

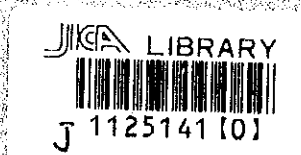
JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF HEALTH, LAO PEOPLE'S DEMOCRATIC REPUBLIC

**THE STUDY ON GROUNDWATER DEVELOPMENT
FOR
CHAMPASAK AND SARAVAN PROVINCES
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC**

**FINAL REPORT
MAIN REPORT**

DECEMBER 1995



**KOKUSAI KOGYO CO., LTD.
CONSTRUCTION PROJECT CONSULTANTS, INC.**

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JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF HEALTH, LAO PEOPLE'S DEMOCRATIC REPUBLIC

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PREFACE

In response to a request from the Government of the Lao People's Democratic Republic, the Government of Japan decided to conduct a study on Groundwater Development for Champasak and Saravan Provinces and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Laos a study team headed by Dr. Akira KAMATA, Kokusai Kogyo Co., Ltd., and composed staff members of Kokusai Kogyo Co., Ltd. and Construction Project Consultants Inc., 4 times between March 1994 and December 1995.

The team held discussion with the officials concerned of the Government of Laos, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

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

December 1995



Kimio Fujita
President

Japan International Cooperation Agency

December 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit the final report of "The Study on Groundwater Development for Champasak and Saravan Provinces in Lao People's Democratic Republic". This report has been prepared based on the field survey and the study conducted during the period from March 1994 to December 1995.

The report contains the study results on the hydrogeology, hydrology, water quality and groundwater potential of the study area. A groundwater development plan and a rural water supply program are presented in detail in the report.

We hope that the implementation of the groundwater-based rural water supply program would greatly contribute to the creation of the healthy and sanitary environment in the villages of Champasak and Saravan provinces.

All the members of the Study Team wish to express their sincere thanks to the personnel of your Agency, the Embassy of Japan in Laos and the officials and personnel of the Ministry of Health, Provincial Health Departments in Champasak and Saravan for the assistance extended to them.

Very truly yours,

Akira KAMATA
Team Leader

The Study on Groundwater Development
for Champasak and Saravan Provinces, Lao
PDR.

The Study on Groundwater Development for Champasak and Saravan Provinces in Lao People's Democratic Republic

Study Period: March 1994 to December 1995
Counterpart Agency: Clean Water Institute, National Institute of Hygiene and Epidemiology, Ministry of Health

Abstract

1. Background

Lao PDR is located on the left bank of the Mekong River. Topographically, it is composed of mountains and undulating lands. Its population is about 4.64 million, and more than 80% of the people are living in the rural areas. The rural population are served with water supply, lagging far behind the urban areas. Hence, unserved people traditionally resort to the use of rivers, springs, shallow dug wells and ponds for their domestic water needs.

Water sources usually dry up in the dry season and are also exposed to contamination of human and livestock wastes. This contamination causes high infant mortality and water-borne diseases, which hinders having a healthy population in the rural areas. Shortage of clean water eventually impedes the development of active rural communities. It is therefore urgently needed to establish a groundwater-based rural water supply program.

2. Study Objectives

The Study aims to achieve the following objectives.

- (1) To formulate a groundwater development plan for village water supply in Champasak and Saravan provinces.
- (2) To transfer technology on hydrogeology, water supply engineering and well maintenance in the course of the Study.

3. Study Area

The 26,000-km² Study Area covers two hundred (200) villages located in the following districts of the two provinces.

Champasak Province: Bachiangchaleusook, Khong, Pathoomphone, Sukhuma and Sanasomboon (100 villages)

Saravan Province: Saravan, Khongseudon, Lao Ngam, Lakhonepheng and Vapy (100 villages)

4. Study Results

(1) Natural Environment

The Study Area is composed of plain, hill, plateau and mountain. The Mekong River and its tributaries, i.e., the Xedon River and Xekon river, flow through the Study Area. The plain and hill are mainly composed of Jurassic sandstone and shale. The plateau and mountain are composed of basalt and Paleozoic sandstone and slate, respectively. The climate of the Study Area is divided into the dry season and rainy season. The average annual rainfall is 1,600 to 2,000 mm.

(2) Existing Water Source

About 80% of 200 villages obtain water from traditional sources such as river, springs, ponds and shallow dug well which are often unreliable and polluted. Groundwater is being utilized by means of dug well and tube well. Most of these wells are not equipped with hand pump.

(3) Hydrogeology

Based on its geology and topography, the Study Area can be classified into ten (10) hydrogeologic units, i.e., **Qf,Qt, Ep,Eh, Ba1,Ba2,Ba3,Et, P** and **M**. Groundwater occurs in all of these hydrogeologic units except "**M**".

(4) Optimum Yield

Based on the test well data, the optimum yield is estimated as follows:

for the alluvial plain :90-260 l/min, for the Jurassic area (Ep,Eh): 6-115 l/min, for the Basalt Slope (Ba1 area): 14-88 l/min, for Ba2 area: 1,200-1,800 l/min, for the Ba3 area: 185 l/min, and for the Triassic tuff 22-90 l/min.

(5) Groundwater Quality

In comparison with WHO standards or guideline values, many samples of existing water sources exceed the guideline values in three (3) chemical components (Fe, Mn and NO₃). The coliforms and bacteria were detected in all the water sources. Some test wells exceed the guideline value for iron and manganese. Nitrate was not detected. The coliforms and bacteria were not found.

(6) Pilot Water Supply System

The hand pumps were installed at 20 test wells and the Study Team conducted a trial operation and maintenance of these systems including organization of the water user's association. After completion, the systems are operated and maintained adequately by villagers and the water fee is collected smoothly every month.

(7) Groundwater Development Plan

The 5-inch (hand pump well) and 6-inch (motor pump well), 50m-depth well were designed for groundwater development. The well is gravel-packed and has the screen openings at 12 % (hand pump well) and 20 % (motor pump well), respectively.

(8) Water supply Program

Target year:	2005	
Target villages and population:	200 villages	131,789
Water supply systems:	Hand pump well	485
	Motor pump well	1
	Maintenance center	2
Project cost:	1,726 million Yen	

(9) Project Evaluation

The proposed project will satisfy the *basic human needs* of the rural population in the 200 villages, and it is expected to yield economic and social benefits such as time saving and health improvement. It will greatly improve the quality of life in the community and the village people will be involved more in the future development of the community.

(10) Environmental Impact Assessment

The environmental impact caused by the project will be very small in the entire groundwater basin. However, new well locations have to be determined considering the existing wells. The intrusion of salinity-high and iron-manganese-rich groundwater must be prevented in the new wells.

5. Recommendations

(1) Earlier implementation of the project

The supply of clean water is one of the basic human needs, it will benefit and contribute greatly to the rural community in the long term. It will also create a healthy and sanitary environment in the villages, which is the basis of rural development. Earlier implementation of the project is, therefore, strongly recommended.

(2) Utilization of hydrogeological map and investigations

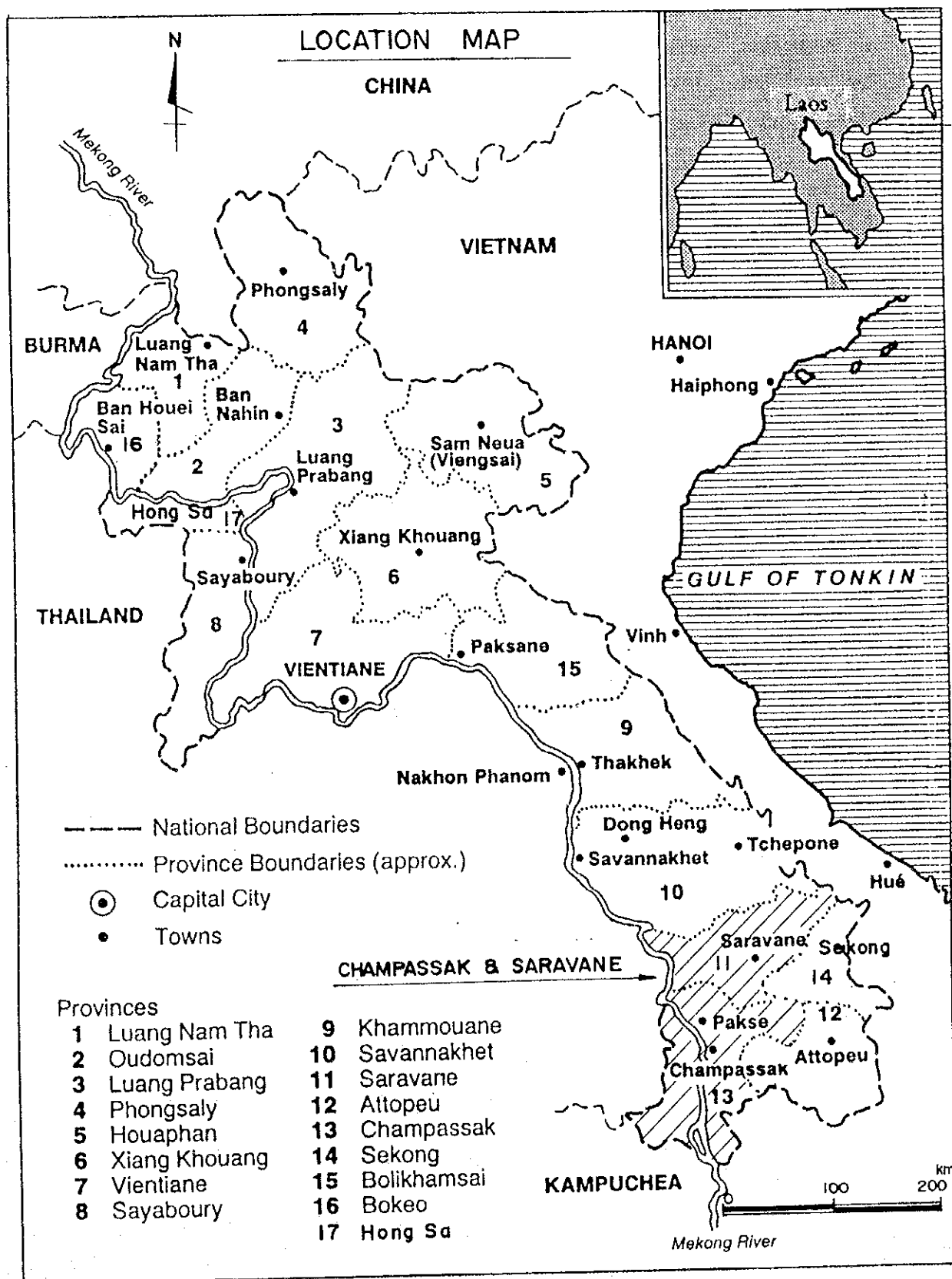
It is desirable that the groundwater development be carried out by using the hydrogeological map prepared by the Study Team.

(3) Monitoring and management of water quality

The concentrations of iron and manganese in groundwater exceed the WHO standard in many places in the Study Area. Periodical monitoring of water quality is, therefore, strongly recommended. The treatment system, such as a simple sand filter, should be installed in some cases.

(4) Establishment of the maintenance center

In order to provide preventive and curative maintenance services and supply of spare parts to ensure the operation and maintenance by the village people themselves, the proposed maintenance center should be established.



FINAL REPORT

MAIN REPORT

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CURRENCY EQUIVALENTS

(As of July 1995)

US\$1.00 = Kip 820 = Yen 88.45

Kip 1 = Yen 0.11

Yen 1 = Kip 9.27

ABBREVIATIONS

ADB	Asian Development Bank
BGS	British Geological Survey
CWI	Clean Water Institute
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
MCTPC	Ministry of Communications, Transport, Post and Construction
MAF	Ministry of Agriculture and Forestry
MPH	Ministry of Public Health
NIHE	National Institute of Hygiene and Epidemiology
OSTE	Organization for Science, Technology and Environment
PHD	Provincial Health Department
PHDC	Provincial Health Department, Champasak
PHDS	Provincial Health Department, Saravan
PMO	Prime Minister's Office
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organization
lpcd	liter per capita per day

CHAPTER 1. INTRODUCTION

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CHAPTER 1 INTRODUCTION

This final report on the Study on Groundwater Development for Champasak and Saravan Provinces in Lao PDR (hereinafter referred to as "The Study") presents the results of the studies on the hydrogeology, hydrology, and socio-economics of the area as well as the evaluation of groundwater potential and the planning of groundwater development for community water supply. Organized by the Japan International Cooperation Agency (JICA), the Study Team conducted an intensive survey of an area of about 26,000 km² that covers Champasak and Saravan Provinces. The Study was carried out in accordance with the Scope of Work (SW) which was agreed upon between the Ministry of Health (MOH) Lao PDR and the JICA. The Study was launched in late March 1994 and completed in December 1995.

1.1 Background

The Lao Peoples Democratic Republic (Lao PDR) is located on the left bank of the Mekong River. The Lao PDR is bounded on the north by China and Myanmar, on the east by Vietnam, on the south by Cambodia, and on the west by Thailand. The Mekong River flowing from north to southeast partly separates Lao from Thailand. Lao lies between 14°N and 22°30'N latitudes and 100°E and 108°E longitudes.

Lao has an area of 236,800 square kilometers. Its greatest length from northwest to southeast is about 1,100 kilometers, and its greatest width is about 500 kilometers. Topographically, it is composed of mountains and undulating lands.

In 1990, its population is about 4.36 million; of which, more than 80% are living in the rural areas.

