2.5 AGRICULTURE

2.5.1 Crop Production

Palay is amost predominant crop in the 6 regions. During 1988 to 1990, palay is produced at 1,924 thousand ha annually or 45% of the total crop harvested area of 4,270 thousand ha. Harvested area of coconut and corn, which are the second and third crops, accounts for 22% and 21% of the total area respectively. The sum of those three crops area is around 88% of the total area as shown in Table 2.5-1. Palay harvested area in Region I, II, III and CAR occupies around 60 to 86% of the respective total harvested area. Coconut plantation is largely extended in Region IV (41%) and V (37%) than the area of palay. In Region II, palay and corn are equally planted and both area occupies around 91% of the total area. The major crops harvested area by region is shown in Figure 2.5-1.

TABLE 2.5-1 MAJOR CROPS HARVESTED AREA IN THE STUDY REGIONS

Crops	Area ('000 ha)	(%)
Palay	1,924.3	45.1
Corn	888.7	20.8
Mongo	12.1	0.3
Peanut	24.1	0.6
Camote	43.6	1.0
Tobacco	49.8	1.2
Sugarcane	53.1	1.2
Mango	11.3	0.3
Coconut	925.2	21.7
Abaca	40.5	0.9
Banana	56.8	1.3
Others	240.2	5.6
Total	4,269.7	100.0

Source : BAS

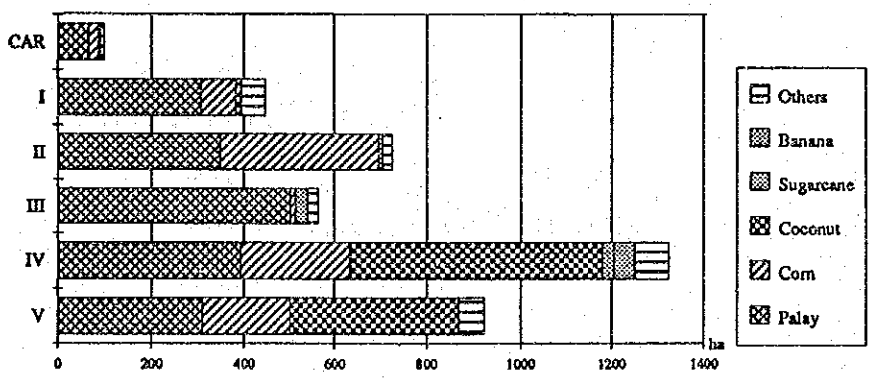


FIGURE 2.5-1 5 MAJOR CROPS HARVESTED AREA BY REGION

The 6 regions produced 5.3 million tons of palay and 953 thousand tons of corn annually during 1988 to 1990, which account for 58% ad 21% of the national 9.2 million tons of palay and 4.6 million tons of corn respectively. Region III is the largest palay producing region in the country, of which share is 30% of the 6 regions or 17% of the nation's as shown in Figure 2.5-2. Region II produced 479 thousand tons of corn which is around a half of corn production in the 6 regions as shown in Figure 2.5-3.

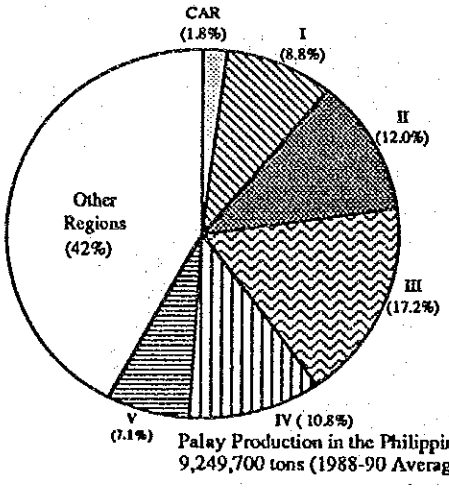


FIGURE 2.5-2 PALAY PRODUCTION BY REGION

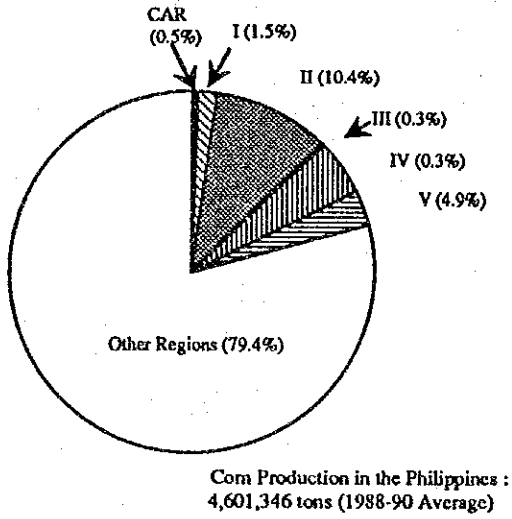


FIGURE 2.5-3 CORN PRODUCTION BY REGION

Recent palay and corn production increase is stagnant in the country due to incidence of natural calamities such as drought and typhoon. Annual production increase rates on palay and corn production were limited to 1.84% and 0.72% respectively during 1986/88 to 1988/90. Of the 6 Regions, CAR and Region V decreased palay production and Region IV decreased corn production as shown in Table 2.5-2. Annual production growth of palay in the 6 regions ranges from minus 0.9% in CAR and Region V to 3.9% in Region III and that of corn from minus 3.9% in Region IV to 19.1% in Region III.

TABLE 2.5-2 PALAY AND CORN PRODUCTION GROWTH TREND (1986/88 to 1988/90)

(Unit: %/year)

	Palay			Corn		
Regions	Area	Yield	Production	Area	Yield	Production
CAR	(0.36)	(0.52)	(0.88)	(1.35)	1.55	2.90
I	1.05	1.20	2.25	2.92	6.74	9.66
II	0.31	3.27	3.58	1.83	7.86	9.69
III	1.99	1.88	3.87	7.04	12.02	19.06
IV	1.72	0.94	2.66	2.07	(5.99)	(3.92)
V	(1.04)	0.14	(0.90)	1.16	1.00	2.16
Philippines	0.47	1.37	1.84	1.04	(0.32)	0.72

Note: ( ); Minus growth

The 6 regions produced a more than half of diversified crop production in the country as shown in Figure 2.5-4. The 6 regions production shares to the national production are 93% for tobacco, 81% for peanut and 69% for mongo. Those of fruit trees such as mango and coconut are 49% and 36% respectively. Regional comparison of major crops unit yields is shown in Fig. 2.5-5. The unit yield of palay in Region II and III is higher than the national average of 2.72 ton/ha, while the rest of the regions are lower. Corn unit yields of the 6 regions are lower than the national 1.23 ton/ha.

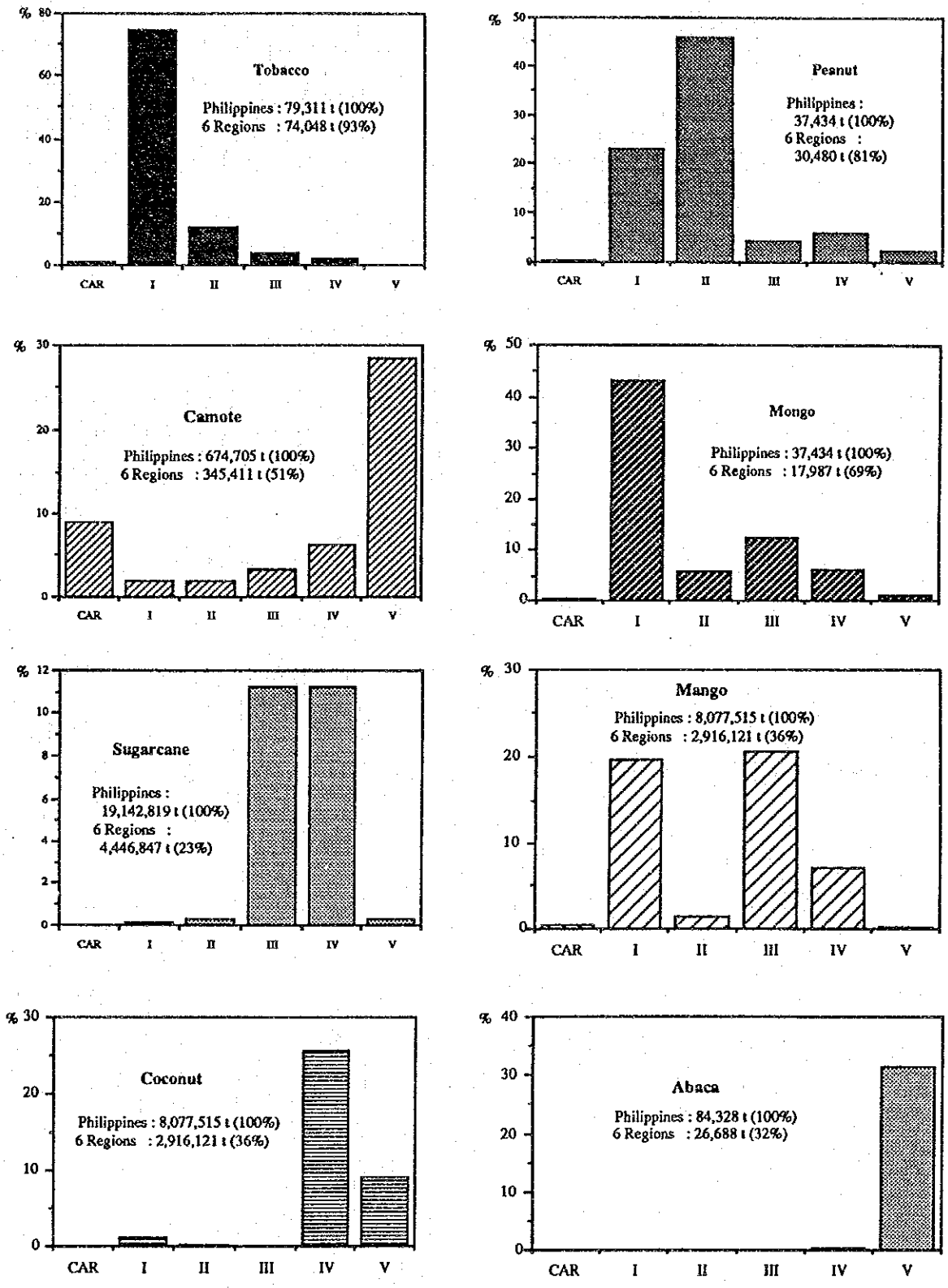


FIGURE 2.5-4 OTHER MAJOR CROPS PRODUCTION BY REGION

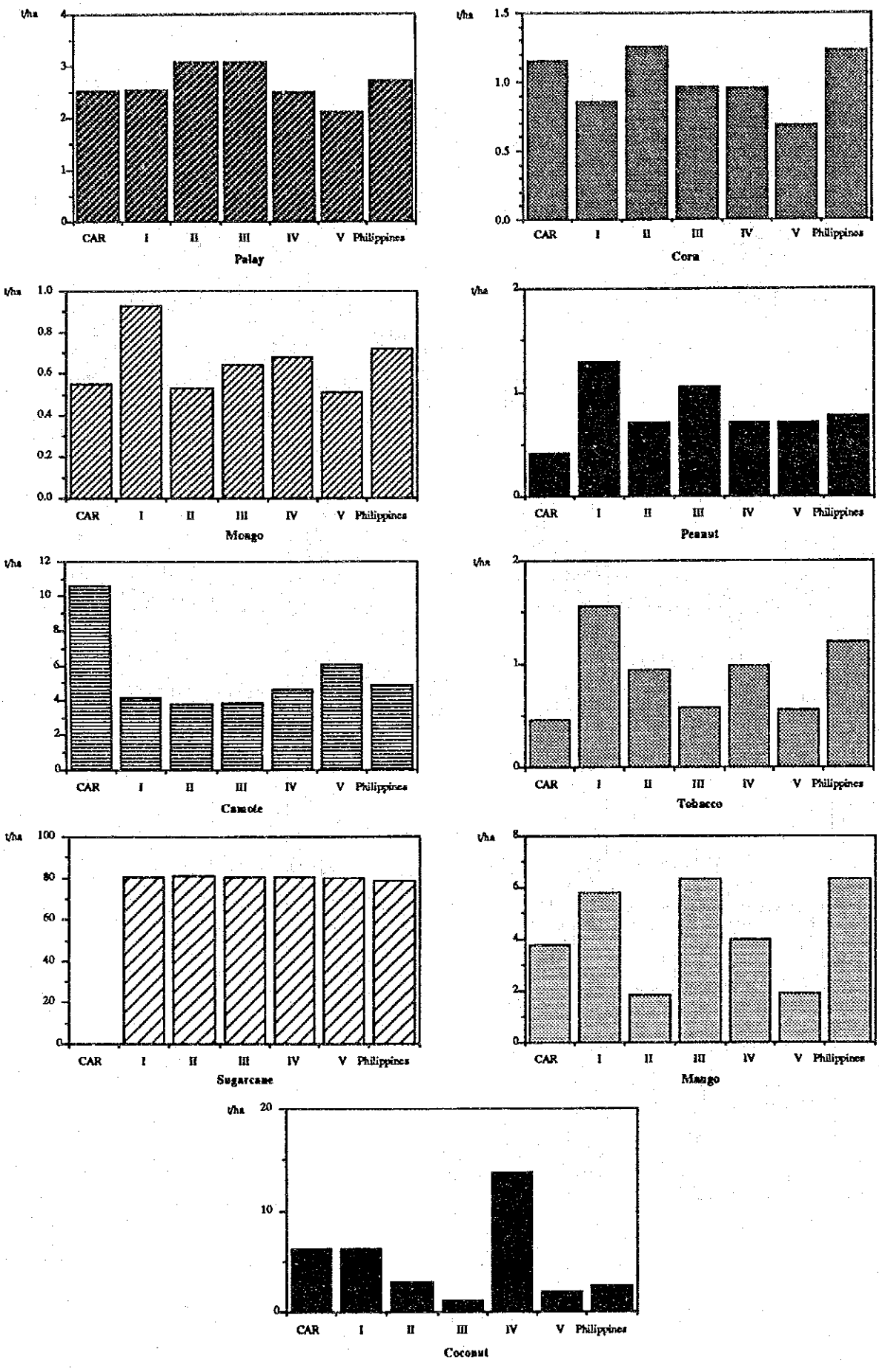


FIGURE 2.5-5 UNIT YIELD OF MAJOR CROPS BY REGION

Crop production in the study area is estimated using provincial crop production statistics in 1990 and summarized as shown in Table 2.5-3. The study area occupies around 77% of the total crop production in the 6 regions.

TABLE 2.5-3 CROP PRODUCTION ESTIMATE IN 1990 (Unit:'000t)

Region	Palay	Corn	Coconut	Others	Total
CAR	165.6	24.2	30.6	726.4	946.8
I	847.7	87.9	83.7	1,484.7	2,504.0
II	1,164.8	550.8	18.6	779.1	2,513.3
III	1,810.9	17.3	2.0	5,733.4	7,563.6
IV	957.3	219.6	1,957.6	16,655.4	19,789.9
V	569.8	150.3	745.2	3,960.7	5,426.0
6 Regions	5,516.1 (14%)	1,050.1 (3%)	2,837.7 (7%)	29,339.7 (76%)	38,743.7 (100%)
Study Area	4,963.2 (17%)	980.4 (3%)	2,296.6 (8%)	21,665.0 (72%)	29,905.2 (100%)

2.5.2 Other Agricultural Production

Livestock production is estimated using livestock inventory statistics, average liveweight and dress weight indicators, dairy production statistics, etc. Fishery production data is analyzed by commercial, municipal and aquacultural productions. Forestry production is estimated on the basis of the log production statistics and firewood consumption. Livestock, fishery and forestry productions in the study area occupy around 95%, 78% and 89% of the 6 regions' productions respectively as shown in Table 2.5-4 to 2.5-6.

TABLE 2.5-4 LIVESTOCK PRODUCTION ESTIMATE IN 1990 (Unit:'000t)

Regions	Carabao and Cattle	Hogs	Poultry	Others	Total
CAR	9.03	9.24	0.04	1.95	20.26
I	11.05	27.07	0.88	1.94	40.94
II	4.98	12.44	0.41	1.29	19.12
III	15.97	77.56	35.58	13.92	143.03
IV	56.14	146.69	52.40	29.54	284.77
V	6.46	18.15	0.29	1.02	25.92
6 Regions	103.63 (19%)	291.15 (55%)	89.60 (17%)	49.66 (9%)	534.04 (100%)
Study Area	97.88 (19%)	273.03 (54%)	89.28 (18%)	48.37 (10%)	508.56 (100%)

TABLE 2.5-5 FISHERY PRODUCTION ESTIMATE IN 1990 (Unit:'000 ton)

Regions	Commercial	Municipal	Aquaculture	Total
CAR	0	0.95	2.32	3.27
I	5.31	23.23	45.35	73.89
II	4.02	14.21	2.59	20.82
III	13.46	42.09	134.24	189.79
IV	136.55	974.72	185.57	1,296.84
V	36.13	129.35	22.18	187.66
6 Regions	195.47 (11%)	1,184.55 (67%)	392.25 (22%)	1,772.27 (100%)
Study Area	114.53 (8%)	928.58 (67%)	344.37 (25%)	1,387.48 (100%)

TABLE 2.5-6 FORESTRY PRODUCTION ESTIMATE IN 1990 (Unit:'000 ton)

Region	Logs	Others	Total
CAR	0.96	117.77	118.73
I	<1	2.26	2.26
II	497.54	574.20	1,071.74
III	5.24	1.87	7.11
IV	335.04	14.61	349.65
V	0	7.50	7.50
6 Regions	838.78 (54%)	718.21 (46%)	1,556.99 (100%)
Study Area	692.22 (50%)	686.67 (50%)	1,378.88 (100%)

<1 ; Less than 10 ton

2.6 NON-AGRICULTURE

2.6.1 Mining and Quarrying

In 1990, mining and quarrying sub-sectors in the 6 regions produce the GVA of around 8,256 million pesos which accounts for a half of the national sub-sector's 16,659 million pesos. The sub-sector's GVA occupies 7% of the industrial GVA and 2% of the GRDPs in the 6 regions. Based on the official record issued by the DENR, mineral production in the study area is estimated at 423 thousand tons for metallics and 28,476 thousand tons for non-metallics annually during 1988 to 1990 as shown in Table 2.6-1. Non-metallics such as limestone, sand and gravel, stones, cement, etc. occupy around 99% of the mineral production. The cements account for 13% of the total non-metallics. Total mineral production of 28,899 thousand tons accounts for 77% of the agricultural production (37,512 thousand tons) in 1990, while it is considered there are a large production of non-metallics mining without any permission or recording. Mining and quarrying sites locate not only at the mountains, but also in the plains and the coasts. Mining and quarrying production by province is shown in Figure 2.6-1.

TABLE 2.6-1 OFFICIAL MINING AND QUARRYING PRODUCTION IN THE STUDY AREA (1988-90 Average) (Unit:'000t)

Regions	Metallic	Non-Metallic	Total
CAR	164,684	7,166,455	7,331,139
I	0	3,763,211	3,763,211
II	13,333	1,439,401	1,452,734
III	243,337	10,481,386	10,724,723
IV	0	4,591,642	4,591,642
V	1,628	1,034,021	1,035,649
6 Regions	422,982 (1%)	28,476,116 (99%)	28,899,098 (100%)

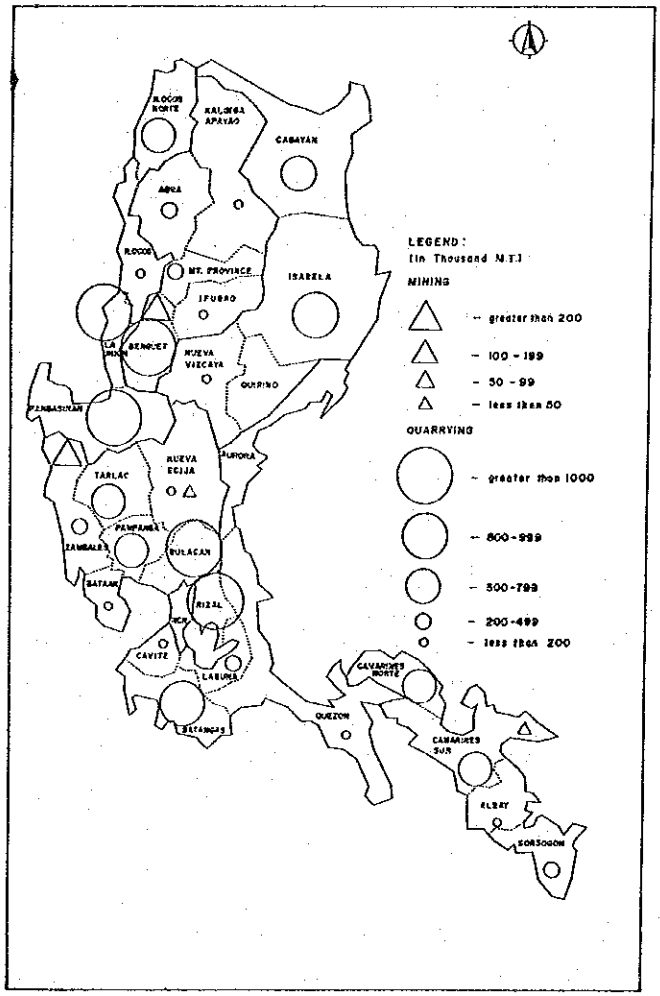


FIGURE 2.6-1 MINING AND QUARRYING PRODUCTION IN THE STUDY AREA

2.6.2 Manufacturing

Manufacturing sub-sector in the 6 regions produces around the GVA of 81,409 million pesos which accounts for 30% of the national sub-sector's 271,407 million pesos in 1990. The sub-sector's GVA occupies 70% of the industrial GVA and 24% of the GRDPs in the 6 regions. Manufacturing establishment by kind is shown in Table 2.6-2. Of the total establishment number of 9,712 in the study area, food processing manufacturing occupies 39%, fol lowed by wood processing (18%), textile and garment (17%). Agro-related industry is still predominant in terms of number of establishment, especially in the rural study area. Number of establishment by province is shown in Figure 2.6-2.

TABLE 2.6-2 MANUFACTURING ESTABLISHMENTS IN THE STUDY AREA (1990)

Regions	Food Processing	Handi-craft	Wood Processing	Metal-craft	Textile & Garment	Total
CAR	131	303	134	45	291	904
I	910	182	400	113	333	1,938
II	42	57	305	15	30	449
III	930	646	380	359	242	2,557
IV	455	109	253	132	318	1,267
V	1,366	255	260	233	483	2,597
6 Regions	3,834 (39%)	1,552 (16%)	1,732 (18%)	897 (9%)	1,697 (17%)	9,712 (100%)

Manufacturing development have been promoted and assisted by the DTI and other related government agencies. There are three export processing zones (EPZ) in the study area which locate at Baguio, Bataan and Cavite. The EPZs are established and supervised by the Export Processing Zone Authority under the Board of Investments, DTI to increase export earnings as well as industrialization of the country through foreign investments. The rest major industrial estates locate in Cavite, Laguna and Zambales (Subic) as shown in Figure 2.6-3. Regional industrial centers and provincial industrial estates classified as a large scale with 10 or more workers or with or with average monthly receipts of one (1) million pesos or more, and peoples industrial centers with a small scale have been planned or promoted by the central and local government units. There are also private industrial estates mainly located in Cavite and Laguna. The industrial areas locate along the existing national road, while the present access road condition from the national road to the sites is poor in general.

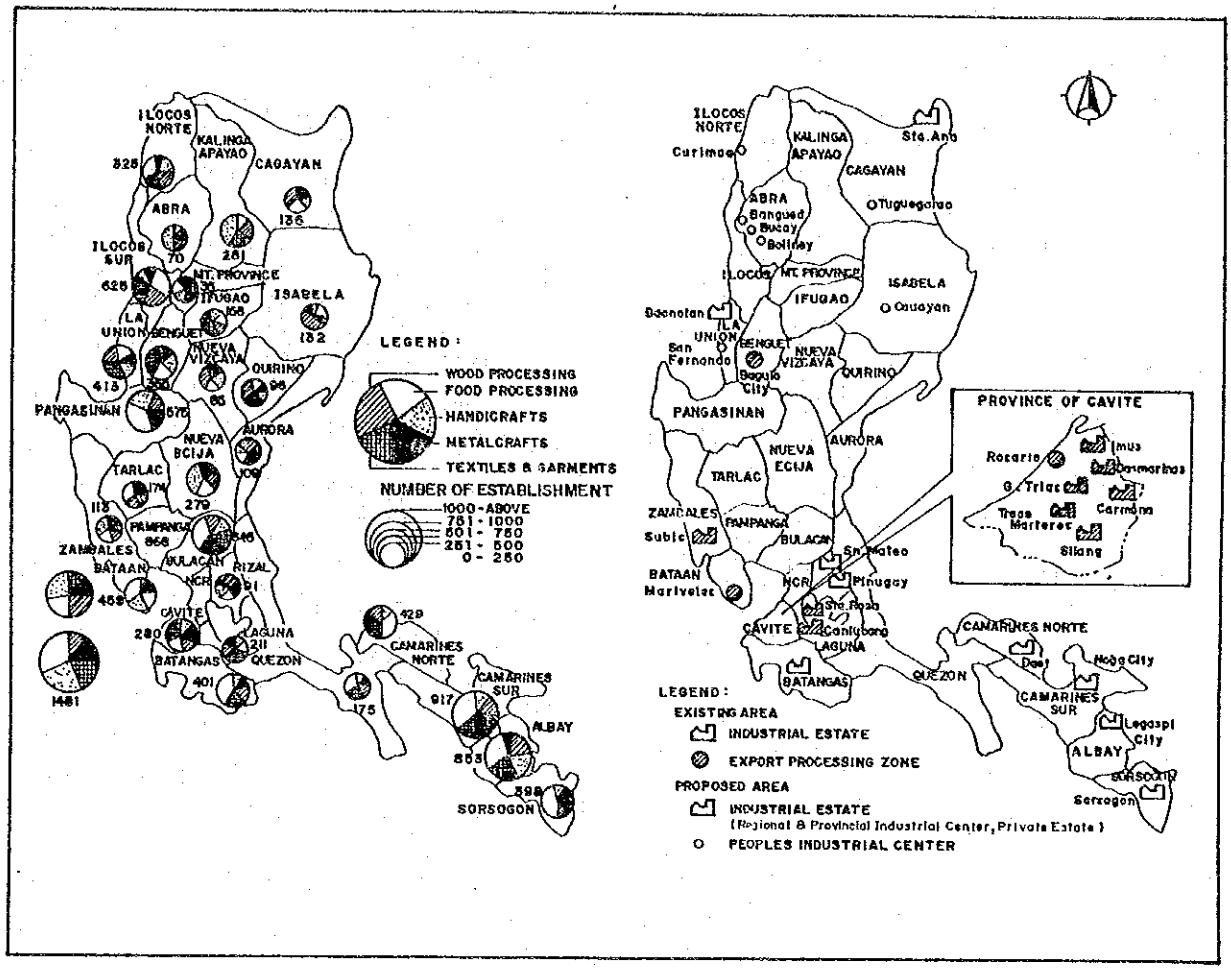


FIGURE 2.6-2 MANUFACTURING ESTABLISHMENT IN THE STUDY AREA

FIGURE 2.6-3 INDUSTRIAL DELOPMENT IN THE STUDY AREA

2.6.3 Tourism

Tourism development in the country have been promoted by the Department of Tourism (DOT). Under the DOT, the Philippine Tourism Authority (PTA) is implementing infrastructure and superstructure development such as hotels, lodges, resort, etc. as an official agency. There are 462 hotels with around 9,400 rooms in the study area as shown in Table 2.6-3. The tourism spots such as caves, waterfall, beach, hot springs, parks, etc. locate at 618 sites in total. The distribution of hotel rooms and tourism spots by province is shown in Figure 2.6-4. Poor accessibility to the tourism spots is one of the constrains to promote tourism development in the country. Not only for foreign visitors, but also for the Philippine residents, improvement of road accessibility is essential to increase number of visitors and to develop new tourism spots.

