1.4 Current Economic Activities in Project Area

1.4.1 Population

The population of the project area was 850 thousands in 1973 which corresponds to 24.6% of the population of the Region of Haut Zaire, and 8% live in Kisangani as shown in Table 1.4.1.

The population density is 5.6 inhabitants per sq. km for the whole region, while it is 144.8 for Kisangani, 3.4 for Banalia, 3.5 for Buta, 3.1 for Aketi, 2.6 for Bondo, 8.7 for Bambesa, 1.7 for Ango, and 4.8 for Poko. In the project area excluding Kisangani the density is only 3.3, while the whole region excluding Kisangani is 6.3; the project area is really a low-populated area in the region as shown in Plate 1.4.1.

The growth rate of population of the project area is about 1.6% per annum, on the other hand the rate is 6.4% for Kisangani, 1.9% for Banalia, 1.4% for Buta, 0.2% for Bambesa, 0.2 for Ango. But Aketi, Bondo, and Poko decrease at the rate of 0.3, 0.5 and 0.6% respectively. The annual growth rate of population of the project area excluding Kisangani is as low as 0.2%.

Table 1.4.1
Tableau

Trends of Population in Project Area
Tendance de population dans l'aire de projet

Zone	Area Superficie km²	%	1957 person personne	%	1957 person/km² personne/km²	1973 person personne	%	1973 person/km² personne/km²	Average Annual Growth Rate (%) Taux moyen de croissance annuelle 1957 - 1973
Kisangani	1,710	0.4	103,096	4.3	54.0	276,579	8.0	144.8	6.36
Banalia	24,430	4.8	62,422	2.6	2.6	84,222	2.4	3.4	1.89
Buta	18,098	3.6	50,218	2.1	2.8	62,612	1.8	3.5	1.39
Aketi	25,417	5.0	82,371	3.4	3.2	78,560	2.3	3.1	-0.30
Bondo	38,075	7.6	107,821	4.5	2.8	99,027	2.9	2.6	-0.53
Sub - total Sous	107,930	21.4	405,928	17.0	3.8	601,020	17.4	5.6	2.48
Sub - total (excluding Kisangani) Sous (à l'exlusion de Kisangani)	106,020	21.0	302,832	12.7	2.9	324,421	9.4	3.1	0.43
Bambesa	9,128	1.7	77,265	3.2	8.5	79,635	2.3	8.7	0.19
Ango	34,704	6.6	58,320	2.4	1.7	60,649	1.7	1.7	0.24
Poko	22,909	4.4	119,809	5.0	5.2	108,948	3.1	4.8	-0.59
Total	174,671	33.1	661,322	27.5	3.8	850,252	24.5	4.9	1.58
Total (excluding Kisangani) (à l'exclusion de Kisangani)	172,761	32.8	558,226	23.3	3.2	573,653	16.5	3.3	0.17
Haut-Zaire	504,366	100.0	2,393,369	100.0	4.7	3,461,858	100.0	6.9	2.34
Haut-Zaire (excluding Kisangani) (à l'exclusion de Kisangani)	502,456	99.6	2,290,273	95.7	4.6	3,185,259	92.0	6.3	2.08

Source: Office des Affaires Politiques de la Région du Haut-Zaire "Rapport Annuel", 1957, 1973

Table 1.4.2 Trends of Urban Population of Project Area
Tableau Tendance d'habitants urbains dans l'aire de projet

Zone	Number of Cities / Nombre de cités	1969 persons / personnes	1969 % *	1971 persons / personnes	1971 % *	1973 persons / personnes	1973 % *
Kisangani	6	n.a.	n.a.	208,682	89.7	249,338	90.1
Banalia	0	-	-	-	-	-	-
Buta	1	11,667	20.9	17,713	30.2	22,162	35.4
Aketi	1	17,164	20.7	17,164	22.2	19,369	25.0
Bondo	0	-	-	-	-	-	-
Bambesa	0	-	-	-	-	-	-
Ango	0	-	-	-	-	-	-
Poko	0	-	-	-	-	-	-
Total	8	n.a.	n.a.	243,559	44.5	291,139	48.4
Total (excluding Kisangani) (a l'exclusion de Kisangani)	2	28,831		34,877	11.1	41,801	12.9
Haut-Zaire	18	n.a.	n.a.	418,514	12.7	486,911	14.1
Haut-Zaire (excluding Kisangani) (a l'exclusion de Kisangani)	12	n.a.		209,832	6.9	237,573	7.5

Source: Office des Affaires Politiques de la Région du Haut Zaire "Rapport Annuel"

Note: * Percentage of urban inhabitants to zonal inhabitants.
Pourcentage d'habitants urbains aux habitants zonaux.

REPUBLIQUE CENTRAFRICAINE

SUDAN

UGANDA

BANGASSOU

Nàu

Yakoma

Banda

Ango

Bambesa

Likati

Poko

Djamba

BUTA

Akéti

Bumba

Banalia

Nia-Nia

Mambasa

Njangara

Faradje

Bafwasende

Yahuma

Basoko

YANGAMBI

SANGANI

Pene-Tungu

Ubundu

Lubutu

Beni

N

0 100 200 300km

Parcs
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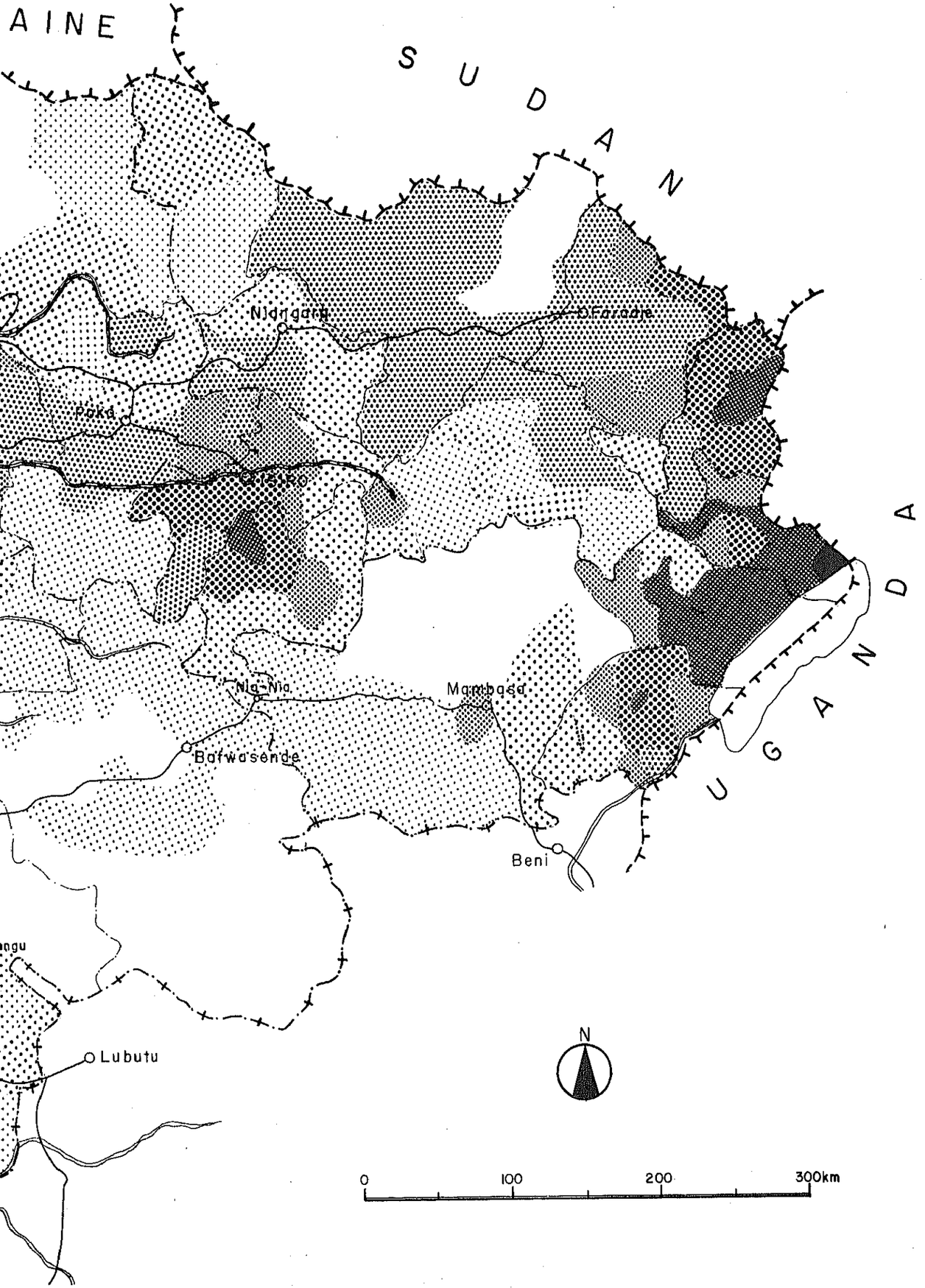


REGION DU HAUT ZAIRE

POPULATION DENSITY MAP

CARTE DE DENSITE DE LA POPULATION

Parcs nationaux et autres zones de moins de 1 habitant / km²	10 ~ 19 habitants / km²
1 ~ 2 habitants / km²	20 ~ 49 habitants / km²
3 ~ 5 habitants / km²	50 ~ 99 habitants / km²
6 ~ 9 habitants / km²	100 habitants et plus / km²

PLATE 1-4-1
PLANCHE 1-4-1

1.4.2 Agriculture

(1) Agriculture in Haut Zaire

Agriculture in Haut Zaire is characterized with two types, namely, the commercial agriculture and the subsistence agriculture. The commercial agriculture is being carried out at plantations, producing cash crops for export such as coffee, oil palm, rubber, etc. The subsistence agriculture is being carried out on a small scale by local inhabitants, producing self-supplying food crops such as cassava, banana, rice, maize, etc.

The subsistence agriculture is primarily to produce self-consuming food crops by the primitive method of farming known as the burn-and-shift process. Local farmers have no experience raising draft animals or cattle; and, consequently, the acreage of land cultivated per family is as small as one to two hectares. Farming operations such as seeding, weeding, and harvesting are traditionally carried out by females, and males usually engage themselves in burning forests, lumbering, hunting and fishing, etc. Fertilizers, insecticides, and farming machines have not been introduced, and also the introduction of improved seeds and advanced farming techniques are limited, so the current production level of agricultural products per unit of farm area is extremely low.

The main crops in Haut Zaire are cassava, banana, paddy, corn, and groundnuts, and the typical cropping pattern are as follows: The forests near the villages are first burned every year during dry season between December and February, and cleared then cultivated into farm land. Thereafter, they seed corn and paddy etc., weed once, and wait for their harvest. After one or two crops of such products, then staple foods such as cassava and bananas, etc., are planted and then harvested after ten or twelve months. The land is abandoned after two crops of bananas. At the farm for cassava they produce only enough for their own consumption during 2-4 years and then abandon the land. The abandoned farm lands are left idle to restore to natural forests. Their general

practice is to burn and shift a land of about 0.5 hectare per annum per family.

The agricultural commercialized products are mainly produced in plantations, but some portion of cotton and other crops are grown by local inhabitants. Major plantation crops in the project area are coffee, oil palm, and rubber. The local plantations had been operated by foreigners before, but now all of them are operated by Zaire citizens. The size and the type of a plantation, as far as it is seen along the project road. varies between 50 to about 1,500 hectares in area and there may be one type of crop such as coffee or oil palm or three types of crop such as the combination of coffee, oil palm and rubber. As to the plantation facilities, there exist variations from large plantations equipped with office, residence for workers, storehouse, primary processing shop, equipment including tractor, etc., to small plantations with only an office and a storehouse. As to the number of workers of a plantation there are variations from a big plantation with 200 regular and 1,000 temporary workers to small plantations with 10 regular and several temporary workers.

Table 1.4.3 shows the productivity of food products in Haut Zaire Region in 1955/56 compared to that of 1972/73. It is clearly understood from this Table that the production of food products has increased in proportion to the increase in the farming area compared with the time before independence. But the production of non-food products grown in plantations has decreased (except for coffee) in the same period when not only the farming area but also the productivity per ha have declined. Especially the production of oil palm products and cotton have declined to 30-40% of pre-independence production level. The noticeable change in food products between 1955/56 and 1972/73 is the remarkable decline of the proportion of commercialized products delivered to the market; and it is seen that the difference between zones on demand and supply has been enlarged in spite of the increase of total production. This is due to the fact that traffic facilities

and the distributing function of commodities have been destroyed due to the political disorder after the independence which has not been restored yet.

Soil and climate conditions of Haut Zaire Region are fit for growing crops and trees of variety; robster coffee, oil palm, rubber, cotton, sugar cane, and tobacco are planted in the tropical forest zone, while arabica coffee, tea, quinine, etc., are raised in the eastern highland, and banana, cassava, paddy, groundnuts, coconut, corn, etc., are planted in most of the area of the region. Fishery resources are abundant in rivers and lakes, and raising livestock is progressing in the eastern highland. But it is not too much to say that the Haut Zaire Region is still undeveloped seeing the vastness of possible land to be exploited. It may be possible to exploit its potentiality if the appropriate integrated regional development plan including livestock and fishery industries is introduced.

Table 1.4.3 Productivity of Main Agricultural Products in Haut-Zaire Region

Tableau Productivité de production de denrée d'agricole principale à la région du Haut-Zaïre

Type of Product / Type de produit	1955/56 Year / Année: Production / Production	1955/56 Year / Année: Commercialized Rate / Rapport commercialisé	1972/73 Year / Année: Production / Production	1972/73 Year / Année: Commercialized Rate / Rapport commercialisé	Cropping Area / Superficie d'enrée: 1955/56	Cropping Area / Superficie d'enrée: 1972/73	Productivity / Productivité: 1955/56	Productivity / Productivité: 1972/73
Food Products / Denrées alimentaires	(ton) (tonne)	(%)	(ton) (tonne)	(%)	(ha)	(ha)	(ton/ha) (tonne/ha)	(ton/ha) (tonne/ha)
Cassava/Manioc	816,000	19.7	2,088,000	0.2	106,759	138,498	7.6	15.1
Banana/Banana	736,197	22.8	486,057	3.4	136,564	90,558	5.4	5.4
Paddy/Paddy	67,377	65.1	78,961	20.3	67,019	99,221	1.0	0.8
Corn/Maïs	63,738	16.2	83,309	1.4	75,049	121,497	0.8	0.7
Groundnuts/Arachides	61,856	31.7	46,446	8.2	79,745	70,736	0.8	0.7
Haricots/Haricots	12,441	34.1	54,559	34.1	18,843	69,285	0.7	0.8
Sweet Potato/Patate douce	104,438	14.1	74,450	14.1	19,006	18,349	5.5	4.1
Sub-total / Sous-total	1,862,007	22.6	2,911,782	2.4	502,985	608,174	3.7	4.8
Non-Food Products / Produits commercialisés								
Oil Palm/Huile de palme	85,365		25,555		22,244	17,591	3.8	1.5
Cotton/Coton	49,422		19,248		115,587	43,064	0.4	0.4
Rubber/Caoutchouc	6,275		5,584		13,172	15,606	0.5	0.4
Coffee/Café	21,135		25,642		30,289	60,465	0.7	0.4
Cacao/Cacao	80		252		671	2,509	0.1	0.1
Sub-total / Sous-total	162,277		76,281		181,763	139,235	0.9	0.6

Source: Division Regional de l'Agriculture, Region du Haut-Zaire, "Rapport Annuel, 1973"

(2) Food Products

Table 1.4.4 shows the comparison of production index and food products of 1956, the representative year before independence, and that of 1972/73 in four administrative zones along the project road except for Kisangani and Bangassou areas. It is evident in this table that the agricultural production and productivity have increased, and the proportion of production of commercialized products delivered to markets has remarkably decreased during the period of 1956-1973.

Table 1.4.4 Production of Food Products in Administrative Zones along the Project Road (Comparison of 1956 with 1972/73) 1/

Items	1956	1972/73	1972/73/1956
(a) Total Production (ton)	479,471	473,889	0.99
(b) Commercialized Products (ton)	109,292	2,168	0.06
(c) Total Farmed Area (ha)	160,993	126,596	0.79
(d) Rural Population 2/	558,226	567,759	1.02
(e) Proportion of Commercialized Products (%) (b/a)	24.9	1.5	0.06
(f) Productivity (ton/ha) (a/c)	2.98	3.74	1.26
(g) Productivity per Capita (ton/inhabitant) (a/d)	0.89	0.83	0.93

Note: 1/ Except the City of Kisangani

2/ The rural population is assumed to be 1/2 of the urban population of Buta

Source: Division Regional de l'Agriculture, Rapport Annuel 1956, 1972 et 1973 Office des Affaires Politiques de la Region du Haut-Zaire.

Rapport Annuel 1965, 1972, 1973

The commercialized products are the portion of products to be delivered to markets excluding self-consumption and are closely related to the volume of local traffic. The noticeable difference of commercialized products between pre-independence and post-independence is considered partly due to the way of collecting statistics, but the information obtained through hearings from local inhabitants, truck companies and government office has lead to the conclusion that it is mainly due to the destruction of traffic routes and the function of transport organizations by the domestic disorder that followed the independence. The roads in the project area before the independence, as mentioned in 1.3.5 in detail, were maintained in good shape throughout dry and wet seasons, and every type of vehicle could operate without difficulty throughout the year. In delivering to markets, not only plantations had their own distributing functions but also private farmers had organized their own co-operative organizations for the purpose of distributing their products. The cooperatives had offered directly or indirectly such through-going services to private farmers from farming guidance to delivery of their products. Under this situation, it is said that the distributing function had been active and the farmers' lives were better off then in the area along the project road.

Tables 1.4.5 to 1.4.12 indicate the production of food products of 1956 and 1972/73 in the project area including the influence area, from which one can understand a little more in detail the local agriculture. Staple food products in the project area are cassava, banana, paddy, corn and groundnuts with about 300,000 tons of production in 1972/73, of which cassava and banana account for about 90%. The proportion of cassava and banana of the production of about 260,000 tons in 1956 was as high as that of 1972/73. But the relative share was reversed during the period and presently cassava is ranked first accounting for 60% of the production of staple food products. Such a trend is seen not only in the project area, but also in the whole country.

Table 1.4.5 Food Products in Project Area (Total)

(1972/73) (unit: ton)

Administrative Zone	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	5,000	347	70	111	2	5,530
Banalia	105,000	11,740	4,370	1,053	994	123,157
Buta	16,000	17,975	1,345	1,330	1,133	37,783
Aketi	29,000	27,654	3,829	3,028	2,250	65,761
Bondo	35,000	30,440	1,543	5,979	4,098	77,060
Total	190,000	88,156	11,157	11,501	8,477	309,291
Total (except Kisangani)	185,000	87,809	11,087	11,390	8,475	303,761
Ango	12,000	11,893	4,664	3,724	2,832	35,113
Bambesa	30,000	33,152	1,530	1,317	2,507	68,506
Poko	36,000	23,835	2,400	2,410	1,864	66,509
Grand Total	268,000	157,036	19,751	18,952	15,680	479,419
Grand Total (except Kisangani)	263,000	156,689	19,681	18,841	15,678	473,889

Source: Division Regional de l'Agriculture, "Rapport Annuel" 1972/73

Table 1.4.6 Food Products in Project Area (Commercialized Portion)

(1972/73) (unit: ton)

Administrative Zone	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	0	0	0	0	0	0
Banalia	1,200	344	344	0	332	2,220
Buta	300	132	17	37	88	574
Aketi	0	0	1,395	0	76	1,471
Bondo	100	50	50	0	10	210
Total	1,600	526	1,806	37	506	4,475
Total (except Kisangani)	1,600	526	1,806	37	506	4,475
Ango	0	0	17	0	3	20
Bambesa	600	551	158	483	770	2,562
Poko	0	31	81	0	-	111
Grand Total	2,200	1,107	2,062	520	1,279	7,168
Grand Total (except Kisangani)	2,200	1,107	2,062	520	1,279	7,168

Source: Division Regional de l'Agriculture, "Rapport Annuel" 1972/73

Table 1.4.7 Cropping Area in Project Area

(1972/73) (unit: ha)

Administrative Zone	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	260	116	87	125	3	591
Banalia	5,265	3,913	5,462	1,189	1,165	16,994
Buta	1,748	1,798	1,922	1,329	2,061	8,858
Aketi	4,907	5,028	4,787	4,175	3,750	22,647
Bondo	2,876	6,088	2,571	7,474	6,340	25,349
Total	15,056	16,943	14,829	14,292	13,319	74,439
Total (except Kisangani)	14,796	16,827	14,742	14,167	13,316	73,848
Ango	1,458	1,796	6,218	5,320	5,664	20,456
Bambesa	3,057	4,144	1,700	3,292	5,013	17,206
Poko	2,333	2,384	3,200	3,442	3,727	15,086
Grand Total	21,904	25,267	25,947	26,346	27,723	127,187
Grand Total (except Kisangani)	21,644	25,151	25,860	26,221	27,720	126,596

Source: Division Regional de l'Agriculture, "Rapport Annuel" 1972/73

Table 1.4.8 Agricultural Productivity in Project Area

(1972/73)

Administrative Zone	Productivity (ton/ha)						Productivity (ton/person)
	Cassava	Banana	Paddy	Corn	Groundnuts	Total	
Kisangani	19.2	3.0	0.8	0.9	0.7	9.4	-
Banalia	19.9	3.0	0.8	0.9	0.9	7.2	1.46
Buta	9.2	10.0	0.7	1.0	0.5	4.3	0.60
Aketi	5.9	5.5	0.8	0.7	0.6	2.9	0.84
Bondo	12.2	5.0	0.6	0.8	0.6	3.0	0.78
Total	12.6	5.2	0.8	0.8	0.6	4.2	-
Total (except Kisangani)	12.5	5.2	0.8	0.8	0.6	4.1	0.94
Ango	8.2	6.6	0.8	0.7	0.5	1.7	0.58
Bambesa	9.8	8.0	0.9	0.4	0.5	4.0	0.86
Poko	15.4	10.0	0.8	0.7	0.5	4.4	0.61
Grand Total	12.2	6.2	0.8	0.7	0.6	3.8	0.56
Grand Total (except Kisangani)	12.2	6.2	0.8	0.7	0.6	3.7	0.83

Table 1.4.9 Food Products in Project Area (Total)

(in 1956 year) (unit: ton)

Administrative Zone	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	10,500	5,270	670	100	0	16,540
Banalia	20,000	50,000	2,474	0	2,313	74,787
Buta	13,500	12,000	1,486	709	1,790	29,485
Aketi	16,000	14,400	5,959	5,057	2,565	43,981
Bondo	36,500	42,513	232	13,904	6,809	99,958
Total	96,500	124,183	10,821	19,770	13,477	264,751
Total (except Kisangani)	86,000	118,913	10,151	19,670	13,477	248,211
Ango	43,000	10,950	2,552	4,678	3,404	64,584
Bambesa	9,000	47,800	1,169	1,509	5,698	65,176
Poko	53,000	56,472	3,645	2,292	5,291	120,700
Grand Total	201,500	239,405	18,187	28,249	27,870	515,211
Grand Total (except Kisangani)	191,000	234,135	17,517	28,149	27,870	498,671

