No. 4

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
RECONSTRUCTING THE BEPOSO BRIDGE
IN
THE REPUBLIC OF GAHNA

MARCH, 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of Ghana, the Government of Japan has decided to conduct a Basic Design Study on the Project for Reconstructing the Beposo Bridge and entrusted the study to the Japan International Cooperation Agency (JICA).

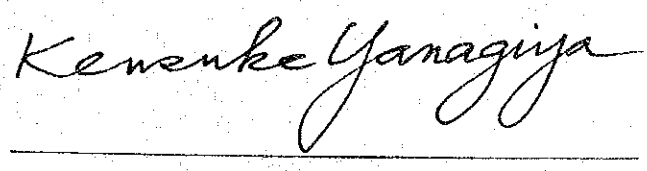
JICA sent to Ghana a survey team headed by Mr. Masahiko MURASATO, Head of Structural Engineering Section, Nagoya Construction Bureau of Japan Highway Public Corporation, from 24 September to 23 October (Phase I) and 3 to 23 December, 1988 (Phase II).

The team exchanged views with the officials concerned of the Government of Ghana and conducted a field survey in Western Region. After the team returned to Japan, further studies were made. Then, a mission was sent to Ghana in order to discuss the draft final report and the present report has been prepared.

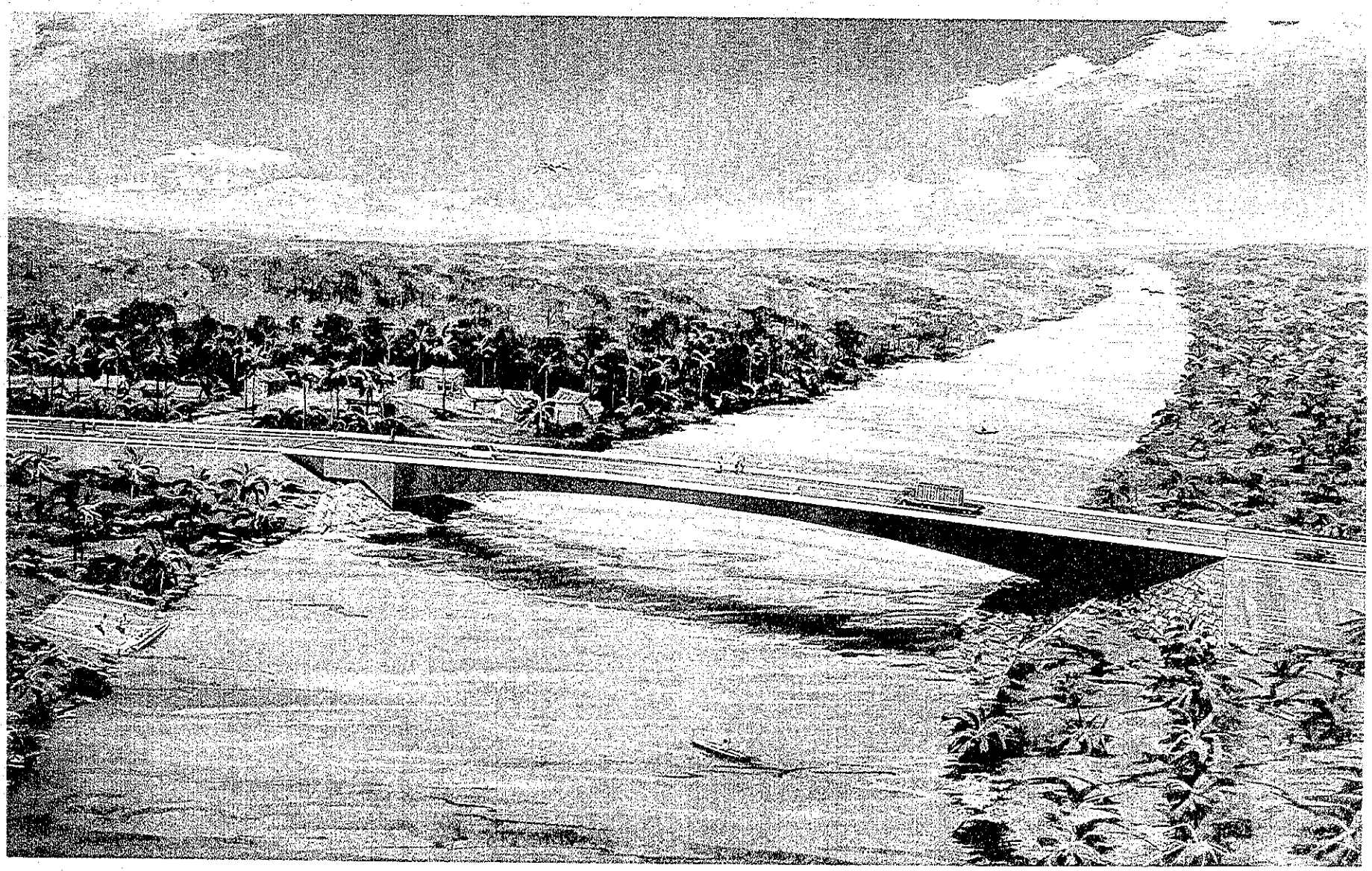
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