TABLE 2.6-3 TOURISM DEVELOPMENT STATUS IN THE STUDY AREA

Region	Number of Hotel Rooms	(%)	Tourism Spots	
			Number	Kind
CAR	2,172	(23%)	103	Caves, Waterfalls Rice Terraces, Springs
I	1,039	(11%)	88	Waterfalls, Beach Resorts, Museums, Caves
II	399	(4%)	38	Hot Springs, Waterfalls, Beach Resorts
III	3,243	(35%)	111	Parks, Churches, Beach Resorts
IV	1,466	(16%)	203	Swimming Pools, Caves, Waterfalls, Hot Springs
V	1,060	(11%)	75	Parks, Beach Resorts, Hot Springs, Caves
Total	9,379	(100%)	618	

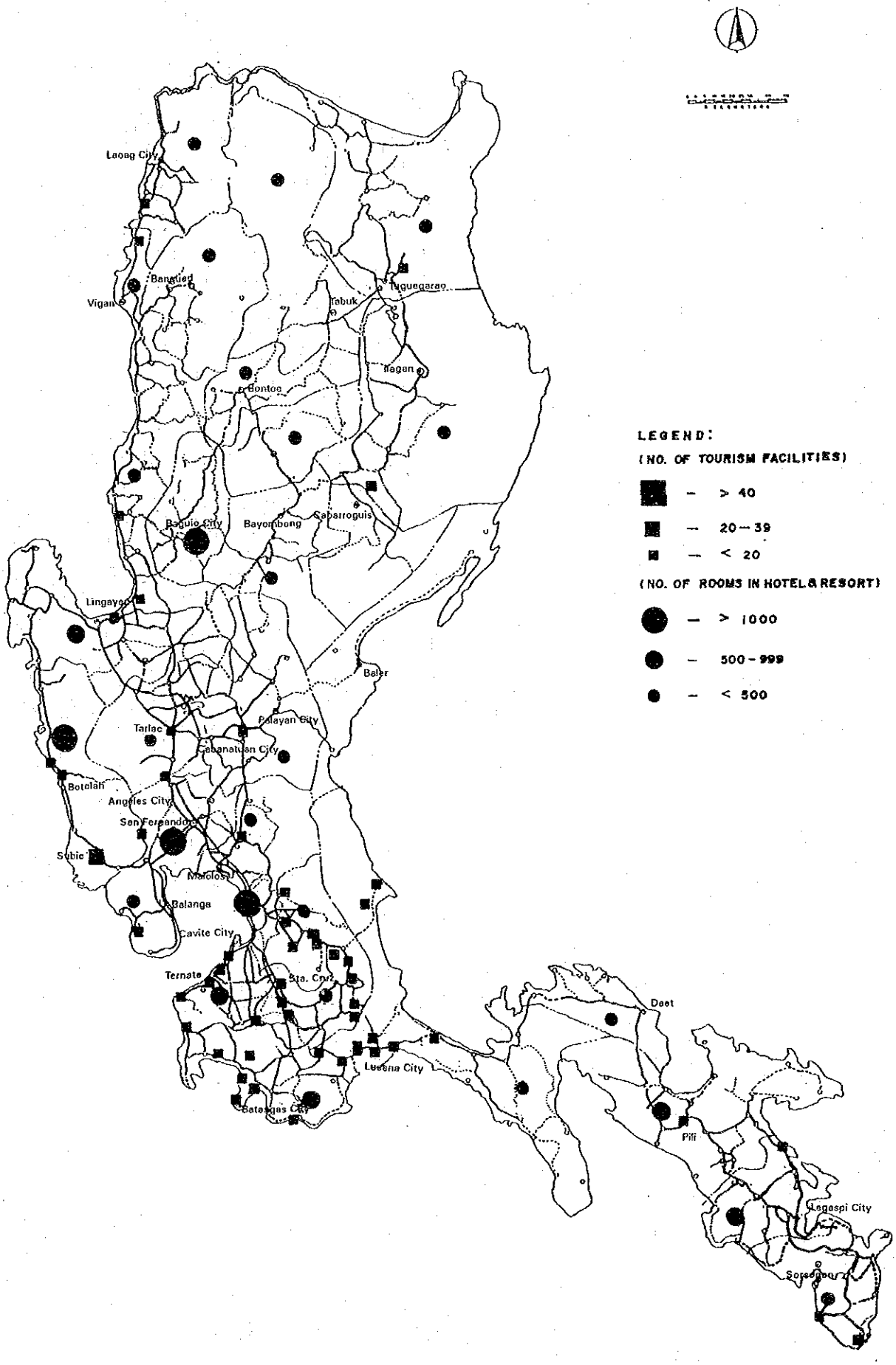


FIGURE 2.6-4 TOURISM DEVELPMENT IN THE STUDY AREA

CHAPTER 3

ROAD NETWORK

3.1 EXISTING ROAD NETWORK

3.1.1 Classification of Road

a) Administrative Road Classification

Road classification in the Philippines has been established by a series of Executive Orders, Republic Acts and or Presidential Decrees, of which the most fundamental use was the Republic Act No. 917 (the Philippine Highway Act) whose classification of roads is as follows:

- National Primary and Secondary
- National Aid Roads
- Provincial and City Roads
- Municipal Roads

This classification was more clearly defined by the Executive Order No. 113 issued in 1955. Since then, various amendments have been made including those shown below.

- "National Aid" roads no longer appear in the Revised Philippine Highway Act, 1972 (Presidential Decree No. 17).

- A new class of roads known as Barangay Roads was introduced by the Presidential Decree No. 702, 1975.

Today the Department of Public Works and Highways (DPWH) classifies roads into the following five (5) groups:

- National Road
- Provincial Roads
- City Roads
- Municipal Roads
- Barangay Roads

Definition of each class is given below, while Figure 3.1-1 shows the underlying concept.

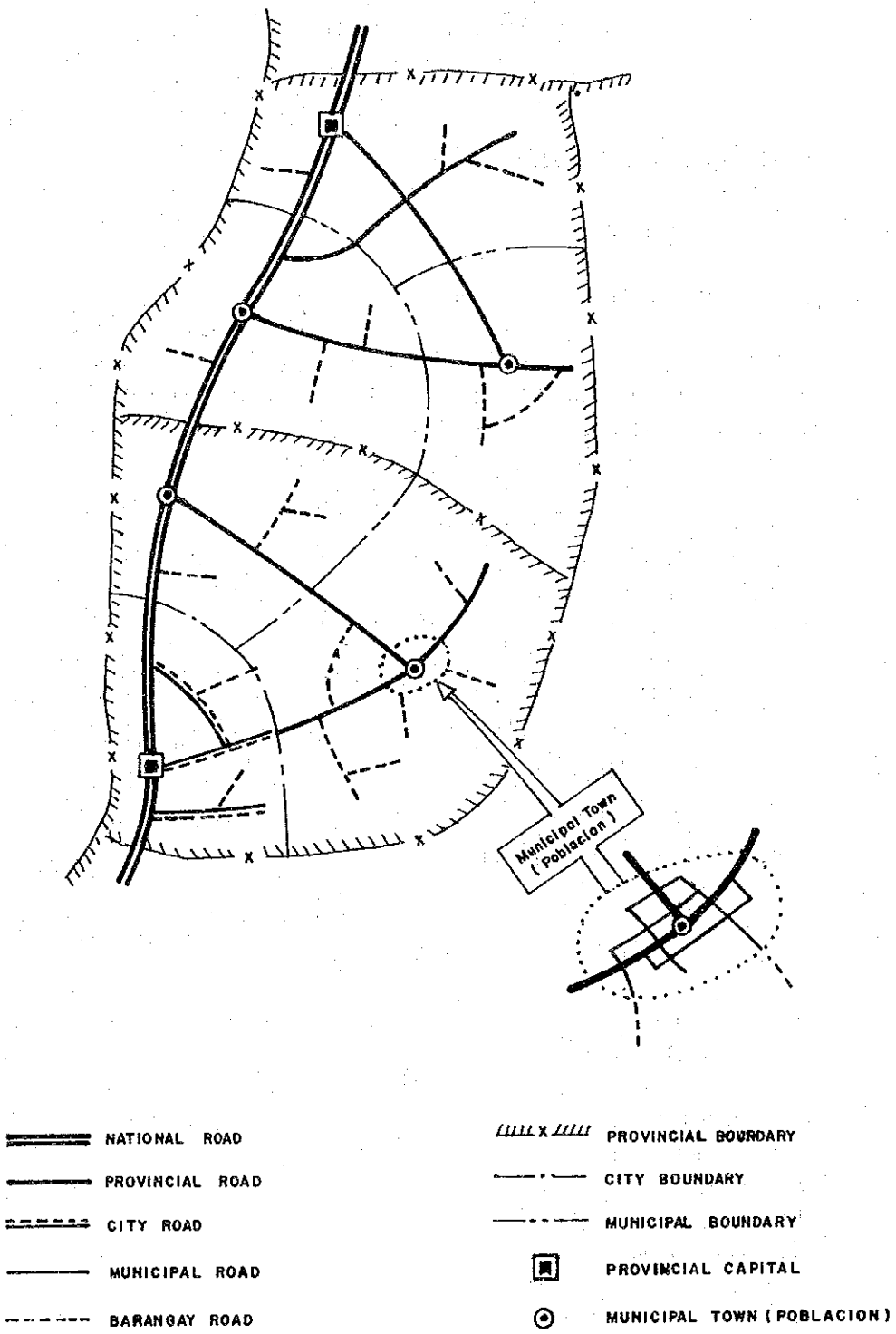


FIGURE 3.1-1 CONCEPTUAL ROAD NETWORK BY ADMINISTRATIVE CLASSIFICATION

National Roads - are all roads that form part of the main trunkline system continuous in extent; all roads leading to national ports, national seaports parks or cost-to-coast roads.

Provincial Roads - are those roads connecting one municipality with another municipality, the termini to be public plazas; all roads extending from a municipality or from a provincial or national road to a public wharf or railway station; and any other road to be designated as such by the Sangguniang Panglalawigan.

City Roads - are those roads/streets within the urban area of the city to be designated as such by the Sangguniang Panglungsod.

Municipal Roads - are those roads/streets within the poblacion area of a municipality to be designated as such by the Sangguniang Bayan.

Barangay Roads - are rural roads located either outside the urban area of a city or outside industrial, commercial or residential subdivision which act a feeder farm-to-market roads, and which are not otherwise classified as a national, provincial, city or municipal roads. Roads located outside the Poblacion area of a municipality and those roads located outside the urban area of a city to be designated as such by the Barangay Council concerned.

Responsibility for planning, construction and maintenance of national roads is with the Department of Public Works and Highways (DPWH). The provincial, city and municipal government units, all under the general supervision of the Department of Interior and Local Government (DILG), are responsible for provincial, city and municipal roads in their areas, through the provincial, City and Municipal Engineers Offices, respectively.

Barangay roads which were under responsibility of DPWH, are now being transferred to jurisdiction of Local Government Units (LGUs)

b) Functional Road Classification

Road Classification by the DPWH is mainly based on the administrative jurisdiction of the concerned agencies. This type of classification may be helpful to identify the responsible agency regarding the funding, construction/improvement and maintenance. However, the administrative classification has been often misinterpreted particularly in terms of importance and character of service of the roads; national road is not always have higher importance than provincial road.

In 1983, a world Bank appraisal mission on the Transport Sector noted the major planning and programming problems encountered because of the deficiencies in the functional classification process. Those problems were also noted in several development studies being conducted about the same time.

Consequently several functional classification study funded through IBRD and ADB were conducted.

In 1982 IBRD Assisted Rural Roads Development Program II classified roads into the following five (5) classes:

- Primary Roads
- Secondary Roads
- Tertiary Roads
- Farm-to-Market Roads
- Streets

IBRD Assisted "Functional Road Classification Study" (FRCS-86), which was undertaken in 1986, classifies the roads as follows:

- National Primary Roads
- National Secondary Roads
- National Tertiary Roads
- Provincial Roads
- Feeder Roads

Definition for classification is presented in Table 3.1-1.

ADB Assisted "Philippine Road Classification Study" (PRCS-91) which is currently being undertaken, tentatively proposes the following classification by revising FRCS-86.

- Primary Arterial
- Secondary Arterial
- Provincial Collector
- Municipal Collector
- Local Roads

A cross reference between FRCS-86, the proposed new classes and the current administrative classification is shown in Table 3.1-2.

As of now no concrete functional classification has not been established yet, and thus promulgation of functional classification proposed by past studies was never accomplished.

TABLE 3.1-1 PREVIOUS FUNCTIONAL ROAD CLASSIFICATION

IBRD Assisted Functional Road Classification Study (DPWH), 1986	IBRD Assisted Rural Roads Development Program II (DLG), 1982
(1) National Primary Road Connect pimary centers	(a) Primary Road Major inter-provincial roads or major intra-provincial trunk roads linking one or more municipal towns to the Provincial Capital
(2) National Secondary Road Connect secondary centers to one another and to National Primary Roads	
(3) National Tertiary Road Connect tertiary centers to one another to a National Primary or National Secondary road	(b) Secondary Road Roads (other than above) linking municipalities with each other or to the provincial capital or the primary network
(4) Provincial Road Connect cities and municipalities not classified as primary/secondary/tertiary center to a national road.	(c) Tertiary Road Roads linking barangays to the municipal towns and to the primary or secondary network
(5) Feeder Road Connect barangays, outside urban development areas as of a city or municipality, to one another and roads not classified as national or provincial	(d) Farm-to-Market Road Roads linking farm areas to their respective barangay centers or to higher level network
	(e) Street Roads within built-up population centers with essentially urban rather than rural functions

. Primary Center (28)
  - either a national or regional capital
  - or base for a national base seaport
  - or base for an international airport
  - or having a rating of 9 or less
. Secondary Center (58)
  - either a provincial capital
  - or base for a national sub-base port
  - or having a rating of 10 to 13 inclusive
. Tertiary Center (14)
  - either a sub-provincial capital
  - or having a rating of 14 to 16

Rating

National/Regional Capital	1
Provincial Capital	2
If combined	0
Sub-provincial Capital	3
National Base Seaport	1
International Airport	1
National Sub-base Seaport	2
National Trunkline Airport	2
National Seaport/Secondary Airport	3
Feeder Port	4
Population over 100,000	1
75,000 1000,000	2
50,000 75,000	3
If none	5

TABLE 3.1-2 RELATIONSHIP BETWEEN FRCS-86 AND PRCS-91

Proposed Functional Classifications		Current Administrative Classification				
FRCS-86	PRCS-91	National	Provincial	Municipal	Barangay	Private
National Primary	Primary Arterial	■				
National Secondary	Secondary Arterial	■	■			
National Tertiary	Provincial Collector		■			
Provincial	Municipal Collector			■	■	■
Feeder Roads	Local Roads			■	■	■

3.1.2 *Growth of Road Length*

Major road improvement activities began in 1969 following completion of the Philippine Transport Survey conducted under UNDP financing with World Bank as the executing agency, which recommended improvement of about 6,000 km of national roads. Also greatly impacting on the road network development was construction of the Pan-Philippine Highway, on which construction was started in 1969 and completed in 1979 with financial assistance from Japan. As shown in Table 3.1-3 and Figure 3.1-2, national road length expanded in the late 1960s and has constantly increased until 1985.

After that, road length decreased slightly due to the latest re-inventory where some roads excluded from the list of national and barangay roads as they are not qualified as such.

As of 1990, the public road network in the Philippines covers a total length of about 160,549 kms, consisting of about 26,261 kms.(16.4%) of national roads which form the main trunkline system; 45,925 kms.(28.6%) of provincial, municipal and city roads; and 88,363 kms.(55.0%) of barangay roads. The existing road length by class is shown in Table 3.1-4.

Likewise, the existing road lengths by pavement type are; 10,320 km.(6.4%) is concrete, 12,661 km.(7.9%) is asphalt, 129,071 km.(80.4%) is gravel and 8,497 km.(5.3%) is earth. The existing road length by pavement type is shown in Table 3.1-5.

TABLE 3.1-3 GROWTH OF ROAD LENGTH (1961-1990)

(km)

Year	National Road	Provincial Road	City Road	Municipal Road	Barangay Road	Total
1961	15,143	18,777	3,447	12,238	-	49,605
1962	15,223	20,055	3,755	13,595	-	52,628
1963	15,457	20,569	3,841	14,432	-	54,299
1964	15,677	20,878	4,064	14,692	-	55,311
1965	15,922	21,363	4,184	14,309	-	55,778
1696	16,189	21,421	4,613	15,332	-	57,555
1967	16,616	22,337	4,875	14,774	-	58,602
1968	17,434	22,588	5,006	15,498	-	60,526
1969	18,540	23,312	5,232	16,176	-	63,260
1970	19,198	25,219	6,254	16,855	10,425	77,951
1971	20,066	27,879	6,805	18,781	12,069	85,600
1972	21,315	28,103	6,714	18,636	13,714	88,482
1973	21,415	28,123	7,397	19,444	16,651	93,030
1974	21,516	28,144	8,340	21,561	18,769	98,330
1975	21,665	28,175	2,680	7,512	44,399	104,431
1976	21,796	28,186	2,726	7,902	52,271	112,881
1977	22,333	28,224	3,004	9,141	56,518	119,220
1978	22,790	28,243	3,133	9,524	61,445	125,135
1979	23,552	29,034	3,406	10,657	80,960	147,609
1980	23,641	29,753	3,692	11,445	83,337	151,918
1981	23,489	29,953	3,723	11,914	84,449	153,528
1982	23,783	29,544	3,741	12,142	85,264	154,474
1983	24,140	29,725	3,718	12,240	85,847	155,670
1984	25,117	28,826	3,896	12,432	86,868	157,139
1985	26,191	28,193	3,987	12,825	90,671	161,867
1986	26,230	28,334	3,987	12,841	87,107	158,499
1987	26,082	28,928	3,984	12,875	85,941	157,810
1988	26,070	29,174	3,982	12,626	85,595	157,448
1989	26,111	29,143	3,949	12,707	87,149	159,059
1990	26,261	29,156	3,949	12,820	88,363	160,549

Source: 1.Monitoring and Statistics Division,PES,DPWH
2.Bureau of Maintenance,DPWH

