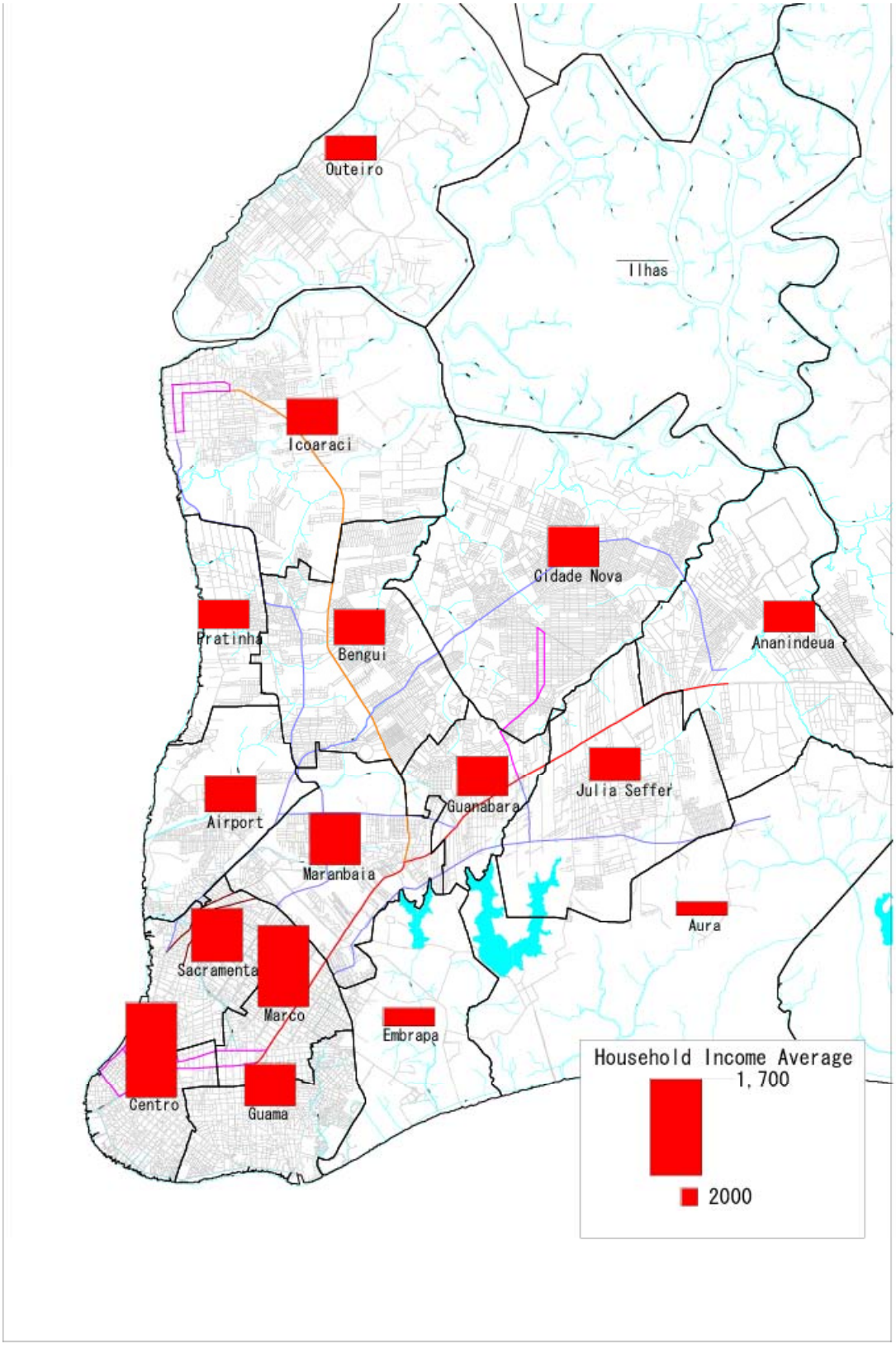


Figure 2.1-3 Average Household Income in 2000

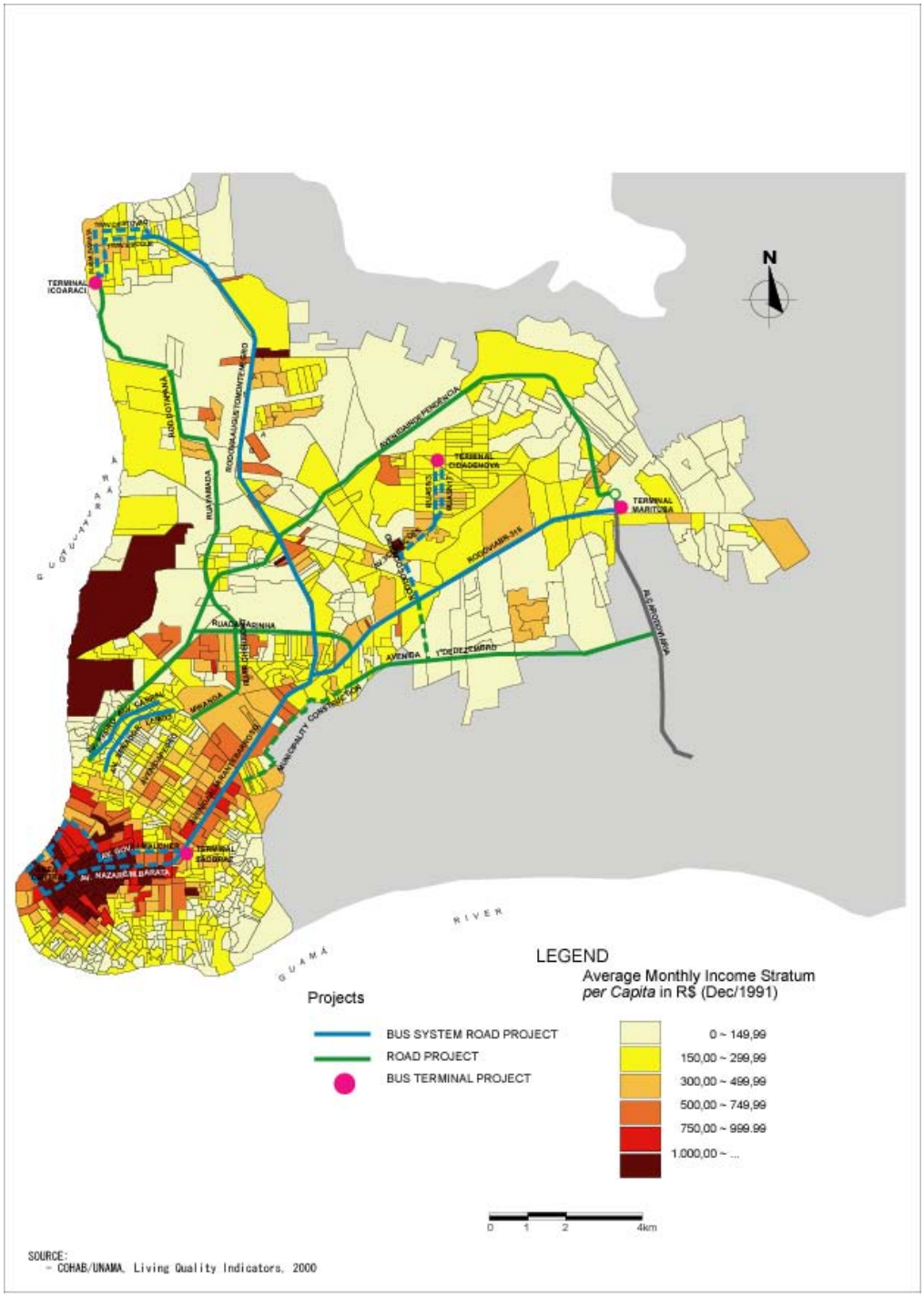


Figure 2.1-4 Average Monthly Income per Capita

(3) Motorized Households

Figure 2.1-5 shows the comparison of motorized households between 1990 and 2000 for the macro-traffic zone. The total motorized households in 1990 and 2000 in the BMA are 56,000 and 78,000, respectively. The increase ratio since 1990 is approximately 1.39, equivalent to 3.3% per annum. The regions with higher increase ratios are Guama, Bengui, Pratinha, Icoaraci, Cidade Nova and Ananindeua; all except Guama are located in suburban areas. The figures range from 1.5 to 6.1 during the decade. On the other hand, the increase ratio in the Central Area is as low as 0.88 to 1.38.

