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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

No. 32

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
ON
PAN-PHILIPPINE HIGHWAY REHABILITATION PROJECT
(MINDANAO SECTION)

FINAL REPORT
MAIN TEXT

MAY 1995

KATAHIRA & ENGINEERS INTERNATIONAL
NIPPON ENGINEERING CONSULTANTS CO., LTD.

The exchange rates used in the Study are:

US$ 1.00 = Philippine Pesos 24.10

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P1.00 = Y4.15

(As of December 1994)

Source: Central Bank of the Philippines

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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a feasibility study on Pan-Philippine Highway Rehabilitation Project (Mindanao Section) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Kunihiko Sawano, Katahira & Engineers International, twice between March 1994 to March 1995.

The team held discussions with the officials concerned of the Government of the Philippines, 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 Republic of the Philippines for their close cooperation extended to the team.

May 1995

Kimio Fujita
President
Japan International Cooperation Agency

May 1995

Mr. Kimio Fujita
President,
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the Final Report of the Feasibility Study on Pan-Philippine Highway Rehabilitation Project (Mindanao Section) in the Republic of the Philippines. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the formulation of the above mentioned project.

This report presents the technical, economical and financial results of the feasibility study on the Pan-Philippine Highway rehabilitation project in Mindanao. The project aims to cope with the various problems that the road presently suffers from, and to make the road solid, reliable and comfortable. As a result of the study, the project is concluded to be feasible from every aspect.

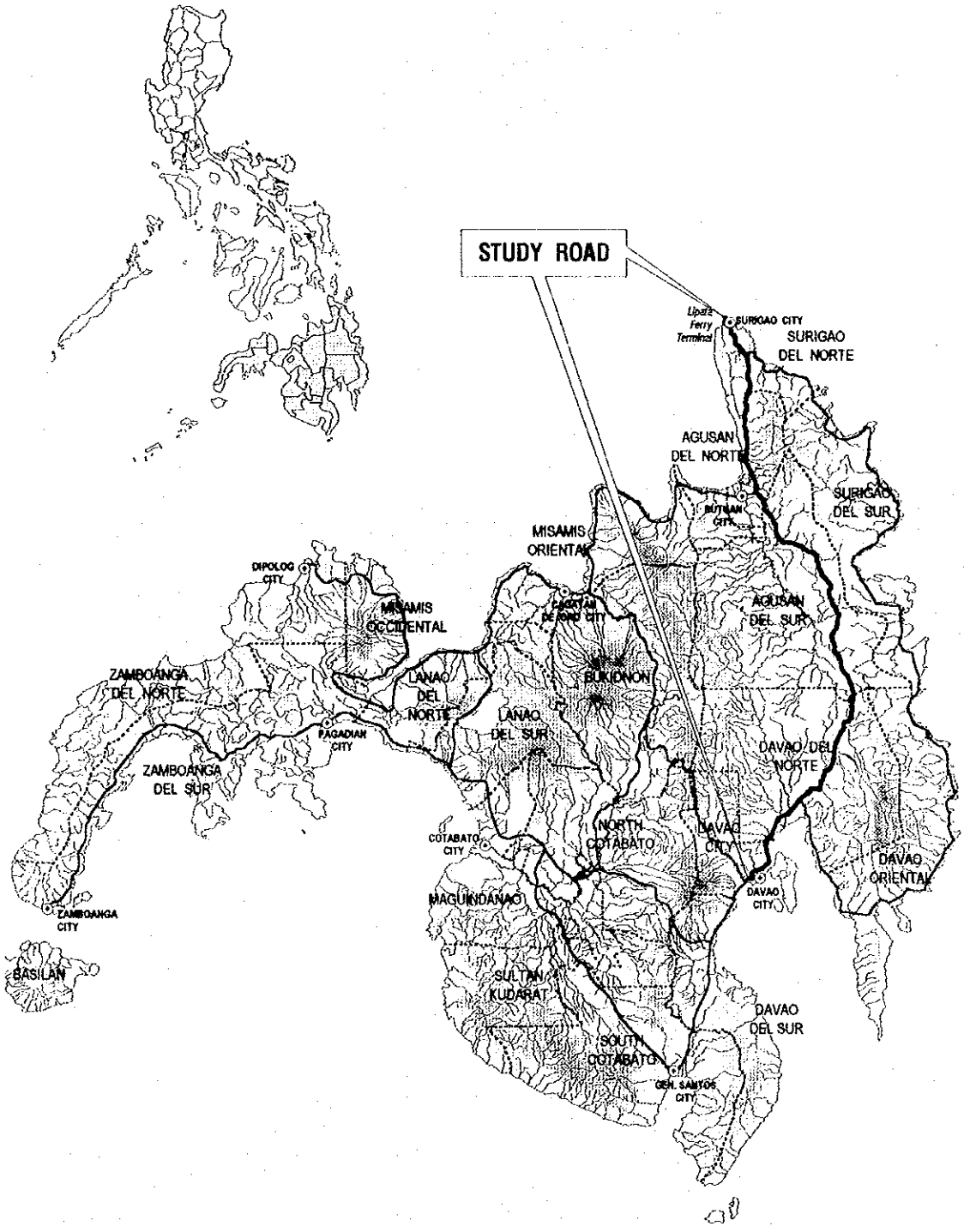
In view of the urgency of rehabilitating the project road which is the only axis in the east Mindanao, and of the need for socio-economic development in Mindanao Island as a whole, we recommend that the Government of the Philippine implement this project as a top priority.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Ministry of Foreign Affairs. We also wish to express our deep gratitude to the Department of Public Works and Highways and other authorities concerned of the Government of the Philippines for the close cooperation and assistance extended to us during our investigations and study.

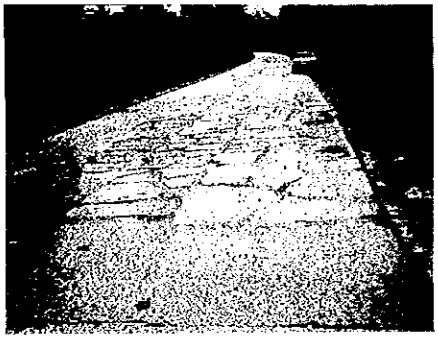
Very truly yours,

Kunihiko Sawano

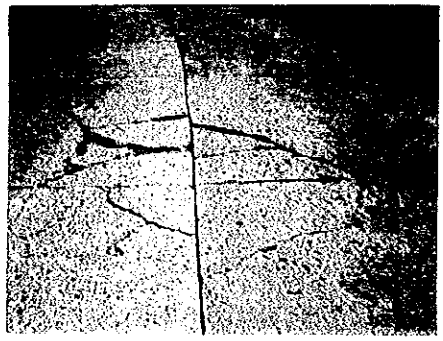
Kunihiko Sawano
Team Leader,
Feasibility Study on Pan-Philippine Highway
Rehabilitation Project (Mindanao Section)



LOCATION MAP



TOTALLY DESTROYED PAVEMENT IN AGUSAN DEL SUR

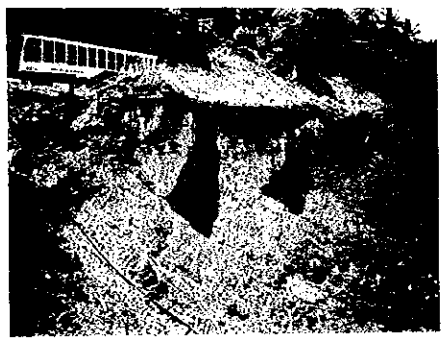


TYPICAL PAVEMENT CRACKS IN DAVAO DEL NORTE

PANAYTAY BRIDGE: SUPERSTRUCTURE NO LONGER FUNCTIONING

LIBOGANON BRIDGE: SUFFERING FROM PIER SETTLEMENT

CUT SLOPE FAILURE IN SURIGAO DEL NORTE



EMBANKMENT SLOPE FAILURE IN DAVAO DEL NORTE

FLOOD SECTION IN AGUSAN DEL NORTE. OVERFLOWED WATER FROM THE RIVER FLOODED THE HIGHWAY.

FLOOD SECTION NEAR LIBOGANON BRIDGE IN DAVAO DEL NORTE. THE SECTION SUBMERGED 3 HOURS AFTER THIS PHOTO WAS TAKEN.

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ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AC	:	Asphalt Concrete
ACEL	:	Associated Construction Equipment Lessors, Inc.
ADB	:	Asian Development Bank
ADT	:	Average Daily Traffic
ARMM	:	Autonomous Region for Muslim Mindanao
AWP	:	Annual Work Program
B/C	:	Benefit/Cost
BOE	:	Bureau of Equipment
BOM	:	Bureau of Maintenance
CAR	:	Cordillera Autonomous Region
CBR	:	California Bearing Ratio
CEO	:	City Engineering Office
DEO	:	District Engineering Office
DENR	:	Department of Environment and Natural Resources
DPWH	:	Department of Public Works and Highways
ECA	:	Environmentally Critical Area
ECC	:	Environmental Compliance Certificate
ECP	:	Environmentally Critical Project
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact System
EMB	:	Environmental Management Bureau
EMK	:	Equivalent Maintenance Kilometer
EO	:	Executive Order
ESAL	:	Equivalent Single Axle Load
FWD	:	Falling Weight Deflectometer
FYB	:	First Year Benefit
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GOJ	:	Government of Japan
GOP	:	Government of the Philippines
GPDP	:	Gross Provincial Domestic Product
GRDP	:	Gross Regional Domestic Product
GVA	:	Gross Value Added
HCM	:	Highway Capacity Manual
IACEP	:	Inter-Agency Committee on Environmental Protection
IBRD	:	International Bank for Reconstruction and Development
IEE	:	Initial Environmental Examination
IRI	:	International Roughness Index
IRF	:	Immediate Response Fund
IRR	:	Internal Rate of Return
JICA	:	Japan International Cooperation Agency
LOI	:	Letter of Instruction
LTO	:	Land Transportation Office
MBA	:	Maintenance By Administration
MBC	:	Maintenance By Contract
MTPDP	:	Medium Term Philippine Development Plan

MTPIP	:	Medium Term Public Investment Program
NCR	:	National Capital Region
NCSO	:	National Census and Statistical Office
NDT	:	Non-Destructive Test
NEDA	:	National Economic and Development Authority
NEPC	:	National Environmental Protection Council
NIA	:	National Irrigation Administration
NPV	:	Net Present Value
NRR	:	Net Reproduction Rate
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistics Office
NTCP	:	National Traffic Count Program
OD	:	Origin-Destination
OECF	:	Overseas Economic Cooperation Fund
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PB	:	Performance Budget
PCC	:	Portland Cement Concrete
PCDG	:	Prestressed Concrete Deck Girder
PD	:	Philippine Description
P.D.	:	Presidential Decree
PHIVOLCS	:	Philippine Institute of Volcanology and Seismology
PHMMS	:	Philippine Highway Maintenance Management System
PPP	:	Philippine Population Projection
PSI	:	Present Serviceability Index
PSR	:	Present Serviceability Rating
RCBC	:	Reinforced Concrete Box Culvert
RCDG	:	Reinforced Concrete Deck Girder
RCPC	:	Reinforced Concrete Pipe Culvert
RES	:	Reinforced Equipment Service
ROW	:	Right-of-way
RRI	:	Rehabilitation Requirement Index
RRR	:	Rehabilitation Requirement Rating
SN	:	Structural Number
SPT	:	Standard Penetration Test
VOC	:	Vehicle Operating Cost

INTRODUCTION

INTRODUCTION

BACKGROUND OF THE STUDY

In the Philippines, the needs for road development were rapidly raised in the late 1960's due to economic growth attended with rapid motorization. To meet the needs, the Government of the Philippines pursued the systematic development of road network from the late 1960's through the early 1980's. In this period, more attention was paid to and most investment was put for the expansion of roads laying aside the qualitative considerations.

Since the middle 1980's when the quantitative expansion of roads was by-and-large attained, the quality of roads has become a matter of primary concern. Especially with the Luzon earthquake in 1990 and the Mt. Pinatubo eruption in 1991 as momenta, the demand of the roads reliable and resistant to natural calamities was raised. Since the trunk roads constructed on or before 1970's are being deteriorated resulting in aggravation of riding quality and rise of transport cost, the rehabilitation of such roads has become a key issue. Thus, the road development in the Philippines is now in the stage of pursuing qualitative improvement after the lapse of the stage of quantitative expansion.

The Pan-Philippine Highway is the most important trunkline in the country's road network running through the four major islands of Luzon, Samar, Leyte and Mindanao with a total length of 2,100 km. The construction of the Highway, which was then a long-cherished desire of the country to attain the national targets such as regional development, industrial growth, preservation of peace and order, national unification, etc., was started in 1969 and completed in 1979.

Now, in 16 to 25 years after opening to traffic, the Pan-Philippine Highway suffers various problems such as progress of pavement deterioration, repeated slope failures in the mountainous areas, damage of bridges and so on.

To cope with the said problems, the Government of the Republic of the Philippines (GOP) conducted the following studies with technical assistance provided by the Japan International Cooperation Agency (JICA):

- Feasibility Study of Philippine Road Disaster Prevention Project, June 1984
- Feasibility Study of Philippine Road Disaster Prevention Project, Stage II, July 1985
- Feasibility Study of the Road Improvement Project on the Pan-Philippine Highway, September 1987
- Feasibility Study on Rehabilitation and Maintenance of Bridges along Arterial Roads, June 1989

These studies cover the Luzon, Samar and Leyte sections of the Pan-Philippine Highway and the rehabilitation projects formulated therein are now being implemented.

Mainly for the reason of peace and order problem, rehabilitation of Mindanao section of the Highway, however, has been left behind although it is of urgent necessity to promote the development of Mindanao. Now in the restoration of peace, GOP has decided to start the rehabilitation of the Mindanao section of the Highway and sought a technical assistance from the Government of Japan (GOJ) for the conduct of the **FEASIBILITY STUDY ON PAN-PHILIPPINE HIGHWAY REHABILITATION PROJECT** (MINDANAO SECTION) (the Study).

In response to the request of GOP, GOJ decided to conduct the Study. JICA, which is the official agency responsible for the implementation of GOJ technical cooperation programs, organized a study team to be engaged in the Study. The JICA Study team, in close collaboration with the DPWH Counterpart team, commenced work in March 1994.

OBJECTIVES OF THE STUDY

The objectives of the Study are:

(1) To identify problem sections and spots along the Pan-Philippine Highway in Mindanao; and
(2) To conduct a feasibility study for the Highway rehabilitation.

STUDY ROAD

The study road is the Pan-Philippine Highway from Lipata Ferry Terminal (km. 1,113+397) up to the end of and including Davao City Diversion Road (km. 1,515+949).

SCOPE OF THE STUDY

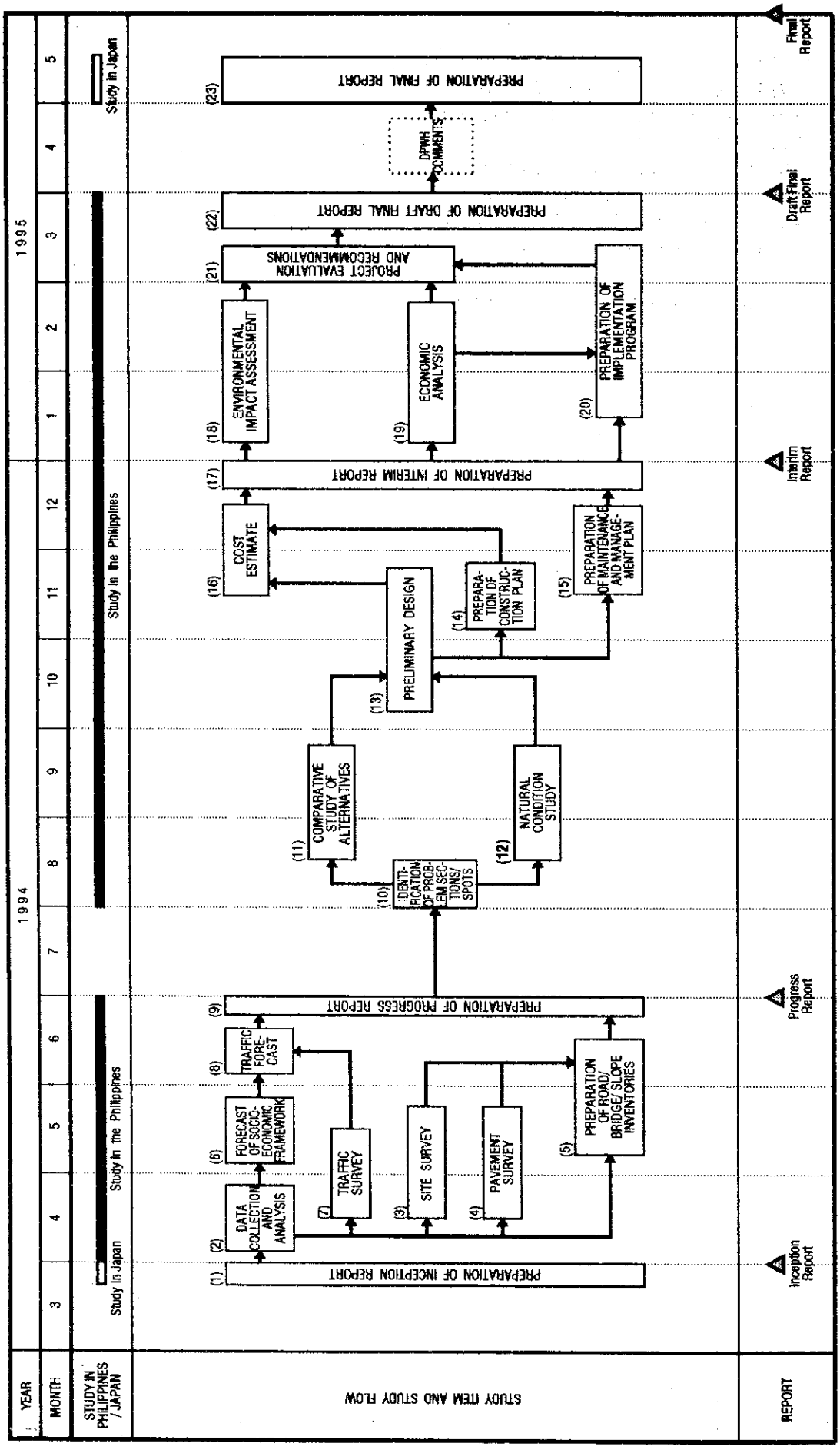
The Study covers the following items:

(1) Preparation of Inception Report
(2) Data Collection and Analysis
(3) Site Survey
(4) Pavement Survey
(5) Preparation of Road/Bridge/Slope Inventories
(6) Forecast of Socio-Economic Framework
(7) Traffic Survey
(8) Traffic Forecast
(9) Preparation of Progress Report
(10) Identification of Problem Sections/Spots
(11) Comparative Study of Alternatives
(12) Natural Condition Study
(13) Preliminary Design
(14) Preparation of Construction Plan
(15) Preparation of Maintenance and Management Plan

(16) Cost Estimate
(17) Preparation of Interim Report
(18) Environmental Impact Assessment
(19) Economic Analysis
(20) Preparation of Implementation Program
(21) Project Evaluation and Recommendations
(22) Preparation of Draft Final Report
(23) Preparation of Final Report

The study flow diagram is presented on the next page.

STUDY FLOW


YEAR
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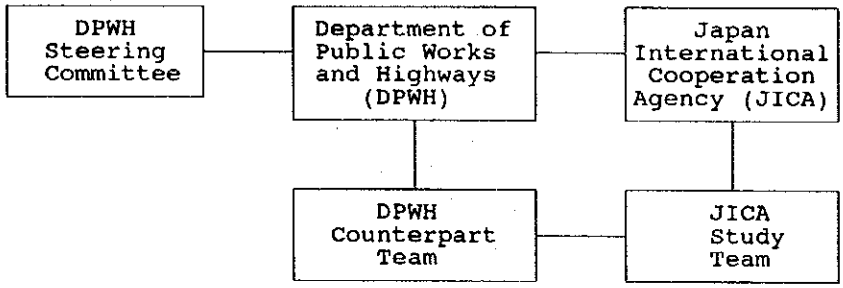
STUDY IN PHILIPPINES / JAPAN
Study in Japan
Study in the Philippines
Study in the Philippines
Study in Japan
STUDY ITEM AND STUDY FLOW
REPORT
Inception Report
Progress Report
Interim Report
Draft Final Report
Final Report
(1) PREPARATION OF INCEPTION REPORT
(2) DATA COLLECTION AND ANALYSIS
(3) SITE SURVEY
(4) PAVEMENT SURVEY
(5) PREPARATION OF ROAD/ BRIDGE/ SLOPE INVENTORIES
(6) FORECAST OF SOCIO-ECONOMIC FRAMEWORK
(7) TRAFFIC SURVEY
(8) TRAFFIC FORE-CAST
(9) PREPARATION OF PROGRESS REPORT
(10) IDENTI-FICATION OF PROB-LEM SEC-TIONS/ SPOTS
(11) COMPARATIVE STUDY OF ALTERNATIVES
(12) NATURAL CONDITION STUDY
(13) PRELIMINARY DESIGN
(14) PREPARA-TION OF CONSTRUC-TION PLAN
(15) PREPARATION OF MAINTENANCE AND MANAGE-MENT PLAN
(16) COST ESTIMATE
(17) PREPARATION OF INTERIM REPORT
(18) ENVIRONMENTAL IMPACT ASSESSMENT
(19) ECONOMIC ANALYSIS
(20) PREPARATION OF IMPLEMENTATION PROGRAM
(21) PROJECT EVALUATION AND RECOMMENDATIONS
(22) PREPARATION OF DRAFT FINAL REPORT
DPWH COMMENTS
(23) PREPARATION OF FINAL REPORT

ORGANIZATION OF THE STUDY

The Study is undertaken jointly by the JICA Study team and the DPWH Counterpart team under the guidance of the DPWH Steering Committee. The organization chart is shown below.



ORGANIZATION CHART

The members participating in the Study are as follows:

DPWH Steering Committee

Chairman	:	TEODORO T. ENCARNACION Undersecretary
Member	:	MANUEL M. BONOAN Assistant Secretary
Member	:	BIENVENIDO LEUTERIO Director, Bureau of Design
Member	:	CLARITA BANDONILLO Director, Bureau of Construction
Member	:	LUISITO S. VISORDE Director, Bureau of Maintenance
Member	:	DOMINADOR Y. SANTOS Director, PMO-PJHL
Member	:	JOSE P. GLORIA Project Manager III, PMO-FS
Member	:	JUAN LUALHATI Director, Planning Service
Member	:	YUKIHIRO TSUKADA JICA Adviser for Highway Engineering

DPWH Counterpart Team

Team Leader	: GERONIMO S. ALONZO
Project Coordinator	: JUANITO R. ALAMAR
Highway Engineers	: GENEROSO S. ALCONIS CORAZON E. ARCETA ELIZABETH C. LLANERA ARTURO M. FLORES

Structural Engineer	: ANTONIO M. YAPTANGCO
Geological Engineer	: MARIETTA T. VELASCO
Traffic Engineers	: FAUSTINO N. STA. MARIA,JR.
	CESARIO VICENTE
Economists	: VICTORIA A. CORPUZ
	EDGAR D. FABREGAS
Cost Estimator	: SHIRLEY CASTRO
Computer Programmer	: RODELITO R. BAGNAS
Economic Researchers	: ROSEMARIE B. DEL ROSARIO
	DOLORES M. VILORIA
	LALAINE MALASSAB
	GLORIA MALINIT
Draftsmen	: ROMEO NAUNGAYAN
	ALEX CUBELO
	ANTONIO VALENZUELA
Engineering Assistants	: CASAN BUSRAN
	ANGELITO M. CAYANAN
	REMEGIO B. CALEZE
Secretary/Bookkeeper	: MA. LOURDES R. SANTOS
Wordprocessors/Typists	: JASMIN C. FIGUERAS
	ESPERANZA A. AGUSTIN
Xerox Machine Operator	: RICARDO TING
	DANTE ZAMORA

JICA Study Team

Team Leader/Highway Planner	: KUNIHIKO SAWANO
Deputy Team Leader/Highway Engineer	: MITSUO HATAKEYAMA
Structural Engineer	: AL HILER
Geological Engineer	: RYOZO NIIYA (Mar. 1994-Jul. 1994)
	: KOKICHI TERAI (Aug. 1994-May 1995)
Hydrological Engineer	: TAKAO MITSUISHI
Environmentalist	: KAZUHIRO HASEGAWA
Transport Economist	: TETSUO WAKUI
Traffic Engineer	: AKIRA TAKAKU

REPORT

The following report were prepared during the Study:

- Inception Report (March 1994)
- Progress Report (June 1994)
- Interim Report (December 1994)
- Draft Final Report (March 1995)

The final report is organized with the following:

- Executive Summary
- Main text
- Appendix
- Drawings

PART I

THE STUDY AREA - PRESENT AND FUTURE

CHAPTER 1

OUTLINE OF THE PAN-PHILIPPINE HIGHWAY

1.1 HISTORY OF CONSTRUCTION

For the Philippines being an archipelagic and multi-racial nation, the construction of a trunk road running through the major islands such as Luzon, Samar, Leyte and Mindanao was essential and long-cherished to attain the national targets, namely, regional development, industrial growth, preservation of peace and order, national unification, etc. The Pan-Philippine Highway was proposed as such a road functioning as an artery interconnecting Cagayan, Bicol, eastern Visayas and eastern Mindanao regions and linking them to the commerce and industry area in central Luzon with Metro Manila being a huge consumption area in order to promote the industrial development in the said regions and to secure peace and order in the problematic areas like the north Luzon and the east Mindanao.

The Pan-Philippine Highway construction plan was initially formulated in 1966. The original plan was a construction of 3,480 km long road from Laoag City in the north Luzon to Zamboanga City in the southwest Mindanao, including improvement/upgrading of 2,503 km existing road, new construction of 488 km road, construction/replacement of 450 bridges and construction of 2 ferry routes.

Of the planned road, the section from Aparri to Davao City with a length of about 2,100 km was selected as Phase 1 of the Pan-Philippine Highway construction project and its construction was started in 1969 with financial assistance from Japan. The major components of the Phase 1 were pavement construction of road sections of 1,481 km in total length (796 km in Luzon Island, 246 km in Samar Island, 159 km in Leyte Island and 280 km in Mindanao Island) and construction of 234 bridges and 2 ferry routes. The project was divided into many small contract segments with lengths varying from 2 km to over 10 km and the construction was undertaken by local contractors mostly of smaller class. The completion years by section (the Highway is divided into 4 sections and each section is named as shown below, see Figure 1.3-1) are as follows:

- Cagayan Valley Road (Luzon section, north of Manila) : 1979
- Manila South Road (Luzon section, south of Manila) : 1978
- Samar Leyte Road (Samar and Leyte section) : 1979
- Surigao-Davao Road (Mindanao section) : 1978

The Pan-Philippine Highway is bynamed Philippines-Japan Friendship Highway because of Japan's participation in financing.

After the completion of the Phase 1, the section from Laoag City to Allacapan with a length of about 210 km was planned to be improved as the Phase 2 of the Philippines-Japan Friendship Highway. This section branches off from the

Phase 1 road at the south of Aparri and is connected to Manila South Road at Laoag City. The construction of this section was started in 1982 and completed in 1994.

1.2 STANDARDS AND STRUCTURE OF THE HIGHWAY

Geometric Standards

Table 1.2-1 shows the geometric standards of the Pan-Philippine Highway and Figure 1.2-1 shows the typical cross-section.