Waterworks supply drinking water to only less than 50% of the urban population living in areas like Vientiane, Savanakheth, Pakse, etc. Lagging far behind them are the rural population that occupy most of the country; only 14% are served with water supply. Both urban and rural unserved population traditionally resort to the use of rivers, springs, shallow dug wells and ponds for their domestic water needs. These water sources that usually dry up in the dry season are exposed to contamination of human and livestock wastes. The contaminated water causes high infant mortality and water-borne diseases. Thus, shortage of clean water eventually impedes the development of active and healthy rural communities.

To overcome such condition, the Clean Water Institute (CWI) under the National Institute of Hygiene and Epidemiology (NIHE) of the MOH has been implementing rural water supply projects that are financially and technically assisted by the UNDP, WHO and UNICEF since 1981. Between 1982 and 1986, the UNDP-WHO supplied the equipment and materials and technical trainings. Since 1987, the UNICEF has been continuously implementing rural water supply projects jointly with CWI. The UNICEF provides equipment and materials, while the CWI directs the provincial public section in the construction of the water supply systems.

Considerable efforts have been made in the past 10 years, but the situation has not changed due to lack of (1) knowledge and information on groundwater resource development, (2) technical

staff, and (3) community participation in the operation and maintenance of the water supply systems.

In January 1993, the Government of Lao PDR finally requested the Government of Japan for a technical assistance for a study on groundwater development in Champasak and Saravan provinces with an objective of constructing deep wells with handpumps for rural water supply. The request was positively responded, and in December 1993 the JICA dispatched a preparatory study team to Lao PDR to clarify the background and specifics of the request.

An agreement was reached between the MOH and the JICA on the Scope of Work (SW) for the Study. This agreement was signed on 20 December 1993 by the representatives of both agencies. As stipulated in the SW, a Study Team was dispatched to undertake the Study.

1.2 Purpose and Scope

1.2.1 Purpose

The study on the groundwater resources of Champasak and Saravan provinces is the first coordinated program of research on the groundwater resources potential to be carried out in Lao PDR. The Study will finally contribute to the construction of more water supply systems in the villages located in the Study Area. Specifically, the Study aims to achieve the following objectives.

- 1) To formulate a groundwater development plan for village water supply in Champasak and Saravan provinces.
- 2) To transfer technology on hydrology, water supply engineering and well maintenance in the course of the Study.

1.2.2 Scope

As stipulated in the SW, the Study was carried out in 22 months from March 1994 to December 1995. The study period was divided into three phases to cover all the major subjects of the Study:

PHASE I (March 1994 to September 1994):

- 1) Collection and Review of Previous Studies and Existing Data
 - (a) Socio-economic conditions
 - (b) Relevant on-going and planned projects
 - (c) Water supply systems
 - (d) Water demand

- (e) Topographical, geological and hydrogeological maps
 - (f) Satellite and aerial photos
 - (g) Land use
 - (h) Natural conditions
 - (i) Data of existing wells
 - (j) Environmental conditions
 - (k) Laws, regulations and policies
 - (l) Institutions, organizations and administrations
 - (m) Others
- 2) Basic Analysis and Field Survey
- (a) Satellite and aerial photo interpretation
 - (b) Field reconnaissance
 - (c) Survey on the condition of water utilizations
 - (d) Survey on water demand conditions
 - (e) Preliminary hydrogeological mapping
 - (f) Selection of geophysical survey points
 - (g) Geophysical survey
 - (h) Building-up of database on water supply
 - (i) Formulation of strategy for groundwater development
 - (j) Selection of rural areas for detailed investigation

PHASE II (October 1994 to March 1995):

- 1) Detailed Investigation for the Selected Rural Areas
 - (a) Electrical soundings
 - (b) Test borings

- (c) Hydrological investigation
- (d) Observation of groundwater levels
- (e) Water flow survey

2) Study and Analysis

- (a) Water quality analysis
- (b) Water balance analysis
- (c) Water demand projection
- (d) Evaluation of groundwater resource potential

PHASE III (May 1995 to December 1995):

1) Formulation of Groundwater Development Plan for the Selected Rural Areas

- (a) Planning framework
- (b) Plan of water resource development
- (c) Plan of water supply system
- (d) Preliminary design of facilities
- (e) Construction plan
- (f) Operation and maintenance plan
- (g) Institution and management plan
- (h) Estimation of cost and benefit
- (i) Social and economic analysis
- (j) Environmental impact assessment
- (k) Evaluation
- l) Implementation plan

2) Recommendations on Groundwater Development Plan for the Whole Study Area

1.3 Study Area

The Study Area is located in the southern part of Lao Peoples Democratic Republic (Lao PDR). It comprises an area of about 26,106 square km² lying between 14°N and 16.5°N latitudes and 105.2°E and 107°E longitudes. The Study Area covers two hundred (200) villages located in the following districts of the two provinces of Champasak and Saravan (**Figure 1.1**).

Champasak Province:

Bachiangchaleusook, Khong, Pathoomphone, Sukhuma and Sanasomboon (100 villages)

Saravan Province:

Saravan, Khongseudon, Lao Ngam, Lakhonepheng and Vapy (100 villages)

1.4 Study Framework

PHASE I:

A groundwater development policy was decided based on a tentative evaluation of groundwater potential and prediction of the future water requirement which were investigated through data collection, field survey, and analysis. The priority areas were selected and studied in Phase II and Phase III.

PHASE II:

Test wells equipped with handpumps and motorized pumps were constructed in order to study (1) the hydrogeologic features of the Study Area, (2) the construction methods and materials, and (3) the maintenance of the water supply systems. The detailed field survey was conducted, and the groundwater resource was evaluated in terms of quantity and quality based on the results of the hydrogeologic investigations.

PHASE III:

A groundwater development plan that covers the two hundred (200) villages in the Study Area was formulated. The recommendations for the future groundwater development in the entire Champasak and Saravan provinces were presented.

The level of water supply service is the *point source system* consisting of a tube well equipped with a handpump. The *communal faucet system* consisting of a well equipped with a motorized pump, a water tank, distribution pipes and faucets were considered in areas where handpump is unsuitable and electric power supply is available. The target year for the groundwater development plan is 2005 (**Figure 1.2**).

1.5 Study Team

For this Study, the Clean Water Institute (CWI) under the National Institute of Hygiene and Epidemiology (NIHE) of MOH, the Provincial Health Department Champasak (PHDC), and the Provincial Health Department Saravan (PHDS) acted as the counterpart agencies.

The Study was carried out jointly by the JICA Study Team experts and the personnel from the counterpart agencies.

JICA Study Team

Dr. Akira KAMATA	Team Leader/Hydrogeologist
Mr. Shoichi OHMORI	Hydrogeologist
Dr. Masao HIGUCHI	Hydrologist
Mr. Hiroshi IBARAKI	Geophysicist
Mr. Eiji TAKEMORI	Water Supply Engineer
Mr. Kensuke SAKATO	Civil Engineer (Well Maintenance)
Mr. Syoji MASUMURA	Socio-Economist
Mr. Precha CHUNTAKORN	Civil Engineer (Village Survey)
Mr. Akio MURAYAMA	Coordinator
Mr. Toru ITATSU	Coordinator

CWI

Dr. Nouanta MANIPHOUSAY	Deputy Director, NIHE
Dr. Khamvieng VILAPHANH	Medical Doctor
Mr. Kongkham SUTHAMMAVONG	Civil Engineer

PHDC

Dr. Vath KONGKEO	Deputy Director, PHDC
Mr. Kaysone THONGSAVANH	Chief, DWSES

PHDS

Dr. Khoutdara VONGSARAVANE	Director
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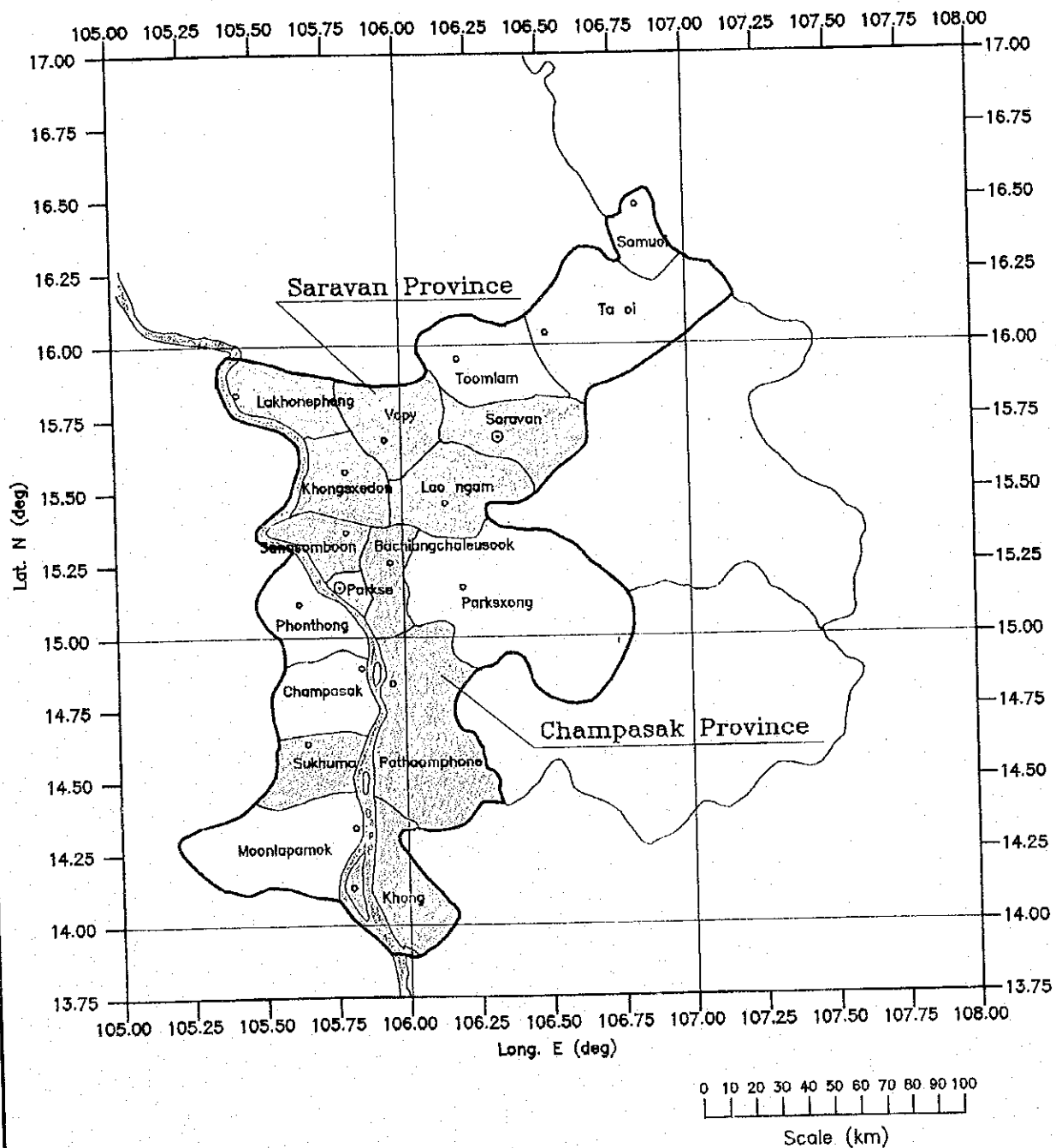


Figure 1.1

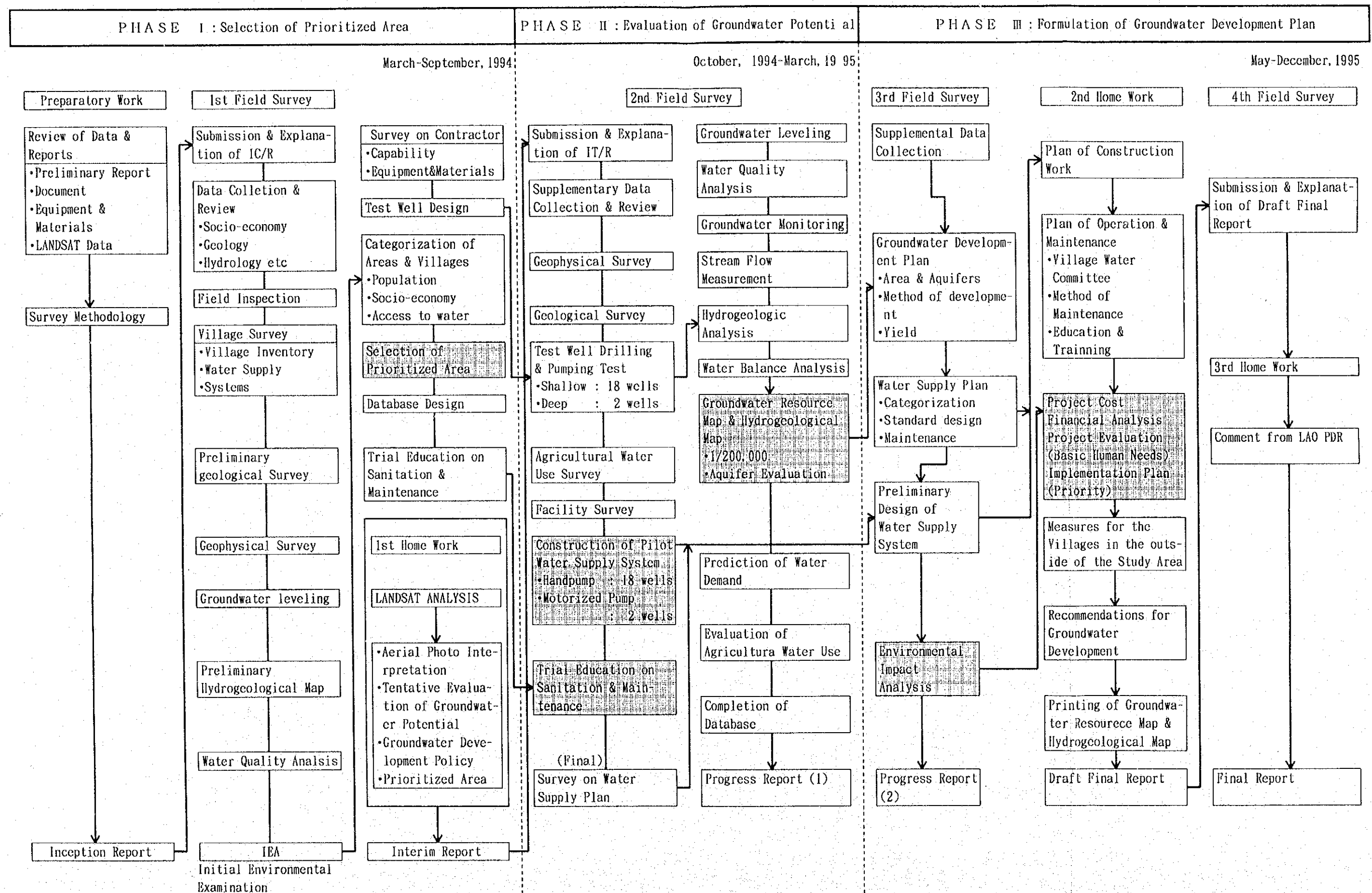
THE STUDY AREA MAP

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

KOKUSAI KOGYO CO., LTD.
CONSTRUCTION PROJECT CONSULTANTS, INC.

