2.2 Socio-Economic Conditions

(1) Population/Rate of population growth

The population of Study area is approximately 184 thousand as of 2006 with an average growth rate of 1.6%. The population among provinces is distributed as shown in table below. Ninh Thuan province has a relatively higher growth rate of population than others, partly because some of the communes receive more immigrating population due to recent development of shrimp farm/salt farm.

Table 2.2.1 Population and Rate of Population Growth for Each Province (2006)

Province	Population	Population growth rate (%/year)
Phu Yen	49,402	1.2 %
Khanh Hoa	23,049	1.7 %
Ninh Thuan	53,025	2.4 %
Binh Thuan	59,257	1.4 %
TOTAL	184,733	1.6 %

Note: JICA study team calculated the rate of population growth as average for the past 5-10 years on the basis of the population data provided by CPC. This population in each province is total of the target 24 communes.
Source: CPC data and JICA study team

(2) Ethnic group

Majority of population in the Study area belongs to ethnic Kin. In addition to ethnic Kin, there are some other "minority" ethnic groups such as Cham, Raclay, Hroi, Ede, Bana, and others. They have tendencies to form their own communities on the basis of same ethnics; therefore, the minority groups are concentrated in some specified areas. The distribution of the ethnic groups, in the Study area, is shown in the following table.

Table 2.2.2 Number of Households by Ethnic Groups in 24 Target Communes (2006)

Province	No. of communes	Kin		Minority groups		Total
Phu Yen	8	10,070	88%	1,387	12%	11,457
Khanh Hoa	3	4,754	100%	0	0%	4,754
Ninh Thuan	6	7,514	77%	2,264	23%	9,778
Binh Thuan	7	12,082	97%	365	3%	12,447
TOTAL	24	34,420	90%	4,016	10%	38,436

Source: CPC data

(3) Religion

Most of people believe in Buddhism as their religion. Besides, Catholics also exist in some areas such as K-1: Cam An Bac where 90% of total population is regarded as Catholics, and also the minority groups have their own belief.

(4) Poverty Ratio and Income/Expenditure

Poverty ratio[1]

[1] Households whose monthly income is less than VND 200,000 per person are classified as the poor households in the case of rural area, according to the governmental poverty standard 2006-2010 (c.f. VND 250,000 is the poverty line in urban area).

Poverty still remains as the most primary issue to tackle in the Study area, but the extent of poverty is unequal among communes. Higher poverty ratio could be observed in mountain areas where people have to rely basically on cattle breeding and/or sugarcane farming without any other alternative source of income. On the other hand, those areas where people have easier access to big cities and can engage in rice farming, aquaculture and horticulture which promises relatively higher and more stable income, experience low level of poverty.

Poverty ratio in the Study area is as follows:

Table 2.2.3 Poverty Ratio (2006)

Provinces	Commune								Average
Phu Yen	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	21.3%
	Xuan Phuoc	An Dinh	An Tho	An My	Son Phuoc	Ea Cha Rang	Suoi Bac	Son T.Dong	
	20.9%	13.9%	29%	9.7%	28.2%	41%	30%	25%	
Khanh Hoa	K-1	K-2	K-3						14.3%
	Cam An Bac	Cam Hiep Nam	Cam Hai Tay						
	22.0%	15.8%	9%						
Ninh Thuan	N-1	N-2	N-3	N-4	N-5	N-6			26.0%
	Nhon Hai	Cong Hai	Bac Son	Phuoc Minh	Phuoc Hai	Phuoc Dinh			
	13%	25.3%	32%	8%	16%	20%			
Binh Thuan	B-1	B-2	B-3	B-4	B-5	B-6	B-7		13.7%
	Muong Man	Gia Huynh	Nghi Duc	Tan Duc	Me Pu	Sung Nhon	Da Kai		
	6.3%	8.4%	8.1%	30%	9.8%	12%	23%		
Total									17.8%

Source: CPC data

Income/expenditure

The income of major fraction of population relies mainly on farming products such as rice, sugarcane, cassava, vegetable and/or fishing (incl. aquaculture) with some retail side business. As to the characteristics of economic activities in the past years, much more people have started retail side business to add to their own income, which is now believed to contribute about one-third to half of their total family income in most cases.

Seasonal emigrant works, which are seen especially in Ninh Thuan province heading to Da Lat region for coffee harvesting, etc., also contribute to their income.