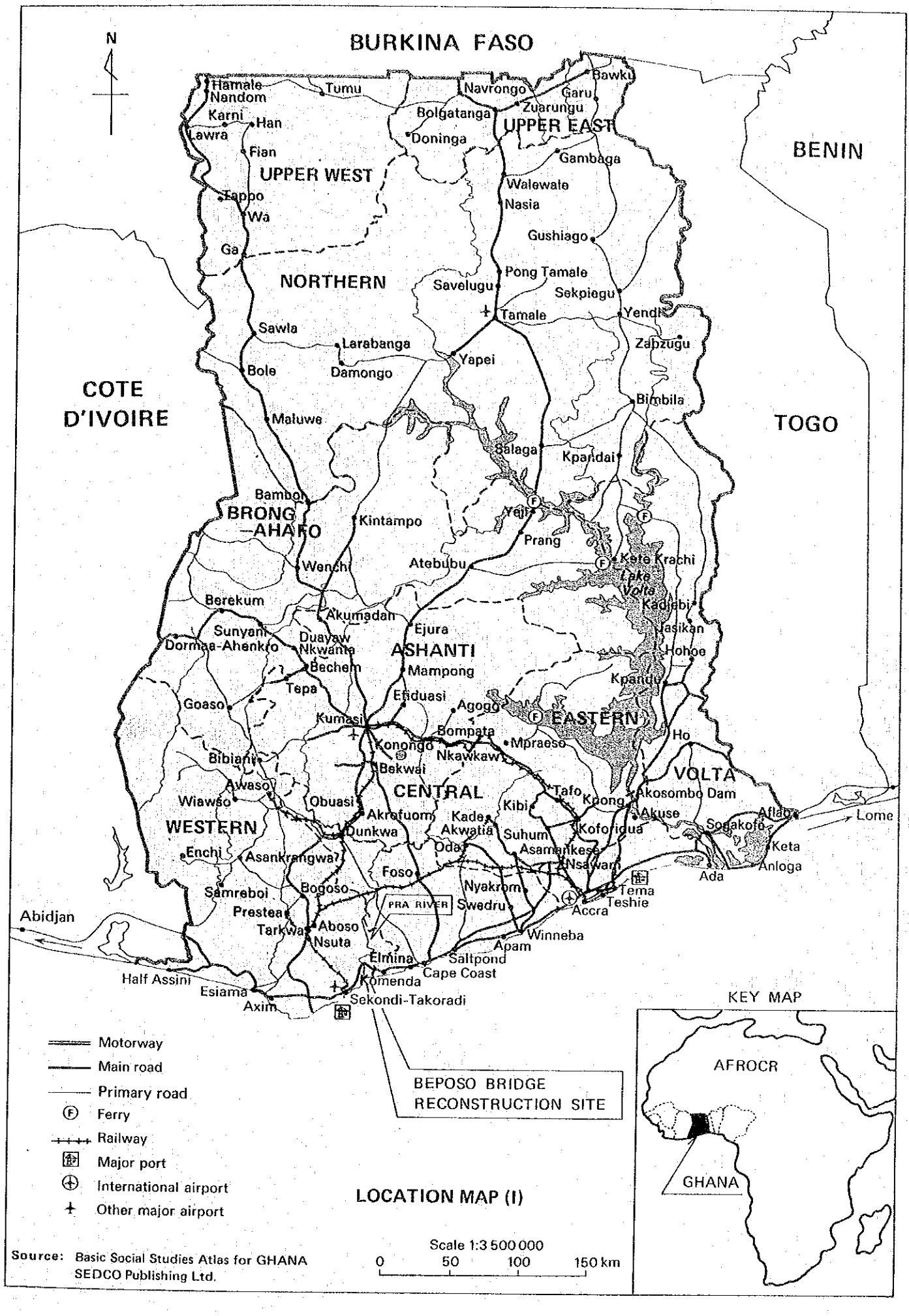
March, 1989



Kensuke YANAGIYA
President
Japan International Cooperation Agency



PERSPECTIVE OF PROPOSED BRIDGE



Source: Basic Social Studies Atlas for GHANA
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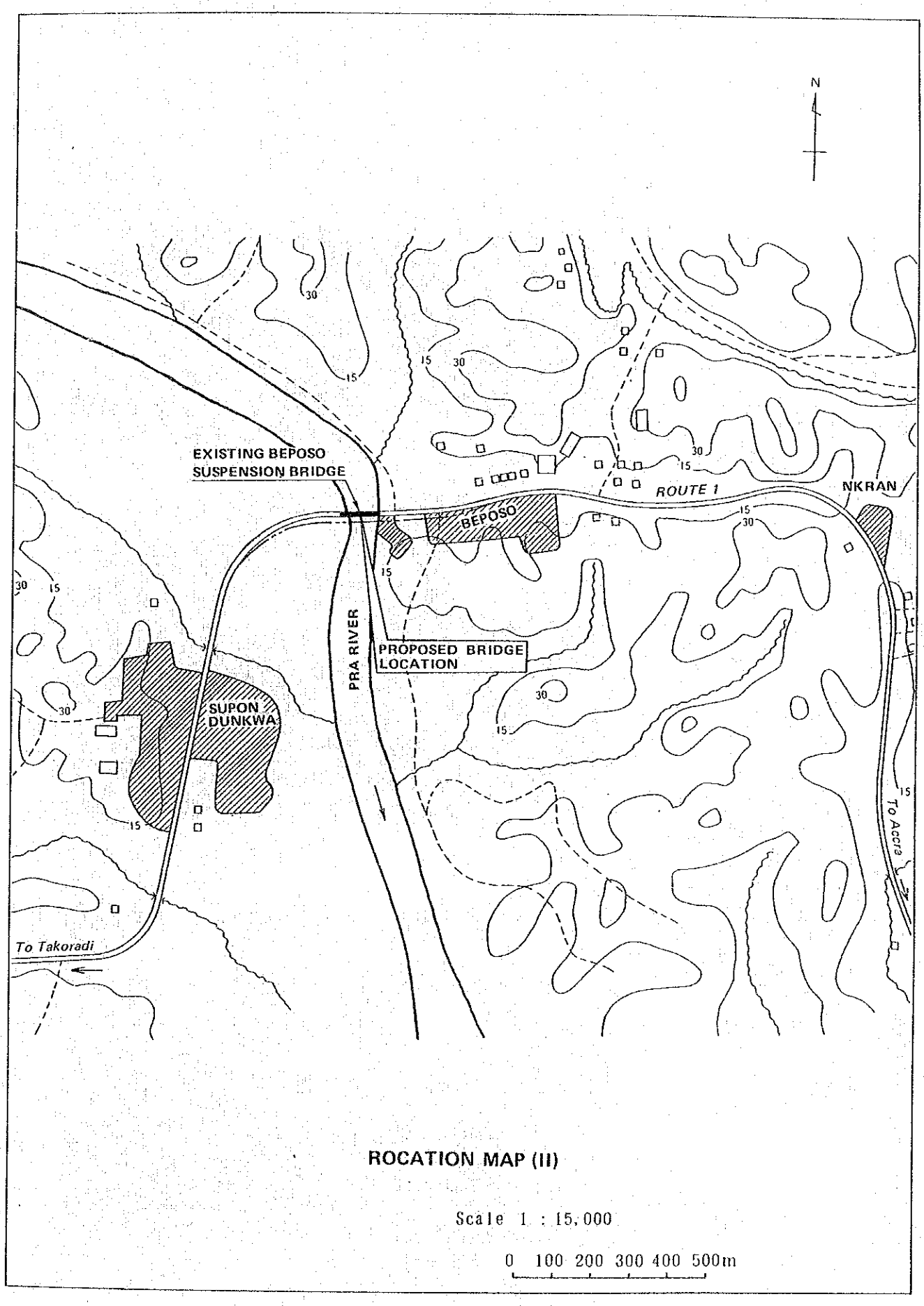
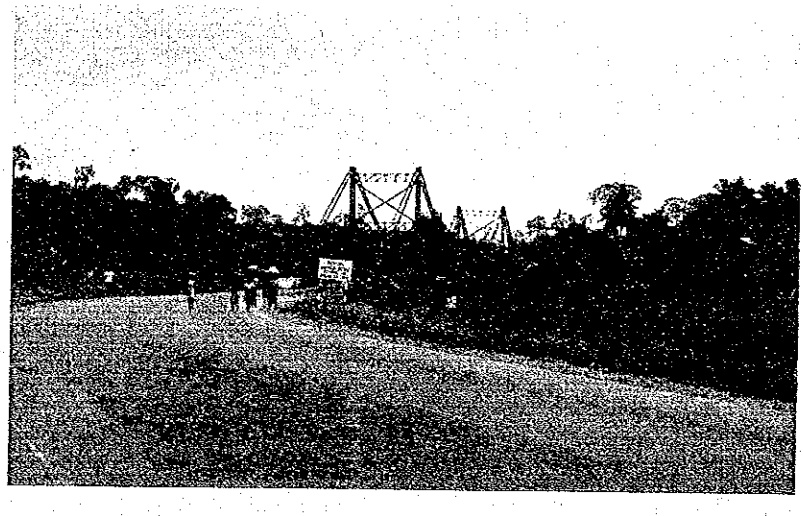