Source: Division Regional de l'Agriculture, "Rapport Annuel" 1956

Table 1.4.10 Food Products in Project Area (Commercialized Portion)

(in 1956 year) (unit: ton)

Administrative Zone	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	1,000	1,000	420	8	0	2,428
Banalia	12,000	15,000	1,533	0	1,128	29,661
Buta	9,000	3,000	1,186	689	890	14,765
Aketi	3,000	3,800	5,439	80	984	13,303
Bondo	1,000	3,400	101	204	3,658	8,363
Total	26,000	26,200	8,679	981	6,660	68,520
Total (except Kisangani)	25,000	25,200	8,259	973	6,660	66,092
Ango	11,000	500	850	230	487	13,067
Bambesa	13,000	22,000	932	382	2,786	39,100
Poko	0	319	360	35	319	1,033
Grand Total	50,000	49,019	10,821	1,628	10,252	121,720
Grand Total (except Kisangani)	49,000	48,019	10,401	1,620	10,252	119,292

Source: Division Regional de l'Agriculture, "Rapport Annuel" 1956

Table 1.4.11 Cropping Area in Project Area

(in 1956 year) (unit: ha)

Administrative Zone	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	1,054	1,054	1,054	125	0	3,287
Banalia	2,000	5,000	3,134	-	2,751	12,885
Buta	2,250	2,255	1,546	300	2,287	8,638
Aketi	8,026	8,026	4,013	5,057	3,181	28,303
Bondo	4,428	4,428	387	10,676	8,857	28,796
Total	17,758	20,763	10,134	16,178	17,076	81,909
Total (except Kisangani)	16,704	19,709	9,080	16,053	17,076	78,622
Ango	11,624	4,600	3,832	5,812	4,873	30,741
Bambesa	2,500	16,400	740	900	5,813	26,353
Poko	2,500	7,114	3,690	2,500	9,473	25,277
Grand Total	34,382	48,877	18,396	25,390	37,235	164,280
Grand Total (except Kisangani)	33,328	47,823	17,342	25,265	37,235	160,993

Source: Division Regional de l'Agriculture, "Rapport Annuel" 1956

Table 1.4.12 Agricultural Productivity in Project Area

(in 1956 year)

Administrative Zone	Productivity (ton/ha)						Productivity (ton/person)
	Cassava	Banana	Paddy	Corn	Groundnuts	Total	
Kisangani	10.0	5.0	0.6	0.8	-	5.0	-
Banalia	10.0	10.0	0.8	-	0.8	5.8	1.20
Buta	6.0	5.3	1.0	2.4	0.8	3.4	0.59
Aketi	2.0	1.8	1.5	1.0	0.8	1.6	0.53
Bondo	8.2	9.6	0.6	1.3	0.8	3.5	0.93
Total	5.4	6.0	1.1	1.2	0.8	3.2	-
Total (except Kisangani)	5.1	6.0	1.1	1.2	0.8	3.2	0.82
Ango	3.7	2.4	0.7	0.8	0.7	2.1	1.11
Bambesa	3.6	2.9	1.6	1.7	1.0	2.5	0.84
Poko	21.2	7.9	1.0	0.9	0.6	4.8	1.01
Grand Total	5.9	4.9	1.0	1.1	0.7	3.1	0.78
Grand Total (except Kisangani)	5.7	4.9	1.0	1.1	0.7	3.1	0.89

(3) Non-Food Products

The non-food products in the project area consist of plantation products, such as oil palm, rubber, and coffee and local private farm products such as cotton. Table 1.4.13 shows the production of non-food products of 1956 and 1972/73 in the project area. As shown clearly in this Table, the remarkable difference of non-food products from food products is not only that the production (tonnage) and the cultivated area have decreased but also that the productivity has much declined during the period. Such declines are due to the social disorder after independence and the inadequate maintenance of plantations during the period.

Table 1.4.13 Production of Non-Food Products in Project Area
(Comparison of 1956 with 1972/73)

Items	1956	1972/73	1972/73/1956
a. Total production (ton)	54,334	25,196	0.46
b. Cultivated Area (ha)	72,472	45,704	0.63
c. Productivity (ton/ha)	0.72	0.55	0.76

Source: Division Regional de l'Agriculture "Rapport Annuel" 1956, 1972/73.

In the operation of plantations, concentrated management such as the protection of plants from damage by diseases and insects using fertilizer and insectides, etc., usually prolongs the life of plants and increases the productivity. In the current management of the local plantations, it is observed that the renewal of old plants with young ones is not adequate, and it results in short life of plants and low productivity.

Table 1.4.14 to Table 1.4.19 show the production, cultivated area and productivity of the non-food products in the project area. According to these Tables, only the production of coffee has increased to more than that before independence, while if it is checked by Zone it is

understood that such increase is due to the sharp increase in the Poko Zone. At the same time it is said that coffee producers declared less amount of income in order to evade taxes and smuggled coffee in order to earn a foreign exchange margin; and so the actual production of coffee had been much more than the production which appeared in the statistics. And judging from these facts, the production of coffee is not considered to increase sharply. The largest decrease is seen in the production of oil palm products, then cotton and rubber follow. The cultivated areas have not decreased as much as their production has, but the cultivated areas of coffee and rubber have rather increased in some zones. Cotton is the product the cultivated area of which has decreased most.

Although there is not clear detailed information as to the current state of the management of plantations, the location and area of plantations situated along the project road are shown in Plate 1.4.2.

Next, the national trend and the sharing ratio of such production of the project area against that of Haut Zaire Region are reviewed by type of product in the following. The production of the main national agricultural products, and imported and exported tonnage are shown in Table 1.4.20.

Table 1.4.14 Production of Non-Food Products in Project Area

(1972/73) (unit: ton)

Administrative Zone	Oil Palm & Products	Cotton	Rubber	Coffee	Total
Kisangani	248	0	18	24	290
Banalia	318	995	212	167	1,692
Buta	282	611	0	43	936
Aketi	12	1,108	0	1,394	2,514
Bondo	16	1,676	0	95	1,787
Total (except Kisangani)	628	4,390	212	1,699	6,929
Ango	0	2,375	0	74	2,809
Bambesa	1,891	2,122	0	1,593	5,606
Poko	514	1,462	0	7,586	9,562
Grand Total	3,281	10,709	230	10,976	25,196

Table 1.4.15 Production of Non-Food Products in Project Area

(1956) (unit: ton)

Administrative Zone	Oil Palm & Products	Cotton	Rubber	Coffee	Total
Kisangani	20	0	150	279	449
Banalia	574	1,879	1,090	1,618	5,161
Buta	1,097	2,737	0	1,164	4,998
Aketi	2,520	3,342	447	666	6,975
Bondo	3,973	4,957	0	2	8,932
Total (except Kisangani)	8,164	12,915	1,537	3,450	26,066
Ango	180	3,434	0	4	3,618
Bambesa	2,353	6,440	0	1,818	10,611
Poko	6,215	5,323	0	1,972	13,590
Grand Total	17,012	28,112	1,687	7,523	54,334

Table 1.4.16 Cropping Area of Non-Food Products in Project Area

(1972/73) (unit: ha)

Administrative Zone	Oil Palm & Products	Cotton	Rubber	Coffee	Total
Kisangani	110	0	135	267	512
Banalia	856	1,573	2,008	1,638	6,075
Buta	85	1,527	142	2,807	4,561
Aketi	650	3,162	1,508	2,059	7,379
Bondo	226	3,520	2	840	4,588
Total (except Kisangani)	1,817	9,782	3,660	7,344	22,603
Ango	0	6,083	0	155	6,238
Bambesa	761	5,309	0	3,431	9,501
Poko	35	3,479	0	3,336	6,850
Grand Total	2,723	24,653	3,795	14,533	45,704

Table 1.4.17 Cropping Area of Non-Food Products in Project Area

(1956) (unit: ha)

Administrative Zone	Oil Palm & Products	Cotton	Rubber	Coffee	Total
Kisangani	98	0	379	880	1,357
Banalia	1,196	3,732	2,049	2,807	9,784
Buta	89	4,858	-	1,529	6,476
Aketi	532	6,085	530	1,331	8,478
Bondo	648	11,394	-	21	12,063
Total (except Kisangani)	2,465	26,069	2,579	5,688	36,801
Ango	74	6,753	-	40	6,867
Bembesa	1,734	10,940	-	1,933	14,607
Poko	186	13,420	-	2,652	16,258
Grand Total	4,557	57,182	2,958	11,193	75,890

Table 1.4.18 Productivity of Non-Food Products in Project Area

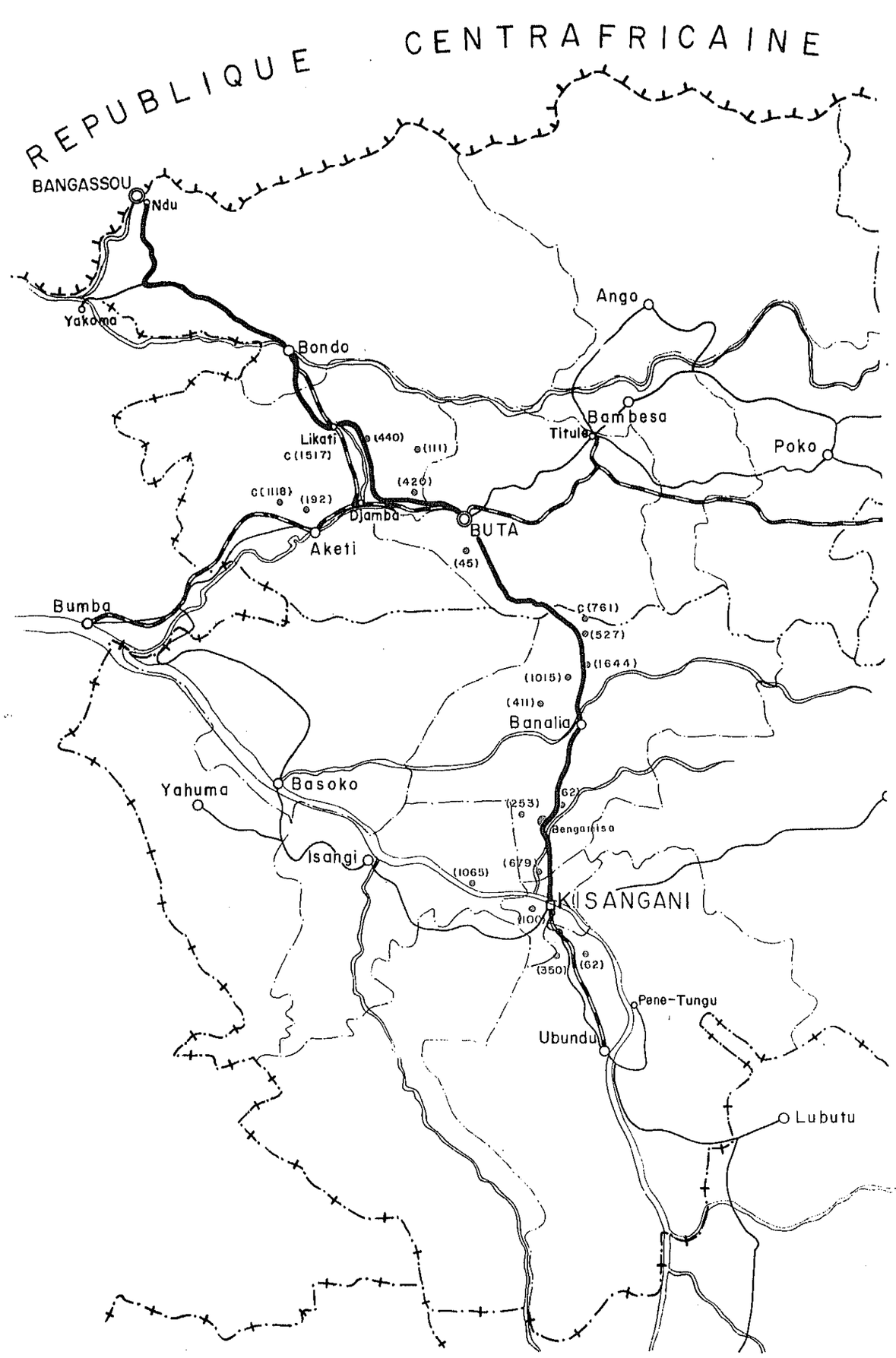
(1972/73) (unit: ton/ha)

Administrative Zone	Oil Palm & Products	Cotton	Rubber	Coffee	Total
Kisangani	2.25	-	0.13	0.09	0.57
Banalia	0.37	0.63	0.11	0.10	0.28
Buta	3.32	0.40	-	0.02	0.21
Aketi	0.02	0.35	-	0.68	0.34
Bondo	0.07	0.48	-	0.11	0.39
Total (except Kisangani)	0.35	0.45	0.06	0.23	0.31
Ango	-	0.45	-	0.48	0.45
Bambesa	2.48	0.40	-	0.46	0.59
Poko	14.69	0.42	-	2.27	1.40
Grand Total	1.20	0.43	0.06	0.75	0.55

Table 1.4.19 Productivity of Non-Food Products in Project Area

(1956) (unit: ton/ha)

Administrative Zone	Oil Palm & Products	Cotton	Rubber	Coffee	Total
Kisangani	0.20	-	0.40	0.32	0.33
Banalia	0.48	0.50	0.53	0.58	0.53
Buta	12.33	0.56	-	0.76	0.77
Aketi	4.74	0.55	0.84	0.50	0.82
Bondo	6.13	0.44	-	0.10	0.74
Total (except Kisangani)	3.31	0.50	0.60	0.61	0.71
Ango	2.43	0.51	-	0.10	0.53
Bambesa	1.36	0.59	-	0.94	0.73
Poko	33.84	0.40	-	0.74	0.84
Grand Total	3.73	0.49	0.57	0.67	0.72



LOCATIONS OF PLANTATION
ALONG PROJECT ROAD
(KISANGANI – BANGASSOU)

SITUATION DE PLANTATION SUR LE
LONG DE LA ROUTE DE PROJET
(KISANGANI – BANGASSOU)

Legend	Legende
◎ Plantation	Plantation
( ) Area in ha	Superficie en ha
C Community Farm	Cooperative Rurale

N

0 100 200 300km

PLATE I-4-2
PLANCHE I-4-2

a) Oil Palm Products

The national production of palm oil products in 1973 was 285,000 tons which has hardly changed since 1971. On the other hand, exported tonnage dropped from the 1971 level of 212,000 tons to the 1973 level of 134,000 tons. The causes of such export decline were an abrupt growth of domestic demand and the productive stagnation.

The surrounding conditions of oil palm products are not favorable low productivity and the inadequate investment in plantations and the aggravated commodity distribution system. Under such conditions the increase in production is not expected in the future; furthermore, it is feared that Zaire may have to import oil palm products from abroad in the 1980's. Although they are presently raising the price, implementing the national agricultural development program, enlarging the private enterprises in order to improve this situation, a sharp increase in the production of oil palm products may not be expected.

The production of oil palm products in Haut Zaire in 1972/73 was merely 26,000 tons which accounted for less than 10% of the national production. Furthermore, the production of oil palm products in the project area was 3,300 tons which accounted for about 13% of the regional production. On the other hand, it is said that the national production of oil palm products in the 1950's was about 400,000 tons and Haut Zaire accounted for about 20% of the national production and the project area accounted for about 20% of the regional production then. From this fact it is clear that the decrease of oil palm production in Haut-Zaire and the project area after independence were much bigger than other regions.

b) Cotton

The production of cotton in Haut Zaire in 1972/73 was 19,000 tons, about 11,000 tons of which (more than 50%) was produced in the project

area. Although this proportion was almost the same as that of 1956, the production dropped to 40% of that in 1956. The main cotton-producing areas in the Haut Zaire Region are Bas-Uélé and Haut-Uélé Sub-Regions located in the belt zone along the CVZ Railway. Cotton produced in these cotton belt areas is transported mostly to Kinshasa via Port of Bumba, but quite a large quantity of cotton will be transported to Kisangani hereafter since a new textile factory was recently constructed there. The national policy puts weight on the promotion of the textile industry, because cotton yarn is exported but textile goods are presently imported from abroad.

c) Rubber

The production of rubber in Zaire in 1973 was about 42,000 tons, 80% of which was exported, and its production had stagnated because of the unfavorable conditions in the international market in recent years. The output of rubber in Haut Zaire is about 5,600 tons which accounts for about 13% of its national production. Regardless of the increase of its planted area in the project area since 1956, the output is almost nil. Although there must be the problem of reliability of statistics, a reason has not been clarified. Since the output of rubber in Haut Zaire in 1956 was about 6,300 tons, 1,500 tons of which was produced in the project area, it can be safely estimated that the annual rubber production in the project area may presently be at least more than about 1,000 tons.

d) Coffee

The national production of coffee in Zaire in 1973 was about 83,000 tons, 90% of which was exported. The exportation of coffee is steadily increasing with the growing demand throughout the world at the rate of 2.5% per annum and the gradual decline in the production of Brazilian coffee. With this background, coffee is an excellent crop, the production of which has largely increased compared to the production in 1956, and

the regional production of Haut Zaire has increased from the 1956 level of 21,000 tons to the 1972/73 level of 26,000 tons. The coffee production in the project area in 1956 was 7,500 tons which accounted for 36% of the regional output, and in 1972/73 it reached 11,000 tons which accounted for 42% of the regional production.

Table 1.4.20 Production of Main Agricultural Products and Their Export and Import

Tableau Production des produits agricoles principaux et leurs export et import

(Unit / Unité: 1,000 ton / tonne)

Type of Product / Article de produit	Item / Article	1971 year / année	1972 year / année	1973 year / année
Rice Riz	Production Import	111.0 20.0	114.0 30.0	132.0 50.0
Corn Maïs	Production Import	130.0 110.0	- 112.0	- 130.0
Cassava (Dry) Manioc (sèche)	Production	430.0	-	-
Cassava (Flour) Manioc (farine)	Import	90.0	100.0	105.0
Other Root Crops, Sweet Potatoes Autres récoltes, patates douce	Production Import	70.0 4.5	- -	- -
Peas & Beans Pois & Haricots	Production	50.0	-	-
Plantations (a kind of banana) Plantations (une espéce de banane)	Production	430.0	-	-
Wheat Flour Farine de blé	Import	75.0	-	-
Sugar Surce	Production Import	44.0 20.0	50.1 20.0	53.0 -
Meat Viande	Production Import	34.0 12.0	34.0 -	- -
Fish Poisson	Production Import	130.0 25.0	120.0 -	120.0 -
Oil Palm Products Produits du Palmier à Huile	Production Export	293.8 211.9	293.0 168.9	285.0 134.1
Coffee Café	Production Export	74.0 67.5	81.0 74.0	83.0 33.0
Rubber Caoutchouc	Production Export	39.9 38.3	42.0 37.7	42.0 33.0
Tea Thé	Production Export	8.0 7.9	8.5 7.0	9.5 6.6
Cacao Cacao	Production Export	5.9 5.8	6.0 6.0	6.5 5.2
Cotton Fiber Laine de coton	Production Export	- 6.0	- 4.5	- 6.0
Tobacco Tobac	Production Import	0.3 5.4	0.7 6.2	1.3 5.6

1.4.3 Forestry

(1) General

The Zaire River Basin has the biggest forestry resources in Africa, the potentiality of which is the second highest in the world next to the Amazon plateau. Although there has been no basic survey conducted systematically to confirm its potentiality, the tropical forest in the Zaire River Basin covers an area of 100 to 130 million hectares which accounts for about half of territory of Zaire; 60 to 85 milion of these hectares are regarded to have available resources, excluding forests in highland and marsh which are considered difficult to be developed. If it is assumed that a cycle of production of commercialized lumber per unit area is 60 years, the production per unit area is said to be between 6 to 10 m^3/ha. For example, in RCA and southwest of Cameroun, the annual productivity of 15 to 30 m^3/ha is considered as the basis of continual lumber production per ha of forest. According to this premise, it is clear that the production of lumber in Zaire has the potentiality of 600 to 850 million m^3 a year. Current annual production of lumber of Zaire is merely about 500,000 m^3, and most of it is concentrated in the coastal area of Ville de Kinshasa and Region du Bas-Zaire. But the production of lumber in this coastal area has decreased recently because of the conversion of forests into farmland and residential zones due to the growth of population, the over-development of forests, the delay of reforestation, etc. And it is said that the center of development of forestry will transfer to the Regions of Equateur, Haut-Zaire in the future.

(2) Current Situation of Forestry in Project Area

The lumber production of the Region of Haut-Zaire in 1973, as shown in Table 1.4.21, merely remained at as low as 66,000 tons in spite of its tremendous potentiality. This production accounted for about 10% of that of the whole of the country of that year. The zones of Ubundu and Yahuma

account for more than 50% of the production of the whole region, and the zones of Isangi and Banalia and Ville de Kisangani are ranked next to Ubundu and Yahuma. Most of the lumber is produced in such convenient zones which are situated along the Zaire River or along the well-maintained trunk roads to be completed as far as Kinshasa.

Table 1.4.21 Lumber Production of Region of Haut-Zaire (1973)

Zone/Sub-Region	Production (ton)
S/R Kisangani	5,036
Zone de Banalia	5,262
Zone de Ubundu	20,882
Zone de Basoko	2,536
Zone d'Isangi	8,694
Zone d'Opala	579
Zone de Yahuma	17,490
Total of S/R TSHOPO	55,443
Zone d'Aketi	-
Zone de Poko	64
Zone de Bambesa	23
Total of S/R Bas-UELE	87
Total of S/R HAUT-UELE	429
Total of S/R ITURI	5,373
Regional Total	66,368

Source: Division Regional de l'Agriculture, "Rapport Annuel 1973"

The regional annual lumber of the production of 66,000 tons is calssified into three categories, and most of two higher categories are delivered for Kinshasa. Table 1.4.22 indicates the local distribution of those categories Ville de Kisangani and the Sub-Region of Tshopo produce 70% of the 1st category, 97% of the 2nd category.

Table 1.4.22 Production of Lumber by Classes (1973)

(Unit: ton)

Sub-Region	1st Category	2nd Category	3rd Caregory	Total
Kisangani	208	6,057	490	6,755
Tshopo	10,100	28,862	2,432	41,394
Bas-Uele	121	195	159	475
Haut-Uele	43	287	68	398
Ituri	3,867	377	2,113	6,357
Total	14,339	35,778	5,262	55,379

Source: Division Regional du l'Agriculture, "Rapport Annuel 1973"

In Table 1.4.21, the lumber production was as small as 5,260 tons in Banalia zone and 87 tons in Poko and Bambesa zones. In view of the small output, most of the lumber produced in Poko and Bambesa was consumed locally , and it is said that the quantitative potentially and quality of forests are not suitable to be commercialized. The lumber in the Banalia zone is mostly produced near the zonal boundary line of Kisangani, where most of it is delivered to Kisangani by road. All lumber produced in the Banalia zone belongs in the 2nd category. There are 5 lumber mills operated at present in Kisangani, one in Banalia, 2 in Aketi, one in Buta, 2 in Bambesa and 3 in Poko, but only those mills situated in Kisangani and Banalia are of large production.