The following table shows the basic trend of monthly expenditure[2] per household provided by the Socio-economic survey conducted by the JICA study team[3].

[2] The figure of expenditure amount is applied here instead of income because the investigation of income is difficult to follow due to existence of various income sources including retail side business, remittance and others.
[3] The outline of the survey is shown in "2.3.3 Condition of water use" and the results of the details are shown in supporting report.

Table 2.2.4 Monthly Expenditure: Distribution of Households (interviewees) by Expenditure Amount (000 VND)

	Less than 490	500-990	1,000-1,490	1,500-1,990	2,000-2,490	More than 2,500	Average	Median[4]
Phu Yen	32	144	327	261	150	239	1,966	1,655
	2.8%	12.5%	28.4%	22.6%	13.0%	20.7%		
Khanh Hoa	10	37	98	91	87	157	2,437	2,076
	2.4%	8.7%	23.1%	21.5%	20.5%	37.0%		
Ninh Thuan	9	105	231	228	184	239	2,159	1,733
	0.9%	10.5%	23.2%	22.9%	18.5%	24.0%		
Binh Thuan	7	45	133	185	178	698	3,439	2,754
	0.5%	3.4%	10.0%	14.0%	13.4%	52.7%		
TOTAL	58	331	789	765	599	1333	2,754	2,037
	1.5%	8.5%	20.4%	19.7%	15.5%	34.4%		

Source: Socio-economic survey by the JICA study team

(5) Waterborne Disease

The prevalence of diseases related to water has obviously reduced for the last decade in nearly all the communes, particularly the prevalence of Malaria. However, despite the presently improving condition, many people still have concern on frequent occurrence of water related diseases including diarrhea, skin diseases such as trachoma, and some other diseases shown in table below.

The correlation between installation/absence of toilet and diseases can be observed strongly in some communes such as P-5: Son Phuoc: more than 80% of people (interviewees), who do not have toilet, get affected by water related diseases rather frequently. On the contrary, the figure among toilet holders who have often suffered from such diseases is less than 5%. Details are shown in Supporting report.

Table 2.2.5 Waterborne Disease

	Diarrhea	Cholera	Dysentery	Hepatitis	Malaria	Schistsome	Trachoma	Skin diseases	No/rare contracts
Phu Yen	207	30	5	16	148	86	65	147	761
	18.0%	2.6%	0.4%	1.4%	12.8%	7.5%	5.6%	12.7%	66.0%
Khanh Hoa	28	2	0	5	6	27	16	52	376
	6%	0%	0%	1%	1%	6%	3%	11%	78%
Ninh Thuan	196	63	1	11	117	68	178	112	541
	19.7%	6.3%	0.1%	1.1%	11.7%	6.8%	17.9%	11.2%	54.3%
Binh Thuan	233	42	9	42	130	194	161	210	609
	18.7%	3.4%	0.7%	3.4%	10.4%	15.6%	12.9%	16.9%	48.9%
TOTAL	459	111	10	62	255	292	356	380	1,786
	11.8%	2.9%	0.3%	1.6%	6.6%	7.5%	9.2%	9.8%	46.1%

Note: Table shows the results of the Socio-economic survey, in which interviewees picked up whatever diseases that they/their family members contracted often as multiple answers. The percentage was calculated by dividing those answers by the number of total figures of answers.

Source: Socio-economic survey by the JICA study team

[4] The figure of "Average" is likely to be influenced by some skewed samples; in this case, some of rich households' expenditure figures. It is believed that "Median" is more suitable index to see the condition for some cases such as income/expenditure figures.

(6) Local Needs regarding Water Supply

Significant needs on water supply exist in many communes in general according to the survey. However, the degree of its significance on their needs varies from communes to communes. Detailed figures by communes are shown in Supporting report.

Table 2.2.6 Local People's Needs on Water Supply

	Much more*	Slightly more	If possible	Currently enough	Total
Phu Yen	418	113	84	537	1,153
	36.3%	9.8%	7.3%	46.6%	100%
Khanh Hoa	260	85	64	71	480
	54.2%	17.7%	13.3%	14.8%	100%
Ninh Thuan	650	131	78	134	996
	65.3%	13.2%	7.8%	13.5%	100%
Binh Thuan	553	246	93	352	1,246
	44.4%	19.7%	7.5%	28.3%	100%
TOTAL	1,881	575	319	1,094	3,875
	48.5%	14.8%	8.2%	28.2%	100%

Note 1): "Much more": need much more water than water volume available at present, "Slightly more": need slightly more water, "If possible": almost feel enough at the current volume, "Currently enough": feel satisfied with the current volume/do not need more water
Note 2): Answers as "others", which occupied only 0.2% are excluded from this Table.
Source: Socio-economic survey by the JICA study team

About 36% of respondents feel satisfied with water volume at present. However, this result is concerned over only water volume and is not concerned over water quality.