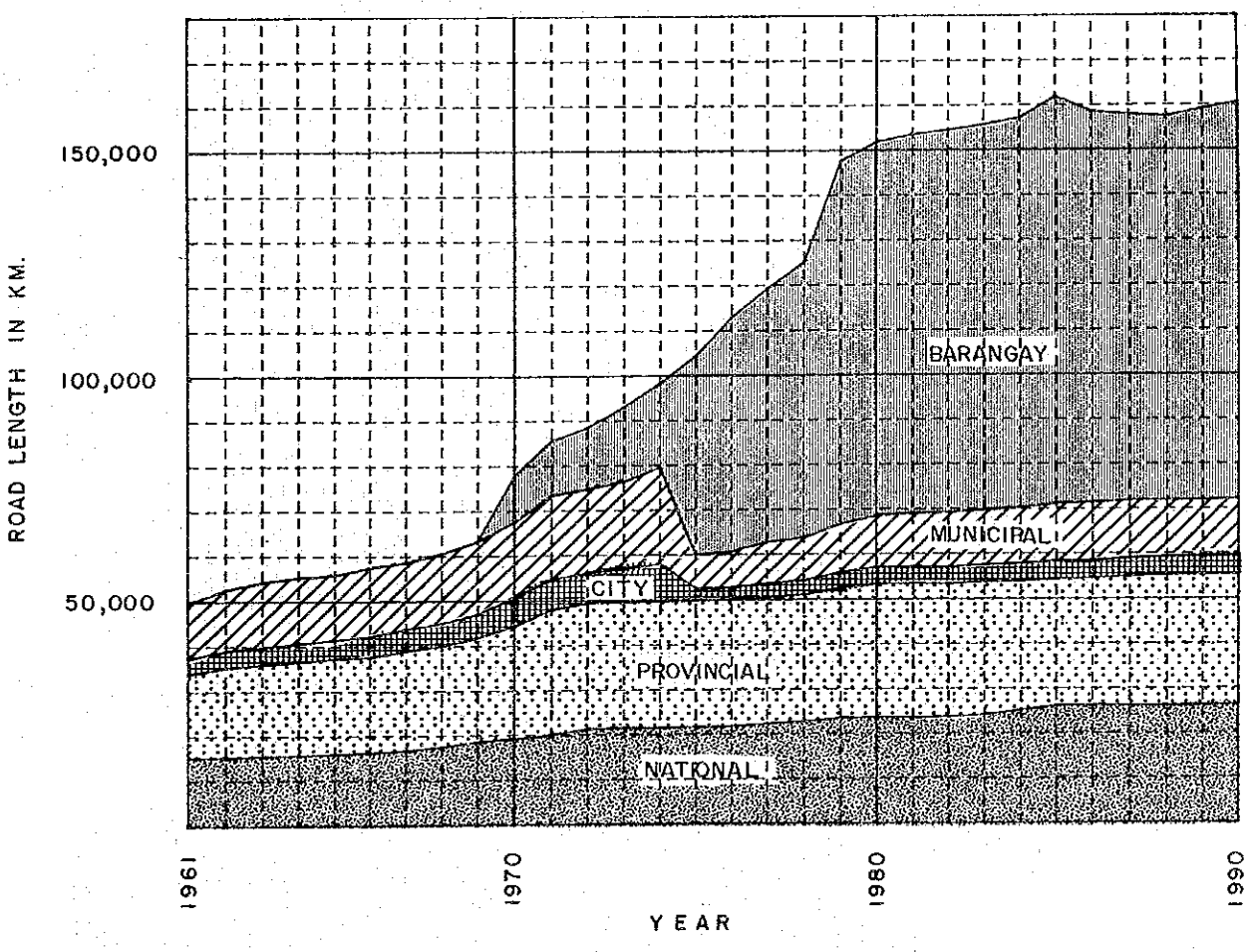


FIGURE 3.1-2 GROWTH OF ROAD LENGTH

TABLE 3.1-4 EXISTING ROAD LENGTH BY CLASS IN THE PHILIPPINES

	Land Area (km²) A	1990 Population P	1990 Road Length by Class (km) National	Provincial	City	Municipal	Barangay	Total L	Road Density L/√(AP/1000)
All Philippines	300,000.2	60,684,887	26,260.5	29,156.2	3,949.4	12,819.5	88,363.0	160,548.6	1.190
NCR	636.0	7,928,867	888.0	-	1,273.7	554.3	271.3	2,987.4	1.330
CAR	18,293.7	1,145,880	1,592.6	1,402.0	142.2	435.2	3,661.4	7,233.4	1.580
Abra	3,975.6	184,743	176.7	479.8	-	228.1	1,428.4	2,289.5	2.735
Benguet	2,655.4	485,546	452.4	321.1	142.2	35.6	818.2	1,769.5	1.558
Mountain Province	2,097.3	116,535	310.1	272.8	-	37.3	194.6	814.8	1.648
Ifugao	2,517.8	147,281	252.6	154.5	-	18.4	556.9	982.4	1.613
Kalinga Apayao	7,047.6	211,775	397.7	173.8	-	85.8	665.4	1,322.7	1.083
Region I	12,840.2	3,550,606	1,454.4	1,783.5	167.5	1,079.6	8,002.5	12,487.6	1.849
Ilocos Norte	3,399.3	461,661	377.8	422.1	130.8	267.7	2,073.0	3,298.4	2.633
Ilocos Sur	2,579.6	519,930	378.4	283.1	-	245.5	2,010.8	2,897.7	2.302
La Union	1,493.1	548,742	217.9	251.9	-	121.6	579.2	1,170.5	1.293
Pangasinan	5,368.2	2,020,273	480.4	826.4	36.7	417.9	3,339.5	5,120.9	1.555
Region II	26,837.7	2,340,652	1,654.4	1,694.3	-	1,037.7	6,619.1	11,005.5	1.389
Batanes	209.3	15,026	69.7	64.6	-	30.5	116.3	277.1	4.941
Cagayan	9,002.7	829,974	588.5	527.0	-	202.6	2,187.4	3,505.6	1.282
Isabela	10,664.6	1,080,341	426.5	580.2	-	430.5	2,569.1	4,006.3	1.180
Nueva Vizcaya	3,903.9	301,179	315.3	369.7	-	285.8	1,523.0	2,493.8	2.300
Quirino	3,057.2	114,132	258.4	152.7	-	88.3	223.2	722.7	1.223
Region III	18,230.8	6,198,957	1,701.0	2,365.7	258.5	1,008.3	7,770.8	13,104.3	1.233
Bataan	1,373.0	425,803	295.9	225.2	-	48.3	457.5	1,024.4	1.370
Bulacan	2,625.0	1,505,219	250.5	354.0	-	237.9	1,791.8	2,634.2	1.325
Nueva Ecija	5,284.3	1,312,610	434.6	697.5	39.6	322.4	1,778.6	3,272.6	1.243
Pampanga	2,180.0	1,532,682	288.1	321.6	128.4	105.0	1,588.3	2,431.4	1.330
Tarlac	3,053.4	859,651	210.1	552.3	-	128.3	1,558.5	2,449.2	1.512
Zambales	3,714.4	562,992	221.9	215.1	90.5	165.9	599.1	1,292.5	0.894
Region IV	46,924.1	8,265,784	3,945.8	3,866.7	292.8	1,390.1	8,906.4	18,401.7	0.934
Aurora	3,239.5	139,286	218.7	115.9	-	57.1	242.1	633.9	0.943
Batangas	3,165.8	1,476,783	520.4	637.0	37.4	237.1	2,253.6	3,685.5	1.704
Cavite	1,287.6	1,152,534	305.5	429.6	91.7	67.9	717.3	1,612.0	1.323
Laguna	1,759.7	1,370,232	343.4	252.2	79.8	154.1	658.4	1,487.9	0.958
Marinduque	959.2	185,524	217.9	173.4	-	135.1	138.8	665.1	1.577
Occidental Mindoro	5,879.8	282,593	330.0	321.7	-	131.6	789.7	1,572.9	1.220
Oriental Mindoro	4,364.7	550,049	276.6	734.7	-	66.6	355.5	1,433.4	0.925
Palawan	14,896.3	528,287	551.2	504.2	66.7	109.0	1,363.7	2,594.7	0.925
Quezon	8,706.7	1,372,381	652.3	368.5	17.2	214.0	793.5	2,045.6	0.592
Rizal	1,308.9	980,194	244.1	66.8	-	143.4	782.8	1,237.1	1.092
Romblon	1,355.9	227,621	285.7	262.8	-	74.2	810.8	1,433.5	2.580
Region V	17,632.5	3,909,799	1,980.1	1,771.3	217.6	767.0	4,188.4	8,924.4	1.075
Albay	2,555.6	903,023	386.3	374.7	26.9	170.5	683.9	1,642.4	1.082
Camarines Norte	2,112.5	390,982	187.1	134.8	-	86.5	315.3	723.7	0.796
Camarines Sur	5,266.8	1,305,919	500.3	689.2	190.7	241.5	2,092.9	3,714.6	1.416
Catanduanes	1,511.5	187,000	252.7	223.6	-	62.6	240.3	779.2	1.466
Masbate	4,047.7	599,915	358.8	117.8	-	92.4	445.8	1,014.8	0.651
Sorsogon	2,141.4	522,960	294.9	231.1	-	113.5	410.1	1,049.7	0.992
Region VI	20,223.2	4,593,333	2,670.7	2,410.7	297.3	693.3	8,135.9	14,208.0	1.360
Aklan	1,817.9	380,497	141.9	286.1	-	80.3	653.6	1,161.9	1.397
Antique	2,522.0	406,361	363.9	96.7	-	93.9	753.6	1,308.1	1.292
Capiz	2,633.2	584,091	306.7	365.6	27.7	81.3	877.4	1,658.8	1.338
Iloilo	5,324.0	1,765,476	930.3	794.3	31.9	224.8	2,245.9	4,227.1	1.379
Negros Occidental	7,926.1	2,256,908	927.9	868.1	237.7	213.0	3,605.4	5,852.1	1.384
Region VII	14,951.5	5,393,151	1,664.1	2,313.0	313.4	878.2	5,462.4	10,631.1	1.283
Bohol	4,117.3	948,315	584.4	878.6	65.4	258.3	2,633.2	4,420.0	2.237
Cebu	5,088.4	2,645,735	622.9	950.1	188.6	404.5	1,645.6	3,811.7	1.039
Negros Oriental	5,402.3	925,311	381.2	299.6	59.3	194.8	1,103.2	2,038.1	0.912
Siquijor	343.5	73,790	75.6	184.8	-	20.6	80.4	361.4	2.270
Region VIII	21,431.7	3,055,184	2,056.2	1,405.4	70.6	701.3	4,304.4	8,537.8	1.055
Leyte	6,268.3	1,486,522	1,009.0	522.4	60.4	322.6	1,897.9	3,812.3	1.249
Southern Leyte	1,734.8	321,940	283.0	350.7	-	80.7	581.7	1,296.2	1.734
Eastern Samar	4,339.6	329,335	267.2	250.4	-	155.6	1,124.9	1,798.1	1.504
Northern Samar	3,498.0	383,654	184.3	146.7	-	89.4	304.7	725.0	0.626
Samar	5,591.0	533,733	312.7	135.2	10.2	53.0	395.2	906.1	0.525
Region IX	18,685.0	3,159,197	1,062.3	2,051.9	121.5	858.6	6,595.6	10,689.9	1.391
Basilan	1,327.2	243,091	62.2	229.2	-	47.9	520.6	859.8	1.514
Sulu	1,600.4	469,971	134.8	217.4	-	19.5	655.4	1,027.1	1.184
Tawi-Tawi	1,087.4	228,204	92.8	29.9	-	26.4	184.7	333.8	0.670
Zamboanga del Norte	6,618.1	673,774	262.6	807.8	46.6	297.4	2,157.8	3,571.7	1.691
Zamboanga del Sur	8,051.9	1,544,157	509.9	767.6	74.9	468.0	3,077.1	4,897.5	1.389
Region X	28,327.8	3,509,821	2,194.2	2,745.8	217.1	1,255.5	8,545.4	14,957.9	1.500
Agusan del Norte	2,590.3	465,458	218.6	232.9	65.9	91.3	600.9	1,206.1	1.098
Agusan del Sur	8,965.5	420,763	305.5	266.8	-	161.3	761.3	1,495.4	0.770
Bukidnon	8,293.8	843,959	689.8	787.1	-	400.9	2,898.1	4,776.0	1.805
Camiguin	229.8	64,247	63.6	88.9	-	27.9	160.1	340.5	2.802
Misamis Occidental	1,939.3	424,365	199.2	507.9	71.2	170.1	1,396.9	2,345.3	2.585
Misamis Oriental	3,570.1	865,051	378.5	501.5	63.5	158.8	2,057.5	3,159.8	1.798
Surigao del Norte	2,739.0	425,978	342.3	360.8	16.5	244.6	670.7	1,634.8	1.513
Region XI	31,692.9	4,457,076	1,967.1	3,251.5	453.6	1,261.0	8,809.9	15,743.2	1.325
Davao del Norte	8,129.8	1,055,016	351.5	985.8	-	305.2	1,501.6	3,144.2	1.074
Davao del Sur	6,377.6	1,482,648	513.3	425.7	267.9	257.8	2,519.5	3,984.2	1.296
Davao Oriental	5,164.5	394,697	308.1	548.8	-	73.9	450.5	1,381.3	0.967
South Cotabato	7,468.8	1,072,617	465.1	1,012.5	185.7	512.2	3,404.2	5,579.7	1.971
Surigao del Sur	4,552.2	452,098	329.2	278.6	-	111.9	934.2	1,653.9	1.153
Region XII	23,293.1	3,171,368	1,429.5	2,094.6	123.5	899.3	7,089.6	11,636.5	1.354
Lanao del Norte	3,092.0	614,092	225.0	279.0	62.9	240.9	1,083.4	1,891.1	1.372
Lanao del Sur	3,872.9	599,637	282.6	416.6	27.4	244.6	3,003.3	3,974.6	2.608
Maguindanao	5,474.1	757,739	249.1	336.8	33.2	108.6	1,057.5	1,785.2	0.877
North Cotabato	6,565.9	763,995	521.5	747.9	-	190.1	662.6	1,822.1	0.814
Sultan Kudarat	4,288.2	435,905	151.2	614.3	-	115.2	1,282.8	2,163.5	1.582

TABLE 3.1-5 EXISTING ROAD LENGTH BY PAVEMENT TYPE IN THE PHILIPPINES

	1990 Road Length by Surface Type (km)					Road Density L/√(AP/1000)	
	Concrete	Asphalt	Gravel	Earth	Total	Total Road	Paved Road
All Philippines	10,320.2	12,660.6	129,071.2	8,496.6	160,548.6	1.190	0.170
NCR	1,148.0	1,386.3	441.3	11.8	2,987.4	1.330	1.129
CAR	98.2	610.4	5,616.8	907.9	7,233.4	1.580	0.155
Abra	5.9	127.3	1,828.0	382.7	2,343.9	2.735	0.155
Benguet	48.8	395.8	1,170.4	154.5	1,769.5	1.558	0.392
Mountain Province	0.3	58.2	650.4	105.9	814.8	1.648	0.118
Ifugao	38.3	1.9	805.9	130.4	982.4	1.613	0.076
Kalinga Apayao	4.9	21.3	1,162.0	134.3	1,322.7	1.083	0.021
Region I	600.2	1,310.7	10,112.5	464.1	12,487.6	1.849	0.283
Ilocos Norte	273.4	139.6	2,706.8	178.6	3,298.4	2.633	0.330
Ilocos Sur	51.3	251.3	2,400.9	194.2	2,897.7	2.502	0.261
La Union	137.3	169.1	822.9	41.2	1,170.5	1.293	0.339
Pangasinan	138.2	750.7	4,181.9	50.2	5,120.9	1.555	0.270
Region II	594.9	280.2	9,770.5	359.9	11,005.5	1.389	0.110
Batanes	22.5	13.4	185.4	55.8	277.1	4.941	0.640
Cagayan	226.9	158.0	3,087.8	32.9	3,505.6	1.282	0.141
Isabela	205.0	92.7	3,658.0	50.6	4,006.3	1.180	0.088
Nueva Vizcaya	126.4	15.4	2,140.3	211.7	2,493.8	2.300	0.131
Quirino	14.0	0.7	699.0	8.9	722.7	1.223	0.025
Region III	1,484.7	1,203.3	10,023.0	393.3	13,104.3	1.233	0.253
Bataan	154.5	226.2	641.6	2.1	1,024.4	1.340	0.498
Bulacan	492.1	207.6	1,909.5	25.0	2,634.2	1.325	0.352
Nueva Ecija	316.9	74.2	2,864.1	17.5	3,272.6	1.243	0.148
Pampanga	344.9	141.4	1,746.2	199.0	2,431.4	1.330	0.266
Tarlac	119.2	250.3	1,997.6	82.1	2,449.2	1.512	0.528
Zambales	57.1	303.6	864.1	67.7	1,292.5	0.894	0.249
Region IV	1,239.9	2,298.1	14,219.5	644.2	18,401.7	0.934	0.180
Aurora	1.8	30.5	582.1	19.5	633.9	0.943	0.048
Batangas	79.9	892.1	2,661.6	51.8	3,685.5	1.704	0.450
Cavite	179.6	371.5	945.5	115.4	1,612.0	1.323	0.452
Laguna	347.2	304.3	787.3	48.8	1,487.9	0.958	0.420
Marinduque	16.6	85.2	499.9	63.5	665.1	1.577	0.241
Occidental Mindoro	22.7	6.6	1,497.0	46.7	1,572.9	1.220	0.023
Oriental Mindoro	4.2	147.9	1,279.4	1.9	1,433.4	0.925	0.098
Palawan	6.4	111.1	2,391.1	86.2	2,594.7	0.925	0.042
Quezon	322.8	114.1	1,519.3	89.4	2,045.6	0.592	0.126
Rizal	219.7	178.4	803.1	35.9	1,237.1	1.092	0.351
Romblon	38.7	56.5	1,253.3	85.0	1,433.5	2.580	0.171
Region V	939.3	994.4	6,504.3	486.5	8,924.4	1.075	0.233
Albay	214.6	282.6	1,046.5	98.8	1,642.4	1.082	0.327
Camarines Norte	135.5	145.2	435.3	7.7	723.7	0.796	0.309
Camarines Sur	365.5	272.7	2,957.5	119.3	3,714.6	1.416	0.243
Catanduanes	40.5	25.4	630.6	80.8	779.2	1.466	0.128
Masbate	27.1	85.1	829.4	73.2	1,014.8	0.651	0.072
Sorsogon	156.5	181.4	604.9	106.9	1,049.7	0.992	0.319
Region VI	741.0	1,140.0	12,142.3	184.7	14,208.0	1.360	0.180
Aklan	56.5	51.4	1,044.4	9.6	1,161.9	1.397	0.130
Antique	61.3	79.5	1,159.4	7.9	1,308.1	1.292	0.139
Capiz	125.0	36.3	1,381.9	115.5	1,658.8	1.538	0.130
Iloilo	278.0	317.9	3,592.6	38.6	4,227.1	1.379	0.194
Negros Occidental	220.1	654.8	4,964.0	13.1	5,852.1	1.384	0.207
Region VII	350.6	1,238.7	8,652.7	389.2	10,631.1	1.283	0.192
Bohol	97.3	287.7	3,917.6	117.3	4,420.0	2.237	0.195
Cebu	195.6	605.3	2,837.4	173.3	3,811.7	1.039	0.218
Negros Oriental	57.7	300.7	1,582.2	97.4	2,038.1	0.912	0.160
Siquijor	-	45.0	315.4	1.1	361.4	2.270	0.283
Region VIII	1,251.4	547.7	6,409.4	329.3	8,537.8	1.055	0.222
Leyte	556.5	22.0	3,157.7	76.2	3,812.3	1.249	0.190
Southern Leyte	159.3	306.3	791.5	39.1	1,296.2	1.734	0.623
Eastern Samar	78.9	201.4	1,418.1	99.7	1,798.1	1.504	0.234
Northern Samar	162.3	13.5	444.3	104.9	725.0	0.656	0.152
Samar	294.4	4.5	597.8	9.4	906.1	0.525	0.173
Region IX	90.9	568.5	9,645.7	384.9	10,689.9	1.391	0.086
Basilan	-	50.5	698.5	110.8	859.8	1.514	0.089
Sulu	21.8	84.6	904.6	16.1	1,027.1	1.184	0.123
Tawi-Tawi	15.4	-	275.5	42.9	333.8	0.670	0.031
Zamboanga del Norte	15.4	114.4	3,587.2	54.7	3,771.7	1.691	0.061
Zamboanga del Sur	38.3	319.0	4,379.8	160.4	4,897.5	1.389	0.101
Region X	768.7	692.4	12,288.5	1,208.2	14,957.9	1.500	0.147
Agusan del Norte	193.6	0.5	997.9	14.1	1,206.1	1.098	0.177
Agusan del Sur	190.3	1.1	1,125.9	178.1	1,495.4	0.770	0.099
Bukidnon	8.1	230.4	4,172.2	365.3	4,776.0	1.805	0.090
Camiguin	3.1	72.4	224.9	40.5	340.5	2.802	0.621
Misamis Occidental	11.5	182.5	1,930.7	220.7	2,345.3	2.585	0.214
Misamis Oriental	250.9	197.6	2,478.2	233.1	3,159.8	1.798	0.255
Surigao del Norte	111.2	8.1	1,358.8	156.7	1,634.8	1.513	0.110
Region XI	536.4	279.9	13,433.0	1,494.0	15,743.2	1.325	0.069
Davao del Norte	189.6	14.5	2,860.9	79.2	3,144.2	1.074	0.070
Davao del Sur	126.4	207.5	5,416.9	233.3	5,984.2	1.296	0.109
Davao Oriental	17.1	23.5	1,206.6	134.1	1,381.3	0.967	0.028
South Cotabato	156.7	29.4	4,357.1	1,036.5	5,579.7	1.971	0.066
Surigao del Sur	46.5	5.0	1,591.6	10.8	1,653.9	1.153	0.036
Region XII	476.0	110.1	9,811.8	1,238.7	11,636.5	1.354	0.068
Lanao del Norte	117.0	43.2	1,676.8	54.2	1,891.1	1.372	0.116
Lanao del Sur	57.7	17.3	3,550.2	349.4	3,974.6	2.608	0.049
Maguindanao	128.3	4.5	1,334.9	317.5	1,785.2	0.877	0.065
North Cotabato	128.3	41.1	1,454.6	198.2	1,822.1	0.814	0.076
Sultan Kudarat	44.8	4.0	1,795.3	319.4	2,163.5	1.582	0.036

3.1.3 Road Density

In general, road requirement depends on both land area and population. Therefore, the road density defined as follows is used as an indicator to assess the adequacy of road.

$$\text{Road Density} = L/\sqrt{PA}$$

Where; L = road length in km

A = land area in km^2

P = population in 1,000

Road density of each province by road class in accordance with above definition is presented in Table 3.1-6 while road density by surface type is shown Table 3.1-7. Figure 3.1-3 illustrates paved road density of each province.

Provinces of Abra, Ilocos Norte, Ilocos Sur, and Nueva Vizcaya have higher road density of total road, this may be attributed to smaller population. Road density of other provinces seem to be fairly distributed over Luzon Island. However, road density of paved road varies widely from province to province.

The provinces which have a lower paved road density are;

- Kalinga Apayao
- Quirino
- Aurora
- Ifugao

Above provinces are located in mountainous area, topographical restriction may deter quantitative development of the road network in these provinces.

The provinces which have a higher paved road density are;

- Bataan
- Cavite
- Batangas
- Laguna

Provinces with higher paved road density are located in flat area nearby NCR whose economic development stage is higher than those with lower density.

Provincial disparity in paved road density is quite notable. In addition to length of road, quality of road should be taken into consideration in assessing adequacy of road, since there are many roads which are not accessible to motorized vehicles at all times, thus hampering sound economic growth the area.

TABLE 3.1-6 ROAD DENSITY BY ROAD CLASS

	Land Area (km2) A	1990 Popu-lation P	Road Density L/√(AP/1000)					
			National	Provinc'l	City	Municipal	Barangay	Total
All Luzon W/O NCR	107,534.6	22,835,663	0.202	0.211	0.020	0.101	0.704	1.239
NCR	636.0	7,928,867	0.395	-	0.567	0.247	0.121	1.330
CAR	18,293.7	1,145,880	0.348	0.306	0.031	0.095	0.800	1.580
Abra	3,975.6	184,743	0.210	0.560	-	0.301	1.664	2.735
Benguet	2,655.4	485,546	0.398	0.283	0.125	0.031	0.721	1.558
Mountain Province	2,097.3	116,535	0.627	0.552	-	0.075	0.394	1.648
Ifugao	2,517.8	147,281	0.415	0.254	-	0.030	0.915	1.613
Kalinga-Apayao	7,047.6	211,775	0.326	0.142	-	0.070	0.545	1.083
Region I	12,840.2	3,550,606	0.215	0.264	0.025	0.160	1.185	1.849
Ilocos Norte	3,399.3	461,661	0.302	0.337	0.104	0.235	1.655	2.633
Ilocos Sur	2,579.6	519,930	0.327	0.227	-	0.212	1.736	2.502
La Union	1,493.1	548,742	0.241	0.278	-	0.134	0.640	1.293
Pangasinan	5,368.2	2,020,273	0.146	0.257	0.011	0.127	1.014	1.555
Region II	26,628.4	2,325,626	0.202	0.207	-	0.128	0.826	1.363
Cagayan	9,002.7	829,974	0.215	0.193	-	0.074	0.800	1.282
Isabela	10,664.6	1,080,341	0.126	0.171	-	0.127	0.757	1.180
Nueva Vizcaya	3,903.9	301,179	0.291	0.341	-	0.264	1.405	2.300
Quirino	3,057.2	114,132	0.437	0.259	-	0.149	0.378	1.223
Region III	18,230.8	6,198,957	0.160	0.222	0.024	0.095	0.731	1.233
Bataan	1,373.0	425,803	0.387	0.295	-	0.064	0.594	1.340
Bulacan	2,625.0	1,505,219	0.126	0.178	-	0.120	0.901	1.325
Nueva Ecija	5,284.3	1,312,610	0.165	0.265	0.015	0.122	0.675	1.243
Pampanga	2,180.7	1,532,682	0.158	0.176	0.070	0.057	0.869	1.330
Tarlac	3,053.4	859,651	0.130	0.341	-	0.079	0.962	1.512
Zambales	3,714.4	562,992	0.153	0.149	0.063	0.115	0.414	0.894
Region IV	19,468.2	6,491,710	0.203	0.166	0.020	0.078	0.485	0.952
Aurora	3,239.5	139,586	0.325	0.172	-	0.085	0.360	0.943
Batangas	3,165.8	1,476,783	0.241	0.295	0.017	0.110	1.042	1.704
Cavite	1,287.6	1,152,534	0.251	0.353	0.075	0.056	0.589	1.323
Laguna	1,759.7	1,370,232	0.221	0.162	0.051	0.099	0.424	0.958
Quezon	8,706.7	1,372,381	0.189	0.107	0.005	0.062	0.230	0.592
Rizal	1,308.9	980,194	0.216	0.059	-	0.127	0.691	1.092
Region V	12,073.3	3,122,884	0.223	0.233	0.035	0.100	0.570	0.161
Albay	2,552.6	903,023	0.254	0.247	0.018	0.112	0.450	1.082
Camarines Norte	2,112.5	390,982	0.206	0.148	-	0.095	0.347	0.796
Camarines Sur	5,266.8	1,305,919	0.191	0.263	0.073	0.092	0.798	1.416
Sorsogon	2,141.4	522,960	0.279	0.218	-	0.107	0.388	0.992

TABLE 3.1-7 ROAD DENSITY BY PAVEMENT TYPE

	Road Density L/√(AP/1000)					
	Concrete	Asphalt	Gravel	Earth	Total Road	Paved Road
All Luzon W/O NCR	0.096	0.124	0.962	0.056	1.239	0.221
NCR	0.511	0.617	0.197	0.005	1.330	1.129
CAR	0.021	0.133	1.227	0.198	1.580	0.155
Abra	0.007	0.149	2.133	0.447	2.735	0.155
Benguet	0.043	0.349	1.031	0.136	1.558	0.392
Mountain Province	0.001	0.118	1.316	0.214	1.648	0.118
Ifugao	0.063	0.013	1.323	0.214	1.613	0.076
Kalinga-Apayao	0.004	0.017	0.951	0.110	1.083	0.021
Region I	0.089	0.194	1.498	0.069	1.849	0.283
Ilocos Norte	0.218	0.111	2.161	0.143	2.633	0.330
Ilocos Sur	0.044	0.217	2.073	0.168	2.502	0.261
La Union	0.152	0.187	0.909	0.046	1.293	0.339
Pangasinan	0.042	0.228	1.270	0.015	1.555	0.270
Region II	0.073	0.034	1.218	0.039	1.363	0.107
Cagayan	0.083	0.058	1.130	0.012	1.282	0.141
Isabela	0.060	0.027	1.078	0.015	1.180	0.088
Nueva Vizcaya	0.117	0.014	1.974	0.195	2.300	0.131
Quirino	0.024	0.001	1.183	0.015	1.223	0.025
Region III	0.140	0.113	0.943	0.037	1.233	0.253
Bataan	0.202	0.296	0.839	0.003	1.340	0.498
Bulacan	0.248	0.104	0.961	0.013	1.325	0.352
Nueva Ecija	0.120	0.028	1.087	0.007	1.243	0.148
Pampanga	0.189	0.077	0.955	0.109	1.330	0.266
Tarlac	0.074	0.154	1.233	0.051	1.512	0.228
Zambales	0.039	0.210	0.598	0.047	0.894	0.249
Region IV	0.102	0.168	0.649	0.032	0.952	0.271
Aurora	0.003	0.045	0.866	0.029	0.943	0.048
Batangas	0.037	0.413	1.231	0.024	1.704	0.450
Cavite	0.147	0.305	0.776	0.095	1.323	0.452
Laguna	0.224	0.196	0.507	0.031	0.958	0.420
Quezon	0.093	0.033	0.440	0.026	0.592	0.126
Rizal	0.194	0.158	0.709	0.032	1.092	0.351
Region V	0.142	0.144	0.821	0.054	1.161	0.286
Albay	0.141	0.186	0.689	0.065	1.082	0.327
Camarines Norte	0.149	0.160	0.479	0.008	0.796	0.309
Camarines Sur	0.139	0.104	1.128	0.045	1.416	0.243
Sorsogon	0.148	0.171	0.572	0.101	0.992	0.319

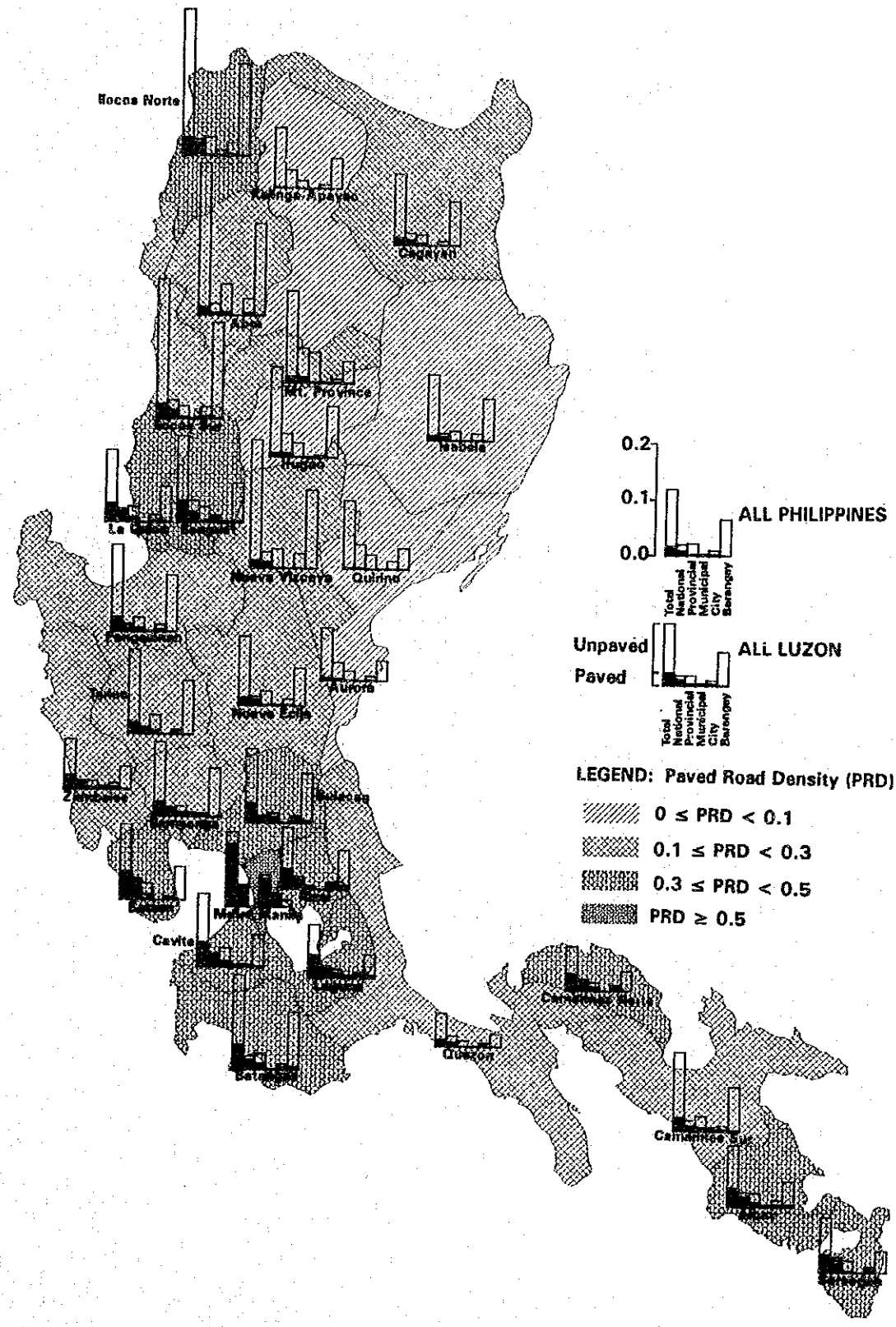


FIGURE 3.1-3 ROAD DENSITY IN LUZON ISLAND

3.1.4 Road Condition

The road condition survey was conducted covering almost all national roads and some provincial roads which were considered as vital linkages to the road network in Luzon Island.