TABLE 1.2-1 GEOMETRIC STANDARDS OF THE PAN-PHILIPPINE HIGHWAY

	Terrain		
	Flat	Rolling	Mountainous
Design Speed (km/h)	80-100	60-80	40-60
No. of Lanes	2	2	2
Carriageway Width (m)	6.7	6.7	6.7
Shoulder Width (m)	2.5	2.5	1.0
Minimum Radius (m)	220-350	120-220	50-120
Maximum Grade (%)	4-3	5-4	7-6

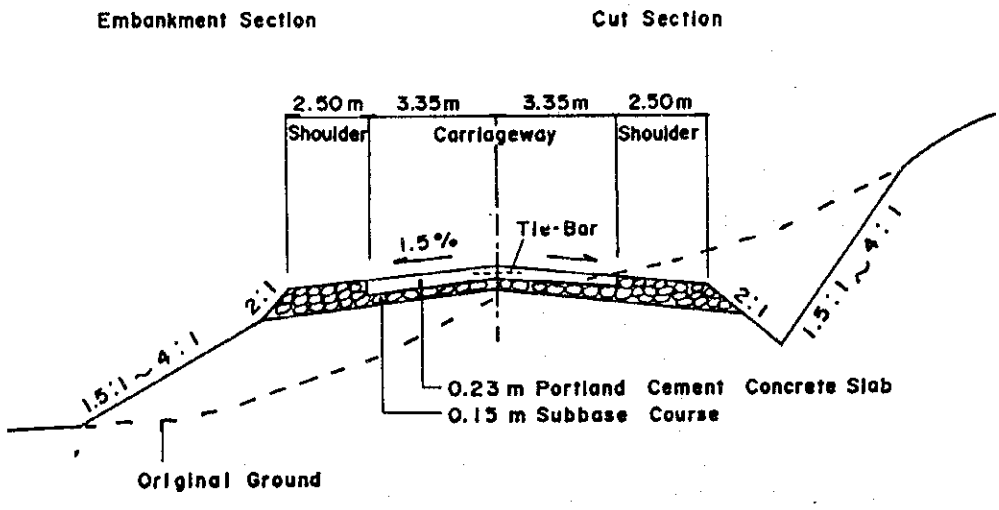


FIGURE 1.2-1 TYPICAL CROSS SECTION OF THE PAN-PHILIPPINE HIGHWAY

Pavement

Initially, about 60% of Aparri-Davao Section was planned to be paved with portland cement concrete and about 40% with asphalt concrete. Afterwards, the pavement design was changed and portland cement concrete pavement was applied to almost all sections. Major reasons of the change were that 1) portland cement is local product while asphalt is imports, 2) producing capacity of aggregate for asphalt concrete is insufficient, and 3) quality control of asphalt concrete is more difficult.

Standard pavement structure is placement of portland cement concrete slab of 23 cm. in thickness on 15-20 cm. thick subbase course.

Bridge

Concrete girder bridges, steel I beam bridges, steel truss bridges, etc. were constructed. Standard width of carriageway was 7.3m and design load was 20 tons. However, considerable number of old bridges constructed on or before 1960's exist especially in Mindanao section of the Highway. Those old bridges were designed for a loading capacity of 14 tons.

1.3 ROLE OF THE HIGHWAY

Figure 1.3-1 shows the national arterial road network established by the Department of Public Works and Highways (DPWH) as a target trunk road network of the country which are composed of the north-south backbone, east-west laterals and other roads of strategic importance. In the network, the Pan-Philippine Highway is the most important component forming a major part of the north-south backbone.

In the north Luzon, the Pan-Philippine Highway, together with Manila North Road, forms axes from which many roads branch off. In the south Luzon, the Highway is the only axis. In Samar, the Highway is an axis covering the western coast and only one reliable axis in the island until the completion of the eastern coast road. In Leyte, the Highway serves as an eastern coast axis while West Leyte Road as western coast axis. However, West Leyte Road is partly substandard. In the east Mindanao, the Highway is the only axis connecting Surigao City and Davao City since the east coast road is incomplete. Thus, the Pan-Philippine Highway provides, in most sections, the only access to the regions traversed by the Highway. If it becomes impassable at any portion, the related regions will be isolated. The Highway is a life line of the socio-economic activities of the Philippine nation.

1.4 REHABILITATION OF THE HIGHWAY

Now, in 16 years after its completion, the Highway suffers various structural problems such as progress of pavement deterioration, damage of bridges, slope failures in the mountainous sections and so on as well as functional

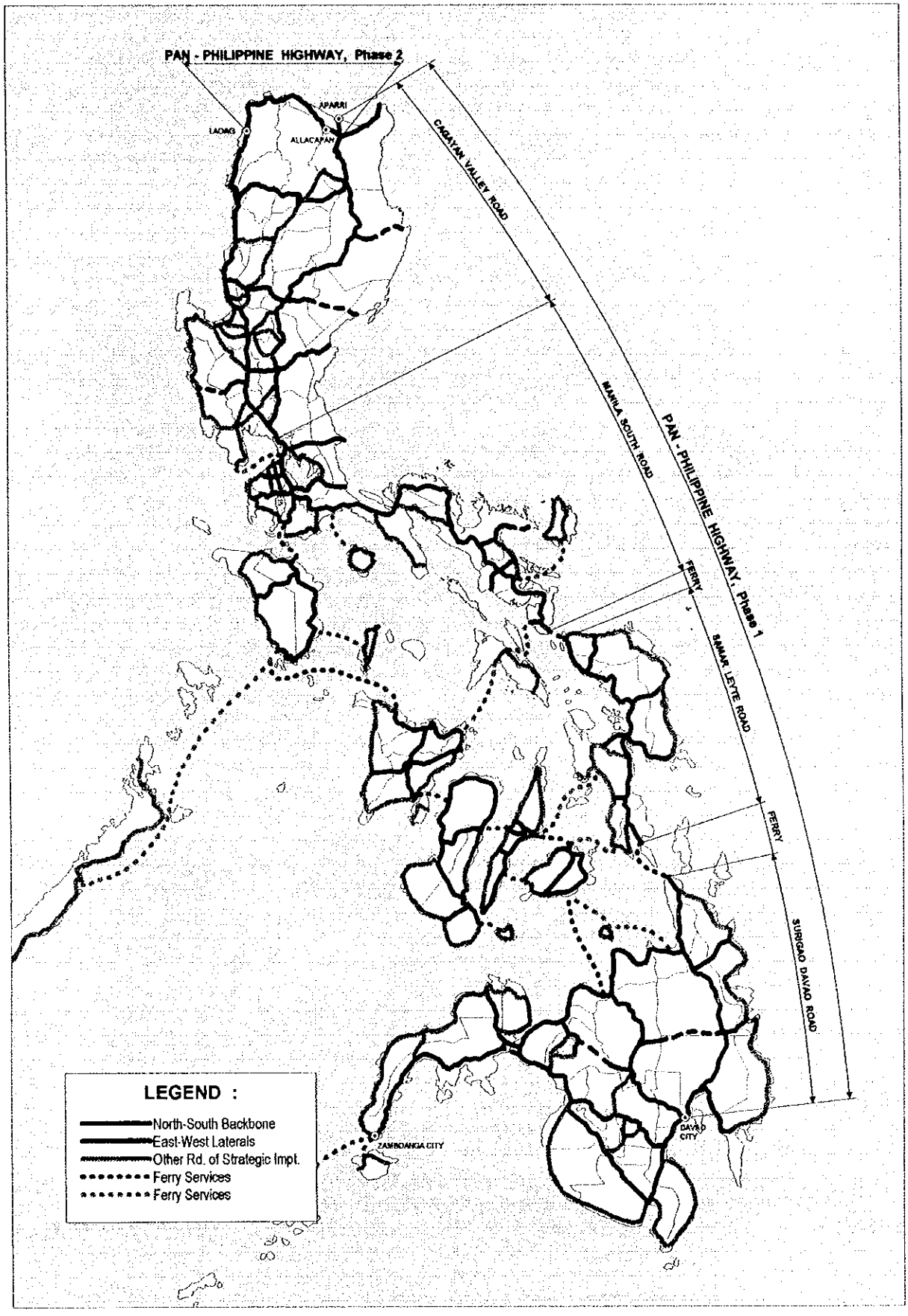


FIGURE 1.3-1 NATIONAL ARTERIAL ROAD NETWORK

problems like traffic congestion in the urban sections. This situation is attributed to the following factors:

- The pressing need at the time of construction was to complete the whole section as soon as possible within the limited budget appropriable under the economic condition then, having no allowance for taking perfect slope protection measures, constructing bridges to withstand the fluctuating rivers and the like.

- Rapid motorization after the completion of the Highway with the economic development resulted in remarkable traffic growth and passage of overloaded vehicles.

- Maintenance operation was insufficient and improper. Especially for pavement, it is often found that its service life passed without proper rehabilitation which would have effectively prolonged the life if carried out timely.

- Technology of investigation, design and construction was not on a high level at the time of construction.

- The Highway is situated in the severe natural environment such as steep topography, fragile geology, heavy rain, etc. and often hit by natural calamities like typhoons, earthquakes and volcanic eruptions.

In view of this situation, several feasibility studies on the rehabilitation of the Highway were conducted with technical assistance provided by the Japan International Cooperation Agency (JICA) and according to the findings of those studies, the rehabilitation projects are now being implemented with financial assistance from the Overseas Economic Cooperation Fund of Japan (OECF).

The JICA assisted feasibility studies are listed in Table 1.4-1 and location of the study sections is shown in Figure 1.4-1.

TABLE 1.4-1 FEASIBILITY STUDIES RELATED TO REHABILITATION OF THE PAN-PHILIPPINE HIGHWAY

Name	Section		Subjects	Period
	Pan-Phil. Highway	Others		
Feasibility Study of Philippine Road Disaster Prevention Project	Aritao - San Jose Mahaplag-Sogod	Kennon Road	Slope Protection	May 1983 - Jun 1984
Feasibility Study of Philippine Road Disaster Prevention Project Stage II	Lucena - Calauag Allen - Calbayog	Naguilian Road	Slope Protection	Sep 1984 - Jul 1985
Feasibility Study of the Road Improvement Project on the Pan-Philippine Highway	Sta. Rita - Aritao Calamba - Calauag		Mitigation of Traffic Congestion Pavement Rehabilitation	May 1986 - Sep 1987
Feasibility Study on Rehabilitation and Maintenance of Bridges Along Arterial Roads	Allacapan - Liloan	Manila North Road (Manila - Laoag)	Bridge Rehabilitation	Nov 1987 - Jun 1989
Feasibility Study on Pan-Philippine Highway Rehabilitation Project (Mindanao Section)	Surigao - Davao		Pavement Rehabilitation Bridge Rehabilitation Slope Protection	Mar 1994 - May 1995

The OECF assisted rehabilitation projects are listed in Table 1.4-2.

TABLE 1.4-2 ON-GOING PROJECTS RELATED TO REHABILITATION OF THE PAN-PHILIPPINE HIGHWAY

Name	Section		Major Works Involved	Period (including Detailed Design)
	Pan-Phil. Highway	Others		
Philippine-Japan Highway Loan Project, Section A	Allacapan-Aritao		Pavement Rehabilitation Bridge Rehabilitation	Apr 1990 - Jan 1996
Philippine-Japan Highway Loan Project, Section B	Aritao-Sta. Rita		Pavement Rehabilitation Bridge Rehabilitation Slope Protection	Feb 1990 - Apr 1996
Philippine-Japan Highway Loan Project, Section C	Calamba - Calauag		Pavement Rehabilitation Bridge Rehabilitation Slope Protection	Mar 1990 - Dec 1996
Disaster Prevention and Rehabilitation Project (Philippine-Japan Friendship Highway and Naguilian Road)	Calamba-Matnog Allen-Calbayog	Naguilian Road	Pavement Rehabilitation Bridge Rehabilitation Slope Protection	Feb 1991 - Nov 1995
Rehabilitation and Maintenance of Bridges along Arterial Roads Project	Allacapan-Liloan	Manila North Road (Manila-Laoag)	Bridge Rehabilitation	Feb 1991 - Sep 1996

In addition to the on-going projects, DPWH has a plan to rehabilitate the whole section of the Highway with financial assistance from OECF. The status and schedule of the rehabilitation projects are shown in Table 1.4-3 and located in Figure 1.4-2.

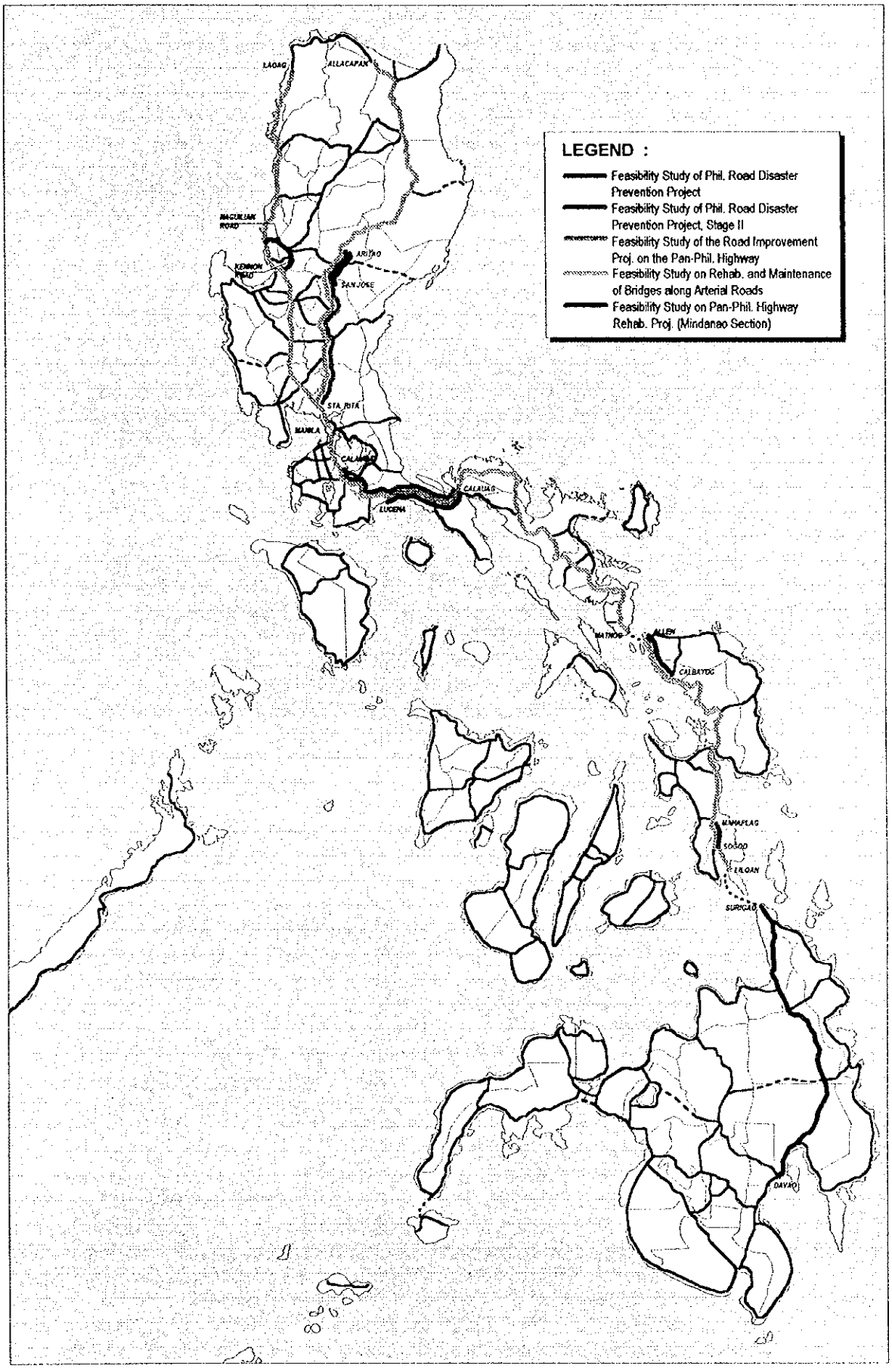
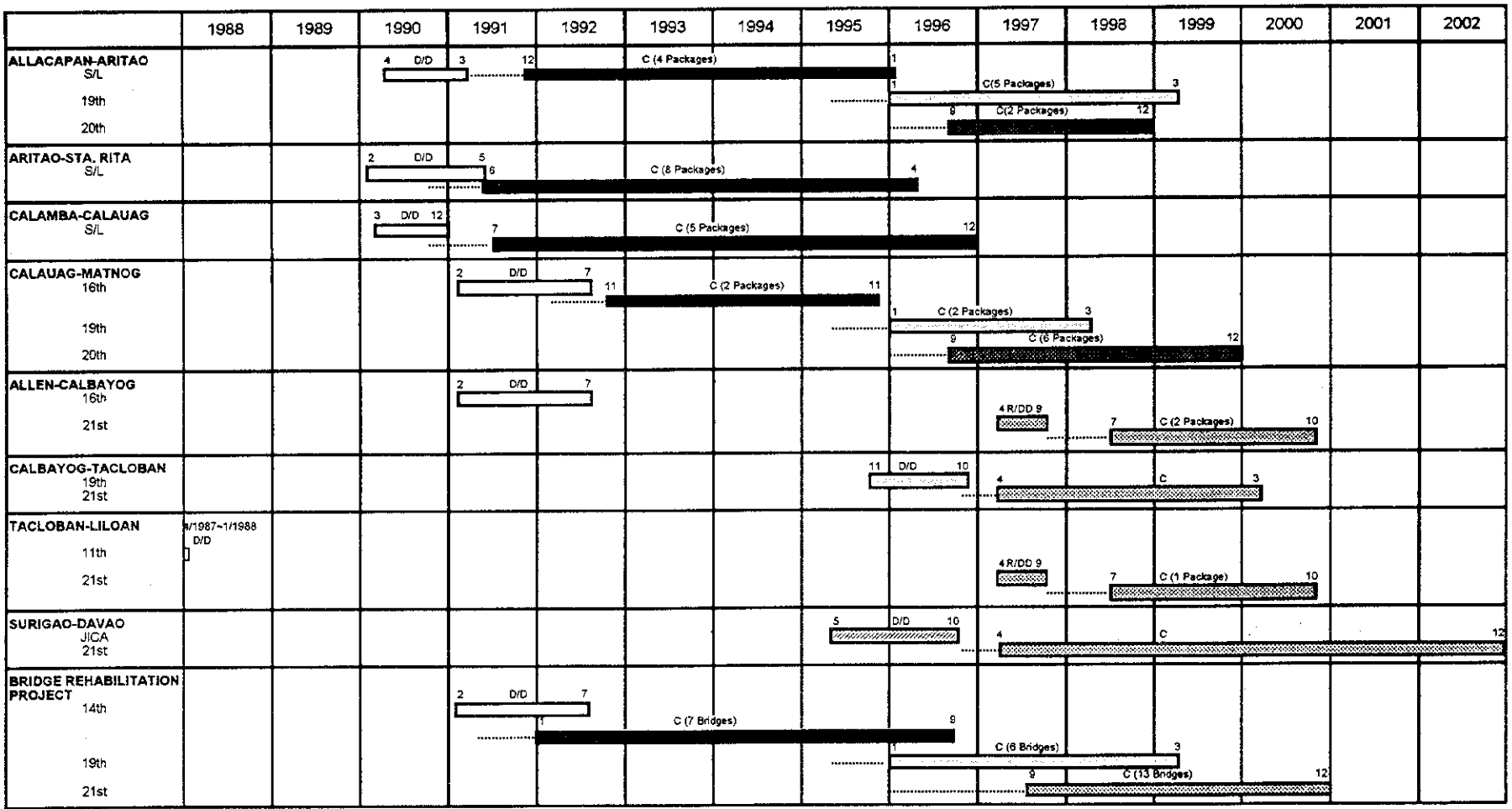


FIGURE 1.4 - 1 FEASIBILITY STUDIES RELATED TO REHABILITATION OF THE PAN-PHILIPPINE HIGHWAY

TABLE 1.4-3 STATUS AND SCHEDULE OF PAN-PHILIPPINE HIGHWAY REHABILITATION PROJECTS

As of December 1994



S/L : Special Loan of Road Rehabilitation
D/D : Detailed Design
R/DD : Review of Detailed Design

..... : Pre-construction (PQ, Bid, Contract)
C : Construction

Previous OECF YCP (Completed/On-going)
19th OECF YCP (Committed)
20th OECF YCP (Proposed)
21st OECF YCP (Proposed)
JICA Technical Assistance (Proposed)

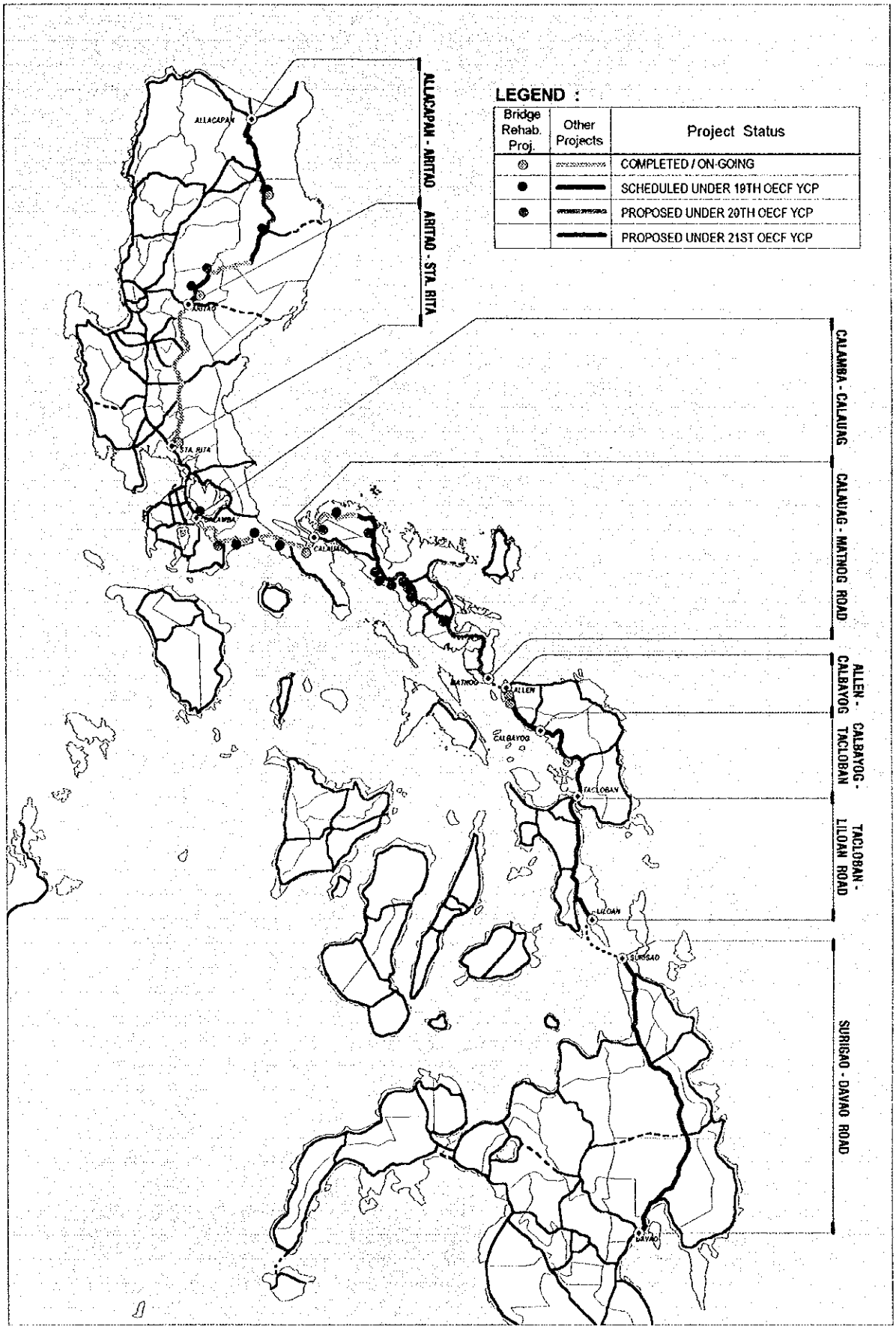


FIGURE 1.4 - 2 PAN-PHILIPPINE HIGHWAY REHABILITATION PROJECTS

CHAPTER 2

PHYSICAL PROFILE OF THE STUDY AREA

2.1 TOPOGRAPHY AND GEOLOGY

2.1.1 Mindanao Island

Topography

The Philippine Archipelago consists of about 7, 100 islands that were formed by orogenic movements and volcanic activities repeated over different geological periods. The islands are divided into three main groups, namely Luzon, Visayas and Mindanao. Luzon is the largest island in terms of land area and is located furthest north. Visayas is composed of Samar, Leyte, Negros, Panay and other islands and is situated between other two groups. Mindanao, the second largest in the country, is located in the south of the archipelago.

The first orogenic movement occurred between late Cretaceous and Palaeogene periods. This constituted metamorphic rocks forming basement complex of the Philippine Archipelago. Later folds and faults caused by the second orogenic movement in middle and late Miocene periods formed the original topographical backbone of the Philippines.

In Mindanao Island, volcanic activities following the third orogenic movement in late Pleistocene formed Matutum Range, Mt. Apo, Mt. Malindag and other volcanoes as well as Bukidnon lava plateau. Since Mindanao Island was formed by uniting some islands, there are coastal plains and terraces formed by upheavals of the land. Height of the terraces ranges from a few meters to 500~600 meters from the sea level. The topographical division of Mindanao Island is shown in Figure 2.1-1.

Geology

Plutonic rocks are found in the eastern mountain ranges, while new effusive rocks lie from north to south with a gird configuration and form the Matutum Range and Mt. Apo. Geology of Bukidnon plateau and the western areas around Lake Lanao is composed of basalt. Mt. Malindang in Zamboanga Peninsula is also formed by new effusive rocks that include basalt.

Sedimentary rocks such as sandstone, mudstone and limestone are found in Matutum Range which is a folding mountain range. After these rock layers were folded in Miocene, they had faults and developed fracture caused by upheavals of the land.

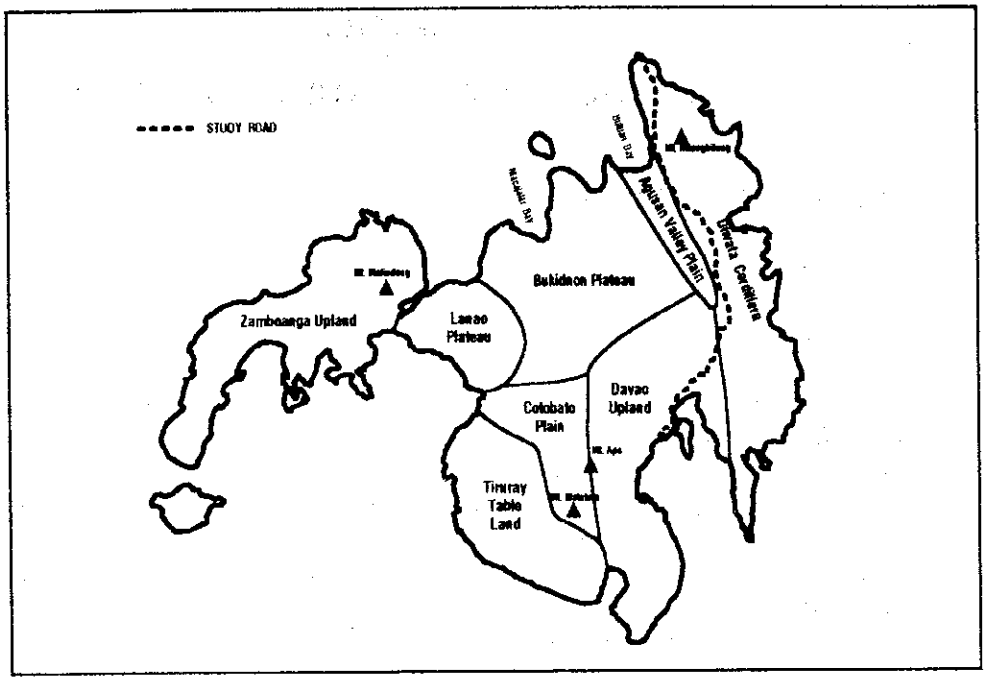


FIGURE 2.1-1 TOPOGRAPHICAL DIVISION OF MINDANAO ISLAND

These faults are parts of the Philippine Fault which runs through the Philippine Archipelago. The Study Road lies almost parallel to the fault, and crosses the fault at the following sections:

- section in mountainous area located about 150 kilometers south of Surigao City, and
- section in mountainous area located about 100 kilometers north-east of Davao City.

