No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL CENTRE FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION (N-CERWASS)

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

(Main)

MARCH 2009

TOKYO ENGINEERING CONSULTANTS CO., LTD.

IN ASSOCIATION WITH

OYO INTERNATIONAL CORPORATION

GED
JR
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PREFACE

In response to a request from the Government of Socialist Republic of Vietnam, the Government of Japan decided to conduct a study on Groundwater Development in the Rural Provinces of the Southern Coastal Zone and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Toshifumi Okaga of Tokyo Engineering Consultants Co., LTD. and consists of Tokyo Engineering Consultants Co., LTD. and OYO International Corporation between May, 2007 and March, 2009. In addition, JICA set up an advisory committee supported by Dr. Saburo Matsui, Emeritus Professor, Kyoto University and Dr. Yuji Maruo, Senior Advisor, JICA, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Vietnam and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Vietnam for their close cooperation extended to the study.

March 2009

Ariyuki Matsumoto,
Vice-President
Japan International Cooperation Agency

Mr. Akiyuki Matsumoto
Vice-President
Japan International Cooperation Agency

March 2009

LETTER OF TRANSMITTAL

Dear Sir,

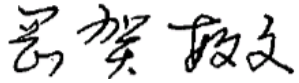
We are pleased to submit you the final report entitled “The Study on Groundwater Development in the Rural Provinces of the Southern Coastal Zone in the Socialist Republic of Vietnam”. This report has been prepared by the Study Team in accordance with the contracts signed on 15th May 2007, between Japan International Cooperation Agency and Tokyo Engineering Consultants Co., Ltd. in association with OYO International Corporation.

The report examines the existing conditions concerning water supply of the Southern Coastal Zone and presents the master plan and feasibility study on priority project selected from the master plan.

This study aimed to improve the water supply conditions of the Southern Coastal Zone. We are sure that the recommendations made in the report shall contribute to improving the water supply conditions of the Southern Coastal Zone.

All the members of the Study Team wish to acknowledge gratefully to the personnel of your Agency, Ministry of Foreign Affairs, JICA Vietnam Office, and also to the officials and individuals of the Government of the Socialist Republic of Vietnam for their assistance extended to the study team.

Yours faithfully,



Toshifumi OKAGA
Team Leader

Executive Summary

1. Project Background and Existing Conditions

Vietnam has promoted an open, market-oriented, and globally integrated economy. However, the gap between rural area and urban area is getting wider. Based on Comprehensive Poverty Reduction and Growth Strategy (CPRGS) established by the government, in 1999 the government worked out to formulate National Rural Clean Water Supply and Sanitation Strategy (NRWSSS) with the target year 2020. Five year plan (NTP 1: National Target on Rural Water Supply and Sanitation, Phase 1) was formulated and the implementation started from 2000. Subsequently, the second Five year plan NTP 2 commenced from 2006. In these plans, the target for the rate of population served has been set as 85 % of total population and target for the rate of population served sanitary toilet is set as 70% by the year 2010.

Meanwhile, the Government of Japan has implemented Technical Cooperation and Grant Aid cooperation for the improvement of water supply in rural area through the groundwater development in the North Provinces and the Central Highlands provinces since year 1998. Subsequently, improvements of water and sanitation for the Southern coastal zone, in 4 provinces of Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan, have been requested by the government of Vietnam. Outline of the study area in year 2006 is shown in table 1.

Table 1 Outline of the study area

Province	Code	Commune	Area (km^2)	Population	Population served by piped water*1	No toilet *2	Poverty ratio*2
Phu Yen	P-1	Xuan Phuoc	80.5	9,059	0%	83%	21%
	P-2	An Dinh	17.9	5,964	0%	69%	14%
	P-3	An Tho	43.0	3,242	6%	91%	29%
	P-4	An My	13.8	11,427	0%	61%	10%
	P-5	Son Phuoc	28.4	3,261	23%	96%	28%
	P-6	Ea Cha Rang	83.1	2,583	30%	95%	41%
	P-7	Suoi Bac	40.5	5,626	11%	55%	30%
	P-8	Son Thanh Don	179.7	8,240	0%	87%	25%
Khanh Hoa	K-1	Cam An Bac	20.5	6,316	20%	60%	22%
	K-2	Cam Hiep Nam	18.8	6,113	0%	36%	16%
	K-3	Cam Hay Tay	19.2	10,620	0%	29%	9%
Ninh Thuan	N-1	Nhon Hai	34.1	14,896	0%	44%	13%
	N-2	Cong Hai	73.6	7,381	0%	93%	25%
	N-3	Bac Son	60.3	5,809	71%	95%	32%
	N-4	Phuoc Minh	75.0	3,509	100%	48%	8%
	N-5	Phuoc Hai	32.5	12,881	35%	42%	16%
	N-6	Phuoc Dinh	130.1	8,549	19%	47%	20%
Binh Thuan	B-1	Muong Man	18.3	5,977	0%	46%	6%
	B-2	Gia Huynh	158.3	5,246	2%	66%	8%
	B-3	Nghi Duc	74.7	10,192	0%	72%	8%
	B-4	Tan Duc	137.4	4,981	6%	59%	30%
	B-5	Me Pu	64.3	13,250	0%	50%	10%
	B-6	Suong Nhon	49.5	8,175	0%	55%	12%
	B-7	Da Kai	87.3	11,436	0%	48%	23%
Total			1540.8	184,733	10%	60%	18%

Source: *1: Water supply survey by the JICA team, *2: Socio-economic survey by the JICA team

The aim of the Study is to achieve improvement in hygiene and promotion of sound socio-economical activities through the project. The objectives of the study are: to formulate a Mater

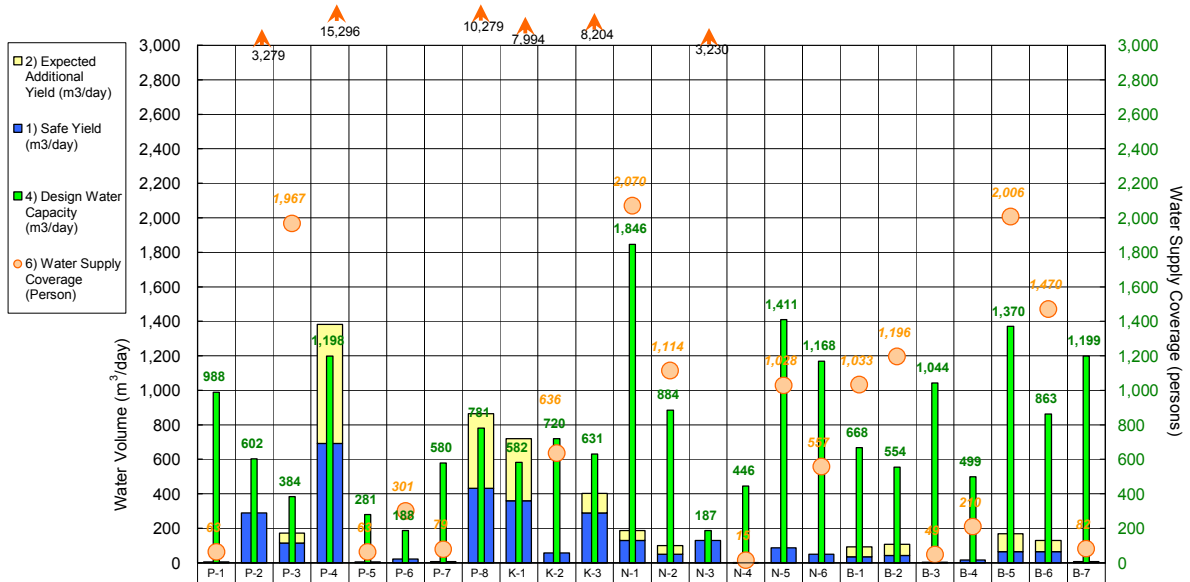
Plan for groundwater development and water supply system. : To conduct a feasibility study for water supply system. : To present approach toward environmental sanitation improvement. : To promote technical transfer. : To disseminate knowledge obtained through the study to concerned organization by holding workshop.

2. Groundwater Development

(1) Groundwater potential

Groundwater potential evaluation was conducted based on the survey results in the Study, which consists of remote sensing survey, hydro-geological investigation, geophysical survey, test borehole drilling survey, seawater intrusion survey and water quality analysis. The groundwater development plan reflected both aspects: quantity and quality of groundwater are presented in the following figure. The communes with no expected additional yield in the figure have no groundwater resources to develop or unsuitable quality for potable water. Slim bar charts present future demand volume of water supply for each commune in 2020 and thick bar charts mean groundwater development volume.

It is made clear that three communes: P-4, P-8 and K-1, have enough potentiality to cover their water demand for rural water supply scheme. However, the expected yield of groundwater for Commune K-3 covers 60 % of the water demand. Furthermore, the results of seawater intrusion survey and groundwater level monitoring survey carried out during the Study also support P-4, P-8 and K-1.