Figure 1.2 THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES IN LAO PDR



CHAPTER 2 NATURAL ENVIRONMENT

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CHAPTER 2 NATURAL ENVIRONMENT

2. 1 Climate

The climate in Lao is influenced by seasonal monsoon winds. During the northeast monsoon, from November to February, cold dry air from the China mainland enters the country, though considerably modified during its southward surge. From May to September, the southwest monsoon brings a stream of warm moist air from the Indian Ocean, causing abundant rain over the country.

The onset of the monsoon varies to some extent. The southwest monsoon usually starts in May and ends in September. The northeast monsoon normally sets in during November and ends in February, but occasional surges of the northeast monsoon may still be experienced in March up to early April.

From the meteorological point of view, the climate of Laos may be divided into four seasons:

- (a) Winter, or northeast monsoon season, from November to February. This is the mildest period of the year.

- (b) Pre-monsoon season or summer, in March and April. This is the transitional period from the northeast to southwest monsoon. It is hottest in April.

- (c) Rainy or Southwest monsoon from May to September, The Southwest wind from the Indian Ocean is most active in July and abundant rain occurs over the whole country. Peak of rainfall usually occurs in August.

- (d) Post-monsoon season in October. It is the transitional period from the southwest to the northeast monsoon season.

Dry weather over the plain persists in the cold season, November-February and throughout the hot season, but it is generally broken in early May with frequent rains and thunderstorms. Although rains generally continue from June to September, occasional dry spells occur in June. Maximum rainfall is in August and September.

The annual rainfall varies greatly over the country, about 1300mm in the northern valley to over 3700mm in the southern mountains. Heaviest rainfall usually occurring along the windward side of mountain ranges lying across the path of the southwest monsoon such as the Annamite Mountain Range(Figure 2.1.1).

According to Soukhathammavong(1992), rainfall measurements started from 1900 at Khong, Attapeu, Muongmai, Savannakhet, Vientiane, Luangprabang, Xiengkhouang ville. At present, there are 80 rainfall stations with at least 10 years of records in the whole country of Laos. An isohyetal map of annual precipitation is shown in Figure 2.1.2. Low rainfall zones are distributed in Xayaboury Province, the Namkhane Valley and Savannakhet Province. High rainfall zones are located in the northern and southern Highlands and Annamite Mountain Range. Annual mean precipitation of 80 stations in Laos is 1953 mm/year as shown in Table2.1.1.

Table 2.1.1 Monthly and Annual Precipitation in Laos

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Laos	8	21	41	107	231	316	403	408	281	91	32	14	1953
Basin	8	15	40	77	198	241	269	292	299	165	54	14	1672

* : The whole country of Laos with 80 rainfall stations

** : The lower Mekong Basin with 245 rainfall stations

On the average, a monthly value of more than 400 mm is observed in July and August. A monthly value exceeding 900 mm is observed in the highlands.

2.2 Topography

Lao may be divided into four physiographic regions, i.e., the mountain range, the undulated plain, the plateau and the alluvial low land along the Mekong River (Figure 2.2.1).

The mountain range, i.e., the Annamite Mountain Range stretches from north-west to south-east along the border of Vietnam forming steep slope and deep V-shaped valley. The mountain peak exceeds 2,000 m above mean sea level (msl).

The plain area, i.e., the Vientian Plain, the Savannaket Plain and the Champasak Plain are lower than 500 m in altitude and form a wide and a flat landform where Mesozoic sandstone and shale are widely distributed.

The Xiangkhoan Plateau (Plain of Jars) in Xiangkhon province and the Boloven Plateau in the southern part of Laos are wide and gently undulated plain with altitude of 1,000 m to 1,300 m.

The Alluvial low land is distributed continuously along the Mekong River and forms a narrow and flat plain in Vientian (200m high), Pakse (100m high) and Khon (80m high).

2.3 Geology

2.3.1 Geology of Indochina

Lao PDR is located inland of the Indochina Peninsula and geologically connected to Vietnam, Thailand, Cambodia and Myanmar (Figure 2.3.1). The Indochina Peninsula is geologically divided into Proterozoic basement rock area (Kontum Massif), strongly folded Hercynian Mountain, Indosinian Massif, slightly folded Paleozoic and Mesozoic area, and basaltic rocks and sedimentary basins of Tertiary and Quaternary ages.

The Kontum Massif is composed of metamorphic rocks and granitic rocks and exposed in southeast of Laos to Vietnam, north of Laos, west of Cambodia and east of Thailand. This Massif is extensively distributed and forms the basement of the Indochina Peninsula.

The Hercynian Mountain surrounds the exposed area of the Kontum Massif. The Hercynian Mountain became land through orogenic movement in middle to late Paleozoic age. The area forms a steep high mountain and is composed of strongly folded sandstone, slate and limestone etc.

The Hercynian Mountain is surrounded by the Indosinian Massif. The Indosinian Massif consists of strongly folded slate, sandstone and limestone. It became land through orogenic movement in Triassic age.

Slightly folded Paleozoic rock is extensively distributed in northeast of Cambodia, forming a plateau. Mesozoic sedimentary rocks are distributed widely in the central part of the Indochina Peninsular. Sedimentary rocks are composed of sandstone and red shale were deposited in the sedimentary basins of Jurassic to Cretaceous age. Evaporite also occurs in late Cretaceous age.

Basaltic rocks of Tertiary and Quaternary ages are sporadically distributed in Boloven Plateau in south of Laos, south of Vietnam and northeast of Cambodia, forming flat high plateau. Rocks consisting of alkali basalt lava were formed during volcanic activities in Pliocene to Pleistocene age.

Sedimentary basins of Tertiary and Quaternary ages are located in Cambodia, the Mekong Delta and the Central Plain of Thailand, where the rocks are composed of unconsolidated sand, gravel, clay and marl.

As mentioned above, the basement of the Indochina Peninsula is composed of Proterozoic metamorphic rocks. The land was originally formed by the orogenic movement from Paleozoic to Mesozoic age. Huge sedimentary basins were formed inland in the late Indosinian orogenic movement (Jurassic to Cretaceous period). Red shale, sandstone and evaporite were deposited in the basins.

Early Cenozoic era was the geologic time of the continent. The land was eroded, and peneplains occurred extensively. The upheaval movement became active again in the late Cenozoic age. Rivers like the Mekong River were eroded downwards, building up the present landform. Volcanic activities also took place during this period, forming the lava plateau. Relative subsidence areas became Tertiary and Quaternary sedimentary basins, forming the lowland.

2.3.2 Geology of Laos

All types of geologic members mentioned above are distributed in Laos (Figure 2.3.2). The stratigraphy and lithology of the formations and rocks are presented in Figure 2.3.3.

Proterozoic rocks

The oldest rocks in Laos are distributed sporadically in the vicinity of Vietnamese border and composed of metamorphic rocks such as migmatite and gneiss. These rocks form a part of Kontum Basement Massif. Few outcrops are also found in the border of Myanmar.

Paleozoic sediments

Lower formations (Cambrian to Devonian) surround the basement and composed of weakly metamorphic sand, slate, limestone and conglomerate in marine origin. Upper formations

(Carboniferous to Permian) are composed of sandstone, limestone and shale in marine origin. Huge limestone block of this formation forms a unique karst topography in Kammounan province. Few coal bearing continental sediments are also found in Vientiane, Pong saly and Saravan.

Permian and Triassic volcanic rocks

Rhyolitic and dacitic volcanic rocks and intrusive rocks are distributed in Paklay-Luangpravan Belt, Sam-noua and Cambodian border. These rocks occurred accompanied with the volcanic activities of Permian to Triassic age.

Mesozoic marine sediments

Marine sediments, consisting of sandstone, slate and tuff occurring in Triassic age, are distributed in the vicinity of the volcanics rocks mentioned above. Marine Triassic sediment exposed in Sekong valley nearby Cambodian border is the youngest of marine origin known in Laos.

Mesozoic non-marine sediments

These sediments consist of sandstone and red shale deposited in the intra-mountain sedimentary basins which were formed during the late Indosinian orogenic movement. The Vientiane Plain, the Savanakheth Plain and the Champasak Plain are composed of these sediments. Upper member contains evaporite.

Cenozoic sediments

Palaeogene sediments are not distributed in Laos. All of the area became land, and peneplains occurred widely in this age.

Neogene sediments are found in the small intra-mountain basin in northern part of Laos. The sediments consist of sandstone, mudstone, marl and lignite of freshwater origin.

Upheaval of land occurred widely in the late Cenozoic age, forming high mountain ranges. The Mekong River and its tributaries were eroded downwards during this period. Sand and gravel, which are deposited by flood are sporadically distributed along the river. In the south of Laos, the Boloven plateau was formed in this age.

Quaternary sediments is distributed in the intra-mountain basin located north of Laos. Terrace deposit is distributed along the Mekong River and its tributaries. It consists of gravel, sand, silt, loess and volcanic ash.

2.4 Hydrology

The Mekong River runs along the western side of Laos and forms the border with Thailand. Originating in China, the Mekong River and its tributaries drain regions in six countries : China, Burma, Lao PDR, Thailand, Cambodia and Vietnam. The Mekong River is one of the major

ivers in the world. The drainage area is 783,000 km², which ranks 30th among the largest drainage basins in the world. The length of the river is 4,300 km, which is the world's 15th longest river. The average discharge to the ocean is 15,000 m³/sec, which is the sixth largest in the world.

General hydrologic characteristics of the Mekong River are listed in Table 2.4.1. The discharge increases very rapidly downstream of the Chinese border. The main Mekong River between Nong Khai and Khong Chiam receives the flows from several large tributaries from the rainy mountain chain in Laos. The runoff increases down to Khong Chiam. The main Mekong River between Khong Chiam and Pakse receives the flow of Nam Mun from the Korat Plateau in Thailand. This increases the drainage area but does not contribute too much to the discharge. Thus the runoff decreases between Khong Chiam and Pakse. The main Mekong River receives the flows from the eastern mountains in Laos, and both the discharge and runoff increase downstream of Pakse.

The flow of the Mekong River and its tributaries is closely related to the rainfall pattern as shown in Figure 2.4.1. The flow begins to rise at the beginning of the wet season, April to May, and reaches a peak in August or September. The flow decreases after October and reaches a minimum in March or April. Generally about 85 % of the runoff occurs in the wet season.