1.4.4 Other Industries

(1) General

In the Haut Zaire Region, the aforementioned agriculture and foresty are the major industries, and the mining and manufacturing industries are much behind in development.

Table 1.4.23 indicates the number of enterprises in the Region; however, their distribution, current operating conditions, scope of production, etc., are not clear. As far as the number of enterprises are concerned, most industrial facilities are affiliated with agriculture, which is considered natural in the light of the industrial structure of the Region.

Table 1.4.23 Number of Enterprises in Haut Zaire Region

(1971)

	Category	Number of Enterprises
1.	Mining	26
2.	Processing Agricultural Products	550
3.	Machinery	20
4.	Construction	99
5.	Textile Processing	101
6.	Chemistry	17
7.	Energy	90
8.	Foods	234
9.	Others	85
	Total	1,222

Source: Division Régionale des Affaines Economiques et de l'Industrie, "Rapport Economique Annuel 1971"

(2) Mining Industries

Although it is generally said that the Haut-Zaire Region is poor in mineral resources, this is probably due to the fact that no extensive basic survey of the resources has been ever conducted. There had been small mines here and there in the Region, and there had existed 18 small mines along the project road. They are all closed now in the Region, except for the Kilomoto Gold Mine in Ituri Sub-Region. Under the government development plan of the North-East Territory which is now underway, resources have been confirmed to some extent as natural gas in Ubundu and Wanie-Lukula, limestone in the suburbs of Kisangani, and iron ore in Wamba and Banalia. Especially, the development of iron ore near Kole is important, because it is directly related to the road to be improved under this project, but no definite development plan has been formulated so far, and no information as to the distribution and the quantity of deposits is available.

Therefore, the development of mineral resources has not been taken into consideration in this report in the estimation of the future traffic on the project road.

(3) Manufacturing Industries

As mentioned before, manufacturing industries in Haut Zaire have been extremely undeveloped. Even in administrative zones along the project road, there are only a brick factory, a brewery, a soft beverage factory, and a textile factory in Kisangani. Factories distributed in the whole Region are for processing products of agriculture which are somewhat developed compared with other industries. Table 1.4.24 indicates the number of factories existent in the administrative zones along the project road.

Table 1.4.24 Number of Processing Factories of Agricultural Products in Administrative Zones along Project Road

Administrative Zone	Rice-Processing Mill	Cotton Factory	Palm Oil Mill	Rubber Factory	Total
Banalia	2	4 (3)	2	7	15 (3)
Buta	1	4 (1)	1	2	8 (1)
Aketi	1	2 (1)	2 (1)	1	6 (2)
Bondo	0	3 (1)	1	0	4 (1)
Sub-total	4	13 (6)	6	10	33 (7)
Ango	0	4 (4)	0	0	4 (4)
Bambesa	2	7 (3)	5 (1)	1 (1)	15 (5)
Poko	1	3 (3)	5	0	9 (3)
Total	7	27 (16)	16 (2)	11 (1)	61 (19)

Note: Figure in parenthesis shows the number of present active factories.

1.4.5 Medical and Educational Facilities

(1) Medical Facilities

The system of medical care in the Haut Zaire Region is under the direction of Regional General Medical Inspector who is stationed in Kisangani. It consists of Sub-Regional medical officers who are stationed in each Sub-Region, and there are a hospital and several dispensaries in each zone. Table 1.4.25 indicates the existing conditions of hospitals in administrative zones along the project road, and Plate 1.4.3 shows the distribution of existing medical facilities including dispensaries in each administrative zone. Generally, most medical treatment is taken care of by the public hospital in each administrative zone; however, this is not always carried out satisfactorily because those hospitals do not have enough medical officers. A dispensary has principally only a nurse and is equipped with a few beds; but in reality most

dispensaries have neither nurses nor beds, and are only available for temporary medical treatment in emergency. The current problem of the medical care in administrative zones along the project road is not being able to supply satisfactory treatment because of the lack of the appropriate number of medical officers and medical facilities and difficulties in obtaining medicines and medical equipment. Medical officers make routine trips to villages to take care of patients in the hospital of each zone; however, because of the shortage of officers and the current poor road conditions, such trips are limited in the restricted area, and also the transportation of patients is accompanied by danger. In the Buta zone, urgent cases in villages are transported by an ambulance; however, the present unfavorable road conditions and the inconvenient communication system hinder the quick transportation of patients. Because of such unfavorable conditions along the project road, there was recently an urgent case: the patient in Aketi had to be sent to Kisangani by an army airplane after being transported from Aketi to Isiro by railway. Such conditions are not only a barrier to routine trips of medical officers to rural areas and transportation of patients, but also keep hospitals from receiving medicines and equipment needed to continue the efficient management of local hospitals.

The medical facilities existing in the project area is shown in Table 1.4.25 and Plate 1.4.3.

Table 1.4.25 Medical Facilities in Project Area (1973 year)

Tableau Facilités médicaux dans l'aire d'influence (en 1973 année)

Zone	Administration Management	Number of Beds Nombre des lits	Number of Medical Doctors Nombre de médecins	Contents of Medical Services Titres de service médical	Number of Dispensaries Nombre de dispensaire
Banalia	Public	120	not affirmative pas affirmative	Internal Medicine/Médecine des maladies internes Pediatrics/Pédiatries Surgery/Chirurgie Gynecology & Obsterics/Gynécologie & obstériques	10
	Mission	53	2	Internal Medicine/Médecine des maladies internes Obsterics/Obstériques	-
Buta	Public	317	2	Internal Medicine/Médecine des maladies internes Pediatrics/Pédiatries Surgery/Chirurgie Gynecology & Obsterics/Gynécologie & Obstériques	5
	Public	300	(Under construction, scheduled to finish in 1975) (Un cours de construction, plan est fini en 1975)		
Aketi	Public	169	1	Internal Medicine/Médecine des maladies internes Pediatrics/Pédiatries Surgery/Chirurgie Gynecology & Obsterics/Gynécologie & obstériques	9
Bondo	Public	158	1	- ditto - - même -	10

Source: Office des Sante Regionale, Kisangani

MEDICAL FACILITIES IN THE ADMINISTRATIVE ZONES ALONG PROJECT ROAD (KISANGANI-BANGASSOU)

FACILITÉS MEDICALES DANS LES ZONES ADMINISTRATIVES LE LONG DE LA ROUTE DU PROJET (KISANGANI-BANGASSOU)

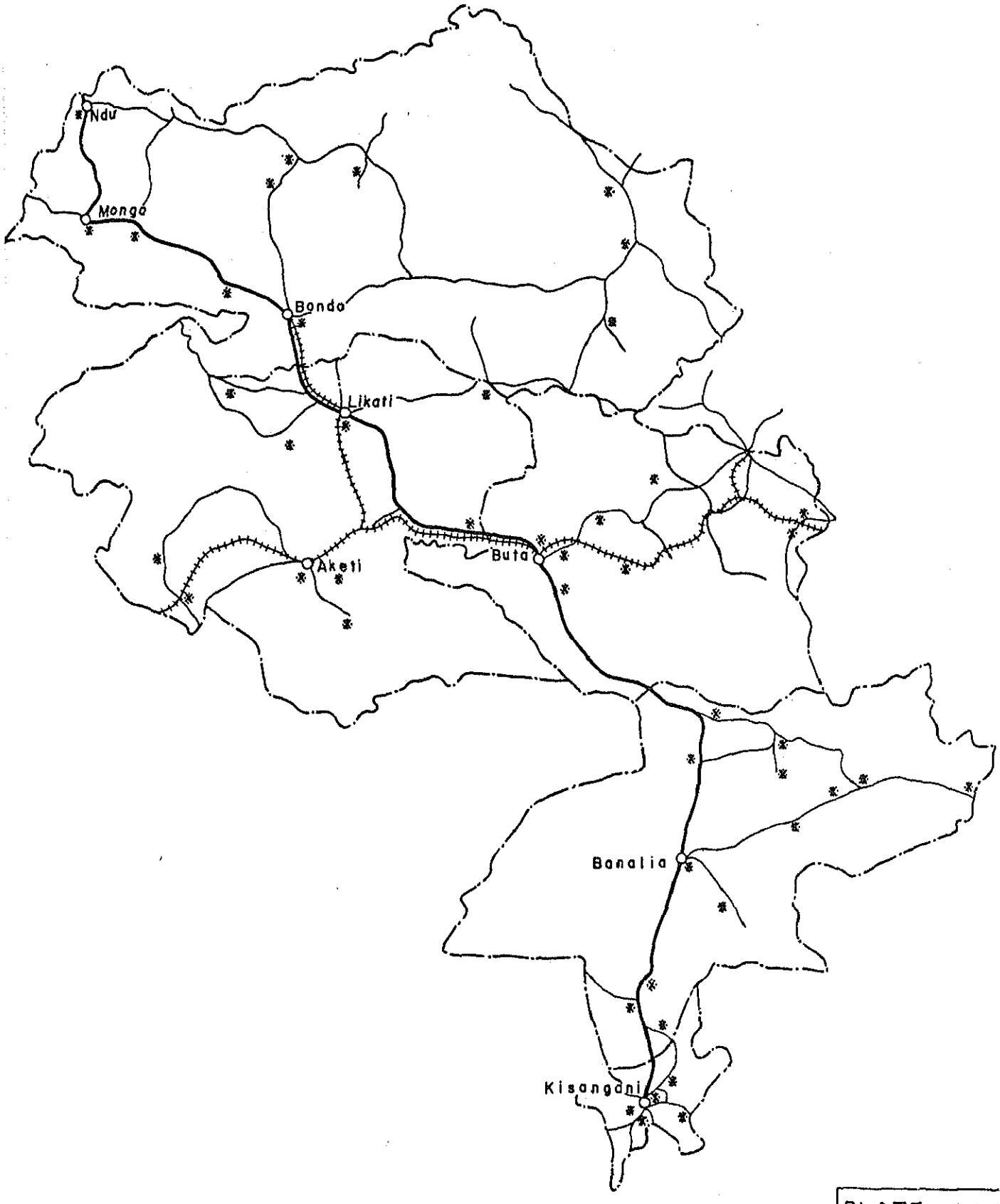


PLATE 1.4.3
PLANCHE 1.4.3

(2) Educational Facilities

Table 1.4.26 indicates the current state of school facilities in administrative zones along the project road and shows that the poor road conditions have brought about many educational barriers.

The bad roads cause the pupils difficulty in going to school, and it is difficult to regularly supply teaching materials and school supplies. This inadequacy causes local schools to change their teaching curriculums or close classes temporarily, and so, qualified school teachers are not willing to go to rural schools. Because of such unstable educational functions, it is the current trend that the children in most rural areas desire to learn at urban schools which are jammed with pupils while rural schools are decreasing in the number of pupils; and accordingly, such a trend affects the educational system of the whole region. Some places badly need additional new schools because of increased population. However, it is difficult to select a place when such unfavorable road conditions exist.

It is pointed out by the Ministry of Education that the schools in the areas where the roads are well maintained function regularly and the rates of children's attendance are high. In view of such a trend, it is expected that the improvement of the project road will surely bring about substantial effects toward normalizing the educational function in the project area.

Table 1.4.26 Current Situation of Schools in Administrative Zones along the Project Road

Administrative Zone	Primary Schools				Secondary Schools			
	Number of School		Number of Pupils	Number of Classes	Number of School		Number of Pupils	Number of Classes
	Public	Mission			Public	Mission		
Kisangani	20	25	44,618	850	17	9	8,716	227
Banalia	11	5	8,630	252	0	2	214	6
Buta	0	8	7,911	183	0	7	1,754	58
Aketi	1	4	3,647	98	0	6	692	24
Bondo	1	16	13,416	387	0	7	734	21
Total	33	58	78,222	1,770	17	31	12,110	336

Source: "Liste Establissements de l'Enseignement, 1972/73 Antenne du plan et des Statistique Scolaires Primaire, Secondaire", Education Nationale, Region du Haut-Zaire

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2. TRAFFIC ANALYSIS

2.1 General Description

In this chapter, the following studies are performed:

- The traffic analysis on the existing state of the project area and the project road, being based on the results obtained in origin-destination survey conducted by the survey team in the field;
- The analysis on the operation costs of vehicle on the existing road and the expected savings in the operation time of vehicles, the expected increase in the loading efficiency of vehicles due to the improvement of the project road and the operating costs on the improved road;
- The estimation of the future traffic of freight on the project road; and
- The estimation of the future traffic of passengers on the project road.

In the traffic estimation, the conventional method is not adopted but the following method is adopted because of the particular local conditions. Firstly, the production of agricultural and forestry products is estimated; secondly the commodity flows of such products are estimated; thirdly, such commodity flows are converted into the vehicular traffic.

2.2 Current Traffic Situation

2.2.1 Current Traffic Situation of Project Road

The transportation network of the project area at present constitutes of the trunk road network of a north-south route and an east-west route crossing each other at Buta and a railroad parallel to the east-west trunk road and several affiliated feeder roads. The Bomu River, the river on the border from Bangui and upstream; the Aruwimi River and the Uele River are not presently utilized for navigation because of the presence of rapids and reefs. As for the current traffic situation of the project area, the existing commodity flows using the existing transportation network are as follows:

(1) Commodity Flow from Bondo to Aketi and Bumba

In the northern part of the project area with Bondo and Likati as centers, the transportation of raw cotton by ONAFITEX and of coffee by ONC is continued in small scale partly due to the poor road conditions. Because the CVZ Railroad has no scheduled operation, most of raw cotton and coffee collected from villages and plantations along the project road taken to collecting centers of ONAFITEX and ONC at Bondo and Likati are carried by trucks to Aketi or Bumba where the freight is transferred to river-boats to be further sent to Kinshasa. However, when the roads are not serviceable during the wet season, the freight is carried by CVZ Railroad.

The towns of Bondo, Buta, Aketi and Bumba are connected by railroad as well as by road, and the current transport charges by road and by railroad between those towns are as follows:

From - To	Railroad[1/]		Road[2/]	
	Distance (km)	Charge (Z/ton)	Distance (km)	Charge (Z/ton)
Bondo - Aketi	151	4.07 - 8.50	163	9.80 -
Bondo - Bumba	337	3.54 - 7.41	372	22.30 -
Bondo - Buta	180	4.82 - 10.02	198	11.90 -
Buta - Aketi	131	3.54 - 7.41	115	6.90 -

Note: 1/ Source: Chemin de Fer Vicinaux du Zaire, Tarifs Généraux de Transport des Marchandises Générales Classes 1 à 13

2/ Data were obtained from hearings at REUNI Office in Kisangani.

(2) Commodity Flow from Isiro and Buta to Aketi and Bumba

In the north-eastern part of the project area, the commodity flow is in the east-west direction which consists of the agricultural products from the project area and Isiro to Kinshasa via Aketi or Bumba by use of the CVZ Railroad. But some part of the products to be produced in the Buta area are taken from Buta to Kisangani by trucks and then shipped to Kinshasa by boat to reach Kinshasa more quickly. This is the major commodity flow of the project area at present.

(3) Commodity Flow through Kisangani

In the southern part of the project area agricultural and forestry products are sent to Kisangani by trucks and most of them except for such products meeting the demand at Kisangani markets are shipped to Kinshasa from Kisangani by river-boats.

The project road is not situated along the main direction of the east-west on which the existing main commodities flow as mentioned above; on the contrary, it runs almost perpendicular to the direction fo these existing commodity flows.

As for the current traffic using the existing project road, long-tirps are few and most of the traffic are short-trips to meet the limited local demand. This is clearly shown by the results of the traffic survey on the roads conducted in 1959 when the road were still in farily good conditions. (see Plate 2.2.1)

On the project road, it was the vicinities of Kisangani and Buta at that time that had the traffic exceeding 100 vehicles per day and the sections between Kisangani and Buta and between Buta and Bondo had the

traffic ranging from 10 to 50 vehicles per day. (see Plate 2.2.1)

A similar tendency has been observed by the origin-destination survey conducted in October 1974. Since the existing project road is physically in the critical conditon and is not in the state to meet the traffic demand of the project area, a mere comparison is not possible at this stage.

In fact interviews held at trucking firms revealed that trucks are not sent to such areas where the road conditions are particularly poor despite the requests for transportation of agricultural products by clients.

Meantime, the Government is studying various development programs such as the industrialization with Kisangani as the base for the development of the north-eastern territory of the country and the urbanization of the city is anticipated to progress more actively in the future.

It is anticipated that the improvement of the project road will indirectly foster the development program of Kisangani as the base and directly effect simultaneously, not only the economic but also the social and cultural aspects of the project area of this road.

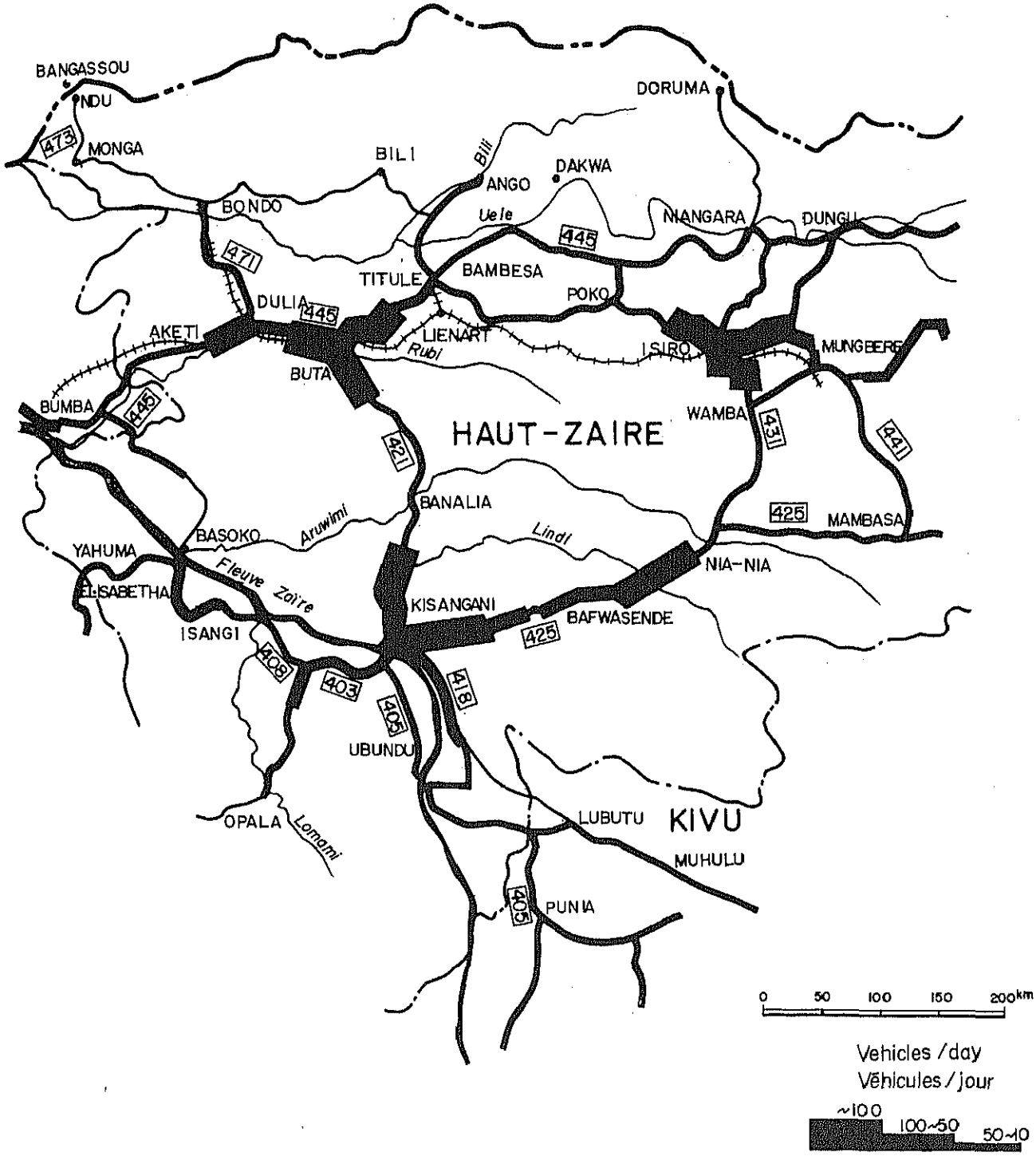


PLATE 2.2.1

TRAFFIC VOLUME OF VEHICLES - 1959

PLANCHE 2.2.1

VOLUME DE TRAFIC DES VEHICULES-1959

Source: Mission de Reconnaissance des Tpansport de la Region Nord-Est du Congo
Rapport Final Dec 1970

2.2.2 Current Traffic on the Existing Project Road

(1) Current Volume of Traffic

From the results of the traffic survey conducted on the project road[1/], the volume of traffic per day at the Tshopo Bridge in Kisangani City is 473 vehicles[2/] which includes considerable suburban traffic because the bridge lies approximately 3.6 km away from the center of the city.

In the vicinity of the boundary between Kisangani City and the Banalia zone, the traffic volume is 104 vehicles. However such volume of traffic is observed only as far as 50 to 60 km away from Kisangani.

At Banalia, 120 km away from Kisangani, the daily volume of traffic at the ferry dropped to an average of 19 vehicles for the seven months from March to September 1973.

At the entrances to Buta City, the volume is 119 vehicles on the Isiro side and 62 vehicles on the Dulia side. However, the data of the roadside interviews here shows that these figures mostly represent suburban traffic and long trip traffic is scarecely observed.

In the areas north of Buta, partly due to the poor road conditions, the number of vehicles observed by the survey team for a distance of approximately 200 km to Bondo was merely 2 to 3.

The volume of traffic crossing rivers by ferry boat at Bondo, Monga and Ndu is at the most 5 vehicles per day each.

Note: 1/ See Vol. 3, A.3.6.

2/ Data provided by Regional Office des Routes. The figure in the average of two days, 17th and 19th, September 1974.

The data of the above surveys is shown in Plate 2.2.2.

When the data of these observations is compared with the traffic volume in 1959, the same trend in the traffic volume of area is noticed.

This is to say that the volume of traffic in a city such as Kisangani is as much as 100 vehicles per day, while that between the towns is much less. In 1959 the average daily traffic between Kisangani and Buta was approximately 30.

However, at present the average daily traffic crossing the river by ferry boat at Banalia, a midpoint between Kisangani and Buta, was 19 vehicles for the 7 months up to October, 1974 and it further decreases when the suburban traffic is not included.

The current traffic volume in the vicinity of towns is approximately on the same level as that of 1959, however, inter-town traffic volume has not yet reached the 1959 level.

As can be seen from the records of traffic volume by month crossing the rivers by ferry at Banalia, Bondo, Monga and Ndu, the wet months from March to November have less traffic than dry months.