The survey was carried out either by the field survey or by interview. The field survey was applied for all road links that were accessible to public utility vehicle while the interview survey was conducted to all road links with security problems and impassable.

a) Road Condition Survey

Prior to field survey, relevant data and information regarding the project areas were collected and reviewed e.g. Provincial Road Maps, Regional Road Maps and Road Straight Line Diagram.

Topographical maps of scales 1:250,000 and 1:500,000 were also utilized as base maps for preparing road maps.

The JICA assisted " Feasibility Study on Rural Road Network Development Project Phase I and II" has conducted extensive road inventory survey in 1987 and 1989 in the province of La Union, Nueva Ecija, Cavite, Rizal and Albay. Road inventory data gathered by above studies was fully utilized and incorporated in this study by updating with supplemental field surveys.

Two survey teams, each team is composed of one (1) Japanese Highway Engineer and two (2) Filipino counterparts, conducted field survey on 22nd of April to 21st of May 1992 to all road links nominated by the Study Team.

In the field survey, all road data and bridge data were recorded in the field survey sheets. Detailed discussion for survey method is presented in " ROAD INVENTORY ".

b) Result of Road Condition Survey

The survey teams investigated a total length of about 12,000 km of roads comprising 368 road links. All inventory survey data were compiled in the diskettes for computer analysis and road data bases. The result is presented in " ROAD INVENTORY " while location of surveyed roads in each province is presented in Appendix 3.1.

Present road length of each province by surface type, surface condition and carriageway width is summarized in Table 3.1-8.

Present road condition in Luzon Island is illustrated in Figure 3.1-4 based on the field investigation.

c) *Road Length by Surface Condition*

The tendency of surface condition can be attributed with respect to its topographical characteristics as follows:

- The Cordillera Region which typifies in-land provinces with mostly mountainous terrain have the worst road condition (68.2% Bad, Very Bad or Impassable Condition).

- Central Luzon which typifies in-land province with vast land of flat terrain have better road condition (75.9% Good or Fair Condition).

d) Road Length by Pavement Type

Generally, road type were classified as follows:

Paved Road	- *Single Bituminous Surface Treatment* (SBST)
	- Double Bituminous Surface Treatment (DBST)
	- Bituminous Macadam (BM)
	- Asphalt Concrete (AC)
	- Portland Cement Concrete (PCC)
Unpaved Road	- Gravel and Earth

According to survey results, Region III has the most well paved region which account for 73.6% (1,481.6 kms.) of 2,014.0 kms. regional total while the less paved region is CAR which has only 19.1% (373.5 kms.) of 1,958.3 kms. regional total.

e) Road Length by Carriageway Width

The type of road width in the region was classified into two (2) types:

- Road width (w) : W< 6.0 meters
- Road width (w) : W> =6.0 meters

According to survey results, road width less than 6.0 meters dominates the mountainous area, such as CAR. CAR garnered the highest percentage of narrow road, 76.7% (1,502.4 kms) of 1,958.3 kms. regional total.

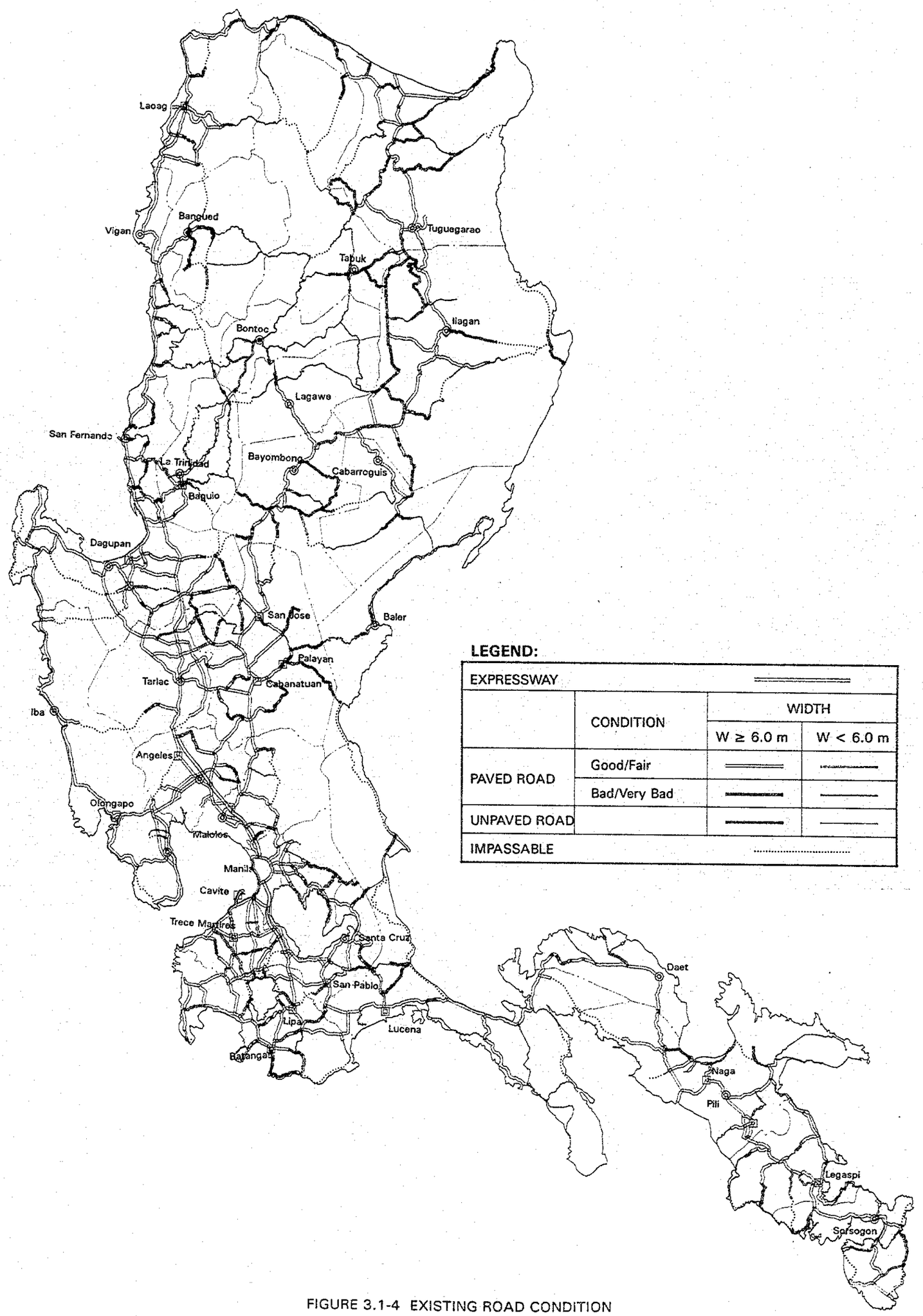
f) Existing Bridge Condition

Eight(8) permanent bridges along surveyed roads were found to be heavily damaged and closed to traffic or need to be reconstructed. Most of them are damaged by mud flows caused by heavy rains. There are 434 temporary bridges such as bailey bridges and timber bridges including spillways along surveyed roads with total length of 9,405.6 m. There still be 158 locations with estimated length of 10,812.0 m have no bridges.

As shown in Figure 3.1-5, location of damaged bridges,temporary bridges and or no bridge sections is fairly distributed all over Luzon Island. Most of then are located along national secondary and provincial roads. Table 3.1-9 shows summary of existing bridges.

TABLE 3.1-8 ROAD LENGTH BY SURFACE TYPE,CONDITION AND WIDTH

	Paved Road					Unpaved Road					Impassable	Total
	Good/Fair		Bad/V. Bad		Total	Good/Fair		Bad/V. Bad		Total		
	W<6.0	W≥6.0	W<6.0	W≥6.0		W<6.0	W≥6.0	W<6.0	W≥6.0			
Whole Luzon w/o NCR	136.3	5,344.7	272.5	431.6	6,185.1	413.6	890.2	2,181.2	604.9	4,089.9	1,605.4	11,880.4
CAR	18.2	239.1	86.5	29.7	373.5	259.1	105.6	839.8	81.5	1,286.0	298.8	1,958.3
Abra	-	34.7	0.3	9.2	44.2	10.3	29.0	125.1	18.3	182.7	65.4	292.3
Benguet	2.2	147.1	29.9	15.1	194.3	64.3	2.3	187.1	2.5	256.2	33.4	483.9
Mountain Province	13.9	1.0	54.6	1.8	71.3	66.8	4.2	190.1	1.3	262.4	2.0	335.7
Ifugao	0.9	48.4	1.4	-	50.7	43.4	5.6	134.5	-	183.5	16.2	250.4
Kalinga Apayao	1.2	7.9	0.3	3.6	13.0	74.3	64.5	203.0	59.4	401.2	181.8	596.0
Region I	13.4	1,078.9	6.6	48.9	1,147.8	16.1	73.7	226.2	48.6	364.6	319.1	1,831.5
Ilocos Norte	-	281.7	0.7	1.1	283.5	2.1	30.2	21.2	5.6	59.1	50.7	393.3
Ilocos Sur	5.6	154.7	2.8	4.7	167.8	6.0	10.7	154.8	7.3	178.8	43.8	390.4
La Union	1.9	165.7	1.4	10.0	179.0	8.0	32.8	27.5	11.7	80.0	5.8	264.8
Pangasinan	5.9	476.8	1.7	33.1	517.5	-	-	22.7	24.0	46.7	218.8	783.0
Region II	1.8	691.4	0.7	78.8	772.7	79.2	577.5	238.6	109.2	1,004.5	224.7	2,001.9
Cagayan	-	319.7	0.7	13.8	334.2	36.7	224.6	58.6	31.5	351.4	62.5	748.1
Isabela	0.3	220.7	-	31.2	252.2	12.4	157.5	50.0	68.0	287.9	117.5	657.6
Nueva Vizcaya	1.5	95.4	-	33.8	130.7	16.1	159.5	14.1	97.0	199.4	32.7	362.8
Quirino	-	55.6	-	-	55.6	14.0	35.9	115.9	-	165.8	12.0	233.4
Region III	12.6	1,417.6	6.5	44.9	1,481.6	6.3	118.1	87.9	116.7	329.0	203.4	2,014.0
Bataan	5.6	198.2	3.1	-	206.9	-	-	14.4	0.7	15.1	40.8	262.8
Bulacan	2.3	209.8	2.8	20.2	235.1	-	-	13.2	4.8	18.0	29.9	283.0
Nueva Ecija	-	340.5	0.6	18.3	359.4	6.3	118.1	60.3	58.9	243.6	12.4	615.4
Pampanga	-	220.5	-	6.4	226.9	-	-	-	32.6	32.6	30.4	289.9
Tarlac	4.7	275.3	-	-	280.0	-	-	-	19.7	19.7	28.7	328.4
Zambales	-	173.3	-	-	173.3	-	-	-	-	-	61.2	234.5
Region IV	42.6	1,211.5	54.2	204.6	1,512.9	30.0	9.2	499.3	200.8	739.3	381.2	2,633.4
Aurora	-	11.4	-	7.6	19.0	27.5	5.0	145.5	9.5	187.5	22.6	229.1
Batangas	14.9	302.6	26.4	88.4	432.3	-	-	37.0	44.3	81.3	86.8	600.4
Cavite	7.9	248.7	7.3	36.9	300.8	-	-	15.6	21.4	37.0	-	337.8
Laguna	2.2	255.2	4.3	9.8	271.5	-	-	15.0	57.0	72.0	20.7	364.2
Quezon	14.9	266.2	12.2	19.4	312.7	2.5	4.2	269.1	47.5	323.3	251.1	887.1
Rizal	2.7	127.4	4.0	42.5	176.6	-	-	17.1	21.1	38.2	-	214.8
Region V	47.7	706.2	118.0	24.7	896.6	22.9	6.1	289.4	48.1	366.5	178.2	1,441.2
Albay	13.7	184.5	30.3	2.2	230.7	22.9	2.9	47.3	22.4	95.5	20.6	346.8
Camarines Norte	-	100.8	0.6	16.1	117.5	-	3.2	48.8	0.4	52.4	-	169.9
Camarines Sur	7.4	262.2	35.1	3.7	308.4	-	-	172.7	22.9	195.6	60.8	564.8
Sorsogon	26.6	158.7	52.0	2.7	240.0	-	-	20.6	2.4	23.0	96.8	359.8



LEGEND:

EXPRESSWAY			
	CONDITION	WIDTH	
		W ≥ 6.0 m	W < 6.0 m
PAVED ROAD	Good/Fair		
	Bad/Very Bad		
UNPAVED ROAD			
IMPASSABLE			

FIGURE 3.1-4 EXISTING ROAD CONDITION

TABLE 3.1-9 SUMMARY OF EXISTING BRIDGES

	Bridge (m)				
	Permanent W/ Heavy Damage	Bailey	Timber	Spillway	No Bridge Ford Crossing
Whole Luzon	457.5(n= 8)	5,046.3(n=250)	2,556.5(n=143)	1,802.8(n=41)	10,812.0(n=158)
CAR	198.3(n= 3)	1,824.8(n=81)	197.9(n= 6)	-	580.0(n= 4)
Abra	98.0(n= 1)	60.0(n= 2)	-	-	-
Benguet	100.3(n= 2)	330.8(n=16)	127.9(n= 2)	-	550.0(n= 3)
Mountain Province	-	566.1(n=22)	-	-	-
Ifugao	-	116.7(n= 3)	-	-	-
Kalinga Apayao	-	751.2(n=38)	70.0(n= 4)	-	30.0(n= 1)
Region I	28.0(n= 2)	934.3(n=33)	179.3(n= 5)	-	1,694.0(n=15)
Ilocos Norte	-	84.0(n= 3)	-	-	-
Ilocos Sur	-	359.3(n=17)	17.0(n= 3)	-	350.0(n= 3)
La Union	28.0(n= 2)	159.0(n= 6)	-	-	100.0(n= 1)
Pangasinan	-	332.2(n= 7)	162.3(n= 2)	-	1,224.0(n=11)
Region II	-	805.3(n=54)	1,070.1(n=50)	541.0(n= 6)	5,204.0(n=33)
Cagayan	-	354.0(n=22)	533.0(n=33)	315.0(n= 2)	2,253.0(n= 6)
Isabela	-	18.0(n= 1)	404.0(n= 2)	111.0(n= 2)	2,120.0(n=16)
Nueva Vizcaya	-	368.1(n=27)	108.5(n=12)	-	531.0(n=10)
Quirino	-	65.2(n= 4)	24.6(n= 3)	115.0(n= 2)	300.0(n= 1)
Region III	793.8(n= 2)	308.3(n= 8)	361.7(n=20)	406.6(n= 5)	330.0(n= 9)
Bataan	-	-	-	-	-
Bulacan	-	10.8(n= 1)	-	-	70.0(n= 2)
Nueva Ecija	-	237.5(n= 4)	348.7(n=18)	316.6(n= 4)	260.0(n= 7)
Pampanga	160.8(n=1)	59.9(n= 3)	13.0(n= 2)	-	-
Tarlac	33.0(n=1)	-	-	90.0(n= 1)	-
Zambales	-	-	-	-	-
Region IV	-	822.7(n=54)	322.8(n=29)	261.0(n=14)	2,090.0(n=77)
Aurora	-	18.0(n= 2)	159.0(n= 8)	154.0(n= 9)	665.0(n=12)
Batangas	-	164.4(n=12)	37.0(n= 5)	-	340.0(n=27)
Cavite	-	298.5(n=19)	93.9(n=10)	46.0(n= 1)	-
Laguna	-	110.5(n= 8)	22.9(n= 5)	16.0(n= 1)	-
Quezon	-	231.3(n=13)	10.0(n= 1)	45.0(n= 3)	1,075.0(n=37)
Rizal	-	-	-	-	10.0(n= 1)
Region V	37.4(n= 1)	351.0(n=20)	424.7(n=33)	594.2(n=16)	194.0(n=20)
Albay	37.4(n= 1)	98.0(n= 7)	275.8(n=18)	347.2(n= 9)	183.0(n=10)
Camarines Norte	-	93.0(n= 3)	76.9(n= 4)	-	-
Camarines Sur	-	106.0(n= 6)	66.0(n=10)	247.0(n= 7)	611.0(n= 1)
Sorsogon	-	54.0(n= 4)	6.0(n= 1)	-	120.0(n= 9)

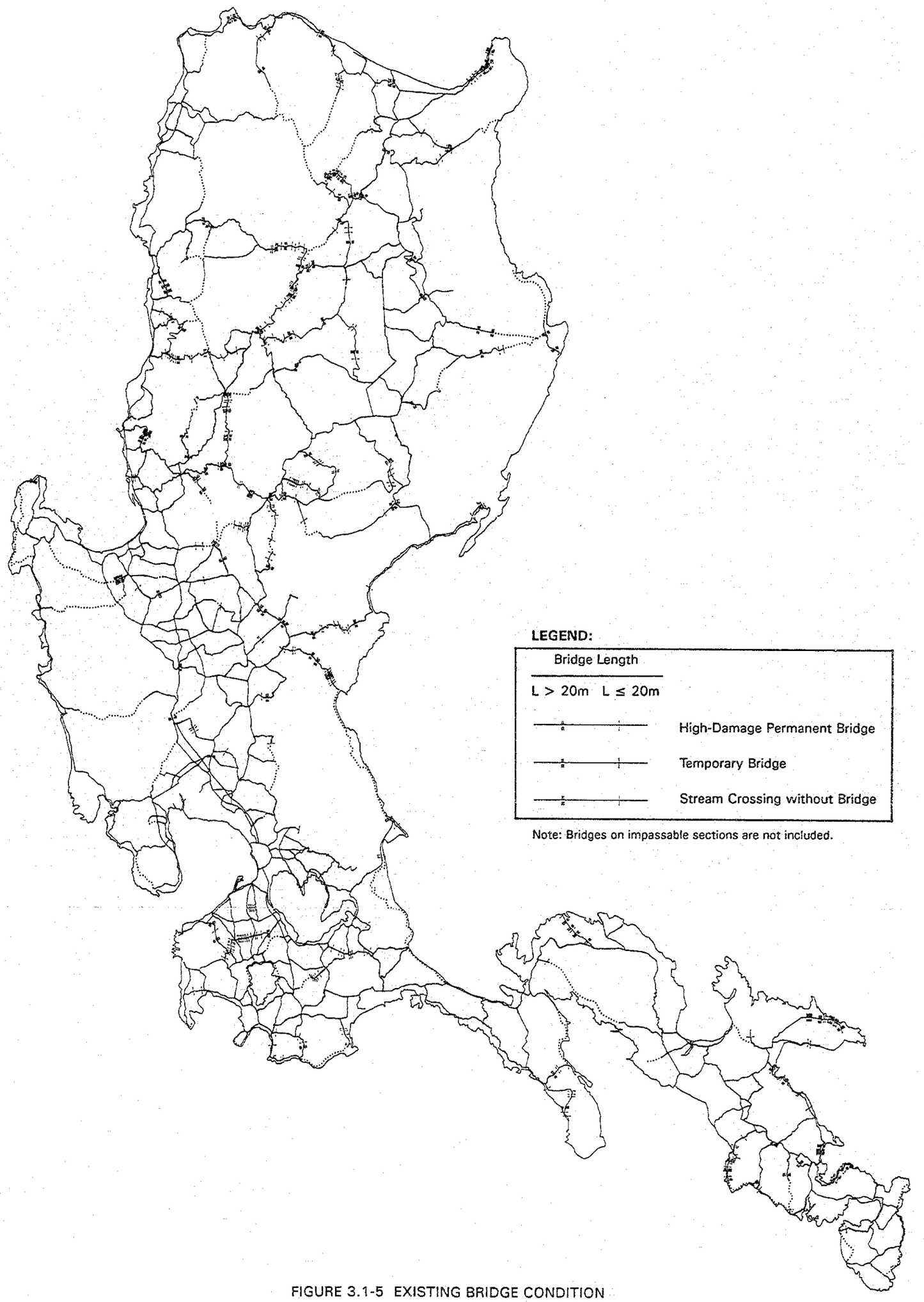


FIGURE 3.1-5 EXISTING BRIDGE CONDITION

3.2 ROAD DISASTER

3.2.1 General

At present, the road system in Luzon Island would seem adequate in terms of location and extent, except those in some remote areas where improvement is now actively implemented. Despite the fact, however, that a quantitative expansion of road system has been realized, the qualitative improvement of road is still far from adequate. There is a fact that an increase number of road disaster that buffet in the country, particularly in Luzon Island such as slope failure, debris flow, landslides and heavy damages to culverts, spillways, seawalls, bridges and other road structures caused by typhoons, floods, earthquakes and volcanic eruptions, resulting innumerable road closures and/or traffic interruptions.

It is very important that the Study Team shall know the present road situation in Luzon Island specifically for the disaster to prepare the Luzon Island Strategic Road Network Development Study more effectively.

3.2.2 Classification of Road Disaster

Road disasters are classified into five (5) types based on location and nature of failure viz.;

1. Cut slope failure
2. Embankment slope failure
3. Debris Flow
4. Scour/Washout of Roadbed
5. Flood

Nature and causes of each disaster is discussed below while detailed description is presented in Appendix 3.2.

1) Cut Slope Failure (including natural slope)

Cut slope failure is classified as surface and deep failure and further subclassified based on causes of failure.

a) Surface Failure

Surface failure is a shallow failure created on cut slope surface. It is subclassified into four types depending on the following causes: i) erosion, ii) top soil slip, iii) weathering, and iv) structural weakness failure. These are mainly result of an action of surface water flowing down the slope surface.

b) Deep Failure

Deep failure is a failure that occurs at considerable deep places within the slope and are sub-classified into three types based on the causes and shape of failure namely: i) scouring, ii) rotational failure, and iii) translational failure.

Scouring generally appears on slope composed of thick soil, soft rock or highly weathered rock, and is induced by concentration of surface water flowing down the slope.

Rotational failure appears on slope composed of thick soil or highly weathered soft rock, and generally has a circular sliding plane. This type of failure is mainly induced by decrease of shear strength or increase of pore water pressure resulting from rising of groundwater level.

Translational failure occurs on structurally weak planes such as fault, bedding planes, border planes between rock and soil, etc. It is mainly caused by seepage of groundwater into weak planes.

2) Embankment Slope Failure (including natural slope)

Embankment slope failure is classified as surface failure and deep failure which are further sub-classified in accordance with the causes of failure.

a) Surface Failure

Surface failure is a shallow failure forming gullies which appear in slope surfaces and are caused by erosion resulting from surface water flow.

b) Deep Failure

Deep failure is a failure which occurs or extend in the deep places within the embankment. They are sub-classified as scouring and saturation failures depending on the causes of failure.

Scouring is often seen on slope where there is concentrated flow of surface water, for example, slopes within the inside curve of road in mountainous area. Scouring is also caused by river flow and waves, and is often seen on riverside embankment slopes.

Saturation failure is a result of the decreasing shearing strength of the roadbed fill due to seepage of ground water into the embankment. Failure of this type has circular sliding plane and occur easily on embankment slopes located on inclined ground or semi-cut and fill sections.

3) Debris Flow

Debris flow is defined as the mass flow of deposits with rainwater whose movement resembles the movement of viscous fluid in velocity distribution.

This occurs when the force of flood flow hit a mass of deposit that is subjected to liquefaction. Debris flow is classified into two types based on the size of flow materials, namely: i) debris flow which contains large stones and big boulders, and ii) mud flow which contains soils and muds with stones.

4) Scour/Washout of Roadbed

Scouring is caused by river flow where river bed is high mainly due to the accumulations of sand, gravel, cobble and boulder materials brought from further upstream and deposited under the bridge/stream bed thus insufficient clearance of bridge site wherein flood discharge cannot be accommodated during heavy rains. As a result, water is to overflow on the roadway. Overflowing had caused on a road surface to scoured shoulder/road bed. Likewise, the said deposited materials under the bridge had caused the river channel to change its course resulting river bank scoured by the floods.