This means that passenger-car trips have extended to the suburban areas such as Icoaraci and Cidade Nova during the decade. Since those travels use the existing major roads such as Rodovia Augusto Montenegro, Av. Almirante Barroso and BR-316, traffic congestion on those roads is very severe during the morning and evening peak hours.

In the near future, it seems that the tendency of population growth and increase of household income will continue in the BMA. The traffic conditions on those major roads will be more serious if road development plans proposed in PDTU2001 are not implemented.

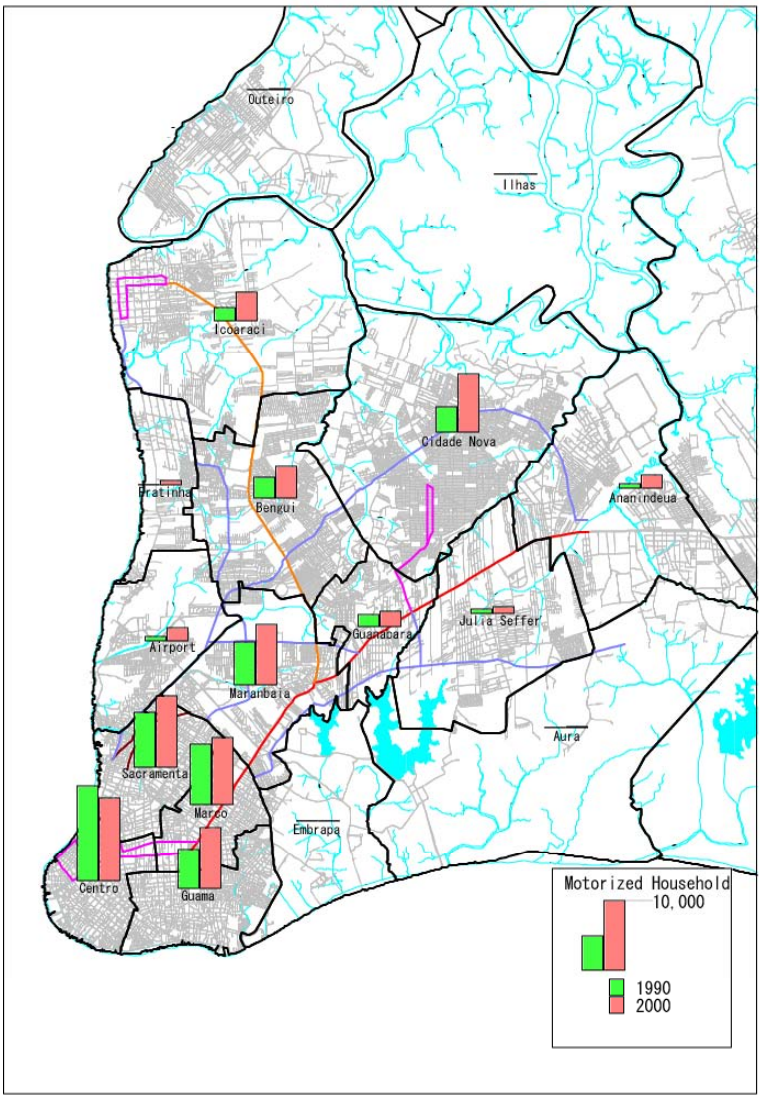


Figure 2.1-5 Comparison of Motorized Households Between 1990 and 2000

2.2. GEOGRAPHY AND GEOLOGICAL CONDITIONS

The study area lies on the diluvial terraces near the mouth of the Amazon. The terrains are more or less flat with neither mountain nor valley, and the altitude varies from 0 to 27m. Annual precipitation is heavy and its run-off creates many natural rivers down the terraces. To the north of the central part of Belem Municipality lie the lowlands, where canals were dug to provide drainage for the area. Three major arterial roads, namely, Av. Almirante Barroso, BR-316 and Rodovia Augusto Montenegro are aligned along watersheds of the terraces and they do not cross rivers.