Table 2.4.1 Hydrological Characteristics of the Mekong River

Hydrological Station	Drainage Basin (km ²)	Daily Discharge, ton/sec			Run-off mm/year
		Mean	Max.	Min.	
Chinese Border	160,000	-	-	-	-
Chiang Saen	189,000	2,693	23,500 [1966]	543 [1966]	448
Luang Prabang	268,000	3,973	25,200 [1966]	652 [1966]	467
Nong Khai	302,000	4,620	26,000 [1966]	701 [1966]	483
Mukdahan	391,000	7,583	36,400 [1978]	970 [1966]	612
Khong Chiam	419,000	9,352	54,300 [1978]	1,230 [1966]	703
Pakse	545,000	9,805	56,000 [1978]	1,060 [1966]	568
Stung Treng	635,000	13,800	65,700 [1939]	934 [1966]	686
Kratie	646,000	14,000	66,700 [1939]	1,250 [1966]	684

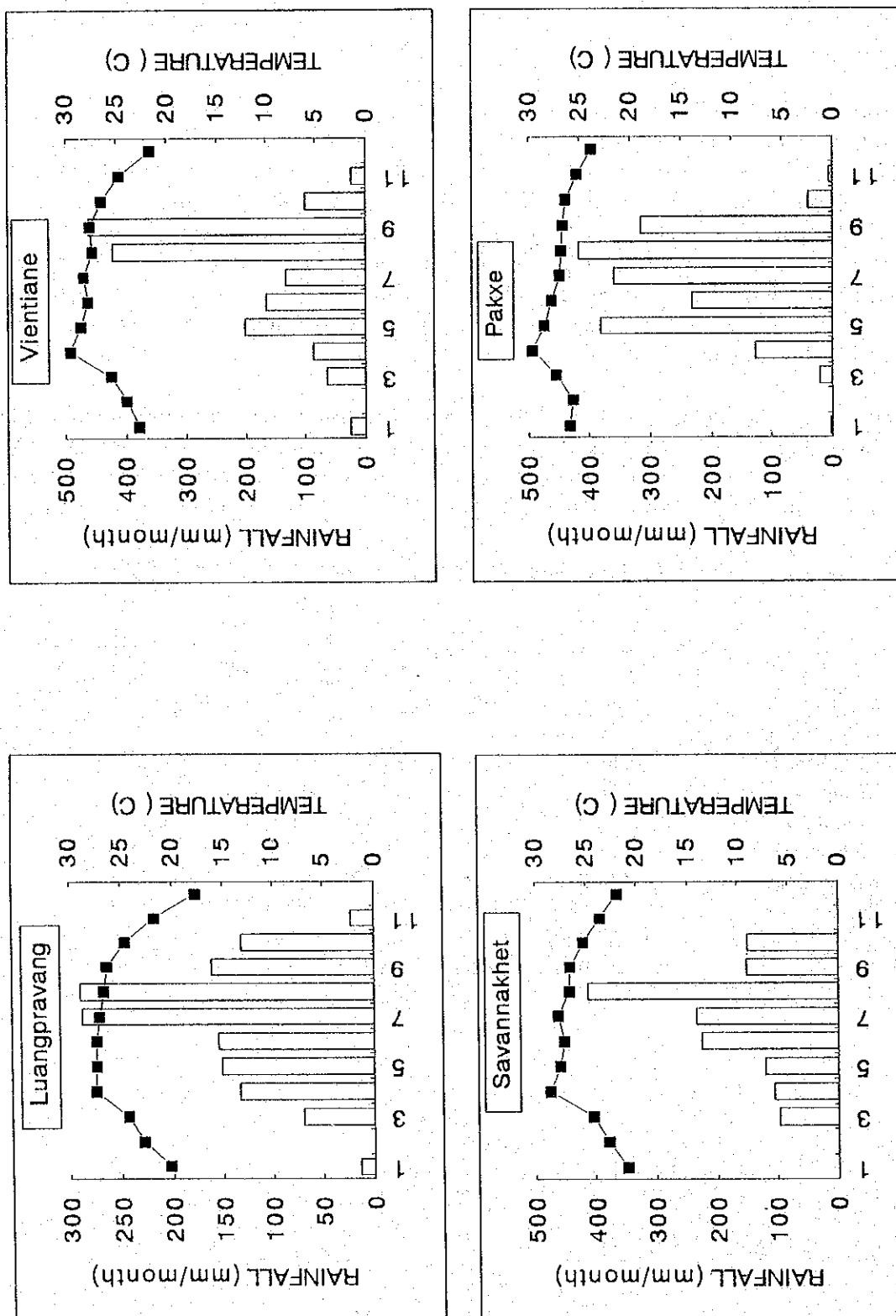


Figure 2.1.1 Climate Graphs in Laos

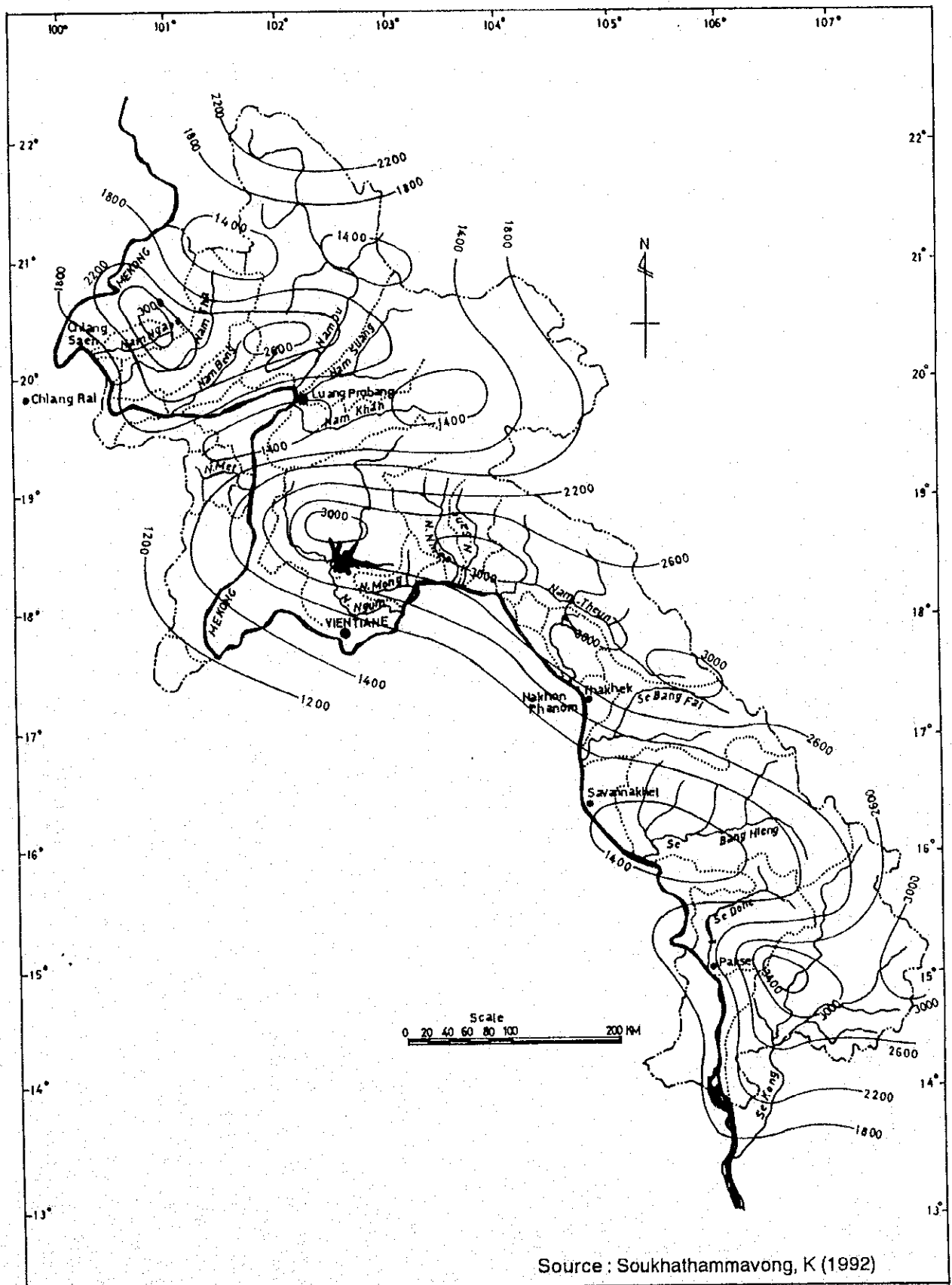
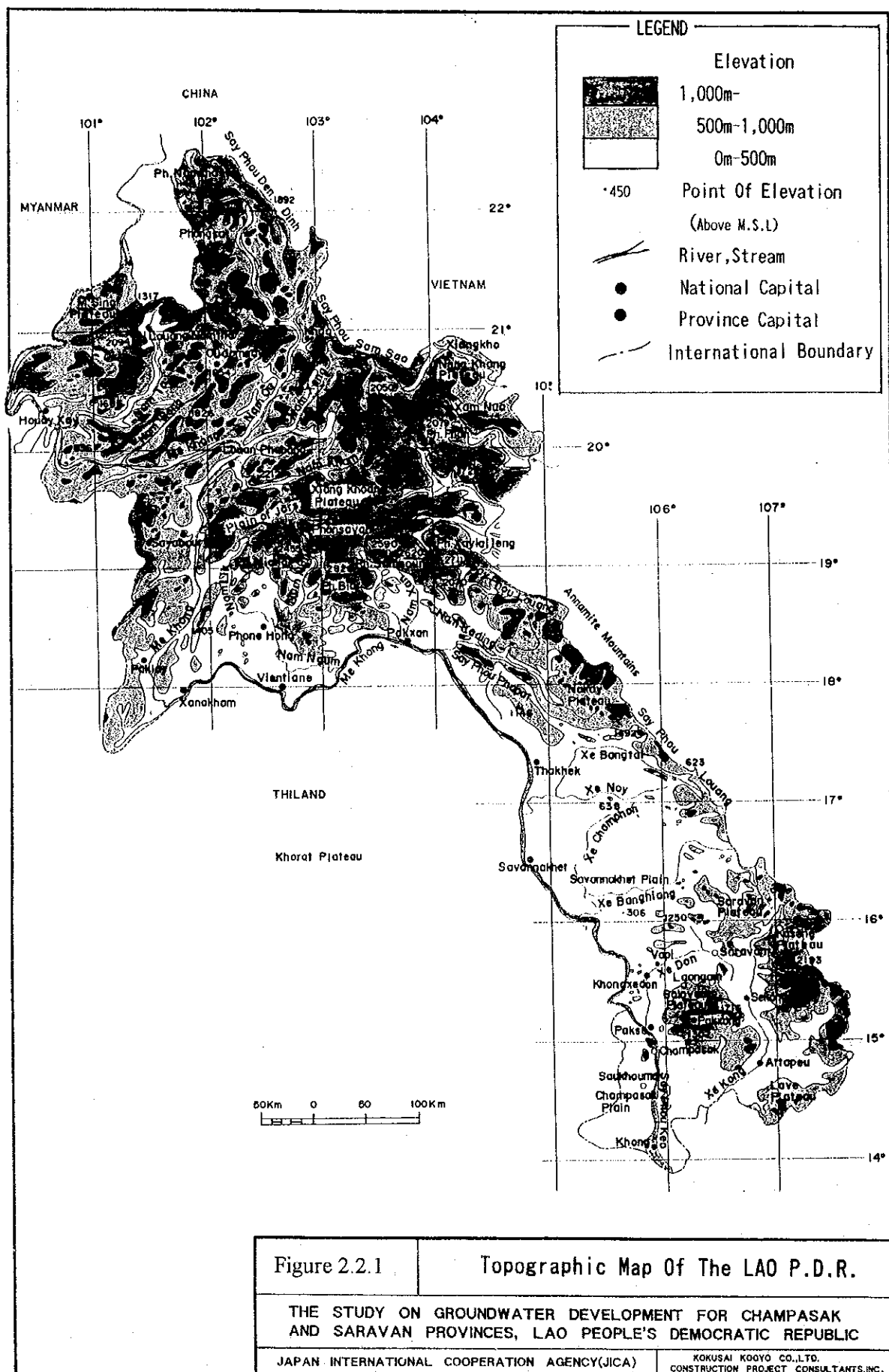


Figure 2.1.2 Isohyetal Map of Annual Precipitation in Laos



Modified: Workman,D.R.(1975)

Geological Map OF EURASIA(USSR1972)

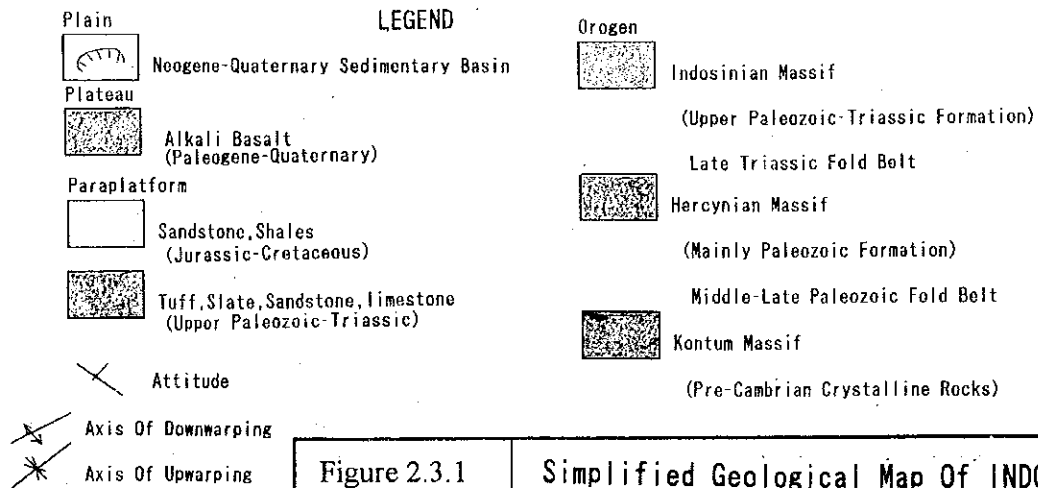
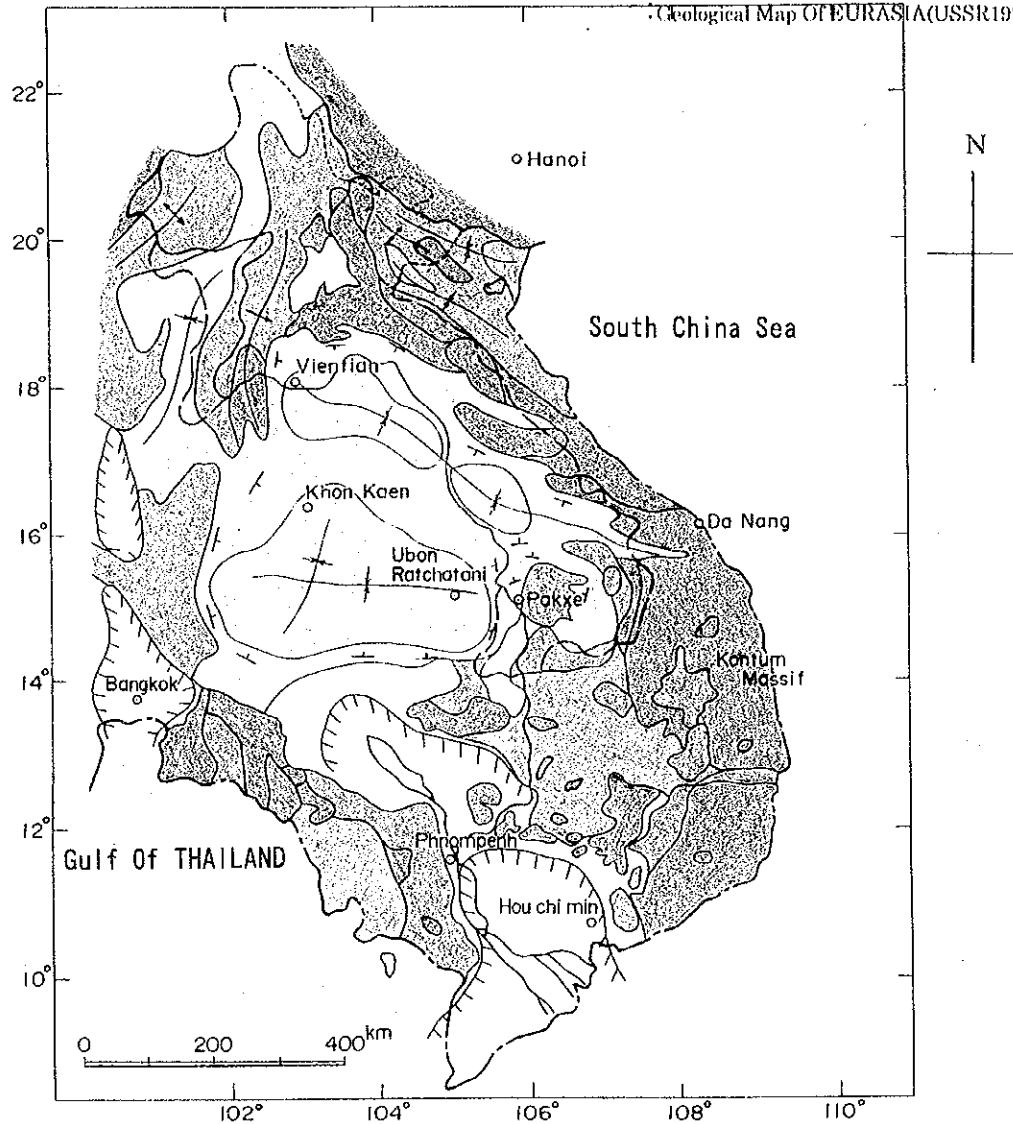