	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	K-1	K-2	K-3	N-1	N-2	N-3	N-4	N-5	N-6	B-1	B-2	B-3	B-4	B-5	B-6	B-7
2) Expected Additional Yield (m3/day)	0	0	58	691	0	0	0	432	360	0	115	58	50	0	0	0	0	58	65	0	0	104	65	0
1) Safe Yield (m3/day)	6	288	115	691	6	22	7	432	360	58	288	130	50	130	1	86	50	36	43	4	17	65	65	7
4) Design Water Capacity (m3/day)	988	602	384	1,198	281	188	580	781	582	720	631	1,846	884	187	446	1,411	1,168	668	554	1,044	499	1,370	863	1,199
6) Water Supply Coverage (Person)	63	3,279	1,967	15,296	63	301	79	10,279	7,994	636	8,204	2,070	1,114	3,230	15	1,028	557	1,033	1,196	49	210	2,006	1,470	82

Figure 1 Relationship between Water Supply Demand and Groundwater Development Plan for the Target Communes

(2) Surface water potential as alternative water source

Almost all communes target communes except above-mentioned three communes need alternative

water sources to cover their whole demand. In addition to the groundwater potential survey, the surface water survey was conducted to look for alternative water sources for the rest of the twenty-one communes.

Based on the survey, nine sites for alternative water sources as shown in Table 2 were applied to the water supply plan in this study from quantitative and qualitative point of view.

Table 2 Summary of Surface Water Source

Site No.	Province	River / Reservoir	Target Commune	Distance (km)	*Difference of Elevation (m)	Water Quantity in Dry Season	Dissatisfied Water Quality Standard Item
PS-2	Phu Yen	Ky Lo River (upstream)	P-1	13	10	Enough	Turbidity, Fe, Total coli, E-coli
PS-4		Dong Tron Reservoir	P-2	5	15	Enough	Turbidity, Fe, Total coli, E-coli
PS-6		Ba River	P-5, 6,7	4-10	-120 to -40	Enough	Turbidity, Fe, Total coli, E-coli
KS-2	Khanh Hoa	Suoi Dau Reseroir	K-2	16-18	0- 20	Enough	Turbidity, Fe, Total coli, E-coli
KS-3		Cam Ranh Reservoir	K-3	8 - 9	-10 to 10	Enough (Water supply with 1,230 m3/day ensured)	Turbidity, Fe, Total coli, E-coli
NS-2	Ninh Thuan	Cai River at Lam Cam Weir	N-1to 3 N-4 to 6	8 - 26	0	Enough	Turbidity, Fe, Total coli, E-coli
BS-2	Binh Thuan	Cam Hang Reservoir	B-1	5	10	Enough (Water supply with 1,000 m3/day ensured)	Turbidity, Fe, Total coli, E-coli
BS-4		La Nga River (Right Bank near B-6)	B-3, 5, 6, 7	4 - 9	-20	Enough	Turbidity, Fe, Total coli, E-coli
BS-6		La Nga River (around Dong Kho Town)	B-2, 4	16-36	20-70	Enough	Turbidity, Fe, Total coli, E-coli

*: Water source latitude - Commune latitude

3. Water Supply Plan

For achieving of the National Strategy of NRWSSS, the project plan to provide sufficient water to the people in the study area. The rate of population served in the area is considered to reach 100% by means of house connection. According to National Strategy, per capita consumption is estimated to be 60 liters up to 2020. Towards achieving the target of NTP 2, the ratio of population served in the target area and per capita water demand are defined as Table 3.

Table 3 Water demand conditions

Water demand per capita (L/c/d)	60
Non-domestic water (%) (Where the whole domestic water is 100)	5 to 13
Leakage water (%)	10

Projected area includes 22 out of 24 communes. 2 communes (P-3 :An Tho, N-4 :Phuoc Minh) have been excluded for the preparation of the Study due to lack of water source in adjacent area and overlapping of other Donor.

In consideration of alternative water source, the water supply system is planed depending on location of water source with view point of economical and technical. The system pattern is divided following 3 patterns.

- Pattern 1: Single system

There is the water source nearby water service area, the water supply system will be constructed and operated by single facility. These systems are applied to communes with codes P-1, P-2, K-3 and B-1.

- Pattern 2: Group system

In case of water supply system with intake from surface water, the transmission pipeline, between water source and service area, is longer than groundwater intake. Thus, the system has advantage to be in conjunction with some nearby communes. The system could be defined as group water system and applicable communes are P-5, 6, 7, N-5, 6, B-3, 5, 6, 7.

- Pattern 3: Wide area system

It is possible that there are some communes (not including among target communes) which are still lacking water supply along transmission main. It is better that future water supply plan include these communes too. The system could be termed as wide area system. In the Master Plan, the study area is limited to target commune so the system will be provisionally designed to pick up target communes only in the wide area. The facilities for communes with codes K-2, N-1, 2, 3, B2 and 4 are planned considering it.

The outline of the commune and their system is shown in Table 4.

Table 4 Commune and water supply system

Province	Commune		System		Population in 2020	Water demand in 2020(m^3/d)	Daily max. (m^3/d)	Raw water source
			No.	Pattern				
Phu Yen	Xuan Phuoc	P-1	FPS-1	Single	10,927	823	1,000	Ky Lo river (PS-2)
	An Dinh	P-2	FPS-2	Single	6,856	502	600	Dong Tron reservoir (PS-4)
	An My	P-4	FPS-3	Single	13,256	998	1,200	**Groundwater**
	Son Phuoc	P-5	FPG-4	Group	11,666	874	1,000	Ba river (PS-6)
	Ea Cha Rang	P-6						
	Suoi Bac	P-7						
	Son Thanh Don	P-8	FPS-5	Single	9,292	651	800	**Groundwater**
Khanh Hoa	Cam An Bac	K-1	FKS-6	Single	6,626	485	600	**Groundwater**
	Cam Hiep Nam	K-2	FKW-7	Wide area	7,962	600	700	Suoi Dau river (KS-2)
	Cam Hay Tay	K-3	FKS-8	Single	6,978	526	600	**Groundwater** + Cam Ranh reservoir (KS-3)
Ninh Thuan	Nhon Hai	N-1	FNW-9	Wide area	32,266	2,431	3,000	Cai river at Lam Com Weir (NS-2)
	Cong Hai	N-2						
	Bac Son	N-3						
	Phuoc hai	N-5	FNG-10	Group	29,715	2,149	2,600	Cai river at Lam Com Weir (NS-2)
	Phuoc Dinh	N-6						
Binh Thuan	Muong Man	B-1	FBS-11	Single	7,378	557	700	Com Hang reservoir (BS-2)
	Gia Huynh	B-2	FBW-12	Wide area	11,825	878	1,000	La Nga river (BS-6)
	Tan Duc	B-4						
	Nghi Duc	B-3	FBG-13	Group	52,241	3,730	4,500	La Nga river (BS-4)
	Me Pu	B-5						
	Suong Nhon	B-6						
	Da Kai	B-7						
Total	22		13		206,988	15,204	18,300	

Investment plan is prepared and proposed for the water supply system which is classified in 3 Packages as shown in Table 5.

Table 5 Packaging for the system

Package	Water source/ system pattern	Number of communes
1	Groundwater/ Single system	4
2	Surface water/ Single and Group system	6
3	Surface water / Wide-area system	3

The total investment amount is to be US$58,000,000 and VND915, 000,000,000 including Package 3 with US$17,000,000. The cost of package No. 3 is not completed as wide area system. Therefore, the cost is for reference only.

Development schedule of the water supply is shown in Figure 2.

year	2009	2010	2011	2012	2013	2014	2015	2016
	1st year	2nd	3rd	4th	5th	6th	7th	8th
Package 1								
Package 2								
Package 3								

Figure 2 Development schedule

4. Priority Project

Based on communes included under Master Plan, the selection procedure of target commune for F/S is shown in figure 3.

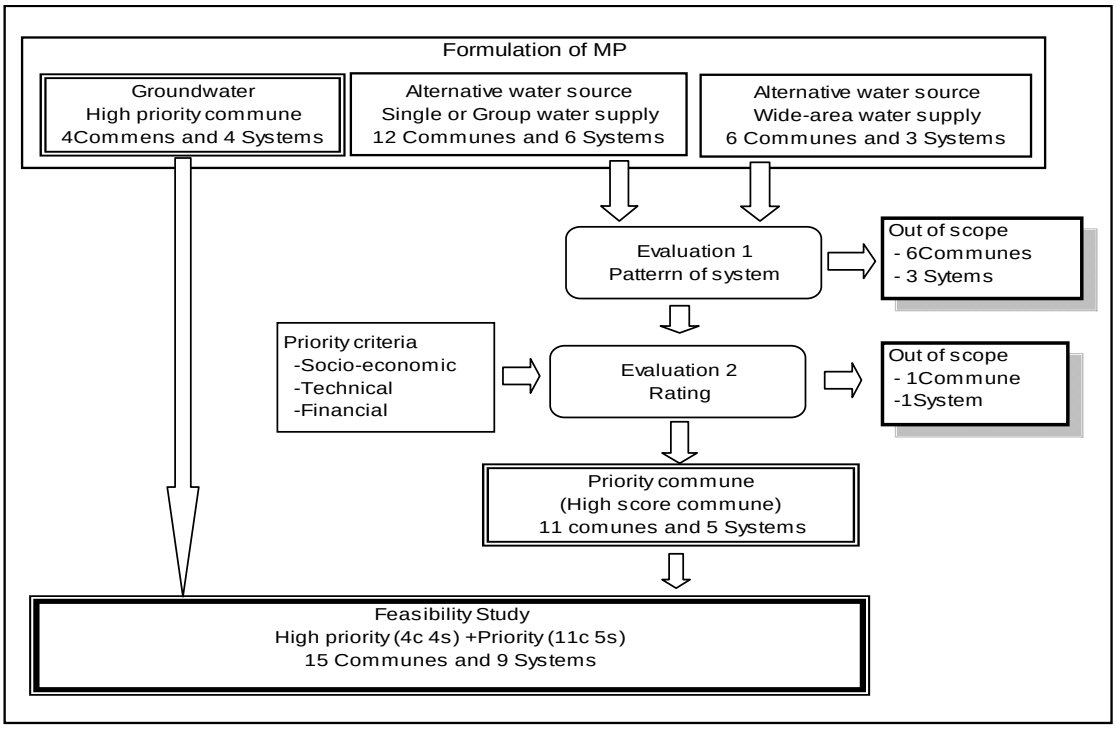


Figure 3 Selection procedure for priority project

Considering the aim of the study, the water supply systems for 4 communes using groundwater sources are designed as high priority. For 18 communes, the Study is carried out for alternative water source. From evaluation 1, 6 communes for wide area system shall not be included as a scope of FS.