In the study the soil investigation survey was carried out about 30 locations along the project roads and busways. Standard penetration test and laboratory test were executed and the existing geological conditions were identified.

The area to extend from the central part of Belem Municipality to the inland area on the eastern side of Guajara Bay lies on the lowlands. The surface soil on the area belongs to the non-consolidated sediments and laterites of the Quaternary which reach about 50m in depth. A geologic layer under the surface soil is composed of the Miocene/Pleistocene of the Tertiary Period with a good condition. The non-consolidated sediments on the surface are composed of mainly clay and silts and its depth of layer gradually shallow toward the east. The surface soil of the east side of Rodovia Augusto Montenegro is the Tertiary Period with a good condition.

The geological conditions in the BMA are classified into 4 categorized areas as shown below and in Figure 2.2-1.

1) The surface soil on the central area of the Belem municipality is the non-consolidated sediments with about 40m in depth and the layer under the surface is a good conditions in geologic.
2) On the area to extend from the west of Rua Yamada to Guajara Bay, the surface layer is the non-consolidated sediments with about 20m- 30m in depth and the layer under the surface is a good conditions in geologic.
3) The surface layer on the area from Rua Yamada to Rodovia Augusto Montenegro is the non-consolidated sediments with about 10m in depth and the layer under the surface is a good conditions in geologic.
4) On the area in the east of Rodovia Augusto Montenegro, the surface is a good conditions in geologic because the layer of the non-consolidated sediments is as thin as 2-3m.

In the road and bridge plans on the area to extend from the central area to Guajara Bay where the thick layer of the non-consolidated sediments exists, consolidation settlement of soft ground of clay caused by embankment is an important item to be considered in designing. So the central part of Belem Municipality lies on the lowlands, ground water level is higher. Therefore, a drainage system is indispensable for underground structure such as box culvert. The underground water near this area will be affected.