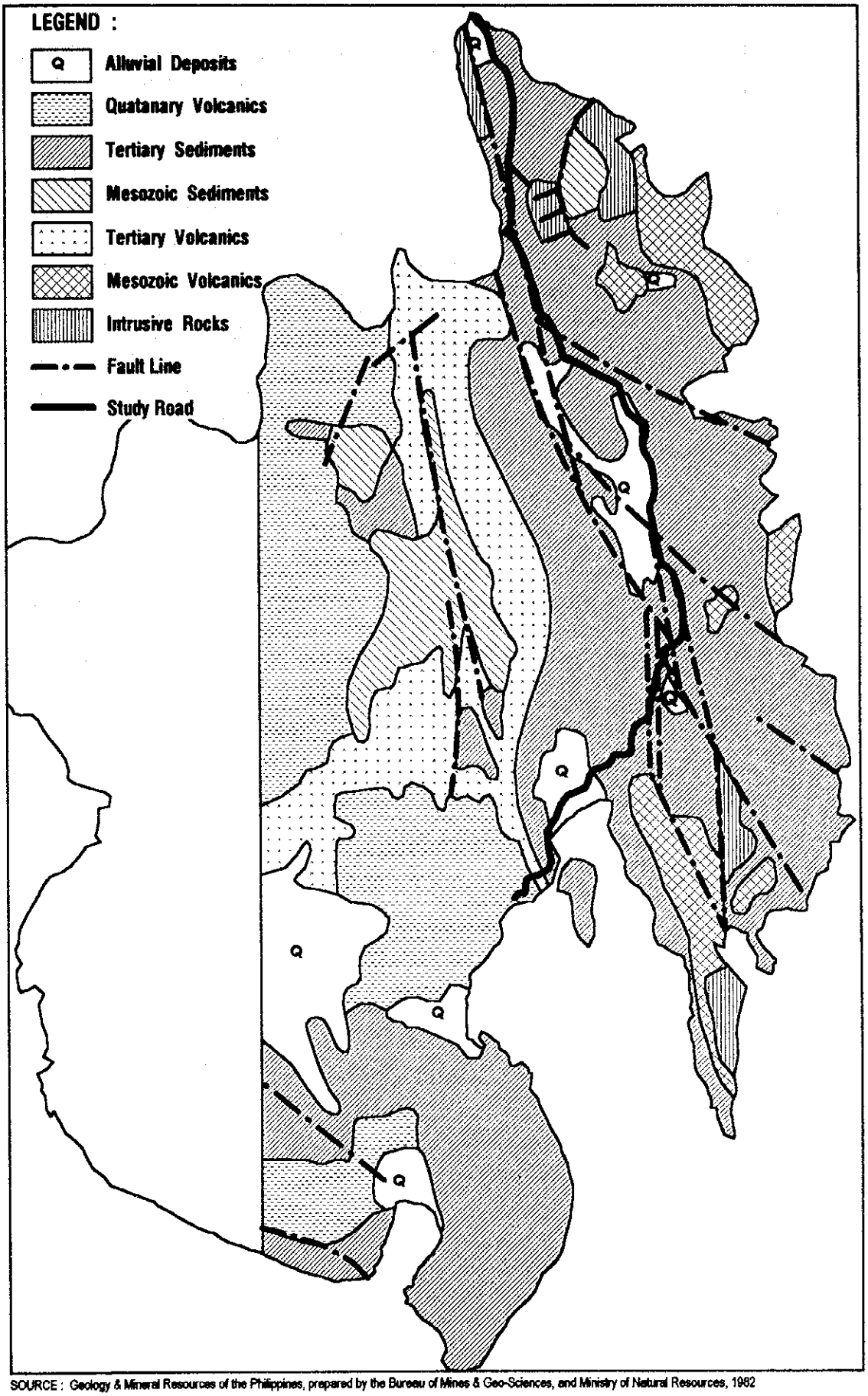
Earthquakes in the Philippines have generally occurred along this fault. The killer quake in the central Luzon on July 16, 1990 as well as the tremor of the 7th degree on the seismic scale in Mindanao Island in February 1990 were also caused by activities of the fault.

2.1.2 The Study Area

Area which the Study Road runs through is divided into the following three areas according to the topographic characteristics; i.e, Diwata Cordillera, Agusan Valley and Davao Upland. Their topographic and geological characteristics are briefly explained as follows (the geology of the Study Area is presented in Figure 2.1-2):

Diwata Cordillera (Sections in Surigao del Norte and Agusan del Norte)

Diwata Cordillera is a slender fold mountain range that is located to the east of Agusan River and runs nearly north to south. In the range, Mt. Hilong-hilong is the highest mountain with an elevation of 1,837 meters above the sea. Diwata Cordillera was formed by the orogenic movement in Miocene period. There are faults and developed fracture zones occurred by upheavals of the land after the fold.



SOURCE : Geology & Mineral Resources of the Philippines, prepared by the Bureau of Mines & Geo-Sciences, and Ministry of Natural Resources, 1982

FIGURE 2.1-2 GEOLOGICAL MAP OF EASTERN MINDANAO ISLAND

Geological composition in areas surrounding Lake Mainit is mainly effusive rocks such as andesites and volcanic ashes. The composition in other areas is mainly sandstone and limestone.

Agusan Valley (Sections in Butuan City and Agusan del Sur)

Agusan Valley is a long vale that is located between Bukidnon Plateau and Diwata Cordillera and extends north and south. It originates in the mountain area east of Davao Gulf, goes up north being fed by many tributaries, and empties into Butuan Bay. Although slopes abutting east on the valley are steep, hill areas which the Study Road runs through hill area which are located on the west of steep slopes. Since the valley lies on a great tectonic line running through the Philippine Archipelago, there are a large number of faults and earthquake centers along the valley. Thus, slopes along the valley are unstable. Geology of the area is mostly composed of Tertiary sandstone and mudstone which are fractured by the faults.

Davao Upland (Sections in Davao del Norte and Davao City)

Davao Upland is a mountainous area lying between Mt. Apo and Agusan River. Mt. Apo is the highest peak in the Philippines with an altitude of 2,954 meters. The lower part of the mountain is formed by pyroclastic rocks, while the upper is composed of andesitic lava. Geological composition of the upland is generally Tertiary or Mesozoic Cretaceous sedimentary rock such as sandstone, mudstone and limestone and effusive rock such as andesite. In the area along the Study Road, Tertiary sandstone, mudstone and limestone are mainly found.

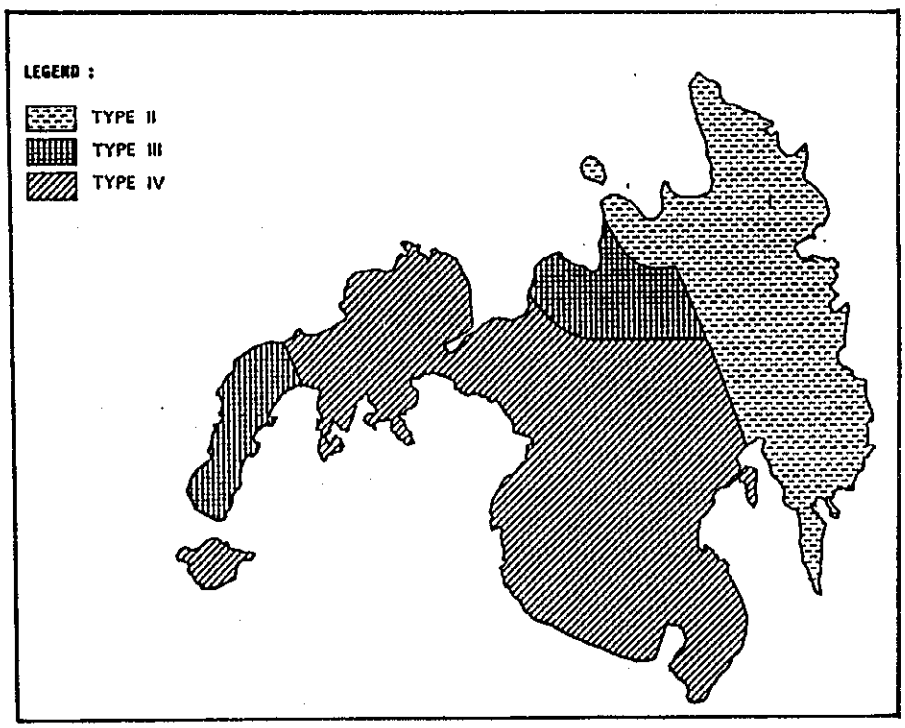
2.2 METEOROLOGY

2.2.1 Climate Type

The climate of the Philippines is classified into four (4) types by PAGASA following Modified Corona's Classification.

Type I. Two pronounced seasons : dry from November to April, wet during the rest of the year.
Type II. No dry season with a very pronounced maximum rainfall from November to January.
Type III. Seasons not very pronounced, relatively dry from November to April and wet during the rest of the year.
Type IV. Rainfall more or less evenly distributed throughout the year.

The geographical distribution of the climate types in Mindanao is shown in Figure 2.2-1. Provinces of Surigao del Norte and Surigao del Sur and part of Agusan del Sur which belong to Type II climate experience significant amount of rainfall between November and April. Remaining areas of Mindanao belong to type III or IV and have evenly distributed rainfall with less amount through the year.



SOURCE: DPWH Infrastructure Atlas, 1988
FIGURE 2.2-1 CLIMATE TYPES

2.2.2 Temperature

Table 2.2-1 shows monthly and annual normal temperature recorded at 11 weather stations in Mindanao. The average annual normal temperature in Mindanao is about 26.9°C. The hottest month is May with 27.8°C and the coldest month is January with 26.0°C.

The seasonal variation of temperature is small with an average annual range of 1.8°C. The maximum temperature reaches 34.0°C while the lowest is 21.7°C.

TABLE 2.2-1 MONTHLY AND ANNUAL NORMAL TEMPERATURE

Unit: Degree Centigrade

Weather Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Butuan City	25.9	26.1	26.8	27.9	28.6	28.0	27.6	28.0	27.7	27.4	27.0	26.3	27.3
Cagayan de Oro	26.3	26.3	26.9	27.9	28.6	28.1	27.8	28.0	27.8	27.7	27.4	26.8	27.5
Cotabato *	26.9	27.2	27.8	28.2	27.9	27.4	27.0	26.9	27.0	27.3	27.2	27.1	27.3
Davao City	26.6	26.7	27.4	28.1	28.1	27.5	27.3	27.4	27.5	27.6	27.6	27.1	27.4
Dipolog	26.9	27.2	27.9	28.7	28.7	28.3	28.0	28.2	28.1	28.0	27.7	27.4	27.9
General Santos	27.4	27.5	28.1	28.4	28.0	27.1	26.7	26.8	26.9	27.2	27.5	27.5	27.4
Hinatuan **	25.5	25.5	25.9	26.6	27.3	27.2	27.2	27.4	27.3	27.1	26.7	26.1	26.7
Lumbia Airport ***	25.2	25.3	26.1	27.0	27.8	27.0	26.4	26.8	26.6	26.4	26.4	25.7	26.4
Malaybalay	23.0	23.1	23.6	24.5	24.9	24.1	23.6	23.7	23.8	23.9	23.9	23.4	23.8
Surigao	25.7	25.7	26.4	27.3	28.1	28.1	27.8	28.1	28.1	27.5	26.8	26.3	27.2
Zamboanga City	27.2	27.2	27.7	28.0	28.1	27.6	27.4	27.5	27.5	27.5	27.5	27.4	27.6
Total Average	26.1	26.2	26.8	27.5	27.8	27.3	27.0	27.2	27.1	27.1	26.9	26.5	26.9

SOURCE: PAGASA, Climatological Normals, 1961-1990

* : 1951-1965 Data
** : 1951-1985 Data
*** : 1976-1985 Data

2.2.3 Wind

Prevailing winds in the Philippines are divided into three groups:

- the **northeast monsoon**, streaming along the easterly and southerly side of the great Asiatic high pressure area.
- the **southwest monsoon** or equatorial air, which pushes its way across the equator from the strong high pressure area of the southern hemisphere.
- the **trade winds** reaching the islands from a generally easterly direction and coming from the tropical high pressure area of the pacific.

The wind direction in the study area is the usual composite of the major air currents, tropical cyclones and local circulations produced by diurnal and topographic effects.

In Surigao City, the prevailing winds are generally from the north east quadrant during November to May, while southwestern wind is prevailing during rest of the year. Davao City has the same tendency as Surigao City with northern winds during October to May and southern winds during rest of the year.

2.2.4 Rainfall

Table 2.2-2 shows the monthly and annual normal rainfall at 11 weather stations in Mindanao recorded from 1961 to 1990. Figure 2.2-2 shows isohyetal map in Mindanao prepared based on the weather records. Provinces in eastern coast of the island which are classified as climate type II exhibit the highest rainfall in the Mindanao island.

Annual Rainfall

Amount of annual rainfall in Mindanao varies much from place to place. Hinatuan, a coastal town in Surigao del Sur directly facing southeastern monsoon and situated on the tropical cyclone passage, recorded 4,328.2mm. which is next to the highest among 58 weather stations in the Philippines following Itbayat in Batanes. On the other hand, General Santos City in a valley in southern Mindanao has the lowest of 962mm. among all weather stations in the Philippines followed by Zamboanga City with 1,212mm. Surigao City recorded fairly higher rainfall with 3,720mm., while Davao City recorded a bit lower than Mindanao average with 1,771mm.

Monthly Rainfall

Monthly rainfall distribution of areas under climate Type II such as Surigao del Norte and Surigao del Sur shows remarkably higher rainfall during November to April. Other areas classified under Type III and IV have no pronounced rainy season and rainfall is fairly distributed through the year.

The maximum monthly rainfall along the Study Road is recorded in Surigao City with 662mm in January. The monthly lowest is recorded in Davao City with 82mm in March.

2.2.5 Humidity

Because of the warm moist air streams flowing over the island, its surrounding seas, rich vegetation and abundant rainfall, the humidity of the air in the island is quite high like other part of Philippine archipelago. Normal monthly humidity in Surigao and Butuan City is always above 80%. Davao City which has less rainfall than those two cities still have annual normal humidity more than 80%.

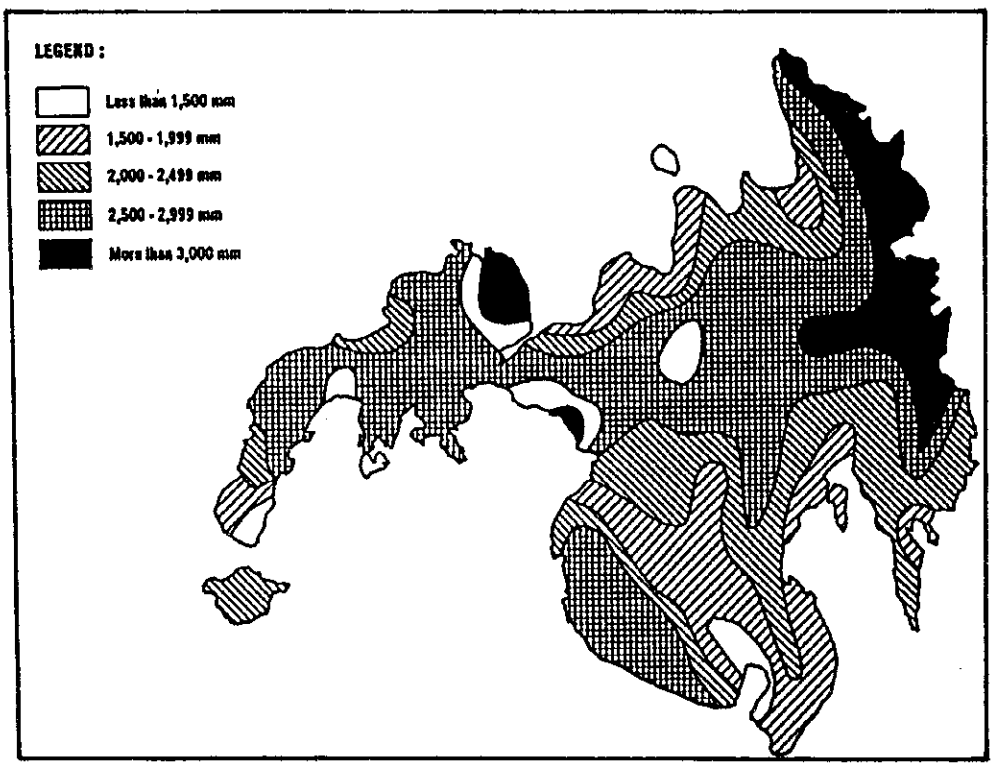
TABLE 2.2-2 MONTHLY AND ANNUAL NORMAL RAINFALL

Unit: mm

Weather Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Butuan City	367.9	179.2	133.9	79.1	119.7	147.6	140.7	95.4	151.8	213.4	214.8	203.4	2,046.9
Cagayan de Oro	106.0	66.9	48.6	34.3	96.1	205.7	208.1	208.6	211.8	189.0	137.2	90.9	1,603.2
Cotabato *	71.3	90.9	95.3	131.8	257.2	251.4	248.9	323.7	238.3	253.6	176.7	98.7	2,237.8
Davao City	115.1	106.5	87.9	150.0	196.3	194.3	150.5	180.0	185.3	177.3	131.0	97.0	1,771.2
Dipolog	147.3	59.6	64.6	90.9	177.2	238.2	223.2	213.6	226.4	295.5	359.0	254.7	2,350.2
General Santos	71.0	69.2	42.0	52.9	73.9	117.6	103.2	78.6	90.4	107.0	85.4	70.4	961.6
Hinatuan **	730.3	523.1	434.8	320.5	275.3	257.6	214.4	190.1	213.3	232.5	350.1	586.4	4,328.4
Lumbia Airport ***	93.7	62.4	29.8	24.6	98.5	209.0	230.5	221.4	181.2	206.9	91.0	100.0	1,549.0
Malaybalay	175.1	133.5	120.7	111.7	234.6	317.4	309.9	327.1	311.6	303.9	187.3	129.4	2,662.2
Surigao	661.1	483.6	345.9	236.7	152.2	137.0	165.4	135.9	146.9	262.1	474.5	518.6	3,719.9
Zamboanga City	40.5	49.0	40.9	50.7	88.7	135.9	141.2	128.1	150.1	180.5	108.1	60.1	1,173.8
Mindanao Average	234.5	165.8	131.3	116.7	160.9	201.1	194.2	191.1	191.6	220.2	210.5	200.9	2,218.6

SOURCE: PAGASA, Climatological Normals, 1961-1990

* : 1951-1965 Data
** : 1951-1985 Data
*** : 1976-1985 Data



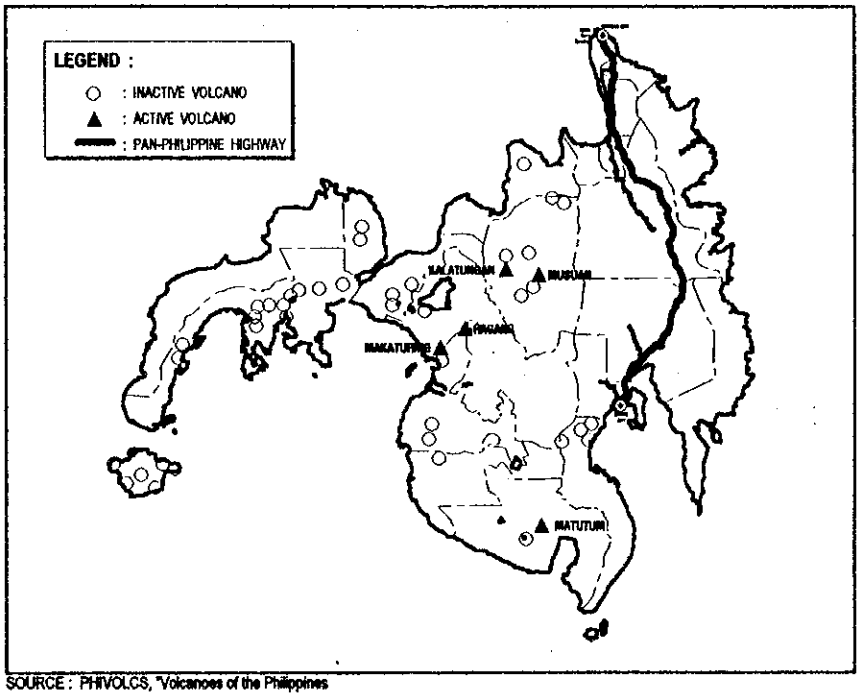
SOURCE: DPWH Infrastructure Atlas, 1988

FIGURE 2.2-2 ISOHYETAL MAP

2.3 NATURAL CALAMITIES

2.3.1 Volcanic Eruptions

There are 220 quaternary volcanoes in the Philippines. Among of them, 21 are classified as active volcanoes and five of them are located in Mindanao island. Figure 2.3-1 shows location of active and inactive volcanoes in Mindanao. The list of active volcano in Mindanao and their year of eruption is presented in Table 2.3-1.



SOURCE : PHIVOLCS, "Volcanoes of the Philippines

FIGURE 2.3-1 ACTIVE / INACTIVE VOLCANOES IN MINDANAO

TABLE 2.3-1 VOLCANOES HAVING ERUPTED IN MINDANAO

Name	No. of Eruptions	Date of Last Eruption	Location
Ragang	9	1915	Cotabato
Calayo	1	1886	Valencia, Bukidnon
Matutum	?	1911	Cotabato
Kalatungan	?	-	Bukidnon
Makaturing	?	-	Lanao

SOURCE: PHIVOLCS, Volcanoes of the Philippines

2.3.2 Earthquake

The Philippine archipelago lies between two major tectonic plates of the world as shown in Figure 2.3-2. The north westward moving pacific plate is presently pushing the Philippine Sea Plate beneath the eastern side of the archipelago. The northeastward component of the Eurasian Plate motion is now sustaining the active collision of the continental block of Palawan with Mindoro and of the northern sections of the Zamboanga Peninsula with western Mindanao.

The identified earthquake generators in Mindanao formed by above tectonic movements are:

- Philippine Trench
- Cotabato Trench
- Davao Trench
- Mindanao Fault
- Philippine Fault Zone

Eastern Mindanao, an area facing Philippine Trench in the east and traversed by Philippine Fault Zone, is the most seismically active area in the Philippines.

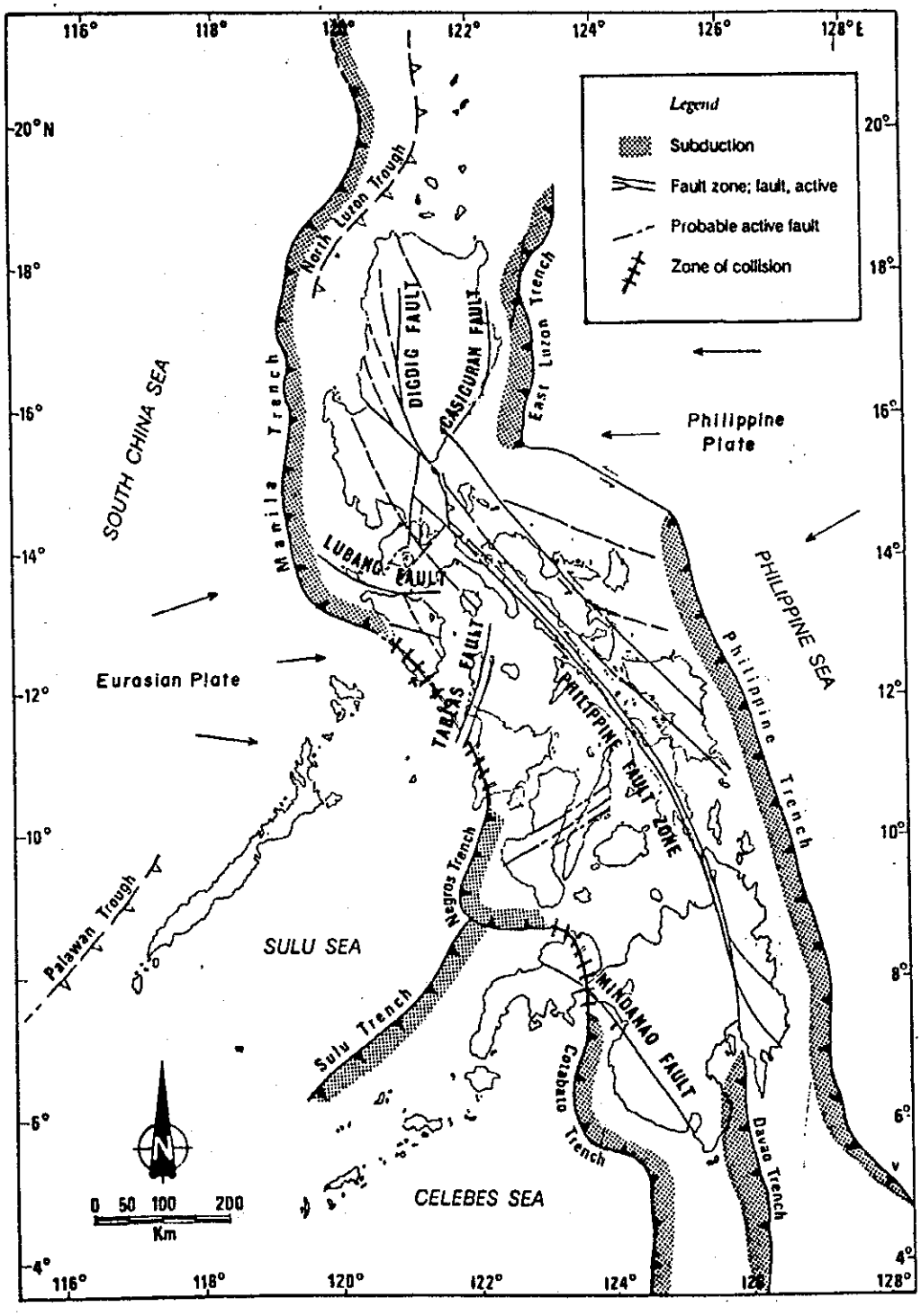
A part of Philippine Fault Zone coincides with alignment of Pan-Philippine Highway, this may require cautious design for highway and bridges against earthquakes.

Figure 2.3-3 shows location of epicenters of strong and major earthquakes with Magnitude 6.0 or above occurred during 1599 to 1988.

2.3.3 Tsunami

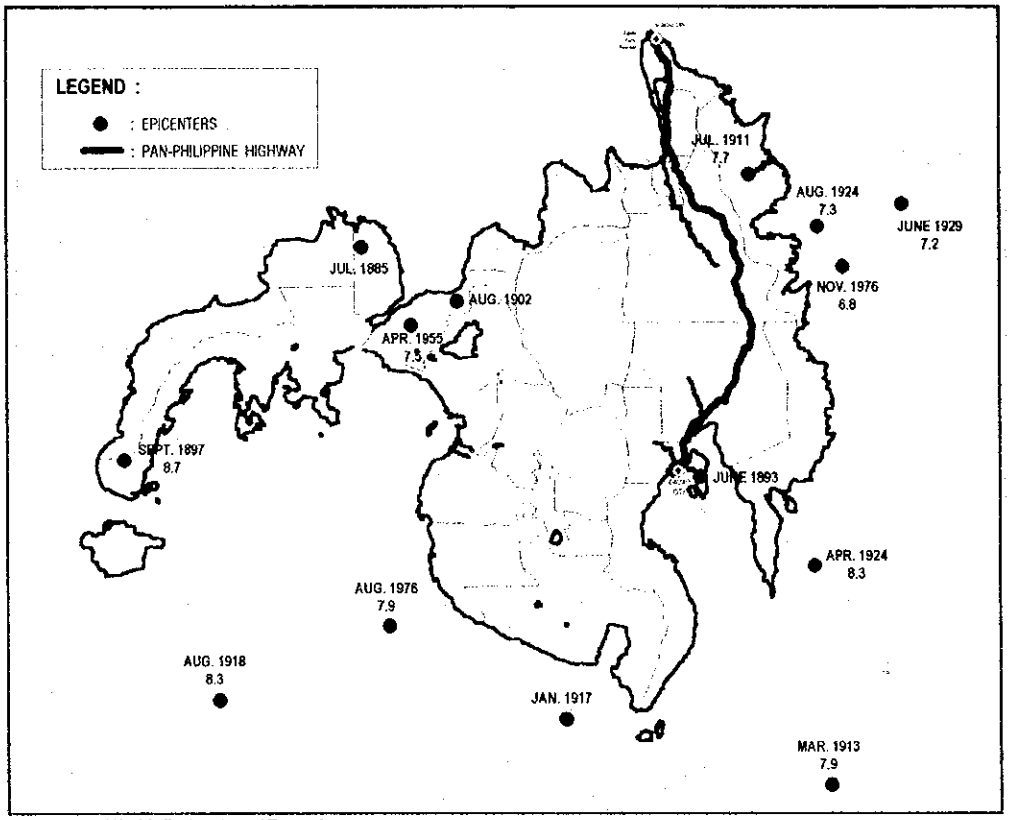
Eastern coast of Mindanao facing the Philippine Sea and coastal areas of southern Mindanao facing the Celebes Sea are most vulnerable area to tsunami because tsunamigenic earthquakes often originate along Philippine Trench and from bottom of Celebes Sea.

Figure 2.3-4 shows area hit by tsunami from local earthquake. The most destructive tsunami in the Philippine history occurred on August 16, 1976 produced by Moro Gulf Earthquake. The tsunami devastated the Southwest coast of Mindanao and left more than 3,000 people dead, with at least 1,000 people missing. More than 8,000 people were injured, and approximately 12,000 families were rendered homeless by 5 meter-high waves.