5) Flood

Flood is defined as the inundation of the road surface lower than the abuting lands due to insufficient capacity of side ditches or overflowing of stream due to aggravation of riverbed by sedimentation.

3.2.3 Road Disaster Survey

The Road Disaster Survey are carried out in two stages:

- The initial road disaster survey was conducted during dry season to estimate the occurrence of potential disaster such as cut slope failure, debris flow, embankment slope failure and scouring.

- The detailed disaster condition was observed in the second road disaster survey period. The second road disaster survey was conducted during rainy season to observe the situation of the areas/sections identified as potential disaster during the initial road disaster survey.

3.2.4 Initial Road Disaster Survey

1) Pre-Disaster Survey

The disaster area/section were reviewed prior to field survey by engineers on the bases of existing reports, disaster records, topographic, meteorologic data and geological data.

2) Field Road Disaster Survey

The Road Disaster Survey was conducted by ocular inspection together with Road Condition Survey on the National Road and some part of Provincial Road in the whole Luzon Island. The total surveyed road length is approximately 12,000 kms.

Two Survey Teams, composed of one (1) Expatriate Road Engineer with two Filipino Counterparts were conducted initial survey on 22nd of April to 21st of May 1992 in Southern and Northern part of Luzon Island respectively.

3.2.5 Result of Initial Road Disaster Survey

Potential disaster sections are noted downs on the survey sheet during field survey. The result is summarized in Table 3.2-1 and illustrated in Figure 3.2-1.

TABLE 3.2-1 SUMMARY OF ROAD DISASTERS (m)

Province	Cut Slope Damage	Embankment Slope Damage	Debris Flow	Scour/Washout of Roadbed	Flooding
Abra	3,750	-	-	-	-
Benguet	134,550	90,790	70	-	-
Mt. Province	56,900	27,400	-	-	-
Ifugao	46,000	31,900	-	-	-
Kalinga Apayao	9,850	12,250	800	-	-
Ilocos Norte	7,150	956	-	-	-
Ilocos Sur	6,358	900	-	-	-
La Union	11,248	4,591	-	300	-
Pangasinan	100	-	-	-	1,500
Cagayan	6,400	700	-	-	3,550
Isabela	50	-	-	-	3,008
Nueva Vizcaya	17,900	11,060	-	300	100
Quirino	-	-	-	-	-
Bataan	-	-	-	400	-
Bulacan	-	-	-	-	-
Nueva Ecija	16,650	520	90	-	46,600
Pampanga	-	-	-	-	-
Tarlac	-	-	-	-	-
Zambales	-	-	-	-	500
Aurora	-	-	-	-	-
Batangas	-	-	-	-	-
Cavite	-	-	-	-	-
Laguna	-	-	-	-	-
Quezon	200	-	-	-	-
Rizal	120	30	-	-	-
Albay	300	100	-	-	300
Camarines Norte	100	-	-	-	-
Camarines Sur	-	-	-	-	-
Sorsogon	-	-	-	-	1,500
TOTAL	317,626	181,197	960	1,000	57,058

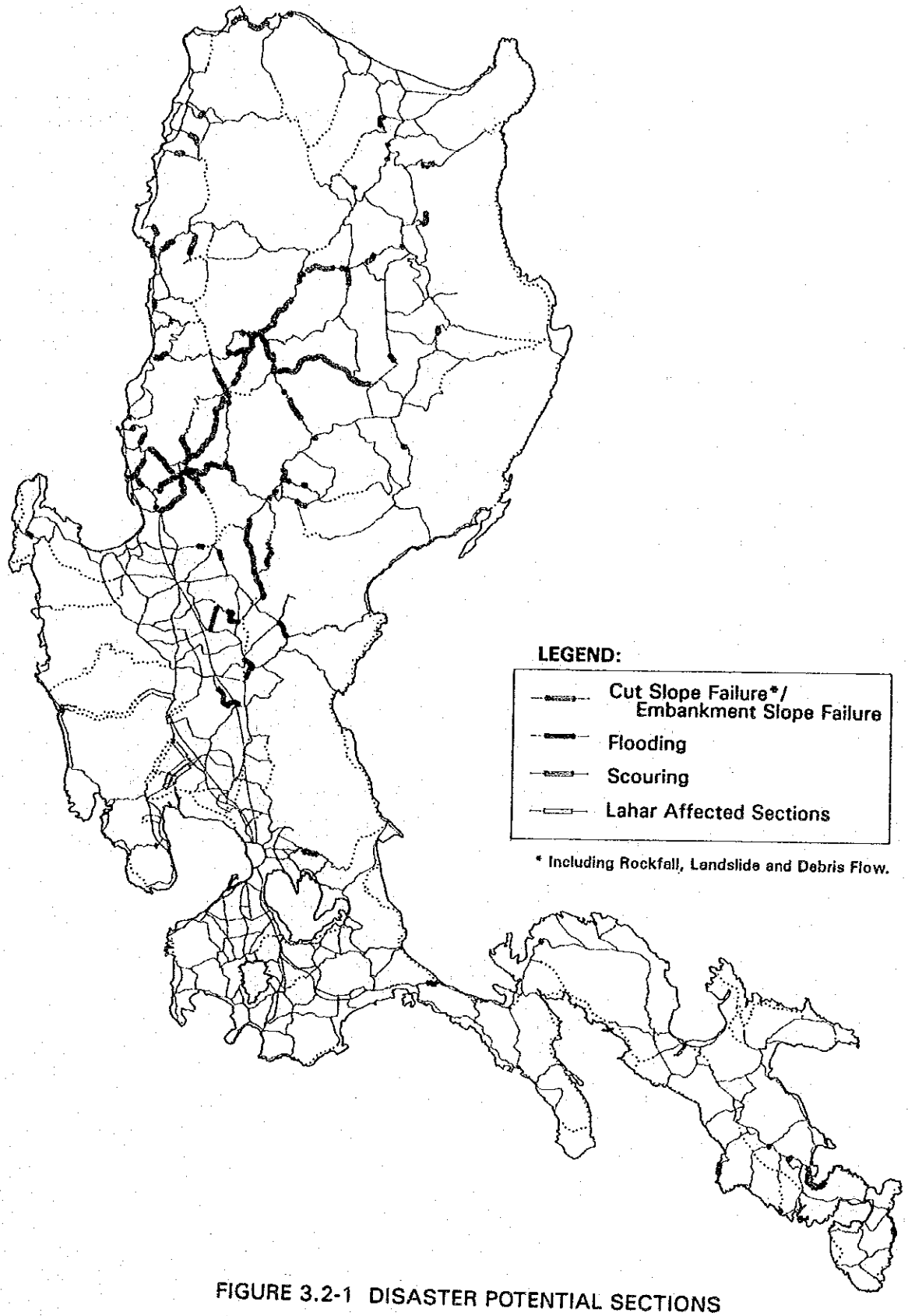


FIGURE 3.2-1 DISASTER POTENTIAL SECTIONS

1) Cut and Embankment Slope Failure

Based on the existing reports and the actual road disaster survey results the causes of disaster for each road sections/areas under study explicitly show are due to the following potential reasons:

a) Steep mountain and valley area which are susceptible to slope failure.
b) Faults and volcanic zones.
c) Meandering river frequently changes its course and river stream hits the embankment directly.
d) Flood prone area.

The disaster mentioned above, except item b) are very popular in Luzon Island and occurred every year during rainy season with heavy rains and typhoons. During site investigation there are many potential portions with slope failure found along the mountain side of the road due to steep mountain with deep cutting without any slope protection, poor drainage facilities and the absence of vegetation activated the materials to fall easily causing landslide and embankment failures. Further damaged was aggravated by heavy rains and/or earthquakes.

The Region CAR and the provinces of Ilocos Norte and Ilocos Sur had suffered many road disasters as mentioned above.

2) Scouring

The scouring of road were also raised in many places particularly roads crossing along Cagayan and Agno rivers and other streams.

Apparently, many bridges and culverts were washed out/buried by silted materials supplied by devastated mountain slope and aggravated by strong rainfall. Like for example is some part of Bued river in Benguet and Cagayan river in Cagayan Valley, river bed was almost in the same level as the road due to accumulated sand and gravels from upstream thus flood overflow on the road surface causing the shoulder/roadbed to scour.

3) Mt. Pinatubo

The eruption of Mt. Pinatubo which is located in the Central portion of the Zambales Range is one of the world's most violent and destructive eruptions in the century. The eruption of the said mountain has brought about untold or immeasurable human sufferings and tragedies. Infrastructure such as roads and bridges were totally damaged particularly in Zambales,Pampanga and Tarlac.

To date, lahar flow continuously destructed/damaged the neighboring towns and infrastructure projects specifically during and after heavy rains. Listed in Table 3.2-2 are the roads affected/damaged by lahar flow during the eruption of Mt. Pinatubo.

TABLE 3.2-2 ROAD DAMAGED BY MT. PINATUBO ERUPTION

Province	Road No.	Road Name
Zambales	35-21B	Olongapo-Zambales Road
	35-93	Zambales-Tarlac Road
Pampanga	34-21A~21C	San Fernando-Olongapo Road
	34-12C,12F,12G	Manila North Road (MNR)
	34-29A,29B	San Fernando-Gapan Road
	34-30A,30B	San Antonio-Florida Blanca Road
	34-01A,01C	Manila North Expressway
	34-12A	Part of MNR (Bulacan Bdry.)
	34-12D,12E	Part of MNR (Bulacan Bdry.)
	34-23	Apalit-Macabebe-Masantol Road
	34-26A,26B	San Fernando-Lagundi Road
Tarlac	35-12A,12E	Manila North Road
	35-21	Tarlac-Zambales Road
	35-22AX~Y	Tarlac-Sta. Rosa Road
	35-24AC	Paniqui-Camiling-Wawa Road
	35-51	Bamban-Lapaz-Paniqui Road

Source: Mudflow Hazard Map as of 01 October 1991

3.2.6 Second Road Disaster Survey

Most of road disaster usually occur during rainy season, from the month of June to October. In order to formulate sound disaster prevention measures which can withstand harsh monsoon weather and unstable geographical formations, it is imperative to observe exact disaster condition during rainy season.

The Survey Team, composing of one (1) Japanese Disaster Prevention Engineer and one (1) Filipino Counterpart conducted site survey between September 1 and 11, 1992.

The following road sections are selected for disaster site survey. These sections exhibit typical road disasters.

- San Fernando - Olongapo - Zambales Road
- Pan-Philippine Highway, Dalton Pass Section
- Major Roads Leading to Baguio City
- Kalinga - Cagayan Road
- Cabatuan - Enrile Road in Isabela Province
- Manila North Road, Laoag - Allacapan Section

During the site survey, the identified disaster area/sections were inspected by the Survey Team using survey sheets. For each type of disasters, factors that may affect the occurrence of disaster were noted down in the Survey Sheets. The factors under consideration are slope length, gradient, type of soil or rock comprising the slope, geological condition, surface water, ground water and evidence of past disaster records etc.

3.2.7 Result of Second Road Disaster Survey

Survey Sheets of second road disaster survey is presented in Appendix 3.3. Road disaster in each nominated road are discussed below.

1) Investigated Road

- San Fernando - Olongapo - Zambales Road

  Some bridges and road sections were destroyed and damaged by lahar flow from Mt. Pinatubo.

- Pan-Philippine Highway, Dalton Pass Section

  This road has various type of disaster such as cut slope failure, embankment slope failure, rockfall,scouring and debris flow mainly because it is situated along the Philippines Fault.

- Major Roads Leading to Baguio City

  The topographical condition of these roads is dominantly mountainous with deep ravine and steep valleys. Also, faults and developed fracture zones were observed.

  Disasters observed along these roads are follows:

  Naguilian Road ..... Rock Fall due to stratum of parallel dip with cut slope and embankment slope failure

  Marcos Highway .....Debris Flow, Cut Slope Failure and Embankment Slope Failure

  Kennon Road .....Debris Flow, Scouring, Cut Slope Failure, Embankment Slope Failure and Flood

  Baguio-Bontoc Road ....Cut Slope Failure, Embankment Slope Failure and Debris Flow

  Baguio-N. Vizcaya Rd...Cut Slope Failure, Embankment Slope Failure and Debris Flow

- Kalinga - Cagayan Road

  This road was damaged by cut slope failure, embankment slope failure and huge landslide

- Cabatuan - Enrile Road

  Some portion of this road is prone to flooding because the road surface is lower than its abutting lands.

- Manila North Road, Laoag - Allacapan Section

  The Section in Patapat viaduct was damaged by rock fall.

2) Investigated Road Disaster

a) Surface Failure of Cut Slope

Cut Slope failure (including deep failure) is very common in Luzon Island and occur every year during monsoon rain and typhoon. In the site survey, many cut slope failure portions were observed along the mountain side of the road.

Cut Slope failures were observed on high cut slope composed of soil and highly weathered or fractured rocks. Most of the cut slope failure were caused by surface water flow. Many cases of this disaster were brought about by erosion or scouring as water flowing is ground water.

- Erosion on Slope Surface

  Many erosions were found on the slope surfaces forming slight gullies due to surface water flow. The most typical erosion can be observed at KM. 203.00 in Dalton Pass (Pan-Philippine Highway) where the slope was recut to gradient 45 degree with two berms after damaged by earthquake in 1990, but there is no slope protection works like vegetation and ditches to drain surface water.

- Top Soil Slip

  This type of failure was also observed in the mountainous areas. The most typical one was located at KM. 275.00 in Baguio City - Nueva Vizcaya Road. Most of the vegetated top soil slipped down and exposed the base rocks. The slope is steeper than normal cut slope and have no ditches on top of the slope.

- Weathering or Structural Failure

These are slope failures commonly found in Naguilian Road which are caused by weathering and structural weakness. The slope surface was covered by weathered rock but rock plates slide down along the planes of developed crack because stratum is parallel to the slope. There are no slope protection works such as rock bolting or shotcrete work.

b) Deep Failure of Cut Slope

- Scouring of Cut Slope

Scouring is one of the most familiar slope failure in Luzon Island. The typical scouring was observed at KM. 280.00 in Marcos Highway. The cut slope was scoured by concentrated water flowing down the slope forming deep gully.

- Rotational Failure

A typical rotational failure on natural valley located at KM. 265.30 in Baguio-Bontoc Road. Concentrated surface water was flowing on the road surface down to the natural slope. Failure occurred along the circular slide plane with weak shearing strength which may be weaker more by water penetration into the natural slope. If there is a vertical ditch with enough capacity, the natural slope will be protected from further damage.

- Translational Failure

The typical translational failure was observed at KM. 292.90 in Naguilian Road. The steep plane crack with clay which inclined to slope divided the mother rock into two mass of rock. Upper rock mass slide down when shear strength was weakened by weathering or penetration of water in the crack.

c) Surface Failure of Embankment

The Typical surface failure of embankment was observed at KM. 257.70 in Baguio-Nueva Vizcaya. Concentrated surface water from the road surface flow down the embankment slope inside the curve, eroding the slope and formed slight gully.

d) Deep Failure of Embankment

- Scouring of Embankment Slope

The typical scouring was observed at KM. 235.50 in Kennon Road. The embankment slope was scoured by the strong current of the meandering

river induced by heavy rain. The strong current hit and scoured heavily the riprapped embankment including the roadbed.

- Saturation Failure

  Saturation failure was observed at KM. 267.10 in Baguio-Bontoc Road. This spot is semi-cut section with small pipe culvert in the roadbed. Embankment was saturated with leaked water from pipe joint and slide down along natural slope.

e) Flood

Many flooded sections were observed. Some of them are;

- Floods at Mt. Pinatubo surrounding roads such as Manila North Road at Bamban or San Fernando-Olongapo Road at Lubaoa are caused by lahar.

- Flood at KM. 218.10 in Kennon road is caused by flash flood on accumulated riverbed.

- Flood at KM. 366.00 in Cabanatuan-Enrile Road is due to lower road surface level which is as low as the riverbed.

f) Debris Flow

The typical debris flow was observed at KM. 273.10 in Baguio-Nueva Vizcaya Road. The flow of debris moved like viscous fluid along the valley from deep in mountain, and crossed over the road scouring the embankment shoulder. This was a flow of deposits which contains water. The gradient of debris flow is roughly 15 degrees.

3.2.8 Formulation of Disaster Prevention Measures

Based on second disaster survey, appropriate disaster prevention measures for each type of disaster are established. These measures are incorporated in the cost estimate as discussed in Chapter 12.

3.3 ASSESSMENT OF EXISTING ROAD NETWORK

Based on the road inventory survey, existing road condition is illustrated in Figure 3.3-1, classifying each subsection according to pavement type, surface condition and carriageway width.

Existing road network in Luzon Island is assessed as follows:

1) Completeness in covering important centers of activity

Important centers of activity such as provincial capitals, highly populated area, major ports/airport/railway stations, highly developed industrial area, etc. are connected by existing roads although some connection roads are unstable and in poor condition especially in Northern Luzon and Bicol area.

2) Shape of Road Network

Road network in central and northern parts of Luzon Island is basically composed of two north-south backbones (Manila North Road and Pan-Philippine Highway) and east-west laterals connecting the two roads in the inner area and branching off eastward from Pan-Philippine Highway, while road network in Bicol area is composed of one backbone (Pan-Philippine Highway) and access roads thereto. Thus, in east side of Pan-Philippine Highway in central and northern Luzon and Bicol area, road network is fish-bone type without direct connection between neighboring areas and flexibility in the occurrence of road disaster.

3) Distribution of Road

Road Density of surveyed roads is presented in Table 3.3-1. Provinces belonging to CAR have high road density setting aside quality. This is because of low population. On the other hand, provinces in Region III have low road density because of high population. In mountainous area, especially east coast of Luzon Island, both roads and population are sparse.

4) Quality of Road

Pavement type and surface condition of surveyed roads are as follows:

Paved, good/fair	:	46%
Paved, bad/very bad	:	6%
Unpaved	:	34%
Impassable	:	14%

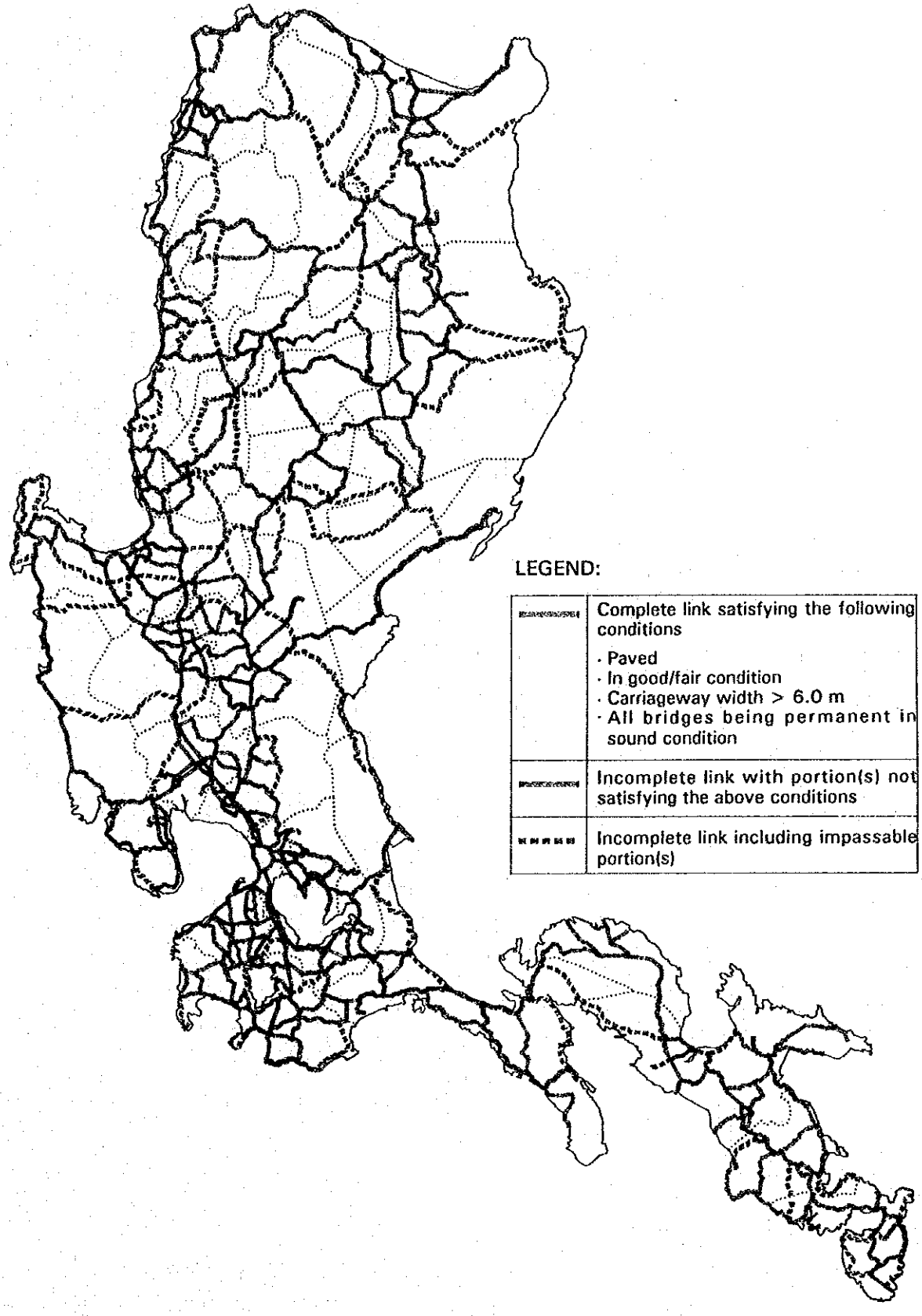


FIGURE 3.3-1 ROAD LINK EVALUATION BY CONDITION

TABLE 3.3-1 PRESENT CONDITION AND DENSITY OF SURVEYED ROAD

Province	Land Area (km^2)	1990 Population	Surveyed Road (km.) Paved Good/Fair		Paved Bad/Very Bad		Unpaved		Impassable		Total		Road Density L/√(AxP/1000) Total	Paved Good/Fair
Whole Luzon except NCR	107,534.6	22,835,660	5,481.0	(46%)	704.1	(6%)	4,088.9	(34%)	1,606.4	(14%)	11,880.4	(100%)	0.240	0.111
CAR	18,293.7	1,145,880	257.3	(13%)	116.2	(6%)	1,286.0	(66%)	298.8	(15%)	1,958.3	(100%)	0.428	0.056
Abra	3,975.6	184,743	34.7	(12%)	9.5	(3%)	182.7	(63%)	65.4	(22%)	292.3	(100%)	0.341	0.040
Benguet	2,655.4	485,546	149.3	(31%)	45.0	(9%)	256.2	(53%)	33.4	(7%)	483.9	(100%)	0.426	0.131
Mt. Province	2,097.3	116,535	14.9	(4%)	56.4	(17%)	262.4	(78%)	2.0	(1%)	335.7	(100%)	0.679	0.030
Ifugao	2,517.8	147,281	49.3	(20%)	1.4	(1%)	183.5	(73%)	16.2	(6%)	250.4	(100%)	0.411	0.081
Kalinga-Apayao	7,047.6	211,775	9.2	(2%)	3.9	(1%)	401.2	(67%)	181.8	(31%)	596.0	(100%)	0.488	0.008
Region I	12,840.2	3,550,606	1,092.3	(60%)	55.5	(3%)	364.6	(20%)	319.1	(17%)	1,831.5	(100%)	0.271	0.162
Ilocos Norte	3,399.3	461,661	281.7	(72%)	1.8	(0%)	59.1	(15%)	50.7	(13%)	393.3	(100%)	0.314	0.225
Ilocos Sur	2,579.6	519,930	160.3	(41%)	7.5	(2%)	178.8	(46%)	43.8	(11%)	390.4	(100%)	0.337	0.138
La Union	1,493.1	548,742	167.6	(64%)	11.4	(4%)	80.0	(30%)	5.8	(2%)	264.8	(100%)	0.292	0.185
Pangasinan	5,368.2	2,020,273	482.7	(63%)	34.8	(5%)	46.7	(6%)	218.8	(28%)	783.0	(100%)	0.238	0.147
Region II	26,628.4	2,325,626	693.2	(35%)	79.5	(4%)	1,004.5	(50%)	224.7	(11%)	2,001.9	(100%)	0.254	0.088
Cagayan	9,002.7	829,974	319.7	(43%)	14.5	(2%)	351.4	(47%)	62.5	(8%)	748.1	(100%)	0.274	0.117
Isabela	10,664.6	1,080,341	221.0	(33%)	31.2	(5%)	287.9	(44%)	117.5	(18%)	657.6	(100%)	0.194	0.065
Nueva Vizcaya	3,903.9	301,179	96.9	(27%)	33.8	(9%)	199.4	(55%)	32.7	(9%)	362.8	(100%)	0.335	0.089
Quirino	3,057.2	114,132	55.6	(24%)	0.0	(0%)	165.8	(71%)	12.0	(5%)	233.4	(100%)	0.395	0.094
Region III	18,230.8	6,198,957	1430.2	(71%)	51.4	(3%)	329.0	(16%)	203.4	(10%)	2,014.0	(100%)	0.189	0.135
Bataan	1,373.0	425,803	203.8	(70%)	3.1	(1%)	15.1	(6%)	40.8	(23%)	262.8	(100%)	0.344	0.241
Bulacan	2,625.0	1,505,219	212.1	(75%)	23.0	(8%)	18.0	(6%)	29.9	(11%)	283.0	(100%)	0.142	0.107
Nueva Ecija	5,284.3	1,312,610	340.5	(55%)	18.9	(3%)	243.6	(40%)	12.4	(2%)	615.4	(100%)	0.234	0.129
Pampanga	2,180.7	1,532,682	220.5	(76%)	6.4	(2%)	32.6	(11%)	30.4	(10%)	289.9	(100%)	0.159	0.121
Tarlac	3,053.4	859,651	280.0	(85%)	0.0	(0%)	19.7	(6%)	28.7	(9%)	328.4	(100%)	0.202	0.173
Zambales	3,714.4	562,992	173.3	(74%)	0.0	(0%)	0.0	(0%)	61.2	(26%)	234.5	(100%)	0.162	0.120
Region IV	19,468.2	6,491,710	1,254.1	(48%)	258.8	(9%)	739.3	(28%)	381.2	(14%)	2,633.4	(100%)	0.234	0.112
Aurora	3,239.5	139,586	11.4	(5%)	7.6	(3%)	187.5	(82%)	22.6	(10%)	229.1	(100%)	0.341	0.017
Batangas	3,165.8	1,476,783	317.5	(53%)	114.8	(19%)	81.3	(14%)	86.8	(14%)	600.4	(100%)	0.278	0.147
Cavite	1,287.6	11,525,534	256.6	(76%)	44.2	(13%)	37.0	(11%)	0.0	(0%)	337.8	(100%)	0.277	0.211
Laguna	1,759.7	1,370,232	257.4	(70%)	14.1	(4%)	72.0	(20%)	20.7	(6%)	364.2	(100%)	0.235	0.166
Quezon	8,706.7	1,372,381	281.1	(32%)	31.6	(4%)	323.3	(36%)	251.1	(28%)	887.1	(100%)	0.257	0.081
Rizal	1,308.9	980,194	130.1	(10%)	46.5	(22%)	38.2	(18%)	0.0	(0%)	214.8	(100%)	0.190	0.115
Region V	12,073.3	3,122,884	753.9	(52%)	142.7	(10%)	366.5	(26%)	178.2	(12%)	1,441.3	(100%)	0.235	0.123
Albay	2,552.6	903,023	198.2	(57%)	32.5	(9%)	95.5	(28%)	20.6	(6%)	346.8	(100%)	0.228	0.131
Camarines Norte	2,112.5	390,982	100.8	(59%)	16.7	(10%)	52.4	(31%)	0.0	(0%)	169.9	(100%)	0.187	0.111
Camarines Sur	5,266.8	1,305,919	269.6	(47%)	38.8	(7%)	195.6	(35%)	60.8	(11%)	564.8	(100%)	0.215	0.103
Sorsogon	2,141.4	522,960	185.3	(52%)	54.7	(15%)	23.0	(6%)	96.8	(27%)	359.8	(100%)	0.340	0.175

Paved roads in good/fair condition are concentrated in central plain from Pangasinan to Batangas. In the other area, especially mountainous area, quality of road is low, most roads being unpaved except Pan-Philippine Highway and Manila North Road.