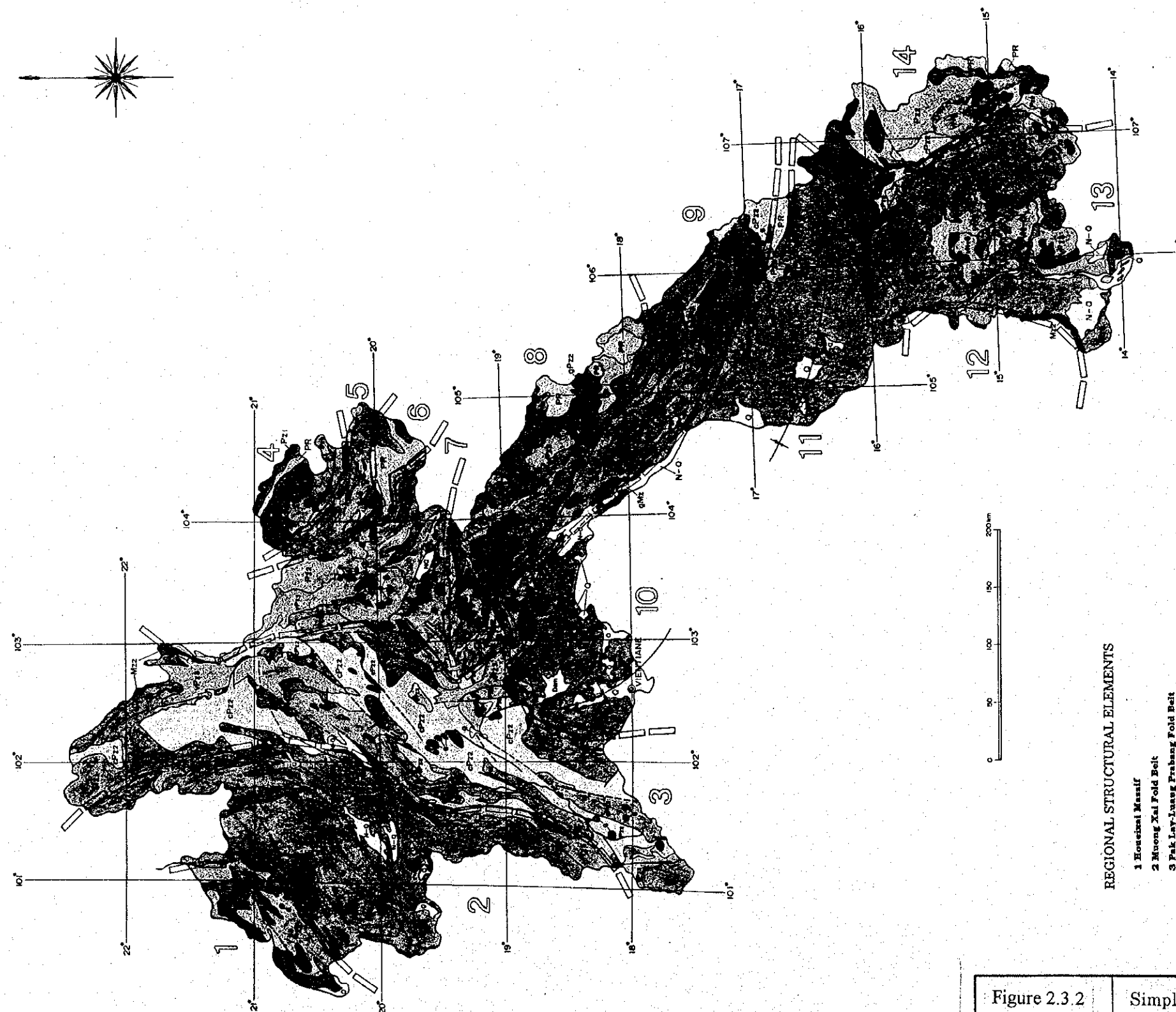
Figure 2.3.1

Simplified Geological Map Of INDOCHINA

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

KOKUSAI KOGYO CO.,LTD.
CONSTRUCTION PROJECT CONSULTANTS,INC.



REGIONAL STRUCTURAL ELEMENTS

- 1 Hoteizai Massif
- 2 Muong Xai Fold Belt
- 3 Pak Lay-Luang Prabang Fold Belt
- 4 Song Ma Massif
- 5 Xam Nua Truong(Basin)
- 6 Phu Hout Massif
- 7 Annamite Fold Belt
- 8 Rao Co Massif
- 9 Traungson Fold Belt
- 10 Vientiane Basin
- 11 Savannakhet Basin
- 12 Khorat Basin
- 13 Boloven Active Swell
- 14 Kontum Massif

Modified Geological And Mineral Occurrence Map
B.G.S.(1990-91).

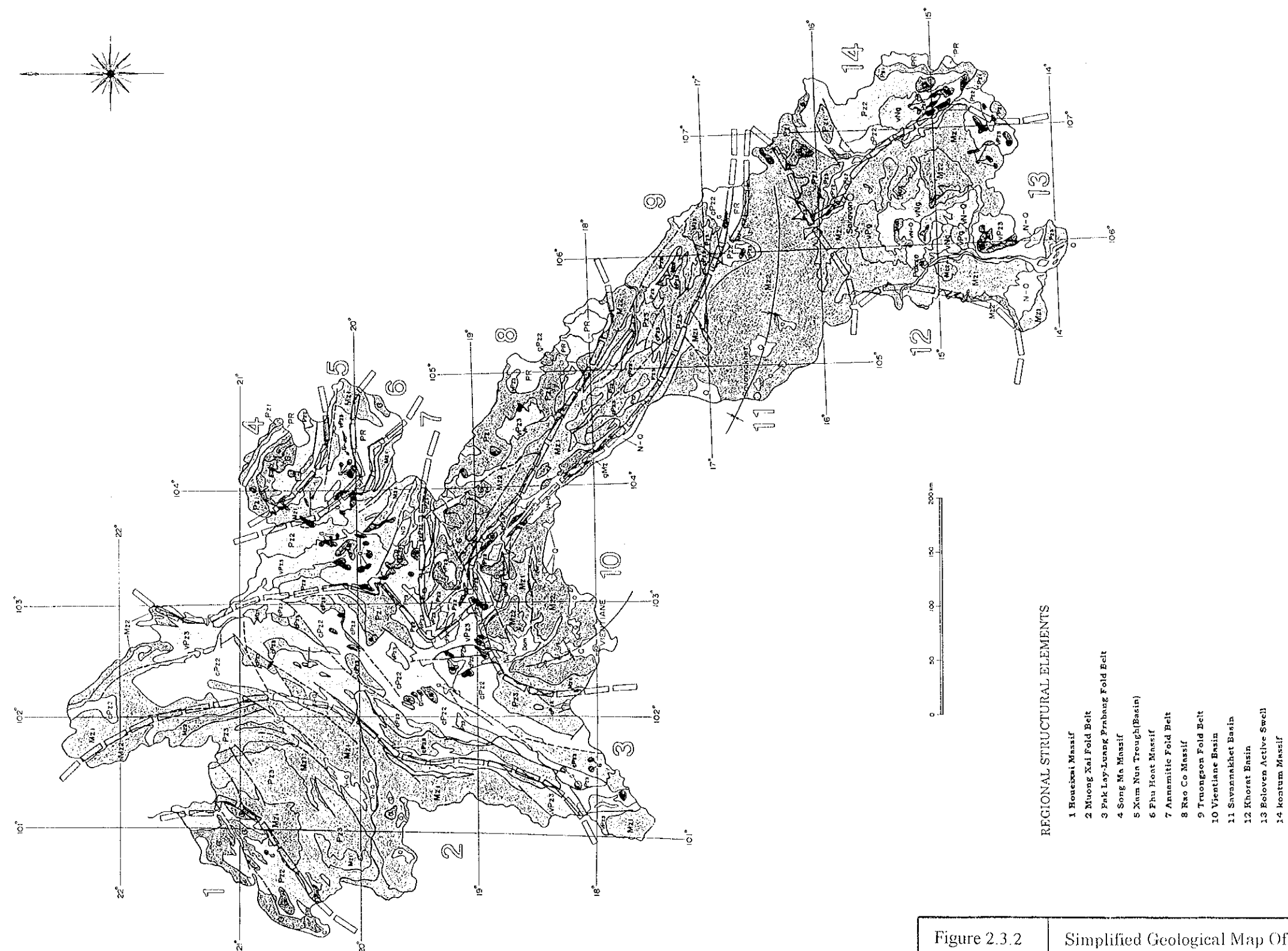
Figure 2.3.2

Simplified Geological Map Of LAO P.D.R.

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK
AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

KOKUSAI KOGYO CO.,LTD.
CONSTRUCTION PROJECT CONSULTANTS,INC.



Modified Geological And Mineral Occurrence Map
B.G.S.(1990-91).

Figure 2.3.2	Simplified Geological Map Of LAO P.D.R.
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.