The vehicular traffic between Kisangani and Buta in 1959 during the wet and dry seasons shows little difference. This is because the road was maintained in fairly good conditions at that time. However, at present, the difference between the road conditions then and now is reflected in the difference of traffic volume between the wet and dry seasons. (see Table 2.2.1 and Plate 2.2.3)

(2) Traffic Composition by Type of Vehicle and Loading Capacity

The vehicular composition of traffic varies with the survey stations. In the vicinity of Kisangani and Buta, the sharing ratio of passenger cars of

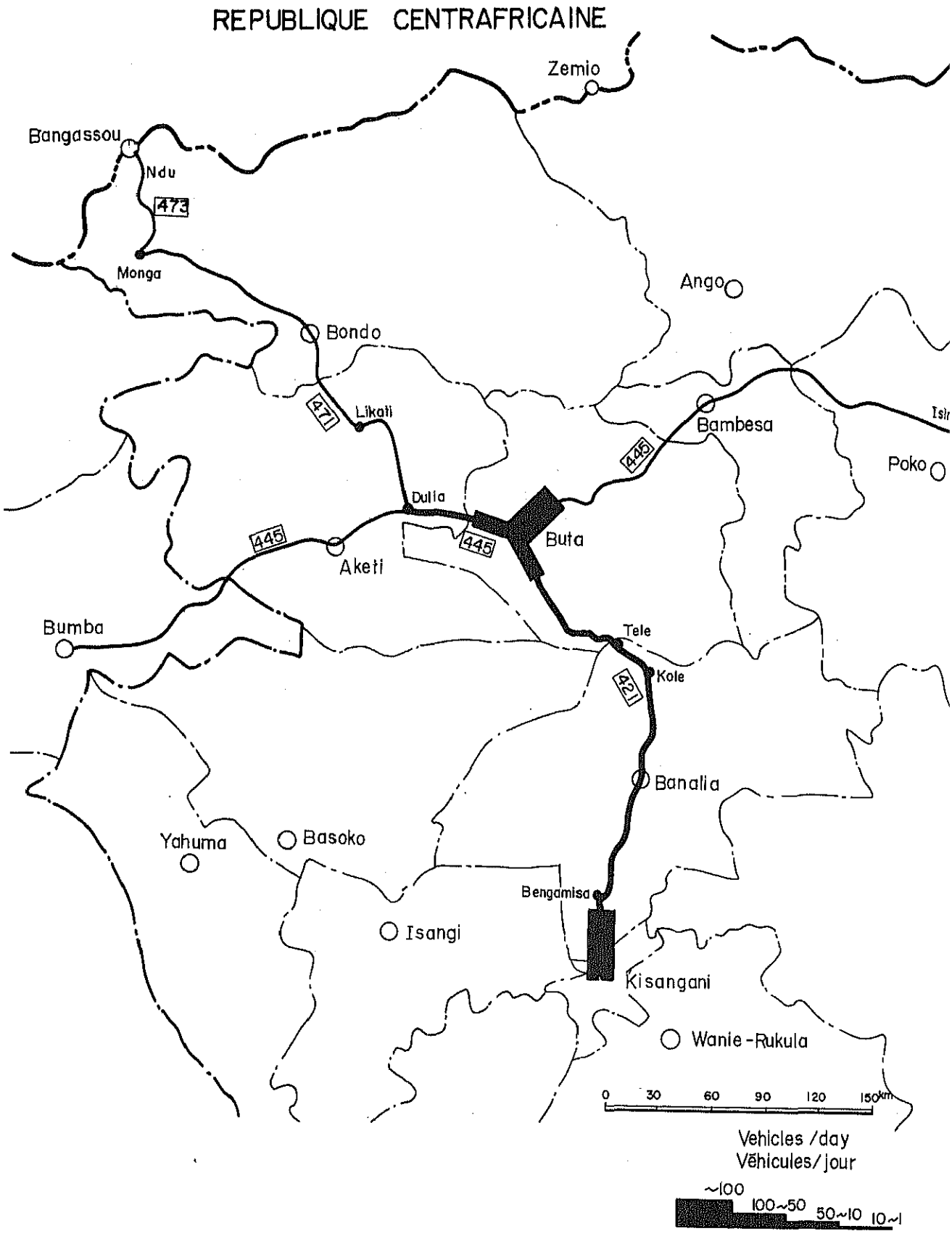


PLATE 2.2.2

TRAFFIC VOLUME OF VEHICLES - 1974

PLANCHE 2.2.2

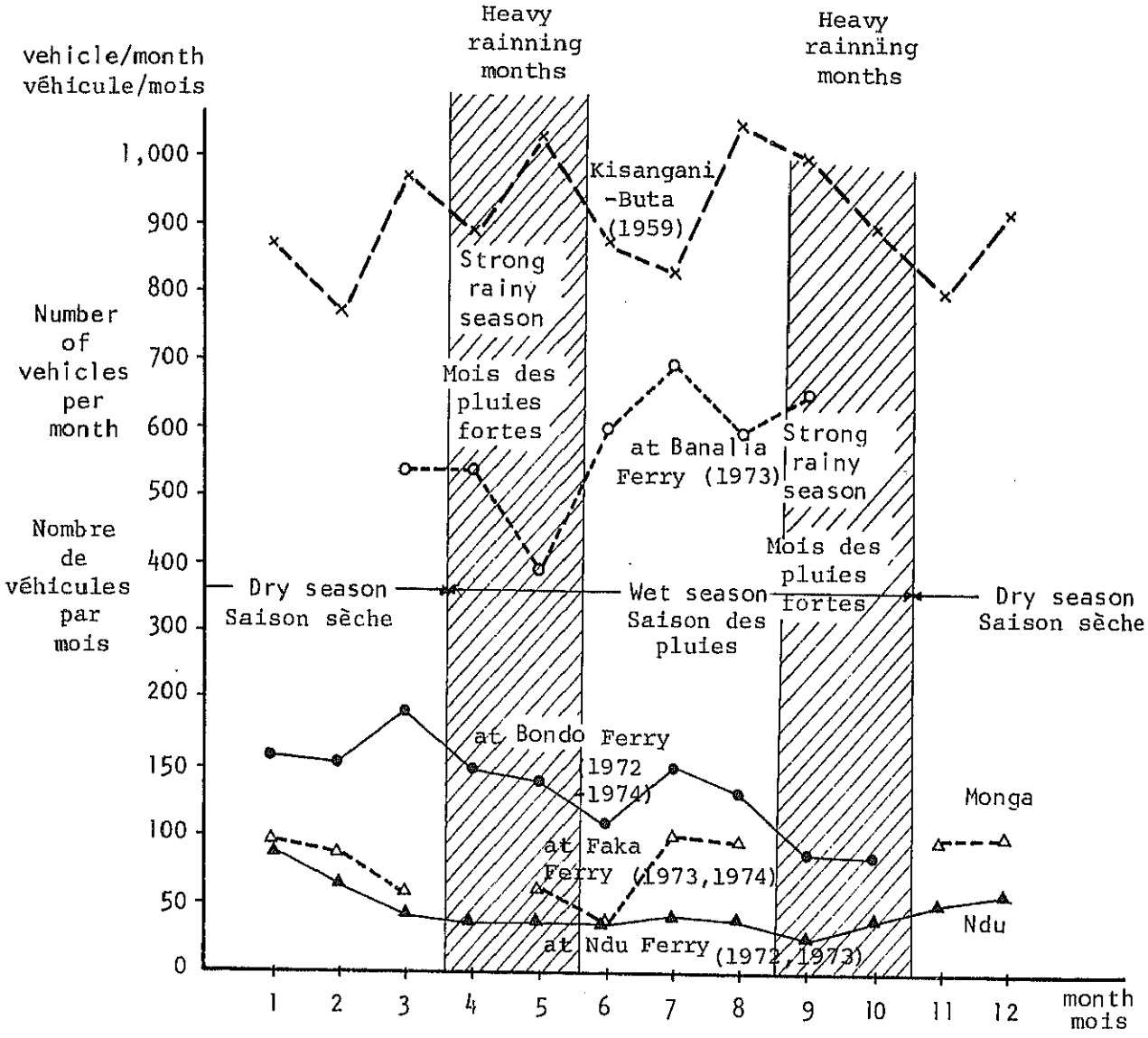
VOLUME DE TRAFIC DES VEHICULES - 1974

Table 2.2.1 Monthly Fluctuation of Vehicular Traffic
Tableau Flux mensuel du trafic véhiculaire

	Present Volume of Traffic Surveyed at Ferry Sites[1] Volume présent du trafic étudié aux bacs				1959[2]
	Banalia	Bondo	Faka	Ndu	Kisangani - Buta
January janvier	-	165	99	81	871
February février	-	163	87	65	772
March mars	543	184	65	48	970
April avril	542	157	-	32	891
May mai	395	140	68	30	1,037
June juin	610	121	43	32	876
July juillet	692	156	104	40	833
August août	590	135	91	38	1,051
September septembre	668	83	-	21	1,001
October octobre	-	84	-	30	894
November novembre	-	-	93	58	811
December décembre	-	-	101	63	920
Average Daily Traffic Moyenne quotidienne du trafic	19.2	4.6	2.8	1.5	29.9
Surveyed in étudié à	1973	Jan.-Mar.:1972 Apr.-Oct.:1974 jan.-mars:1972 avr.-oct.:1974	Jan.-Aug.:1974 Nov.,Dec.:1973 jan.-août:1974 nov.,déc.:1973	Jan.-Oct.:1973 Nov.,Dec.:1972 jan.-oct.:1973 nov.,déc.:1972	1959

Source: (1) "RAPORT NENSUEL STATISTIQUES" Republique du Zaire Departement des Travaux Publics et de l'Amenagement du Territoire.
(2) Statistiques Officielles, Province Orientale, 1959

Plate 2.2.3 Monthly Fluctuation of Vehicular Traffic at Four Ferry Sites (1972-1974) and in Section Kisangani and Buta (1959)



Jeep type is large, namely 68% at the Tshopo Bridge and 65% in Buta.

At present, passenger cars are used only in urban areas and few passed the survey stations.

In areas away from urban areas such as Banalia and Bondo, etc. the percentage of composition of trucks becomes larger, with the figure being 76% at Bayangana (11 km north of Kisangani), 89% at Banalia and 88% at Bondo. (see Table 2.2.2)

While the percentage of composition of heavy trucks at the Tshopo Bridge is approximately 21% and 15% at the entrance to Buta (Dulia side), the same is 37% at Bayangana, 40% at Banalia and 47% at Bondo, which fact clearly shows that there is a difference in vehicular composition between the vicinity of urban areas and the rural areas. This is largely attributable to the present state of road conditions where muddy pools are seen very often allowing the passage of only heavy trucks.

The loading capacity of the vehicles passing the survey stations averaged 3.9 tons.

When the vehicles are classified into heavy vehicles with a loading capacity above 2 tons and light vehicles below 2 tons, 1.5 ton-type trucks are most prevalent in number and accordingly, as for light vehicle class the loading capacity averaged 1.43 tons.

As for those above the 2 ton class, 6 tonners are dominant and the loading capacity averaged 4.9 tons.

Therefore, the loading efficiency of various types of truck $\left(\frac{\text{Loading tonnage}}{\text{Loading capacity}}\right)$ is 66% for light vehicles and 55.9% for heavy vehicles. (see Tables 2.2.3 and 2.2.4)

The reason for the heavy vehicles being lower in loading efficiency than light vehicles is that the heavy vehicles usually carry an average of 9 passengers on the loading platforms in addition to freight. However, if the road could be improved into an all-weather type road, the loading efficiency could increase for the following reasons:

(1) The trucking companies may establish rational transportation programs.
(2) By the establishment of bus routes, passengers riding on the loading platforms of the trucks can utilize bus services.

Table 2.2.2 Traffic composition by Type of Vehicles on Project Road (in 1974)

Location of Survey Station	Cars & Jeeps	Bus	Vans	Light Trucks	Heavy Trucks	Total	Average Daily Traffic
Kisangani							(vehicles)
Tshopo[1/]	68.2%	0.9%	- %	10.3%	20,6%	100.0%	473
Bayangana[2/]	24.1	-	12.6	26.1	37.2	100.0	104
Banalia[3/]	10.7		14.3	35.0	40.0	100.0	24
Buta[4/]							
Isiro side	21.9	-	27.7	15,1	35.3	100.0	119
Dulia side	64.5	-	19.4	1.6	14,5	100.0	62
Bondo	12.2	-	40.0	1.1	46,7	100.0	3
Total	54.0%	0.6%	6.5%	13.3%	25.6%	100.0%	

Note: 1/ Average of survey conducted 17th & 10th September 1974.
2/ Average of survey conducted 23th & 24th October 1974.
3/ Date was counted on October 30, 1974.
4/ Average of survey conducted between Oct. 1 1974 and Nov. 4 1974.
5/ Data at Tshopo were obtained from a separate survey conducted by Regional Office des Route in 1974.

Table 2.2.3 Average capacity and average Tonnage Carried per Vehicle Interviewed

	Light Vehicles					Heavy Vehicles												Total
Capacity (ton)	1.0	1.5	1.6	1.8	*	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0	*	
Number of Vehicle Interviewed	46	166	16	15	65	24	10	9	2	12	8	45	26	2	1	2	29	478
Average Capacity per Vehicle (ton)	1.43					4.96												

Note : 1) The categories having asterisk (*) mark are those vehicles whose capacities and the tonnage carried were not identified, and were not included in the calculation of the average capacity.

2) Passenger cars, jeeps and van-type vehicles are classified in the categories of 1.0 and 1.5 tons in capacity and are included in the calculation of the average capacity per vehicle because they carried also some tonnage of freight with them.

3) The date in the table include only those of Bayangana (Kisangani), Buta and Bondo. The date of Tshopo were excluded because of their strong urban nature, while the data of Banalia were excluded because they did not include their capacities and the tonnage carried.

4) As for related data, refer to Tables 2.2.3 & 2.2.5.

Table 2.2.4 Average Loading Efficiency
Tableau Efficacité moyenns du chargement

	Average Tonnage Carried (ton) / Moyenne du tonnage charrié (tonne)	Capacity (ton) / Capacité (tonne)	Loading Efficiency (%) / Efficatité de chargement (%)
Light Vehicles / Véhicules légers	0.93	1.43	65
Heavy Vehicles / Véhicules lourds	2.74	4.90	55.9

Note : Data were collected through O-D survey conducted during Octover and November 1974.

Ces données ont été recueillies suite aux études O-D menées pendant les mois d'octobre et de novembre 1974.

(3) Travel Time and Speed on Existing Road

It is said that before 1960, it was possible to travel a distance of approximately 320 km between Kisangani and Buta in 6 hours (average speed 53 km/hr) by a truck and in 4 hours (average speed 80 km/hr) by a passenger car. However, more than twice as much is required for the travel at present, and furthermore the time of arrival are largely depending on road conditions. On rainy days, time required may run as much as several times more than that on fine days and in some cases, travel has to be given up entirely.

Travel time and travel speed in each section on the project road by actual measurement are shown in Table 2.2.5.

These figures represent the average of four local investigations conducted between November, 1971 and November, 1974, which consist of 3 investigations in wet season and one investigation in dry season.

The vehicles used for the investigations were, without exception, four-wheel drive Toyota Land Cruisers. The travel time shown is exclusive of time spent to get out of muddy pools, some of which needed several hours at place. The travelling speed is 36 km/hr for the average of the entire sections.

Describing by section, the road condition between Bondo and Dulia is poor with speed of 5 to 40 km/hr, in the sections between Bangassou and Monga and between Dulia and Buta where road conditions are fairly good, vehicles may travel with speed exceeding 40 km/hr and for a short span of time, the speed may be increased even to 70 km/hr.

From the results of these surveys, it is considered that travel time during the wet season requires approximately twice as much as that required during the dry season.

Table 2.2.5 Travelling Time on Existing Road
Tableau Temps du parcours de la route de existante

	Section Tronçon	Distance Distance km	Average Speed Vitesse moyenne (km/h)	Travelling Time (hour) Temps de parcours (heure) Vehicles Véhicules	Ferry Bac (h)	Total (h)
1	Bangassou	72.4	42.3	1.71	Ndu 0.67	2.38
2	Monga	125.0	36.2	3.45	Monga 0.50	3.95
3	Bondo	59.5	29.8	2.00	Bondo 0.33	2.33
4	Likati	65.5	27.1	2.42		2.42
5	Dulia	75.5	42.6	1.77		1.77
6	Buta	88.5	32.9	2.69		2.69
7	Tele	29.8	32.8	0.91		0.91
8	Kole	77.0	39.0	1.97	Banalia 0.33	2.30
9	Banalia	79.0	35.7	2.21		2.21
10	Bengamisa	46.4	42.9	1.08		1.08
	Kisangani					
	Total	718.6	36.3	20.2	1.83	22.04

Note: Data are calculated as the average of four travelling surveys conducted between November 1971 and November 1974.

Les données sont calculées en tant que moyenne des quatre études en déplacement menées entre novembre 1971 et novembre 1974.

2.3 Analysis of Operating Costs of Vehicle

2.3.1 Method of Analysis

(1) General Description

The overall economic benefits obtainable from the improvement of the existing road include not only such direct advantages as the savings in vehicle operating costs, cut-down of transportation time, increase of driving comfortability and reduction of damages to freight but also such indirect effects as contribution to the promotion of productivity rationalization of transport planning, the development of natural resources, the expansion of the markets and so on.

These economic benefits, however, are not necessarily easy to measure in terms of money so that the vehicle operating costs and reduction of transporting time alone are usually designated as calculable objectives out of the such direct advantages. Consequently, only the vehicle operating costs are examined in this study.

As for the indirect economic effects, they were studied in the process to estimate the production increase in the influence area of the project road after it is improved.

(2) Operating Speeds by Type of Vehicle and Type of Road Surface

Prior to the calculation of vehicle operating costs an explanation is given to the aspect of operating speed by the type of vehicle and the type of road surface which constitutes a basis for the calculation.

The types of vehicle is divided into two categories of the light vehicle and the heavy vehicle based on the data obtained in the O-D survey.

The category of light vehicles consists of small trucks with loading capacity of less than two tons, land-cruisers, pick-up trucks, station wagon-type

vehicles, etc., while the category of heavy vehicles are represented by heavy trucks with loading capacity of two tons or more.

The following types of vehicle are used as the representative vehicles for the purpose of calculating the vehicle operating costs:

Table 2.3.1 Vehicle Classification

Type	Loading Capacity	Vehicle Used for Calculation of Operating Cost
Light Vehicle	Below 2 tons	TOYOTA Land-Cruiser (1.5 ton) Truck (Gasoline engine type)
Heavy Vehicle	2 tons or more	Truck (6 tons) (Gasoline used engine type)

The light vehicles are represented by TOYOTA-land cruiser and the heavy vehicles by 6-ton trucks 1/, for both of which gasoline is used as fuel.

The current conditions of the existing road and those after improvement and the operating speeds on them are as follows:

(a) The current conditions of the road without improvement is defined as the situation that the rehabilitation work on the section between Kisangani and Buta is completed and also the maintenance work is continued by the Government on the rest sections of the project road. (see Plate B, 2.1 and B, 3.1)

However, taking the content of the rehabilitation work into consideration, the operating speed is predicted slower in the wet season as the conditions of the road surface is presumably far worse than in the dry season. Therefore, the operating speeds were set respectively for both seasons,

---

Note : The average loading capacity is 1.43 tons for light vehicles
1/ and 4.90 tons for heavy vehicles, and vehicles in the most popular use are 1.5 ton trucks among light vehicles and 6 ton trucks among heavy vehicles. (See the relevant description of Table 2.2.4 in the O-D survey.)

taking into consideration of the speeds measured in four reconnaissances conducted in the period from 1971 toward the end of 1974.

Two alternative proposals of the road improvement are studied in 3.4.3.

(b) Improvement Alternative I: The first phase provides surface dressing for all sections of the project road and the second phase work will involve the asphalt concrete overlay only for the sections between Kisangani and Banalia in 1991. The design speed is 100 km/hr from Kisangani to PK 35 and 80 km/hr for all the rest portion of the project road. A new bridge is constructed over the Aruwimi River at Banalia.

(c) Improvement Alternative II: Surface dressing is provided in the first phase only for the sections between Kisangani, and Banalia and all other rest sections will be improved into a laterite road. Consideration is duly paid even to the laterite road so as to bear the traffic in all weather. Coping with the increasing volume of traffic, the second phase will undertake surface dressing for the sections between Banalia and Buta in 1993, leaving the northern sections of the route from Buta still in the improved laterite road. Facilities of ferry services on the Aruwimi River will be provided by the second, third and fourth ferries respectively in 1986, 1991 and 1997 in proportion with an increase in the traffic volume. The time required to cross the river by ferry remains as before.

Based on the foregoing assumptions the operating speeds are estimated as shown in the Table 2.3.2 by the type of road and the type of vehicle.

Table 2.3.2 Operating Speeds by Type of Road Surface

(km/h)

	Asphalt Paved Road	Improved Laterite Road	Existing Earth Road	
			Dry Season	Wet Season
Light Vehicle	75	60	40	20
Heavy Vehicle	70	55	36	18

Note: (1) The operating speeds are estimated taking into consideration the measured speeds in four reconnaissances conducted during the period 1971 - 1974. The existing earth road means the rehabilitated condition in sections between Kisangani-Buta.

(2) The operating speeds on roads of the asphalt pavement and of laterite are estimated with reference to the average speeds appeared in "Qualification of Road User Savings" by Mr. Jan de Weille, John Hopkins University Press, 1970.

(3) No difference exists between the operating speeds on the surface dressed road and the asphalt concreted road.

(3) Calculation of Vehicle Operating Costs

The vehicle operating costs are composed of such two factors, as one dependent upon the travel distance and the other subject to the travel time, which can be called the running costs and the fixed costs respectively. The running costs include expenses on fuel and oil, tire wear, maintenance and repair of vehicles, while the fixed costs include depreciation costs, labor costs of drivers and assistants and miscellaneous expenses.

These costs vary subject to the condition of the road surface, operating speed and so on. Enough reliable data and informations were not available from the trucking firms, the bus operators such as STK and OTCZ, the insurance company such as SONAS and the Customer's Office.

Therefore, the operating costs were actually calculated on the basis of the valuation and procedure suggested in Mr. Jan de Welle's book and also with reference to several recent reports on the operating costs in Zaire, but with due adjustment of the purchase price of the vehicle, gasoline, oil, tire and tube to the recent post-oil-crisis price level.

Basic data for calculation of the vehicle operating costs are shown in Table 2.3.3.

Some explanation is hereby added as to the calculation of each cost item. As far as the existing road is concerned, the calculation is made on each respective cost item with an adjustment by weighting the actual number of days of each wet and dry season.

(a) Cost of Fuel

The amount of fuel consumption depends upon such factors as the type of vehicle, the speed and the profile grade and the surface conditions of the road. The fuel consumption is quantified by each road with making reference to the relation of the fuel consumption and these factors described in Mr. Jan de Weille's book, which is calculated by multiplying a certain unit of fuel consumption which can be quantified under the specific condition of the horizontal asphalt concrete road by the coefficient of increase in fuel consumption in accordance with the grade and surface condition of each road. For these calculations values recommend by Mr. Jan de Weille are used (See Tables 2.3.4 and 2.3.5). The profile grade of roads is herewith divided into four categories, such as below 3%, between 3% and 5% and also between 5% and 7% and 7% or more.