To simply indicate the condition of link from the viewpoint of serviceabili ty to through traffic wherein link is defined as road section between neighboring intersections, link is classified into three categories as follows:

i. Complete link which satisfies the following condition throughout the link:

   - Carriageway is paved,
   - Pavement surface is in good or fair condition,
   - Carriageway width is 6.0m or more,
   - All bridges are permanent structures in sound condition,

ii. Incomplete link which partly or entirely does not satisfy all of the above conditions, but does not include any impassable portion at the time of conducting the road inventory survey (May 1992).

iii. Impassable link which is partly or entirely inaccessible to motorized vehicle.

Figure 3.3-1 shows the link condition based on the above definitions. Table 3.3-2 summarizes the total length by category.

About 30% of links are complete, 48% incomplete and 22% impassable. Manila North Road, west coast road in Zambales and a part of Pan-Philippine Highway are complete and others are mostly incomplete.

5) Flexibility in the occurrence of road disaster

Roads in the Philippines are situated in the severe natural environment such as mountainous topography, fragile geology, heavy rain, etc., and often hit by natural calamities like typhoons, earthquakes and volcanic eruptions. Furthermore, such area as often hit by disaster is behind in road development, in most cases relying on one major road. When the road is damaged by calamity, no detour road is available resulting in complete isolation of the area. This problem is found in many remote areas. Cordillera Mountains is a typical one.

TABLE 3.3-2 COMPLETE/IMCOMPLETE/IMPASSABLE LINKS OF SURVEYED ROAD

Province	Surveyed Road (Km)			
	Complete Link	Imcomplete Link	Impassable Link	Total
Whole Luzon w/o NCR	3,550.75(30%)	5,033.8(42%)	3,295.9(28%)	11,880.4(100%)
CAR	14.4(1%)	1,221.0(62%)	723.1(37%)	1,958.5(100%)
Abra	.0(0%)	154.7(53%)	137.7(47%)	292.4(100%)
Benguet	14.4(3%)	260.8(54%)	208.8(29%)	484.0(100%)
Mt. Province	.0(0%)	295.0(88%)	40.7(12%)	335.7(100%)
Ifugao	.0(0%)	206.2(82%)	44.2(18%)	250.4(100%)
Kalinga-Apayao	.0(0%)	304.3(51%)	291.7(49%)	596.0(100%)
Region I	748.9(41%)	524.0(29%)	558.6(30%)	1,831.5(100%)
Ilocos Norte	189.0(48%)	133.4(34%)	70.6(18%)	393.2(100%)
Ilocos Sur	139.9(36%)	150.3(38%)	100.4(26%)	390.6(100%)
La Union	121.6(46%)	85.3(32%)	57.8(22%)	264.7(100%)
Pangasinan	298.2(38%)	155.0(20%)	329.8(42%)	783.0(100%)
Region II	368.4(18%)	1,166.6(58%)	467.0(23%)	2,001.9(100%)
Cagayan	176.5(24%)	313.5(42%)	258.1(35%)	748.1(100%)
Isabela	118.4(18%)	316.7(48%)	224.5(34%)	657.6(100%)
Nueva Vizcaya	63.0(17%)	165.7(86%)	134.1(37%)	362.8(100%)
Quirino	15.7(6%)	125.3(54%)	92.4(40%)	233.4(100%)
Region III	1,094.6(54%)	506.4(25%)	413.2(21%)	2,014.2(100%)
Bataan	183.0(69%)	17.7(7%)	62.2(24%)	262.9(100%)
Bulacan	179.9(64%)	51.8(18%)	51.4(18%)	283.1(100%)
Nueva Ecija	167.1(27%)	328.3(53%)	120.0(20%)	615.4(100%)
Pampanga	180.0(62%)	79.5(27%)	30.4(10%)	289.9(100%)
Tarlac	228.8(70%)	29.1(9%)	70.5(21%)	328.4(100%)
Zambales	155.8(66%)	0.0(0%)	78.7(34%)	234.5(100%)
Region IV	888.5(34%)	1,220.6(46%)	524.3(20%)	2,633.3(100%)
Aurora	.0(0%)	198.7(87%)	30.4(13%)	229.1(100%)
Batangas	236.3(39%)	200.8(34%)	163.3(27%)	600.4(100%)
Cavite	187.0(55%)	145.9(43%)	5.0(2%)	337.8(100%)
Laguna	185.1(51%)	144.50(40%)	34.6(9%)	364.2(100%)
Quezon	205.8(23%)	395.9(45%)	285.8(32%)	887.0(100%)
Rizal	74.8(35%)	134.8(63%)	5.2(2%)	214.8(100%)
Region V	430.9(30%)	640.6(44%)	369.7(26%)	1,441.2(100%)
Albay	77.4(22%)	126.9(37%)	142.5(41%)	346.8(100%)
Camarines Norte	20.3(12%)	149.3(88%)	.0(0%)	169.7(100%)
Camrines Sur	203.0(36%)	264.2(47%)	97.8(17%)	564.9(100%)
Sorsogon	130.2(36%)	100.2(28%)	129.4(36%)	359.8(100%)

6) Traffic Congestion

Some roads, particularly those located near Metro Manila suffer traffic congestion (see Chapter 10).

7) Contribution to Regional Development

Weakness of major road network is deemed to impede the sound regional development, especially in Cagayan and Bicol Regions which have a high potential of agricultural development.

CHAPTER 4

ROAD TRANSPORT

4.1 INTRODUCTION

As of 1990, the Philippine road network has a total length of 160,560 kilometers in which 26,270 kilometers are classified as national roads under the construction and maintenance responsibility of the Department of Public Works and Highways (DPWH). Provincial governments are responsible for the construction and maintenance of provincial roads which have a total length of 29,160 kilometers. Cities and municipalities construct and maintain their road networks with existing total lengths of about 3,950 and 12,820 kilometers respectively. In the total length of the road network, about 88,360 kilometers are classified as barangay roads.

Luzon Island, as the study area, has a road network with a total length of about 66,450 kilometers which are classified as 11,560 kilometers of national roads, 10,890 provincial roads, 2,290 city roads, 5,750 municipal roads and about 35,960 of barangay roads. With the highest share in handling passengers and freight comparing with rail, sea and air transport sub-sectors, the road transport has its important role in supporting the regional and national development.

As the main objective of this study is to develop a strategic master plan of the road network in Luzon Island, information on present and future traffic pattern are required. The Nationwide Traffic Counting Program (NTCP) of the DPWH provides the basic traffic volume data to be updated, supplemented and utilized in this study. Registered vehicles data of the Land Transportation Office (LTO) are analyzed to study the pattern of growth and composition of the different vehicle categories.

To collect additional data on the existing traffic movement of passengers and cargo, a roadside OD survey is carried out on selective screen lines dividing the island into seven areas. In addition, a traffic count survey is carried out to collect data necessary to expand the OD data collected on sampling base and to supplement existing traffic volumes estimated through the data of NTCP.

Traffic volumes of 1992 are initially estimated for the roads covered by traffic surveys and applied to get the effect of the road condition on traffic composition. Present OD tables are established for a total number of 98 zones and analyzed on provincial and regional base for the movement of passengers and cargo as well as per vehicle categories to complete information on the existing trip pattern on the road network and to forecast the future traffic demand. Traffic assignment techniques are applied to allocate the present trip matrices to the road network in order to estimate the traffic volumes on the road network.

4.2 NATIONWIDE TRAFFIC COUNTING PROGRAM (NTCP)

The main and most updated source of data on traffic volumes on the road network in the Philippine is the DPWH Philippine Road Traffic Statistics 1991 which is based on the Nationwide Traffic Counting Program (NTCP). Information includes values of the Annual Average Daily Traffic (AADT) of the years 1987-1990 as well as vehicle classification and monthly, daily and hourly rates. In addition to the nationwide program, numerous counts are carried out as part of feasibility studies and other road projects.

Data collected by the NTCP are utilized in different stages in this study, and supplemented through two traffic surveys. Estimation of the average daily traffic (ADT) in this program is conducted by applying Hourly and Daily factors (HF & DF) obtained through control stations to the traffic counts of other stations. To estimate the annual average daily traffic (AADT), a seasonal factor (SF) derived from data collected at a nearby seasonal station is applied to ADT. AADT values presented by NTCP are classified into six groups of vehicle categories, which are: car, jeepney, mini-bus, big-bus, rigid truck and articulated truck.

With the anticipated accuracy of the processed data into annual average daily traffic (AADT) by vehicle type is targeted at ±20%, the system design of the present Nationwide Traffic Counting Program (NTCP) counting station types can be classified as follows:

a. Seasonal Traffic Count Station: Continuous classified manual counts for seven consecutive days once every month are conducted for 12-hour (07.00-19.00). There is a continuous 24-hour count for one working day, specifically on Wednesday, within the week. Stations are located mainly on the first class Arterial National Road Network (ANRN) at regional boundaries, and on second class ANRN at provincial boundaries. The output of seasonal stations is used as a basis to derive seasonal factors by vehicle type to be applied to the control and coverage station results to get the AADT, and it can be used also to produce daily and hourly factors for application in updating procedures for coverage stations.

b. Control Traffic Count Station: Continuous classified manual counts for seven consecutive days once every three months are conducted for 12-hour (07:00-19:00). There is a continuous 24-hour count for one working day, most specifically on Wednesday, within the week. Stations are located mainly on the ANRN at provincial boundaries and at selected screen lines. Each control station is related to a superior seasonal station and to a number of nearby coverage stations within the same region and district.

c. Coverage Traffic Count Station: Continuous classified manual counts for seven consecutive days once every year are conducted for 12-hour (07:00-19:00) and stations are alternately scheduled every five years. There is a continuous 24-hour count for one working day, most specifically on Wednesday, within the week.

The NTCP covers 59 seasonal stations, 115 control stations and 1,222 coverage stations in the whole 15 regions of the country with an average of four stations per region or one station per 18.6 kilometers of the national road network. In the study area of Luzon Island, and in a total of 655 count stations, there are 28 seasonal stations and 52 control stations. Automatic traffic recorders/classifiers are installed at the 59 stations and an additional 41 units are installed at selected control stations. Automatic traffic counters are installed at another 74 control stations. Machine counts provide supplementary information and may serve as a counter check to the manual counts.

The NTCP was started late 1975 and the only changes in the station set-up since then is the inclusion of seasonal stations from 1978 and automatic stations from late 1979. As of 1980, the program covered a total of 48 seasonal stations, 155 control stations and 1,048 coverage stations. In addition, automatic counters are used in 126 stations. The overall organization and main responsibilities of the counting program can be described as in the following classification:

a. DPWH, Planning Service, Manila: The headquarter organizes the annual count program, secures funds needed, allocates funds to regions and supervises the count program. It has also the responsibility of processing the semi-processed results received from regional offices, and preparing quarterly progress reports and annual reports with values of annual average daily traffic.

b. Regional Office: The planning engineer in the regional office receives the final instructions from the headquarter, sub-allocate funds needed to the districts and supervise their counts. He also recommends changes in the count system including adding new count stations, receives and checks count results and submits monthly count reports to the headquarter.

c. District Office: Field operations and counts on raw field sheets are the responsibility of the district office which allocates and hires count personnel. The office processes field counts to be submitted with the monthly count reports to the regional office.

In addition to the traffic volume data, the program carries out weighbridge operation to protect the roads and bridges from premature deterioration and destruction brought about by rampant overloading of cargo trucks and trailers. There are 16 weighbridge stations operated almost on regional base in which 8 stations are located in Luzon Island. All stations are operated daily by trained technicians, and cargo vehicles must not exceed the gross weight shown on the registration certificates. Data of Luzon Island shows that an average of 32% of loaded trucks are overloaded in northern Luzon, 24% in southern Luzon and 62% in central Luzon.

Statistics on traffic accidents are also included in the program based on data and accident reports collected by the Philippine National Police (PNP) and Highway Patrol Group (HPG). Accidents are classified mainly according to the severity, time, road and weather conditions, vehicle type, age and sex of drivers and causative factors of accidents.

4.3 REGISTERED VEHICLES

The Land Transportation Office (LTO) plans, formulates and implements policies, rules and regulations governing the land transport system of the country. It is also tasked with the registration of motor vehicles, issuance of drivers' licenses and permits, enforcement and adjudication of land transportation laws, rules and regulations. Motor vehicle registration is carried out through agencies of LTO in all provinces. There are 90 agencies which are operated to register vehicles in Luzon Island. Vehicles are classified into five groups of private, government, diplomatic, for hire and exempt.

Annual growth in the number of registered vehicles in the Philippine and Luzon Island is shown in Figure 4.3-1. Luzon Island has more than 70% of the whole registered vehicles in the country. After a nearly steady period between the years 1983 and 1987 without any considerable growth, the increase in number of vehicles is highly recognized and is expected to continue.

Table 4.3-1 presents the number of vehicles per category in the regions of Luzon Island and in the Philippine, While the share in the vehicle composition per region is clarified in Figure 4.3-2. Highest share of cars is noticed in NCR and lowest share in Region II. Utility vehicles (jeepneys) have their highest share in CAR and Regions III and IV. Regions I, II and V are characterized by the high rate of motorcycles and tricycles (MC/TC).

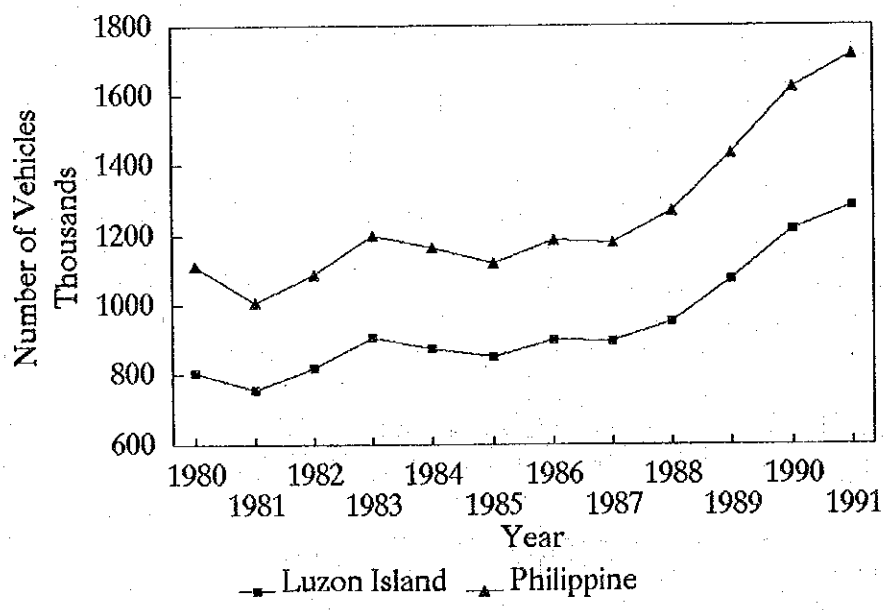


FIGURE 4.3-1 GROWTH OF REGISTERED VEHICLES

Comparing the vehicle composition between Luzon Island and the whole country, Luzon has higher share of cars and lower share of motorcycles and tricycles while other vehicle categories have nearly the same share.

TABLE 4.3-1 NUMBER OF REGISTERED VEHICLES - 1991

REGION	CARS	U. VEH	BUS	TRUCK	MC/TC	TRAILER	TOTAL
I	8614	27072	5447	2246	35585	613	79577
II	3337	13460	6217	849	17858	761	42482
III	38066	90179	17750	2905	48584	3343	200827
NCR	309262	277533	45300	6318	73851	9512	721776
CAR	5066	10969	1661	324	2658	51	20729
IV	25748	89974	10035	2471	32969	1180	162107
V	3522	12296	2969	997	18485	97	38366
LUZON	393615	521483	89379	16110	229990	15557	1266134
PHILIPPINE	456606	670848	138138	20690	410127	18957	1715366

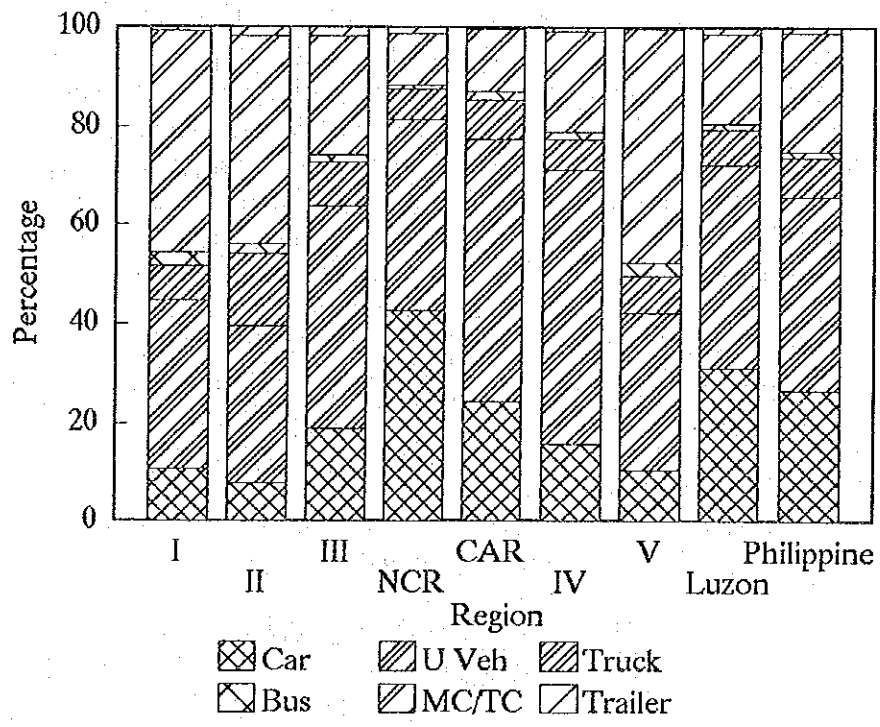


FIGURE 4.3-2 VEHICLE COMPOSITION BY REGION - 1991

4.4 TRAFFIC SURVEY

To establish the present OD matrices for the trips of passengers, commodities and vehicles, and to estimate the traffic volumes on the road network of Luzon Island, required information are collected through two traffic surveys. The main survey is an OD survey to collect data of inter-city trips at 15 stations located on screen lines on the national roads, and simultaneously, a traffic count survey is conducted at 20 locations to determine the traffic composition and to estimate factors to be used in adjusting the OD data collected on sampling base.

4.4.1 Mobilization

Attention has been paid in the planning process of the traffic surveys because of their complexity. The majority of tasks during the mobilization stage are focused on the field operation planning to enable the survey works to progress efficiently and to insure the continuous flow of survey data. The key field operations planned in conjunction with the other tasks of the study can be summarized as follows.

a. Program Coordination and Management: Because the islandwide traffic surveys involve extensive work in conjunction with specific data sampling requirements and also to avoid special-traffic-pattern days during the survey months on April and May 1992, a detailed schedule of activities was programmed for each field operation. Two survey teams were required to cover all the survey stations under the supervision of members of the Study Team and DPWH Counterpart. The coordination with the different local authorities and police departments was an important task to get their assistance during the survey period in controlling traffic and to stop vehicles and interview drivers and passengers. Also, an orientation program was undertaken for the survey teams to explain the objectives, methodology and requirements of the surveys.

b. Survey Forms: Survey forms are developed based on the forms used by DPWH for recording data obtained by surveyors in the field. Forms are designed in a simple pattern to be easily understood and filled, and with coding areas to ease the data processing procedure. The developed survey forms are presented in Appendix 4.1.

c. Field Reconnaissance: The purpose of this task is to locate the exact and appropriate sites which provides safety considerations during the surveys. Collected information through this task include:

- Station Number
- Road Name
- Province, Municipality and Barangay Jurisdiction
- Kilometer Post
- Road Width
- Shoulder Width
- Number of Lanes
- Traffic Volume (10 min.)
- Location Map
- Location Photos
- Other Remarks

4.4.2 Roadside OD Survey

1) Purpose

The roadside OD survey is conducted on the national road network in Luzon Island in order to prepare the present OD tables, forecast the future OD tables and estimate the future traffic volumes on the road network.

2) Zoning

The zone is the unit of OD movements, and is also the unit for the future traffic forecast. OD data are collected on the administrative base in which each city/municipality is considered as one zone with a total number of 768 zones. To locate the survey stations, six screen lines are established by dividing the study area into socioeconomic spheres in a manner allows to catch the traffic in the main directions in the island. For the preparation of the present and future OD matrices, however, the number of zones is decreased to 98 zones by combining some zones into one.

3) Location of Survey Stations

The criteria in selecting the location of stations is set mainly to collect data represent the optimum movement of vehicles between zones in the island and for the main arterial roads specially those handling NCR traffic. By establishing six screen lines dividing the island into seven areas, a total number of 15 stations is used to cover the requirements of the survey. The detailed information of all the survey stations are presented in Table 4.4-1, while Figure 4.4-1 clarifies the location of the stations.

TABLE 4.4-1 LIST OF TRAFFIC SURVEY STATIONS

Station No.	Region	Province	Municipality	Barangay	Km-Post	NTCP Station	Road Section	AADT 1990
OD and Count Stations:								
1	I	Ilocos S	Sta Maria	Maynganay	370	521	Narvacan - Sta Maria	2041
2	II	Isabela	Ilagan	Malalam	402	818	Ilagan - Tumovini	1228
3	I	Pangasinan	San Fabian	Bulasi	397	109	San Fabian - Dagupan	3189
4	I	Pangasinan	Rosario	Udiao	213	29	Sison - Rosario	3189
5	III	Nueva Ecija	San Jose C.	Malasin	162	1616	San Jose - Carranglan	4532
6	III	Pampanga	Mabalacat	Tabon	96	27	Mabalacat - Bamban	9486
7	III	Nueva Ecija	Cabiao	San Vicente	95	127	Cabiao - Arayat	1951
8	III	Nueva Ecija	Gapan	Porcutela	87	2	San Miguel - Gapan	4961
9	III	Pampanga	Lubao	Sta. Cruz	90	130	S Fernando - Dinalupihan	6100
10	IV-A	Cavite	Bacoor	Panapaan	17	43	Jct. Tagaytay - Bacoor	21975
11	IV-A	Cavite	Carmona	Bangkal	62	136	Carmona - Tagaytay	12953
12	IV-A	Laguna	Calamba	Turbina	48	7	Calamba - Sto. Tomas	14457
13	IV-A	Laguna	Los Baños	Maahas	65	137	Los Baños - Bay	13912
14	IV-A	Quezon	Pagbilao	Ikirin	156	147	Pagbilao - Atimonan	2127
15	V	Camarines S	Naga	Del Dosario	443	11	Naga - Pili	1914
Count Stations:								
16	I	Ilocos N	Pagudpud	Pansian	577	32	Claveria - Laoag	133
17	CAR	Ifugao	Banawe	Viewpoint	350	59	Banawe - Bontoc	1003
18	I	Pangasinan	Mangatarem	Macarang	169	39	Camiling - Mangatarem	1013
19	III	Nueva Ecija	Lupao	Cordera	171	123	Lupao - San Jose City	461
20	III	Nueva Ecija	Bongabon	Farcon	146	41	Bongabong - Aurora	241

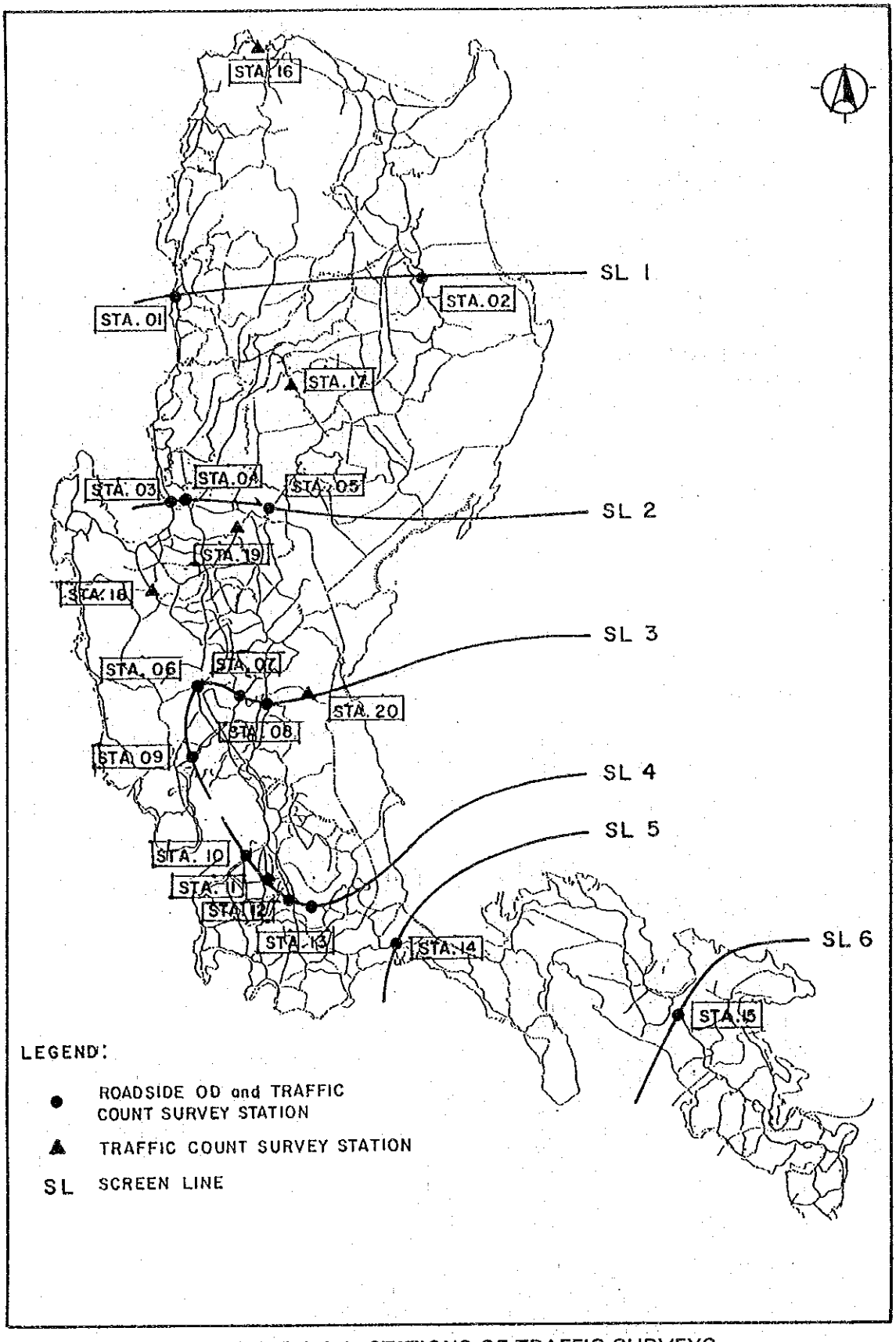


FIGURE 4.4-1 STATIONS OF TRAFFIC SURVEYS

4) Survey Items

Drivers and passengers of buses and Jeepneys and drivers of the following nine types of vehicles are interviewed during the OD survey.