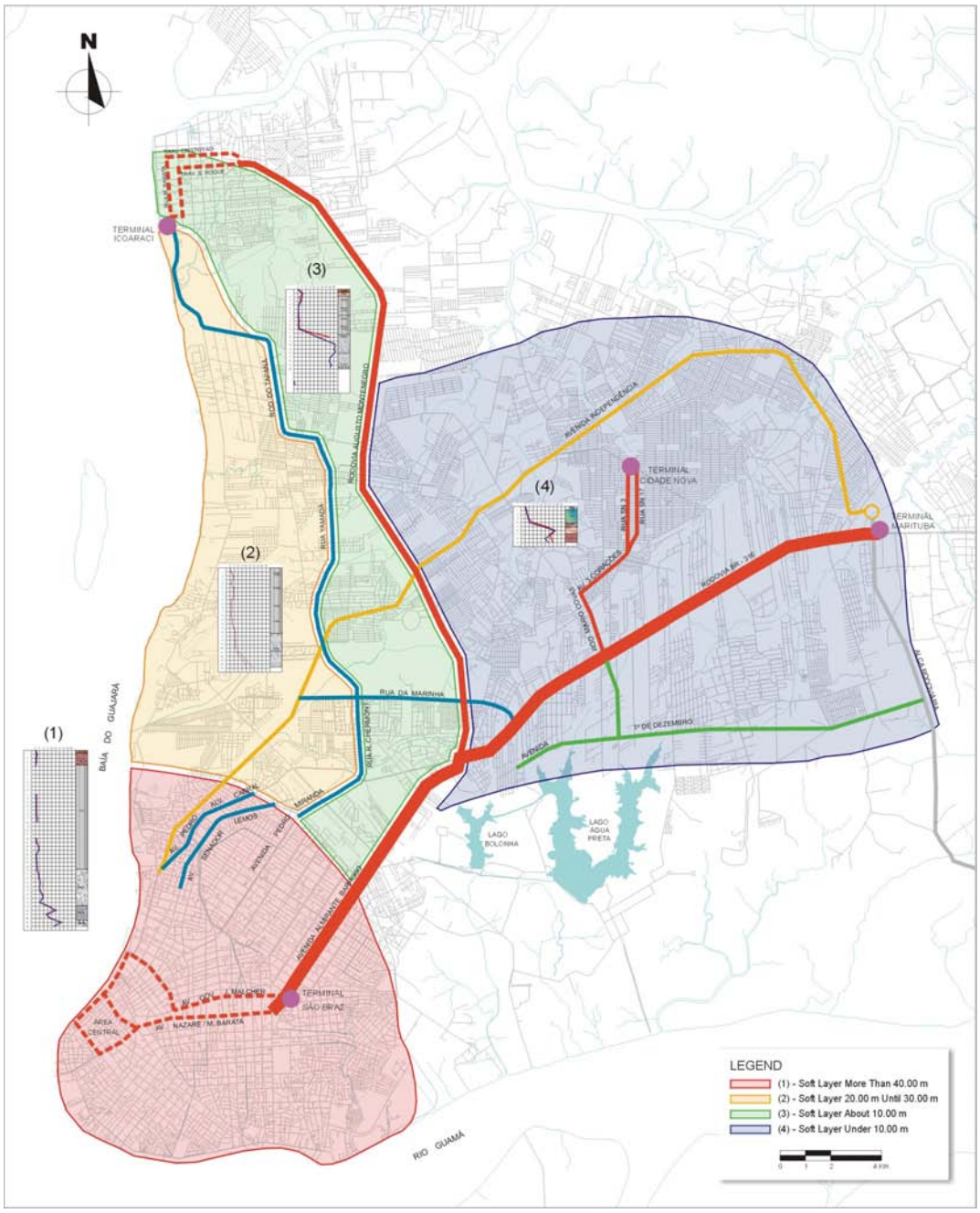


Figure 2.2-1 Geological Conditions in Belem Municipality

2.3. NATURAL CONDITIONS

2.3.1. RAINFALL AND OTHER METEOROLOGICAL DATA

There are three meteorological stations of the Ministry of Agriculture that measure and record the rainfall around Belem Municipality (See Table 2.3-1). Besides these three federal stations, the Belem Airport Authority measures and records wind (blowing direction and magnitude). SECTAM started recording daily rainfall data (9:00 a.m.) in 2000 [SECTAM, personal communication, 2002]. Table 2.3-2 summarizes the monthly rainfall measured at the Meteorological Institute of the Ministry of Agriculture (Latitude 01° 28' S, Longitude 48° 27' W).

Table 2.3-1 Meteorological Stations

	Name & Location	Parameters	Measurement Periods
1	INMET, MoA Latitude 01° 27' S Longitude 48° 30' W	Rainfall	1961 - Present
		Temperature	1961 - Present
		Relative Humidity	1961 - Present
		Evaporation	Unknown
		Atmospheric Pressure	Unknown
		Wind (<10.0 m/s)	Unknown
2	INMET, MoA Latitude 01° 28' S Longitude 48° 27' W	Rainfall	1967 - Present
		Temperature	Unknown
		Relative Humidity	Unknown
		Evaporation	Unknown
		Atmospheric Pressure	Unknown
		Wind (<10.0 m/s)	Unknown
3	INMET, MoA EMBRAPA @ Latitude 01° 27' S Longitude 48° 28' W	Rainfall	Unknown
		Temperature	Unknown
		Relative Humidity	Unknown
		Evaporation	Unknown
		Atmospheric Pressure	Unknown
		Wind (<10.0 m/s)	Unknown
4	SECTAM	Rainfall	2000 - Present
5	Belem Airport Val-de-Caes Airport	Rainfall	Unknown
		Temperature	Unknown
		Relative Humidity	Unknown
		Evaporation	Unknown
		Atmospheric Pressure	Unknown
		Wind	Unknown