Remaining 12 communes are evaluated based on the priority criteria. As a result of the evaluation 2, 1 commune is not included in the scope of the FS because of low score. It is decided that 15 communes and 9 systems are conducted FS and their design population in 2020 as target year is to be 144,000.

Facility of the system is designed depending on their raw water quality and drinking water standard in Vietnam. The component of the facility is shown in Table 6.

Table 6 Facility component

System No.	Process						
	Groundwater Well	Intake for surface water	Non treatment	Iron removal	Turbidity removal	Reservoir tank	Distribution facility
FPS-2		x			x	x	x
FPS-3	x		x			x	x
FPG-4		x			x	x	x
FPS-5	x		x			x	x
FKS-6	x			x		x	x
FKS-8*1	x		x			x	x
FKS-8*2		x			x	x	x
FNG-10		x			x	x	x
FBS-11		x			x	x	x
FBG-13		x			x	x	x

Note: *1: using groundwater source: *2 using surface water source

The project cost and implementation schedule are shown in Table 7 and Figure 4.

Table 7 Project cost

System No.	FPS2	FPS3	FPG4	FPS5	FKS6	FKS8	FNG10	FBS11	FBG13	Total
Base cost (x 1,000US$)	1,692	1,059	3,775	811	967	1,671	9,013	1,650	10,714	31,351
Project cost (x 1,000US$)	2,015	1,261	4,496	966	1,151	1,990	10,734	1,965	12,760	37,336
Project cost (Mil. VND)	33,950	21,245	75,758	16,274	19,402	33,527	180,891	33,112	215,028	629,188

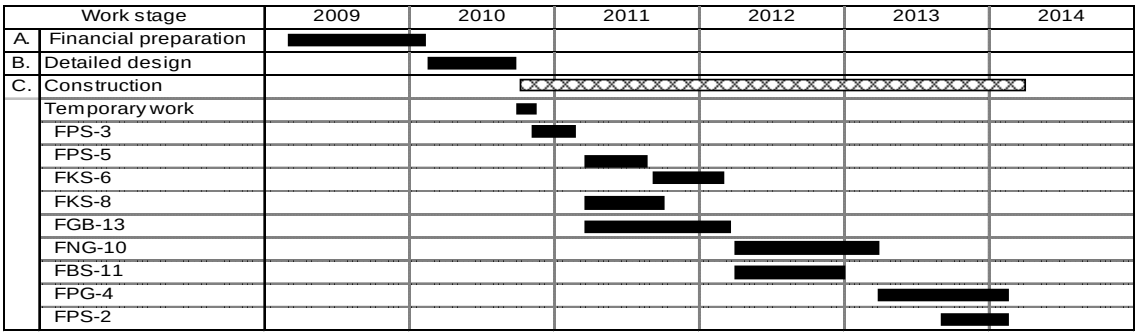


Figure 4 Implementation schedule

5. Management of the Water Supply System

Basically the NRWSSS and its subordinate document NTP Ⅱ recommend that new water supply facilities are operated and maintained by a commune-led organization or a local community. However, the results of the site survey indicate that it is very difficult for local communes to operate and maintain a modern water supply system by themselves due to the shortage of human and financial resources. Thus, the Study team recommends the establishment of new and multi-organizational interrelated O&M system with the P-CERWASS being at the core of the structure.

Capacity Development (CD) shall be divided into 3 phases for each target group such as

management, working level and water user group in the Study. In 1st Phase, CD should be focused on the management class such as directors of P-CERWASS and managers of N-CERWASS to establish the foundation of O&M. In the 2nd Phase, CD shall mainly cover working-level group or employees working on practical level such as operators, accountants, and administrators of P-CERWASS. Finally, the target group of Phase 3 is shifted down to water users including CPC and its inhabitants. The contents of the phase may consist of the Information, Education and Communication (IEC) activities and trainings targeted to local operators.

6. Sanitation improvement plan

Based on findings through model sanitation program, issues on environmental sanitation in rural areas are identified and summarized as the following seven topics:

- Sanitation coverage in rural area is much lower than the national target
- Institution and organization for sanitation promotion in provincial level is weak
- Personal hygiene is insufficient due to lack of IEC
- Lack of funds to build sanitation facility
- Groundwater pollution by effluent from septic tank
- Absence of administration for wastewater and night soil treatment
- Environmental issues caused by disposal of untreated septic tank sludge

The following 5 approaches toward sustainable improvement of environmental sanitation are presented. Each of these plans is summarized in Project Design Matrix (PDM: a project summary sheet with logical framework).

- Establishment of provincial taskforce for sanitation promotion
- Raising personal hygiene through enhancement of IEC channels
- Dissemination of new design of septic tank toilet
- Enhancement of financial support and incentive mechanism
- Environmental administration and wastewater treatment

To realize these approaches, implementation schemes are examined, especially with consideration of foreign technical assistances.

7. Evaluation of the Project

The financial analysis of the project for the targeted 9 systems carried out by means of the financial internal rate of return (FIRR) and net present value (NPV) methods under the designated assumption. The FIRR of total project is -11.4% and the NPV is US$ -34 million at the discount rate of 2.5%. However, although financial analysis indicates that the Project would be financially infeasible, O&M costs can be coved by the expecting net income from water charges if initial investment (construction) cost is raised from any fund sources. Moreover, according to the result of socio-economic survey conducted by the Study Team, the Affordability to Pay (ATP) in the targeted four Provinces is much higher than the proposed water charges which mainly refer to the Willingness

to Pay (WTP).

In addition to the financial analysis, economic analysis ascertains that the Project can contribute to the social and economic development for the entire society in the targeted four Provinces, and the significance of the Project can fit to the concept of Basic Human Needs (BHN) and poverty reduction.

From the results of the Initial Environmental Examination (IEE), some adverse impacts in environmental and social items of land acquisition, water vender, disruption of traffic situation and noise/vibration are expected. However, these adverse impacts are minor, and if mitigation measures including proposed measures in this IEE are undertaken properly, these impacts will be satisfactory minimized and mitigated.

8. Conclusion and Recommendation

(1) Conclusion

The purpose of this Study is in harmony with the objective of NRWSSS and the Study is expected to generate synergistic effect by keeping pace with NTP project. As a result of FS as a short term program, the water supply system is planned for 15 communes in 4 provinces. It is expected that implementation of this project shall have positive impact on living conditions of 144,000 persons in the Study area.

In the Study, the ground water potential of many target areas has been confirmed to be lacking through the investigation data of the test well and this is attributed to complicated hydro-geological structure. The water supply system for only 3 communes is considered to use groundwater as prime water source. The source for 1commune is applied to combine groundwater and surface water. The water intake for remaining communes has been planned considering use of alternative sources of water.

The environment impacts caused by water source development and facilities construction are minor due to small size facility and the impact will be minimized and mitigated through proposed countermeasures.

The project should be financed by Grant Aid or through subsidy from the Government to cover initial high investment cost mainly for construction works. If the initial investment cost could be secured, it is expected that net income can cover the O & M cost.

Necessity of further efforts to increase sanitation coverage is identified. Needs of environmental measures are also focused, including prevention of groundwater pollution from septic tank effluent and administration for septic tank sludge disposal. Approaches toward sustainable improvement of environmental sanitation are recommended, such as establishment of provincial taskforce, enhancing

IEC, dissemination of new design of septic tank toilet, enhancing financial support and environmental administration.

(2) Recommendation

As well-known, both aspects: natural and social conditions should be considered to make rural water supply plan. However, groundwater resources potential evaluation as the most important item of the natural conditions has not been studied adequately or unpublicized in Vietnam. It should be leveraged for the planning prior to selection of candidate areas or communes for rural water supply plan.

As a study result of the alternative water source, the wide area water supply system shall be investigated and designed including surrounding communes that lack appropriate water supply system and increased future demand from technical and economical aspect.

As for Phu Yen and Khan Hoa P-CERWASSs, it is recommended to promote drastic restructuring of the organization so as to increase the operational efficiency. In addition, with regard to the financial issue, uniform management of a number of facilities could be one of the effective measures to redress the profitable balance between the red-ridden and the surplus facilities.

Result of the FIRR for overall project is -11.4%, which can be concluded that the project is financially infeasible under the designated condition in the Report. The proposed project should, therefore, be financed by grant funds to cover initial investment cost mainly for construction work. If only the initial investment cost could be secured, net income can cover the O&M costs.