The operating speed, which is worked out on the horizontal road in the preceeding paragraph, becomes slower as the profile grade of the road increases, and the fuel consumption is accordingly calculated on the slower speed for the road with grade.

The quantity of fuel consumption by vehicle was calculated by the following formula:

$$Fc = FRabcd \times FP \times 1/1,000$$

where: Fc = The cost of fuel to be consumed by type of vehicle (k/vehicle/km)

FRabcd = The quantity of fuel to be consumed by type of vehicle (a), by speed (b), by profile grade (c) and by type of road surface (d) (litre/1,000 km)

FP = Unit price of fuel (k/litre)

(b) Cost of Oil and Grease

The values shown in Table 2.3.6 and Table 2.3.7 which are based on the values recommended by Mr. Jan de Weille in his book. The calculation was conducted by the following formula:

$$OC = ORabd \times OP \times 1/1,100$$

where: OC = The costs of oil and grease to be consumed by type of vehicle (k/vehicle/km)

ORabd = The quantity of oil and grease to be consumed by type of vehicle (a), by speed (b), by type of road surface (c) (litre/1,000 km)

OP = Unit price of oil and grease (k/litre)

(c) Cost of Tire and Tube

The costs of tire and tube were calculated by the following formula:

$$TC = TRabd \times TP \times 1/n \times 1/1,000$$

where: TC = The costs of tire and tube to be consumed by type of vehicle (k/vehicle/km)

TRabd = The rate of consumption of tire and tube by type of vehicle (a), by speed (b) and by type of road surface (d) (%/vehicle/1,000 km/year)

TP = Unit price of tire and tube (k/vehicle)

n = Number of years of the life span of tire and tube (year)

(d) Depreciation Cost

The cost of depreciation per vehicle/km was calculated by basing on the depreciation cost shown in Table 2.3.3, the average life span and the average annual kilometerage of vehicle and using the interest rate of 10% per annum. In the calculation the depreciation cost is divided into halfs,

a half for the running costs and the other half for the fixed cost for the conveniences of the calculation because this cost is closely related to both items. The calculation was conducted by the following formula:

$$DC = (VCa - RVad) \times \frac{i \times (1 + i)^{na}}{(1 + i)^{na} - 1} \times \frac{na}{LMad}$$

where: DC = The depreciation cost by type of vehicle and by type of road surface (k/vehicle/km)

VCa = The cost of vehicle excluding the costs of tire and tube (k/vehicle)

RVad = Scrap value of vehicle by type of vehicle and by type of road surface (k/vehicle)

i = The rate of interest (10%)

na = Number of years of vehicle life span (year)

LMad = Life-span kilometerage of vehicle by type of vehicle and by type of road surface (km)

(e) Maintenance and Repairing Costs of Vehicle

The maintenance and repairing costs of vehicle appeared in the Report "Kikwit-Luluabourg Highway Economic and Engineering Feasibilisty Study" conducted by Lyon Associates Inc. in 1970-1971 are considered appropriate and were used in this calculation.

(f) Cost of Personnel

This cost is for driver and his assistant and is calculated by the following formula:

$$PE = Tad \times TVa$$

where: PE = Costs of driver and assistant of vehicle by type of vehicle (a) and by type of road surface (k/vehicle/km)

Tad = Travelling hours by type of vehicle and by type of road surface (hour/km)

TVa = Time cost of personnel by type of vehicle (k/hour). This cost includes only for a driver in the case of light vehicle, while for a driver and an assistant in the case of heavy vehicle.

(g) Cost of Insurance

As the cost of insurance of vehicle 10% of the purchased price is paid in the year when the vehicle is purchased and the amount of Z 200 is paid for the life span of the vehicle as the civil responsibility. It is calculated by the following formula:

$$IC = (VCa \times 0.10 + 20{,}000) \times \frac{1}{LMad}$$

where: IC = The insurance cost of vehicle by type of vehicle (k/vehicle/km)

VCa = The purchase cost of vehicle by type of vehicle (k/vehicle)

LMad = Life-psan kilometerage of vehicle by type of vehicle and by type of road surface (km)

(h) Overhead Cost

The overhead cost was assumed to be 10% of the total amount of the items from (a) to (g) and it was included in the fixed cost.

Table 2.3.3 Basic Data in the Caluculation of Vehicular Operating Cost

	Light Vehicle		Heavy Vehicle		
	With tax	Without tax	With tax	Without tax	
A. Costs					
(1) Purchase Price of Vehicle	3,910 Z	3,128 Z	6,990 Z	5,592 Z	
(2) Hood	-	-	400	320	
(3) Tires & Tubes	184	128.80	576	403.20	
(4) Residual Value of Vehicle					Residual value
on paved road	391	312.80	699	559.20	Pavement
on other road	196	156.40	349.50	279.60	Purchase price x 0.10
(5) Depreciation of Vehicle					Others
					Purchase price x 0.05
on paved road	3,335	2,687.40	5,315	4,309.60	Depreciation of Vehicle
on other road	3,530	2,842.80	5,664.50	4,589.20	(1) - [(2) + (3) + (4)]
(6) Fuel (Z/ℓ)	0.19	0.15	0.19	0.15	
(7) Engine Oil (Z/ℓ)	0.64	0.54	0.64	0.54	
(8) Insurance	591	568.30	899	773.10	
1) 10% of New Vehicle Price for First Year	391		699		
2) Civil Responsability for Other Years	200		200		
B. Life Time Kilometerage of Vehicle					
(1) Life Time Kilometerage of Vehicle					
on paved road	108,000 km		200,000 km		
on improved laterite road	86,400		160,000		
on existing earth road	64,800		120,000		
(2) Annual Kilometerage					
on paved road	18,000		50,000		
on improved laterite road	14,400		40,000		
on existing earth road	10,800		30,000		
(3) Years of Services	6 years		4 years		
C. Salary per Month					
(1) Driver	40 Z	38.80 Z	40 Z	38.80 Z	
(2) Assistant	-	-	24	23.28	

Source: A. The data were provided as follows:

(1) (2) & (3) from AFRIMA; (6) & (7) from Petro Zaire; and (8) from SONAS. All prices are those in November 1974.

B. The data were obtained not only through hearings at trucking agencies but also from "Tome II Justification Economiques des Programmes A Court et Moyen Terme", Febrier 1973 and "Kikwit-Luluabourg Highway Economic Engineering Feasibilisty Study Report", July 1971 by Lyon Associates, Inc.

C. The data were provided by trucking agencies such as STK and OTCS.

Table 2.3.4 Fuel Consumption (Light Vehicle)
Tableau Consommation du carburant (véhicule léger)

Speed	Basic Consumption on Paved Road	Increase of Consumption due to rise and fall (%) / Augmentation de la consommation causée par la montée et la descente (%)				Increase of consumption from paved road due to types of road surface (%) / Augmentation de la consommation des routes pavées causées par le type de surface (%)	
		under 3% of grade	Grade between 3% & 5%	Grade between 5% & 7%	Grade Steeper than 7%	Improved Laterite Road	Existing Earth Road
Vitesse	Consommation de base sur une route pavée	Pente en-dessous de 3%	Pente entre 3% et 5%	Pente entre 5% et 7%	Pente plus raide que 7%	Route latérite améliorée	Route en terre existante
(km/h)	(lit/1,000km)	(%)	(%)	(%)	(%)	(%)	(%)
20	136.1	2	11	34	66		42 [1]
25	112.7	2	11	36	72		29
30	117.4	3	11	38	77		31
35	112.5	3	11	39	80		32
40	109.6	3	11	40	82	16	32
50	110.0	4	13	39	82	17	
55	111.8	4	13	37	81	17	
60	115.3	4	13	36	80	17	
70	125.6	4	12	33	77		
75	133.2	4	12	31	76		

Source: "Quantification of Road User Savings" IBRD 1966

1) Percentage was enlarged 50% of that of dry season, taking into consideration rainy season.

Le pourcentage a été augmenté 50% sur celui de la saison sèche en tenant compte de la saison des pluies.

Table 2.3.5 Fuel Consumption (Heavy Vehicle)
Tableau Consommation du carburang (véhicule lourds)

Speed	Basic Consumption on Paved Road	Increase of Consumption due to rise and fall (%)				Increase of consumption from paved road due to types of road surface (%)	
		Augmentation de la consommation causée par la montée et la descente (%)				Augmentation de la consommation des routes pavées causées par le type de surface (%)	
		under 3% of grade	Grade between 3% & 5%	Grade between 5% & 7%	Grade Steeper than 7%	Improved Laterite Road	Existing Earth Road
Vitesse	Consommation de base sur une route pavée	Pente en-dessous de 3%	Pente entre 3% et 5%	Pente entre 5% et 7%	Pente plus raide que 7%	Route latérite améliorée	Route en terre existante
(km/h)	(lit/1,000km)	(%)	(%)	(%)	(%)	(%)	(%)
18	398.2			22	57		53[1]
20	379.7			24	59		35
25	336.7			30	63		37
30	306.8		9	37	66	21	42
35	285.5		14	40	69	22	45
36	282.4	-	15	40	69	22	45
40	273.6		19	41	70	24	48
45	261.8		23	42		25	51
55	253.5	4	33			27	54
70	262.3	11					

Source: "Quantification of Road User Savings" IBRD 1966

1) Percentage was enlarged 50% of that of dry season, taking into consideration rainy season.

Le pourcentage a été augmenté 50% sur celui de la saison sèche en tenant compte de la saison des pluies.

Table 2.3.6
Tableau

Consumption of Lubricating Materials and Tire Wear by Type of Road Surface and by Speed (Light Vehicles)

Consommation des lubrifiants et usure des pneues selon le type de surface de la route et de la vitesse (véhicules légers)

Type of Road Surface / Type de surface de la route		Paved Road / Route pavée	Improved Laterite Road / Route latérite améliorée	Existing Earth Road / Route en terre existante	
Speed / Vitesse	(km/h)	75	60	40	20
(1) Lubrication / Lubrification	(lit/1,000km)	1.3	1.8	2.3	2.5
(2) Tire (% per tire per 1,000km) / Pneu (% par penu pour 1.000km)		5.5	10.8	20.3	30.5[1)]

Source: "Quantification of Road User Savings", IBRD 1966

Note: 1) Percentage was enlarged 50% of that of dry season, taking into consideration rainy season.

Le pourcentage a été augmenté 50% sur celui de la saison sèche en tenant compte de la saison des pluies.

Table 2.3.7
Tableau

Consumption of Lubricating Materials and Tire Wear by Type of Road Surface and by Speed (Heavy Vehicles)

Consommation des lubrifiants et usure des pneus selon le type de surface de la route et de la vitesse (véhicules lourds)

Type of Road Surface / Type de surface de la route		Paved Road / Route pavée	Laterite Road / Route latérite améliorée	Existing Earth Road / Route en terre existante	
Speed / Vitesse	(km/h)	70	55	36	18
(1) Lubrication / Lubrification	(lit/1,000km)	1.8	2.5	3.8	4.3
(2) Tire (% per tire per 1,000km) / Pneu (% par pneu pour 1.000km)		8.5	17.5	38.3	57.5[1)]

Source: "Quantification of Road User Savings", IBRD 1966

Note: 1) Percentage was enlarged 50% of that of dry season, taking into consideration rainy season.

Le pourcentage a été augmenté 50% sur celui de la saison sèche en tenant compte de la saison des pluies.

(4) Vehicle Time Costs

(a) Valuation of Time Costs

Most vehicles presently operating on the existing project road are trucks of high floor, and passenger cars are limited to from the down town the vicinity of the urban areas where the road is comparatively better maintained. Thus trucks provide not only freight transportation service, but also to some extent passenger transportation although it is at the discretion of truck drivers.

Reduction of transporting time results in the benefits of freight owners and passengers too. As for the passengers, the time thus saved can be utilized in farming in most of the rural areas, it is limited in the urban areas though. As for trucking firms, the number of which is so limited. Most of them have direct contracts with the public corporations such as the ONC, the ONAFITEX, etc. and have no service for private enterprises. The local transportation fares are at the moment such expensive as the rate of 6 to 12 makutas/ton.km because of difficulties in the scheduled transport due to the unfavourable conditions of the roads and the lack of alternative modes or detour ways of transportation. In such a situation, the improvement of the road can largely result in the saving of transportation time by the scheduled trucking, and accordingly the savings in the operating costs and the time cost.

As it was quite difficult to obtain the local information on the valuation of time costs with exception of the limited data based on the Feasibility Study 1/ undertaken in the Kasai Region, so that the time cost data surveyed in Japan is adopted with some modification as follows:

As for the national income per capita, its current level of Z47.6 per annum for Zaire corresponds to 4.3% of that for Japan. It is understood that the modification of time costs only due to the differnece of national

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Note: 1/ De Leuw Cather International Inc. Etude du Génie Civil et de Praticabilité Economique Routes de Lulabourg Mbuji Mayi les Provinces du Kasai, Juin 1970.

income per capita is not appropriate for the purpose, because the attention should be paid to the difference of the value of vehicle itself between two countries as Zaire has much smaller vehicle fleets and comparatively shorter vehicle life time when comapred with Japan.

The comparison of the average population per vehicle between these two countries indicates 159 in Zaire and 5.4 in Japan, that means, the real number of vehicles in the former corresponds to 3% of that of the latter. But these data shall not easily be adopted as the reasonable value. But because the modifying factor is not clear, the time cost by vehicle type is calculated as follows, assuming the modifying factor to be half the ratio of the vehicle population of Zaire to that of Japan.

Heavy Vehicle:

Z 1.641	x	0.043	x	(1/0.03 x 1/2)	= Z 1.176/vehicle.hour
Time costs in Japan		Comparison ratio of national income per capita		Modification by vehicle population	

Light Vehicle:

Z 0.841	x	0.043	x	(1/0.03 x 1/2)	= Z 0.603/vehicle.hour
Time costs in Japan		Comparison ratio of national income per capita		Modification by vehicle population	

The examples are given in the above-mentioned study in the Kasai region for the time costs ranging from Z 0.582 to Z 0.744/vehicle.hour varied by section of the route. On the other hand, the interview with the trucking firms in Kisangani revealed a rental fee of Z 2 to Z 3/vehicle.hour. Although the hourly time cost of Z 1.18 for a heavy vehicle and Z 0.60 for

a light vehicle seem to be reasonable by taking these data above mentioned into account, such time costs may not be considered to be unconditionally appropriate for this study. Consequently, whether or not the time saving benefit should be included in the user benefit is subjected to the sensitivity analysis.

(b) Travel Time

The travel time by route section and type of road surface of the existing road and the improved road is the total of operating time calculated from the operating speed by type of road surface shown in Table 2.3.2 and the distance of each route section and in addition the necessary time for ferry operation. In the improvement Alternative I the time for ferry operation shall be replaced by that for vehicles to cross over a long bridge which is to be newly constructed across the Aruwimi River as an integral part of the proposed Alternative I. The total length of the existing road between Kisangani and Ndu, which amounts to 718.6 km, shall be reduced to 698.96 km with improvements of the existing alignment in both Alternative I and Alternative II.

The travel time for a light vehicle to run through all sections of the project road, which reaches 24.66 hours on the existing road, is reduced to 13.24 hours after Phase I is completed and to 12.62 hours after Phase II is completed in the improvement Alternative II, while it is reduced to 10.83 hours in the Alternative I. As for the heavy vehicle, similar or larger effect can be expected to reduce the time presently required of about 27.2 hours is reduced 14.2 hours saving 13 hours in the Phase I in the Alternative II and is reduced to 13.5 hours when the Phase II improvement is completed, while it is reduced to 11.5 hours in the Alternative I that the road is entirely paved in Phase I. (See Table 2.3.9.)

Table 2.3.8 Travel Time on Different Types of Road Surface

		Distance		Travel Time by Ferry Boat or Bridge	Travel Time by Type of Road-Surface					
					Light Vehicle			Heavy Vehicles		
		Existing Earth Road	Paved Road & Improved Laterite Road		Existing Earth Road	Improved Laterite Road	Paved Road	Existing Earth Road	Improved Laterite Road	Paved Road
	Kisangani	km	km	hour	hour	hour	hour	hour	hour	hour
10		46.4	44.92		1.46	0.60	0.60	1.63	0.64	0.64
	Bengamisa									
9		79.0	77.69		2.49	1.04	1.04	2.77	1.11	1.11
	Banalia			Aruwimi Riv.						
8		77.0	77.69	Ferry: 0.50	2.93	1.72	0.99	3.20	1.83	1.06
				Bridge: 0.01	(2.43)	(1.22)	(0.98)	(2.70)	(1.33)	(1.05)
	Kole									
7		29.8	28.19		0.94	0.47	0.38	1.05	0.51	0.40
	Tele									
6		88.5	86.375		2.79	1.44	1.15	3.11	1.57	1.23
	Buta									
5		75.5	74.62		2.38	1.24	0.99	2.65	1.36	1.07
	Dulia									
4		65.5	64.83		2.07	1.08	0.86	2.30	1.18	0.93
	Likati			Uele Riv.						
3		59.5	58.465	Ferry: 0.50	2.38	1.47	1.28	2.59	1.56	1.34
	Bondo			Bili Riv.	(1.88)	(0.96)	(0.78)	(2.09)	(1.06)	(0.84)
2		125.0	122.335	Ferry: 0.50	4.44	2.54	2.13	4.89	2.72	2.25
	Monga			Bomu Riv.	(3.94)	(2.04)	(1.63)	(4.39)	(2.22)	(1.75)
1		72.4	68.285	Ferry: 0.50	2.78	1.64	1.41	3.04	1.74	1.48
	Ndu				(2.28)	(1.14)	(0.91)	(2.54)	(1.24)	(0.98)
	Total	718.6	698.955		24.66	13.24	10.83	27.23	14.22	11.51

Notes: (1) Figures in parentheses do not include the time to cross rivers by ferry.

(2) In case of paved road, the travel time between Banalia and Kole shows the case of constructing a new bridge across Aruwimi River.

(3) Travelling speeds are shown in Table 2.3.2. Speeds on the existing earth road are the weighted averages of dry and wet seasons.

Table 2.3.9 Travel Time on Existing Road and Estimated Travel Time on Improved Road by Improvement Alternative (Unit: Hour/oneway)

Route Section	Distance		Existing Road		Improved Road					
					Alternative I (T=4-30)		Alternative II (T=4-13)		Alternative II (T=14-30)	
	Existing Road (km)	Improved Road (km)	Heavy Vehicle	Light Vehicle	Heavy Vehicle	Light Vehicle	Heavy Vehicle	Light Vehicle	Heavy Vehicle	Light Vehicle
#10	46.4	44.92	1.63	1.46	0.64	0.60	0.64	0.60	0.64	0.60
# 9	79.0	77.69	2.77	2.49	1.11	1.04	1.11	1.04	1.11	1.04
# 8	77.0	73.25	3.20 (2.70)	2.93 (2.43)	1.06 (1.05)	0.99 (0.98)	1.83 (1.33)	1.72 (1.22)	1.55 (1.05)	1.48 (0.98)
# 7	29.8	28.19	1.05	0.94	0.40	0.38	0.51	0.47	0.40	0.38
# 6	88.5	86.38	3.11	2.79	1.23	1.15	1.57	1.44	1.23	1.15
# 5	75.5	74.62	2.65	2.38	1.07	0.99	1.36	1.24	1.36	1.24
# 4	65.5	64.83	2.30	2.07	0.93	0.86	1.18	1.08	1.18	1.08
# 3	59.5	58.47	2.59 (2.09)	2.38 (1.88)	1.34 (0.84)	1.28 (0.78)	1.56 (1.06)	1.47 (0.97)	1.56 (1.06)	1.47 (0.97)
# 2	125.0	122.33	4.89 (4.39)	4.44 (3.94)	2.25 (1.75)	2.13 (1.63)	2.72 (2.22)	2.54 (2.04)	2.72 (2.22)	2.54 (2.04)
# 1	72.4	68.28	3.04 (2.54)	2.78 (2.28)	1.48 (0.98)	1.41 (0.91)	1.74 (1.24)	1.64 (1.14)	1.74 (1.24)	1.64 (1.14)
Total	718.6	698.96	27.23	24.66	11.51	10.83	14.22	13.24	13.49	12.62

Note: (1) T is the year counting 1979, when the construction is expected to start, as the zero year; and the paving of the route sections #6, #7 and #8 is completed in T=14.

(2) Light vehicle means passenger car and pick-up truck.

(3) Heavy vehicle means heavy truck and bus.

(4) Figures in parentheses are such time excluding to cross rivers by bridge in Alternative I and by ferry in Alternative II.

2.3.2 Results of Analysis

(1) Operating Costs

(a) Vehicle Operating Costs per Kilometer

Taking all such cost items into account, the operating costs per km are shown in Table 2.3.10 and Table 2.3.11(1) by type of vehicle and surface of the road. As far as the existing road concerns, the costs for the wet and dry seasons are claculated first, and the average vehicle operating costs is calculated as the weighted average by number of wet and dry days of a year.

In the economic evaluation of the project the operating costs are also shadow priced and exclude taxes, which means the transfer of the costs from the road bearing users to the national budget and results in the reduction of benefits or costs in the national economy. Consequently, the calculation of the vehicle operating costs is made entirely free from duties, local taxes, levies on vehicles.

(b) Vehicle Operating Costs by Route Section

Operating costs by route section are worked out by multiplying the operating costs per kilometer shown in the Table 2.3.10, 2.3.11(1) and 2.3.11(2) for each type of road surface by the length of the route sections by profile grade respectively. The accumulated length of the laterite and asphalt concrete roads would be shortened from the original length of the existing route through improving its alignment. The vehicle operating costs by section and road surface are shown in the Tables 2.3.12, 2.3.13 and 2.3.14 in which the amount of savings in the operating costs through the improvement of road surface are indicated in parenthesis.

(2) Savings of Travel Time

Estimated time and time cost to be served by road improvement are shown in the table 2.3.16.

Table 2.3.10 Operating Costs by Type of Vehicle and Road Surface (k/km.vehicle)

Type of Vehicles	Light Vehicles															
Road Surface	Paved Road				Improved Laterite Road				Existing Earth Road							
									Dry Season				Wet Season			
Road Grade	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Operating Speed (km/h)	75	70	60	50	60	55	50	40	40	35	30	25	20	20	20	20
Operating Costs																
1. Running Costs																
(1) Fuel Consumption	2.08	2.11	2.35	3.00	2.10	2.22	2.68	3.47	2.24	2.47	3.18	3.75	2.96	3.22	3.89	4.81
(2) Engine Oil	0.07				0.10				0.12				0.14			
(3) Tire Wear	0.18				0.35				0.65				0.98			
(4) Maintenance	1.88				2.60				4.00				4.00			
(5) Depreciation & Int.	1.75				2.32				3.09				3.09			
Sub Total	5.96	5.99	6.23	6.88	7.47	7.59	8.05	8.84	10.10 (10.55)	10.33 (10.79)	11.04 (11.49)	11.61 (12.20)	11.17	11.43	12.10	13.02
2. Fixed Costs																
(1) Depreciation & Int.	1.75				2.32				3.09				3.09			
(2) Insurance	0.47				0.59				0.78				0.78			
(3) Driver's Wage	0.37				0.46				0.69				1.39			
(4) Overhead	0.86	0.86	0.88	0.95	1.08	1.10	1.14	1.22	1.47	1.49	1.56	1.62	1.64	1.67	1.74	1.83
Sub Total	3.45	3.45	3.47	3.54	4.45	4.47	4.51	4.59	6.03 (6.39)	6.05 (6.41)	6.12 (6.48)	6.18 (6.56)	6.90	6.92	7.00	7.09
Total (1 + 2)	9.41	9.44	9.70	10.42	11.92	12.06	12.56	13.43	16.13 (16.94)	16.38 (17.20)	17.16 (17.97)	17.79 (18.76)	18.07	18.36	19.10	20.11

Note: (1) I : under 3% of grade

(2) II : grade between 3% and 5%

(3) III : grade between 5% and 7%

(4) IV : grade steeper than 7%

(5) As for the length and the distribution of profile grades by road section on the existing road and the improved road. See Table 3.4.2-(2)

(6) Figures in parentheses are the weighted averages, taking into consideration the ratio of number of days of dry season against wet season as 0.583:0.417.