NOTE: INMET: METEOROLOGICAL INSTITUTE, MOA: MINISTRY OF AGRICULTURE

Table 2.3-2 1981 - 1990 Rainfall Data (INMET, MoA, Latitude 01° 28' S, Longitude 48° 27' W)

	1	2	3	4	5	6	7	8	9	10	11	12
1981	386	776	630	373	205	163	184	151	113	56	146	122
1982	367	407	330	342	256	167	81	136	150	127	82	226
1983	468	360	553	389	232	82	136	173	124	280	121	176
1984	356	482	449	481	255	183	170	129	232	129	53	266
1985	316	494	368	240	278	305	139	133	93	17	64	235
1986	273	373	532	442	293	189	232	136	67	168	164	194
1987	399	405	522	510	407	193	213	53	146	81	116	293
1988	418	568	383	354	370	126	131	78	97	76	78	368
1989	324	420	450	212	174	186	179	125	226	100	80	286
1990	322	344	360	251	441	85	245	91	89	131	97	191
Mean	353	440	157	393	294	171	164	125	133	115	118	312

Average annual rainfall = 2,775 mm.

(Source: Technical Report of Alca Rodoviaria Road Construction Project, SETRAN, 1999).

2.3.2. FLOOD CONTROL CONDITIONS

The study area (Belem Metropolitan Area) is located at the mouth of the Guamá River and its topography is flat and very low (57m above sea level in Benevides Municipality). Various-size canals run through the area and flow into the river. Because of these geographical and topographical characteristics, sea influence and also less developed drainage facilities, a flooded area is frequently found in urban areas of Belem Municipality

and in areas below four meters in the Maracaquera River Basin, especially in the rainy season. Therefore, the Macro-Drainage Project, which had been funded by the Para State and IDB, is now being implemented in the Una Basin in the municipality and will be completed soon. This project is aimed at improving the urban environment and people's living environment within the project area by discharging rainwater to nearby canals smoothly and quickly. The main components of this project are improvement of canals, development of a rainwater drainage and sewage system, water supply system development and road improvement.