The current water charges are not high enough to cover all the operational expenses including depreciation and future investment. Water charges should be increased in order to allow P-CERWASSs to generate higher fund reserve. In addition to the tariff increase, subsidies from the central and local governments and other fund sources such as international aid organizations are expected to improve the financial condition of each P-CERWASS.

In order to implement the approaches presented in the Study, foreign assistance schemes are recommended since rural sanitation contains cross-sectoral issues and institutional framework is still weak. For example; grass-roots assistance to follow up the Model Sanitation Program under the Study, technical cooperation for capacity development on environmental administration in rural area, and sludge treatment plant project by CDM are recommended.

Further technical examination on septic tank sludge treatment is recommended. As a case study, preliminary design and cost estimation on septic tank sludge treatment is carried out as ANNEX 2, which includes examination on environmental effects through the sludge treatment.

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Abbreviation and Acronyms

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
BHN	Basic Human Needs
CD	Capacity Development
CEMA	Committee for Ethnic Minorities
CPC	Communal People's Committee
CPRGS	Comprehensive Poverty Reduction and Growth Strategy
DANIDA	Danish International Development Assistance
DARD	Department of Agriculture and Rural Development (Provincial Level)
DOET	Department of Education and Training (Provincial Level)
DOH	Department of Health (Provincial Level)
DONRE	Department of Natural Resources and Environment (Provincial Level)
DPC	District People's Committee
DPI	Department of Planning and Investment (Provincial Level)
DVCL	Double Vault Composting Latrine
EIA	Environmental Impact Assessment
FS	Feasibility Study
GOV	Government of Vietnam
HEP	Horizontal Electrical Profiling
IEC	Information, Education and Communication
IEE	Initial Environmental Evaluation
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOET	Ministry of Education and Training
MOF	Ministry of Finance
MOH	Ministry of Health
MOLISA	Ministry of Labour, War Invalids and Social Affairs
MONRE	Ministry of Natural Resources and Environment
MP	Master Plan
N-CERWASS	National Centre for Rural Water Supply and Environmental Sanitation
NGO	Non Government Organization
NRWSSS	National Rural Water Supply and Sanitation Strategy

NTP	National Target Programme
ODA	Official Development Assistance
O&M	Operation and Maintenance
P-CERWASS	Provincial Center for Rural Water Supply and Sanitation
PMU	Project Management Unit
PPC	Provincial People's Committee
RWSS	Rural Water Supply and Sanitation
SRTM	Shuttle Radar Topography Mission
TPBS	Targeted Programme Budget Support
UNICEFF	United Nations Children's Fund
USD	US Dollar
VBSP	Vietnam Bank for Social Policy
VES	Vertical Electrical Sounding
VND	Vietnamese Dong (The Vietnamese currency unit)
WSS	Water Supply and Sanitation

CURRENCY EQUIVALENTS

(July 2008)

USD 1.00 = JPY 106.17

USD 1.00 = VND 16,852

CHAPTER 1 INTRODUCTION

1.1 Background

The Socialist Republic of Vietnam has promoted an open, market-oriented, and globally integrated economy. Consequently, Vietnamese economy continues to grow. However, the economic gap between rural area, where 80 percent of the population dwell, and urban area is getting wider.
The Government of Vietnam has worked out Comprehensive Poverty Reduction and Growth Strategy (CPRGS) and is planning to reduce the level of poverty positively by support of the donors.
In the current Five-Year Plan for Socio-Economic Development (2006-2010), it was noted that supply of safe drinking water and improvement of sanitation in the rural area could be considered as one of the priority issues. Therefore, development of the basic infrastructures including water supply, for the poverty affected communes is promoted by the Government.

Considering the policy for improvement of water supply and sanitation in the rural area, in 1999 the Ministry of Construction (MOC) and the Ministry of Agriculture and Rural Development (MARD) worked out jointly to formulate “National Rural Clean Water Supply and Sanitation Strategy (hereinafter referred to as NRWSSS) with the target year 2020”.

The first Five-Year Plan (NTP I: National Target on Rural Water Supply and Sanitation, Phase 1) was implemented from year 2000. Subsequently, the second Five-Year Plan NTP II from year 2006 to year 2010 was approved by the Government of Vietnam in December 2006 and was put into effect. In these plans, the target for the ratio of population served by water supply facilities has been set as 85% of total population and target population ratio served by sanitary toilet facilities is set as 70% by the year 2010.

The four Provinces of Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan that are included in the study areas for this Project, are called as the southern coastal provinces.

As these provinces have a complicated hydro-geological structure, success rate of the deep wells is low. Even the shallow wells cannot be used as source of drinking water due to salinity problem. As a result, the rate of access to clean water is confined to 42~60 percent due to difficulty in water source development.

Annual rainfall in these provinces reaches to 1000 mm. However, rainfall in the dry season is significantly low as most of the rainfall occurs during few months in the rainy season only.

Most households in the rural area depend upon shallow wells, rain water or spring water as water source. However, as the shallow wells dry up in dry season, they have to follow the practice of buying drinking water from private water vendors. This proves to be a serious burden to family budgets and it poses a hindrance to poverty reduction.

Under this situation, the Government of Vietnam requested the Government of Japan to implement the Development Study in order to formulate a master plan study on possibility of groundwater

development and conduct a feasibility study for construction of the water supply facilities for 24 communes that requires urgent improvement in the water supply condition (Province of Phu Yen: 8, Khanh Hoa: 3, Ninh Thuan: 6, Binh Thuan: 7).

On the basis of evaluation of the results of NTP I (implemented during 2000-2005), the Government of Vietnam emphasizes the importance of improvement of management system for sustainable operation of the existing water supply facilities in NTP II.

Meanwhile, the Government of Japan has implemented Technical Cooperation (Development Study) and Grant Aid Cooperation for the improvement of water supply for rural areas through the groundwater development in the north provinces and the central highlands provinces since year 1998.

Based on the results and lessons learned from these development projects, this Study is expected to support the capacity development for sustainable management of the water supply facilities owned by the counterpart of the Government of Vietnam so that they can work on the basis of sustainable development by their own effort hereafter.

1.2 Objectives of the Study

The objectives of the Study are;

(1) To formulate a master plan in order to secure sufficient drinking water and to improve sanitary conditions in the rural area of the southern coastal provinces (Provinces of Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan).
(2) To conduct a feasibility study on improvement of water supply facilities for the communes that requires urgent improvement due to insufficient water supply facilities.
(3) To promote technical transfer through collaboration with the counterpart.
(4) To disseminate knowledge obtained through the Study to concerned authorities/agencies by holding workshop, etc.

1.3 Study Area

The study areas are located in 24 candidate Communes of four (4) provinces, Phu Yen: 5,045 km^2, Khanh Hoa: 5,197 km^2, Ninh Thuan: 3,360 km^2 and Binh Thuan: 7,282 km^2. Location of the Study area is shown in Figure 1.3.1.