Table 2.3.11-(1) Operating Costs by Type of Vehicle and Road Surface (k/km.vehicle)

Type of Vehicles	Heavy Vehicles															
Road Surface	Paved Road				Improved Laterite Road				Existing Earth Road							
									Dray Season				Wet Season			
Road Grade	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Operating Speeds (km/hr)	75	70	60	50	60	55	50	40	40	35	30	25	20	20	20	20
Operating Costs																
1. Running Costs																
(1) Fuel Consumption	4.37	5.06	5.58	7.24	5.02	6.04	7.31	9.24	6.14	7.12	9.00	12.23	9.14	9.14	11.15	14.35
(2) Engine Oil	0.10				0.14				0.21				0.23			
(3) Tire Weare	0.57				1.18				2.57				3.86			
(4) Maintenance	2.27				3.41				5.68				5.68			
(5) Depreciation & Int.	1.44				1.91				2.55				2.55			
Sub Total	8.75	9.44	9.96	11.62	11.66	12.68	13.95	15.88	17.15 (18.95)	18.13 (19.52)	20.01 (21.46)	23.24 (24.67)	21.46	21.46	23.47	26.67
2. Fixed Costs																
(1) Depreciation & Int.	1.44				1.91				2.55				2.55			
(2) Insurance	0.39				0.48				0.64				0.64			
(3) Driver's Wage	0.63				0.80				1.23				2.46			
(4) Overhead	1.12	1.19	1.24	1.41	1.49	1.59	1.71	1.91	2.16	2.26	2.44	2.77	2.71	2.71	2.91	3.23
Sub Total	3.58	3.65	3.70	3.87	4.68	4.78	4.90	5.10	6.58 (7.32)	6.68 (7.38)	6.86 (7.57)	7.19 (7.89)	8.36	8.36	8.56	8.88
Total (1 + 2)	12.33	13.09	13.66	15.49	16.34	17.46	18.85	20.98	23.73 (26.27)	24.81 (26.90)	26.87 (29.03)	30.43 (32.56)	29.82	29.82	32.02	35.55

Note: (1) I : under 3% of grade

(2) II : grade between 3% and 5%

(3) III : grade between 5% and 7%

(4) IV : grade steeper than 7%

(5) As for the length and the distribution of profile grades on the existing road and the improved road. See Table 3.4.2-(2)

(6) Figure in parentheses are the weighted averages, taking into consideration the ratio of number of days of dry season against wet season as 0.583:0.417.

Table 2.3.11-(2) Length and Distribution of Profile Grades by Section on Existing Road and Improved Road

Section	Distance (km)		Existing Road (km)				Improved Road (km)			
	Existing Road	Improved Road	< 3%	3 - 5%	5 - 7%	7% <	< 3%	3 - 5%	5 - 7%	7% <
#10	46.4	44.92	43.2	1.9	0.9	0.4	41.72	3.2	-	-
# 9	79.0	77.69	68.5	4.9	3.4	2.2	67.19	10.5	-	-
# 8	77.0	73.26	74.9	1.9	0.2	-	71.19	2.07	-	-
# 7	29.8	28.19	29.6	0.2	-	-	27.99	0.2	-	-
# 6	88.5	86.37	86.4	1.6	0.5	-	84.27	2.1	-	-
# 5	75.5	74.62	72.45	1.4	1.05	0.6	71.57	3.05	-	-
# 4	65.5	64.83	63.69	0.36	0.95	0.5	63.02	1.81	-	-
# 3	59.5	58.46	55.3	4.2	-	-	54.26	4.2	-	-
# 2	125.0	122.34	105.6	15.65	3.3	0.45	102.94	19.4	-	-
# 1	72.4	68.28	61.15	6.9	1.85	2.5	57.03	11.25	-	-
Total	718.6	698.96	660.79	39.01	12.15	6.65	641.18	57.78	-	-
			(92.0%)	(5.4%)	(1.7%)	(0.9%)	(92.0%)	(8.0%)	(0%)	(0%)

Note: In the improved road the length and the distribution of profile grades are same in both alternatives I and II.

Table 2.3.12
Tableau

Operating Costs by Section & by Type of Vehicle
(Existing Earth Road)

Coûts du fonctionnement par tronçon et par type de véhicule
(Route en terre existante)

(Unit / Unité : Makuta)

	Section / Tronçon	Distance / Distance	Light Vehicle / Véhicule léger			Heavy Vehicle / Véhicule lourd		
			Running Costs / Coûts de l'exploitation	Fixed Costs / Prix fixé	Total	Running Costs / Coûts de l'exploitation	Fixed Costs / Prix fixé	Total
		km						
10	Kisangani	46.4	491.5	296.6	788.1	884.9	340.2	1,225.1
9	Bengamisa	79.0	841.5	505.5	1,347.0	1,521.0	580.7	2,101.7
8	Banalia	77.0	813.0	492.0	1,305.0	1,460.8	563.8	2,024.6
7	Kole	29.8	314.5	190.4	504.9	564.8	218.2	783.0
6	Tele	88.5	934.5	565.6	1,500.1	1,679.2	648.0	2,327.2
5	Buta	75.5	798.8	482.7	1,281.5	1,437.5	553.2	1,990.7
4	Dulia	65.5	692.8	418.8	1,111.6	1,246.6	479.9	1,726.5
3	Likati	59.5	628.7	380.3	1,009.0	1,129.9	435.8	1,565.7
2	Bondo	125.0	1,326.4	799.5	2,125.9	2,388.5	917.1	3,305.6
1	Monga	72.4	771.4	463.3	1,234.7	1,394.9	532.2	1,927.1
	Bangassou							
	Total	718.6	7,613.1	4,594.7	12,207.8	13,708.1	5,269.1	18,977.2

Table 2.3.13 Operating Costs by Section & by Type of Vehicle
Alternative II (T = 4 - 30)

(unit: Makuta)

Section	Distance km	Light Vehicle			Heavy Vehicle		
		Running Costs	Fixed Costs	Total	Running Costs	Fixed Costs	Total
Kisangani							
	44.92	267.9	155.0	422.9	395.3	161.1	556.4
Bengamisa		(223.6)	(141.6)	(365.2)	(489.6)	(179.1)	(668.7)
	77.69	463.4	268.0	731.4	687.0	278.8	965.8
Banalia		(378.1)	(237.5)	(615.6)	(534.0)	(301.9)	(1,135.9)
	73.885	440.4	254.9	675.3	648.0	264.8	912.8
Kole		(372.6)	(237.1)	(609.7)	(812.8)	(299.0)	(1,111.8)
	28.19	168.0	97.3	265.3	246.8	100.9	347.7
Tele		(146.5)	(93.1)	(239.6)	(318.0)	(117.3)	(435.3)
	86.375	514.9	298.0	812.9	757.2	309.4	1,066.6
Buta		(418.6)	(267.6)	(687.2)	(922.0)	(308.6)	(1,260.6)
	74.62	444.9	257.4	702.3	655.0	267.3	922.3
Dulia		(353.9)	(229.3)	(579.2)	(782.5)	(285.9)	(1,068.4)
	64.83	386.4	223.7	610.1	568.5	232.2	800.7
Likati		(306.4)	(195.1)	(501.5)	(678.1)	(247.7)	(925.8)
	58.465	348.6	201.7	550.3	514.4	209.6	724.0
Bondo		(280.1)	(178.6)	(458.7)	(615.5)	(226.2)	(841.7)
	122.335	729.7	422.1	1,151.8	1,083.8	439.3	1,523.1
Monga		(596.7)	(377.4)	(974.1)	(1,304.7)	(477.8)	(1,782.5)
	68.285	407.4	235.6	643.0	605.3	245.3	850.6
Bangassou		(364.0)	(227.7)	(591.7)	(787.6)	(286.9)	(1,076.5)
Total	699.595	4,171.6	2,413.7	6,585.3	6,161.3	2,508.7	8,670.0

Note: (1) This is the case of the improvement alternative I in which the entire route is paved in Phase I. Overlaying the pavement in later year does not influence on the operating speed and the operating cost. At Aruwimi River the existing ferry is replaced with a 2-laned highway bridge, accordingly, the distance of the section #8 includes the bridge length of Aruwimi River.

(2) Figures in parenthesis indicate the savings against the existing earth road.

(3) T is the year counting 1979, when the construction is expected to start, as the zero year; consequently, the improved road is opened for traffic in the year T = 4.

Table 2.3.14 Operating Costs by Section & by Type of Vehicle
Alternative II (T = 4 - 14)

(Unit: Makuta)

	Section	Distance km	Light Vehicle			Heavy Vehicle		
			Running Costs	Fixed Costs	Total	Running Costs	Fixed Costs	Total
	Kisangani							
10		44.92	267.9	155.0	422.9	395.3	161.1	556.4
	Bengamisa		(223.6)	(141.6)	(365.2)	(489.6)	(179.1)	(668.7)
9		77.69	463.4	268.0	731.4	687.0	278.0	965.8
	Banalia		(378.1)	(237.5)	(615.6)	(834.0)	(301.9)	(1,135.9)
8		73.245	547.4	326.0	873.4	856.1	343.0	1,199.1
	Kole		(265.6)	(166.0)	(431.6)	(604.7)	(220.8)	(825.5)
7		28.19	210.6	125.5	336.1	328.9	132.0	460.9
	Tele		(103.9)	(64.9)	(168.8)	(235.9)	(86.2)	(322.1)
6		86.375	645.4	384.4	1,029.8	1,009.2	404.4	1,413.6
	Buta		(289.1)	(181.2)	(470.3)	(670.0)	(243.6)	(913.6)
5		74.62	557.7	332.1	889.8	873.2	349.5	1,222.7
	Dulia		(241.1)	(150.6)	(391.7)	(564.3)	(203.7)	(768.4)
4		64.83	484.5	288.6	773.1	757.8	303.6	1,061.4
	Likati		(208.3)	(130.2)	(338.5)	(488.8)	(176.3)	(665.1)
3		58.465	437.3	260.3	697.6	686.0	274.1	960.1
	Bondo		(191.4)	(120.0)	(311.4)	(443.9)	(101.7)	(605.6)
2		122.335	916.1	544.8	1,460.9	1,446.2	574.4	2,020.6
	Monga		(410.3)	(254.7)	(665.0)	(492.3)	(342.7)	(1,285.0)
1		68.285	511.5	304.1	815.6	807.7	320.7	1,128.4
	Bangassou		(259.9)	(159.2)	(419.1)	(587.2)	(211.7)	(798.9)
	Total	698.955	5,041.8	2,988.8	8,030.6	7,847.4	3,141.6	10,989.0
			(2,571.3)	(1,605.9)	(4,177.2)	(5,860.7)	(2,127.5)	(7,988.2)

Note: (1) This is the case of the improvement alternative II - Phase I and only the sections #10 and #9 are paved as some as in Alternative I and the rest sections are in improved laterite road. The existing ferry at Aruwimi River is still in service.

(2) Figures in parenthesis indicate the savings against the existing earth road.

(3) T is the year counting 1979, when the construction is expected to start, as the zero year; consequently, the improved road is opened for traffic in the year T = 4.

Table 2.3.15 Operating Costs by Section and by Type of Vehicle
Alternative II (T = 15 - 30)

(Unit: K/vehicle)

Road Section		Distance (km)	Light Vehicle			Heavy Vehicle		
			Running Costs	Fixed Costs	Total	Running Costs	Fixed Costs	Total
	Kisangani							
#10	Bengamisa	44.92	267.9 (223.6)	155.0 (141.6)	422.9 (365.2)	359.3 (489.6)	161.1 (179.1)	556.4 (668.7)
# 9	Banalia	77.69	463.4 (378.1)	268.0 (237.5)	731.4 (615.6)	687.0 (834.0)	278.8 (301.9)	965.8 (1,135.9)
# 8	Kole	73.24	436.6 (376.4)	242.7 (239.3)	689.3 (615.7)	642.4 (818.4)	262.5 (301.3)	904.9 (1,119.7)
# 7	Tele	28.19	168.0 (146.5)	97.3 (93.1)	265.3 (249.6)	246.8 (318.0)	100.9 (117.3)	347.7 (435.3)
# 6	Buta	86.38	514.9 (419.6)	298.0 (267.6)	812.9 (687.2)	757.2 (922.0)	309.4 (338.6)	1,066.6 (1,260.6)
# 5	Dulia	74.62	557.7 (241.1)	332.1 (150.6)	898.8 (391.7)	873.2 (564.3)	349.5 (203.7)	1,222.7 (768.0)
# 4	Likati	64.83	484.5 (298.3)	288.6 (130.2)	773.1 (338.5)	757.8 (488.8)	303.6 (176.3)	1,061.4 (665.1)
# 3	Bondo	58.46	437.3 (191.4)	260.3 (120.0)	697.6 (311.4)	686.0 (443.9)	274.1 (161.7)	960.1 (605.6)
# 2	Monga	122.34	916.1 (410.3)	544.8 (254.7)	1,460.9 (665.0)	1,446.2 (942.3)	574.4 (342.7)	2,020.6 (1,285.0)
# 1	Ndu	68.29	511.5 (259.9)	304.1 (159.2)	815.6 (419.1)	807.7 (587.2)	320.7 (211.5)	1,128.4 (798.7)
	Total	698.96	4,757.9 (2,855.2)	2,800.9 (1,793.8)	7,558.8 (4,649.0)	7,299.6 (6,408.5)	2,935.0 (2,334.1)	10,234.6 (8,742.6)

Note: (1) This is the case of the improvement alternative II - Phase II, and the section #10, #9, #8, #7 and #6 are paved and the rest sections are all remain as an improved laterite road and also all existing ferries are still in service among which the ferry at Aruwimi is increased in number.

(2) Figures in parenthesis indicate the savings against the existing earth road.

(3) T is the year counting 1979, when the construction is expected to start, as the zero year.

Table 2.3.16 Estimated Time and Time Cost to be Saved by Road Improvement

{ Upper Figure: Saved Time in Hour/one way
(Lower Figure): Saved Time Cost in Z/vehicle/one way }

Route Section	Alternative I (T=4-30)		Alternative II (T=4-14)		Alternative II (T=15-30)	
	Heavy Vehicle	Light Vehicle	Heavy Vehicle	Light Vehicle	Heavy Vehicle	Light Vehicle
#10	0.99 (1.17)	0.86 (0.52)	0.99 (1.17)	0.86 (0.52)	0.99 (1.17)	0.86 (0.52)
# 9	1.66 (1.96)	1.45 (0.87)	1.66 (1.96)	1.45 (0.87)	1.66 (1.96)	1.45 (0.87)
# 8	2.14 (2.53)	1.94 (1.16)	1.37 (1.62)	1.21 (0.73)	1.65 (1.95)	1.45 (0.87)
# 7	0.65 (0.77)	0.56 (0.34)	0.54 (0.64)	0.47 (0.28)	0.65 (0.77)	0.56 (0.34)
# 6	1.88 (2.22)	1.64 (0.99)	1.54 (1.82)	1.35 (0.80)	1.88 (2.22)	1.64 (0.99)
# 5	1.58 (1.86)	1.39 (0.83)	1.29 (1.52)	1.14 (0.68)	1.29 (1.52)	1.14 (0.68)
# 4	1.37 (1.62)	1.21 (0.73)	1.12 (1.32)	0.99 (0.59)	1.12 (1.32)	0.99 (0.59)
# 3	1.25 (1.47)	1.10 (0.66)	1.03 (1.22)	0.91 (0.55)	1.03 (1.22)	0.91 (0.55)
# 2	2.64 (3.12)	2.31 (1.39)	2.17 (2.56)	1.90 (1.14)	2.17 (2.56)	1.90 (1.14)
# 1	1.56 (1.84)	1.37 (0.87)	1.30 (1.53)	1.14 (0.68)	1.30 (1.53)	1.14 (0.68)
Total	15.72 (18.56)	13.83 (8.36)	13.01 (15.36)	11.42 (6.84)	13.74 (16.22)	12.04 (7.22)

2.4 Traffic Estimation

2.4.1 Process of Traffic Estimation

(1) Conventional Process

If the traffic on the project road is estimated by a conventional process, the process will be as shown in Plate 2.4.1. The conventional process is explained in the following:

(i) Future Traffic by Section:

The future traffic by section is obtained by accumulating the traffic by zonal pair in each section. In this respect, the process that was adopted in this study is the same as the conventional process.

(ii) Future Zonal Pair Traffic:

The future zonal pair traffic is obtained by adjusting the present pattern of zonal pair traffic so as to coincide with future generated traffic by zone.

(iii) Future Generated Traffic:

The future generated traffic is obtained by multiplying the present generated traffic by the growth factor.

(iv) Present Generated Traffic and Present Zonal Pair Traffic:

The present generated traffic and the present zonal pair traffic are obtained through the O-D survey.

(v) Growth Factor:

The growth factor of each zone is determined by comparing the present economic status with the estimated future economic status.

(2) Reasons Why the Conventional Process Was Not Adopted in This Study

In this report the afore-mentioned conventional process was not adopted because the result of the O-D survey conducted by the survey team was not highly reliable enough to adopt the conventional process. The reasons for the low reliability of data are explained in the following:

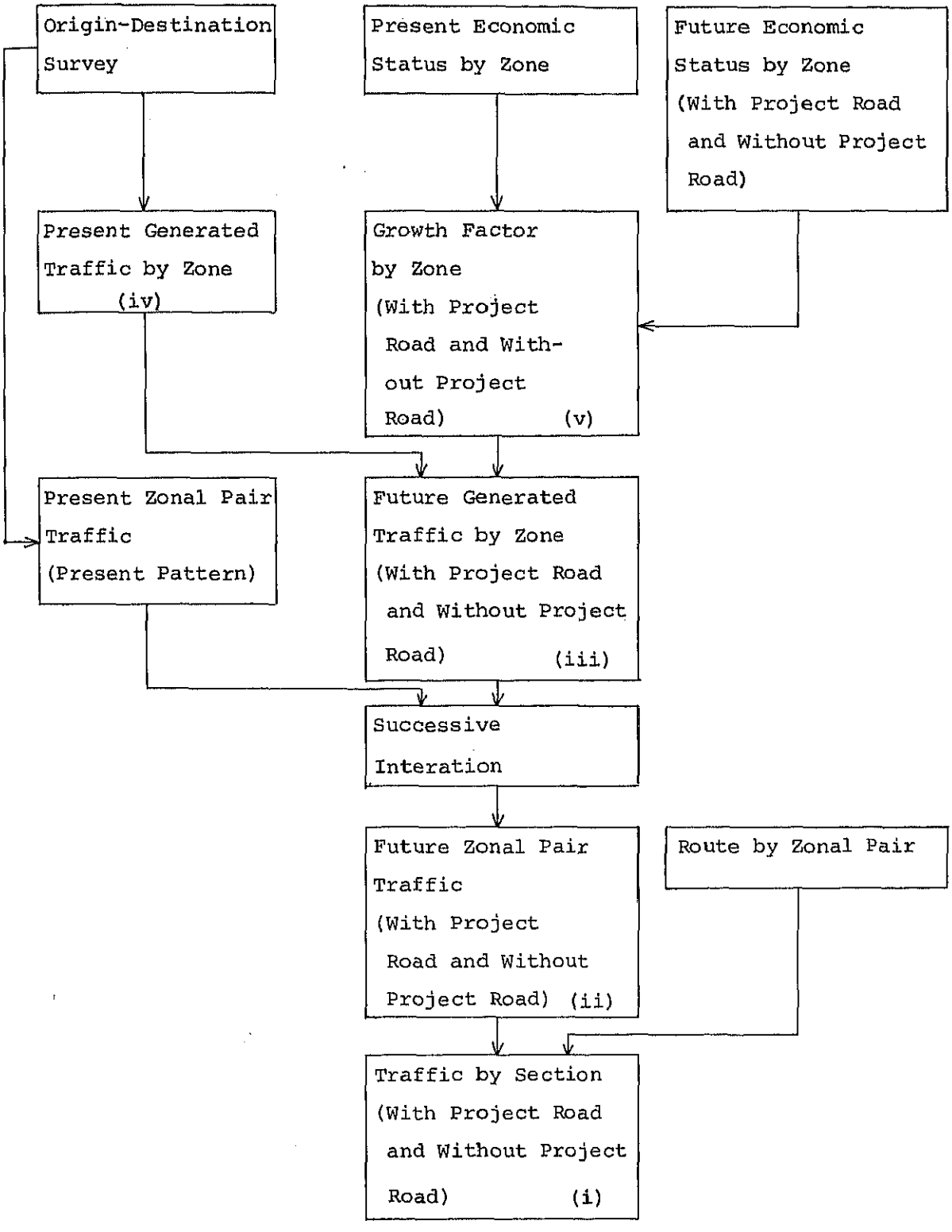
(i) O-D Survey Was Conducted in the Wet Season

Since the O-D survey was conducted in October 1974, the peak of the wet season, the truck traffic was only 20-30% of that of the dry season, and the road was impassable for passenger cars. Consequently, the results of the O-D survey collected under such unfavorable conditions are not considered to show the representative traffic pattern during the whole year. So the results of the O-D survey are not suitable to be adopted as the basis of the future traffic estimation.

(ii) Shortage of Duration for the O-D Survey

The present traffic on the project road is extremely light (See A.3.6.2). In case of conducting such a survey in a region where traffic is light, it needs a long duration for a survey to be reliable. About how many days are needed for such a survey? The necessary

Plate 2.4.1 Traffic Estimation by Conventional Process



minimum number of days is obtained through the following rough estimation.