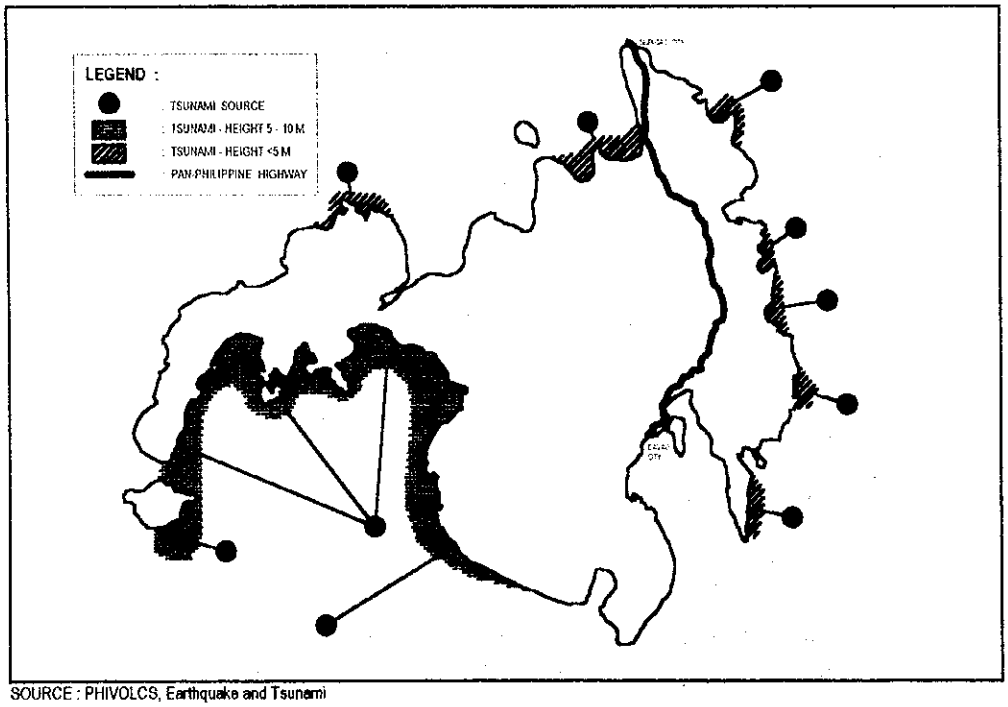
SOURCE: PHIVOLCS, Earthquake and Tsunami

FIGURE 2.3-2 DISTRIBUTION OF EARTHQUAKE



SOURCE : PHIVOLCS, Earthquake and Tsunami

FIGURE 2.3-3 LOCATION OF EPICENTERS OF STRONG / MAJOR EARTHQUAKES



SOURCE : PHIVOLCS, Earthquake and Tsunami

FIGURE 2.3-4 AREA HIT BY TSUNAMIS

2.3.4 Tropical Cyclones

Tropical cyclone is characterized by a low pressure center and cloud band spiraling inward from all sides. The Philippines is prone to such natural disaster as tropical cyclones accompanying destructive winds, floods and storm surges. An average of 19.6 cyclones per year crossed the Philippine Area of Responsibility (PAR). Approximately ₱850M (1982 values) worth of properties are lost or damaged by tropical cyclones every year.

Table 2.3-4 shows number of tropical cyclone passed over the provinces in Mindanao for the period of 1968 to 1992.

TABLE 2.3-4 NUMBER OF TROPICAL CYCLONE PASSED OVER MINDANAO

(1948-1992, 45 year period)

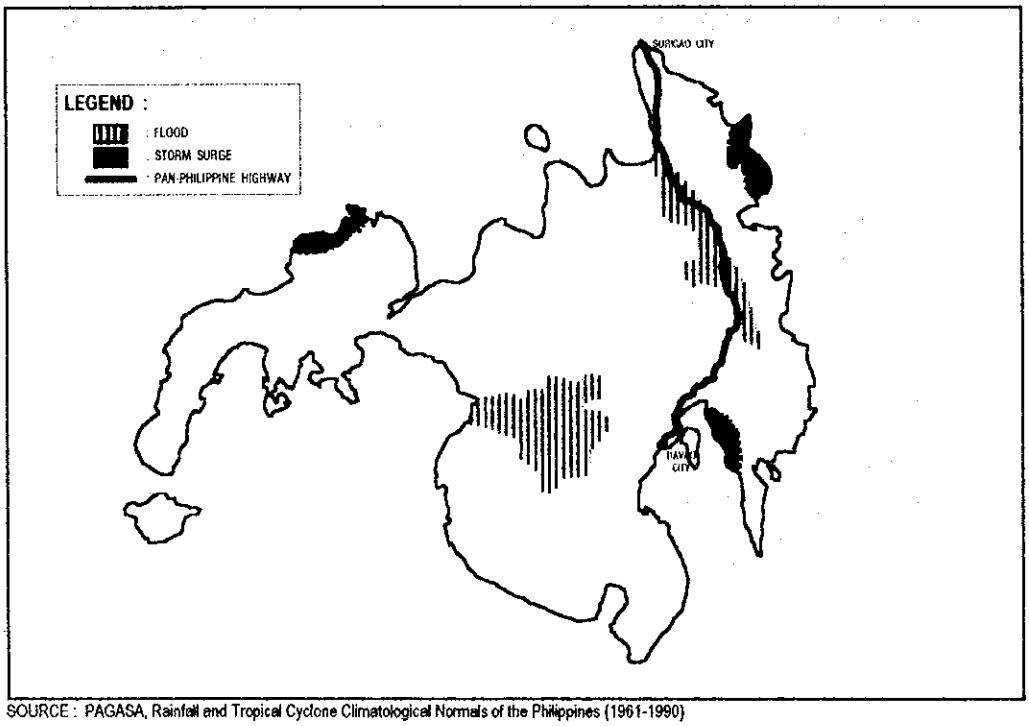
Province	Tropical Depression	Tropical Storm	Typhoon	Total
Region IX				
Zamboanga del Norte	1	2	1	4
Zamboanga del Sur	0	1	1	2
Region X				
Agusan del Norte	6	6	11	23
Agusan del Sur	6	4	3	13
Bukidnon	1	3	0	4
Misamis Occidental	1	1	1	3
Misamis Oriental	1	2	0	3
Surigao del Norte	3	8	10	21
Region XI				
Davao del Norte	0	2	0	2
Davao del Sur	0	0	1	1
Davao Oriental	0	3	1	4
South Cotabato	0	0	0	0
Surigao del Sur	7	2	3	12
Region XII				
Lanao del Norte	0	1	1	2
Lanao del Sur	0	1	1	2
Maguindanao	0	0	1	1
Cotabato	0	0	1	1

SOURCE: PAGASA, Tropical Cyclone Statistics (1948-1992)

Generally quite small number of cyclones pass over Mindanao compared with other areas in the Philippines. However, provinces along and near Pan-Philippine Highway such as Surigao del Norte, Surigao del Sur, Agusan del Norte and Agusan del Sur are hit by remarked number of cyclones every year. This causes flood for significant extend of length along the highway.

Figure 2.3-5 shows flood and storm surge prone areas in Mindanao. Agusan river basin along Pan-Philippine Highway as one of prominent inundate area, due to abundant rainfall in the area, mild hydraulic gradient and absence of flood protection dikes.

Table 2.3-5 shows summary floods due to heavy rains along Pan-Philippine Highway occurred since 1985.



SOURCE : PAGASA, Rainfall and Tropical Cyclone Climatological Normals of the Philippines (1961-1990)

FIGURE 2.3-5 FLOOD AND STORM SURGE PRONE AREA

TABLE 2.3-5 SUMMARY OF FLOODS DUE TO HEAVY RAINS ALONG STUDY ROAD

Date of Occurrence	Causes	Area Affected	Effects		
12/16~17, 1985	Heavy Rains	Davao del Norte - 11 municipalities and 57 barangays	Dead Families Affected Persons Affected	- - -	1 3,549 10,145
1/7, 1986	Heavy Rains	Surigao del Norte - 4 municipalities	Dead Missing Injured Families Affected Persons Affected Houses totally damaged Public and private combined	- - - - - - 	1 2 none 30 210 24 P8.0M
1/20, 1987	Heavy Rains	Davao del Norte - 3 municipalities and 10 brgys.	Families Affected Persons Affected	- -	106 643
8/20, 1987	Heavy Rains	Davao City and Toril District	Families Affected Persons Affected Houses totally damaged Houses partially damaged Bridges partially damaged	- - - - -	100 600 24 84 2
8/31, 1988	Heavy Rains	Davao City, Davao del Sur and Norte, Agusan del Norte and Digos - 1 bgys.	Families Affected Persons Affected Houses totally damaged	- - -	50 300 43
3/22, 1989	Heavy Rains	Agusan del Sur - Prosperidad - 4 brgys.	Families Affected Persons Affected	- -	200 1,305
1/12~24, 1991	Heavy Rains	Agusan del Sur - 11 municipalities and 39 brgys. affected	Families Affected Persons Affected Houses totally damaged	- - -	319 2,445 3
1/8,26,2/5 3/1, 4/12, 1993	Heavy Rains	Regions 10 and 11 6 provinces and 3 cities	Families Affected Persons Affected Houses totally damaged Casualties (dead)	- - - -	66,010 340,998 158 27
12/24~29, 1993	Heavy Rains (Typhoon Ruping)	East of Mindanao	Families Affected Persons Affected Dead Injured Missing Houses totally damaged Value of damage	- - - 	340,081 1,877,921 157 276 52 34,154 P2,732M

SOURCE: National Disaster Coordinating Council, "Summary of Flooding/Flashfloods due to Heavy Rains", "Summary of Destructive Tropical Cyclones"

CHAPTER 3

SOCIO-ECONOMIC PROFILE OF THE STUDY AREA

3.1 GENERAL

Mindanao is the second largest island in the Philippines. Located at the southernmost section of the country, it has a land area of 102,043 sq. kms. or one-third of the national total. Mindanao is ideally situated outside of the typhoon belt and enjoys a generally fair and tropical climate all throughout the year.

Mindanao is composed of four (4) administrative regions (Regions IX to XII) and one autonomous region (Autonomous Region for Muslim Mindanao or ARMM) which are generated and united towards development. The four regions are divided into provinces and cities, each unit headed by a duly-elected governor or duly-elected city mayor, respectively. The ARMM is headed by a Regional Governor, and the provinces comprising it are also headed by duly-elected governors.

The Study Road is located in the Regions X and XI, and traverses four (4) provinces and three (3) cities as shown in Table 3.1-1.

TABLE 3.1-1 PROVINCES AND CITIES TRAVERSED BY THE STUDY ROAD

REGION	PROVINCE/CITY
Region X: Northern Mindanao Region	Surigao City Province of Surigao del Norte Province of Agusan del Norte Butuan City Province of Agusan del Sur
Region XI: Southern Mindanao Region	Province of Davao del Norte Davao City

3.2 PRESENT LAND USE

3.2.1 General Land Use

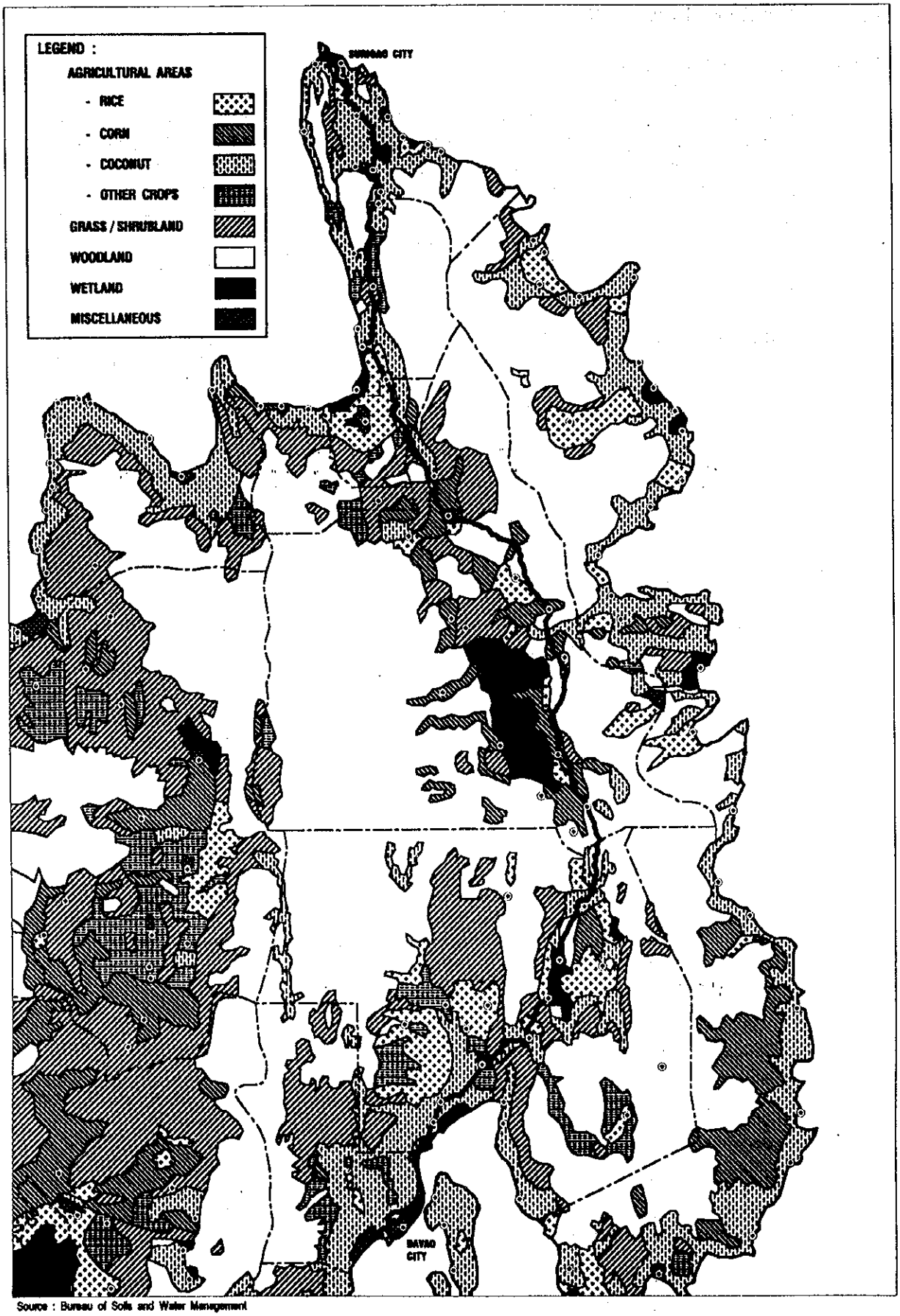
Mindanao Island is characterized by favorable climate that contributes to the ineherent diversity of its biological and physical environment, the fundamental proof of which is the presence of a very diverse land use system. Agricultural areas in Mindanao occupy 33.7% of the total area. Woodland areas and grassland/shrubland areas have shares of 32.1% and 28.9%, respectively. Wetland areas and miscellaneous areas occupy only a few percent each. Land use distribution in the Study Area is shown in Table 3.2-1 and is also illustrated in Figure 3.2-1.

TABLE 3.2-1 GENERAL LAND USE/VEGETATION BY PROVINCE/CITY

(in hectares)

	Agricultural Areas	Grass/shrub land Areas	Woodland Areas	Wetland Areas	Miscellaneous Areas	Total Area
Region IX	762,928	638,632	343,368	109,064	14,518	1,868,510
	40.8%	34.2%	18.4%	5.8%	0.8%	100.0%
Region X	863,796	877,837	969,925	76,220	44,992	2,832,770
	30.5%	31.0%	34.2%	2.7%	1.6%	100.0%
- Agusan del Norte	41,218	41,940	99,055	3,063	2,954	188,230
	21.9%	22.3%	52.6%	1.6%	1.6%	100.0%
- Agusan del Sur	209,451	243,838	403,024	39,283	954	896,550
	23.4%	27.2%	45.0%	4.4%	0.1%	100.0%
- Butuan City	29,378	38,217	-	2,106	1,099	70,800
	41.5%	54.0%	0.0%	3.0%	1.6%	100.0%
- Surigao City	9,427	10,817	-	2,814	3,205	26,263
	35.9%	41.2%	0.0%	10.7%	12.2%	100.0%
- Surigao del Norte	16,611	149,254	44,864	23,526	13,382	247,637
	6.7%	60.3%	18.1%	9.5%	5.4%	100.0%
- Rest of Region X	557,711	393,771	422,982	5,428	23,398	1,403,290
	39.7%	28.1%	30.1%	0.4%	1.7%	100.0%
Region XI	1,103,000	1,026,495	923,598	34,613	81,584	3,169,290
	34.8%	32.4%	29.1%	1.1%	2.6%	100.0%
- Davao City	64,556	62,279	104,590	50	12,525	244,000
	26.5%	25.5%	42.9%	0.0%	5.1%	100.0%
- Davao del Norte	241,780	266,670	282,330	11,357	8,217	810.354
	29.8%	32.9%	34.8%	1.4%	1.0%	100.0%
- Rest of Region XI	796,664	697,546	536,678	23,206	60,842	2,114,936
	37.7%	33.0%	25.4%	1.1%	2.9%	100.0%
Region XII	617,544	820,608	712,317	113,998	64,853	2,329,320
	26.5%	35.2%	30.6%	4.9%	2.8%	100.0%
Mindanao Total	3,347,268	3,363,572	2,949,208	333,895	205,947	10,199,890
	32.8%	33.0%	28.9%	3.3%	2.0%	100.0%

Source: Crop Development and Soil Conservation Framework for Mindanao Island, Bureau of Soils and Water Management, Department of Agriculture.



Source : Bureau of Soils and Water Management

FIGURE 3.2 - 1 LAND USE MAP

3.2.2 Agricultural Areas

Agricultural areas are the lands that are actively utilized for various agricultural activities. Coconut that is the most dominant crop in each region occupies 37.9% and 44.3% of the total agricultural lands of Regions X and XI, respectively. Corn is the second most dominant crop grown in the regions. It is generally planted in well-drained areas along the elevated plains and river terraces. Rice is the third ranking agricultural crop in terms of area planted. Other than these major crops, the very diverse crops grow in the different regions as shown in Table 3.2-2

TABLE 3.2.2 AGRICULTURAL AREAS BY CROPS

Land Use	Region IX		Region X		Region XI		Region XII	
Vegetation	Area(Ha)	(%)	Area(Ha)	(%)	Area(Ha)	(%)	Area(Ha)	(%)
Paddy rice irrigated	51,844	6.8	42,329	4.9	85,125	7.7	144,913	20.5
Paddy rice non-irrigated	30,586	4.0	38,701	4.5	81,344	7.4	80,818	11.4
Upland rice	31,937	4.2	11,171	1.3	2,365	0.2	7,808	1.1
Corn	121,402	15.9	222,639	25.7	162,597	14.7	172,239	24.4
Sorghum	0	0.0	2,032	0.2	63,569	5.8	0	0.0
Legumes vegetables	453	0.1	228	0.0	3,341	0.3	1,300	0.2
Fruit/leafy vegetables	1,093	0.1	7,680	0.9	3,792	0.3	1,075	0.2
Root crops	21,700	2.8	13,188	1.5	3,490	0.3	966	0.1
Spices	104	0.0	4	0.0	5	0.0	262	0.0
Coffee	9,245	1.2	32,732	3.8	29,369	2.7	11,793	1.7
Cacao	1,498	0.2	212	0.0	6,422	0.6	1,628	0.2
Pineapple	0	0.0	20,592	2.4	15,860	1.4	0	0.0
Banana	24,870	3.3	45,177	5.2	51,326	4.7	1,659	0.2
Fruit trees	5,841	0.8	4,208	0.5	45,269	4.1	761	0.1
Fiber crops	5,797	0.8	2,556	0.3	20,870	1.9	7,346	1.0
Tobacco	253	0.0	0	0.0	0	0.0	2,070	0.3
Sugarcane	0	0.0	42,552	4.9	13,203	1.2	15,393	2.2
Coconut	426,022	55.8	328,081	37.9	489,180	44.3	207,964	29.4
Oil palm	324	0.0	5,955	0.7	0	0.0	3,704	0.5
Pasture land	5,445	0.7	36,854	4.3	23,971	2.2	8,951	1.3
Rubber	25,315	3.3	8,981	1.0	2,123	0.2	35,822	5.1
Cut flowers	67	0.0	0	0.0	66	0.0	0	0.0
Total Agricutural Areas	763,796	100.0	865,872	100.0	1,103,297	100.0	706,472	100.0

Source: Bureau of Soils and Water Management, Department of Agriculture

3.2.3 Grassland/Shrubland Areas

Land area under this category occupies about one third of the total land area in each region. The areas are classified into four zones, namely warm lowlands, warm-cool uplands, warm-cool hilly lands and cool highlands. Warm lowland and warm-cool upland zones are suitable for agricultural development whereas hilly land and higland zones have limited potentialities. Based on this

classiffication, lands that have potentiality for various forms of agricultural uses are estimated as follows: Region IX has 458,688 hectares or 24.5% of the total area, Region X 568,880 hectares or 20.1%, Region XI 766,393 hectares or 24.2% and in Region XII is 338,452 hectares or 14,5%.

3.2.4 Woodland Areas

Woodland areas are primarily covered with trees or dominated by woody type of vegetation. The regional distribution of the areas is as follows: Region IX - 343,368 hectares (18.4% of the total land area), Region X - 969,925 hectares (34.2%), Region XI - 923,598 hectares (29.1%), and Region XII - 712,317 hectares (30.6%).

3.2.5 Wetland Areas

Wetland areas constitute the marshes and mangroves covering 333,895 hectares or 3.27% of the total area of Mindanao Island. Mangrove and nipa occupy 118,589 hectares or 35.5% of the total area of wetlands. Also included in the wetland category are salt beds, fishponds and fresh water swamps.

3.3 POPULATION

3.3.1 Demographic Trend

In Mindanao, there were 14.3 million people or 23.6% of the country's total population in 1990. Population density was then 140.1 persons per. sq.km. which was fairly lower than the national average of 202.3 per sq.km.

According to the censuses in the past, population of Mindanao has been increasing with higher growth rates than those of the nation (Table 3.3-1). However, an average annual population growth rate is gradually declining from 3.99% during the period 1960-70 to 2.75% during the period 1980-90.

Among the four(4) regions in Mindanao, the Region XI or Southern Mindanao Region has the highest population growth rate during the past 30 years and it is followed by the Region X or Northern Mindanao Region. Although population growth of the Region XII during the past 30 years is the slowest, its average annual growth rate is still higher than the national average.

TABLE 3.3-1 NATIONAL AND REGIONAL DEMOGRAPHIC TREND

	Census Population (in thousand)				Average Annual Growth Rate			
	1960	1970	1980	1990	1960-70	1970-80	1980-90	1960-90
Mindanao	5,384	7,964	10,906	14,298	3.99%	3.19%	2.75%	3.31%
- Region IX	1,351	1,869	2,529	3,158	3.30%	3.07%	2.25%	2.87%
- Region X	1,297	1,953	2,759	3,510	4.18%	3.52%	2.44%	3.37%
- Region XI	1,353	2,201	3,347	4,459	4.99%	4.28%	2.91%	4.06%
- Region XII	1,383	1,941	2,271	3,171	3,45%	1.58%	3.39%	2.80%
Luzon & Visayas	21,704	28,720	37,192	46,405	2.84%	2.62%	2.24%	2.57%
The Philippines	27,088	36,684	48,098	60,703	3.08%	2.75%	2.35%	2.73%

Source: 1993 Philippine Statistical Yearbook, National Statistical Coordination Board

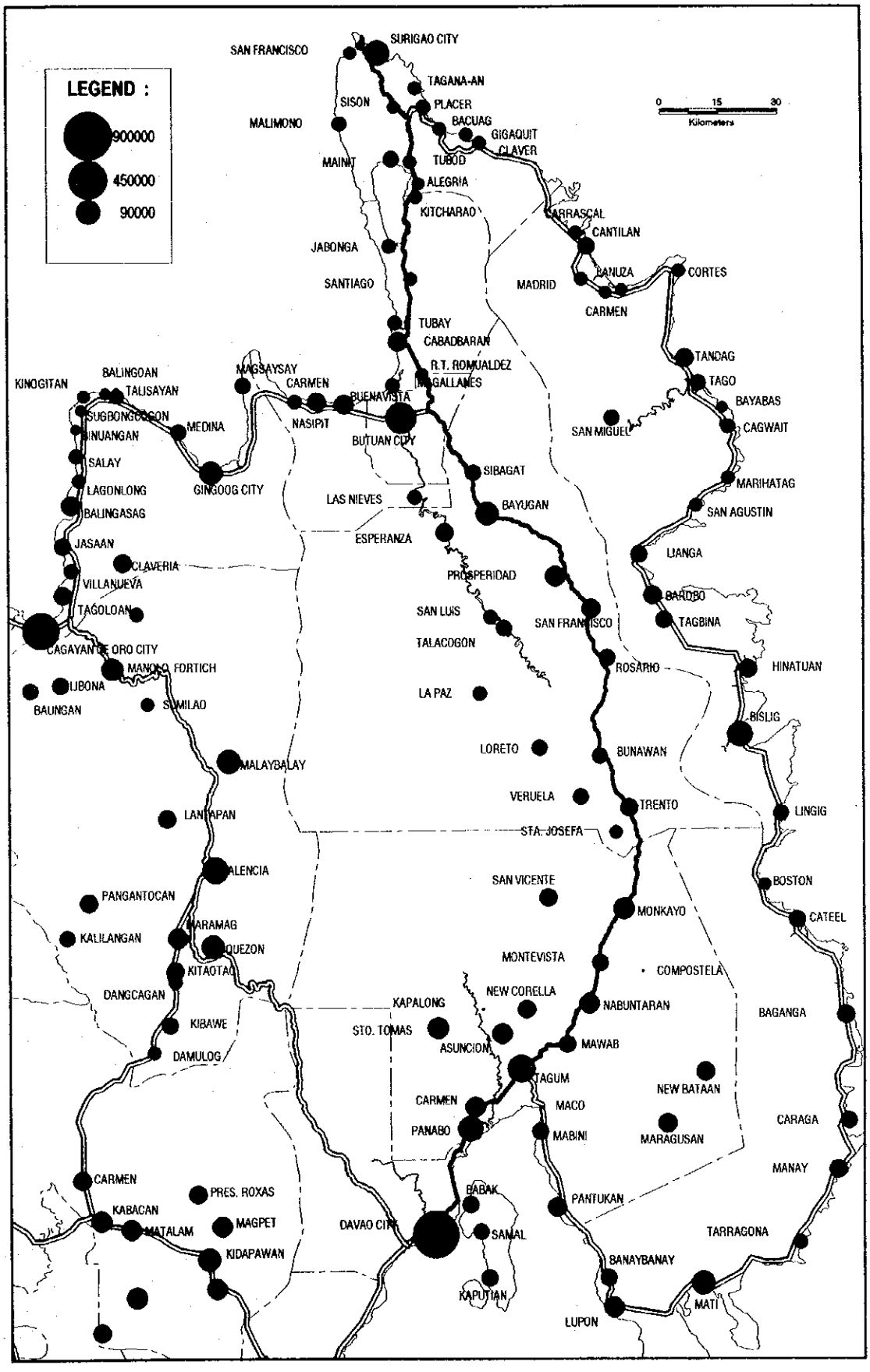


FIGURE 3.3 - 1 CITY / MUNICIPALITY POPULATION DISTRIBUTION (1990)

3.3.2 Geographical Distribution

The 1990 census population of the provinces/cities where the Project Road passes through are shown in Table 3.3-2. Of a total population of 3.217 million in the area, 1.381 million or 42.9% inhabit in the urban area. Three cities namely Butuan, Surigao and Davao have higher population density by about two times than the national average of 202.3 persons per square kilometer. Agusan del Sur, on the other hand, has still quite low population density of only 47 persons per square kilometer, although a population growth rate of the province is notably high.

Figure 3.3-1 presents the municipal population distribution in the Study area as of 1990, Davao City had exceedingly large population of 849,947. Among the cities/municipalities along the Study Road, the second and third largest in terms of population were Butuan City and Surigao City with their population of 227,829 and 100,071, respectively. Cagayan de Oro City and Bislig were also large city/municipality having influence on traffic of the Study Road. Cagayan de Oro had a total population of 339,598 and Bislig had 103,510.

TABLE 3.3-2 POPULATION DISTRIBUTION BY PROVINCE IN 1990

	Population in 1990			Growth Rate 1980-1990	Land Area (km^2)	Density ($person/km^2$)
	Urban	Rural	Total			
Surigao City	65,847	34,224	100,071	2.30%	245.3	408
Surigao del Norte *1	69,576	256,221	325,797	1.39%	2,494.8	131
Agusan del Norte *2	64,949	172,680	237,629	2.11%	2,064.0	115
Butuan City	90,028	137,801	227,829	2.82%	526.3	433
Agusan del Sur	102,956	317,807	420,763	4.70%	8,965.5	47
Davao del Norte	365,563	689,453	1,055,016	3.76%	8,129.8	130
Davao City	622,161	227,786	849,947	3.30%	2,211.3	384
Study Area Total	1,381,080	1,835,972	3,217,052	3.22%	24,637.0	131

Note: *1_/ excluding Surigao City
*2_/ excluding Butuan City
Sources: National Statistics Office and Provincial/City Profiles

3.4. ECONOMY

3.4-1 National Economy

The Philippine economy began to recover in 1986 after two consecutive years of negative growth. An annual growth rate of the gross national product (GNP) was recorded at 5.1% in 1987, 7.2% in 1988, and 5.7% in 1989. This recovery was generally characterized as "consumption-led" after the government embarked on pump-priming activities to spark growth and to take advantage of unused capacity. Investment also grew remarkably.