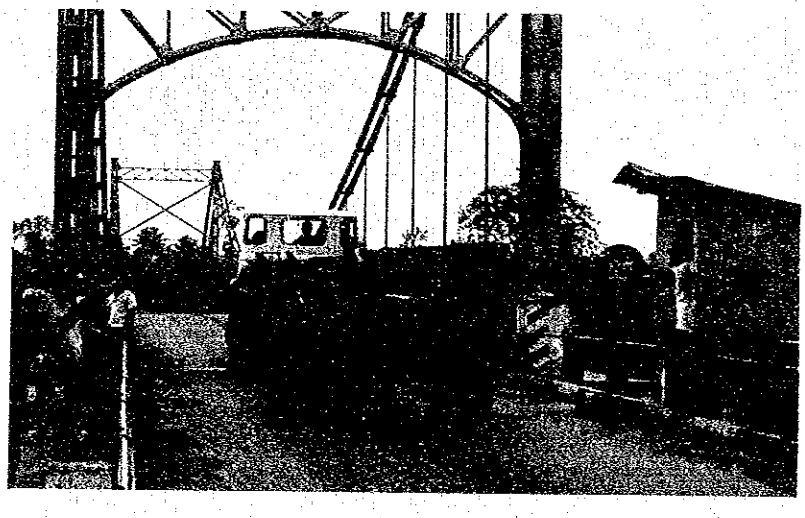
ROCATION MAP (II)

Scale 1 : 15,000

0 100 200 300 400 500m

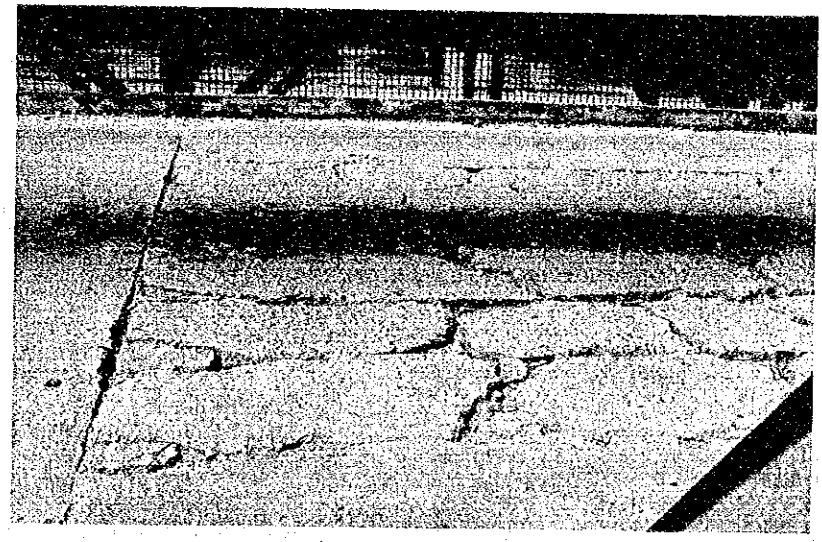


APPROACH ROAD FROM
TAKORADI SIDE UP TO
EXISTING BRIDGE



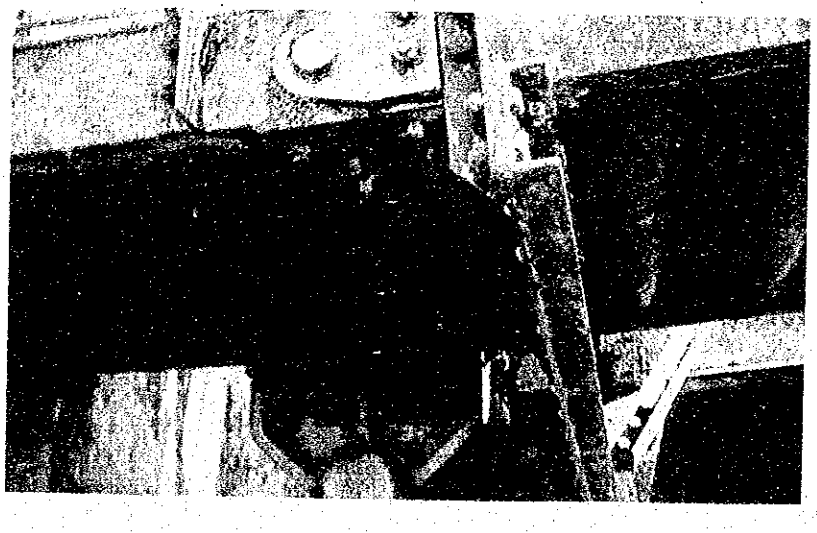
ENTRANCE TO BRIDGE
AT WEST SIDE

ROUTE NO. 1
(AT YAMORANSA)