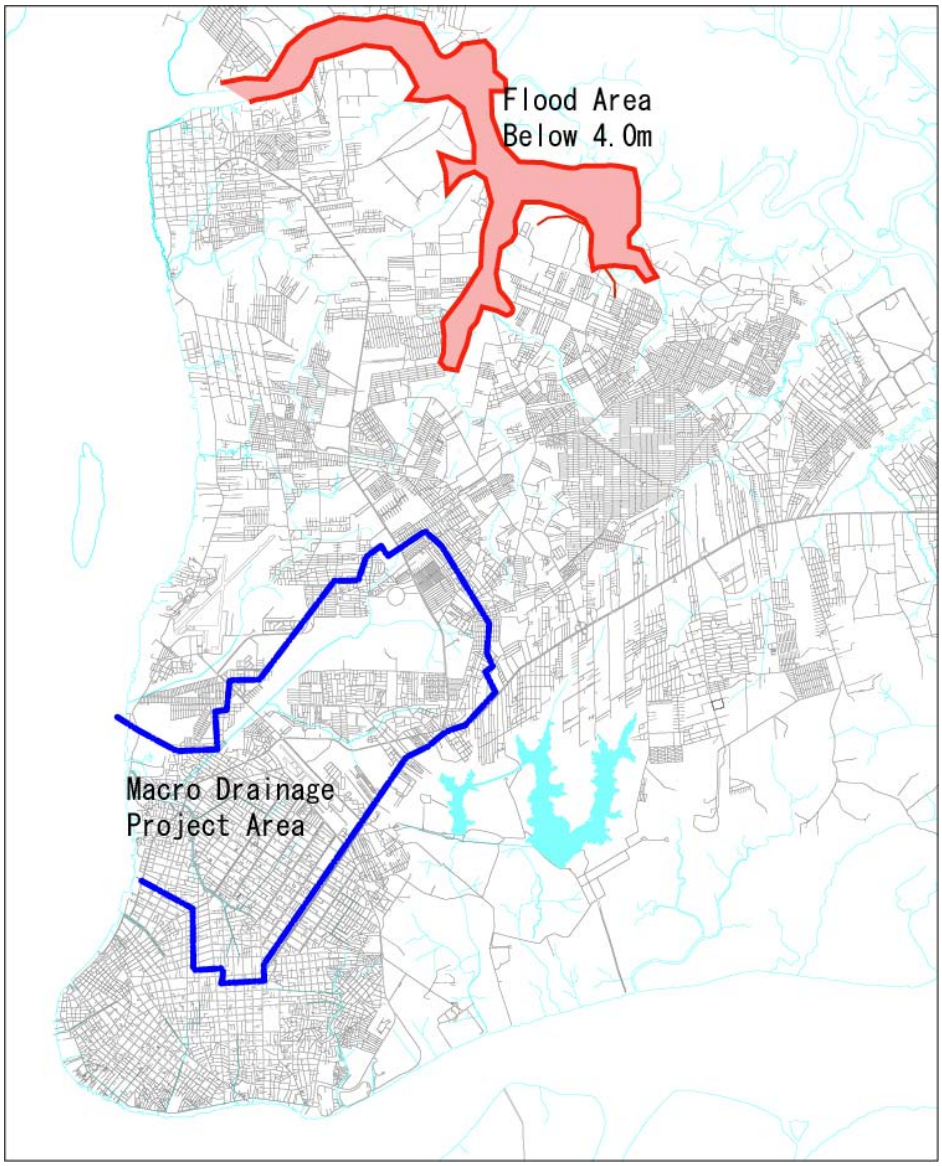


Figure 2.3-1 Flooded Area and Una's Macro-Drainage Project Area

2.3.3. NATURAL DISASTERS AND OTHER PROBLEMS

No severe earthquakes, cyclones or other natural disaster events are reported in the Belem Metropolitan Area [e.g., COHAB, personal communication, 2002]. However, there are other types of relevant social problems that might happen indirectly due to the compound effects of both natural and social conditions of Belem Municipality. Table 2.3-3 summarizes the typical disaster and social problems commonly recognized in Belem Municipality.

Most of the lowland area is highly flood-prone due to the heavy torrential rain in the rainy season, the poor regional drainage system, and/or the significant diurnal tidal movement of the Guama River during the Equinox, as described in the previous section. Usually, these inundation/flood events last a relatively short time, and people in Belem do not regard these events as severe disasters, so no official flood record exists [COHAB, personal communication, 2002].

The spread of epidemic disease around the lowland area is also a major public concern in Belem Municipality, and can be considered as the second impact of frequent regional inundation events. Another problem related with this inundation issue is the outbreak of mosquitoes around the permanently inundated area, which might transmit malaria, yellow fever and dengue.

Fire is also considered as one of the main causes of disasters in some areas. There are many factors that would cause relatively large fires, including the current narrow road network and inadequate location of nearby fire stations.

Table 2.3-3 Typical Problems Recognized in Belem City

	Disaster Events	Comments
1	Floods/inundation.	Poor drainage system and frequent heavy torrential rains.
2	Spread of waterborne epidemic disease	Spread of epidemic disease due to regional inundation and poor sanitary conditions. Following are typical diseases reported in Belem: cholera, typhoid, dysentery, schistosomiasis (swimmer's itch).
3	Spread of malaria/ yellow fever and dengue.	Due to the poor drainage around the lowland area, mosquitoes that might transmit malaria, yellow fever and dengue might multiply in chronically inundated areas (Malaria used to be a serious problem 50 years ago [COHAB, personal communication, 2002]).
4	Fires	1. Old, poorly maintained houses around the Centro Region. 2. Illegal use of electrical equipment. 3. Large percentage of liquefied fuel usage at houses, shops and restaurants. 4. Poor road network system (e.g., narrow streets).