(7) Expense on water supply

Selling price of water ranges from 20,000 VND to 30,000 VND/m^3, depending on location and season. Local people purchase water directly from vendors who circulate in communities with water carried by cattle wagon or small truck. There are some locations where the people have to visit vendors' sites by motorbikes taking 10-30 minutes to purchase water such as in K-3 Cam Hai Tay.

The following table shows the information on how much people spend on water as percentage of total monthly expense.

Table 2.2.7 Number of People according to the Expense on Water as Percentage of Total Monthly Expense (Dry Season)

Expense on water use as percentage of total monthly expense		Zero	Less than 1%	1-5%	5-10%	More than 10%
Phu Yen	Persons	900	60	143	50	3
	%	78.1%	5.2%	12.4%	4.3%	0.3%
Khanh Hoa	Persons	287	13	104	76	35
	%	59.8%	2.7%	21.7%	15.8%	7.3%
Ninh Thuan	Persons	388	137	373	98	19
	%	39.0%	13.8%	37.4%	9.8%	1.9%
Binh Thuan	Persons	766	253	190	37	15
	%	61.5%	20.3%	15.2%	3.0%	1.2%
TOTAL	Persons	2,341	463	810	261	72
	%	60.4%	11.9%	20.9%	6.7%	1.9%

Source: Socio-economic survey by the JICA study team

Table 2.2.7 shows that water expense does not pose a heavy burden on their monthly expense in case of more than half the number of households in the area, 60% of them fall in Zero category. However, there are also some communes where expense on water occupies larger proportion: for example, many in N-4 Phuoc Minh spend on water more than average in the area, whose "Mode" of the answers regarding the percentage falls in the category "5-10%" (details are shown in Supporting report).

Besides water usage cost, people actually spend around 2.5 million to 4 million VND as initial installation cost on dug well construction, and 10 million VND or more in the case of installation of tube well, in general. Particularly in the case of tube well construction, they have chances to avail special loan including Program 134/135 and other types of promoting policy[5].

2.3 Water Supply

2.3.1 Current Status of Rural Water Supply

Ratio of access to safe water in rural area is 66% (N-CERWASS, 2006), up more than 20 percent from the year 2000 when National Rural Water Supply and Sanitation Strategy (NRWSSS) was formulated. It is prospected that the target rates by the year 2010 as well as 2020 could be reached on condition that current progress would be maintained. Since difficult areas for groundwater development remains to be worked on due to severe natural conditions, and communes of poverty and ethnic minority are also left from getting benefits of development, more efficient development than ever before is required.

It is reported that there are more than two million rural water supply facilities, including piped systems, drilled wells, dug wells, rain water jars, etc. Most of private owned facilities are not well-maintained or constructed with poor workmanship which often causes water pollution to water sources. (Information by N-CERWASS)

Ratio of rural population in Vietnam served by piped water supply system is approximately 30%. The Vietnamese government puts higher priority on the piped scheme for its advantageous nature in terms of water quality control. However, there have been few cases that got into troubles because maintenance was not properly performed even though it is a piped system. Thus, in addition to increasing access rate to safe water, it is required to enhance water quality control and to strengthen institutional capacity through improvement of water tariff collection and skill of staff. At the same time, integrated water resources management (IWRM) is also required for necessity of efficient water resources development becomes more important.

[5] National Bank for Social Policies (VBSP) offers loan to households below the poverty line along with the governmental policy. The borrowers can allocate the loan to whatever purposes as follow: production supply, housing, electricity, water supply and education. Loan amount is 40 thousand VND at maximum, and the repayment period is 3 years with 0.65% interest rate/month.