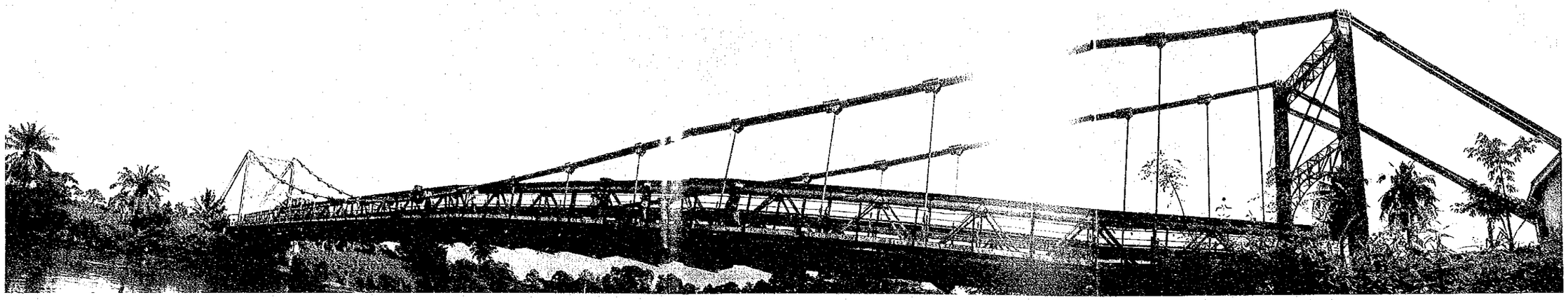


CRACK ON THE DECK SLAB

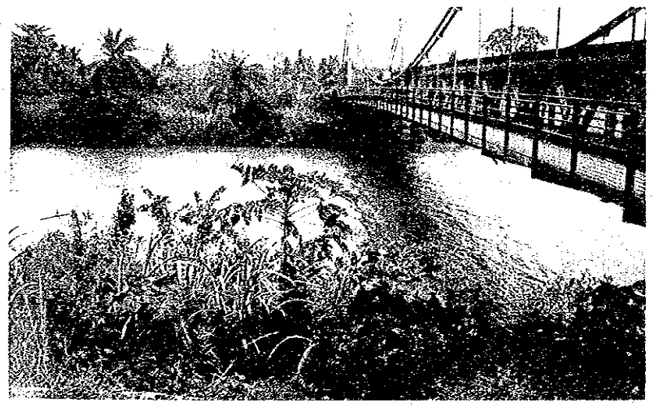
DAMAGED EXPANSION
JOINT AT ABUTMENT



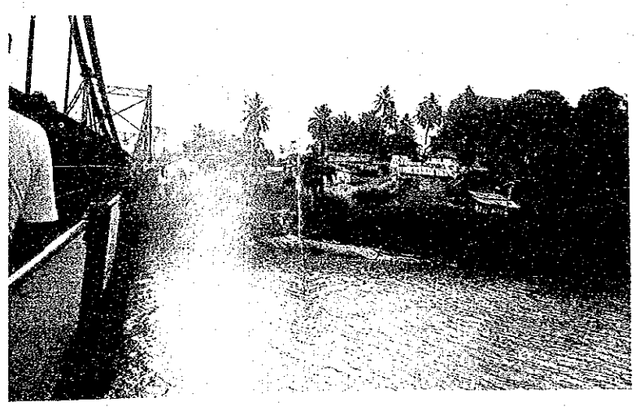
CORRODED SIDEWALK



EXISTING BEPOSO BRIDGE



PROPOSED BRDIGE SITE
DOWNSTREAM OF EXISING
BRIDGE FROM ACCRA SIDE



PROPOSED EAST ABUTMENT
SITE

SUMMARY

SUMMARY

Ghana is located approximately in the center of West Africa facing to the gulf of Guinea on the south and, is bordered on the east by Togo, on the north by Burkina Faso and on the west by Ivory Coast. The population of Ghana is currently estimated at 13.4 million with an average annual growth rate of 2.6 percent between the 1970 and 1984 population census years.

The economy of Ghana is sustained mainly by agriculture, forestry, fisheries and mining resources. In 1987 the sector comprising crop production, livestock, fisheries and forestries contributed about 52 percent of Gross Domestic Product (GDP), while the manufacturing industries provided only 10% of GDP.

The Government of Ghana launched the Economic Recovery Programme in 1983 (the First ERP 1984/86) with assistance of the World Bank and IMF. A second ERP was launched for the period 1986/88 and to date, the results have been encouraging, with an annual economic growth of 5% in 1986.

Ghana had reasonably well developed trunk road network of 14,000 km. However, the road network had suffered more than a decade of neglect of proper maintenance and almost all the roads have deteriorated. Recently, the Government of Ghana has continued to implement the road rehabilitation and maintenance programmes (4th Transport Rehabilitation Programme) with the assistance of the World Bank, and the road network developed gradually and now play key role in transport media.

National Route 1 passing through the existing Beposo Bridge is the East-West corridor running along the coast, with total length of about 550 km from border of Togo to that of Ivory Coast. The route connects major industrial area of Accra/Tema, Cape Coast and Secondi/Takoradi.

Beposo Village, where the Project is proposed, is situated in the south eastern part of Western Region bordering Central Region on its west and about 150 km to the west of Accra on National Route 1. The existing Beposo Bridge is a one-spanned suspension bridge of 100 m long and crosses Pra River on the National Route 1.

At 20 km west to Beposo on National Route 1, there is Secondi/Takoradi industrial circle and Takoradi Port is a deep sea port which exports almost all of timber, cocoa and part of mineral products which are transported from Kumasi and its vicinity through National Route 4 and 1. While, there is Accra/Tema capital circle, on Route 1, at 150 km west to Beposo and Tema port functions as an import port of the industrial raw materials. Considerable part of the imported materials are transported on National Route 1 to Sekondi/Takoradi industrial circle.

The National Route 1 forms a most basic line of three sides of the so called "Golden Triangle" of Ghana, that links Kumasi, Accra/Tema and Sekondi/Takoradi. The area included in the triangle is endowed with most of the agricultural, forestry and mining resources in Ghana. Thus far, the National Route 1 plays a role of main export corridor of the principal commodities in Ghana.

The existing Beposo Bridge is "the one and only" transport means of crossing Pra River. However, as it has been aged 54 years after its completion in 1934, it has been in general, superannuated and, furthermore, there have been observable physical damages or failures on the principal structural members subjected to the accelerated growth of traffic and increase of heavier vehicles.

Consequently, it is not hyperbolic to state that the existing Beposo Bridge may always be in danger of falling. The points at issue raised by the mission through the field surveys are as follow:

1) Cracks occur on deck slab, and corrosions appear to develop on the surface of main members. It is difficult to quantify the degree of deterioration of each member, however it will be safe and pertinent to judge the overall structures have arrived at the limit of the physical lives.
2) Should the use of existing Beposo Bridge continue, an extensive reinforcement or repair work may be required, however, it is very difficult to specify practically the range and degree of the improvements.
3) In practice, it will be impossible to make such extensive reinforcement or repair works without stopping the present traffic flow on the bridge, because it is of only one lane, and there are no detour bridges in its vicinity.

4) Since there are restrictions of weight and regulations of alternate one way-traffic to the vehicles on the existing Beposo Bridge, its transport efficiency declines. The present traffic on the bridge has exceeded the traffic capacity of the bridge.

Taking into consideration of such actuality of the physical and traffic problems, the Ghana Highway Authority (GHA) had commenced the study for reconstructing the Beposo Bridge based on the F/S report (Feasibility study of First Priority Bridges, Ghana Bridge Development Programme, by Tahal Consulting Engineers Ltd. 1986) for the rehabilitation of the bridges on the national road network. As a result of the above F/S report and the detailed examination of the alternative structures (Beposo Bridge Design Report and Scheme Drawings, by Cementation International Engineering Ltd. 1984), the Government of Ghana finally decided to reconstruct the Beposo bridge urgently and requested to Japanese Government to implement the Project under the grant aid programme.

Japanese Government, upon the request of Ghana Government, decided to conduct the basic design study and Japan International Cooperation Agency (JICA) dispatched Basic Design Study Teams twice to Ghana during the periods of September 24 through October 23, and December 3 through December 23, 1988.

The first study team conducted survey on physical conditions of the site such as topographic and hydrographic survey, borehole investigations, and confirmation of the content of the request. The second study team carried out the confirmation of design standard, selection of bridge reconstruction site and type of bridge, and survey on construction related items.

The result of survey and analysis of data collected revealed the following.

All alternative schemes which were done by Consulting Engineer (Cementation International Ltd. of England) were of the design to provide two or three piers for concrete girder of small span. These schemes are not realistic to construct. Cofferdam construction for piers in deep water (more than 15 m) have problems due to hard rock and steeply sloping

rock of riverbed. Also reduction of flow area resulting from piers and wide cutwaters will affect flow, causing increased velocity and higher water level during flooding.