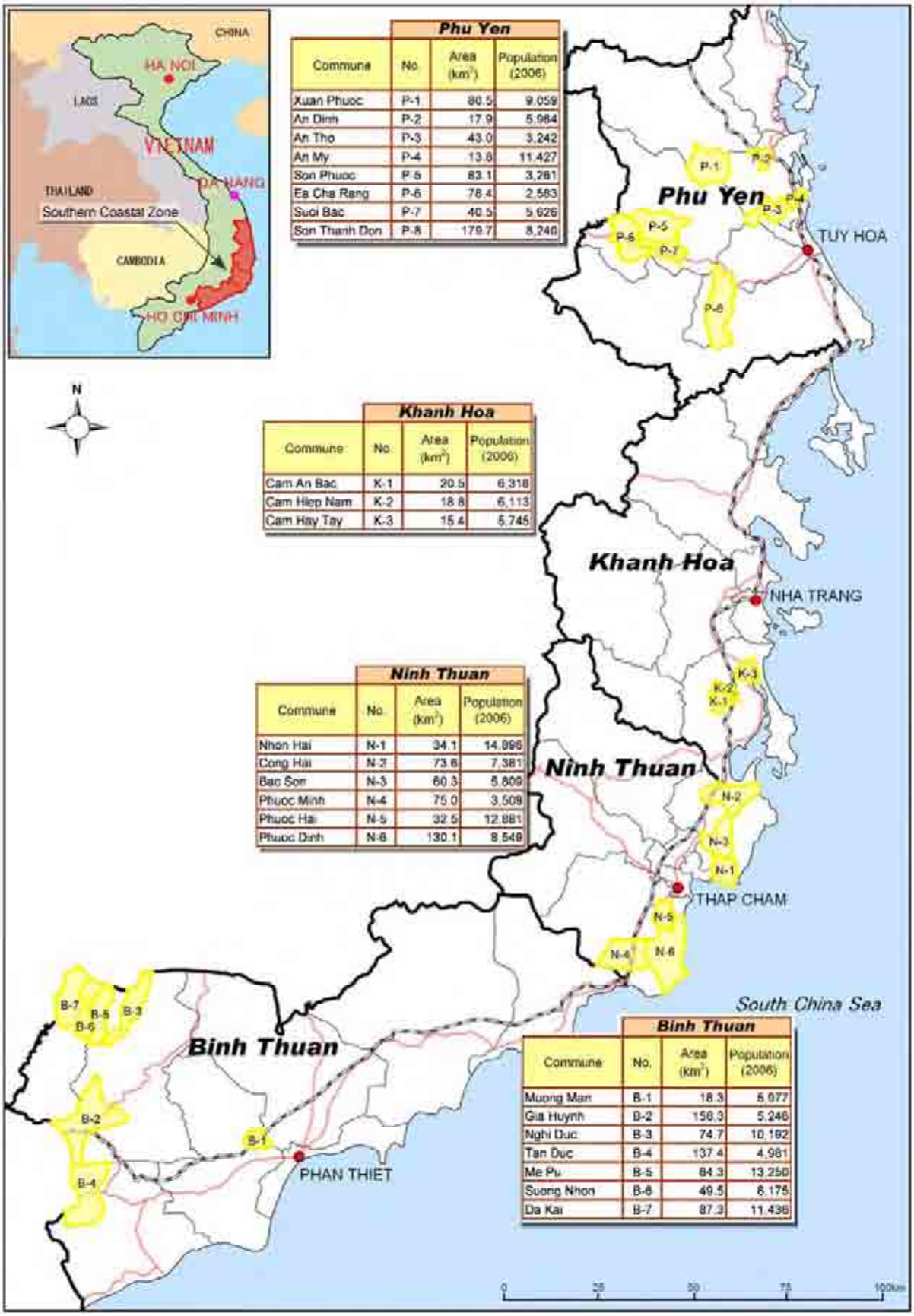


Figure 1.3.1 Location of the Study Area

CHAPTER 2 CURRENT STATUS

2.1 Natural Condition

2.1.1 Meteorology

According to "Köppen-Geiger Climate Classification" (Updated by Univ. of Vienna, April 2006), the study area belongs to the tropical savanna climate (Aw) entirely. Meteorological and hydrological data have been collected and analyzed. The locations of their stations are shown in Figure 2.1.1

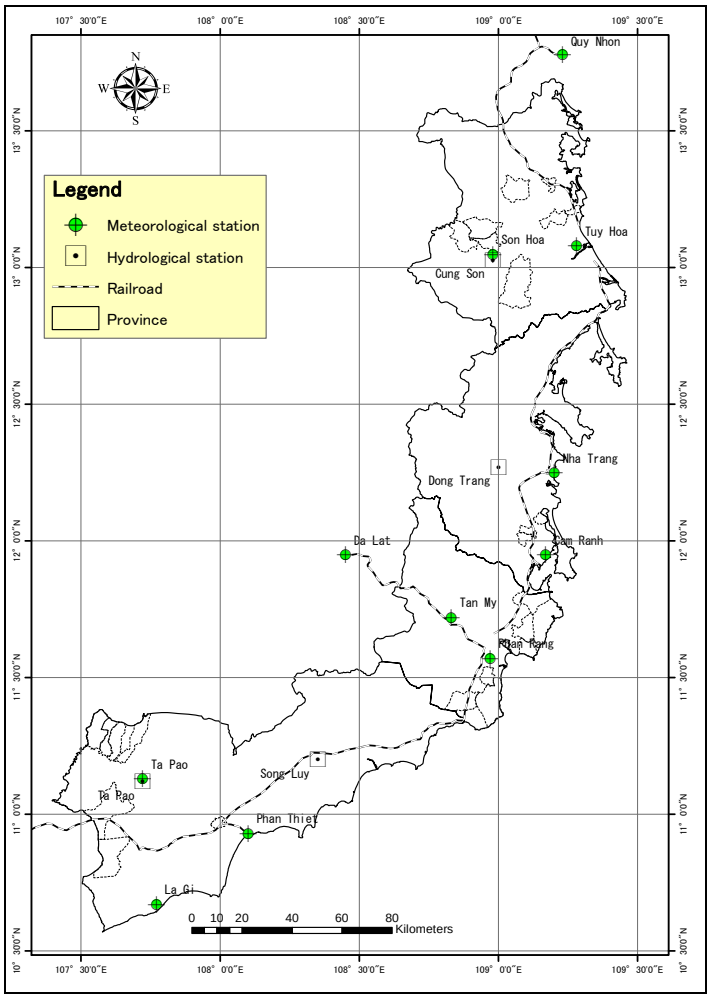


Figure 2.1.1 Locations of Observation Stations

(1) Precipitation

1) Annual Precipitation

The annual and monthly precipitation maps of the study area were made from the precipitation data of the published atlas in Vietnam and meteorological stations above mentioned. Figure 2.1.2 shows the annual precipitation map of the study area.

The annual precipitation varies from 780 to 3,100 mm. The annual precipitation in most of the study area is greater than 1,500 mm. Especially, the mountainous area in Khanh Hoa and Binh Thuan province reaches to greater than 2,500 mm. On the other hand, the annual precipitation of coastal lowland areas in Ninh Thuan province and the northern part of Binh Thuan province is less

than 1,000 mm and the precipitation in the dry season is significantly low. Period of collected data of the nine meteorological stations is from 1995 to 2005.

Annual precipitation gradually decreases from north to south in the three northern provinces, and shows significantly small at Phan Rang in Ninh Thuan. On the other hand, the annual precipitation in inland area of Binh Thuan province has 150 to 180 percent greater than that of coastal area. The cause may be due to direction of seasonal wind and distribution of mountains in the area.