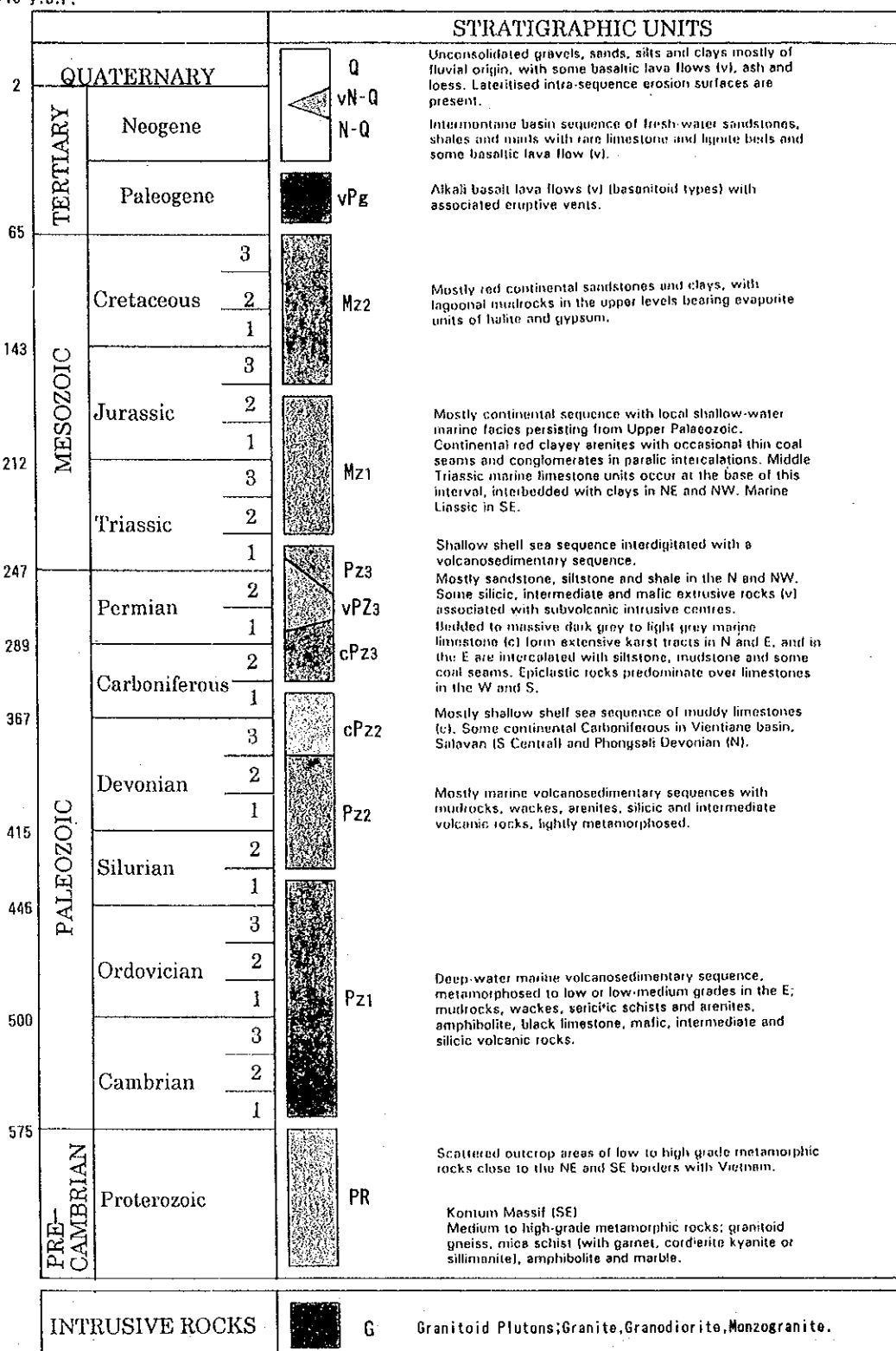
REGIONAL STRUCTURAL ELEMENTS

- 1 Houeiou Massif
- 2 Muong Xai Fold Belt
- 3 Pak Lay-Luang Prabang Fold Belt
- 4 Song Ma Massif
- 5 Nam Nua Trough(Basin)
- 6 Phu Hoa Massif
- 7 Annamite Fold Belt
- 8 Ruo Co Massif
- 9 Truong Son Fold Belt
- 10 Vientiane Basin
- 11 Savannakhet Basin
- 12 Kham Basin
- 13 Bolaven Active Swell
- 14 Bentue Massif

Modified Geological And Mineral Occurrence Map
B.G.S. (1990-91)

Figure 2.3.2 Simplified Geological Map Of Lao P.D.R.
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK
AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

*10⁶y.B.P.



Modified GEOLOGICAL AND
MINERAL OCCURRENCE MAP
B.G.S(1991).

Figure 2.3.3

Stratigraphy Of LAO P.D.R.

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK
AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

KOKUSAI KODYO CO.,LTD.
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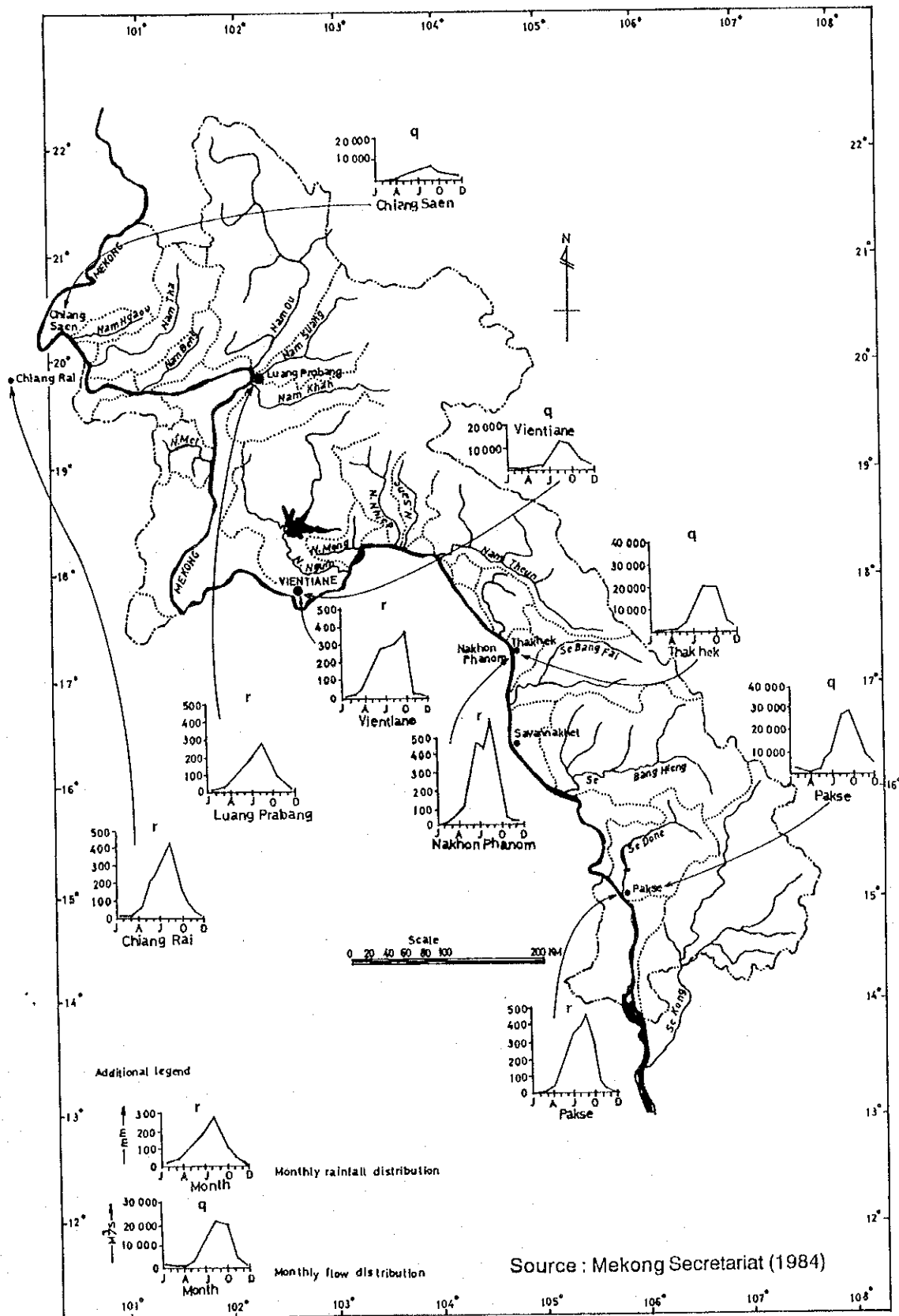


Figure 2.4.1 River Flow and Rainfall Pattern in Laos

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CHAPTER 3 SOCIO-ECONOMY AND WATER SUPPLY

3.1 Socio-economy in the Country

3.1.1 Land and Population

Lao People's Democratic Republic (Lao PDR) is located in the central part of Indochina Peninsula with a total land area of 236,800 sq km. It stretches more than 1,700 km from north to south, reaching 500 km east to west at the widest part in the north, against only 150 km in the southern province of Khammouane. Its neighbours are Vietnam to the east, Thailand to the west, China and Myanmar to the north and Cambodia to the south.

Although Lao PDR has no direct access to the sea, it has an abundance of rivers including a 1,500 km of the Mekong, where farming activities including rice cultivation are extensively carried out.

Lao PDR had a population of 3,584,803 at the time of the 1985 Population Census which have increased to the level of 4.14 million in 1990 (Population Count conducted in 1990). Based on the estimated population growth rate of 2.9 % per annum between 1985 and 1990, population of Lao PDR is estimated have reached 4.64 million in 1994 (refer to Table 3.1.1).

3.1.2 Local Administrative Divisions

Lao PDR is administratively divided into 16 provinces and Vientiane municipality. These provinces consists of 126 districts (muong) which are further sub-divided into 11,883 villages (ban). Provincial authorities have a fairly high degree of autonomy provided that they adhere to the directives and policy guidelines laid down by the central government. Presidents of provinces have the same rank as ministers. Provincial administration is organized similarly to the central government and divided into department corresponding to central government ministries.

Administrations at the district as well as local level are weak due to personnel and financial constraints. Those factors such as inadequately and insufficiently trained personnel, insufficient financial resources, and difficulties of communication between districts and provinces hampers effective implementation of the program.

3.1.3 Economic Situation

(1) Economic Growth Rate

Gross Domestic Product (GDP) of Lao PDR increased from Kip 574.7 billion in 1989 to Kip 728.1 billion in 1993 in terms of 1990 fixed prices which showed a real growth rate of 6.1 % per annum. Annual economic growth rate has been 6 to 7 % during 1989 and 1993, except the 1990-1991 period when growth rate was only 4 % (refer to Table 3.1.3a). The GDP between 1992 and 1993 has grown at the favorable rate of 6.8 %. This high growth rate has been contributed by the manufacturing sector (growth at 9.0 %) and services sector (growth at 7.0%). Agricultural GDP during the same period has been low due to unfavorable weather conditions.

(2) Inflation Rate

The consumer price index (CPI) computed for the Vientiane municipality decreased from the level of 75.9 % in 1989 to 19.2 % in 1990, and further decreased to the level of 6.3 % in 1993. Lower level of the consumer price index in 1993 is mainly due to lower prices of agricultural products.

(3) Trade Balance

Import amount in Lao PDR exceeded export amount every year, showing a chronic trade deficit in this country. In 1993, the country imported merchandise valued at US\$344.5 million and exported the same valued at US\$158.6 million with a trade deficit of US\$185.9 million. Principal exports in Lao PDR are wood products with US\$38.2 million, accounting for 24 % of the total exports. Other exports included textiles and clothes with US\$25 million and electricity with US\$18.2 million.

The principal imports are machinery and raw materials with US\$185.4 million, accounting for 53.7 % of the total imports. Other imports included rice and other foods with US\$30.5 million, imports related to foreign aids with US\$24.5 million and petroleum with US\$19.2 million. (Refer to Table 3.1.3b)

(4) Public Finance

The fiscal year of Lao PDR starts from 1 October and ends on 30 September. Total revenue and grants received in 1993 amounted to Kip 144,526 million. Total expenditure incurred amounted to Kip 170,514 million, yielding an overall budget deficit of Kip 25,989 million.

On the revenue side, taxes collected amounted to Kip 85,928 million, non-tax revenues amounted to Kip 27,328 million and Kip 32,270 million in grants was received by the state. Current expenditures amounted to Kip 104,940 million and the capital expenditures amounted to Kip 65,574 million.

3.1.4 Economic Development Plan

(1) Development Policy

The political report endorsed by the Fifth Party Congress held in 1991 set the policy directives for its medium-term policy framework and the public investment programme for the 1991-1995 period. A major element of the plan is the continuation and consolidation of economic reforms. The medium-term development objectives are to:

- (a) Consolidate the macroeconomic reforms to ensure a smooth transition to a market-oriented economy;
- (b) Improve the efficiency and performance of the public sector;
- (c) Expand economic, social and physical infrastructure;

- (c) Expand economic, social and physical infrastructure;
- (d) Develop and adopt sustainable resource and conservation management approaches.

In accordance with the development policy as mentioned above, the following activities would be necessary.

- (a) continuation of economic adjustment, stabilization and growth;
- (b) growth of agricultural outputs and diversified exports;
- (c) improved tax efforts and collection and growth of public and private saving;
- (d) privatization of State enterprises;
- (e) growth of private, foreign and joint-venture businesses;
- (f) growth of agricultural extension and community development and involvement of women in agriculture and small industry;
- (g) availability of socio-economic data on a broadened and timely basis.

(2) Investment Plan

In order to achieve the objectives as mentioned above, the Government prepared the public investment plan for the period 1991-1995 amounting to US\$745 million (refer to Table 3.1.4). Communications sector accounted for the largest share (37.6%), followed by electricity sector (20.6%), agriculture and forestry sector (13%), education sector (8.7%), public health sector (5.6%), telecommunications sector (4.5%), water supply sector (3.5%), and others.

3.1.5 Health Sector

(1) Health Administration

Health care services in Lao PDR has been delivered by the Ministry of Health with technical assistance to each provincial health departments. Provinces and districts are administratively decentralized and decide their own health priorities, staff requirements and budget. However, each level lacks the technical and financial resources to support the level below it.

The minister for health is assisted by four vice-ministers who are responsible for Department of Curative and Preventive Services, Department of Training, Department of Organization and Human Resources, and Department of Pharmaceutical and Medical Equipment, respectively. At provincial and district level, provincial and district Departments of Health provide health services. There are 1,303 doctors and 2,789 assistant doctors at central level, while 665 doctors

and 2,053 assistant doctors are registered at provincial level including the Vientiane municipality in 1991.

(2) Level of Health Service

One of the main objectives of health services is to reduce the mortality rate. The mortality rate in 1990 was 16 per 1,000 in Lao PDR which was the highest among the neighbouring countries: Thailand (7), Vietnam (9), and Myanmar (9). Life expectancy was 49 years in Lao PDR which was the lowest among the neighbouring countries: Thailand (66 years), Vietnam (67 years), and Myanmar (61 years).

In order to improve the health services in the country, the Ministry of Health is trying to strengthen and to improve the quality of health services in rural areas through the training of additional medical personnel to be assigned to the rural areas, with the emphasis on preventive activities which would meet the basic health need of the rural communities and a self-help campaign with the participation of community people.

However, judging from the health indicators as mentioned above, the level of health services in Lao PDR is considered to be among the lowest compared to those of other countries.

(3) Major Issues in Health Sector

1) Higher Rate of Infant and Child Mortality

As mentioned in the preceding section, Lao PDR ranks among the worst in mortality rates. It is noteworthy that higher mortality rates are reflected particularly on the infant mortality with 103 per 1,000 (1990) and the under five mortality with 156 per 1,000 (1989). Infant and the under five deaths account for more than 50 % of all the deaths in the country. Most deaths of children are due to malaria, acute respiratory infection (ARI), and diarrhoea. Leading causes of morbidity of children are ARI, diarrhoea and malaria. Most of these deaths and diseases are due to lack of clean water, bad sanitation, malnutrition and inadequate health services.