- Car/Taxi/Jeep
- Jeepney
- Pick-up/Van
- Mini Bus < 30 seats
- Large Bus > 30 seats
- Truck 2-Axle
- Truck 3-Axle
- Truck 4- or more Axle
- Motor Tricycle
- Motorcycle

In addition to the typical information of each survey station, collected data during the survey are:

- Vehicle Type
- Trip Purpose
- Origin (Province and City/Municipality)
- Destination (Province and City/Municipality)
- Type of Fuel
- Number of Passengers
- Seat Capacity
- Commodity Type
- Commodity Weight
- Total Commodity Weight
- Net Load Capacity

5) Procedure

The survey period at each station continued in the two directions of traffic for two-day twelve-hours (06:00-18:00) on weekdays only avoiding days with unusual traffic characteristics, starting from April 21, 1992 for about six weeks. Survey teams used portable traffic signs and cones for the traffic control and safety purposes.

Sampling techniques are applied to get the target number of samples which was calculated for each survey station according to the ADT (1990) and using the following simplified formula which gives high sampling rates for low ADT and low rates for high ADT. The formula is diverted from the methodology of the Department of Transport in the United Kingdom and provides ± 5% accuracy rate.

$$\text{Target Sample Size} = \text{ADT} / (0.0003\ \text{ADT} + 1)$$

Based on the above formula, the target sample rate for the survey stations can be generalized as follows:

ADT	Target Sampling Rate
- 1,500	75 %
1,501 - 5,000	45 %
5,001 - 20,000	20 %
20,001 -	10 %

4.4.3 Traffic Count Survey

1) Purpose

The purpose of this survey is to supplement and update the traffic volume data and to determine the distribution of vehicle categories in the traffic flow, so that expansion factors can be estimated to expand the OD data collected on sampling rates.

2) Procedure

The survey period at each station for this survey is two-day twelve-hours (06:00-18:00) on weekdays only and also avoiding days with unusual traffic characteristics. It is carried out at the same fifteen stations and on all the same days of the OD survey in addition to another five supplementary stations. The survey is conducted to collect traffic composition data in both directions separately for the following vehicle categories:

- 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

4.5 TRAFFIC SURVEY RESULTS

It is essential to check the validity of traffic surveys and their expansion from sample survey data to represent the daily traffic volumes. All the data collected in the field are first manually checked and scrutinized for errors, omissions and ambiguous classifications during the coding procedure. Coding system of the National Statistics Office (NSO) is used for municipalities and provinces as origins and destinations. Next, data are subject to systematical checks which are applied through the data processing stage to verify the accuracy of coding and the consistency of trip data. However, no matter how many coding and data checks are carried out, some errors will still exist in any data have been collected from and by human beings. Applied systematical checks include the coding range check, and capacity limits check. A summary of the collected data during the traffic surveys is presented in Appendix 4.2.

4.5.1 Traffic Count Survey

1) Expansion and Fluctuation Factors

The hourly and daily traffic variations as well as the monthly or seasonal

traffic fluctuations reveal important trends regarding trip purpose which in turn affect the magnitude of the traffic volumes on the road network. Hourly factors are applied to supplement the 12-hour traffic count data on 24-hour traffic volumes and other fluctuation factors are applied so the bias in the collected data can be adjusted on the AADT basis of each road.

The relationship between the whole population of each vehicle category as per 12-hours traffic on a road and the sample size for the same category gives its expansion factor on that road. Expansion factors are determined using the following formula.

$$a_{ijk} = T_{ijk} / t_{ijk}$$

Where, a_{ijk} = expansion factor of *k* category vehicles at station *i* in direction *j*

T_{ijk} = number of *k* category vehicles at station *i* in direction *j*

t_{ijk} = sample size of *k* category vehicles at station *i* in direction *j*

Data of the National Traffic Count Program (NTCP) of the DPWH Philippine Road Traffic Statistics 1991, are used to obtain the night traffic share in the daily traffic volumes. Estimated values of both the expansion and fluctuation multiplying factors for all the vehicle categories, as well as the counted and estimated traffic volumes for the survey days, are presented in Appendix 4.2 for each of the survey stations.

2) Heavy Vehicles Rate

Number of heavy vehicles running on the roads is an important factor to be considered specially in the capacity analysis and pavement design and maintenance stages. The share of heavy vehicles, which are buses and trucks, is determined separately based on the traffic count data for all the survey stations, and plotted as shown in Figure 4.5-1.

Highest share of buses is noticed for the southern Luzon traffic, while trucks have mostly higher shares in the northern parts of the island than in the south. Provinces just south of Metro Manila, at stations from 10 to 13, have in general lower share of heavy vehicles. The minimum share of heavy vehicles at all survey stations is recorded at stations in Central Luzon, while the maximum share in at stations in Bulacan and Quezon.

4.5.2 Roadside OD Survey

1) Collected Survey Data

Figure 4.5-2 clarifies that the actual collected samples are in general higher than the target samples estimated based on the daily traffic volumes with

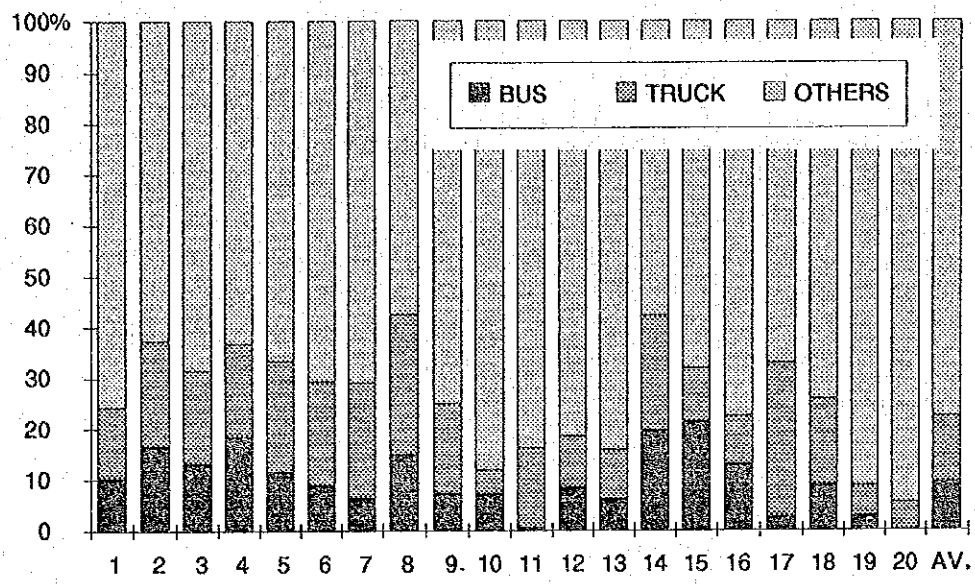


FIGURE 4.5-1 SHARE OF HEAVY VEHICLES

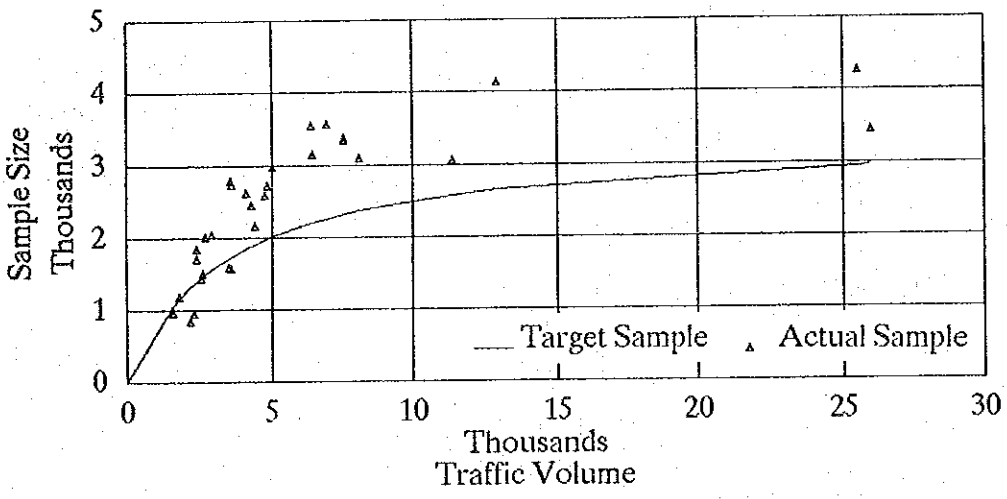


FIGURE 4.5-2 ACTUAL AND TARGET SAMPLE SIZE

an accuracy level of ± 5%. Because the field operations were carried out under different weather conditions such as rain or fog, the target sample size was not achieved at few stations. A summary for the size of actual OD samples for vehicles interviewed at each survey station is presented in Appendix 4.2.

2) Commodity-Vehicle Movement Characteristics

Four categories of commodity vehicles are interviewed during the OD survey which are pick-up/van, truck 2-axle, truck 3-axle and truck 4- or more axles. Average data related to the movement and loading characteristics of these four categories are presented in the following sections separately for each of the survey stations.

a. Capacity

The average actual capacity in tons for the four categories of all commodity vehicles interviewed during the OD survey is presented in Table 4.5-1 for all survey stations in two days. With an average capacity of about 20 tons for heavy vehicles and of 3.4 tons for light vehicles, the total average capacity of commodity vehicles is 10.8 tons.

TABLE 4.5-1 AVERAGE CAPACITY OF COMMODITY VEHICLES (ton)

Station No.	Vehicle Category				
	Pick-up/Van	2-axle	3-axle	4- or more axle	Average
1	2.3	10.0	12.1	20.9	11.6
2	1.6	5.8	11.5	18.2	12.1
3	1.8	7.9	10.5	17.0	9.9
4	2.9	7.4	14.6	23.5	11.9
5	3.6	5.7	11.8	17.2	9.5
6	5.8	6.7	11.3	21.2	9.9
7	2.2	5.7	10.7	18.2	11.0
8	4.2	6.8	11.0	17.0	10.4
9	2.2	8.4	11.1	20.1	11.3
10	1.6	4.7	10.4	19.5	8.4
11	4.7	9.0	12.6	24.5	11.2
12	3.7	9.3	10.8	18.6	10.9
13	3.1	10.7	11.2	19.8	12.0
14	2.7	10.1	13.9	20.0	13.3
15	4.6	8.0	13.5	21.3	10.9
Total Average	3.4	7.1	11.6	19.6	10.8

b. Payload

The interviewed commodity vehicles are not weighted during the traffic surveys, however, the payload is approximately estimated according to the proportional of the loaded volume to the total capacity in tons. Table 4.5-2 gives the estimated values of the average payload for each of the four categories of commodity vehicles, excluding the empty vehicles, at each survey station. The average payload per commodity vehicle is 6 tons which gives a loading rate of about 55 % in average for only the loaded vehicles.

c. Empty Vehicles

The percentage of empty commodity vehicles is calculated for interviewed commodity vehicles at all survey stations. Table 4.5-3 gives the percentage for the four categories of commodity vehicles in both directions. A high rate of about 64 % of the interviewed commodity vehicles is recorded as empty vehicles.

TABLE 4.5-2 AVERAGE PAYLOAD OF COMMODITY VEHICLES (ton)

Station No.	Vehicle Category				
	Pick-up/Van	2-axle	3-axle	4- or more axle	Average
1	0.9	4.6	12.5	18.8	4.2
2	0.8	3.6	14.4	23.2	6.6
3	0.6	4.0	11.3	14.6	3.5
4	0.8	5.2	13.7	18.8	5.1
5	1.0	5.1	15.9	24.4	7.8
6	0.8	5.1	13.9	15.4	7.0
7	1.1	4.7	17.9	18.9	9.3
8	1.2	6.2	15.1	22.0	7.3
9	0.8	6.0	10.3	13.4	6.2
10	0.9	5.5	19.1	20.3	7.4
11	0.9	6.6	14.6	18.3	6.7
12	0.9	5.4	13.2	15.6	4.3
13	1.1	7.6	16.4	24.4	7.4
14	0.8	4.8	13.6	18.4	5.3
15	0.8	6.9	9.9	13.4	4.6
Total Average	0.9	5.5	14.4	18.1	6.0

TABLE 4.5-3 PERCENTAGE OF EMPTY COMMODITY VEHICLES (%)

Station No.	Vehicle Category				
	Pick-up/Van	2-axle	3-axle	4- or more axle	Average
1	48.6	36.4	34.4	48.1	43.4
2	73.9	37.8	39.2	34.4	56.1
3	59.8	46.6	43.6	20.5	53.8
4	55.2	47.3	46.2	37.5	51.2
5	59.3	37.9	27.5	29.2	46.3
6	86.7	67.0	53.4	49.1	76.2
7	79.1	47.2	44.9	17.6	62.7
8	74.8	59.8	50.3	31.5	65.1
9	79.4	57.7	49.8	38.2	67.8
10	87.6	65.2	60.3	60.0	79.3
11	71.8	52.9	51.3	50.0	62.5
12	70.4	58.7	52.7	48.0	65.7
13	82.7	64.2	57.6	34.0	75.2
14	59.1	47.1	40.8	25.9	52.4
15	74.9	45.9	35.8	65.2	63.7
Total Average	73.2	53.4	48.3	38.1	63.9

d. Commodity Distribution

The total number of 99 commodity types, according to the classification of the National Statistics Office (NSO) is grouped into four different groups of: 1) agricultural products; 2) manufacturing products; 3) mining and mineral products; and 4) construction materials. The percentage of estimated commodity share for each group at the survey stations is presented in Figure 4.5-3 for the two directions of traffic. For the agricultural products, stations in Region II recorded the highest share. Share of manufacturing products is high at stations around Metro Manila and in the south. Mining

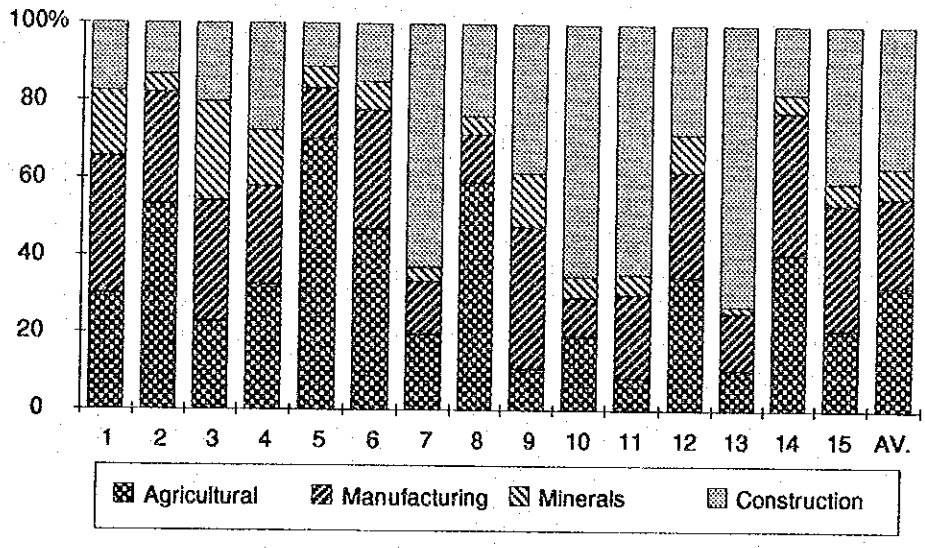


FIGURE 4.5-3 ESTIMATED COMMODITY SHARES

and mineral products including petrol products have higher share in the north than the south while the fourth group of the construction materials has higher share in the south than the north.

3) Passenger-Vehicle Movement Characteristics

Following sections present primary results of the roadside OD survey which clarify the movement characteristics of the five categories of passenger vehicles, which are: car/taxi/jeep, jeepney, pick-up/van, mini bus and large bus, as well as the total average.

a. Capacity

The average capacity for the five categories of passenger vehicles and the total average are presented in Table 4.5-4 at each survey station. The total average capacity is about 35 passengers per vehicle due to the big number of interviewed large buses.

b. Occupancy

Occupancy data of passenger vehicles provide input to person-kilometers of travel and modal choice models which are normally used in comprehensive transportation studies. The average values for each category of passenger vehicles are presented in Table 4.5-5 for each survey station.

c. Trip Purpose

Trip purpose is classified into four types of: to/from work, to/from school, work/business and private. As passengers of jeepneys and buses are interviewed during the traffic survey regarding their trip purpose, Table 4.5-6

TABLE 4.5-4 AVERAGE CAPACITY OF PASSENGER VEHICLES (person)

Station No.	Vehicle Category					
	Car/Taxi/Jeep	Jeepney	Pick-up/Van	Mini Bus	Large Bus	Average
1	4.00	19.63	11.50	-	52.08	29.99
2	3.78	19.36	11.78	-	51.20	33.29
3	3.98	20.56	13.00	-	47.06	46.28
4	4.20	18.64	11.98	31.33	51.73	40.33
5	4.22	19.82	12.21	-	54.00	40.00
6	3.61	17.64	12.75	39.65	60.61	33.82
7	3.70	17.45	13.50	-	57.48	38.64
8	3.70	17.60	11.87	-	56.48	53.19
9	4.15	17.21	10.60	37.63	58.35	33.82
10	4.50	17.55	12.58	34.62	53.48	27.77
11	3.78	19.34	14.67	39.00	50.96	23.00
12	4.00	18.14	14.33	40.25	59.75	43.29
13	3.64	19.28	15.00	38.33	61.10	36.03
14	4.21	19.79	13.20	37.00	50.82	41.83
15	4.00	20.03	11.00	39.00	49.99	33.21
Total Average	3.96	18.61	12.79	36.68	54.72	35.24

TABLE 4.5-5 AVERAGE OCCUPANCY OF PASSENGER VEHICLES (person)

Station No.	Vehicle Category					
	Car/Taxi/Jeep	Jeepney	Pick-up/Van	Mini Bus	Large Bus	Average
1	3.02	10.79	3.74	-	29.60	8.95
2	2.57	13.16	4.00	-	34.90	11.90
3	2.68	16.50	4.90	-	31.83	11.30
4	3.02	9.14	5.26	15.33	30.81	10.61
5	3.03	18.27	5.04	-	45.98	14.81
6	2.84	9.49	3.97	19.81	36.38	9.04
7	2.68	10.10	2.94	-	30.40	6.54
8	2.63	10.17	2.67	-	35.79	10.38
9	2.72	8.64	2.65	23.97	38.19	7.51
10	2.30	10.14	2.75	16.84	34.98	5.49
11	2.52	13.20	3.32	21.00	30.00	6.02
12	2.84	13.16	3.87	24.00	52.43	11.73
13	2.37	13.02	3.35	34.50	49.39	7.10
14	2.95	15.64	4.37	27.20	42.13	16.55
15	2.61	14.15	3.90	14.00	38.34	9.97
Total Average	2.63	11.66	3.59	19.59	38.31	9.14

TABLE 4.5-6 TRIP PURPOSE OF PASSENGER VEHICLES (%)

Station No.	to/from Work	to/from School	Work/Business	Private
1	6.85	0.82	16.96	75.38
2	2.71	0.22	28.36	68.71
3	6.32	4.83	18.80	70.05
4	3.92	2.21	14.47	79.40
5	6.26	0.62	18.78	74.34
6	6.27	1.10	24.53	68.10
7	17.81	0.61	19.58	62.63
8	7.33	0.64	24.94	67.08
9	6.67	2.60	25.12	65.61
10	14.22	1.68	21.42	62.68
11	15.45	2.02	25.73	56.80
12	9.10	1.09	18.16	71.64
13	24.96	2.83	25.22	46.98
14	9.66	0.70	8.68	80.96
15	12.90	0.99	26.99	59.12
Total Average	9.27	1.73	22.46	66.54

presents the average percentage for the trip purpose of passengers of all the passenger vehicles at each survey station. Private trips have nearly 67 % of the total number of interviewed passengers, and is followed by work and business related trips.

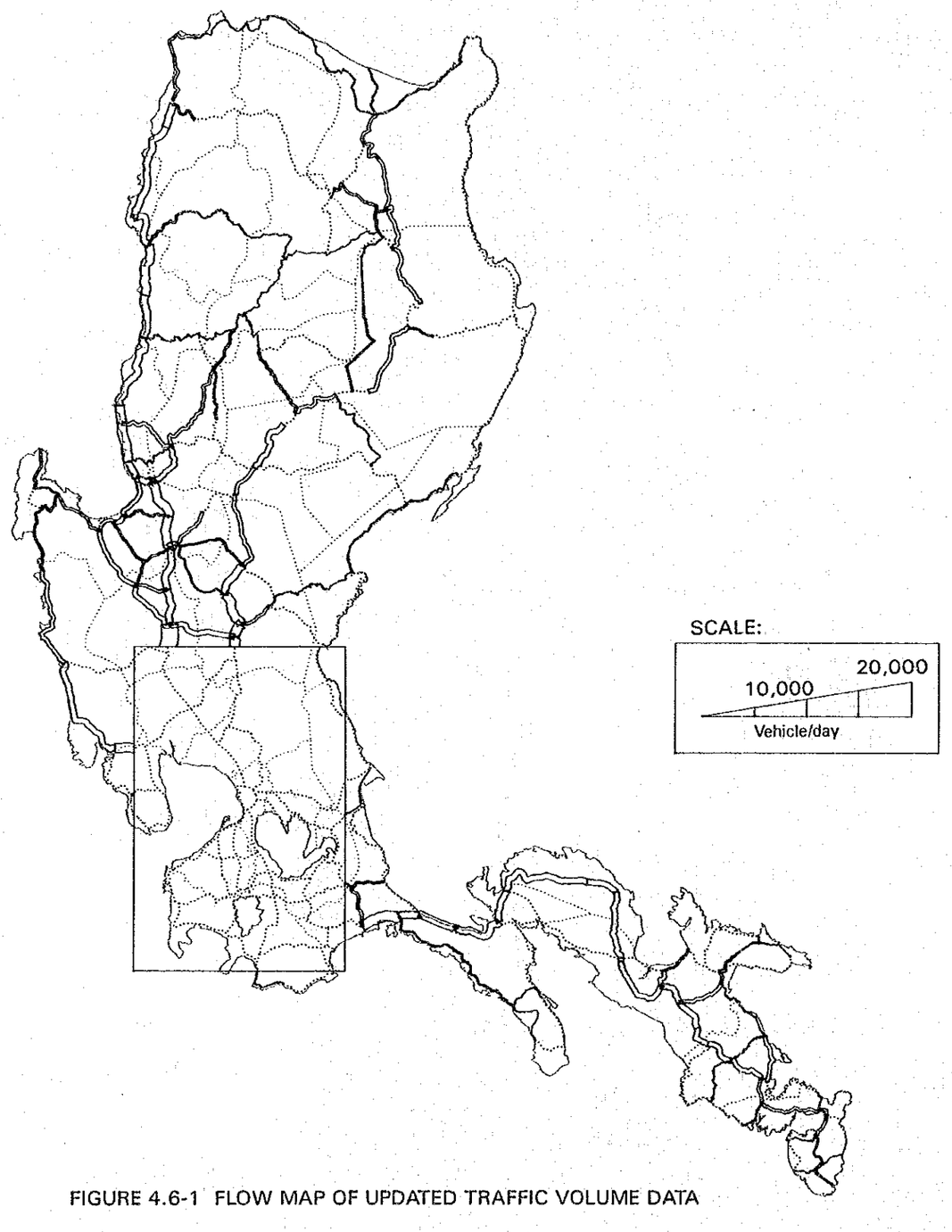
4.6 TRAFFIC VOLUME ON EXISTING ROAD NETWORK

To estimate the traffic volumes of 1992 on the existing road network, traffic volume data of four available sources are collected, reviewed, updated and supplemented through an assignment procedure to conclude volumes of unsurveyed roads. Traffic surveys carried out during the study at 20 survey stations are one of the sources. NTCP data gives volumes at 655 stations in Luzon Island, however, 397 stations are excluded because they are located inside city boundaries. Data of six survey stations, out of 15 stations, at the cordon-line of Metro Manila collected through another simultaneous study by JICA on the Metro Manila Expressway System are also expanded and utilized in this study. In addition, traffic data are also obtained from a previous JICA study on Rural Road Network Development Project (1990) in which traffic surveys are carried out in five provinces in Luzon Island. Data of 94 stations, out of 101 stations, are updated and used to supplement necessary data and for evaluation procedures.