These favorable developments were, however, not sustained. Growth in real output decelerated from 5.7% in 1989 to 4.0% in 1990. It then remained flat in 1991 and barely grew 1.0 and 1.7% in 1992 and 1993, respectively. External and internal factors prevented the country's attainment of sustained growth. The recession in the economics of the country's foreign trade partners

and the Gulf Crisis in 1991 exacted heavy pressures on the economy. At home, the country was beset by a number of calamities - natural, like drought, the series of destructive typhoons, the July 1990 earthquake and Mt. Pinatubo eruption in June 1991; as well as man-made calamaties like the six coup attempts and the power shortages which severely set back economic recovery.

TABLE 3.4-1 MAJOR MACROECONOMIC INDICATORS, 1987-1992

(In percent)

	Year						Average
	1987	1988	1989	1990	1991	1992	1987-92
Growth Rate of Real GNP	5.1	7.2	5.7	4.4	0.0	1.0	3.9
- Personal Consumption	4.0	6.2	5.0	5.4	2.2	3.2	4.3
- Government Consumption	4.9	9.1	5.6	8.1	0.7	-4.3	4.0
- Investment	17.6	11.6	23.6	14.6	-17.0	9.3	10.0
- Export	6.5	14.7	10.7	1.3	6.6	1.2	6.8
- Import	28.6	19.6	15.2	10.0	-2.0	13.2	14.1
Growth Rate of Real GDP	4.8	6.3	6.1	2.6	-0.8	0.0	3.2
- Agriculture	3.2	3.2	3.0	0.5	-0.2	-0.4	1.6
- Industry	5.4	7.6	8.2	2.3	-2.9	-0.6	3.3
- Services	5.2	6.9	6.0	4.0	0.6	0.7	3.9
Inflation Rate	3.0	8.9	12.2	14.2	18.7	8.9	11.0

Source : Medium-Term Philippine Development Plan, 1993-1998 (Draft), August 1993

The country's recent economic performance shows that the Philippines has not yet regained its economic footing. However, the situation is expected to improve under the Medium-Term Philippine Development Plan (MTPDP) for the period 1993-1998. In fact, improved power supplies have boosted the economy. According to the National Economic Development Authority (NEDA), the 1994 first quarter economic growth of 4.8% against a negative 0.3% in the 1993 first quarter is reported.

3.4.2 Regional and Provincial Accounts

Mindanao produced 236.9 billion pesos or 17.6% of the gross domestic product (GDP) in 1992. The gross regional domestic product (GRDP) in the Region XI occupies 6.7% of the GDP or 38.2% of the GRDP in Mindanao, which is the biggest share and followed by the Region X (27.0%) as shown in Table 3.4-2.

Table 3.4-2 shows also sectorial share of gross value added (GVA) in the four regions. Mindanao contributes a good 33.7% of the Philippines' total agricultural production. The GVA of each non-agricultural sector, however, accounts for only 15% or less of the respective national GVA. In each region, an agriculture and forestry sector also contributes greatly to the regional economy. Its share in the GRDP is 40% more or less. A service sector take also a large share in the GRDP. Its contribution is greater than that of the agriculture and forestry in Region X (Figure 3.4-1).

TABLE 3.4-2 GRDP DISTRIBUTION IN 1992 BY SECTOR, BY REGION

(In Million Pesos; at current prices)

Regions	Agriculture & Forestry	Mining & Quarrying	Manufac-turing	Cons-truction	Electricity, Gas & Water	Service Sector	GRDP
Region IX	18,782	367	3,982	338	305	13,649	37,423
	6.47%	2.26%	1.22%	0.49%	0.93%	2.25%	2.79%
Region X	23,263	706	14,150	662	1,325	23,888	63,994
	8.01%	4.34%	4.32%	0.96%	4.05%	3.93%	4.77%
Region XI	36,379	1,383	18,409	1,060	702	32,441	90,374
	12.53%	8.50%	5.62%	1.54%	2.14%	5.34%	6.73%
Region XII	19,302	14	11,744	986	1,843	11,185	45,074
	6.65%	0.09%	3.59%	1.44%	5.63%	1.84%	3.36%
Mindanao Total	97,726	2,470	48,285	3,046	4,175	81,163	236,865
	33.66%	15.19%	14.74%	4.43%	12.75%	13.37%	17.64%
The Philipines	290,338	16,263	327,501	68,695	32,743	607,090	1,342,630
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: National Statistical Coordination Board

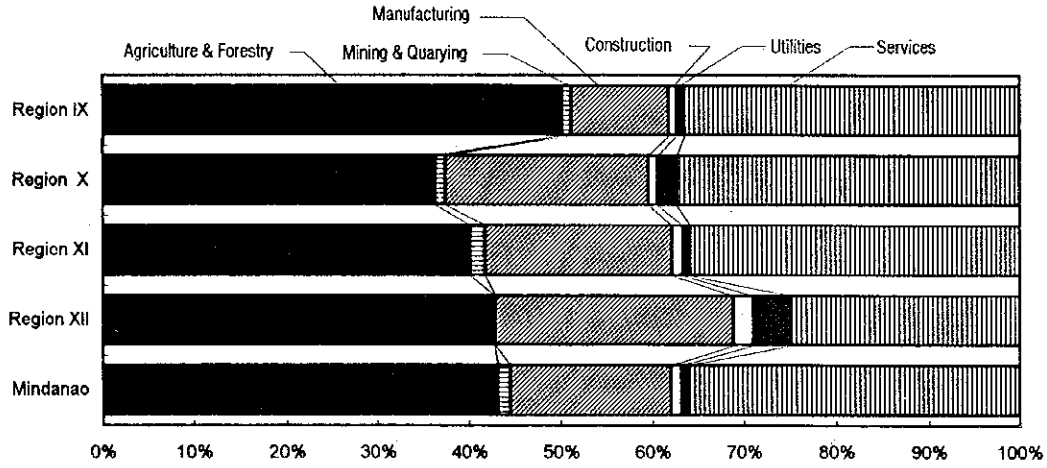


FIGURE 3.4-1 SECTORIAL COMPOSITION OF GRDP : 1992

The GDP of each province is not officially estimated. For the study purposes, the Study Team estimates the gross provincial domestic product (GPDP) in the study area on the assumption that the regional GVA is allocated to the respective province according to the distribution of employed population by sector (see Table 3.4-3). The GPDP estimate in 1992 is shown in Table 3.4-4.

3.4.3 Family Income and Expenditure

Average family income in Mindanao has grown with a higher growth rate than the national average during the period 1985-88 (Table 3.4-5). During 1988-91, however, an annual growth rate of each region in Mindanao remained 10% more or less, while the national average exceeded 17%. Consequently an average annual family income of Mindanao was still lower than the national average by 20 to 30% in 1991. Amounts of an average expenditure and savings were about 80% and 20% of the average income, respectively.

TABLE 3.4-3 HOUSEHOLD POPULATION BY EMPLOYMENT STATUS AND INDUSTRY GROUP, 1990

	Household Population 15 years old and over	In the Labor Force									Not in the Labor Force
		Employed								Unemployed	
		Agriculture & Forestry	Mining & Quarrying	Manufac-turing	Construction	Electricity Gas, Water	Service Sector	Not Defined	Total		
Region IX	**1,834,926**	**466,307**	**5,317**	**24,161**	**16,455**	**1,506**	**196,449**	**230,015**	**940,210**	**99,917**	**794,799**
- Basilan	137,608	21,112	40	909	679	112	10,678	42,468	75,998	7,870	53,740
- Sulu	282,978	33,604	10	1,394	280	47	11,775	34,830	81,940	21,618	179,420
- Tawi-Tawi	139,050	44,298	0	1,698	857	59	8,685	41,816	97,413	7,059	34,578
- Zamboanga del Norte	393,260	103,337	1,274	5,021	3,836	285	40,273	23,403	177,429	29,616	186,215
- Zamboanga del Sur	882,030	263,956	3,993	15,139	10,803	1,003	125,038	87,498	507,430	33,754	340,846
Region X	**2,029,736**	**530,877**	**16,030**	**53,333**	**28,427**	**3,430**	**279,227**	**196,855**	**1,108,179**	**97,849**	**823,708**
- Agusan del Norte	137,280	31,279	2,220	6,148	1,957	190	18,867	10,718	71,379	7,761	58,140
- Agusan del Sur	231,756	72,720	3,020	2,867	1,417	30	20,429	41,243	141,726	9,420	80,610
- Bukidnon	461,054	180,797	883	5,364	3,603	738	42,807	60,630	294,822	22,499	143,733
- Camiguin	39,419	10,010	28	618	994	101	6,526	1,029	19,306	1,808	18,305
- Misamis Occidental	262,030	71,758	362	5,856	4,241	593	41,467	7,279	131,556	11,407	119,067
- Misamis Oriental	513,259	72,644	1,320	21,222	10,214	1,022	89,085	53,940	249,447	22,804	241,008
- Surigao del Norte	251,497	71,696	7,792	4,185	3,448	433	32,440	14,029	134,023	14,379	103,095
- Butuan City	133,441	19,973	405	7,073	2,553	323	27,606	7,987	65,920	7,771	59,750
Region XI	**2,587,734**	**641,104**	**17,228**	**70,275**	**40,812**	**3,577**	**360,374**	**203,585**	**1,336,955**	**146,091**	**1,104,688**
- Davao del Norte	606,094	161,258	10,727	8,176	5,416	486	55,226	63,615	304,904	29,260	271,930
- Davao del Sur	362,789	130,341	605	6,803	4,241	264	43,471	7,351	193,076	22,203	147,510
- Davao Oriental	225,702	80,140	792	1,938	2,247	140	22,301	8,308	115,866	6,819	103,017
- South Cotabato	610,169	142,977	1,175	17,908	7,828	699	68,563	80,465	319,615	34,487	256,067
- Surigao del Sur	261,293	50,984	1,838	10,100	2,906	604	25,924	33,142	125,498	18,282	117,513
- Davao City	521,687	75,404	2,091	25,350	18,174	1,384	144,889	10,704	277,996	35,040	208,651
Region XII	**1,793,863**	**584,049**	**1,098**	**43,220**	**16,722**	**2,550**	**221,373**	**94,750**	**963,762**	**65,501**	**764,600**
- Lanao del Norte	353,511	76,936	295	16,094	6,012	1,523	49,556	19,911	170,327	11,940	171,244
- Lanao del Sur	334,902	71,689	182	12,372	2,045	157	46,360	41,402	174,207	13,003	147,692
- Maguindanao	428,417	156,615	91	6,027	2,666	206	55,156	9,014	229,775	6,014	192,628
- North Cotabato	430,291	191,048	344	5,966	3,419	491	44,392	9,681	255,341	21,896	153,054
- Sultan Kudarat	246,742	87,761	186	2,761	2,580	173	25,909	14,742	134,112	12,648	99,982

Source: 1990 Census of Population and Housing, National Statistics Office
Note : Excluding population less than 15 years old

TABLE 3.4-4 GPDP DISTRIBUTION IN 1992 BY SECTOR, BY PROVINCE

(In Million Pesos; at current prices)

	Agriculture & Forestry	Mining Quarrying	Manufac-turing	Construc-tion	Electricity Gas, Water	Service Sector	GRDP
Region IX	**18,782**	**367**	**3,982**	**338**	**305**	**13,649**	**37,423**
- Basilan	850	3	150	14	23	742	1,781
- Sulu	1,354	1	230	6	10	818	2,417
- Tawi-Tawi	1,784	0	280	18	12	603	2,697
- Zamboanga del Norte	4,162	88	828	79	58	2,798	8,012
- Zamboanga del Sur	10,632	276	2,495	222	203	8,687	22,515
Region X	**23,263**	**706**	**14,150**	**662**	**1,325**	**23,888**	**63,994**
- Agusan del Norte	1,371	98	1,631	46	73	1,614	4,833
- Agusan del Sur	3,187	133	761	33	12	1,748	5,873
- Bukidnon	7,923	39	1,423	84	285	3,662	13,416
- Camiguin	439	1	164	23	39	558	1,224
- Misamis Occidental	3,144	16	1,554	99	229	3,548	8,589
- Misamis Oriental	3,183	58	5,630	238	395	7,621	17,126
- Surigao del Norte *1	3,142	343	1,110	80	167	2,775	7,618
- Butuan City	875	18	1,877	59	125	2,362	5,316
Region XI	**36,379**	**1,383**	**18,409**	**1,060**	**702**	**32,441**	**90,374**
- Davao del Norte	9,150	861	2,142	141	95	4,971	17,361
- Davao del Sur	7,396	49	1,782	110	52	3,913	13,302
- Davao Oriental	4,547	64	508	58	27	2,008	7,212
- South Cotabato	8,113	94	4,691	203	137	6,172	19,411
- Surigao del Sur	2,893	148	2,646	75	119	2,334	8,214
- Davao City	4,279	168	6,641	472	272	13,043	24,874
Region XII	**19,302**	**14**	**11,744**	**986**	**1,843**	**11,185**	**45,074**
- Lanao del Norte	2,543	4	4,373	354	1,101	2,504	10,879
- Lanao del Sur	2,369	2	3,362	121	113	2,342	8,310
- Maguindanao	5,176	1	1,638	157	149	2,787	9,908
- North Cotabato	6,314	4	1,621	202	355	2,243	10,739
- Sultan Kudarat	2,900	2	750	152	125	1,309	5,239

Note: Consultant's estimate based on the data from NSCB and NSO
*1: including Surigao City

TABLE 3.4-5 ANNUAL FAMILY INCOME AND EXPENDITURES BY REGION

		Pesos at Current Prices			Annual Growth Rate	
		1985	1988	1991	1985-88	1988-91
Region IX	Average Income	23,779	31,984	43,011	10.39%	10.38%
	Average Expenditure	19,456	24,624	33,715	8.17%	11.04%
	Savings	4,323	7,360	9,296	19.41%	8.10%
Region X	Average Income	27,402	35,801	45,179	9.32%	8.06%
	Average Expenditure	22,703	28,865	37,641	8.33%	9.25%
	Savings	4,699	6,936	7,538	13.86%	2.81%
Region XI	Average Income	28,222	37,132	51,722	9.58%	11.68%
	Average Expenditure	24,068	30,061	41,011	7.69%	10.91%
	Savings	4,154	7,071	10,711	19.40%	14.85%
Region XII	Average Income	24,366	35,090	43,971	12.93%	7.81%
	Average Expenditure	22,509	27,696	35,354	7.16%	8.48%
	Savings	1,857	7,394	8,617	58.50%	5.23%
Philippine	Average Income	31,052	40,408	65,186	9.18%	17.28%
	Average Expenditure	26,865	32,521	51,991	6.58%	16.93%
	Savings	4,187	7,887	13,195	23.50%	18.71%

Source : 1991 Family Income & Expenditures Survey

Table 3.4-6 shows distribution of families by main income source. In Mindanao, agricultural entrepreneurial activities including crop farming and gardening, livestock and poultry raising, fishing, and forestry generally predominate over the other sources. Of the five regions, only the Region X has a distribution of families relatively similar to that of the national average.

According to 1991 Family Income and Expenditures Survey conducted by National Statistics Office, the Engel's coefficients of the regions in Mindanao are higher than the national average of 48.5%. The coefficients of the Region IX, X, XI, XII and A.R.M.M. are 56.7, 52.2, 51.6, 53.4 and 56.9%, respectively.

TABLE 3.4-6 DISTRIBUTION OF FAMILIES BY MAIN SOURCE OF INCOME:1991

	Wages and Salaries		Entrepreneurial Activities		Other Sources of Income	Total
	Agricultural	Non-Agricultural	Agricultural	Non-Agricultural		
Region IX	6.2%	27.5%	45.8%	11.9%	8.6%	100.0%
Region X	14.9%	30.1%	28.7%	13.6%	12.6%	100.0%
Region XI	12.2%	26.6%	36.2%	12.9%	12.1%	100.0%
Region XII	8.8%	24.3%	47.2%	10.6%	9.1%	100.0%
A.R.M.M.	0.5%	9.0%	75.6%	8.5%	6.4%	100.0%
Mindanao	10.0%	25.3%	42.1%	12.1%	10.5%	100.0%
Philippines	8.7%	35.4%	26.0%	13.0%	17.0%	100.0%

Source : 1991 Family Income and Expenditures Survey, NSO.

3.5 MAJOR PRODUCTS

As discussed in the preceding section, agriculture and forest sector plays a dominant role in the economy of Mindanao sharing about 40% of GRDP. The sector employs about one-half of the total labor force in Mindanao. Thus major products in the project area are discussed here-in-under placing the focus on agriculture and forest sectors.

3.5.1 Agricultural Products

Major agricultural crops in the Study area are coconut, palay, banana and corn. Of the total values of 7,643 million pesos in 1992, 2,492 million pesos or 32.6% were contributed by cereals including palay and corn, while the rest were earned by other major crops (See Table 3.5-1).

In the province of Surigao del Norte and Davao City, coconut was the leading crop in terms of production and value as well as crop area in 1992. A total of 226,720 metric-tons of coconut was produced in Surigao del Norte, and 421,980 metric-tons was in Davao City. In the provinces of Agusan del Norte, Agusan del Sur and Davao del Norte, banana was the first ranking crop in terms of production and corn was the most dominant crop in terms of crop area. The total production of banana and corn in the Study area were 1,145 thousand metric-tons and 238 thousand metric-tons, respectively. Other major

TABLE 3.5-1 AGRICULTURAL AREA, PRODUCTION AND VALUE, BY KIND OF CROP IN 1992

Crop	Surigao del Norte			Agusan del Norte			Agusan del Sur			Davao del Norte			Davao City			Total		
	Area (has.)	Prod'n (m. tons)	Value (T. Pesos)	Area (has.)	Prod'n (m. tons)	Value (T. Pesos)	Area (has.)	Prod'n (m. tons)	Value (T. Pesos)	Area (has.)	Prod'n (m. tons)	Value (T. Pesos)	Area (has.)	Prod'n (m. tons)	Value (T. Pesos)	Area (has.)	Prod'n (m. tons)	Value (T. Pesos)
Cereals	18,188	47,662	214,483	41,438	68,890	313,814	68,040	111,995	510,000	175,680	278,179	1,323,011	18,758	27,698	130,549	322,104	534,424	2,491,857
- Palay	18,110	47,627	214,322	7,960	26,570	119,565	14,380	45,074	202,833	41,320	157,344	728,503	7,240	19,742	91,405	89,010	296,357	1,356,628
- Corn	78	35	161	33,478	42,320	194,249	53,660	66,921	307,167	134,360	120,835	594,508	11,518	7,956	39,144	233,094	238,067	1,135,229
Major Crops	135,606	301,599	451,122	45,176	186,740	382,149	43,178	102,204	318,611	141,303	1,325,909	2,754,884	57,160	421,980	1,242,053	422,423	2,338,432	5,148,819
- Coconut	118,956	226,720	231,254	29,349	68,781	70,157	8,535	3,017	3,077	95,383	526,099	1,530,948	38,587	207,816	604,745	290,810	1,032,433	2,440,181
- Banana	6,907	42,978	63,177	8,650	98,326	144,540	13,006	75,900	111,566	26,700	750,680	788,214	3,355	177,116	185,972	58,618	1,145,000	1,293,469
- Pineapple	21	285	936	2	39	127	52	441	1,446	11	87	201	889	10,023	23,153	975	10,875	25,863
- Coffee	50	29	58,522	3,270	3,524	71,108	2,150	378	7,640	6,600	7,090	212,336	8,950	9,269	277,607	21,020	20,290	627,213
- Mango	14	198	296	90	1,031	15,403	40	74	1,104	62	225	3,915	303	1,917	33,356	509	3,445	54,074
- Tobacco	11	4	14	16	6	160	10	6	160	0	0	0	0	0	0	37	16	334
- Abaca	80	48	626	240	290	3,815	3,000	5,188	68,219	1,800	2,205	22,385	10	6	61	5,130	7,737	95,106
- Rubber	0	0	0	24	790	7,315	10,736	9,524	88,188	4,884	10,453	95,539	630	1,937	18,227	16,274	22,704	209,269
- Cacao	329	74	1,788	235	294	7,100	2,061	266	6,417	697	463	9,069	2,634	1,184	23,195	5,956	2,281	47,569
- Cassava	4,106	14,967	29,486	933	4,703	9,265	490	1,982	3,906	1,182	9,936	17,388	134	1,101	1,927	6,845	32,689	61,972
- Camote	4,850	15,542	60,612	1,907	7,356	28,688	2,406	4,310	16,809	3,013	16,381	53,566	224	884	2,891	12,400	44,473	162,566
- Peanut	13	6	42	14	8	54	110	66	444	111	82	1,396	375	264	4,546	623	426	6,482
- Mongo	125	37	830	274	57	1,294	135	36	826	357	434	6,922	202	94	1,499	1,093	658	11,371
- Tomato	16	115	527	42	266	1,221	11	27	124	59	389	2,237	100	496	2,852	228	1,293	6,961
- Eggplant	48	326	1,540	26	124	586	175	325	1,537	145	230	1,116	138	3,421	16,592	532	4,426	21,371
- Cabbage	14	100	462	11	54	249	21	238	1,097	39	272	1,371	210	1,273	6,416	295	1,937	9,595
- Citrus	54	90	575	20	391	2,502	165	265	1,696	130	196	906	84	1,682	7,771	453	2,624	13,450
- Pomelo	12	80	435	8	119	647	10	24	130	75	480	2,347	205	2,768	13,536	310	3,471	17,095
- Durian	0	0	0	65	581	17,918	65	137	4,225	55	207	5,028	130	729	17,707	315	1,654	44,878
Total	153,794	349,261	665,605	86,614	255,630	695,963	111,218	214,199	828,611	316,983	1,604,088	4,077,895	75,918	449,678	1,372,602	744,527	2,872,856	7,640,676

Source: Bureau of Agricultural Statistics and Regional Offices, Department of Agriculture

crops were camote (44,473 m. tons), cassava (32,689 m. tons), rubber(22,704 m. tons) and coffee (20,290 m. tons).

3.5.2 Forestry Products

In 1992, logging was restricted within adequately stocked residual forests that are at least 25 years old. The volume of logs produced in the nation totaled to 1.4 million cubic meters which is 26% lower than the production in 1991. Mindanao contributed 90% of the Philippines' total log production with a total volume of 1,294,515 cubic meters. Surigao del Sur was the leading province with a total production of 536,740 cubic meters, and was followed by Agusan del Sur and Agusan del Norte that had a production of 329,532 and 206,566, respectively.

A total of 647 thousand cubic meters of lumber was produced in the Philippines in 1992. This is 11% lower than last year's record. Of 265 thousand cubic meters of the total products in Mindanao, 77,948 cubic meters were produced in Agusan del Norte and 55,971 cubic meters were in Surigao del Sur.

There were six veneer plants and 26 plywood plants existing in Mindanao. A total volume of 74,380 cubic meters of veneer or 93% of the national total was manufactured there. Plywood production, on the other hand, registered 316,721 cubic meters or 96% of the national total.

CHAPTER 4

TRANSPORT SYSTEM IN THE STUDY AREA

4.1 ROAD TRANSPORT FACILITY

Transport system in Mindanao Island consists of road, sea and air transportation. There is no rail transportation. Intra-island transportation is mostly served by road transportation. Inter-island transportation is served by sea and air transportation.

4.1.1 Road Length and Road Development Level

The country has 160,900 km of public roads which comprise of 26,600 km of national roads and 134,300 km of local roads. National roads in Mindanao and the Study Area extend for 6,700 km (about 25% of total national roads) and 4,200 km (about 16% of total national roads), respectively. Road development level of Mindanao and the Study Area is summarized in Table 4.1-1. Road length by pavement type and road development level by area is shown in Table 4.1-2 and Table 4.1-3, respectively.

TABLE 4.1-1 ROAD DEVELOPMENT LEVEL OF STUDY AREA

	Road Density 1/			Pavement Ratio 2/		
	National Roads	Local Roads	All Public Roads	National Roads	Local Roads	All Public Roads
Philippines	0.197	0.995	1.192	51.4	9.6	16.5
Mindanao	0.176	1.214	1.390	42.9	3.8	8.8
Study Area	0.192	1.214	1.406	46.1	3.8	9.6

Note: 1/ Road Density $= L/\sqrt{PA}$

2/ Pavement Ratio $= L_p/L$

where: L = Road length in km.

P = Population in thousand

A = Land area in sq. km.

L_p = Road length paved with PCC and AC in km.

Mindanao

- Road density of national roads in Mindanao is lower than the national average. Likewise, pavement ratio is much less than the national average. National roads in Mindanao are less developed.

- In terms of extension, local roads in Mindanao are well developed compared with the national average, however, qualitative development in terms of pavement ratio is much lower level than the national average.

TABLE 4.1-2 ROAD LENGTH BY PAVEMENT TYPE AND BY AREA

	National Road 1/				Local Road 2/				All Public Roads			
	PCC	AC	Gravel/ Earth	Total	PCC	AC	Gravel/ Earth	Total	PCC	AC	Gravel/ Earth	Total
Philippines	7,269 (0.27)	6,388 (24%)	12,936 (49%)	26,593 (100%)	6,138 (5%)	6,742 (5%)	121,408 (90%)	134,288 (100%)	13,407 (8%)	13,130 (8%)	134,344 (84%)	160,881 (100%)
Luzon	3,959 (29%)	3,610 (27%)	5,842 (44%)	13,411 (100%)	3,576 (6%)	4,676 (8%)	52,676 (86%)	60,928 (100%)	7,535 (10%)	8,286 (11%)	58,518 (79%)	74,339 (100%)
Visayas	1,505 (23%)	1,695 (26%)	3,254 (51%)	6,454 (100%)	1,498 (6%)	1,370 (5%)	24,118 (89%)	26,986 (100%)	3,003 (9%)	3,065 (9%)	27,372 (82%)	33,440 (100%)
Mindanao	1,805 (27%)	1,083 (16%)	3,840 (57%)	6,728 (100%)	1,064 (2%)	696 (2%)	44,614 (96%)	46,374 (100%)	2,869 (5%)	1,779 (3%)	48,454 (92%)	53,102 (100%)
Region X	659 (30%)	511 (23%)	1,032 (47%)	2,202 (100%)	309 (2%)	265 (2%)	12,190 (96%)	12,764 (100%)	968 (6%)	776 (5%)	13,222 (89%)	14,966 (100%)
Region XI	589 (29%)	177 (9%)	1,230 (62%)	1,996 (100%)	311 (2%)	120 (1%)	13,345 (97%)	13,776 (100%)	900 (6%)	297 (2%)	14,575 (92%)	15,772 (100%)
Study Area (Regions X & XI)	1,248 (30%)	688 (16%)	2,262 (54%)	4,198 (100%)	620 (2%)	385 (1%)	25,535 (97%)	26,540 (100%)	1,868 (6%)	1,073 (3%)	27,797 (91%)	30,738 (100%)

Luzon : NCR, CAR, Regions I, II, III, IV-A, IV-B, and V
Visayas : Regions VI, VII and VIII
Mindanao: Regions IX, X, XI and XII

1/ National road length in 1993, Planning Service, DPWH
2/ Local road length in 1992, Planning Service, DPWH

TABLE 4.1-3 ROAD DEVELOPMENT LEVEL BY AREA

	Population (1000 persons)	Land Area (sq.km.)	Road Development Level											
			National Road				Local Road				All Public Roads			
			L/A (km/sq.km)	L/1000P (km/1000pop.)	L/ PA	Pave. Ratio (%)	L/A (km/sq.km)	L/1000P (km/1000pop.)	L/ PA	Pave. Ratio (%)	L/A (km/sq.km)	L/1000P (km/1000pop.)	L/ PA	Pave. Ratio (%)
Philippines	60,703	300,000	0.089	0.438	0.197	51.4	0.448	2.212	0.995	9.6	0.536	2.650	1.192	16.5
Luzon	33,365	141,320	0.095	0.402	0.195	56.4	0.431	1.826	0.887	13.5	0.526	2.228	1.083	21.3
Visayas	13,040	56,607	0.114	0.495	0.238	49.6	0.477	2.069	0.993	10.6	0.591	2.564	1.231	18.1
Mindanao	14,298	102,073	0.066	0.471	0.176	42.9	0.454	3.243	1.214	3.8	0.520	3.714	1.390	8.8
Region X	3,510	28,328	0.078	0.627	0.221	53.1	0.451	3.636	1.280	4.5	0.528	4.264	1.501	11.7
Region XI	4,459	31,693	0.063	0.448	0.168	38.4	0.435	3.089	1.159	3.1	0.498	3.537	1.327	7.6
Study Area (Regions X & XI)	7,967	60,021	0.070	0.527	0.192	46.1	0.442	3.331	1.214	3.8	0.512	3.858	1.406	9.6

Luzon : NCR, CAR, Regions I, II, III, IV-A, IV-B, and V
Visayas : Regions VI, VII and VIII
Mindanao : Regions IX, X, XI and XII

Population : 1990
L/A = Road Length per Land Area
L/1000P = Road Length per 1,000 population
L/ PA = Road Length / Population in 1000 x Land Area
Pave. Ratio = Paved Road Length with PCC and AC/Road Length of All Surface Types

Study Area

- Road density of national roads in the Study Area is almost the same level as the national average, however, pavement ratio is much lower than the national average.