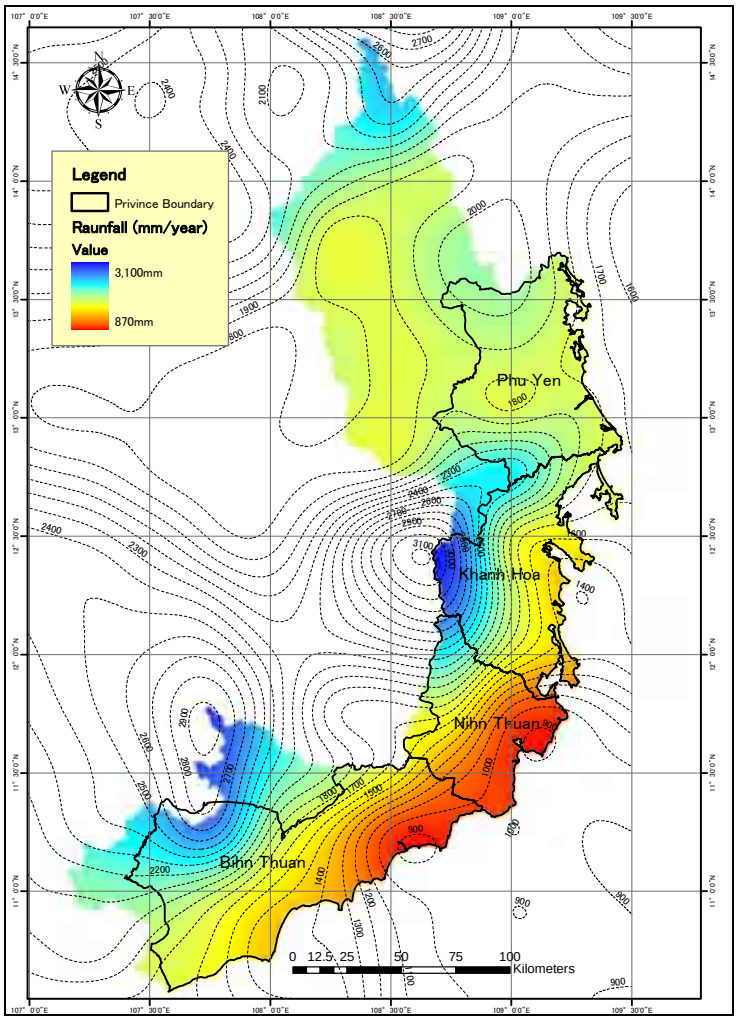


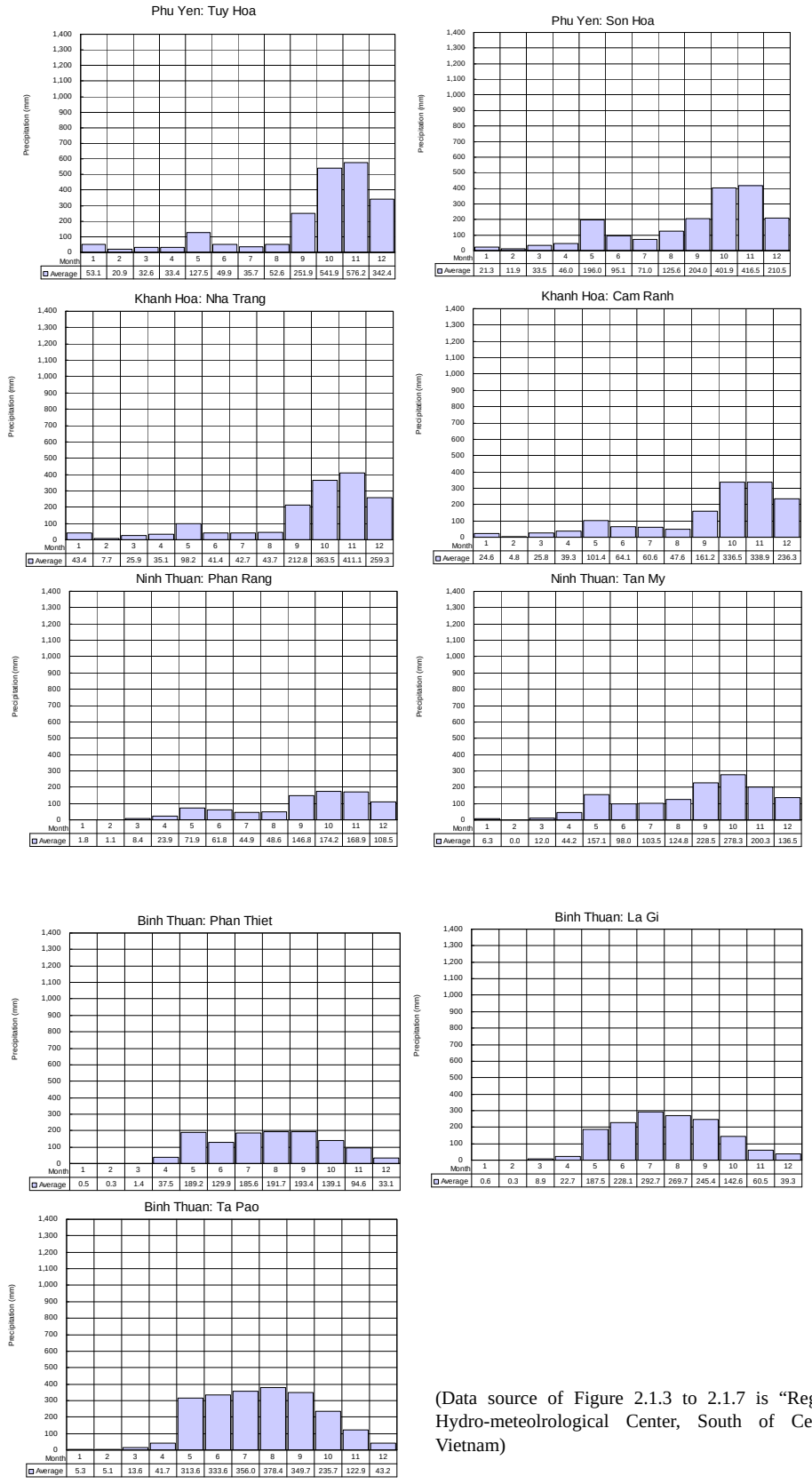
Figure 2.1.2 Annual Precipitation in the Study

(Source: modified "Atlas of Vietnam")

2) Monthly Precipitation

Seasonal change of monthly precipitation of the nine meteorological stations in the study area was analyzed as Figure 2.1.3. This figure presents average monthly precipitations at each meteorological station. Monthly variation patterns of precipitation among the stations are divided into two groups, which are Phu Yen, Khanh Hoa and Ninh Thuan group and Binh Thuan group. The stations of the former group show that the rainy season begins in September and finishes in December, and the dry season begins from January to August. Annual precipitation of this group varies from 700 mm to 2,400 mm. This value is considerably large, but the precipitation pattern of each rainfall event is similar to storm-water so that its contribution to groundwater recharge is not so much expected.

Meanwhile the stations of the latter group show that the rainy season begins in May and finish in October.



(Data source of Figure 2.1.3 to 2.1.7 is "Regional Hydro-meteolrological Center, South of Central" Vietnam)

Figure 2.1.3 Monthly Precipitation Change

(2) Air Temperature

Monthly air temperature of the seven stations in the study area was analyzed as Figure 2.1.4. The stations are located at coastal areas except one: Son Hoa station at mountainous area.

Monthly average air temperature changes from about 25 to 30 degrees and the variation among the stations has almost the same tendency except Phan Thiet and La Gi stations in Binh Thuan province. Maximum temperature is about 30 degrees in June and July. Two stations at Binh Thuan Province (Phan Thiet and La Gi) have a slightly lower temperature from June to August. This may be due to the rainy season in Binh Thuan province.

Minimum temperature is than 25 degrees on January. Son Hoa and Tuy Hoa stations have lower temperature less than 25 degrees from December to February. This may be caused by those locations, which are relatively at northern part of the study area, and by high elevation of Son Hoa station in mountainous area.

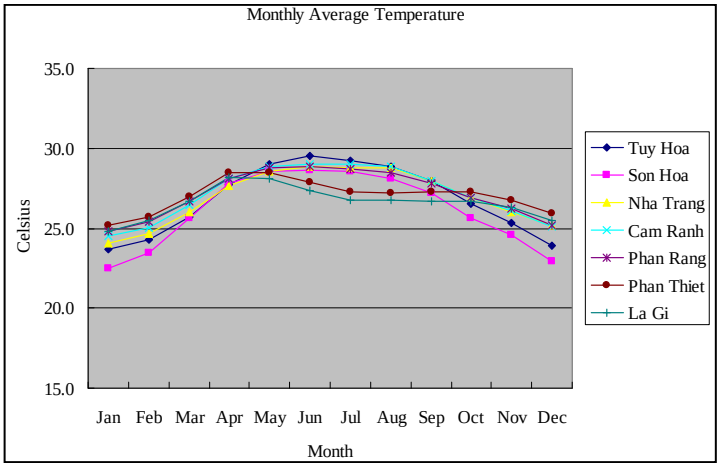


Figure 2.1.4 Monthly Average of Air Temperature

(3) Sunshine Duration

Sunshine duration of the four stations in the study area was analyzed as Figure 2.1.5. Annual variation patterns of sunshine duration among the stations are divided into two groups, which are Tuy Hoa and Nha Trang group, and Phan Rang and Phan Thiet group. The distributions of the former group show sharper change pattern than that of the latter group.

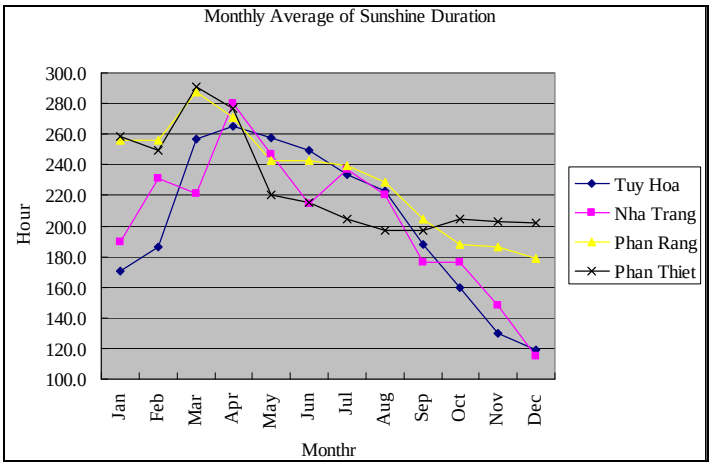


Figure 2.1.5 Monthly Average of Sunshine Duration

(4) Pan Evaporation

Pan evaporation of the seven stations in the study area was analyzed as Figure 2.1.6. Average pan evaporation of each station follows monthly average temperature and period of those rainy seasons. It shows the highest value of 190 mm in September and the lowest value of 50 to 80 mm in November and December at Tuy Hoa, Son Hoa stations in Phu Yen Province.

In Khanh Hoa Province, Nha Trang and Cam Ranh stations have the highest value of 130 to 150 mm in July and August, and the lowest value of 90 to 110 mm from September to November. However the differences among the monthly pan evaporations are relatively small throughout years.

In Ninh Thuan Province, Phan Rang station has the highest value of 190 mm in July, and the lowest value of 110 to 130 mm in the rainy season from September to November.

In Binh Thuan Province, Phan Thiet and La Gi stations have the highest value of 130 to 140 mm from July to March, and the lowest value of 90 to 100 mm in the rainy season from June to October.

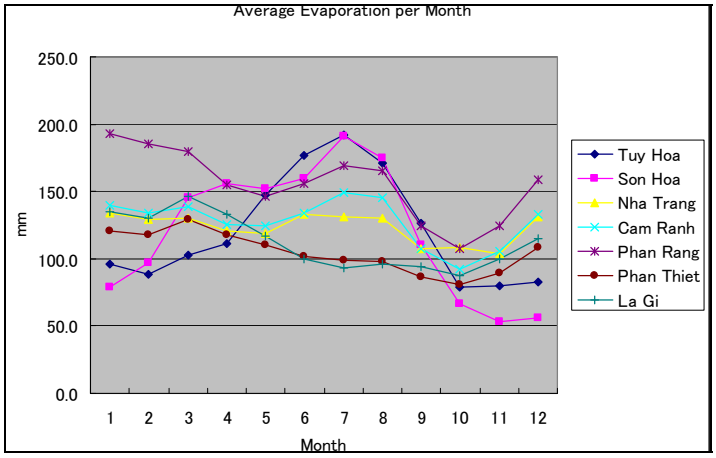


Figure 2.1.6 Monthly Average of Pan Evaporation

2.1.2 Hydrology (river discharges)

Monthly discharges of main four rivers in the study area are collected. The period of the data acquisitioned is from 1995 to 2006. The outline of each hydrological station is shown in Table 2.1.1. The result is summarized in Figure 2.1.7. The characteristics of each river discharges are as follows.

Table 2.1.1 Outline of each River Gauging Station

River	Hydrological Station	Province	Notes
Ba	Cung Son	Phu Yen	Ba river is a main tributary of Da Rang river. The station stands near P-7 (Suoi Bac) about 40 km far from the river mouth. The catchment area is very large among the four rivers.
Cai	Dong Trang	Khanh Hoa	Cai river flows through Nha Trang city. The station is about 20 km far from the river mouth. The catchment area is medium among the four rivers.
Luy	Song Luy	Binh Thuan	The station is about 40 km far from Phan Thiet toward north and about 25 km far from the river mouth. The catchment area is small among the four rivers.
La Nga	Ta Pao	Binh Thuan	The station is about 50 km far from Phan Thiet toward north-west. The catchment area is large among the four rivers.