To update the traffic volume data to the year 1992, average growth rates on provincial base are estimated through the annual traffic volumes of the seasonal and control stations of the NTCP between the years 1987 and 1991, to be applied to all AADT data before 1992.

As there are many roads found to have more than one survey station with completely different values of traffic volume and composition, exact sites of all stations are located on road maps and volumes collected near municipalities and cities are screened and excluded since they include intra-zonal traffic and the purpose here is to get inter-city traffic volumes. Next, all the data are plotted and evaluated on a flow map for the road network to allocate the most appropriate volumes on the links of the road network.

Updated traffic volume data of the four resources for inter-city traffic used as an input in the AADT estimation procedure are presented graphically in Figure 4.6-1, with separate flow map for Central Luzon, and numerically in Appendix 4.3. The estimated AADT of 1992 for all the roads of the network, including estimated results for some roads without survey stations, are presented in Appendix 4.4. These resulted values of the present traffic volumes on the network are plotted on the flow map shown in Figure 4.6-2. As the intra-zonal trips inside the National Capital Region (NCR) are not included in this study, highest traffic volume outside NCR is recorded on the Manila North Expressway and is followed by the Manila South Expressway at the boundary sites. Other high volumes are those on the coastal road south of Metro Manila to Cavite, and some other roads in the provinces of Batangas and Laguna.



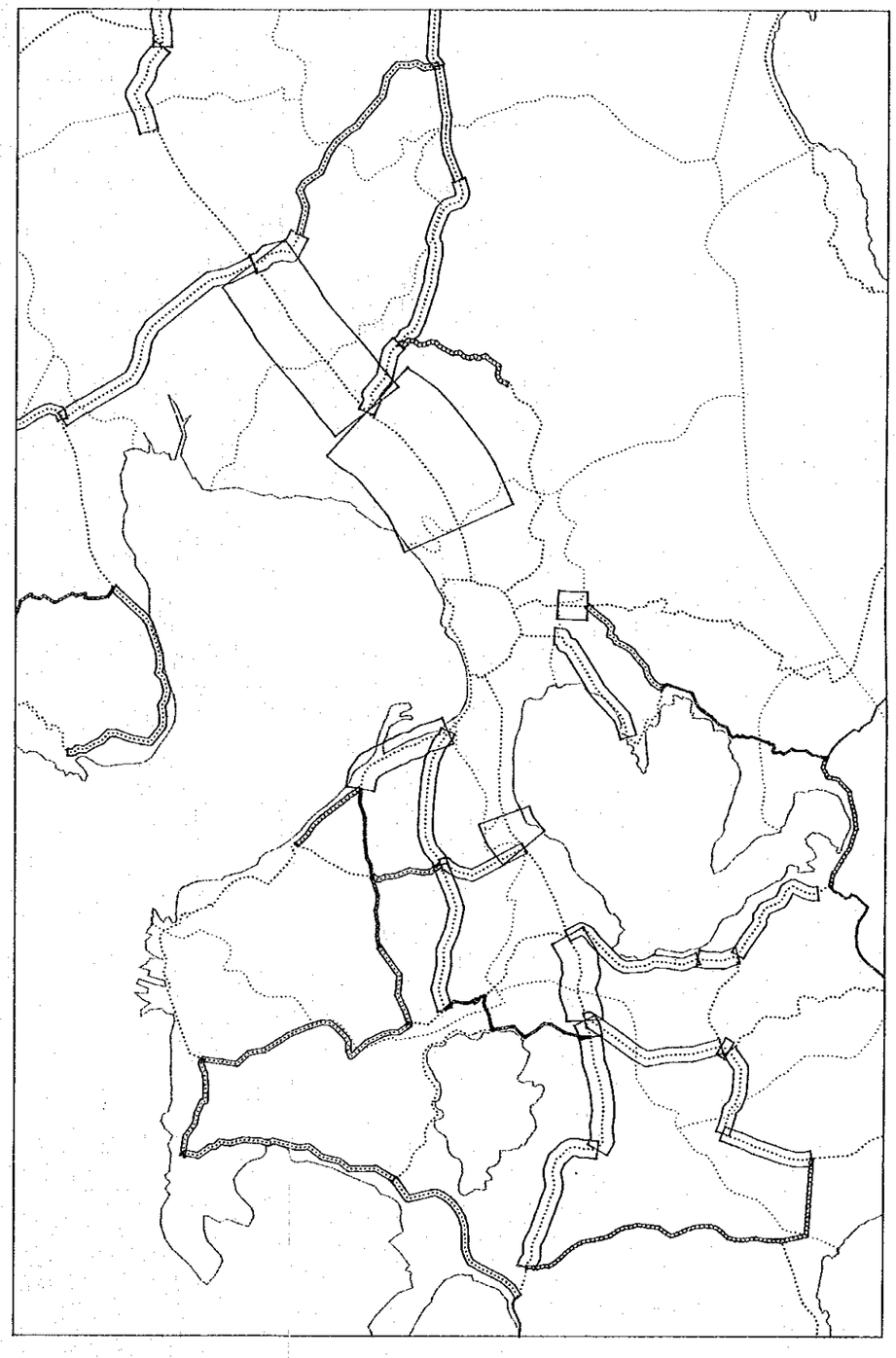
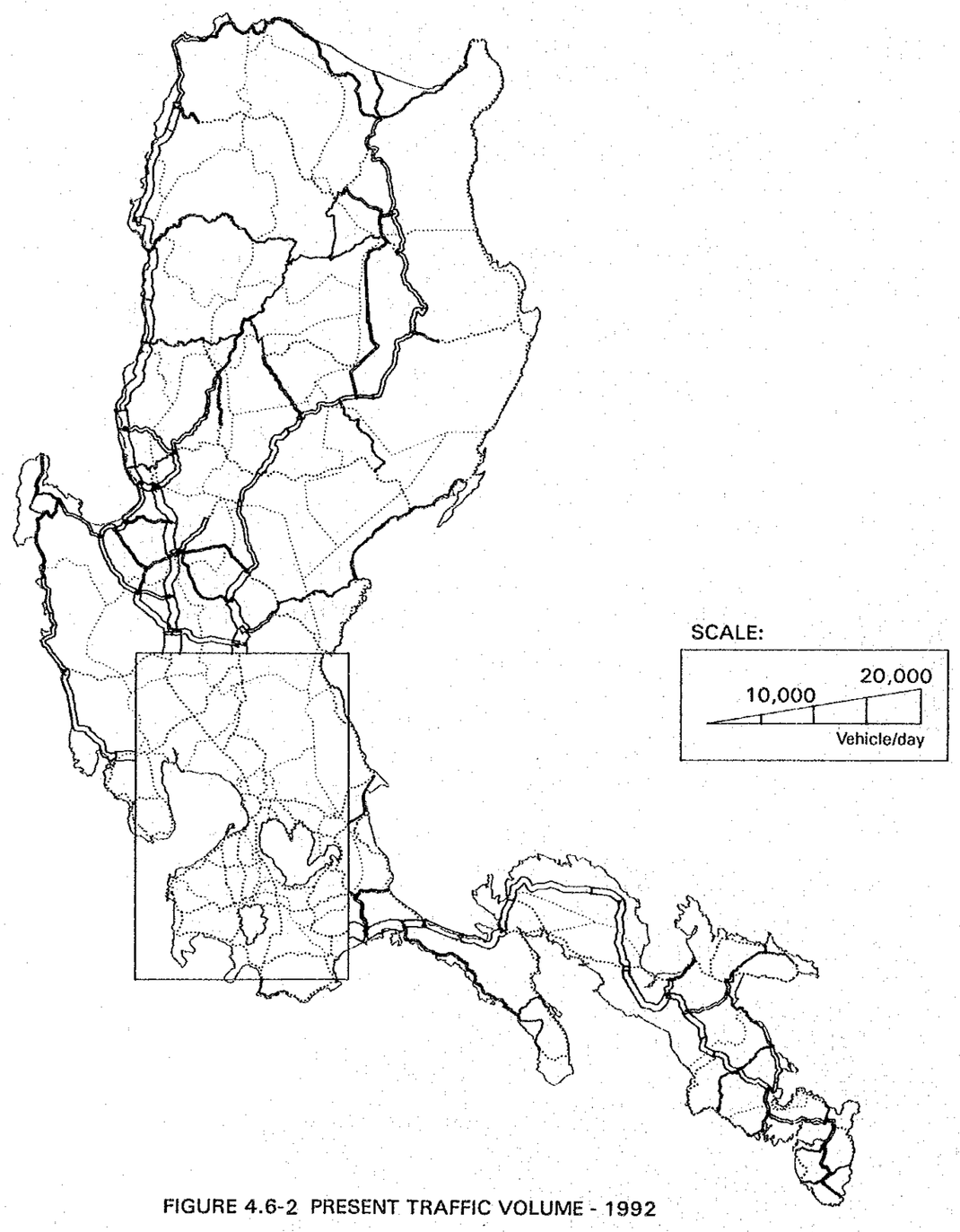


FIGURE 4.6-1 FLOW MAP OF UPDATED TRAFFIC VOLUME DATA



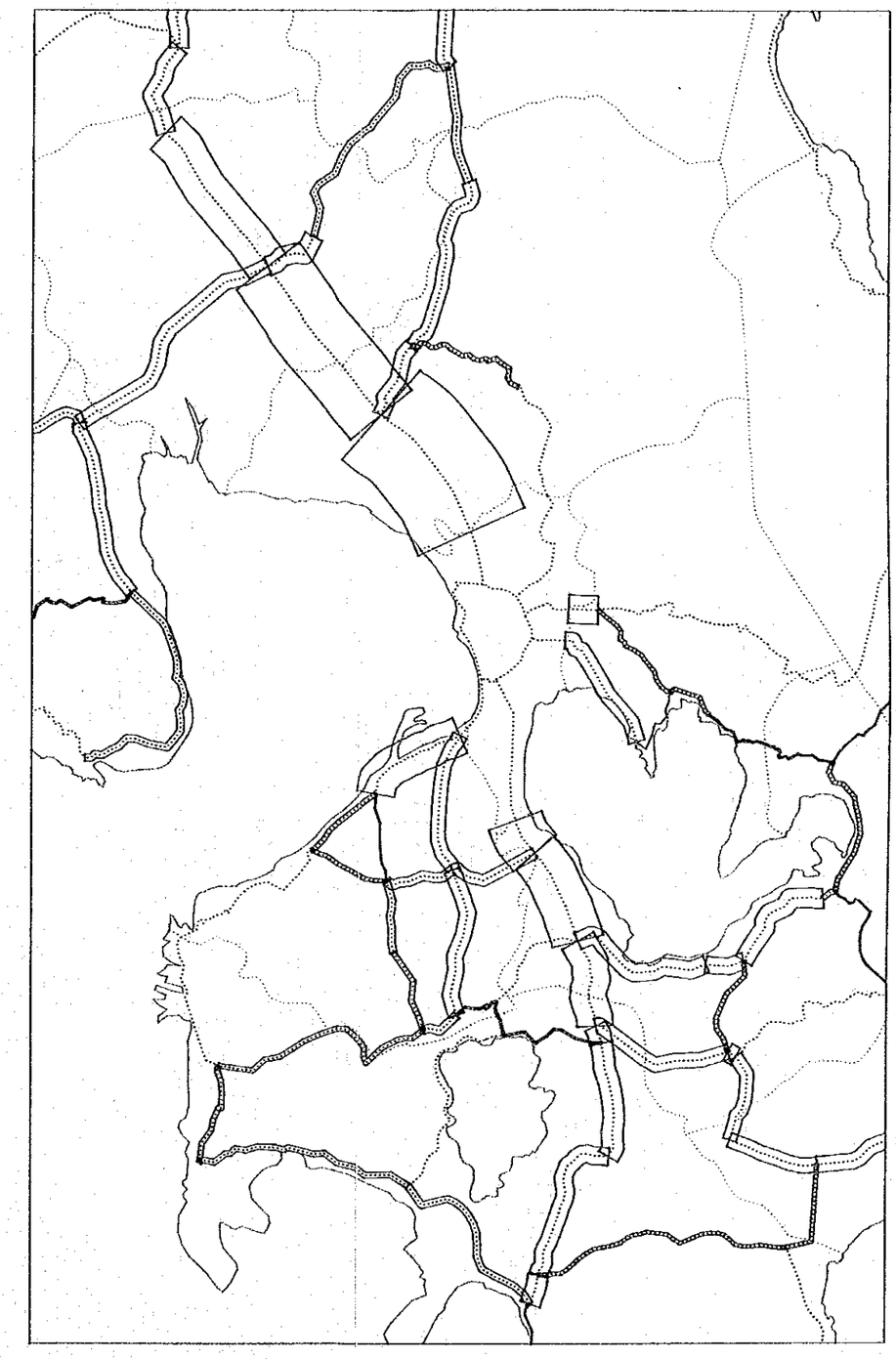


FIGURE 4.6-2 PRESENT TRAFFIC VOLUME - 1992

In northern areas of the island, Manila North Road in Region I handles higher traffic volumes than Pan Philippine Highway which is connecting Metro Manila with Region II. The only arterial road to the south is the Pan-Philippine Highway, which handles all the high volumes of traffic directed to Quezon Province and Region V.

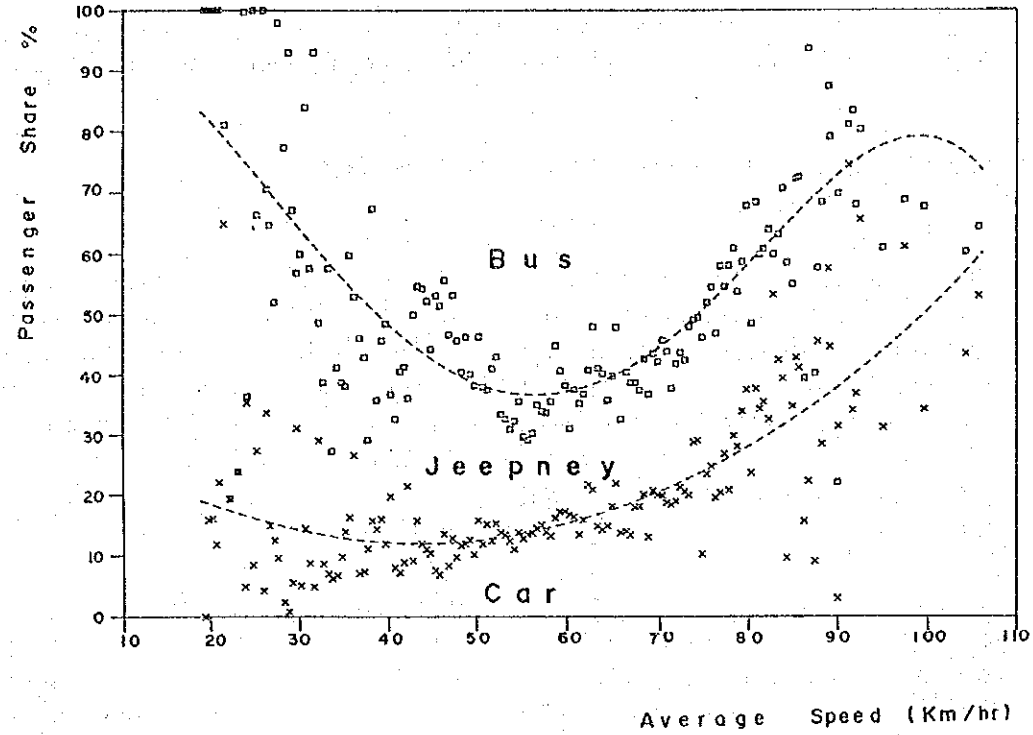
4.7 TRAFFIC COMPOSITION AND ROAD CONDITION

The relationship between traffic composition or volumes by vehicle category and road condition is investigated to get the effect of the road condition on the share of either passengers or commodities by each vehicle category on that road. Dealing only with inter-city trips, the road condition parameter is expressed here as the average speed for each vehicle category between OD pairs on the road network. Low speeds represent roads with bad condition, and moderate speeds are experienced on better road conditions, while the highest speeds are those of the expressways.

Figure 4.7-1 shows the effect of the road condition, expressed in average speed, on the share of both passengers and commodities in each vehicle category. In this figure, two regression curves are dividing the share of either passengers or commodities handled in three vehicle categories. For the passenger movement, and on the bad condition roads with low speeds, jeepneys have the highest share in handling passengers and the share of buses and cars is low. With better road conditions, the bus share increases dramatically with nearly constant share of car passengers and lower share of jeepneys. On expressways, cars are the most dominant vehicle category handling passengers, and both jeepney and bus have lower share. Income is an another factor which may influence the modal choice between vehicle categories, however, it is not investigated in the survey. For the commodity movement, trucks have generally the highest share in handling commodities specially on moderately good condition roads. On bad roads and on expressways, the share of trucks is decreasing while that of cars and jeepneys is increasing.

Another parameter which affects also the modal choice between different vehicle categories is the trip length. Results of analyzing this parameter are shown in Figure 4.7-2. For passengers, jeepney is the most used category for short trips and is followed by car and bus categories. With the increase in trip length, share of bus passengers increases and of jeepney passengers decreases. The share of car passengers is almost constant in medium and long trips. For trips with length over about 120 kilometers, the share of jeepney passengers nearly disappears. As for commodities, the share of jeepney is existed in short trips but it also disappears at an average trip length of about 40.0 kilometers. Trucks are the most dominant in handling commodities and their share increases with the increase in the trip length. The share of cars is generally small but it is nearly constant for medium and long trips. Commodity type is an another parameter which is also not investigated in this analysis and may affect the modal choice between commodity vehicles.

a. Passenger Movement:



b. Commodity Movement:

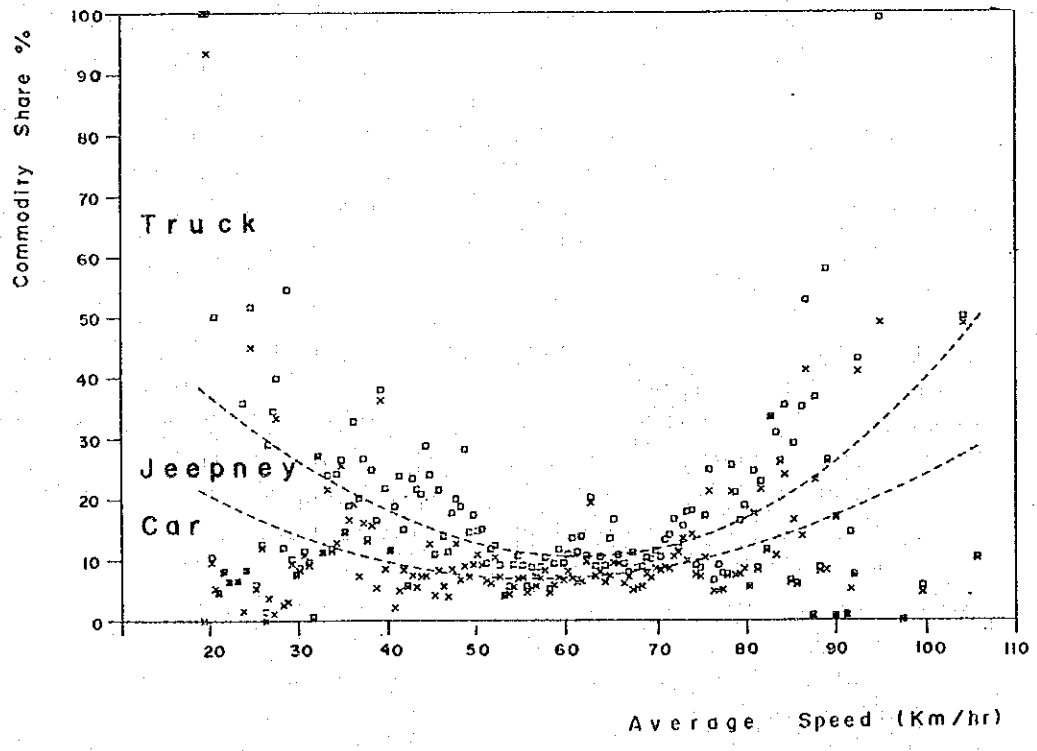
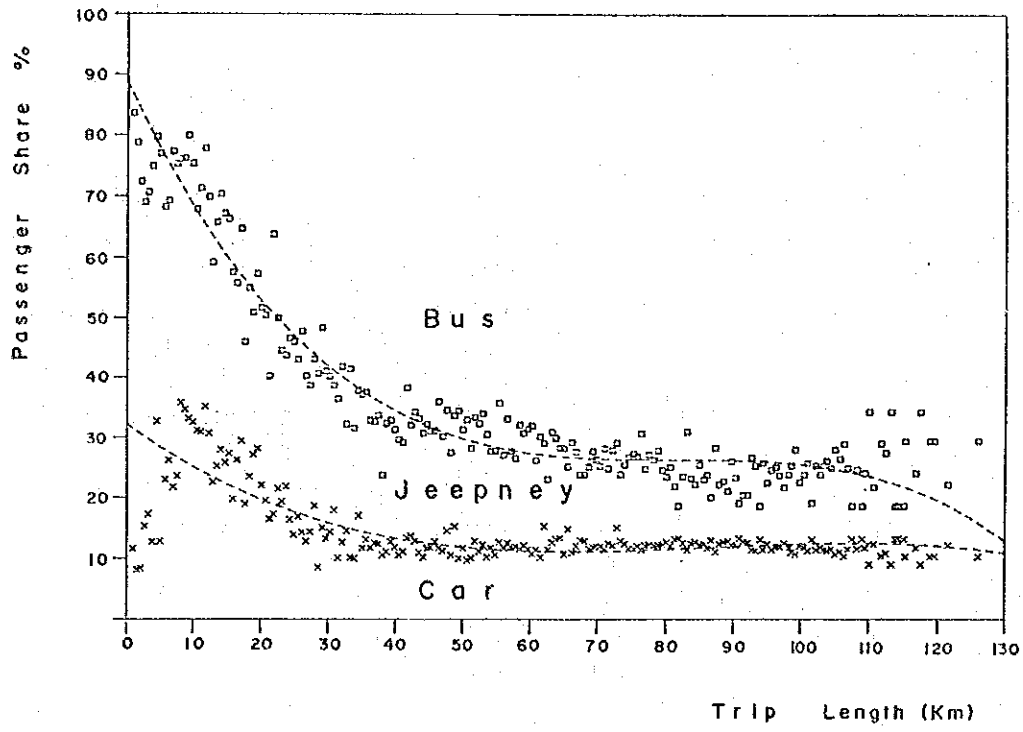


FIGURE 4.7-1 EFFECT OF ROAD CONDITION ON VEHICLE SHARE

a. Passenger Movement:



b. Commodity Movement:

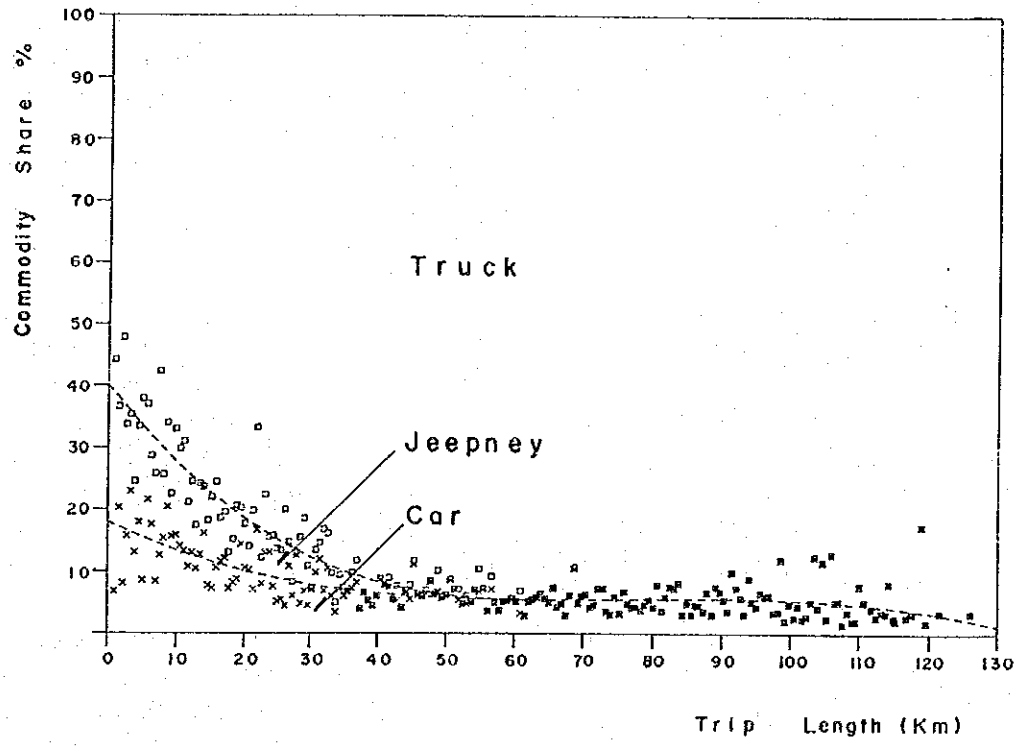


FIGURE 4.7-2 EFFECT OF TRIP LENGTH ON VEHICLE SHARE