As a result of careful examination of the other alternatives the study team, taking into account the bridge type without piers and maintenance aspect, has decided the Project as follows:

1) Reconstruct a one spanned concrete bridge of about 142 M long with two traffic lanes at the side adjacent to the existing Beposo Bridge.

2) Reconstruct the approach roads to the Bridge of 260 m long on the east bank and 360 m on the west bank.

After Exchange of Note between Japanese and Ghana Governments, the procurement of consultant will be made. The detailed designs will then be done followed by preparation of tender/contract documents. It is expected to take about 3 months for tendering to be executed after conclusion of consultant contract. After the verification of the contract, construction will start. The construction period will be about 12 months.

The Ghana Highway Authority (GHA) shall be the implementing agency for the Project under the jurisdiction of the Ministry of Roads and Highways. GHA shall supervise the construction and maintenance of the Project.

The implementation of the Project will solve the current alternate one-way traffic regulation and weight restriction on vehicles, and shall reduce immediately, the probable danger of the bridge collapsing, securing semi-permanently, the transport means and function across the Pra River on National Route 1. The Project will also generate employment opportunities, and technical transferring will be highly expected.

From these various point of views, it is recommended the Project be implemented as immediately as possible under the Japanese Grant Aid Programme.

BASIC DESIGN STUDY

ON

THE PROJECT

FOR RECONSTRUCTING THE BEPOSO BRIDGE

TABLE OF CONTENTS

CHAPTER 1

GENERAL

CHAPTER 1

GENERAL

1-1 Objective of the Basic Design Study

The existing Beposo Bridge is situated on National Route 1, crossing Pra River at Beposo Village, 150 km west of Accra.

The National Route 1 forms one side of the so called "golden triangle" shaped by three vertices of Kumasi, Accra and Secondi-Takoradi. It functions as an essential export corridor of the commodities produced in the interior of the above golden triangle, and forms part of Pan African Highway connecting Abidjan, Accra and Lome (See Fig. 1-1). The existing Beposo Bridge built in 1934, is a 125 m long suspension bridge with one lane of carriageway of 5.5m width. There has been observed traffic bottleneck phenomenon on the bridge due to alternate one-way traffic control for the increased number of vehicles.

Since the bridge is already more than 50 years old and has not had proper maintenance for a decade, many physical damages and failures on the structural members have occurred. Even cracks have developed on the deck slab. It has been predicted that the bridge is always in danger of falling. Consequently, GHA has conducted comparative studies for the improvement of the Beposo Bridge in conjunction with the Feasibility Study of Ghana Bridge Development Programme commissioned to Tahal Consulting Engineers Ltd. in 1982. (See attached Annex 3.6)

In March 1984, Cementation International Engineering Ltd., commissioned by GHA, has conducted the preliminary comparative designs in terms of reconstruction of Beposo Bridge and recommended that the new bridge be constructed at immediate downstream side of existing facilities. (See attached Annex 3.7)

1-2 The Basic Design Study Team

In response to a request from the Government of Ghana, the Government of Japan decided to conduct a basic design study.

Accordingly, JICA sent to the Republic of Ghana a study team headed by Mr. Masahiko MURASATO, Head of Structural Engineering Section, Nagoya Construction Bureau of Japan Highway Public Corporation, two times for the periods from September 24 to October 23, and December 3 to December 23, 1988 and exchanged "the Minutes of Discussions" (attached as Annex 1.4). The Team was to conduct the basic designs of necessary and proper size of bridge facilities with ancillary approach roads, and establish the method of construction of two-lane bridge to replace the existing old one-lane bridge.

1-3 Content of the Basic Design Study

The Basic Design Study Team conducted the following studies and surveys with the close cooperation of officials of relevant agencies of the Government of Ghana. (See attached Annex 1.3)

1) Confirmation of content of the Request
2) Examination of significance and size of the Project facilities,
3) Study of administration and management system of the Project,
4) Present condition and problems of the existing bridge facilities,
5) Confirmation of design standard and criteria,
6) Survey of physical conditions of the existing bridge,
7) Survey of construction-related items of the Project, and
8) Collection of data and information relevant to the Project.

The Team have carried out the examinations and studies on the Project facilities and these have been summarized in the "Draft Final Basic Design Report". JICA decided to send to Ghana again, the Team headed by Mr. Masahiko MURASATO, head of Structural Engineering Section, Nagoya Construction Bureau of Japan Highway Public Corporation from February 10 to February 24, 1989 to finalize the Basic Design Study.

The Team submitted the "Draft Final Basic Design Report" to the Government of Ghana for its review and had discussions with the Ghanaian officials connected with the project. The resulting "Minutes of Discussion" was then prepared.