2.3.2 Population Served

(1) National Conditions

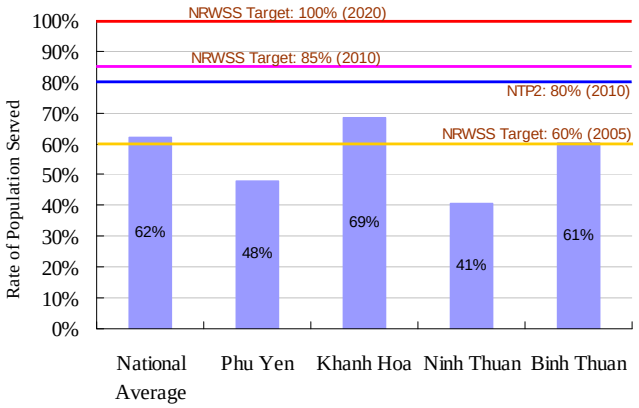
Total population served with clean water by the end of 2005 is estimated to be approximately 40 million. According to the plan 2006-2010 of NTP II, the population served in Vietnam will be 85% in 2010. The proposed service population stage 2006-2010 by region is shown in Table 2.3.1. However, it is necessary to make the ratio of population served increase to 100% by the year 2020.

Table 2.3.1 Proposed Service Population Stage 2006-2010 by Region

Region	2005 (NTP I)		Plan 2006-2010 (NTP II)		End of 2010	
	Population Served (person)	Ratio (%)	Increasing the Population Served (person)	Increasing Ratio (%)	Total Population Served (person)	Total Ratio (%)
Northern part	5,559,506	56	1,876,050	19	7,450,000	75
Hong river delta	9,742,835	66	3,538,300	24	13,300,000	90
Northern central	5,707,670	61	1,789,800	19	7,536,000	80
Southern coastal	3,923,530	57	1,575,500	23	5,480,000	80
Central highland	1,593,730	52	1,005,900	33	2,590,800	85
Southern eastern	3,259,129	68	1,057,450	22	4,326,000	90
Mekong delta	10,126,332	66	3,651,300	24	13,692,500	90
Whole country	39,912,732	62	14,494,300	23	54,375,300	85

Source: Preparatory Study on Groundwater Development in the Rural provinces of the Southern Coastal Zone in the Socialist Republic of Vietnam

(2) Provinces Conditions



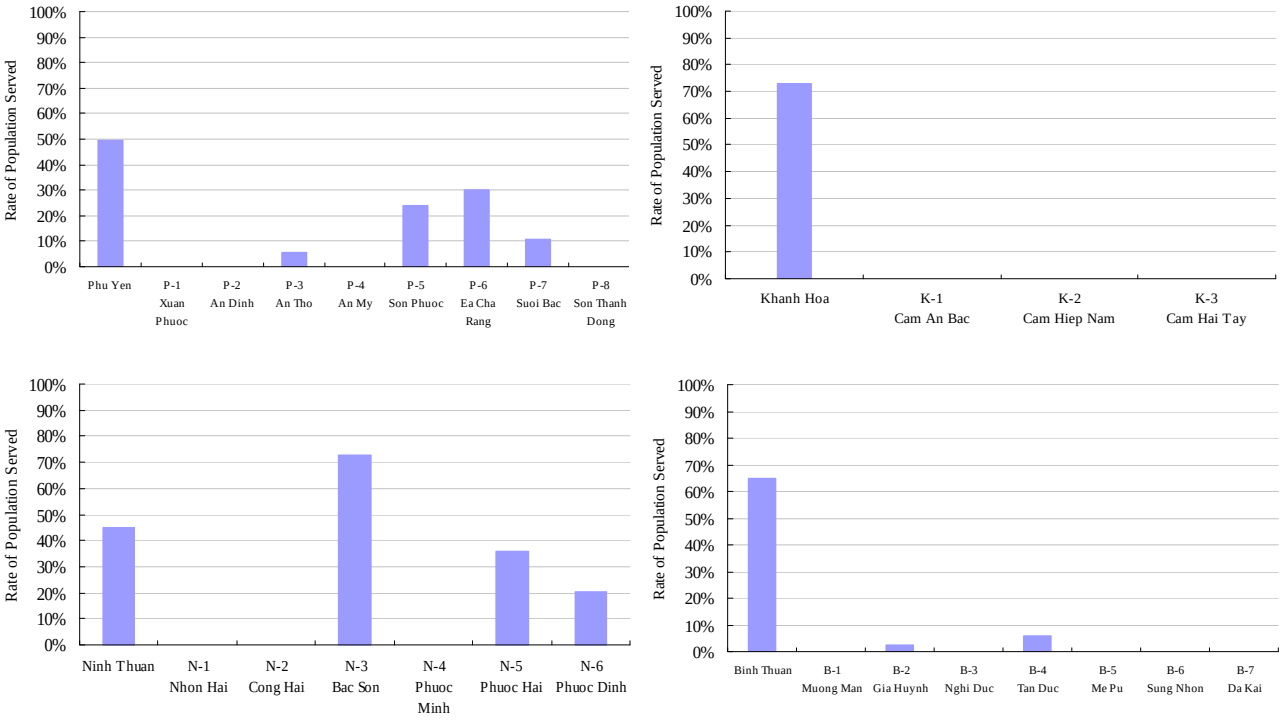
Source: Preparatory Study on Groundwater Development in the Rural provinces of the Southern Coastal Zone in the Socialist Republic of Vietnam