- Although quantitative development (or road density) of local roads is higher level than the national average, qualitative development (or pavement ratio) is much behind the national average.

4.1.2 National Arterial Road Network

National arterial road network in Mindanao is shown in Figure 4.1-1, which consists of the following:

National Arterial Roads	Length (km)
North-South Backbones	1,861
East-West Laterals	782
Other Roads of Strategic Importance	2,363
Total	5,006

Pan-Philippine Highway in Mindanao (the Study Road) constitutes one of the most important North-South Backbones and its length shares about 20% of total length of North-South Backbones in Mindanao. It is quite important to make the Study Road functional throughout the year in order to vitally support the sound development of Mindanao.

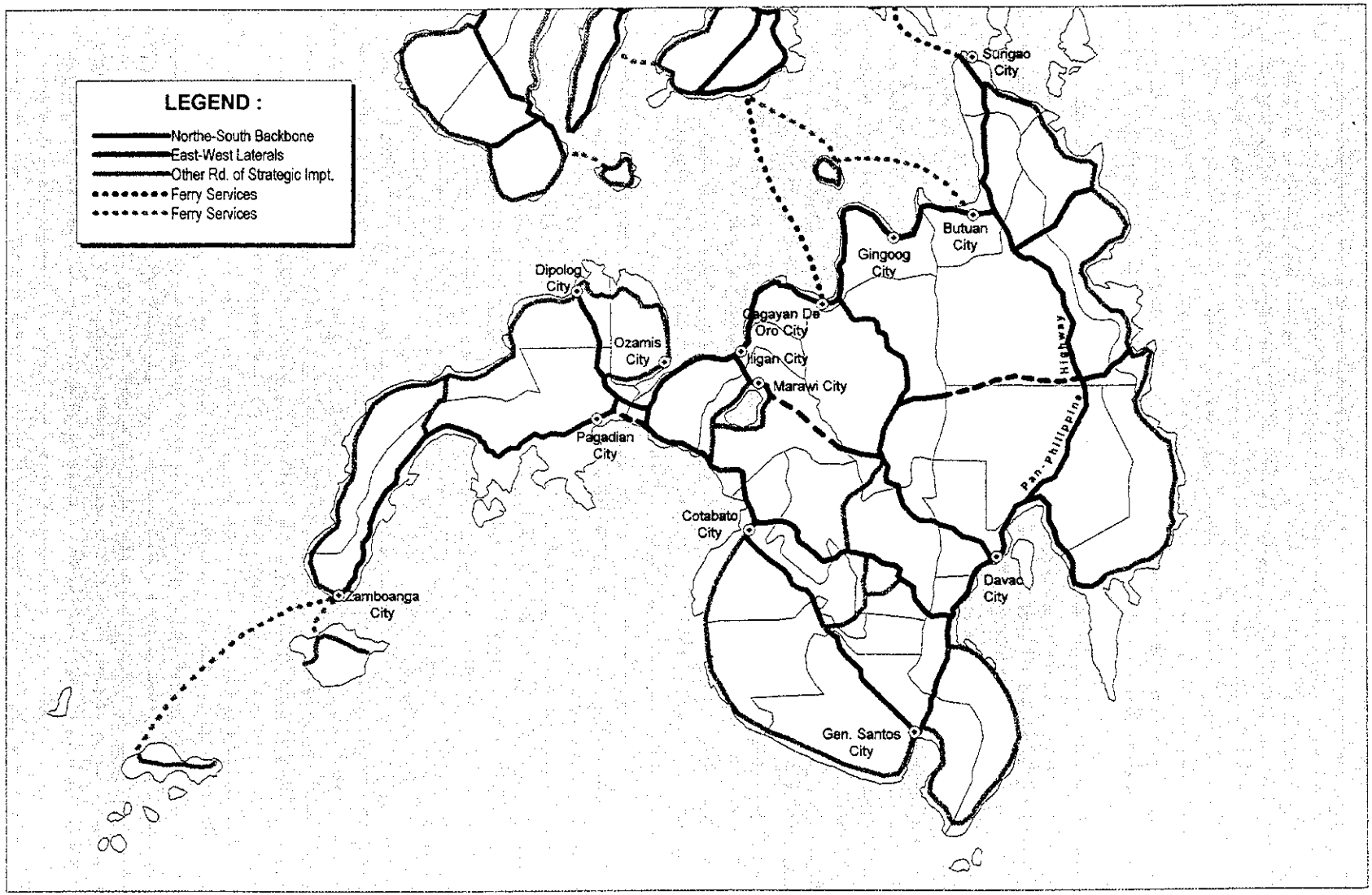


FIGURE 4.1 - 1 NATIONAL ARTERIAL ROAD NETWORK IN MINDANAO

4.2 OTHER TRANSPORT FACILITIES

Sea Transport

In Mindanao Island, there are 19 national ports of which locations are shown in Figure 4.2-1 and cargo throughput and passenger traffic in 1990 are presented in Table 4.2-1. Shipping routes from/to Mindanao are presented in Figure 4.2-2.

TABLE 4.2-1 NATIONAL PORTS IN MINDANAO ISLAND

PORT	Region	Cargo Throughput (1000 ton)	Passenger Traffic (1,000 persons)
Pagadian	IX	71	294
Pulawan	IX	128	255
Zamboanga City	IX	710	1,265
Butuan	IX	12	-
Cagayan de Oro	X	1,483	858
Dapa	X	13	43
Jimenez	X	48	-
Masao	X	24	-
Nasipit	X	465	586
Ozamis City	X	441	395
Surigao City	X	175	378
Mati	XI	19	-
Sasa	XI	1,451	-
Sta. Ana	XI	130	107
General Santos	XI	No Data	No Data
Bislig	XI	No Data	No Data
Iligan City	XII	352	218
Cotabato City	XII	No Data	No Data
Ilagan	XII	No Data	No Data

SOURCE: DPWH Infrastructure Atlas, 1991

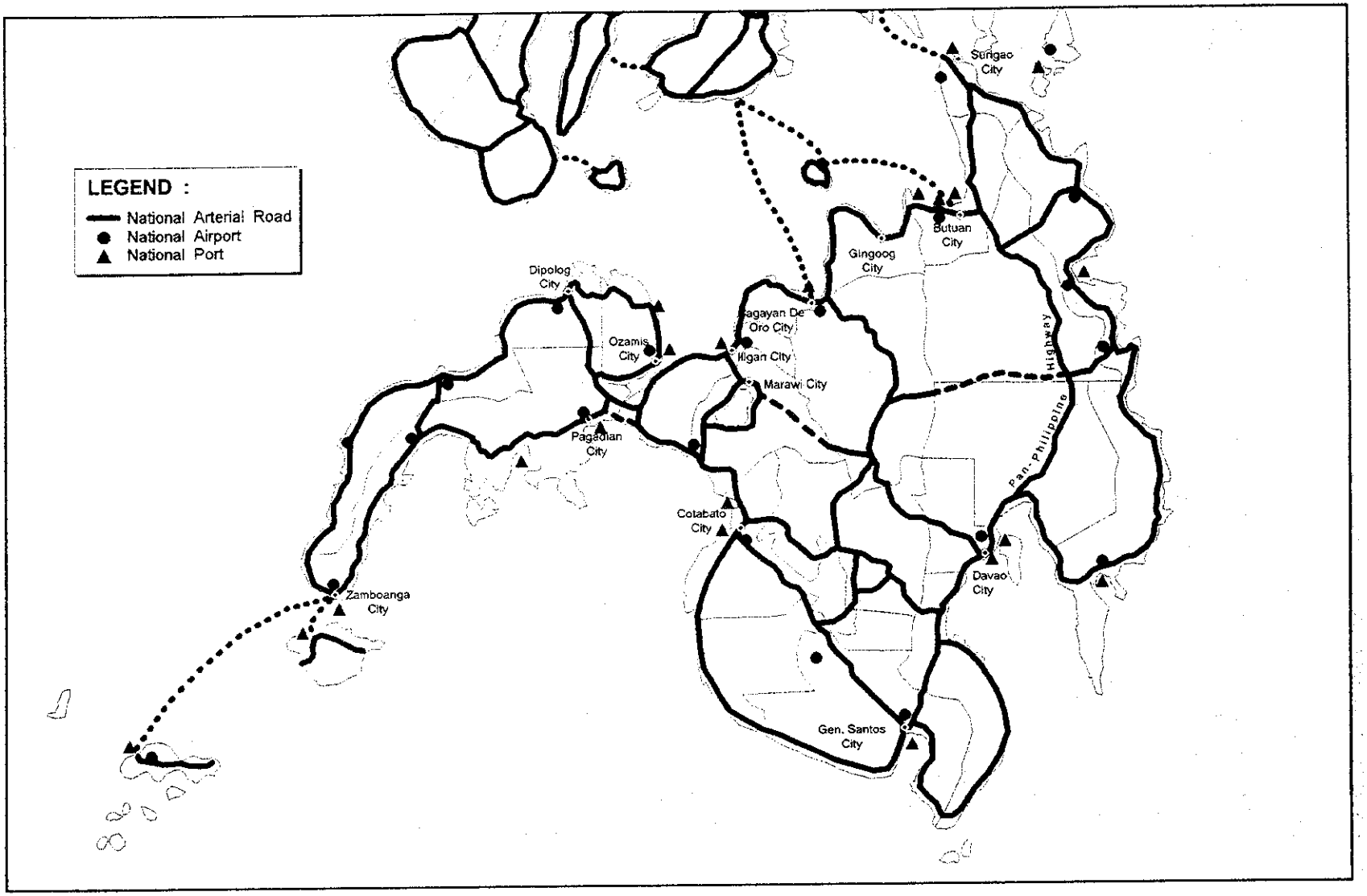


FIGURE 4.2 - 1 TRANSPORT FACILITIES IN MINDANAO OTHER THAN ROADS

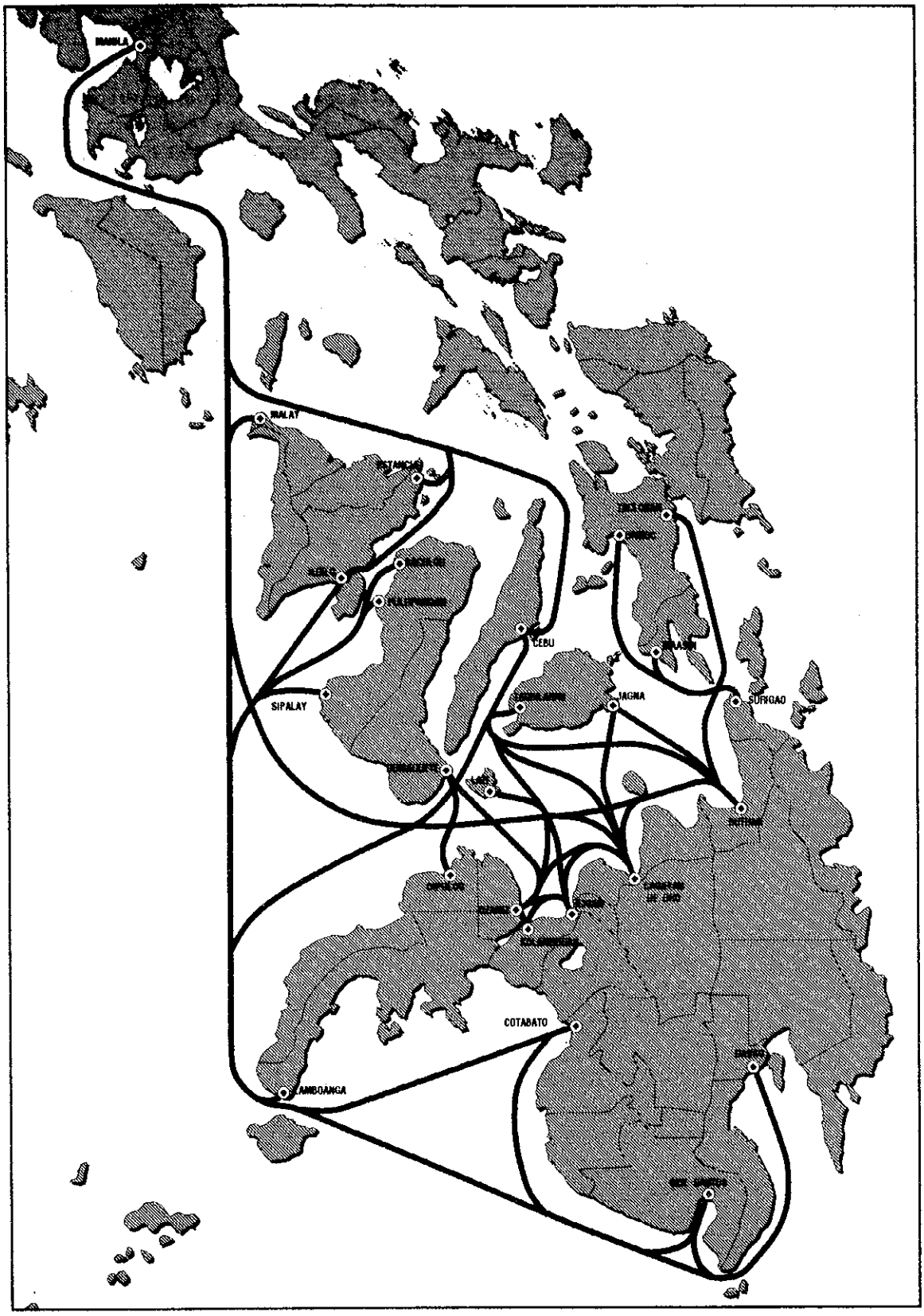


FIGURE 4.2 - 2 SHIPPING ROUTES FROM / TO MINDANAO PORTS

Air Transport

There are 21 national airports consisting of two alternate international, three trunkline, 12 secondary and four feeder airports. Location of national airports is shown in Figure 4.2-1. Passenger traffic in 1989 of above airports is shown in Table 4.2-2. Air routes from/to Mindanao are presented in Figure 4.2-3.

TABLE 4.2-2 NATIONAL AIRPORTS IN MINDANAO ISLAND

Airport	Classification	Passenger Traffic (1,000 persons)
Davao City	Alternative International	636
Zamboanga City	- " -	461
Cagayan de Oro	Trunk Line	286
Cotabato	- " -	144
Gen. Santos	- " -	52
Allah Valley	Secondary	8
Bislig	- " -	No Data
Butuan	- " -	50
Calapan	- " -	-
Dipolog	- " -	67
Mati	- " -	No Data
Ozamis	- " -	17
Pagadian	- " -	52
Iligan	- " -	43
Malabang	- " -	No Data
Surigao	- " -	28
Tandag	- " -	15
Siargao	- " -	No Data
Siocon	- " -	10
Ipil	- " -	5
Liloy	- " -	-

SOURCE: DPWH Infrastructure Atlas, 1991

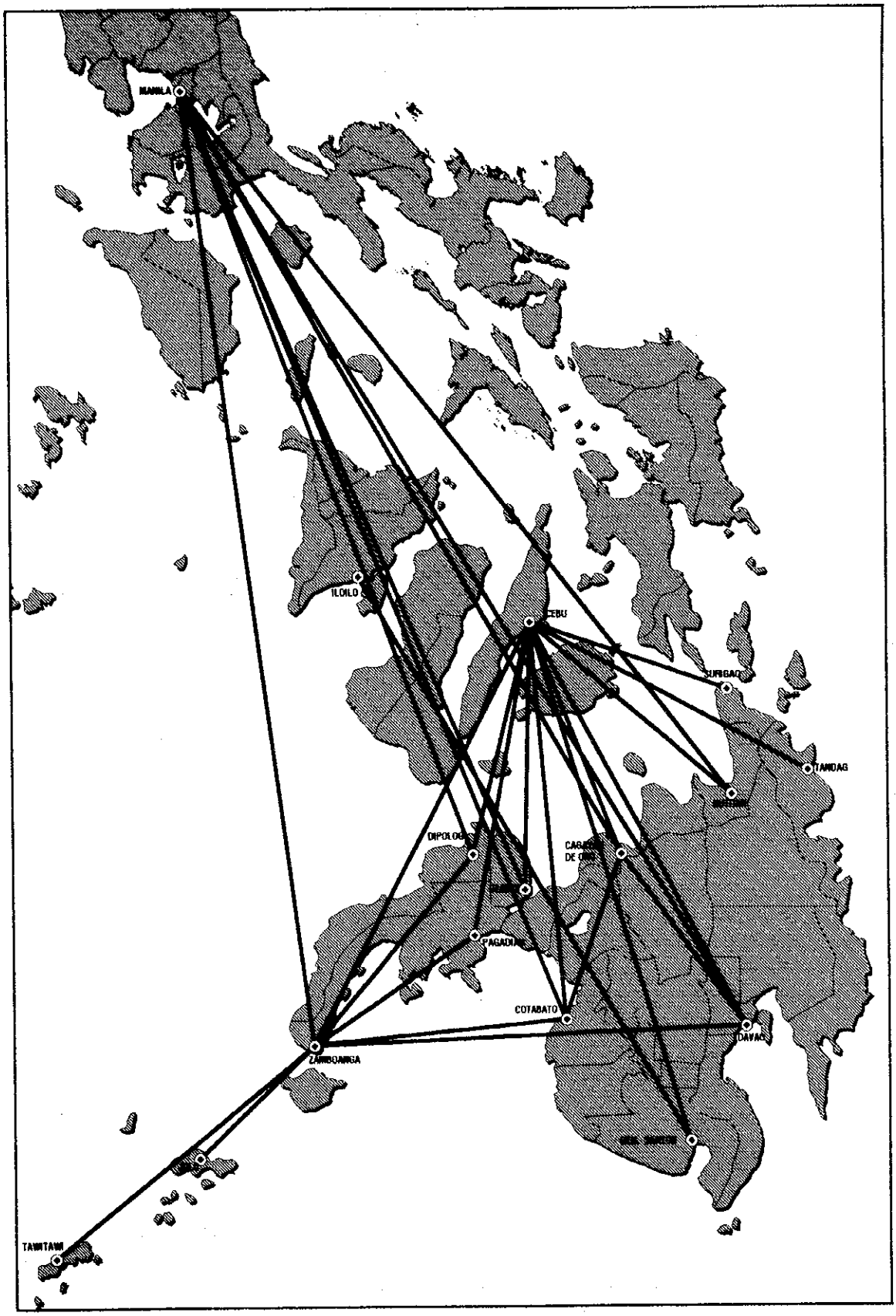


FIGURE 4.2 - 3 AIR ROUTES FROM / TO MINDANAO AIRPORTS

CHAPTER 5

PRESENT TRAFFIC

5.1 TRAFFIC SURVEY

In order to grasp characteristics of the existing traffic on the Study Road, the following traffic surveys were conducted in April and May 1994:

- Traffic counts,
- Travel speed survey,
- Axle load survey
- Commodity OD survey, and
- Collection of various traffic data.

5.1.1 Traffic Counts

Based on the findings of the reconnaissance survey undertaken in early April 1994, the Study Road was divided into 24 homogeneous sections in terms of traffic characteristics. Traffic counts were carried out at each of the points that represents the homogeneous section and at the Junction Ampayon that connects the Butuan-Cagayan de Oro-Iligan Road with the Study Road. Location of traffic count stations are shown in Figure 5.1-1.

At four (4) stations located on the provincial boundaries (Stations 3,9,16 and 23), counts were conducted on weekdays for two consecutive days, while counts at remaining 21 stations were undertaken for one day. The counts start at 6:00 AM and end at 6:00 PM on each day.

Traffic volume was manually counted using the field sheet shown in Appendix 5.1 for all the passing vehicles classifying them into the following types:

- Car/Taxi/Jeep
- Jeepney
- Pick - up/Van
- Mini Bus
- Large Bus
- Truck (2-axle)
- Truck (3 axle)
- Truck (4 or more axle)
- Motor tricycle
- Motorcycle
- Special vehicle

5.1.2 Travel Speed Survey

The survey was conducted by measuring the time spent for travelling the each homogeneous section and recording the causes of delays and stops during the travel.

The Study Road with a total length of 402.6 kilometers was divided into three segments each of which included 7 to 10 homogeneous sections. The survey on the each segment was conducted on weekdays for two consecutive days. One and a half round trips were made along each segment a day, and total

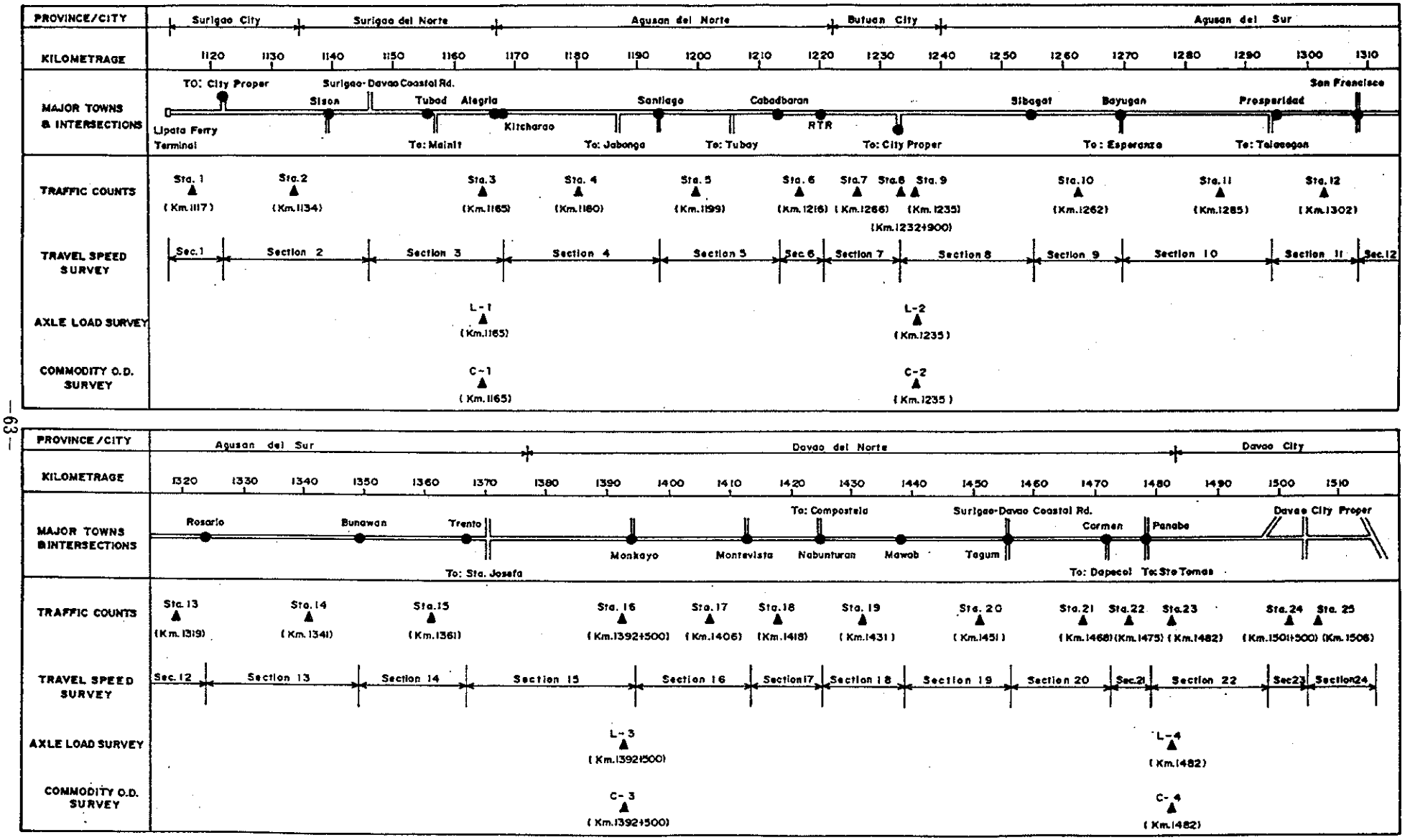


FIGURE 5.1-1 TRAFFIC SURVEY STATIONS

three trips were made in two days. A passenger car, used as a test vehicle, ran at the floating speed. An average travel speed of each section was obtained dividing the section length by the travel time. The field sheet is presented in Appendix 5.2

5.1.3 Axle Load Survey

The axle load survey was carried out at four (4) stations located at the following provincial boundaries.

Station L-1: between Surigao del Norte and Agusan del Norte

Station L-2: between Agusan del Norte(Butuan City) and Agusan del Sur

Station L-3: between Agusan del Sur and Davao del Norte, and

Station L-4: between Davao del Norte and Davao City

The survey at each station was conducted in two directions on two consecutive weekdays for twelve-hours (6:00AM - 6:00PM). Trucks, semi-trailers and buses were weighted by using two portable loadometers, and recorded in the field sheet shown in Appendix 5.3. The vehicles to be weighted were sampled at random.

5.1.4 Commodity OD Survey

Simultaneously with the axle load survey, the roadside commodity OD survey was conducted. Drivers of trucks, semi-trailers and truck trailers were interviewed on the following items:

- Vehicle type
- Type of fuel
- Origin of trip
- Destination of trip
- Type of commodity loaded
- Commodity weight

Results were recorded in survey sheet shown in Appendix 5.4 in the field and encoded afterward in the office.

5.1.5 Data Collection

Various traffic data were obtained from agencies in the provinces concerned as well as in Metro Manila. Major data collected were as follows:

a. Routes and frequency of long distance bus services (Bus companies in Surigao City, Butuan City and Davao City)

b. Number of vehicles carried by ferryboat service between Lipata and Liloan (Ferryboat company),

c. Number of motor vehicles registered (Land Transportation Offices in Region X and XI), and

d. Traffic accident data (Philippine National Police, Provincial Commands).

5.2 TRAFFIC VOLUME AND CHARACTERISTICS

5.2.1 Traffic Volume

1) Fluctuation Factors

Under the National Traffic Count Program (NTCP) in 1992, the DPWH conducted traffic counts at 22 stations (18 coverage stations and 4 seasonal stations) along the Study Road. At the seasonal stations, 24 hours counts on Wednesday and 12 hours counts on the other 6 days of the week were carried out in every month. Fluctuation factors explaining the hourly, daily and monthly traffic variations were determined on the basis of the survey results. The hourly factors are applied to convert the 12-hour traffic count data into 24-hour volumes and other factors are applied to convert the 24-hour volume into the annual average daily traffic (AADT). The fluctuation factors applied to the count data of each station are shown in Appendix 5.5

2) AADT

Traffic Volume by Section

Figure 5.2-1 shows annual average daily traffic (excluding tricycles and motorcycles) in 1994 and Table 5.2-1 presents the volume by vehicle type on the Study Road. Traffic on the Study Road is obviously influenced by three urban centers; i.e. Surigao City, Butuan City and Davao City. Sections adjacent to these centers have heavier traffic volume. Section 22 (between Panabo, Davao del Norte and Junction Panakan in Davao City) has the heaviest traffic volume of 8,067 vehicle per day, followed by Section 21 (between Carmen, Davao del Norte and Panabo) and Section 23 (Davao City Diversion Road between Panakan and Buhangin), traffic volume on the sections between Sison, Surigao del Norte and Cabadbaran, Agusan del Norte, as well as the section in the Southern Agusan del Sur are quite low. They are less than 1,000 vehicle per day.