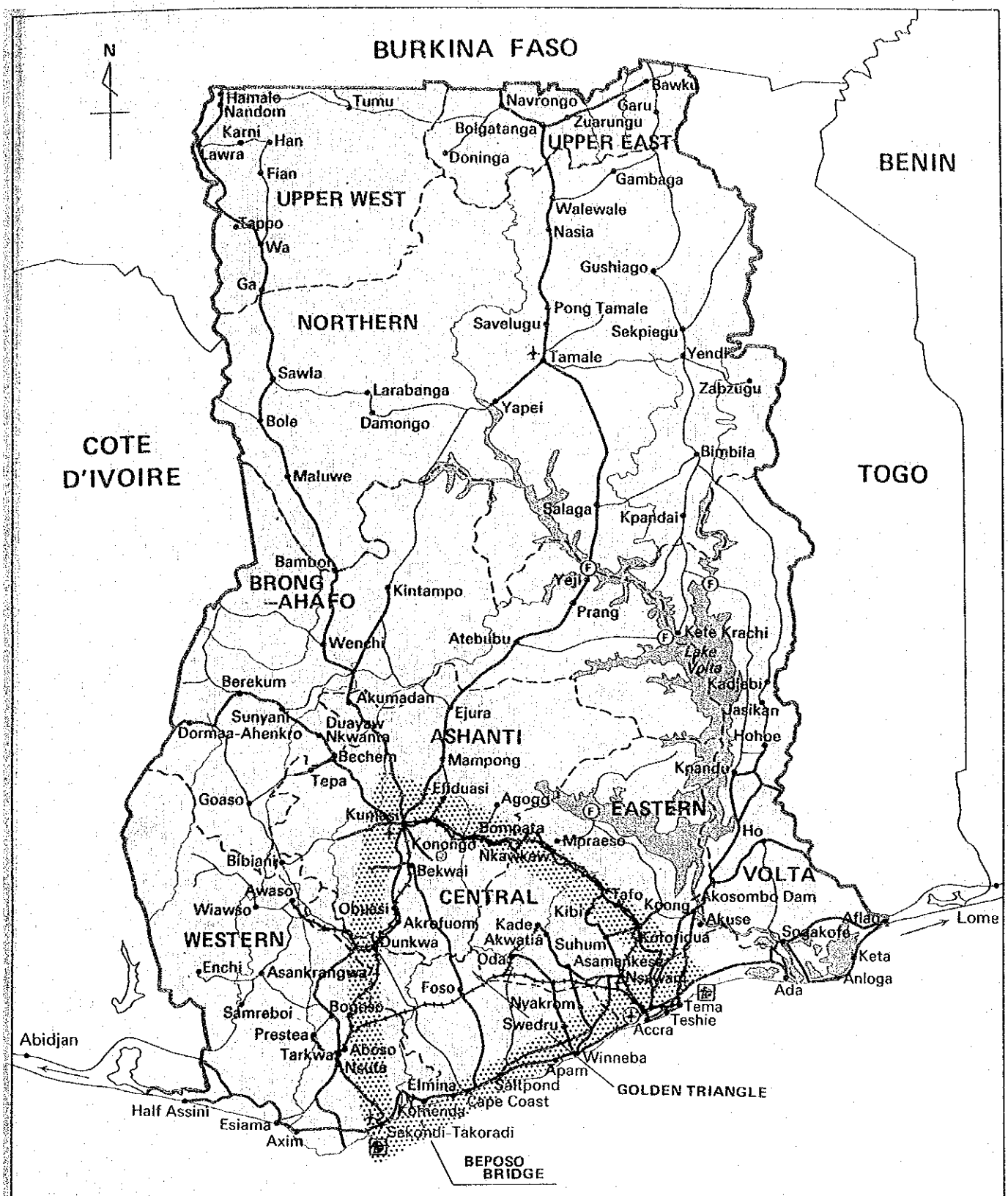


Fig. 1-1 TRANSPORT NETWORK

Source: Basic Social Studies Atlas for GHANA
SEDCO Publishing Ltd.

CHAPTER 2

BACKGROUND OF PROJECT

CHAPTER 2

BACKGROUND OF PROJECT

2-1 General

2-1-1 Land and Population

(1) Geography

Ghana is situated approximately at the center of West Africa and it is bordered on the south by the Gulf of Guinea, on the east by Togo, on the north by Burkina Faso, and on the west by Ivory Coast. The coastline with the Gulf is about 560 km long. The total area of the country is approximately 239,000 sq. km, about two third that of Japan.

Geographically, the land is divided into four zones as follows:

1) Coastal scrub and grassland
2) Tropical rain forest land in Western Region
3) Moist semi-deciduous forest land ranging from the western border with Ivory Coast to the central part of Ashanti Region, and
4) Northern and eastern dry land.

The largest river running through Ghana is Volta, and Black and White Voltas are its upstream tributaries. The Volta originates from Burkina Faso, runs down along the border with Ivory Coast and traverses the eastern part of Ghana. The Volta lake made by Akosombo Dam is the largest man-made lake in the world, with the water area of 8,400 sq. km. There are large rivers, such as Pra, Ankobra and Tano, besides Volta, all of which arise from the Ashanti Region and flow down into the Gulf of Guinea. (See Fig. 2-1)

The climate of Ghana is tropical with dominant influences of so called "Harmataan", the hot and dry north-eastern trade winds and the comparatively cool and wet south-western trade winds blowing

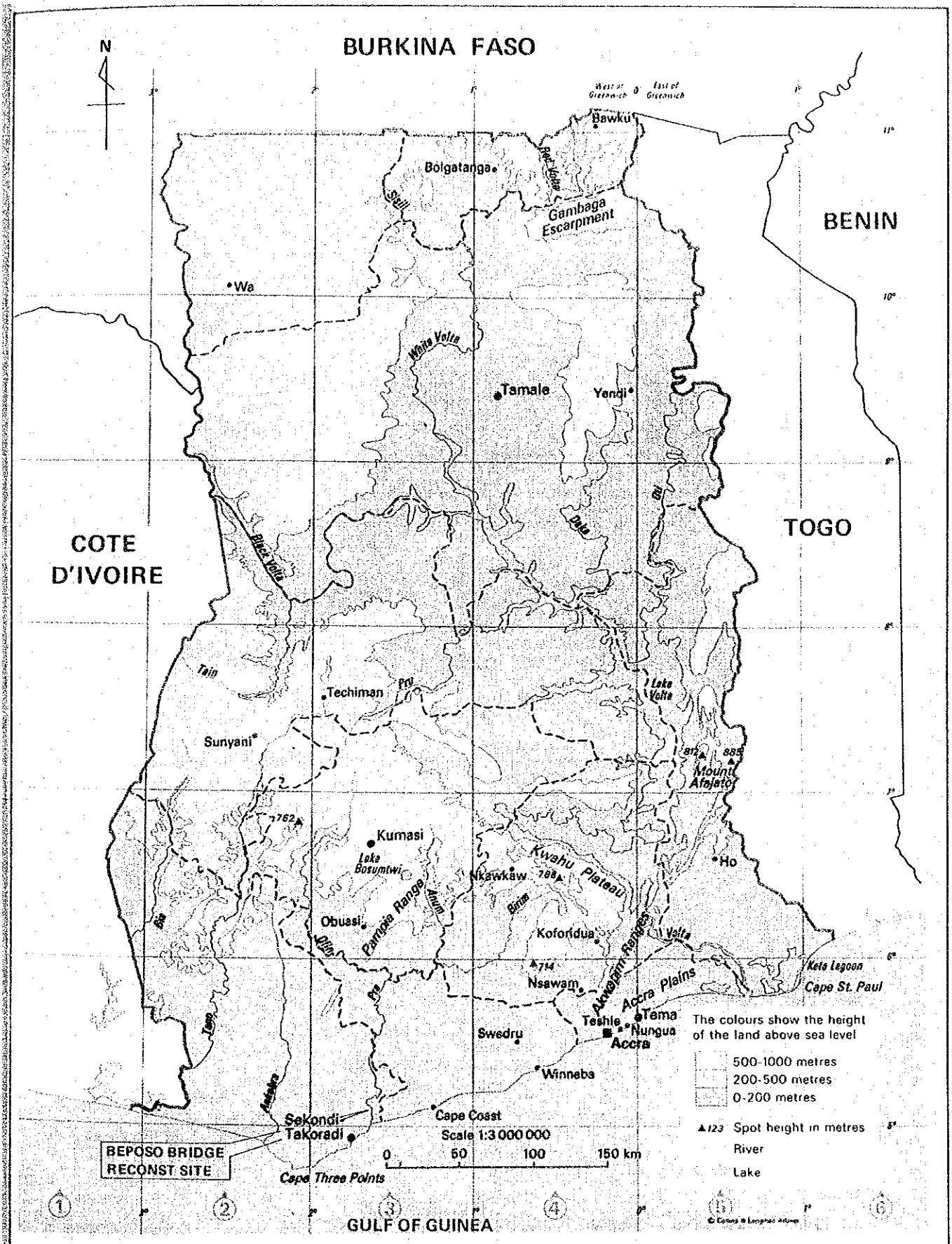


Fig. 2-1 RELIEF MAP

Source: Basic Social Studies Atlas for GHANA
SEDCO Publishing Ltd.

from the southern gulf. The temperature varies by regions from 20°C (lowest) to 37°C (highest). It shows generally, highest value in March and lowest in August. The humidity is almost 80% over the whole country except for the northern dry land. Rainfall is heavy in the south-western part and light around Accra and the Eastern Region. The rainy season extends from April through September.