2) Higher Rate of Maternal Mortality and Morbidity

Maternal mortality in Lao PDR was recorded at 545 per 100,000 live births on the average in 1990, ranging from 150 per 100,000 in Vientiane Municipality to more than 900 per 100,000 in the provinces. It is estimated that in every 25 women of child bearing age there will be 1 who dies from causes related to pregnancy and 10 to 15 others who will suffer from morbidity such as tuberculosis, malaria and diarrhoeal diseases. The main causes of maternal mortality and morbidity are too many children, malnutrition, heavy work loads, low literacy levels, and lack of essential drugs.

3) Lack of Clean Water and Bad Sanitation

The percentage of the urban population having access to clean water is 80 %, but in rural areas the percentage is only 10 to 15 %. The population, especially women and children, have to spend

energy and time in water collecting. Water borne diseases are common due to lack of clean water. In rural areas, the percentage of latrine utilization is very limited. Installation of pit latrines and improvement in sewage disposal would be necessary to reduce the incidence of diseases.

3.1.6 Socio-economy in Champasak and Saravan Provinces

(1) Socio-economy in Champasak Province

Champasack province is located in the southern part of Lao PDR. It is bordered with Thailand to the west, with Cambodia to the south, with Attapeu and Sekong provinces to the east, and with Saravan to the north. It has a total land area of 15,825 sq km with a total population of 403,041 in 1985. Based on the 1985 Census, the population density was 26 persons per sq km which was the second highest after Vientiane municipality (97 persons per sq km). The population consisted of 195,240 male (48.4%) and 207,801 female (51.6%) with the sex ratio of 94. The reason for the lower sex ratio is mainly due to the out-migration of male labor force to urban areas. Out of the total population, productive population (the population of 15 to 64 years old) account for 204,616, of which economically active population or labor force account for 158,998 consisting of 72,371 male and 86,627 female. A large part (more than 90 %) of the labor force are engaged in agriculture sector. The total households in the province were 68,799 with an average family size of 5.86. (Data are based on the 1985 Census).

Champasack province is administratively divided into 10 districts. The provincial government office is located at Pakse. The districts are further sub-divided into 789 villages. The provincial government has a fairly high degree of autonomy as far as it follows the directives and policy guidelines laid down by the central government. Provincial administration is organized similarly to the central government and divided into departments corresponding to central government ministries.

Out of 1.43 million ha of land area in Champasak Province, permanent agricultural land, forest land and other land account for 13%, 61%, and 26%, respectively. Permanent agricultural land in Champasak Province includes 121,500 ha of rice paddy. Land use in Champasak Provinces is shown in Table 3.1.6.

(2) Socio-economy in Saravan Province

Saravan province is located in the southern part of Lao PDR. It is bordered with Thailand to the west, with Champasack province to the south, with Vietnam to the east, and with Savannakhet to the north. It has a total land area of 10,285 sq km with a total population of 187,515 in 1985. Based on the 1985 Census, the population density was 18 persons per sq km which was higher than the national average of 15 per sq km. The population consisted of 88,240 male (47.1 %) and 99,275 female (52.9 %) with the sex ratio of 89. The reason for the lower sex ratio is mainly due to the out-migration of male labor force to urban areas and result of intense war. Out of the total population, productive population (the population of 15 to 64 years old) accounted for 96,454, of which economically active population or labor force accounted for 87,049 consisting of 38,889 male and 48,160 female. Most (more than 90 %) of the labor force are engaged in

agriculture sector. The total households in the province were 31,506 with an average family size of 5.95. (Data are based on the 1985 Census).

Saravan province is administratively divided into 8 districts. The provincial government office is located at Saravan. The districts are further sub-divided into 682 villages. The provincial government has a fairly high degree of autonomy as far as it follows the directives and policy guidelines laid down by the central government. Provincial administration is organized similarly to the central government and divided into departments corresponding to central government ministries.

Out of 1.03 million ha of land area in Saravan Province, permanent agricultural land, forest land and other land account for 7%, 54% and 39%, respectively. Permanent agricultural land in Saravan Province includes 54,200 ha of rice paddy. Land use in Saravan Province is shown in Table 3.1.6.

3.2 Water Supply Organizations and Situations

3.2.1 Institutions

There are three different ministries which are responsible for water supply in Lao PDR. They are the Ministry of Communication, Transport, Post and Construction (MCTPC), the Ministry of Public Health (MPH) and the Ministry of Agriculture and Forestry (MAF).

The MCTPC supervises the Lao Water Supply Enterprise (Nam Papa Lao) which operates and maintains the systems in large municipalities such as Vientiane, Luang Prabang, Savannakhet, Pakse and Saravan. MPH is responsible for overall management of rural water supply systems through the Clean Water Institute (CWI) which reports to the National Institute for Hygiene and Epidemiology. MAF is promoting the development of surface and groundwater for irrigation purposes.

(1) MCTPC

The MCTPC controls water supply, sewerage and sanitation in urban areas. The municipal water supply is being implemented by its implementing agency, the Nam Papa Lao (NPL) which functions as the national water supply enterprise. The NPL has two functions, i.e. (i) operational management of the water supply schemes for Vientiane; and (ii) provision of technical assistance to Provincial Nampapas (PNPs). PNPs are under the Provincial Departments of Communication, Transport, Post and Construction. The water works of the provincial capitals including Pakse and Saravan are also controlled by the PNPs.

(2) MPH

Since 1981, the MPH is responsible for overall management of rural water supply systems through the Clean Water Institute (CWI) which reports to the National Institute for Hygiene and Epidemiology (NIHE). The CWI provides central level coordination and training to the 16 provincial departments which are responsible for planning, logistics and supervision of all rural

water supply and sanitation activities in their province.

(3) CWI

The CWI was created on the occasion of the water decade in 1982 with the assistance of UNDP, WHO and UNICEF and has been entrusted with the following functions.

- (i) overall planning and coordination of national water supply and sanitation activities including receipt of imported supplies and their distribution to the provinces;
- (ii) training of technicians in the design and construction of water supply and sanitation installations; and
- (iii) research, development and dissemination of various technologies.

CWI consists of 3 sections; (i) Technical Administration, Statistics and Planning Section; (ii) Water Supply Section, and (iii) Environmental Health and Sanitation Section. Water Supply Section is divided into Surface Water Subsection and Groundwater Subsection.

The role of the Surface Water Subsection are:

- (a) Investigation of water sources and feasibility of development in mountainous area;
- (b) Site survey and designing of water supply system with communal faucet;
- (c) Technical guidance on construction, operation and management of water supply systems in the provinces and districts;
- (d) Decision making on the planning priority.

Groundwater Subsection manages technical matters on groundwater development in the province and district levels, and guides technically the following.

- (a) Well drilling method (manual/mechanical) under several geologic conditions;
- (b) Hand pump installation, operation and maintenance;
- (c) Investigation for well site;
- (d) Decision making on the planning priority.

(4) PHD

Provincial Health Department (PHD) provides public health services to the rural communities. PHD's Water Supply and Environmental Sanitation Section (WES) is responsible for providing rural water supply and sanitation services. WES is divided into Rural Clean Water Supply Subsection and Environmental Sanitation Subsection. Rural Clean Water Supply Subsection of the WES is responsible for the supply of clean water in rural areas including the construction and maintenance of boreholes with hand pumps. Equipment and materials for the drilling of boreholes and installation of handpumps are provided by the CWI.

At District level, each District Public Health Office has some WES staff, of which only one or two staff is responsible for rural water supply. Activities for rural water supply at District level is limited due to lack of staff and equipment.

Organization charts of MPH and CWI are presented in Figures 3.2.1a and 3.2.1b.

(5) MAF

The Irrigation Department of MAF controls policy on water supply for irrigation and manages operation and maintenance of irrigation facilities. MAF is responsible for developing groundwater for irrigation purposes in the country.

3.2.2 Present Water Supply Situation

(1) The 3rd 5-Year Plan of MOH

The medium-term plan of development and the Public Investment Programme (PIP 1991-1995) of the Lao PDR intends to invest more to improve education and public health. In accordance with this policy, the MOH launched its Third Five Year Plan (1992-1996), and its goals and major objectives are highlighted under the slogan "Health for all by the Year 2000". The goals of the Third Five Year Plan are:

- 1) To reduce the infant mortality rate by 20 % by 1996
- 2) To reduce the maternal mortality by 10% by 1996
- 3) To reduce the second grade malnutrition among children under 5 to 40% by 1996.
- 4) By 1996, an additional one million persons in rural areas will have access to safe water, bringing the total to 40 % of the rural population

(2) Urban Water Supply

1) General

At present, there are only seven urban water supply schemes in the country. Vientiane, Pakse, Savannakhet and Luang Prabang have piped water supply schemes with treatment works, while Saravan, Attapeu and Oudomxay have only elementary piped supply schemes with no treatment works. The coverage of water supply services in the towns is still low, about 60% in Vientiane and less than 50% in the other towns.

Although drinking water is served to about half of urban population, the system shows high rate of leakage (25 to 30%) due to lack of proper design, construction and maintenance. In addition, water quality is inferior from the viewpoints of WHO drinking water standard.

In order to improve such situations, MCTPC has initiated a program which aims at construction of urban water supply systems in the major cities of all provinces by mid-1990s. Presently, a

feasibility study covering seven major cities in northern part of the country is being conducted as a part of this program.

2) Pakse City Water Supply

Pakse is the capital of Champasak Province and the major town in the southern region. Pakse has a population of about 60,000 in 1994.

Pakse city water supply system was constructed during 1973 and 1975 under French assistance. At present, the volume of water treated is about 3,200 m³ to 5,000 m³ per day for a total production of 1,804,856 m³ per year. Of this total, 1,196,315 m³ was sold in 1993. The total amount of water supplied to households is 4,128 m³ per day (for about 30,000 persons). The water supply ratio is about 50% in the city.

The Pakse Waterworks in Champasak Province, which is a state enterprise under the Provincial Department of Communication, Transport, Post and Construction in Champasak Province, has 114 employees with an annual income of 116 million Kips in 1992.

The water rates imposed by the Pakse Waterworks are as follows:

	Unit: Kips per m ³		
	Domestic Use	Government Use	Industrial and Commercial Use
0 to 10 m ³	72	100	111
11 to 40 m ³	84	111	139
over 41 m ³	95	128	150

The city's water demand increases annually thereby necessitating the rehabilitation of existing treatment facilities. For this reason, the Pakse Waterworks Improvement Project was launched. Targetted for completion in 1996, this project construct a new water treatment plant capable of treating 7,500 m³ per day and rehabilitate the existing plant.

The water supply plan for the target year (1994) is shown as follows.

Volume of water to be treated:	1.76 million m ³
Volume of water to be sold:	1.23 million m ³
Expected total income:	119 million Kips

3) Saravan City Water Supply

Saravan is the capital of Saravan Province and also the capital of Saravan District. Saravan city has an estimated population of about 6,000 which is approximately 10% of the total population of Saravan District in 1994.

The combined distribution system employed by the Saravan Waterworks is a linear-branched type network constructed at the center of the city. The main conveyance steel pipe is 100 mm in

diameter, and approximately 8,000 m in total length. In 1993, the volume of water treated was 600 m³ per day, and the total amount supplied to households was 603 m³ per day (for about 3,500 persons). The water supply connections of the Saravan Waterworks serve about 30% of the city population. The city has no residential zoning. Most residences are built along main roads, and the water supply distribution lines are constructed accordingly.

The Saravan Waterworks which is under the Provincial Department of Communication, Transport, Post and Construction also serves the water supply facility (237 houses) of the town of Laongam. The Saravan Waterworks employs 18 people and its annual income was 34 million Kips in 1993.

For household and government uses, the water charge of Saravan Waterworks is 150 Kips per m³ and that of Laongam Waterworks is 100 Kips per m³.

Technical assistance from the Asian Development Bank for a new water supply development project commenced in April 1994, aiming at the following goals:

- (a) Service population: 8,000 people by the target year 2001
- (b) Water treatment volume: 2,000 m³ per day at a constant 24-hour production
- (c) A total construction cost: US\$ 0.8 million
- (d) Commencement of the construction of intake and treatment plants: August 1994
reservoir (2,000 m³): October 1994
- (e) Completion of distribution system: by 1996

(3) Rural Water Supply

1) General

Approximately 85% of the population is living in rural areas. Although there is no definite data on the coverage of clean water supply in rural areas, it is estimated that the coverage for improved facilities (such as shallow wells, tubewells, gravity feed systems, and piped water supplies) is 10 to 15% (UNICEF Report, 1991). As a result, most of these people have to rely on their own means of supply, mainly from nearby surface water sources, such as the Mekong river and its tributaries, streams, ponds and groundwater from hand-dug wells. But few of these water sources are sustainable enough to last throughout the dry season.

2) Champasak Province

(a) General Situation

Up to 1990, the Provincial Health Department, Champasak (PHDC) simply distributed through its Water Supply and Environmental Sanitation Section (WES), hand dug wells in the rural communities in order to secure water because of lack of technology, machines and materials. However, not many dug wells were drilled because many communities were not financially capable. The depth of dug well is generally 10 m below ground face and due to seasonal and local

fluctuation of groundwater level many dug wells dry up in the dry seasons. In order to secure water all the year round, dug wells must be drilled at least 16 to 20 m, but the cost of digging may double which will be well beyond the financial capability of the community.