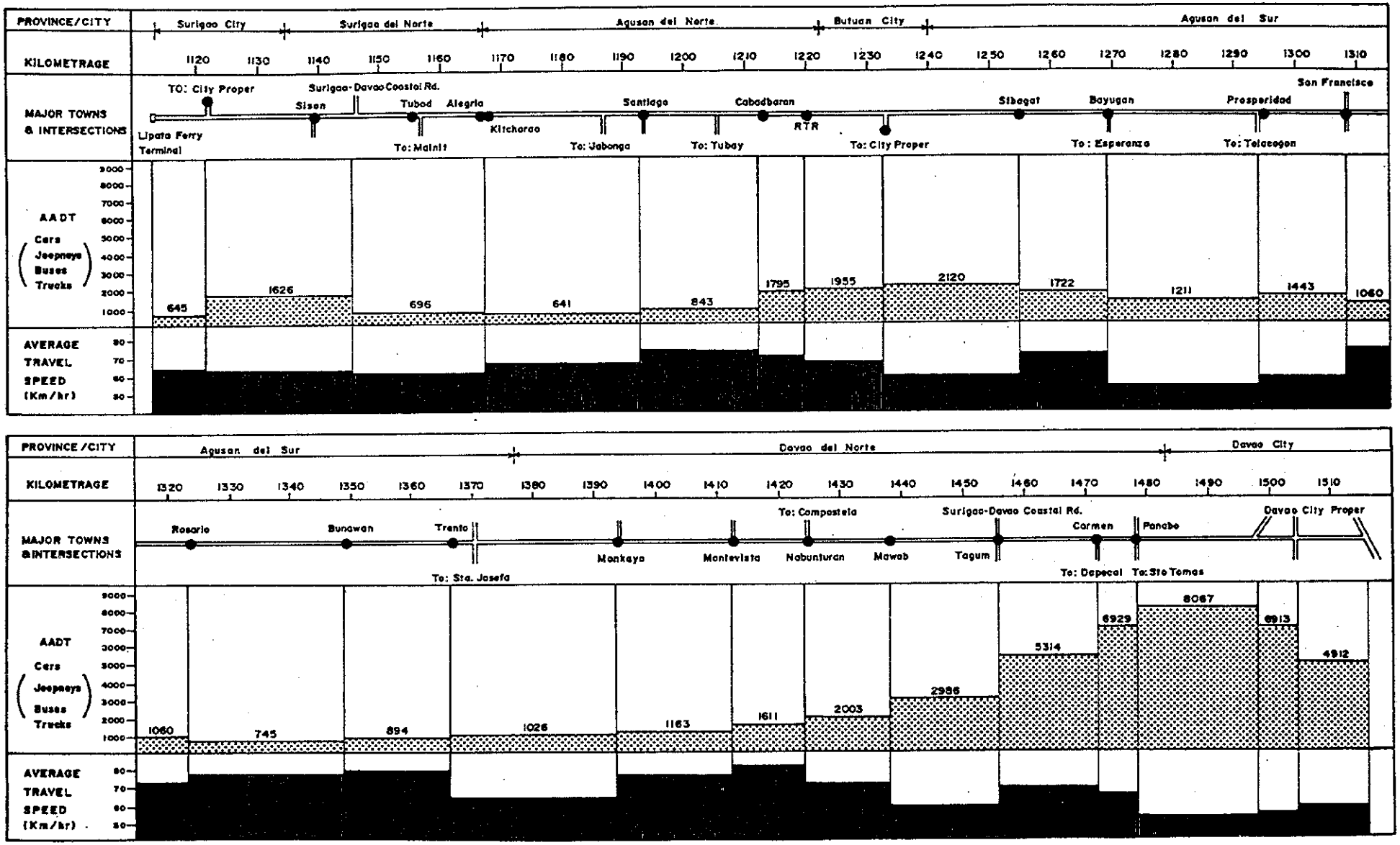


FIGURE 5.2-1 AADT (1994) AND AVERAGE TRAVEL SPEED

TABLE 5.2-1 ANNUAL AVERAGE DAILY TRAFFIC

Section	4 or more Wheels Vehicle									Others			Total
	Car, Taxi & Jeep	Pick-up & Van	Jeepney	Mini-bus	Large Bus	Truck (2-axle)	Truck (3-axle)	Trailers	Sub-total	Tricycle	Motor-cycle	Special Vehicle	
01	79	172	115	0	41	168	70	0	645	449	199	1	1,294
02	133	239	595	0	61	242	352	4	1,626	16	134	3	1,779
03	69	167	241	0	68	116	33	4	698	5	82	0	785
04	78	122	194	0	61	140	36	10	641	7	49	0	697
05	76	176	312	0	73	143	49	14	843	4	91	0	938
06	419	193	673	0	70	304	117	19	1,795	73	278	27	2,173
07	276	495	635	0	74	323	134	18	1,955	40	186	6	2,187
08	238	474	782	0	164	349	102	11	2,120	39	250	5	2,414
09	181	366	495	0	189	395	80	16	1,722	134	195	3	2,054
10	121	338	225	0	184	239	90	14	1,211	6	156	2	1,375
11	139	415	293	0	175	294	116	11	1,443	33	291	6	1,773
12	194	192	264	0	115	201	46	48	1,060	72	794	78	2,004
13	223	111	101	0	119	109	48	34	745	8	178	3	934
14	129	242	151	0	120	155	56	41	894	20	549	16	1,479
15	106	299	113	0	153	242	65	48	1,026	202	633	4	1,865
16	132	364	126	0	183	220	90	48	1,163	11	450	4	1,628
17	206	443	157	0	305	310	101	89	1,611	80	511	4	2,206
18	426	429	157	0	318	408	148	117	2,003	20	605	7	2,635
19	331	698	332	31	457	726	239	172	2,986	1,050	1,110	10	5,156
20	1,256	1,112	515	119	786	1,025	316	185	5,314	153	947	3	6,417
21	1,446	1,361	957	500	543	1,247	415	460	6,929	1,016	1,595	3	9,543
22	1,481	1,803	1,733	231	709	1,385	568	157	8,067	147	651	1	8,866
23	1,282	1,384	2,237	0	442	824	527	217	6,913	15	858	9	7,795
24	1,059	1,416	0	0	291	1,157	665	324	4,912	265	806	32	6,015

Source : Study Team

TABLE 5.2-2 DIRECTIONAL AADT 1994 AT JUNCTION AMPAYON

Leg	Direction	AADT by Vehicle Type												
		Cars & Vans	Pickups	Jeep-neys	Large Buses	Trucks (2-axle)	Trucks (3-axle)	Trailer	Sub-total	Tricycle	Motor-cycle	Special	Sub-total	Total
Surigao Leg	Surigao to Davao	15	26	13	2	32	25	1	116	0	19	0	19	135
	Surigao to Butuan	224	251	376	27	228	113	6	1,225	54	282	4	341	1,566
	Total	239	277	389	29	260	138	7	1,341	54	302	4	360	1,701
Davao Leg	Davao to Butuan	96	260	288	84	135	31	6	900	12	116	2	129	1,029
	Davao to Surigao	19	45	16	2	25	13	0	121	4	43	2	49	170
	Total	115	305	305	86	160	44	6	1,021	15	159	4	178	1,198
Butuan Leg	Butuan to Surigao	141	301	316	33	183	129	2	1,106	25	162	3	189	1,296
	Butuan to Davao	139	304	262	81	180	56	6	1,028	11	122	4	136	1,164
	Total	280	605	578	114	363	186	8	2,134	35	284	6	326	2,460

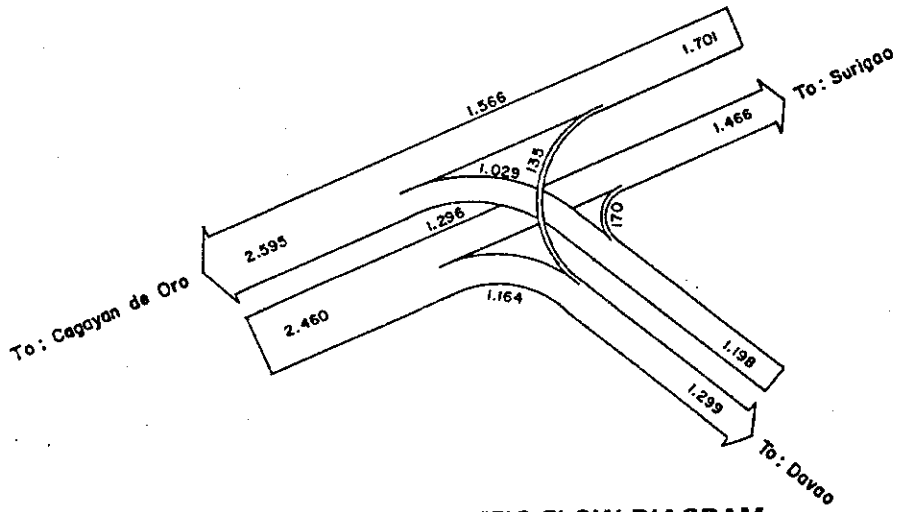


FIGURE 5.2-2 DIRECTIONAL TRAFFIC FLOW DIAGRAM AT JUNCTION AMPAYON IN BUTUAN

Peak hour ratio (ratio of peak hour traffic volume to daily traffic volume) of each section ranges from 5.2% to 12.8%. Sections north of Butuan City have relatively higher ratio, while sections south of Tagum have lower ratio. The highest rate of 12.8% is found in Section 5 and the lowest rate of 5.2% is in Section 24.

Directional variation of traffic volume at the peak hour is generally small. Ratio in percent of traffic volume of each direction ranges from 50:50 to 55:45, excluding the sections 4, 5 and 8 where the ratio is about 65:35.

Directional Traffic Flow at Junction Ampayon

Table 5.2-2 and Figure 5.2-2 present the directional traffic flows at the Junction Ampayon, Butuan City. About 92% of the traffic coming from the Surigao leg goes to the Butuan leg, while about 86% of the traffic from the Davao leg goes to the Butuan leg. These flows show that most of the traffic entering this junction, even the traffic not having their origins or destinations in Butuan City, drop in at Butuan City, drop in at Butuan city proper.

AADT boarding the Ferryboat between Lipata and Liloan

The Mindanao Section of the Pan-Philippine Highway is connected with the Leyte Section by the Lipata-Liloan Ferryboat service. The ferryboat plies across the Surigao Strait with one round trip a day. As shown in Table 5.2-3, the ferryboat carries 33 vehicles in annual average daily traffic basis.

TABLE 5.2-3 AADT ON LIPATA-LILOAN FERRYBOAT

	Private Car	Com'l Vehicle	Bus	Truck	Try/Mcy and others	Total
January	84	313	309	252	64	1,022
February	40	227	183	204	53	707
March	39	347	323	354	32	1,095
April	101	497	339	356	59	1,352
May	130	604	358	418	84	1,594
June	61	130	243	320	235	989
July	49	113	244	179	157	742
August	36	86	365	159	158	804
September	62	105	317	233	141	858
October	45	106	370	254	137	912
November	38	89	338	203	181	849
December	91	284	316	290	34	1,015
Total	776	2,901	3,705	3,222	1,335	11,939
AADT	2	8	10	9	4	33

SOURCE: PSEI Transport Corp.

3) Levels of Service

In the Feasibility Study of the Road Improvement Project on the Pan-Philippine Highway (RIPPH), September 1987, "Levels of Service" was used as a measure to evaluate traffic operational conditions, and methodologies presented in " Highway Capacity Manual, Highway Research Board, 1985" (HCM, 1985) were applied with modification to suit the road and traffic conditions in the Philippines.

The concept of "Levels of Service" is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by road users. Six levels of service are defined with level-of-service "A" representing the best operating conditions and level-of-service "F" the worst. Definition of each level of service is as follows:

"A" :- Free Flow
- Freedom to select desired speeds and to manuever is extremely high

- General level of comfort and convenience is extremely high

"B" :- Stable flow
- Freedom to select desired speeds is relatively unaffected, but there is a light decline in the freedom to manuever

- Level of comfort and convenience is somewhat less than "A"

"C" :- Stable flow
- Selection of speed is affected by the presence of other, and maneuvering requires substantial vigilance

- General level of comfort and convenience declines noticeably

"D" :- High density, approaching unstable flow but in the range of stable flow

- Speed and freedom to maneuver are severely restricted

- Road users experience a generally poor level of comfort and convenience

- Small increase in traffic flow will generally cause operational problems

"E" - Unstable flow

-Operational conditions at or near capacity level

- All speeds are reduced to a low but relatively uniform value

- Freedom to manuever is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accomodate such maneuvers

- Comfort and convenience levels are extremely poor and driver or pedestrian frustration is generally high

"F" - Forced or breakdown flow
- Operations are characterized by stop-and-go waves
- Arrival flow exceeds discharge flow which causes the queue to form

The RIPPH study also established appropriate "improvement levels", which is defined as the minimum allowable level of traffic operational conditions to be maintained by the Pan-Philippine Highway in order to fully fulfill its roles and functions as the most important trunk road in the country. The recommended improvement levels are as follows:

For rural sections: Latter stage of level-of-service "D"

For urban sections: Early stage of level-of-service "E"

In accordance with the methodologies recommended in the RIPPH study, the present levels-of-service of the Study Road is assessed as shown in Figure 5.2-3. All sections of the Study Road, with the exception of Section 24 (Davao City Diversion Road between Junctions Buhangin and Davao-Digos Road), have provided acceptable levels-of-service so far. Due to high heavy vehicles rate and steep grades of the section, Section 24 provides level-of-service "E".

5.2.2 Travel Speed

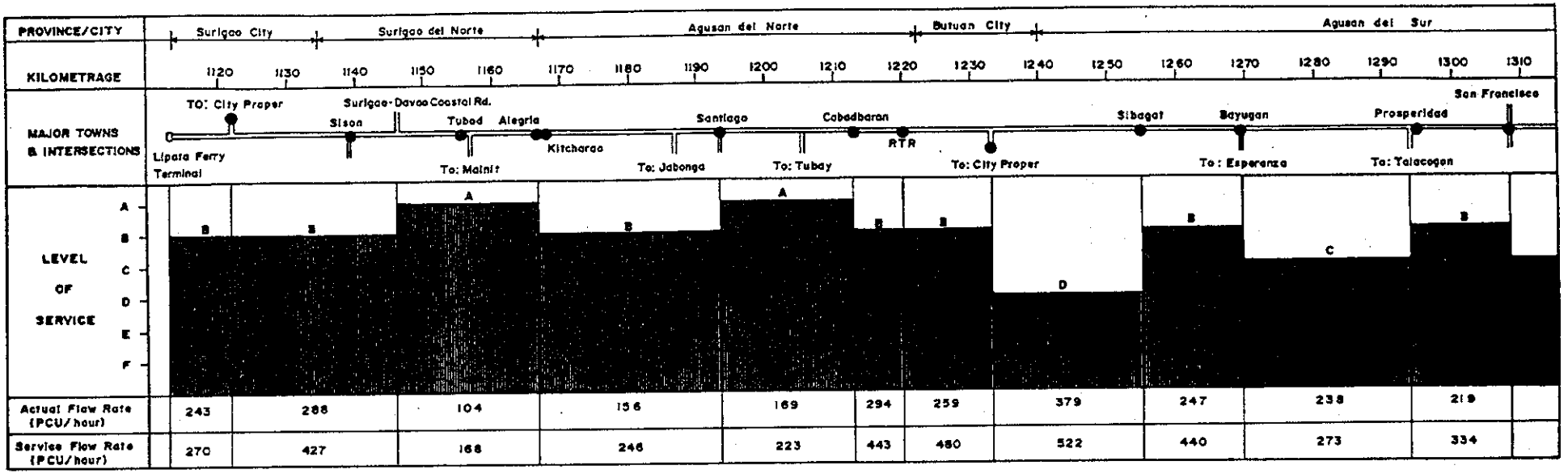
As shown in Figure 5.2-1 and Appendix 5.6 average travel speeds in the sections are generally high, mostly over 60 kilometers per hour (kph) ,except the following sections:

- Section 10 (Bayugan-Prosperidad) with an average travel speed of about 50 kph due to very poor road surface condition.

- Sections 22 and 23 (Panabo-Jct. Buhangin in Davao City Diversion Road) with average travel speeds of about 50 kph due to heavy traffic volume and roadside friction.

Although an average travel speed in Section 24 (Jct. Buhangin - Jct. Davao-Digos Road) is recorded at 58 kph for passengers cars, that for heavy vehicles is expected to be low because of steep grades.

In most of the sections, slow vehicles such as heavily loaded trucks and tricycles are the major cause for the ordinary vehicle to be forced to lower its speed. Steep bridge approaches are another causes which often occur along the Study Road. In the sections located in Agusan del Sur, the deteriorated road pave-



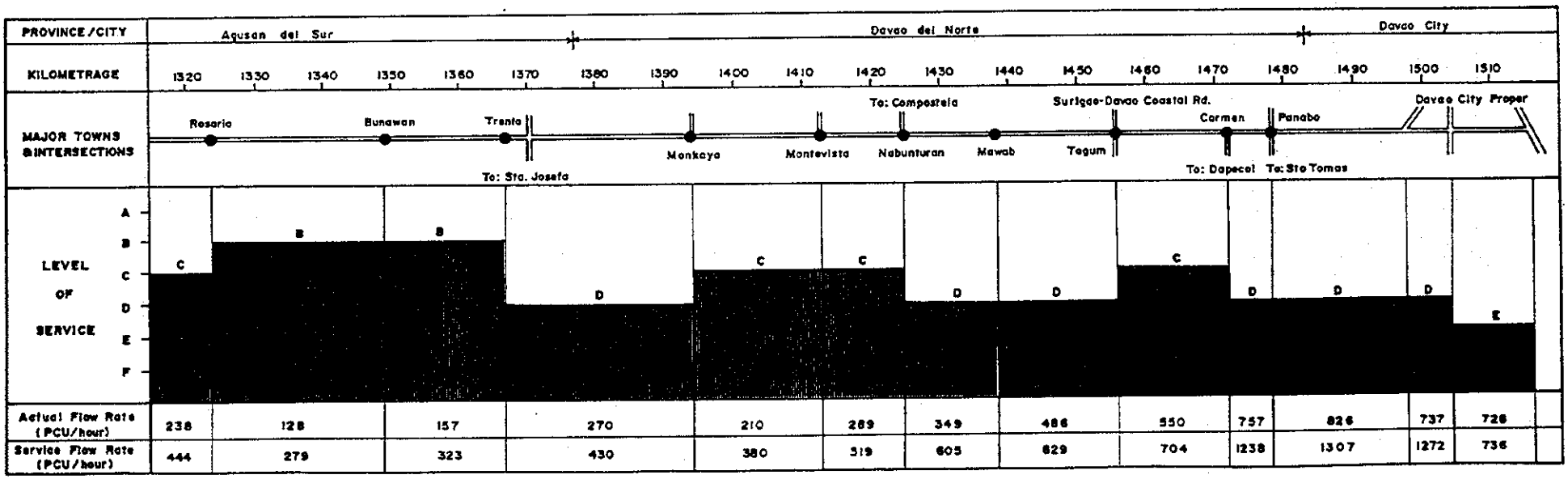


FIGURE 5.2-3 PRESENT LEVEL OF SERVICE

ment also let the vehicle slow down frequently. Major causes of slow downs and stops in each section are summarized in Appendix 5.7

5.2.3 Commodity Flow

Based on the traffic count results and the fluctuation factors, the commodity volume obtained from the commodity O-D survey are converted into an annual average daily volume of the commodity transported through each survey station. Volume of commodities by type and direction are presented in Appendix 5.8 and summarized in Table 5.2-4. The O-D matrices of major commodities as well as the matrix of the total commodities are prepared as shown in Appendices 5.9 to 5.10 adopting the traffic zone systems presented in Appendices 5.11 to 5.14. The characteristics of the inter-provincial commodity flows are as follows:

1) Survey Station C-1: Surigao del Norte - Agusan del Norte

A total of 530.8 tons of commodities are transported crossing the provincial boundary between Surigao del Norte and Agusan del Norte. Of the total, 242.1 tons or 45.6% are conveyed in the direction from Surigao City to Butuan City, while 288.7 tons or 54.4% are in the opposite direction.

Building and construction materials, mostly cement, predominate the commodities transported to the south. As for commodities in the direction to the north, manufactured foodstuffs have the largest share in terms of weight, and are followed by mineral oil products (diesel oil) and agricultural products. There is quite big difference in the empty truck ratio (ratio of empty trucks to all trucks) between directions. Fifty three percent of trucks bound for south are empty trucks, while only 17 percent are empty in the direction to the north.

O-D patterns of the total commodities are graphically shown in Figure 5.2-4. Most of the commodities (89% of commodities bound for south and 85% bound for north) have their origin or destination in Surigao City. As for the southern extent of trips, there are three large trip generation/attraction centers, i.e. Butuan City, Cagayan de Oro City and Cabadbaran, which are folowed by Davao City.

2) Survey Station C-2 : Agusan del Norte - Agusan del Sur

A total volume of commodities transported beyond the provincial boundary of Agusan del Norte and Agusan del Sur in 1994 are 1,583.2 tons per day, of which 712.8 tons or 45.0% are the south bound and the rest (870.3 tons per day) are the north bound.

Major commodities bound for Agusan del Sur in terms of weight are 298.0 tons per day of manufactured consumer goods (soft drinks, groceries,etc.), 202.9 tons per day of building and construction materials (stone and gravel), and 109.5 tons per day of mineral oil products (gasoline and diesel oil). Agricultural products including 141.7 tons per day of fresh fruits, 105.1 tons per day of milled rice, and 103.0 tons per day of palay, and forestry products (163.0 tons per day) are major commodities bound for Agusan del Norte. The empty truck ratios of trucks bound for south and north are 50% and 39%, respectively.

TABLE 5.2-4 COMMODITY VOLUME BY TYPE AND DIRECTION

(in ton/day)

Station	Type of Commodity	Volume of Commodity Transported		
		South Bound	North Bound	Total
C-1	Unprocessed Agricultural Products	14.6	56.9	71.4
	Processed Agricultural Products	4.5	26.5	31.0
	Manufactured Consumer Goods	16.4	100.2	116.7
	Forestry Products	4.9	0.5	5.4
	Mineral Oil Products	9.1	82.1	91.2
	Building & Construction Material	150.6	3.8	154.4
	Manufactured Producers Goods	0.0	12.3	12.3
	Empty Containers	42.0	6.4	48.3
	T o t a l	242.1	288.7	530.8
C-2	Unprocessed Agricultural Products	36.8	337.8	374.5
	Processed Agricultural Products	34.8	164.4	199.3
	Manufactured Consumer Goods	298.0	37.5	335.4
	Forestry Products	8.3	163.0	171.3
	Mineral Oil Products	109.5	11.2	120.7
	Building & Construction Materials	202.9	58.0	260.9
	Manufactured Producers Goods	16.9	6.2	23.1
	Empty Containers & Others	5.7	92.2	97.9
	T o t a l	712.8	870.3	1,583.2
C-3	Unprocessed Agricultural Products	221.3	98.6	319.9
	Processed Agricultural Products	70.0	107.1	177.1
	Manufactured Consumer Goods	46.6	87.4	134.0
	Forestry Products	132.4	9.6	142.0
	Mineral Oil Products	0.0	83.1	83.1
	Building & Construction Materials	2.8	266.9	269.7
	Manufactured Producers Goods	57.1	72.5	129.5
	Empty Containers	141.2	42.7	183.9
	T o t a l	671.4	767.8	1,439.3
C-4	Unprocessed Agricultural Products	1,897.7	486.4	2,384.1
	Processed Agricultural Products	702.2	522.8	1,225.0
	Manufactured Consumer Goods	575.8	1,168.6	1,744.4
	Forestry Products	556.2	99.1	655.3
	Mineral Oil Products	52.7	838.3	891.0
	Building & Construction Materials	2,335.9	876.6	3,212.5
	Manufactured Producers Goods	239.7	734.9	974.5
	Empty Containers	502.4	190.8	693.2
	T o t a l	6,862.5	4,917.5	11,780.0

Source : Study Team

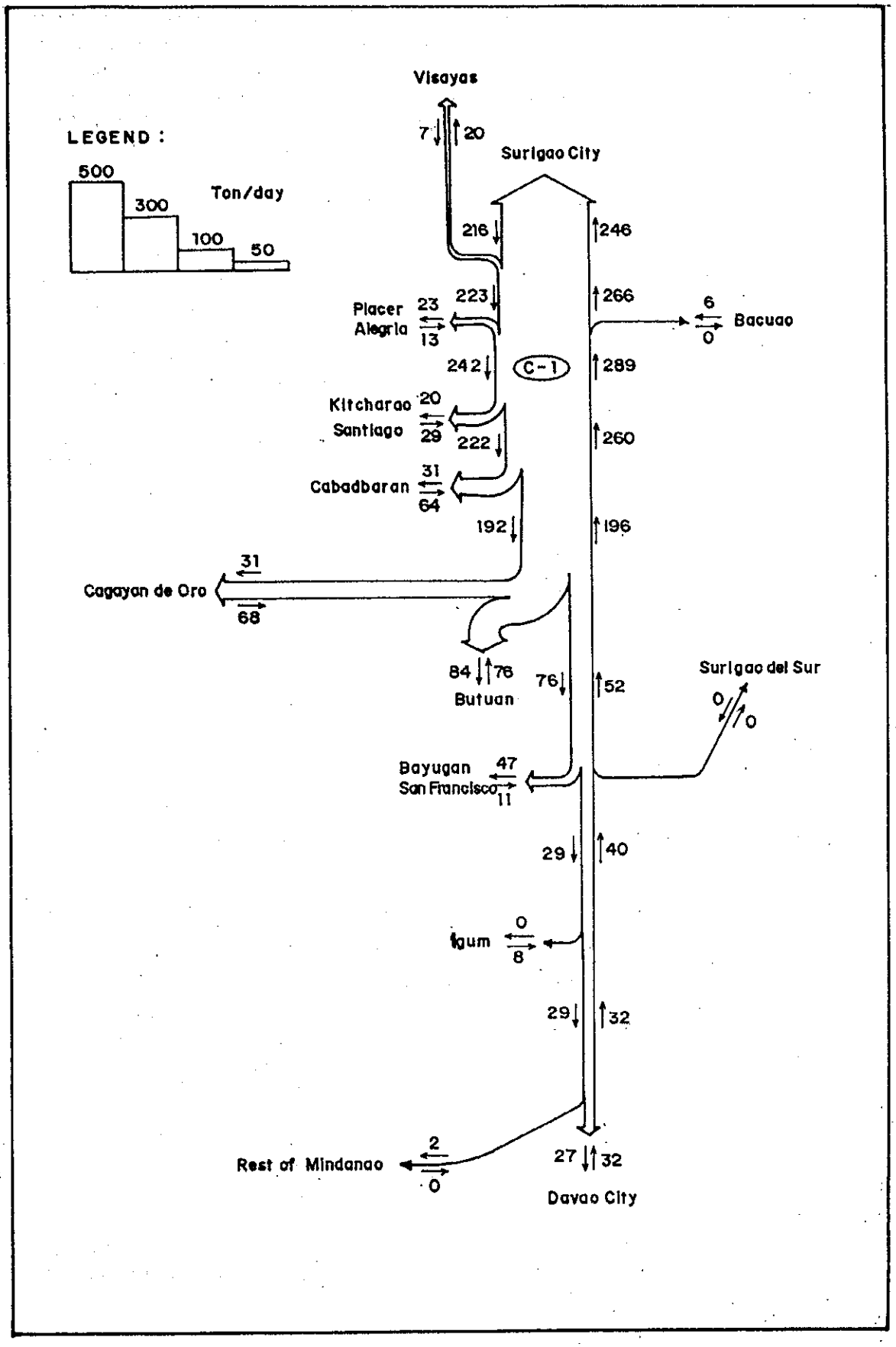


FIGURE 5.2-4 EXISTING COMMODITY FLOW AT C-1

As shown in Figure 5.2-5, Butuan City is the largest trip generation/attraction center. Bayugan and San Francisco in the south, Cabadbaran in the north and Cagayan de Oro City in the east are also large trip generation /attraction centers. Forestry products from Agusan del Sur are conveyed mostly to Cabadbaran and Butuan City. Mineral oil products are distributed from Butuan City, Cabadbaran and Nasipit to towns in Agusan del Sur and Surigao del Sur.

3) Survey Station C-3: Agusan del Sur - Davao del Norte

About 1,439.3 tons of commodities transported daily crossing the provincial boundary of Agusan del Sur and Davao del Norte. About 671.4 tons (or 47% of the total) are bound for south and the rest (767.8 tons) are bound for north.

Among the commodities bound for south, unprocessed agricultural products (palay, seafood and fresh fruits), forestry products and empty containers are predominant in terms of weight. They are 221.3, 132.4 and 141.2 tons per day respectively. As to the north bound, building and construction materials (sand and gravel) predominate with a weight of 266.9 tons per day. The empty truck ratios are 53% for south bound and 42% for north bound.

Figure 5.2-6 shows O-D distribution of the total commodities passing the survey station C-3. About 59% of commodities bound for south have their destination in Davao City and about 67% of those bound for north have their trip origin in Davao City. Another trip ends of such commodities are distributed in the whole Region X and Surigao del sur as well.