(1) Ba river

The tendency of monthly river discharge change is well corresponding to monthly precipitation change of Son Hoa meteorological station. The river discharge significantly increases during the rainy season. The monthly discharge shows the highest value of 784 m^3/ sec in November and the lowest value of 57 to 59 m^3/ sec from March to April.

(2) Cai river

The tendency of monthly river discharge change is corresponding to monthly precipitation change of a meteorological station in Nha Trang. The river discharge increases during the rainy season. The monthly discharge shows the highest value of 241 m^3/ sec in December and the lowest value of 30 to 36 m^3/ sec from March to April.

(3) Luy river

The river discharge increases during the rainy season. The monthly discharge shows the highest value of 65 m^3/ sec in October, and the lowest value of one to four m^3/sec from January to April. It gradually increases from May toward October. There is no meteorological data obtained at surrounding area.

(4) La Nga river

The tendency of monthly river discharge change is well corresponding to monthly precipitation change of Ta Pao meteorological station. The river discharge increases during the rainy season. The monthly discharge shows the highest value of 154 to 167 m^3/ sec from August to October, and the lowest value of 27 m^3/ sec from February to March.

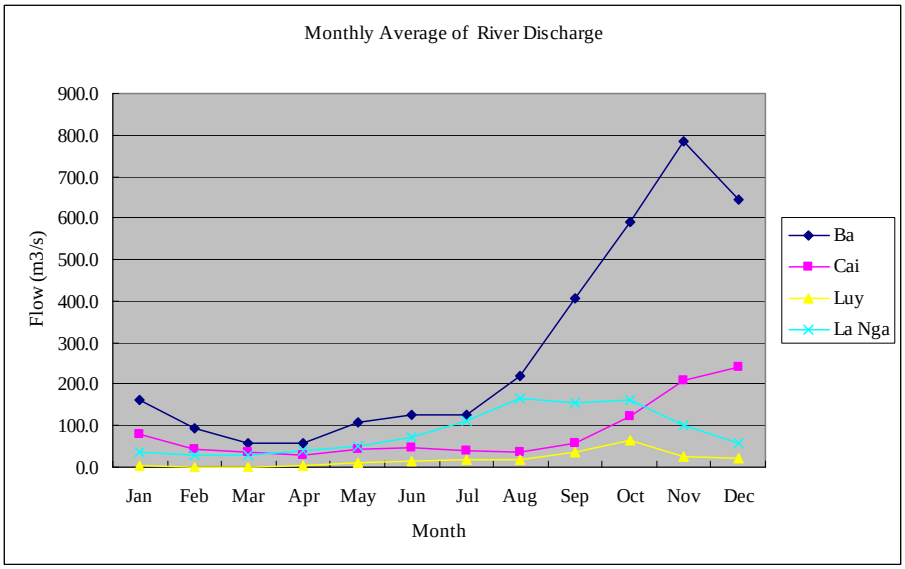


Figure 2.1.7 Monthly Average of River Discharges

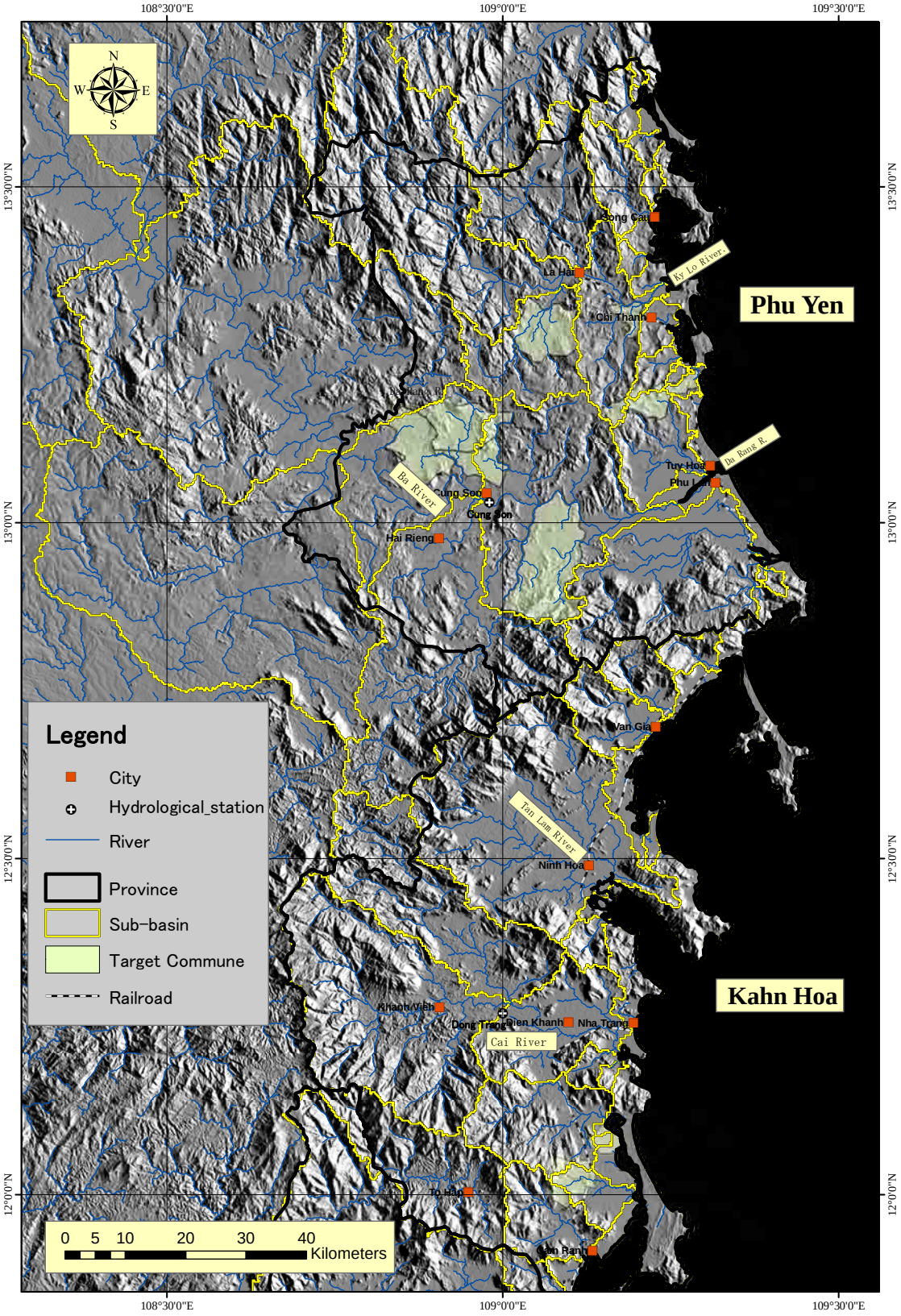


Figure 2.1.8 Location Map of Hydrological Stations

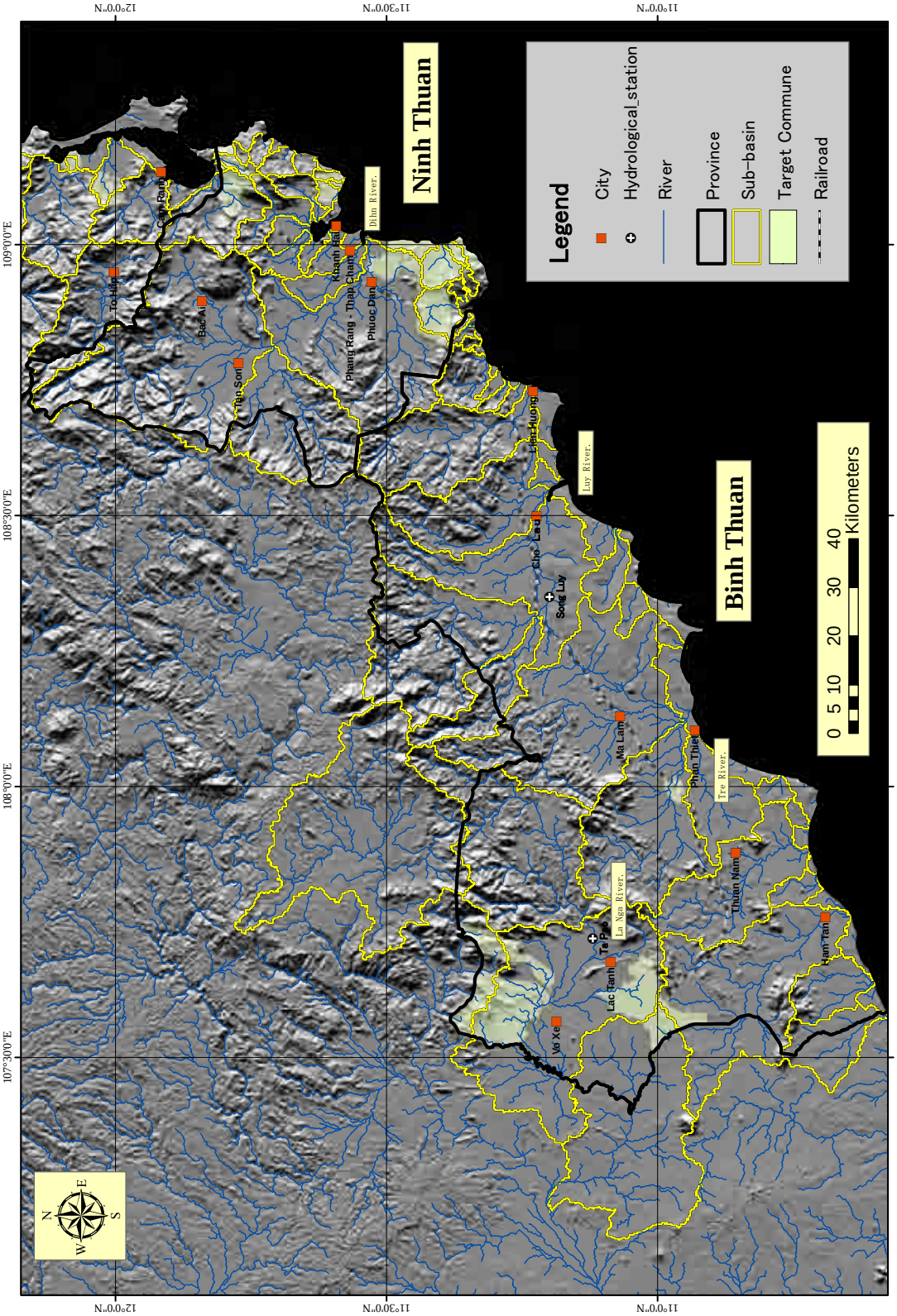


Figure 2.1.9 Location Map of Hydrological Stations

2.1.3 Geomorphology

The study area is located in the southern coastal zone of Vietnam facing East China Sea, and consists principally of lowlands, hills and densely vegetated mountains. Most of the study area is covered by the steep-sided mountainous area which makes up the edge of the Central Highland. The mountainous area runs from the north to the south along the western boundary of the study area, and a part of steep-sided mountains reaches to the coastline bounding the eastern end of the study area and each target province. The lowlands and hills surrounded by the steep-sided mountains occur in the confined areas along the coastlines and rivers. Reflecting these geomorphological conditions, almost all rivers in the study area except the southern part of Phu Yen and Binh Thuan provinces have short length rivers, and their flood plains are not well developed.

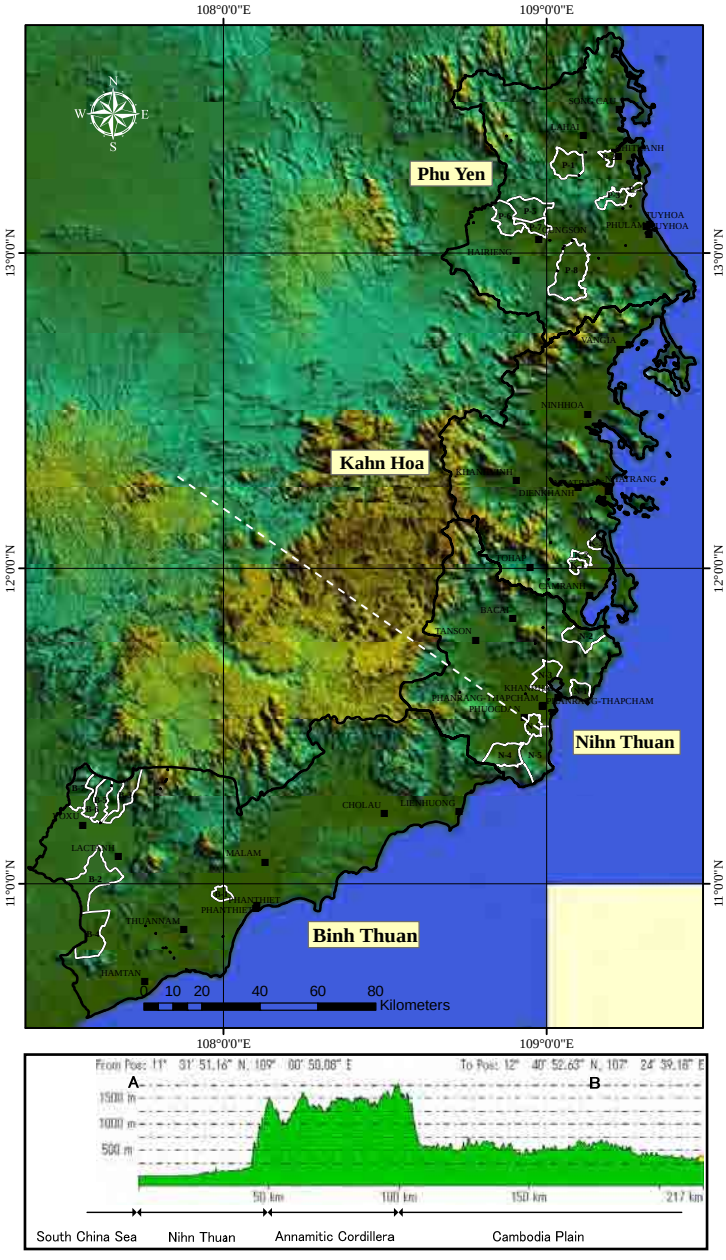
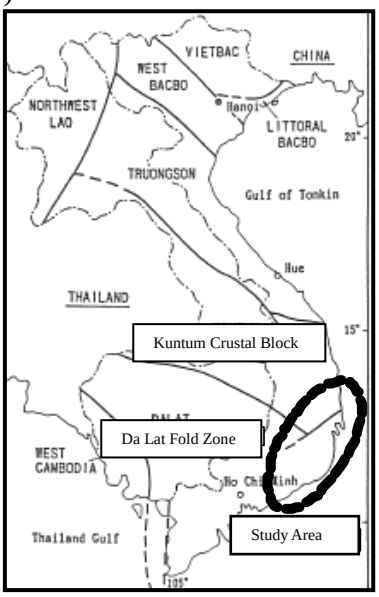


Figure 2.1.10 Geomorphology of the Study Area

The mountainous area accounts for 43.4 % (approx. 9,100 sq. km) of the study area, likewise the hilly terrain is 32.9 % (approx. 6,900 sq. km) and the lowland is 23.7 % (approx. 5,000 sq. km). In Phu Yen, Khanh Hoa and Ninh Thuan provinces, the mountainous area occupies around 50 % of the area. However, the mountainous area in Binh Thuan province makes up 32.0 % and most of the area is the hilly terrain (46.1 %).