The sampling rate of the O-D survey is generally estimated by the following formula:

$$R = \frac{1}{1 + (\frac{E}{Z})^2 \cdot \frac{N \cdot \bar{P}}{1 - \bar{P}}}$$

where: R = sampling rate, Z = normalized function,
N = number of trips, E = error,
$\bar{P}$ = average trip ratio = $\frac{1}{\text{number of zonal pairs}}$

Now let Z = 1.96, E = 0.1, N = 54,500,[1/] $\bar{P}$ = 0.077[2/] then we get,

$$R = \frac{1}{1 + (\frac{0.1}{1.96})^2 \cdot (\frac{54,500 \times 0.077}{1 - 0.077})} = 0.078$$

Accordingly, the necessary minimum number of days for the O-D survey should be at least 365 days × 0.078 = 28 days. That means, it needs at least 28 days altogether for the O-D survey for each zone pair traffic to secure its highly reliable results as the basis to be used for the future traffic estimation. And yet if these 20 days are concentrated during a continuous period, the results will be meaningless, so the O-D survey needs to be conducted at various times during the year and it was impossible for

---

Note: 1/ The number of trips observed in the wet season was about 100 vehicles and if the number of trips in the dry season is estimated to be three times of this figure, (See Table 2.2.10) then the approximate yearly number of vehicles is estimated as follow:

100 x 275 days + 300 x 90 days = 54,500 vehicles

2/ As the number of zone pairs with traffic is about 13 then, $\bar{P} = \frac{1}{13} = 0.077$ (See A.3.6.4 to A.3.6.6)

the survey team to conduct a O-D survey covering a year.

(3) Process of Traffic Estimation Adopted in This Study

The process of traffic estimation adopted in this report is referred to Plate 2.4.2 and is expressed in the following formula:

(i) Zone-Pair Traffic with the Project Road Improvement

$$DAkii' = \sum_{j} (AQij \times RADjii' \times ARNtk \times 2 \div 365) \quad \ldots\ldots \quad (2\text{-}1)$$

where: DAkii' = The daily vehicular traffic of type k between the origin zone i and the destination zone i' with the project road. (See Table 2.4.43)

AQij = The yearly production of agricultural product j in the origin zone i with project road. (See Table 2.4.26)

RADjii' = The delivery rate of agricultural product j from the origin zone i to the destination zone i' with the project road. (See Table 2.4.2 ∿ 2.4.6)

ARNtk = The conversion factor from a ton of freight to the number of vehicle of k type with the project road. (See Table 2.4.7)

In order to calculate from one way traffic to round trip traffic, the right side of formula (2-1) is multiplied by 2. And the seasonable fluctuation of traffic is not considered, because the traffic needed in the economic feasibility study is only ADT.

(ii) Zone-Pair Traffic without Project Road Improvement

$$DBkii' = \sum_{j} (BQij \times RBDjii' \times BRNtk \times 2 \div 365) \quad ..... \quad (2\text{-}2)$$

where: DBkii' = The daily vehicular traffic of type k between the origin zone i and the destination zone i' without the project road. (Table 2.4.43)

BQij = The yearly production of the agricultural product j in the origin zone i without the project road. (Table 2.4.22)

RBDjii' = The delivery rate of the agricultural product j from the origin zone i to the destination zone i' without the project road. (Table 2.4.1, 2.4.4 and 2.4.6)

BRNtk = The conversion factor from a ton of freight to the number of vehicle of type k without the project road. (Table 2.4.7)

(iii) Traffic by Section

$$DAmk = \sum_{ii'} (DAkii' \times ROUTEmii') \quad ..... \quad (2\text{-}3)$$

where: DAmk = Traffic of vehicles of type k in the section m with the project road. (Table 2.4.36)

ROUTEmii' = The dummy coefficient which is 1.0 or zero; that is the coefficient equals to 1.0 when the zone-pair traffic i - i' passes through the section m, and equals to zero when not in the case.

$$DBmk = \sum_{ii'} (DBkii' \times ROUTEmii') \quad \ldots\ldots\ldots\ldots \quad (2\text{-}4)$$

where: DBmk = Normal vehicular traffic of type k, in a section m, without the project road. (Table 2.4.36)

(iv) Developed Traffic

$$DDmk = DAmk - DBmk \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2\text{-}5)$$

where: DDmk = The developed vehicular traffic of type k, in the section m. (Table 2.4.35)

(v) Number of Passengers by Section

$$APEm = \sum_{k} (DAmk \cdot PDAk) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2\text{-}6)$$

where: APEm = The number of passengers per day passing through the section m, with the project road improvement. (Table 2.4.40)

PDAk = The average number of passengers aboard per vehicle of type k, with the project road. (Table 2.4.9)

$$BPEm = \sum_{k} (DBmk \cdot PDBk) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2\text{-}7)$$

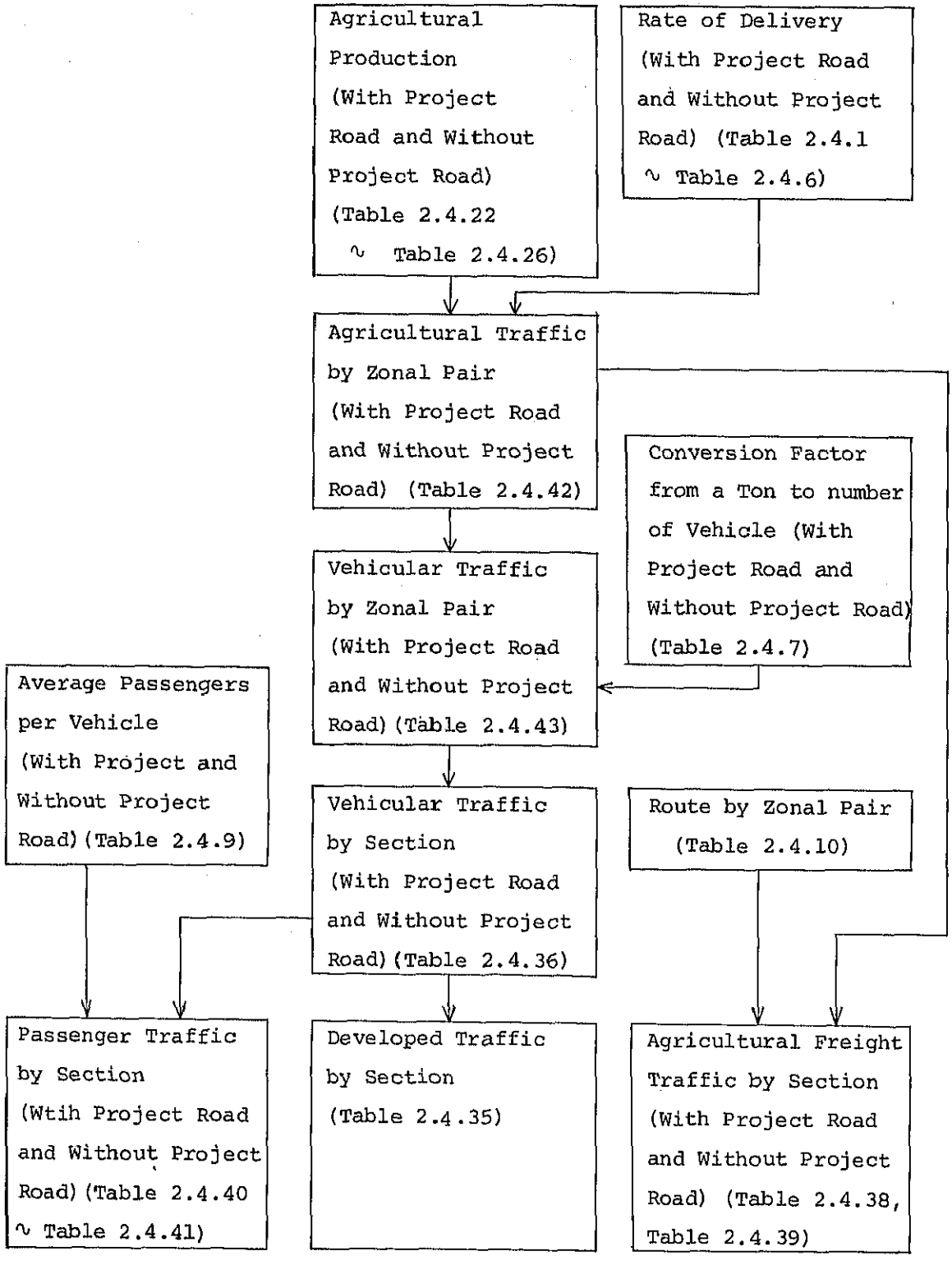
where: BPEm = The number of passengers per day passing through the section m, without the project road improvement. (Table 2.4.41)

PDBk = The average number of passengers aboard per vehicle of type k, without the project road. (Table 2.4.9)

(vi) Tonnage of Agricultural Products Passing through Each Section

$$AWGm = \sum_{ii'} \{ \sum_{j} (AQij \times RADjii' \times \frac{1}{365}) \times ROUTEmii' \} \quad \ldots\ldots \quad (2\text{-}8)$$

Plate 2.4.2 The Process of Traffic Estimation



where: AWGm = The average tonnage of agricultural products per day passing through the section m, with the project road improvement. (Table 2.4.38)

$$BWGm = \sum_{ii'} \{ \sum_{j} (AQij \times RADjii' \times \frac{1}{365}) \times ROUTEmii' \} \quad .... \quad (2\text{-}9)$$

where: BWGm = The average tonnage of agricultural products per day passing through the section m, without the project road improvement. (Table 2.4.39)

The average tonnage carried per type of vehicle utilized as a reference to estimate the future average tonnage to be carried by type of vehicle after the improvement of the road.

(4) Premises of Traffic Estimation

In order to adopt the afore-mentioned process of traffic estimation, the following premises are adopted:

(i) Any traffic diversion will not take place even if the project road is improved.
(ii) The international through traffic is neglected.
(iii) Consumptive commodities (such as beer, cement and dry goods etc.) would be carried in trucks returning to agricultural producing centers (such as Banalia) from destinations (such as Kisangani) after having delivered agricultural products and lumber. The tonnage of such commodities on their return trips is less than that of the delivering trips.
(iv) The passenger traffic follows and is proportional to the volume of freight traffic.

Each of these premises is studied as follows:

(i) Diverted Traffic

Main rivers and the CVZ Railway in the project area do not situated paralleled with the project road, but cross the project almost in right angle. Consequently, the traffic

to be diverted from rivers and the railway to the project road is hardly expected to be substantial after the opening of the project road.

(ii) International Traffic

Almost neglegible international traffic exists even now through Bangassou and is expected to increase only a little after the opening of the project road. But it is almost impossible to estimate its future growth at the present stage because such traffic demand depends heavily on the international situations and the trade policy of the countries concerned. Therefore, such an unreliable volume of international traffic is not being included in the traffic on the project road in the stage of economic evaluation of the project. However, the estimated traffic volume includes such traffic transporting local products from the influence area along the project road to Bangassou. As a result it was assumed to be the domestic traffic if the freight from Zaire to RCA is unloaded at Bangassou and to be international traffic if its destination is beyond Bangassou.

(iii) Transportation of Consumptive Commodities on Return Trips

According to the hearings conducted by the survey team at the offices of a local trucking firm, it was confirmed that the annual quantity of agricultural products delivered from the area along the project road is overwhelmingly more than that of consumptive commodities carried on their return trips although at times the situation is reversed temporarily due to monthly fluctuations. Accordingly, this premises is also considered to be reasonable.

(iv) Flow of Passengers in Relation to Flow of Agricultural Products

At the moment, there exists no commuter transportation and almost neglegible tourism traffic on the project area. It is difficult to consider the existence of passenger flow which has no relation with the economic activities of the local agriculture. If the agricultural economical level is expressed by the quantity of agricultural products delivered, the flow of passengers may follow and be in proportion to that of the quantity of local freight delivered.

(5) Delivery Rate

(i) Current Delivery Rate of Staple Foods

The present proportion of commercialized products of the staple foods (rice, corn, peanuts, cassava, sweet-potato) to the local total agricultural production is 0.01 in Bondo, 0.02 in Buta, 0.02 in Banalia and 0.04 in Aketi (See Table 2.4.20). On the other hand, according to hearings from farmers, merchants and trucking agents about the destinations of such commercialized staple foods, the following facts were revealed:

a) The commercialized staple foods produced in Bondo area is delivered equally to Bondo, Buta and Kisangani.

b) The commercialized staple foods produced in Buta area is delivered equally to the town of Buta and the City of Kisangani.

c) Almost all the total tonnage of the commercialized portion of staple foods produced in Banalia area is delivered to

the City of Kisangani.

d) Half the quantity of the commercialized portion of staple foods produced in Aketi area is delivered to town of Aketi and the rest is delivered equally to the town of Buta and the City of Kisangani.

The summary of the delivery rates of the commercialized portion of staple food products by zone is shown in Table 2.4.1.

Table 2.4.1 Current Delivery Rate of Staple Foods

Origin (zone number)	Destination (2) Bondo	(3) Buta	(5) Kisangani	(7) Aketi	Proportion of commercialized portion to the total production
(2) Bondo	0.003	0.003	0.003	0	0.01
(3) Buta	0	0.01	0.01	0	0.02
(4) Banalia	0	0	0.02	0	0.02
(7) Aketi	0	0.01	0.01	0.02	0.04

(ii) Future Delivery Rate of Staple Foods

In the case without the improvement of the project road, the current delivery rates (Table 2.4.1) are estimated to remain the same in the future, because without project road improvement, the proportion of commercialized portion of staple foods is considered to remain the same. (See Table 2.4.24)

On the other hand, if the project road is improved, the proportion of commercialized portion is considered not only

to be back to that of before the independence in five years but also receive the impact due to the project road improvement and consequently the delivery rates are estimated at 33% in Bondo, 59% in Buta, 50% in Banalia and 48% in Aketi zones in 1988 which is 5 years after the project road is opened. (See Table 2.4.26) Such delivery rates are obtained by distributing the above-mentioned proportion to each town, but it may not be distributed according to the present traffic pattern because after the opening of the project road the traffic pattern itself will change. The traffic pattern of Table 2.4.1 is distorted because of the bad conditions of the road, but after the opening of the project road the traffic pattern will be obtained by using the gravity model as following:

$$Qij = Qi \times Pj \times \frac{K}{Lij^n} \qquad \cdots\cdots\cdots\cdots\cdots \quad (2\text{-}10)$$

where: Qij = Delivery of staple foods from the zone i to the zone j. (Table 2.4.16)

Qi = Production of staple foods in the zone i.

Pj = Population in the zone j. (Table 2.4.16)

Lij = Distance between the zone i and the zone j.

K, n = Parameter

And the delivery rate is obtained by the following formula that is a variation of the gravity model.

$$Rij = Ri \times \frac{Pj/Lij^2}{\sum_j (Pj/Lij^2)} \qquad \cdots\cdots\cdots\cdots\cdots\cdots \quad (2\text{-}11)$$

where: Rij = Delivery rate from the zone i to the zone j.

Ri = Proportion of commercialized portion of staple foods to the total staple food products in the zone i.

The delivery rates in the 5th year after the opening of the

project road (1988) thus obtained by formula (2-11) are shown in Table 2.4.2.

Table 2.4.2 Delivery Rate of Staple Foods in the 5th Year after Opening of the Project Road (1988)

Origin (zone number)	Destination (2) Bondo	(3) Buta	(5) Kisangani	(7) Aketi	Proportion of commercialized portion to the total production
(2) Bondo	0.24	0.08	0.01	0	0.33
(3) Buta	0	0.55	0.04	0	0.59
(4) Banalia	0	0.02	0.48 1/	0	0.50
(7) Aketi	0	0.02	0.01	0.24	0.48

Note: 1/

$$0.48 = 0.50 \times \frac{680{,}329 \text{ inhabitants} \div 129^2\text{km}}{(680{,}329 \text{ inhabitants} \div 129^2\text{km}) + (54{,}644 \text{ inhabitants} \div 195^2\text{km})}$$

According to the hearings conducted in Banalia, about half the tonnage of the staple foods produced in Banalia Zone was delivered to Kisangani before independence.

In the 10th year after the opening of the project road, that is expected in 1993, the proportion of the commercialized portion of staple foods is considered to have increase to 38% in Bondo, 63% in Buta, 58% in Banalia and 52% in Aketi. (See Table 2.4.3 and 2.4.26). Hence the delivery rates in 19ss are shown in Table 2.4.3 obtained by formula (2-11).

Table 2.4.3 Delivery Rate of Staple Foods in the 10th Year after Opening of Project Road (1993)

Origin (zone number)	Destination (2) Bondo	(3) Buta	(5) Kisangani	(7) Aketi	Proportion of commercialized portion to the total production
(2) Bondo	0.28	0.09	0.01	0	0.38
(3) Buta	0	0.58	0.05	0	0.63
(4) Banalia	0	0.02	0.56 1/	0	0.58
(7) Aketi	0	0.02	0.01	0.49	0.52

Note: 1/

$$0.56 = 0.58 \times \frac{912{,}482 \text{ inhabitants} \div 129^2\text{km}}{(912{,}482 \text{ inhabitants} \div 129^2\text{km}) + (69{,}219 \text{ inhabitants} \div 195^2\text{km})}$$

(iii) Delivery Rate of Plantation Products

At the present plantations products, such as cotton, coffee, palm oil, rubber and cocoa, produced in the Buta zone are ultimately transported to Kinshasa, by one of two different routes. That is, the route Buta-Aketi-Bumba-Kinshasa route or, Buta-Kisangani-Kinshasa route. Comparing the two routes, the latter takes the detour route. In spite of being a longer route via Kisangani, about 40% of all freights uses this route, and particularly in the dry season the transportation via Kisangani increases. The following three facts may explain such a phenomenon in spite of the present unfavorable road conditions between Kisangani-Buta.

a) The transportation by the CVZ Railway which links Buta with Bumba via Aketi is at present not reliable, and

it is difficult to anticipate in advance the possible date of freight arrival to its destination. If the consignors have to transport commodities to Kinshasa on any appointed date, they themselves have to hire trucks to Kisangani, taking the longer but reliable route. Although the railway track reaches Bumba, commodities are transferred to river boat at Aketi to be transported to Bumba because of the shortage of locomotives; but the waterway transportation is suspended during the dry season because the Itimbili River reaching Aketi becomes too shallow to navigate.

b) The road linking Buta-Aketi-Bumba is in a worse condition than the road between Buta and Kisangani.

c) Most trucking firms have their offices in Kisangani.

The current delivery rates of plantation products are shown in Table 2.4.4.

Table 2.4.4 Current Delivery Rate of Plantation Products (1973)

Origin (Zone Number)	Destination (5) Kisangani	Destination (8) Bumba	Total
(2) Bondo	0.4	0.6	1.0
(3) Buta	0.4	0.6	1.0
(4) Banalia	1.0	0	1.0
(7) Aketi	0	1.0	1.0
(9) Bambesa	0.4	0.6	1.0
(10) Ango	0.4	0.6	1.0
(12) Poko	0.4	0.6	1.0

The delivery rates shown in Table 2.4.4 may not change even after the opening of the project road, because the CVZ Railway has an improvement plan and if the number of locomotives is increased, it will be possible to transport freight from Buta to Bumba directly without transferring to boat at Aketi. The influence relation between these two alternative transportation routes is considered to remain unchanged, because it is assumed the railway will have been improved by the time the project road is improved. However, after the opening of the project road there is a possibility that a part of the agricultural products which have been exported to the Central African Republic via Zaire River is transported through the project road via Bangassou. According to opinions by trucking firms, it was found that since coffee and palm oil are not produced in the Central African Republic, at least 10% of coffee and palm oil produced in Bondo, Buta, Aketi and Bambesa areas will be transported through the project road via Bangassou. Consequently, after the opening of the project road, the delivery rates of coffee and palm oil are estimated as shown in Table 2.4.5.

Table 2.4.5 Delivery Rates of Coffee and Palm Oil after Opening of Project Road

Origin (Zone Number)		Destination (1) Bangassou	(5) Kisangani	(8) Bumba	Total
(2)	Bondo	0.10	0.35	0.55	1.0
(3)	Buta	0.10	0.35	0.55	1.0
(4)	Banalia	0	1.00	0	1.0
(7)	Aketi	0.10	0	0.90	1.0
(9)	Bambesa	0.10	0.35	0.55	1.0
(10)	Ango	0	0.40	0.60	1.0
(12)	Poko	0	0.40	0.60	1.0

(iv) Delivery Rate of Lumber

Presently, Banalia is the only zone along the project road where lumber is produced (See 1.4.3-(2)), and the total quantity of lumber produced in Banalia Zone is transported to Kisangani by truck.

After the opening of the project road, the forestry resources of the Buta Zone is also expected to be developed (See 1.4.3-(2)), and all products are to be transported to Kisangani by truck. Consequently, the delivery rate of lumber is estimated as shown in Table 2.4.6.

Table 2.4.6 Delivery Rate of Lumber to Kisangani

Origin (Zone Number)	Without Project Road Improvement	With Project Road Improvement
(3) Buta	0	1.0
(4) Banalia	1.0	1.0

(6) Conversion Factors from a Ton of Freight into Number of Vehicles

The conversion factors from the freight tonnage into the number of vehicles used in the afore-mentioned formula (2-1) and (2-2) are shown in Table 2.4.7.

Table 2.4.7 Conversion Factors from a Ton of Freight into Number of Vehicles by Type of Vehicle

Case	Year	Conversion Factors		
		Heavy Truck (k = 1)	Light Vehicle (k = 2)	Buses (k = 3)
(BRNtk) Without Road Improvement	t = 4	0.30	0.48	0
	t = 8	0.30	0.48	0
	t = 13	0.30	0.48	0
	t = 23	0.30	0.48	0
(ARNtk) With Road Improvement	t = 4	0.22	0.48	0.011
	t = 8	0.22	0.57	0.031
	t = 13	0.22	0.65	0.051
	t = 23	0.22	0.88	0.088

Note: t means the number of years after starting the construction; accordingly it is not until t = 4, that is, in the year of 1983, that the project year is estimated to be opened for traffic. For the interim years that are not shown in this table, the trend is estimated to be linear.

(i) Conversion Factors from a Ton of Freight to Number of Heavy Trucks

As the result of the traffic survey conducted in October 1974, the average freight tonnage carried per heavy truck (above 4-tons in capacity) was 2.74-tons. (See Table 2.2.7) Consequently the number of heavy truck per ton of freight is presently 0.36.

On the other hand, the average freight tonnage of 2.74-tons

per heavy truck is fairly low considering that its average loading capacity is 4.9 ton, and this fact is undoubtedly due to the current unfavorable road conditions. It is estimated that the average freight tonnage to be carried per heavy truck after the opening of the project road be 3.9-ton. (See 2.3.1-(5)) Therefore, its conversion factor after the opening of the project road can be 0.26 heavy truck per ton of freight.