4) Survey Station C-4: Davao del Norte - Davao City

Comparing with the other three stations, volume of commodities transported passing the station C-4 is exceedingly large and totals to 11,780 tons per day. Unbalanced directional distribution (58% in south bound and 42% in north bound) is observed.

Volume of building and construction materials (mainly stone and gravel) and unprocessed agricultural foodstuffs (mainly fresh fruits) are conspicously large in the commodity flow toward Davao City. In the flow from Davao City, on the other hand, manufactured consumer goods (groceries, beer, soft drinks, etc) with a total volume of 1,168.6 tons per day, building and construction materials (cement, iron and steel products) with a total volume of 876.6 tons per day, mineral oil products with 838.3 tons/day and manufactured producers goods with 734.9 tons/day are the major commodites. The empty truck ratios and average loading (without empty trucks) in this section are as follows:

a. Empty truck ratio : 28% for south bound
   36% for north bound

b. Average loading : 9,427 kgs per truck
   7,045 kgs per truck

The commodity flow in this section is strongly influenced by Davao City (Figure 5.2-7). About 78% of the total commodity volume have their trip origins or destinations in Davao City.

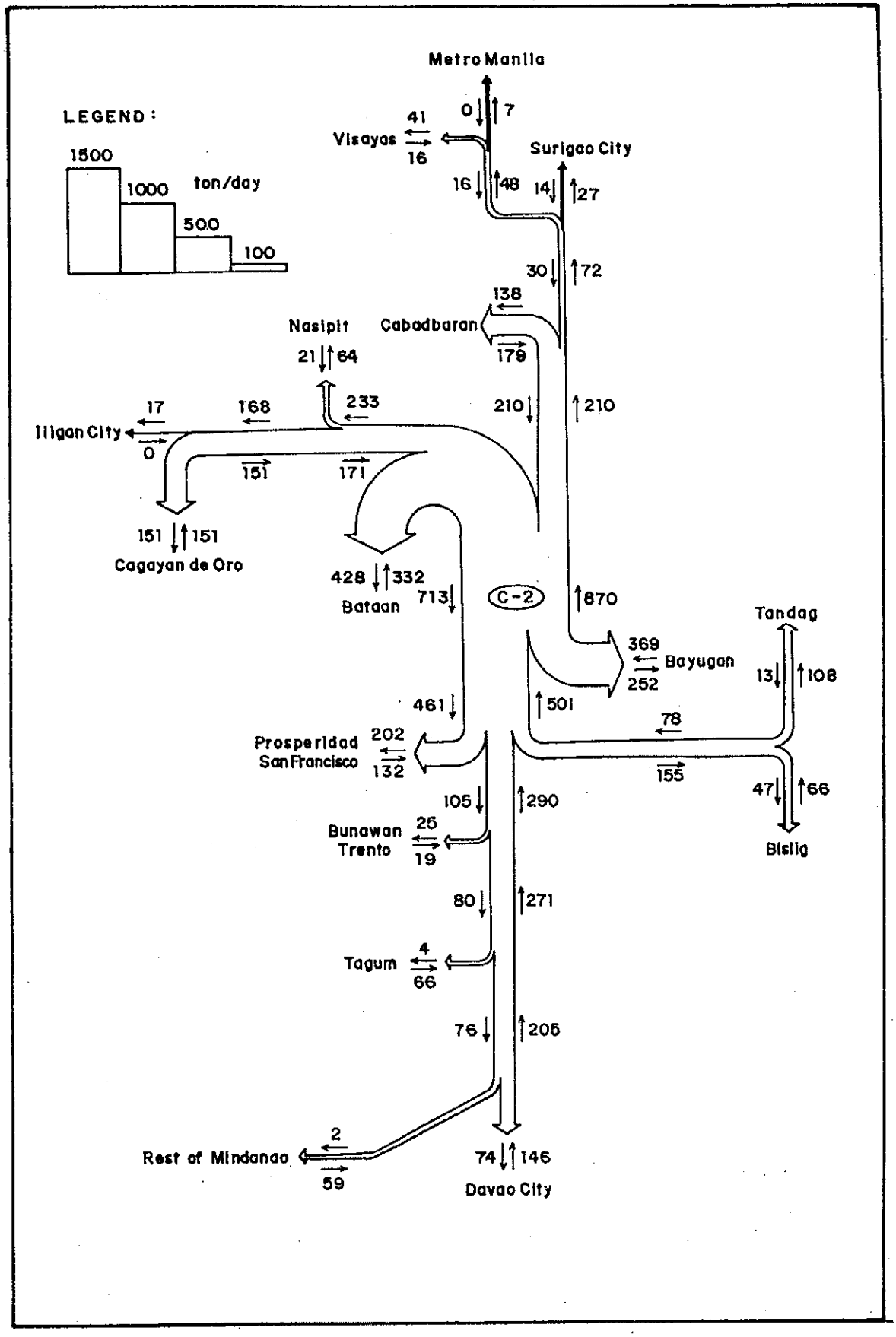


FIGURE 5.2-5 EXISTING COMMODITY FLOW AT C-2

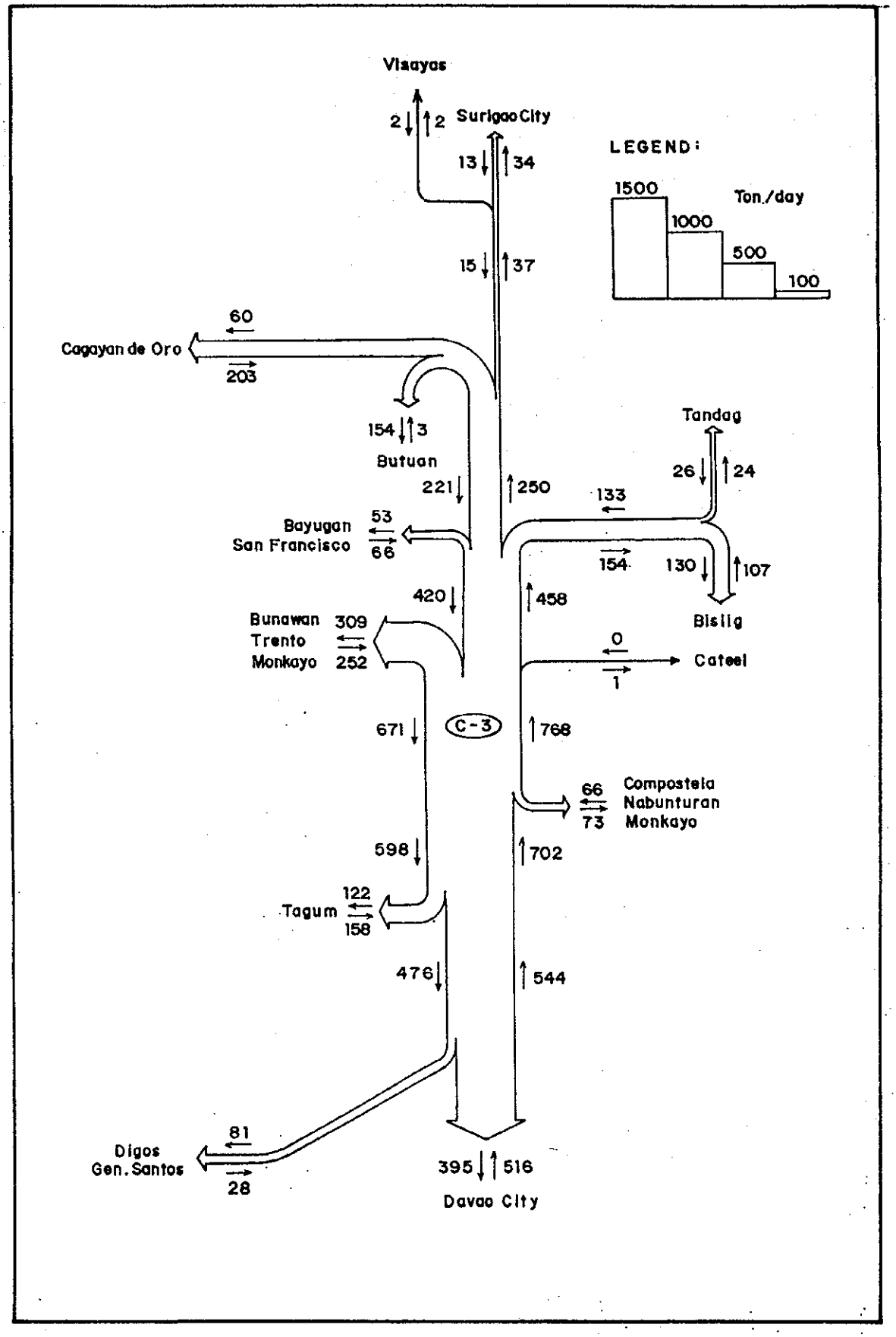


FIGURE 5.2-6 EXISTING COMMODITY FLOW AT C-3

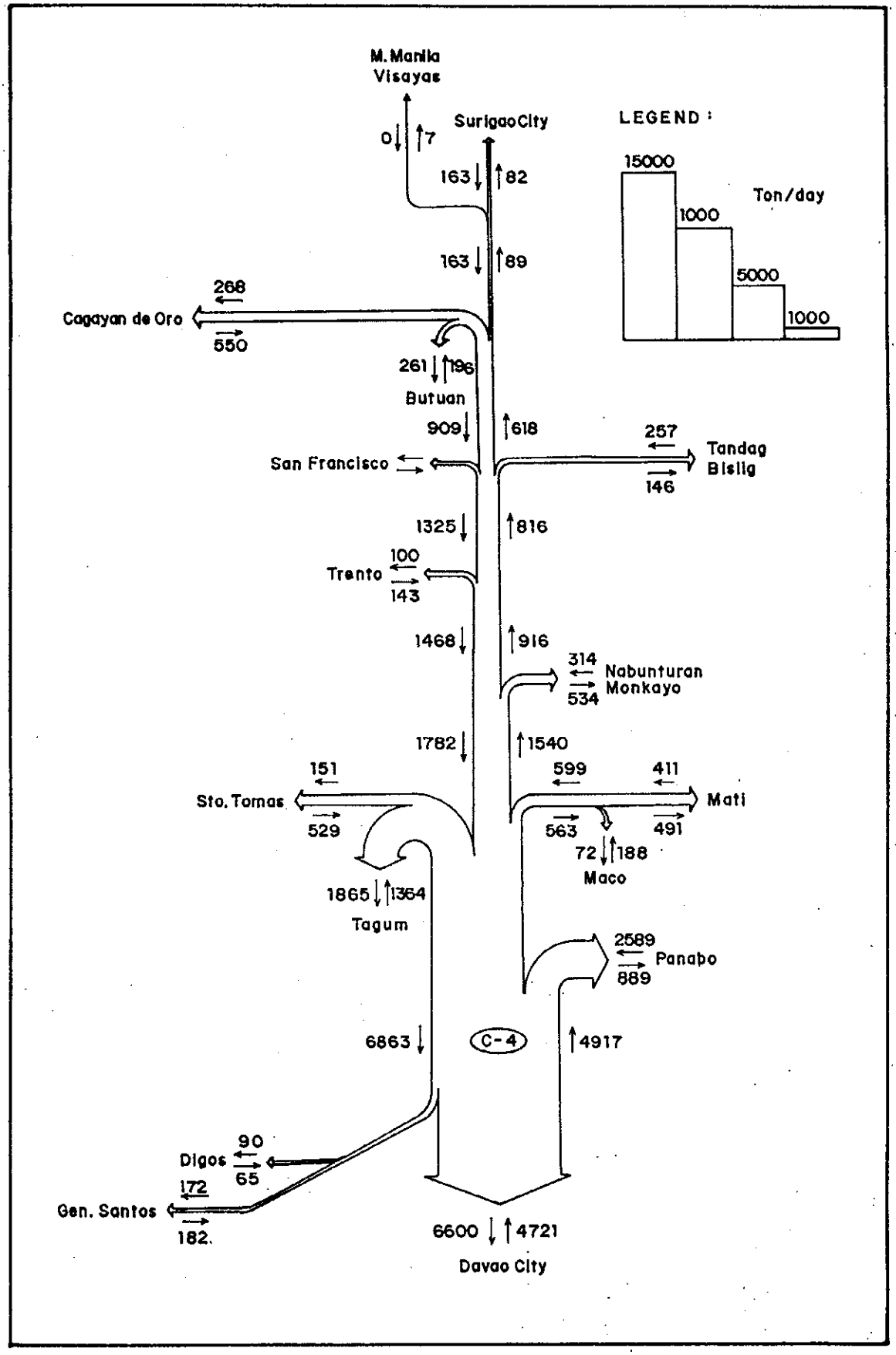


FIGURE 5.2-7 EXISTING COMMODITY FLOW AT C-4

5.2.4 Other Traffic Data/Information

1) Long Distance Bus Service

Figure 5.2-8 presents routes of long distance buses which passes through whole or part of the Study Road.

2) Traffic Accident Data

Traffic accidents which occurred along the Study Road in 1993 are shown in Table 5.2-5.

TABLE 5.2-5 TRAFFIC ACCIDENTS ALONG THE STUDY ROAD

Province	No.of Accidents	No. of Casualties Killed	Injured	Amount of Damages
Surigao del Norte	79	4	(*)	(*)
Agusan del Norte	477	45	348	P 3,439,400
Agusan del Sur	151	42	153	P 2,081,000
Davao del Norte	63	6	28	(*)
Davao City	644	16	130	(*)

SOURCE: Philippine National Police
Note, (*): Data not available

3) Vehicle Registration

Table 5.2-6 shows the number of registered vehicles in the study area. In the last three years, the number of registered vehicles have rapidly increased with an average growth rate of 8.8% per annum. Increase of heavy vehicles are remarkable.

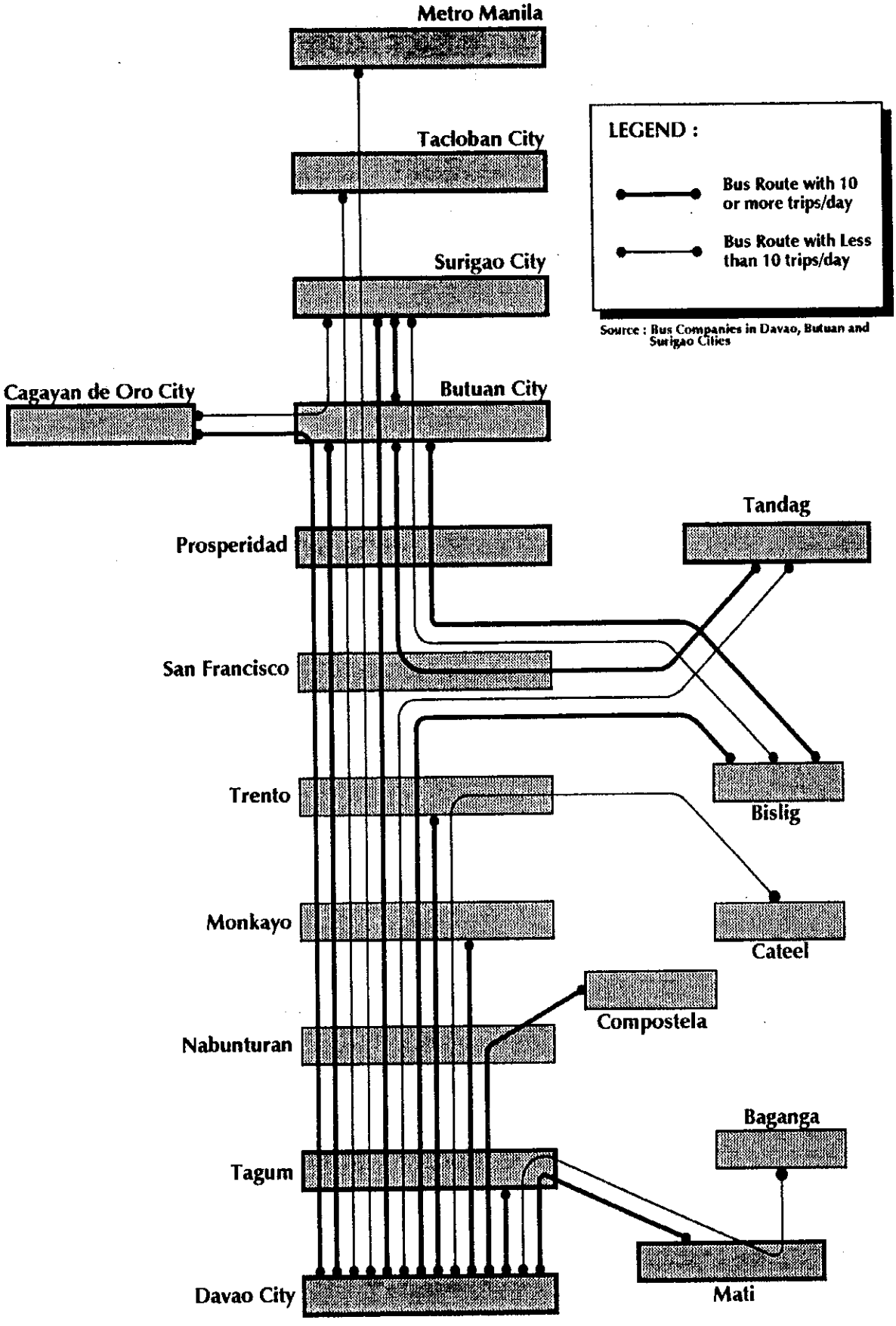


FIGURE 5.2-8 ROUTES OF LONG DISTANCE BUS SERVICES

TABLE 5.2-6 NUMBER OF REGISTERED VEHICLES

Province	Vehicle Type	Number of Registered Vehicles				Annual
		1990	1991	1992	1993	Growth
Surigao del Norte	Cars/Jeeps	1,375	1,495	1,499	1,581	4.8%
	Trucks/Buses	270	276	266	297	3.2%
	Motorcycles	2,062	2,078	2,514	2,775	10.4%
	Trailers	1	1	1	2	26.0%
	Total	3,708	3,850	4,280	4,655	7.9%
Agusan del Norte	Cars/Jeeps	3,564	3,517	3,651	4,013	4.0%
	Trucks/Bus	798	778	768	852	2.2%
	Motorcycles	3,526	3,703	3,710	4,144	5.5%
	Trailers	24	27	26	42	20.5%
	Total	7,912	8,025	8,155	9,051	4.6%
Agusan del Sur	Cars/Jeeps	693	742	731	782	4.1%
	Trucks/Bus	181	234	222	256	12.3%
	Motorcycles	899	980	1,168	1,401	15.9%
	Trailers	2	1	4	2	0.0%
	Total	1,775	1,957	2,125	2,441	11.2%
Davao del Norte	Cars/Jeeps	4,010	4,129	4,225	4,339	2.7%
	Trucks/Bus	1,042	1,146	1,202	1,350	9.0%
	Motorcycles	8,202	9,076	10,411	12,964	16.5%
	Trailers	76	105	146	108	12.4%
	Total	13,330	14,456	15,984	18,761	12.1%
Davao City	Cars/Jeeps	23,837	24,459	24,803	29,918	7.9%
	Trucks/Bus	4,701	4,562	4,707	7,704	17.9%
	Motorcycles	8,270	7,773	9,421	9,055	3.1%
	Trailers	509	538	580	834	17.9%
	Total	37,317	37,332	39,511	47,511	8.4%
Total	Cars/Jeeps	33,479	34,342	34,909	40,633	6.7%
	Trucks/Bus	6,992	6,996	7,165	10,459	14.4%
	Motorcycles	22,959	23,610	27,224	30,339	9.7%
	Trailers	612	672	757	988	17.3%
	Total	64,042	65,620	70,055	82,419	8.8%

Source: Annual Report, Land Transportation Offuce Region X & XI

5.3 STRUCTURE OF OD TRAFFIC ON THE STUDY ROAD

5.3.1 OD traffic Estimation Procedure

With the purpose of further analysis on the traffic characteristics of the Study Road, the Origin-Destination traffic was estimated, using the results of the commodity OD survey and estimated present AADT of each traffic section. The procedure is as follows.

Step 1: To convert the zone-to-zone truck OD table to the section-to-section OD table by assigning OD traffic on the road.

Step 2: To estimate the section-to-section OD table by type of vehicle based on the AADT data, following the iteration algorithm described below.

<Notation>

T_{km} : AADT of vehicle type k on section m.

X_{ijk} : OD traffic volume of vehicle type k from section i to section j.

where;

k = 1 : Car
k = 2 : Jeepney
k = 3 : Bus
k = 4 : truck

F_{km} : Discrepancy between T_{km} and estimated traffic volume on section m

Z_{ij} : Truck OD volume from section i to section j, estimated in Step 1, above.

y_{ijm} : a variable taking the value 1 if the traffic from section i to section j will pass the section m, otherwise, its value is 0.

e : Allowable error.

<Algorithm for estimation of OD table of vehicle type k>

Sub-step 1: As the initial value, for every i and j,

$$X_{ijk} = Z_{ij}$$

Sub-step 2: For every m, $F_{km} = T_{km} / \sum_i \sum_j (X_{ijk} * y_{ijm})$

Sub-step 3: If $| F_{km} - 1.0 | < e$ for every m, then end, otherwise, go to Sub-step 4

Sub-step 4: For every i and j,

$$X_{ijk} = X_{ijk} * (\sum_{m} (F_{km} * y_{ijm}) / \sum_{m} y_{ijm})$$

and go to Sub-step 2

Step 3: To convert the section-to section OD traffic to the Zone-to-zone OD traffic, using the same pattern as truck OD traffic.

5.3.2 OD traffic Structure

1) OD Structure

The estimated OD table is shown in Table 5.3-1 and illustrated in Figure 5.3-1. It should be noted that the OD table covers only trips which use the Study Road, and then, does not show the overall trips between zones.

The estimated OD table shows that the Study Road is used be about 18,000 trips, and 17% of the total trips are done inside Davao City and 61% have either of origin or destination in Davao City. The second largest trip generating/attracting zone is Sto. Tomas (33%), followed by Agusan del Norte(14%) and Surigao del Norte(11%).

The largest OD traffic is observed between Davao and Sto. Tomas which stands at 22% of the total trips and the second one is between Davao and Tagum of 7%.

2) Vehicle Composition

The vehicle-type composition in terms of vehicle-km shows 30% of cars, 23% of trucks and 16% of jeepneys, respectively. The share of trucks is generally higher in a rural area than in an urban area.

TABLE 5.3-1 OD TABLE OF STUDY ROAD TRAFFIC

(Vehicle/day)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
1 Surigao del Norte	1158	132	6	55	46	37	9	1	0	0	7	6	13	7	5	1	24	0	62	2	1	1	1573
2 Agusan del Norte	132	504	48	405	110	69	9	8	0	0	10	6	12	10	5	1	35	0	108	4	2	5	1483
3 Misamis Oriental	6	48	0	50	6	4	0	1	0	0	0	0	0	0	0	0	2	0	7	0	0	0	124
4 Bayugon	55	405	50	100	22	13	0	2	0	0	0	0	0	0	0	0	11	0	40	2	1	5	706
5 San Francisco	46	110	6	22	228	67	0	0	0	0	0	0	0	0	0	0	7	0	38	1	1	1	527
6 La Paz	37	69	4	13	67	0	19	0	0	0	1	0	0	1	0	0	11	0	64	2	2	0	290
7 Trento	9	9	0	0	0	19	0	0	0	0	16	0	2	1	2	0	12	0	65	3	2	0	140
8 Tandag	1	8	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	13
9 Bislig	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
10 Cateel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
11 Monkayo	7	10	0	0	0	1	16	0	0	0	0	0	1	2	0	0	13	0	75	3	2	0	130
12 Monte Vista	6	6	0	0	0	0	0	0	0	0	0	0	7	3	1	0	24	0	122	4	3	0	176
13 Nabunturan	13	12	0	0	0	0	2	0	0	0	1	7	3	25	2	2	127	1	492	16	10	0	713
14 Tagum	7	10	0	0	0	1	1	0	0	0	2	3	25	0	4	0	369	0	649	18	11	0	1100
15 New Corella	5	5	0	0	0	0	2	0	0	0	0	1	2	4	1	0	26	0	115	4	3	0	168
16 New Bataan	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	29	0	50	1	1	0	85
17 Sto. Tomas	24	35	2	11	7	11	12	0	0	0	13	24	127	369	26	29	476	12	1991	43	27	0	3239
18 Mati,Davao Oriental	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	12	0	22	1	0	0	36
19 Davao	62	108	7	40	38	64	65	1	1	2	75	122	492	649	115	50	1991	22	3167	93	58	1	7223
20 Davao del Sur	2	4	0	2	1	2	3	0	0	0	3	4	16	18	4	1	43	1	93	0	0	0	197
21 South Cotabato	1	2	0	1	1	2	2	0	0	0	2	3	10	11	3	1	27	0	58	0	0	0	124
22 Bukidnon, N.Cotabato	1	5	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	13
Total	1573	1483	124	706	527	290	140	13	1	2	130	176	713	1100	168	85	3239	36	7223	197	124	13	18063

Note: Excluding tricycle and motorcycle.

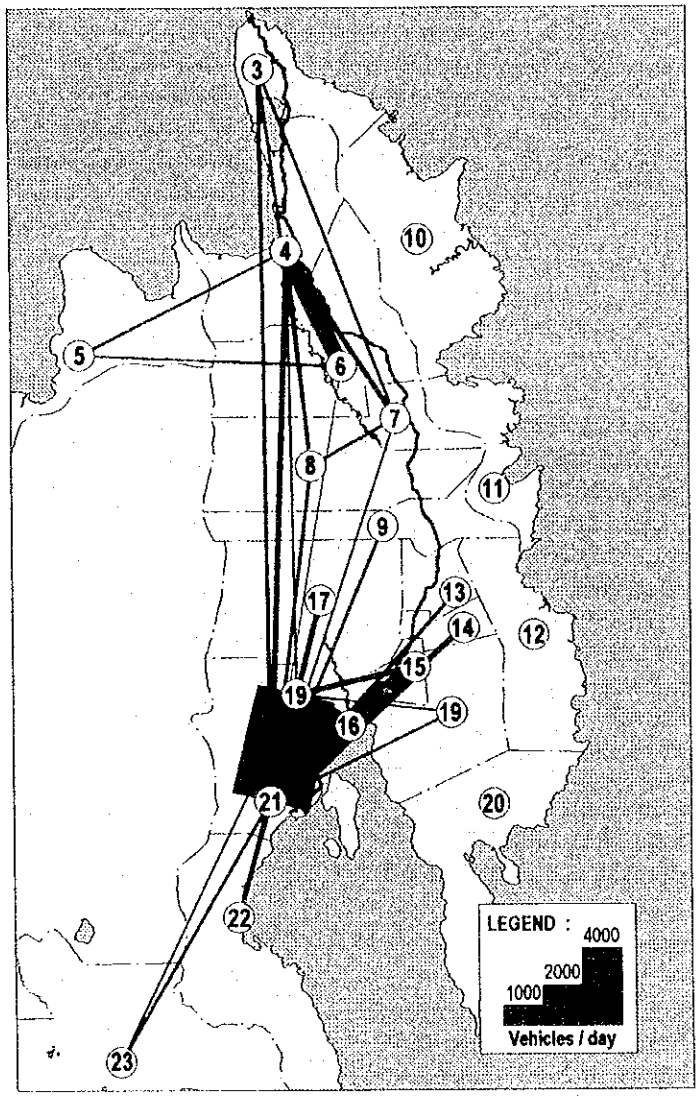


FIGURE 5.3-1 DESIRE LINE CHART OF STUDY ROAD TRAFFIC

TABLE 5.3-2 TRAFFIC COMPOSITION BY TYPE OF VEHICLES
(% in terms of vehicle-km)

	1000 veh-km	Composition(%)	
		incl. Local Traffic	excl. Local Traffic
Car	326.1	30.8	38.9
Jeepney	166.4	15.7	20.0
Bus	97.3	9.2	11.6
Truck	247.7	23.4	29.5
Tricycle	51.5	4.9	-
Motorcycle	169.1	16.0	-
Total		100.0	100.0

3) Trip Length

Trip length of the traffic on the road is rather short: 38% of total trips run less than 10 km of the road and the two-third of the total less than 30 km. Only 10% of the traffic run over 100 km. The average trip length is 46.1 km.

TABLE 5.3-3 TRIP LENGTH DISTRIBUTION OF THE STUDY ROAD TRAFFIC

Trip Length (km)	Composition (%)	Trip Length (km)	Composition (%)
0 - 10	38.1	70 - 80	1.9
10 - 20	14.7	80 - 90	2.3
20 - 30	13.1	90 - 100	1.1
30 - 40	5.3	100 - 200	5.4
40 - 50	8.7	200 - 300	3.0
50 - 60	2.1	300 - 400	1.6
60 - 70	2.7		