2.1.4 Geology

Geology of Vietnam is divided into two groups with latitude line of 15°30´, one is the middle and the northern parts of Vietnam and the other is the southern part of it. The study area belongs to the latter group. (Refer to Figure 2.1.11)



Source: Japan Mining Engineering Center for International Cooperation (1996), "Basic Study of Mineral Resources Development in Vietnam".

Figure 2.1.11 Geological Structure of the Study Area

The study area: the southern part of Vietnam, is located in the late Mesozoic Andean-type magmatic arc which consists of voluminous granitic, andesitic and rhyolitic rocks. The study area is made up of Proterozoic basement rocks, Mesozoic sediments and volcanic rocks, Tertiary and Quaternary sediments and volcanic rocks, and voluminous Paleozoic and Mesozoic granitic rock emplaced widely in the study area. The classifications of each lithological unit are shown in Table 2.1.2. The geological map is also shown in Figure 2.1.12.

Granitic rocks widely cover the study area, especially in Khanh Hoa and Ninh Thuan provinces. Sedimentary rocks are distributed among the plutonic rocks. Basaltic rocks are mainly distributed in Phu Yen province, on the other hand, the distribution in the other provinces are small and limited. Quaternary deposits are distributed widely near the mouth of large rivers, such as Da Rang River and Cai River.

Most lineaments are distinguished in the units of the Permian, Triassic and Cretaceous plutonic rocks.

Table 2.1.2 Lithological Classification in the Study Area

Legend	Geological Time	Formation Name	Lithology
Q	Quarternary		Sand, gravel, silt, clay
Qd			
Qb1			Basalt
Qb2			
Qs			Sand, gravel, silt, clay
Qg			
Qpr			
Nb	Pliocene - Pleistocene Basalts		Tholeitic basalt, plagio-basalt, basalt- dorelite, alkaline basalt
Ns	Paleogene	Kontum, Songba & Dilinh F.	Volcano sediments (siltstone, diatomite, bentonite, lignite, basaltic layer)
Js	E. - M. Jurassic	Bandon F.	Marine sediments (calcareoussandstone, siltstone, marl, siltstone)
Jv	L.Jurassic - Cretaceous	Baoloc F.	Volcano sediments (conglomerate, sandstone), andesite, dacite, tuff
Kv	L. Ctretaceous	Donduong F.	Rhyolite, dacite, tuff, continental sediments
Kg1	L.Jurassic - E. Cretaceous	Ankroet - Dinhquan Complex	Quatz diorilte, granodiorite, granite
Kg2			
Kg3			
Kg4			
Kg5			
Tv	E. - M. Triassic	Manggiang F.	Conglomerate, Sandstone, Siltstone, rhyolitic or dacite, tuff
Tg1	E. - M. Triassic	Vancahn Complex	Granite, granophyre
Tg2			
Pg1	L. Permian - E. Triassic	Bengiang - Queson Complex	Gabbro, diorite, granodiorite, granite
Pg2			
PR	E. Proterozoic	Dakmi F.	Gneiss,crystalline schist, marble, migmatite

*E:early, M:mid, L:late, F: formation,