Although water can be secured in the rainy season, dug wells are exposed to potential contamination of human and livestock wastes because most of them are located near rice fields or ground depressions for easy collection of water. Not properly maintained well will therefore be a source of water borne diseases.

In 1992, the PHDC was provided with two drilling rigs, hand pumps, vehicles and spare parts by the UNICEF. Since that time, the PHDC has changed its policy on rural water supply and started the development of hand pump wells instead of dug wells. Maximum drilling capacity of the rig provided by the UNICEF was 40 m deep with 4" to 8" diameter casings.

(b) Policy of Water Supply

The community water supply policies in Champasak Province are:

- 1) The use of tubewells equipped with Tara and India Mark III handpump is being promoted because more clean water can be available at relatively cheap cost, as compared with that of using dug wells and river water.
- 2) In terms of distributing clean water in the villages, individual handpump wells are more effective than one large water supply system. Tara handpump is suitable for this purpose and being promoted in the village.
- 3) Existing dug wells can be used for livestock and emergency purposes. Necessary maintenance of dug wells such as reconstruction of well frame and removal of sand accumulation, must be carried out.

(c) Present Water Supply Situation

The present rural water supply situation in Champasak Province is as follows:

District	Population in 1993	Served by Handpump	Served by Dugwell	Served Popu- lation Total	Rate of Service
Sanasomboon	45,257	5,100	4,800	9,900	21.9%
Bachiang	26,810	0	160	160	0.6%
Pathoumphone	37,218	600	2,560	3,160	8.5%
Sukhuma	31,289	750	2,240	2,990	9.6%
Khong	68,298	6,042	2,240	8,282	12.1%
Sub-total	208,872	12,492	12,000	24,492	11.7%
Phongthong	61,615	10,650	8,640	19,290	31.3%
Champasak	42,830	3,150	8,640	11,790	27.5%
Moonlapamok	27,090	0	960	960	3.5%
Pakhsong	35,505	0	720	720	2.0%
Pakse	62,120	1,500	320	1,820	2.9%
Total	438,032	27,792	31,280	59,072	13.5%

Source: Provincial Health Department, Champasak, 1994

(d) Drilling Achievement

Drilling achievement from November 1993 to April 1994 is as follows:

District	No. of Drilling	No. of Production Well	Average Depth (m)	Cost per Meter (Kips)
Phonthong	105	90	25-30	8,500
Champasak	22	17	23-30	8,500
Sanasomboon	9	4	30-35	8,500
Pakse	2	0	30	8,500

(e) Issues on Community Water Supply

- i) Implementation depends on the assistance from UNICEF and other donors. Changes in annual budget occasionally cause trouble in supply and repair of equipment and materials.
- ii) The drilling often encounters unproductive aquifer or aquifuge due to lack of technology and equipment in groundwater investigations. The required equipment was not accepted by the Government.
- iii) Increase of budget for drilling operations and manpower was also not accepted.

- iv) Children filled three suction pumps with sands. Due to the carelessness of the engineers, the pumps heads were not firmly capped after installation.

(f) Water Supply Plan

Water Supply and Environmental Sanitation Section (WES) of PHDC was provided with another 2 units of drilling rigs in 1995 by UNICEF and they have an ambitious plan of installing 305 units of handpumps during June and December 1995 in Champasak Province. The drilling works during June and July, 1995, however, resulted in only 11 boreholes along the main roads. It is unlikely that 305 units of handpumps will be installed by the end of December, 1995.

WES is trying to increase the coverage of clean water supply by installing boreholes with Tara and India Mark III handpumps. Their target is to achieve the coverage of 61% by the end of 1996.

3) Saravan Province

(a) General Situation

Up to 1990, the Clean Water Supply Subsection of the Provincial Health Department, Saravan (PHDS) mainly promoted the use of hand dug wells and rain water jars in the rural communities in order to secure water. In 1993, the UNICEF provided equipment and materials for well construction, and a total of 10 wells equipped with India Mark II hand pumps were built in Saravan, Khongxedon and Toumlam.

(b) Present Water Supply Situation

The present rural water supply situation in Saravan Province is as follows:

District	Population in 1993	Served by Handpump	Served by Dugwell	Served Population Total	Rate of Service
Lakhongpheng	27,884	1,050	1,920	2,970	10.7%
Khongxedon	43,293	3,150	8,800	11,950	27.6%
Vapy	26,912	600	7,920	8,520	31.7%
Saravan	58,980	1,050	10,160	11,210	19.0%
Laongam	41,849	150	0	150	0.4%
Sub-total	198,918	6,000	28,800	34,800	17.5%
Toumlam	14,927	10,650	7,520	18,170	121.7%
Ta Oi	18,589	3,150	10,160	13,310	71.6%
Samuoi	7,731	0	0	0	0.0%
Total	240,165	19,800	46,480	66,280	27.6%

Source: Provincial Health Department, Saravan, 1994

(c) Drilling Achievement

As of February 1994, fourteen wells were drilled in 6 villages of Khongxedon and Lakhongpheng. However, only eight wells were successful. Main reason for this is due to lack of knowledge and equipment in groundwater investigations.

(d) Water Supply Plan

WES is trying to increase the coverage of clean water supply by installing tubewells equipped with Tara and India Mark III handpumps. Their target is to achieve the coverage of 65% by the end of 1996.

3.3 Socio-economy and Institutions in the Study Area

3.3.1 Population and Employment

(1) Population Statistics in Champasak and Saravan Province, 1985-1994

Based on the 1985 Population Census and the 1990 Population Count conducted by the Ministry of Economy, Planning and Finance, annual population growth rates in Champasak and Saravan Provinces were 2.36% and 2.97%, respectively. Applying these growth rates in the two provinces during 1990 and 1994, the population is estimated to be 497,301 in Champasak Province and 252,945 in Saravan Province, respectively in 1994. (Refer to Table 3.3.1a)

(2) Population in the Study Area, 1994

Study Area covers 200 villages in Champasak and Saravan Provinces. Population of the Study Area is based on the data obtained from the Village Survey conducted by the Study Team in April, 1994. Population consists of 53,297 persons residing in 100 villages located at five Districts of Champasak Province (Sanasomboon, Bachieng, Pathoumpone, Sukhuma and Khong) and 45,588 persons in 100 villages located at five Districts of Saravan Province (Lakonepheng, Khonexedong, Vapy, Saravan and Laongam) as presented in Table 3.3.1b.

(3) Population in the Prioritized Area

Out of these 200 villages, a total of 40 villages have been selected as the prioritized area for detailed study. The prioritized area covers 20 villages each in Champasak and Saravan Provinces and is estimated to have a population of 18,448 in 1994 (refer to Table 3.3.1c).

(4) Population Projections in the Study Area, 1994-2005

Based on the population growth rates in Champasak and Saravan Provinces during 1985 and 1990, population in the Study Area is expected to grow at the annual growth rates of 2.64%, reaching 115,643 persons in 2000 and 131,789 persons in 2005 (refer to Table 3.3.1d).

(5) Employment Status in the Study Area

According to the 1985 Census data, total population, working age population and engaged population in Champasak and Saravan Provinces were as follows.

Province Name	Total Population	Working Age Pop.	%	Engaged Population	%	The un-employed	%
Champasak	403,041	183,355	45.5%	158,998	39.4%	24,357	13.3%
Saravan	187,515	87,049	46.4%	81,417	43.4%	5,632	6.5%

Source: Population of Lao PDR, Ministry of Economy, Planning and Finance, 1992

Note: Working age population is taken as male from 16 to 60 years and female from 16 to 55 years.

Based on the above mentioned data, the working age population, engaged population and the unemployed are estimated to be 24,250, 20,999, and 3,225, respectively in the 100 villages in Champasak Province, and 21,152, 19,785, and 1,375, respectively in the 100 villages in Saravan Province. It is estimated that approximately 90% of the engaged population are involved in agricultural activities including livestock raising and hunting. The remaining (10%) are estimated to be engaged in non-agricultural activities such as public services, commerce, manufacturing, etc.

3.3.2 Social Conditions

(1) Village Environment

The villages in the Study Area can be categorized topographically into the villages in the plain area and in the plateau area. Villages in the plain area are located near the Mekong river or its tributaries, surrounded by rice fields. Rice cultivation in lowland rice fields and livestock raising are the main economic activities. Lowland Lao (Lao Loum) is the dominant group in these villages. Villages in the plateau area are located at the area with an elevation of 300 to 450m. Due to topographical conditions, most of the villages in the plateau area find difficulty in obtaining reliable water sources. Upland rice cultivation and tree crops cultivation such as durian, mango, orange, coffee and cardamom are main economic activities. Mon Khmer (Lao Theung) is the dominant group in these villages.

Villages average around 490 inhabitants in the Study Area. Houses are raised on piles and constructed of bamboo or wood and covered with thatch, tiles or iron sheets. The space underneath the house is used for storing tools and securing livestock and farm animals at night.

(2) Village Size

According to the Village Survey in April 1994, out of 100 villages in Champasak Province, 57 villages have the population of less than 500 and the remaining 43 villages have the population of

more than 500, averaging 533 persons per village. Out of 100 villages in Saravan Province, 64 villages have the population of less than 500 and 36 villages have the population of more than 500, averaging 456 persons per village. Village size is larger in Champasak Province. Village size ranges from 113 to 1,696 in Champasak Province and from 72 to 1,691 in Saravan Province. Number of villages according to village size is shown below:

	Less than 500	More than 500	Population	Average Size
Champasak	57 villages	43 villages	53,297	533
Saravan	64 villages	36 villages	45,588	456

Source: Village Survey, April 1994

(3) Ethnic Groups

Ethnic groups in the Study Area can be roughly divided into Lowland Lao (Lao Loum), Mon Khmer (Lao Theung) and Tibeto Burman (Lao Soung). Lao Loum is the dominant ethnic group, accounting for 89.5% in Champasak Province. Lao Theung group account for only 8% and Lao Soung group is negligible. The percentage of Lao Theung group is higher in Bachiang (44%), Pakhsong (47%) and Sukhuma (11%) Districts. A small percentage (less than 1%) of Lao Soung group is recorded in Bachiang and Pakhsong Districts. Distribution of ethnic group by District is presented in Table 3.3.2.

Lao Loum is the dominant ethnic group also in Saravan Province. However, the percentage (61.4%) is not very high as in Champasak Province. Lao Theung group account for 38.6% and Lao Soung is negligible.

3.3.3 Economic Base

Agriculture is the mainstay of economy in Saravan and Champasak Provinces. In Champasak Province, 209,923 tons of unhulled rice (of which upland rice account for 6,222 tons) have been produced in 1993/94 season. Other major crops include green bean, groundnut, coffee, cardamom, soybean, sugarcane, and tobacco. Agricultural production statistics by each District in Champasak Province is presented in Table 3.3.3a.

In Saravan Province, 115,618 tons of unhulled rice (of which upland rice account for 12,177 tons) have been produced in 1993/1994 season. Other major crops include groundnut, coffee, cardamom, soybean, and banana. (Refer to Table 3.3.3b)

3.3.4 Household Income

Primary income source of inhabitants comes from rice cultivation in the Study Area, although most of rice produced are consumed at home. Secondary income sources are derived from other crops cultivation (groundnut, coffee, tobacco, etc.), livestock raising (cattle, pigs, and poultry) and off-farm activities such as farm labor, construction labor, trade, hunting, etc.

The result of Rural Income Survey in Saravan Province has indicated that average family size is 7.8 persons consisting of 4.25 adults and 3.55 children with average landholding of 2.57 ha. In Champasak Province, the same has indicated that average family size is 5.5 persons consisting of 3.4 adults and 2.1 children with average landholding of 1.84 ha. The net income per rural household averages Kip 176,819 (US\$246.27) in Saravan Province and Kip 199,048 (US\$277.23) in Champasak Province. Details of Rural Income Survey are presented in Tables 3.3.4a and 3.3.4b.

3.3.5 Local Government

The local government structure extends from provincial level through district level to village level. Divisions of responsibilities within the provincial and district administrations are similar to those at the central level, covering the same fields as the central ministries except in the areas of national defense, foreign affairs and police.

Provincial government is headed by the governor who has the same rank as ministers. Provincial administration is organized similarly to the central government and divided into departments corresponding to central government ministries as presented in Figure 3.2.5. The provincial government office is located at Pakse in Champasak Province and that of Saravan Province is located at Saravan. Each district has its District office at the capital town.

3.3.6 Public Health Services

(1) General

Provincial Public Health Department (PHD) is responsible for delivering public health services including medical services, rural water supply and sanitation in each province. Organization chart of PHD is presented in Figure 3.3.6a.

Medical services in Champasak Province are delivered through a Provincial Hospital located at Pakse, 10 District Hospitals located at each district capital, and 58 dispensaries located at Sub-District level. Number of Staff at medical services infrastructure in Champasak Province are tabulated in Table 3.3.6a. Malaria is the main cause of morbidity in Champasak Province, followed by diarrhea, influenza, dysentery, pneumonia, and tuberculosis as presented in Table 3.3.6b.

Medical services in Saravan Province are delivered through a Provincial Hospital located at Saravan, 8 District Hospitals located at each District capital, and 22 Dispensaries located at Sub-District level. Malaria is the main cause of morbidity in Saravan Province, followed by diarrhea, influenza, dysentery, pneumonia, and tuberculosis. (Refer to Tables 3.3.6c and 3.3.6d)

(2) Water Supply and Sanitation

The Water Supply and Environmental Sanitation Sections (WES) of Public Health Offices in Saravan and Champasak Provinces are responsible for providing rural water supply and sanitation. WESs of both provinces have been promoting water supply and sanitation program