(2) Population

The population of Ghana is currently estimated at 13.4 million with an annual growth rate of about 2.6% for the period 1970 - 1984. It will reach 19.0 million or more in 2000 if the existing growth rate continues. Of the total population, 32% lives in the urban areas. The population density is 52 per one sq. km. Although the population is divided into many tribes, Ga (Accra), Ewe (South-eastern Volta) and Akan (Middle-western Kumasi) are major tribes.

Table 2-1 POPULATION AND DENSITY BY REGION (1984)

Region	Area (Sq Km)	Population	Density
Total country	238,533	12,296,081	52
Western	23,921	1,142,335	48
Central	9,826	1,143,023	116
Greater Accra	3,245	1,431,099	441
Eastern	19,323	1,680,890	87
Volta	20,570	1,211,907	59
Ashanti	24,389	2,090,100	86
Brong Ahafo	39,557	1,206,720	31
Northern	70,384	1,164,583	17
Upper West	18,476	438,008	24
Upper East	8,842	772,744	87

Source: "Quarterly Digest of statistics June 1988"
Statistical Service, Accra, Ghana

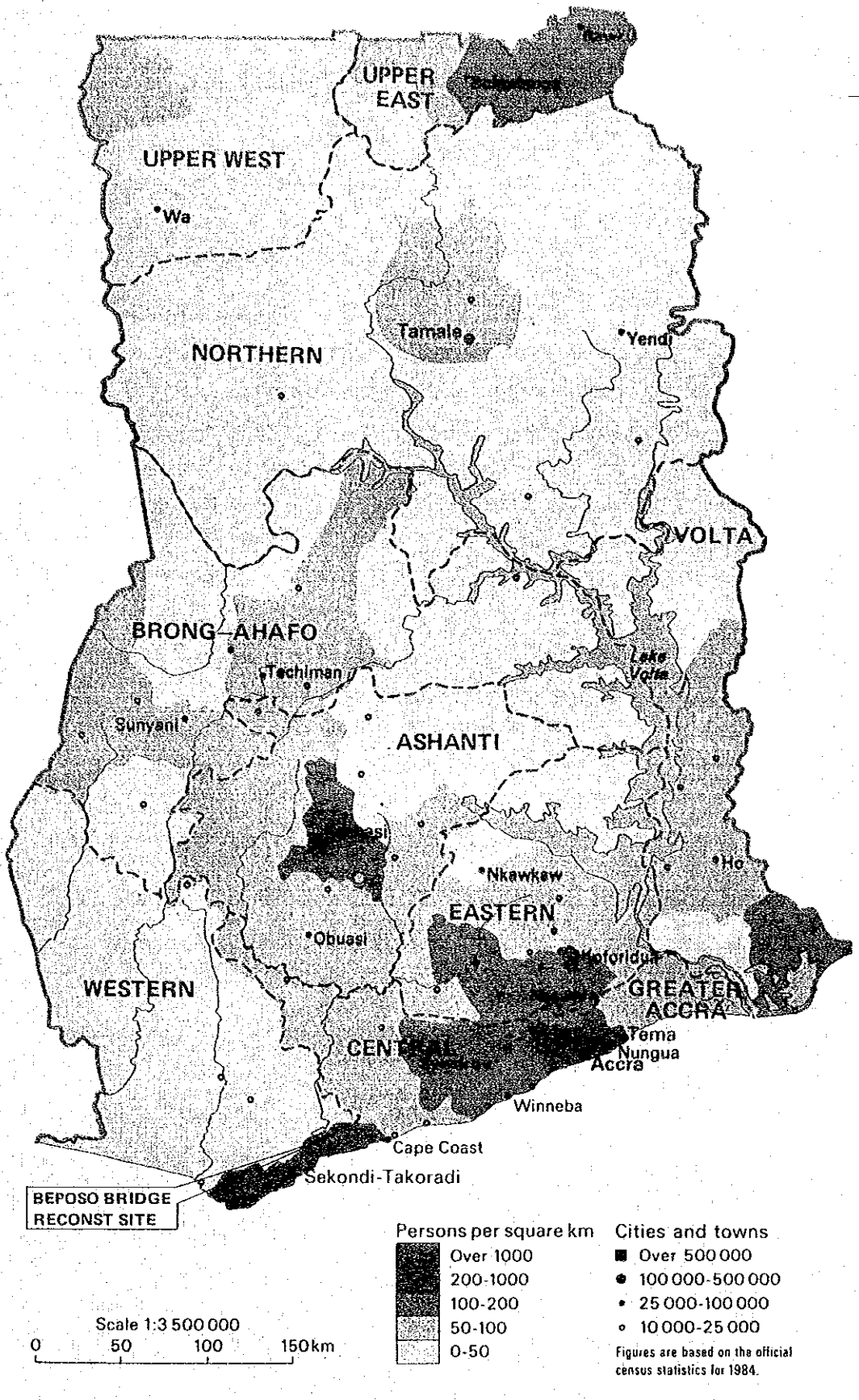


Fig. 2-2 POPULATION DISTRIBUTION

Source: Basic Social Studies Atlas for GHANA
SEDCO Publishing Ltd.

2-1-2 Structure of Industry

The economy of Ghana is dominated by the Agricultural sector including sub-sectors of livestocks, forestry logging and fishery, as shown in Table 2-2. Cocoa accounts for the largest proportion of foreign exchange earned.

In 1985, the Agriculture sector accounted for 54.3%, and cocoa subsector alone provided 9% of GDP. The revenue of Ghana has been largely influenced by the fluctuation of production and price of cocoa and the amount of cocoa beans and products exported accounts for about 63% of the total export commodities as shown in Table 2-3. Though Ghana has been endowed with mineral resources such as gold, diamond, manganese and bauxite, the mineral resource sector's export accounts for only 15% of the total export, and it is the next principal export to Japan after cocoa. The manufacturing industry's contribution to GDP remained less than 8% in 1985, despite the successive Ghanian administrations' accumulated efforts to move away from sole dependence on cocoa and aim at industrialization.