In fact, since about 15% of the total tonnage of freight is carried by light vehicles, then the above-mentioned conversion factors are modified as follows:

In the case without the project road improvement:

$$0.36 \times 0.85 = 0.30$$

In the case with the project road improvement:

$$0.26 \times 0.85 = 0.22$$

The modifying factor 0.85 in the calculation is obtained as follow:

$$R = \frac{AP \times AW}{(AP \times AW) + (BP \times BW)} \qquad \cdots\cdots\cdots\cdots\cdots \quad (2\text{-}12)$$

$$= \frac{25.6\% \times 2.74\text{ton}}{(25.6\% \times 2.74\text{ton}) + (13.3\% \times 0.93\text{ton})} = 0.85$$

where: R = modifying factor

AP = sharing proportion of heavy trucks = 25.6%
(See Table 2.2.5)

BP = sharing proportion of light vehicles = 13.3%
(See Table 2.2.5)

AW = average tonnage of pay load per heavy truck
= 2.74 tons

BW = average tonnage of pay load per light truck
= 0.93 tons

ii) Conversion Factors from a Ton of Freight to Number of Light Vehicles

The calculation process of the factors shown in Table 2.4.7 is as follows. According to the results of the traffic survey conducted in October 1974 the composition of vehicles by type is as follows:

Table 2.4.8 Sharing Proportion of Vehicles by Type Observed in Traffic Survey in October 1974

(Unit: %)

Location	Light Vehicles	Heavy Trucks	Total
Suburbs of Kisangani (Bayangana)	62.8	37.2	100
Banalia	60.0	40.0	100
Buta (Isiro Side)	64.7	35.3	100

If the weighted average of the values in the table are calculated the ratio of heavy trucks to light vehicles is 1.0:1.6. The conversion factor for light vehicle is caluculated as 0.48 by using this proportion (0.30 x 1.6 = 0.48). The value of 0.48 is not considered to decrease even after the opening of the project road, which deffers from the case of heavy trucks. This is because the average tonnage of freight per light vehicle is 0.93 ton at present, and this is estimated to be 1.00 ton even after the opening of the project road. (See 2.3.1-(5))

On the contrary, the conversion factor of 0.48 is considered to increase with the progress of agricultural development along the road after the opening of the project road, because the number of registered vehicles

increases in proportion to the increase of the local inhabitants.

Of the national total number of registered vehicles, the proportion of the number of passenger cars as compared with that of trucks has varied year by year as follows.

Proportion of the Number of Passenger Cars as Compared with that of Trucks

(The number of trucks is assumed to be 1.0.)

Year	Proportion	
1947	0.65	
1959	1.42	
1965	1.42	
1966	1.41	
1967	1.25	3.0% increase as an average annually.
1968	1.22	
1969	1.37	
1972	1.50	

Note: These proportions are calculated by the number of registered vehicles obtained from the Report Luluabourg - Mbujimayi Road Feasibility Study by Deleuw Cather & Co., 1970 and Programme Court et Mayen Terme, 1974, Office des Route.

According to this Table, the proportion of passenger cars has increase approximately 3% annually from 1967 to 1972, during which time the domestic political situation is regarded to have settled.

The present ratio of vehicles of the traffic on the project route, as mentioned before, is 1.0 of heavy trucks

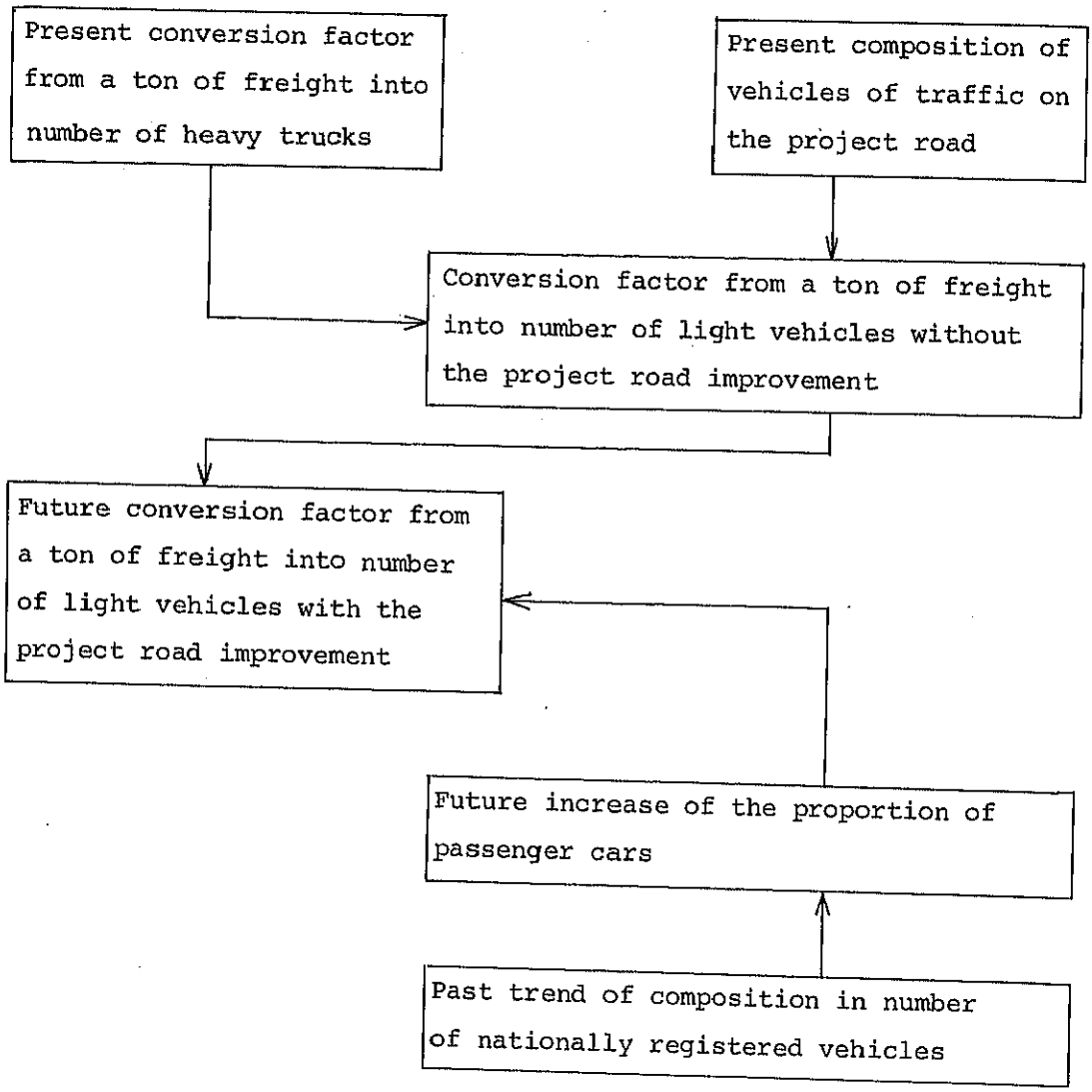
to 1.6 of light vehicles. The proportion of light vehicles is estimated to increase 3% annually when the project road is opened. Even without the project road improvement the proportion of light vehicles is expected to increase slightly, but because the poor road conditions which cause the driving difficulties for light vehicles and are considered to remain, this proportion is estimated to be constant at 1.6.

Estimated Proportion Trend of Light Vehicles as Compared with that of Heavy Trucks on the Project Road

Year	In case without project road improvement	In case with project road improvement
1983 (1st Year)	1.6	1.65
1987 (5th Year)	1.6	1.86
1992 (10th Year)	1.6	2.14
2002 (20th Year)	1.6	2.90

Accordingly, the conversion factor from a ton of freight into a number of light vehicles is obtained from Table 2.4.7, the process of which is shown in the following flow-chart:

Calculating Process to Convert Tonnage of Freight into Number of Light Vehicles



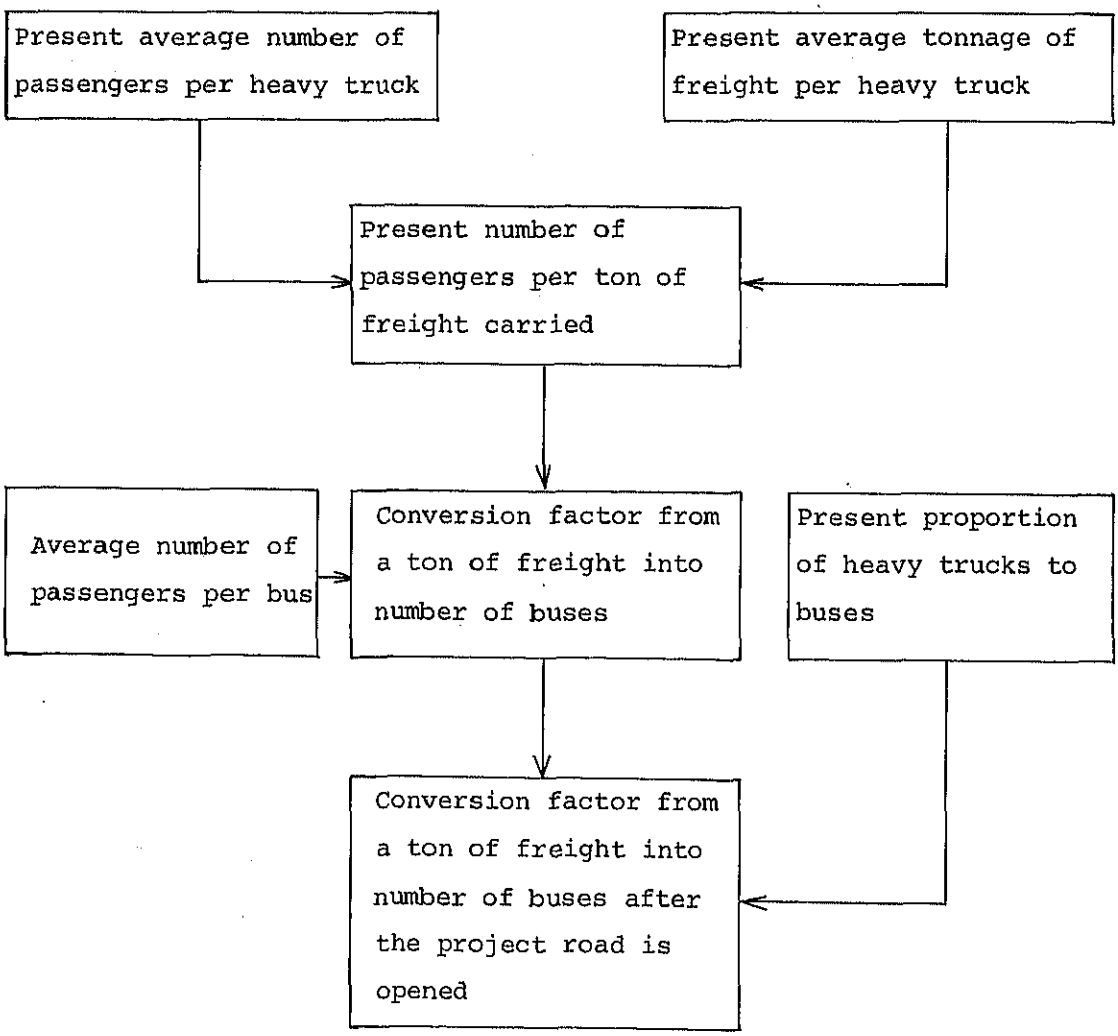
(iii) Conversion Factor from a Ton of Freight into Number of Buses

The factor to convert a ton of freight into number of buses indicated in Table 2.4.7, its calculating process is as follows:

At the present time, the average tonnage of freight per truck, as mentioned before, is 2.74 tons (Table 2.2.7), and an average of 7.2 passengers excluding drivers per truck in addition to freight are carried (Table 1.3.7); therefore 2.63 passengers per ton of freight are transported. Supposing that after the project road is opened all truck passengers transfer to buses and the average number of passengers per bus is estimated to be 30, a ton of freight moves 0.088 bus (2.63 ÷ 30 = 0.088). On the other hand, since a ton of freight is transported by 0.26 truck after the project road is opened, the proportion of heavy trucks to buses is 0.26:0.088, that is approximately 3 heavy trucks to 1 bus which means a comparatively high proportion. But at the present time at the Tshopo River check-point, in spite of the good road conditions of the section, the proportion of heavy trucks compared to buses is not more than 1.00:0.043 as the results of the traffic survey in October 1974 (Table 2.2.5). Therefore, it was assumed that a ton of freight generate the traffic of 0.088 bus in the 20th year; in other words, it is likely that all truck passengers will transfer to bus in 20 years and the trend in the intermediate years will be linear and also immediately after the opening of the project road the proportion of heavy trucks to buses is estimated 1.0:0.011 (0.088 x 0.043/0.34 = 0.011).

The above-mentioned process is shown in the following flow chart:

Calculation Process of Conversion Factor from Tonnage of Freight into Number of Buses



(7) Average Number of Passengers per Vehicle

The average number of passengers per vehicle (PDAk and PDBk) used in the formula (2.6) is shown in Table 2.4.9.

Table 2.4.9 Average Number of Passengers per Vehicle

(unit: Passengers/vehicle)

Case	Type of Vehicle (k)		
	Heavy Truck (k = 1)	Light Vehicle (k = 2)	Bus (k = 3)
Without project road improvement (PDBk)	(a) 7.2	(a) 3.4	(b) 0
With project road improvement (PDAk)	(c) 10.0	(d) 3.4	(e) 30

The process of calculation is explained as follows:

(a) The average number of passengers per heavy truck is 7.2 and that of light vehicle is 3.4 without the project road improvement are obtained by the results of the survey in October 1974.

(b) The number of passengers per bus without the project road improvement is estimated to be zero since there exists no long-distance bus service on the project road at present.

(c) The average 10 passengers per heavy truck with the project road improvement is obtained by the following formula:

$$PDA = PDB \times \frac{BRN}{ARN} = 10.0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2\text{-}13)$$

where: PDA = Average number of passengers per heavy truck with the project road improvement.

PDB = Average number of passengers per heavy truck without the project road improvement

= 7.2

BRN = Conversion factor from a ton of freight into number of heavy trucks without the project road improvement
= 0.30 (See Table 2.4.7)

ARN = Conversion factor from a ton of freight into number of heavy trucks with the project road improvement
= 0.22 (See Table 2.4.7)

The formula (2-13) means, after all, that the number of passengers increases in inversely proportionate to the decrease of the number of heavy trucks due to the increase of average pay load per truck. Ten passengers per truck obtained here are considered to transfer to bus gradually year by year, therefore, it become zero after 20 years. But in calculating the number of passengers by route section it was estimated to be zero passenger per bus and 10 passengers per truck because the transition of the type of vehicle has no effect on the number of passengers.

(d) An average of 3.4 passengers per light vehicle with the project road improvement was assumed to remain the same in that without the project road improvement.

(e) The average number of passengers per bus with the project road improvement is assumed to be 30 (See Table 2.4.9).

(8) Route Sections to Pass through

The dummy coefficient ROUTEmii' in the formula (2-3) for the zone-pair traffic is obtained by the routing list of Table 2.4.10(a). The zone numbers are shown in Plate 2.4.3.

Table 2.4.10(a) Routing by Zone Pair

ROUTEii'

Origin Zone i	Destination Zone i'		
	01 Bangassou	05 Kisangani	03 Buta
02 Bondo	01, 02	03, 04, 05, 06, 07, 08, 09, 10	03, 04, 05
03 Buta	01, 02, 03, 04, 05	06, 07, 08, 09, 10	X
04 Banalia	01, 02, 03, 04, 05, 06, 07, 08	09, 10	05, 06, 07, 08
05 Kisangani	01, 02, 03, 04,05 06,07,08,09,10	X	X
07 Aketi	01, 02, 03, 04	05, 06, 07, 08 09, 10	05
09 Bambesa	01, 02, 03, 04,05	06, 07, 08, 09,10	X
10 Ango	01, 02, 03, 04,05	06, 07, 08, 09,10	X
12 Poko	01, 02, 03, 04,05	06, 07, 08, 09,10	X

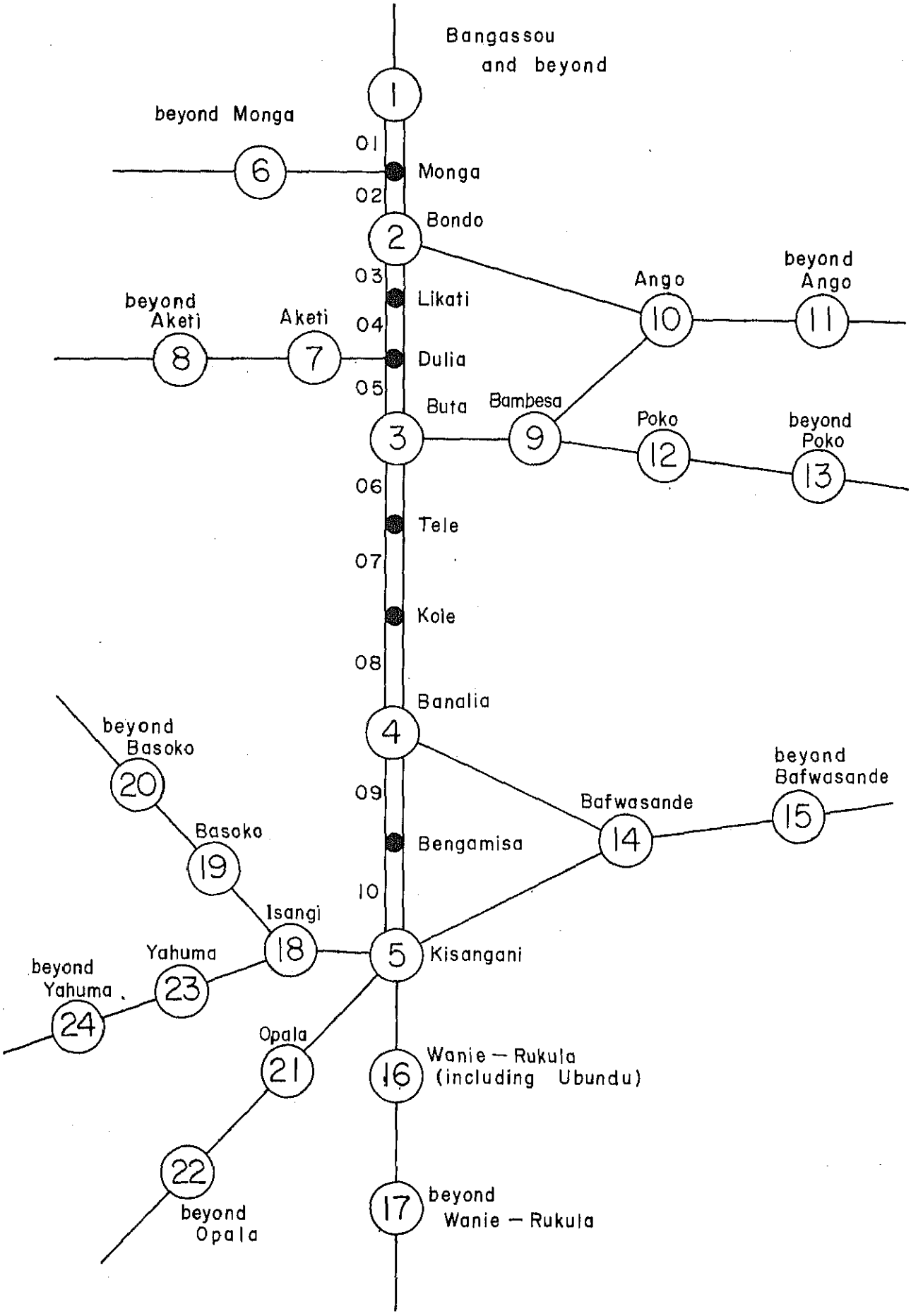
This table shows that for example in case of transportation from Aketi to Kisangani, the route passes through the zones 05, 06, 07, 08, 09 and 10.

PLATE 2.4.3

Zone Number & Road Section Number

PLANCHE 2.4.3

Numéro de zone et tronçons (de la Route)



(9) Present Loading Factors and their Future Aspects

The improvement of the project road brings about the increase of the loading factors of truck in addition to the reduction in the travel distance and the travel time, and also savings in the vehicular operating cost. This increase in the loading factors is attained by the reasonable transport planning taking into the consideration the road conditions and the weather and also transferring passengers gradually from trucks to route buses.

Trucks larger than existing ones are not considered to be introduced due to the road improvement except the large trailers to carry logs and lumber which is possibly to be introduced after existing bridges are all replaced with the stronger bridges. Consequently, the loading capacities of truck are considered not to differ from the existing ones.

The average loading factors of existing trucks are found to be 65% in the case of light vehicles and 55.9% in the case of heavy vehicles according to the O-D survey data. The future average loading factors are estimated as 70% in the case of light vehicles and 80% in the case of heavy vehicles after careful analysis of the present average loading factors (See Table 2.4.10(b))

As for the bus transport services there exists presently no regular route bus service between towns on the project road except those urban bus transport services presently existing in Kisangani and Buta; consequently, passengers intending to travel from town to town have to utilize truck transport service irregularly operated on the project road. Viewing from the international nature of the project road and the fact that the Vici-Zaire Railroad provided the bus transport services between towns on the existing road before the independence

it is proposed to resume the bus transport services between towns on the project road when it is opened.

The average size of buses to be used on the project road is estimated to be of the medium type of 30 in seating capacity viewing from the efficient utilization of vehicles and the fact that the long distance passengers are not many as those of the urban ones.

Table 2.4.10(b) Loading Capacity, Average Tonnage Carried and Loading Factor by Type of Vehicles

	Light Vehicles			Heavy Vehicles		
	Average Tonnage Carried	Loading Capacity	Loading Factor	Average Tonnage Carried	Loading Capacity	Loading Factor
	(ton)	(ton)	(%)	(ton)	(ton)	(%)
Existing Project Road	0.93	1.43	65.0	2.74	4.94	55.9
Project Road after improvement	1.00	1.43	70.0	3.92	4.00	80.0

Note: Values for the existing project road are the results of O-D Survey conducted by the survey team.

Values for the project road after the improvement were set taking into consideration the following data:

		Vehicle Types[1/]			
		Less than 2.5 tons (1.0)	2.0-5.0 tons (3.5)	5.0-7.5 tons (6.25)	More than 7.5 tons
Average Tonnage Carried	Commercial	0.6	2.3	5.9	10.2
	Private	0.4-0.5	1.9-2.0	4.8-5.4	9.4
Average Loading[2/] Factor (%)	Commercial	60	66	94	-
	Private	40-50	54-57	77-86	-

Note: 1/ The values in parentheses are thouse set for the representative type of the group.

2/ Average loading factor = $\frac{\text{Average tonnage carried}}{\text{Loading capacity of representative vehicle}} \times 100\%$

Source: Research Center on Transportation Economy, Japan
Study on Commodity Districution in Urban Area, March 1972

2.4.2 Estimate of Future Production in Agricultural and Forestry Products

(1) Influence Area and Basic Process of Estimation

The types of product to be estimated are agricultural food products, agricultural cash products, and forestry products; but because the extent of the influence on the production is different in each category of crops, then the influence area by type of product is delimited as follow:

The influence area for agricultural food products

The area is delimited in a belt zone along the project road, 20 km wide on each side of the project road, being 40 km wide altogether. Because food products can bear only a small amount of the transportation cost to markets, the extent of influence of the project road is extremely limited unless its existing feeder foads area rehabilitated simultaneously. The width on each side of 20 km was selected because of the fact that food products are carried by man-power from farms to the transportation route or markets and also it is generally said that the distance to be carried on foot is 20 km as a maximum.

The influence area for agricultural cash products

The area is delimited in the whole project area. It is because of the facts that those cash products are destined to Kinshasa, consequently, such products can bear considerably high transportation costs. So they are transported by large trucks to overcome the difficulties on the deteriorated roads.