Table 2-2 GENERAL DOMESTIC PRODUCT BY INDUSTRIES (1980 PRICE)

(Million Cedis)

	1983	1984	1985 a/
Agriculture	19,187	21,151	21,974
Agric. & Livestock	12,938	14,880	15,106
Cocoa	3,322	3,256	3,585
Forestry & Loggin	2,263	2,336	2,570
Fishing	664	679	713
Industry	3,986	4,278	4,863
Mining & Quarrying	394	409	467
Manufacturing	2,555	2,811	3,234
Electricity and Water	197	183	241
Construction	840	876	920
Services	13,490	13,987	14,686
Transport & Communications	1,402	1,446	1,518
Trade & Hotels	3,745	3,972	4,170
Banking, Insurance, Real Estate	3,028	3,115	3,271
Government Services	4,819	4,928	5,175
Other Services	496	526	552
Imported Service Charges	-1,289	-1,373	-1,453
Import Duties	314	365	383
GDP at Market Prices (Cedis)	35,689	38,409	40,453
Population (Million)	11.99	12.29	12.61

a/ Estimated

Table 2-3 EXPORT 1983/85

	1983	1984	1985 a/
Cocoa Beans			
Value (US$ million)	242	352	320
Volume ('000 tons)	150	150	153
Cocoa Products			
Value (US$ million)	27	30	64
Volume ('000 tons)	15	15	25
Gold			
Value (US$ million)	114	103	98
Volume ('000 Fine Troy Ounces)	278	286	315
Timber			
Value (US$ million)	16	21	30
Volume ('000 cubic meters)	115	147	121
Residual Oil & Electricity			
Value (US$ million)	34	43	71
Others			
Value (US$ million)	439	566	610

a/ Estimated

2-1-3 Economic Recovery Programme

The performance of the Ghanaian economy in the last decade has been characterized by declining output of key sectors, persistently high rate of inflation, balance of payments difficulties, large Government budgetary deficits, and excess liquidity. Between 1974 and 1981, per capita income declined by over 20 per cent. Cocoa production has fallen to less than half its 1974 level, and inflation has averaged over 50 per cent per year.

As export earnings fell, there was inadequate foreign exchange for raw materials, spares and investment in the export sectors and other critical areas of the economy. As a result, critically needed infrastructure in transport and communications and public utilities declined. The decline in the transport sector became so severe that export goods could often not be moved to the ports for shipment. Declining imports and exports limited the Government's revenues, while a growing population increased the demand for services, resulting in huge deficits.

In 1983, Ghana launched a successive Economic Recovery Programmes. (See attached Annex 3.8) The first ERP (1984/86) was designed to rehabilitate the economy and reverse the economic deterioration suffered over the past decade. The policy package of economic reforms associated with the rehabilitation programme aimed at re-aligning relative prices in favour of the productive sectors, particularly cocoa, timber and minerals, improving the financial position of the public sector and encouraging expanded private investment.

The progress of the ERP was initially stymied by the slow response of the economy to policy reforms. It became clear that the extent of damage to infrastructure, particularly roads, and the time and expenditure required to rehabilitate it had been underestimated. Capital expenditures needed to be increased, mobilization of domestic resources needed to be stepped up, price reforms were yet insufficient to elicit adequate supply responses and the investment needed to be improved.

From the experience gained in 1984 in implementing the ERP, the Government of Ghana continued to forge ahead in 1985 with a broadening and strengthening of policies, and their improved implementation in several areas. (ERP 1986/88)

In the latest second ERP 1986/88, the major macro-economic objectives are set forth as follows:-

1) GDP growth of about 5% per annum implying an increase of at least 1.5% per annum in per capita incomes,

2) The inflation rate declining from about 20 to below 15% by 1988,

3) Revenue growth based upon a reformed tax structure and significant administrative changes that will increase the revenue to GDP ratio from 10% in 1985 to about 14% in 1988,

4) Total expenditures are expected to increase from 15 to about 22% of GDP by 1988, entailing a recurrent expenditure share of about 11% throughout and an increase in the share of development expenditure from about 5% to about 11% by 1988, with the distribution of these expenditures being based on a recently completed assessment of public expenditure priorities in the recurrent areas, and of a core three-year public investment programme,

5) The investment ratio increases from 10 to about 17% of GDP, with the share of domestic savings rising from about 5 to about 10% of GDP by 1988, and foreign savings averaging about 7% over the period,

6) Significant export growth aimed at increasing the export GDP ratio from about 10 to about 19% of GDP, while the import/GDP ratio increases from about 15 to about 25% of GDP,

7) The overall deficit/GDP ratio including projects financed by external aid rises from 5% to about 8% in 1986 through the period, with foreign financing rising from about 4 to about 7%, while the domestic financing remains at 1% through out the period,

8) An increase in the M2/GDP ratio, through a deepening of the financial sector, from about 12% to about 20% in 1988. (See Table 2-4 and 2-5)

Table 2-4 MAJOR MACRO ECONOMIC PROJECTION IN ERP 1986/88(%)

	1985	1986	1987	1988
Growth Rates				
GDP (1984 prices)	5.3	5.5	5.0	4.5
GDP Deflator	20 - 15	18 - 20	15 - 18	12 - 15
Share of GDP (Market prices)				
National Accounts				
Consumption	95	95	90	90
Investment	10	14	16	17
National Savings	4	6	8	10
Foreign Savings	5	8	8	7
Budget				
Total Revenues	10	12	13	14
Total Expenditures	15	20	22	22
Recurrent	10	11	11	11
Capital 1/	5	6	10	11
Special Efficiency Programme				
Overall Balance	-5	-8	-0	-8
Financed by:				
Foreign (net)	4	7	8	7
Domestic (net)	1	1	1	1
Balance of Payments				
Exports GNFS	10	14	17	19
Imports GNFS	-15	-20	-25	-25

1/ Including projects financed by external aid.

Table 2-5 SECTORIAL INVESTMENT IN EPR 1986/88 (1985 PRICE)

		Expenditure Proposed	% Share	Foreign Financing Committed/Under Negotiation
1.	Agriculture	9,511	12.4	2,834
2.	Mining	10,549	13.7	4,788
3.	Energy	11,023	14.3	11,235
4.	Industry	2,572	3.3	848
5.	Roads and Highways	15,576	20.3	5,712
6.	Transport & Communications	15,057	19.6	7,964
7.	Social Sector	6,662	8.7	704
	(of which water)	(2,162)		(236)
	(" Education)	(2,500)		(228)
	(" Health)	(2,000)		(240)
8.	Other	5,850	7.6	-
	Total	76,800	100.0	34,085

2-1-4 Present Situation of Economy

The economy in 1985 has been distinctly recovered mainly in the agricultural sector by favour of good weather and by virtue of the implementation of the ERP 1984/86.

The growth rate of economy in 1985 showed +5.3% for the previous year and the inflationary tendency became calm as shown in Table 2-6. The production of principal export commodities such as cocoa, gold, manganese, bauxite and timber has steadily been restored, but has not yet reached the productive level in 1980.

Table 2-6 MAIN ECONOMIC INDICATORS 1980/85
(AVERAGE ANNUAL CHANGE %)

	Consumer Price Index	Real GDP Total	Real GDP Per Capita	Exports	Imports	Maize Output
1980	50.1	1.2	-1.4	3.6	12.5	
1981	116.5	-3.8	-6.3	-35.6	5.1	-1
1982	22.3	-6.1	-8.5	-9.8	-38.2	-8
1983	121.9	-2.9	-5.4	-31.5	-1.8	-50
1984	40.9	7.6	5.0	28.9	23.2	233
1985 (Est) 1/	20.0	5.3	2.6	7.8	18.0	-5

1/ estimated