Figure 2.3.1 The Ratio of Access to Clean Water in 2005

The ratio of access to clean water in four (4) provinces is shown in Figure 2.3.1. In 2005, the ratio of access to clean water in Phu Yen and Ninh Thuan provinces are lower than national average, valued 62%, and is also lower than national target.

On the other hand, Khanh Hoa and Binh Thuan province have already achieved the national target in 2005 for the ratio of access to clean water. However, people are able to obtain water from poor water sources such as shallow wells, rain water, irrigation ponds or channels. Their water consumption is quite low.

(3) Target Communes



Source: CPC data

Figure 2.3.2 Ratio of Population Served in the Target Communes in 2006

The rate of population served in each commune in 2006 is shown in Figure 2.3.2. Most of the target communes are lower than the provincial average in 2006. Towards achieving the target of the NRWSSS, it is necessary to improve the condition of sufficient water in the target communes. In some communes, the existing water supply systems have been operating by residents, CPC, DPC and urban water supply company.

2.3.3 Condition of Water Use

Based on the result of socio-economic survey, the condition of water use is described in the below.

(1) Water Source

As to the availability of water, different pictures by places are observed, particularly in rainy season and dry season as shown in Table 2.3.2. Primary water sources for people in the Study area are piped water, dug well, tube well, spring, river/stream, rain water and purchased water. The numbers of People, who have dug well, have increased a lot in the past decade due to the gradual growth of their affordability to pay construction cost as well as their growing demand on more water along with gradual depletion of available water in existing wells. More than 60% of interviewees are using own/private dug well. Meanwhile, 10% of interviewees are using tube well. The governmental subsidiary support also raised the number of tube wells, although the figure does not reach the level of dug wells.

There are some areas where most people have to rely on purchased water from water vendors (e.g. More than 75% of interviewees rely on purchasing water as primary water source in N-4: Phuoc Minh in dry season, and 55% in N-1: Nhon Hai in dry season). On the other hand in rainy season, the severity of available water generally alleviates towards the season, and the percentage of people relying on purchased water from vendors, diminishes during rainy season.

The usage rate of primary water sources doesn't vary with the seasons. In dry season, people have difficulty in finding alternative water source due to water shortage. Therefore, people have no choice but use same water source and live by reducing water consumption as a temporary measures. Thus, the capacity of current water sources is unstable.

As mentioned above, people rely on purchased water in some areas. The price of water sold by water vendor is high and therefore proves to be a burden on the household expenses of buyers. According to the result of Table 2.3.2, rate of households purchasing water is approx. 10% of total. Except some communes in Ninh Thuan, which show high rate of approx. 50-70%, results for most communes indicate low rate of less than 10%. However, these results do not necessarily mean that communes with lower ratio of population buying water (less than 10%) have sufficient water available for their use. The actual reason for this is reflected from the results of interviews with local people. The low rate of water purchase in many communes are attributed to the fact that water vending is not common business in most communes and people do not have easy access to water vendors. In addition, the water price of vendors is very high. Therefore, people have no other choice but to reduce water consumption in order to minimize their household expenses.

The water charge of existing waterworks based on the results of field survey varies from VND700 to VND2,500 per m^3 as shown in Table 2.3.3. The water supply at low water charge, stable water supply and safe water quality through piped water schemes shall lower the level of residents' burden and contribute to improvement in living standard.

Table 2.3.2 Primary Water Source in Rainy Season and Dry Season

Commune		No. of Sumples	Season	Piped water	Dug well	Tube well	Spring	River/ Stream	Rain water	Purchase water	Other	TOTAL
P-1	Xuan Phuoc	180	Rainy	0.6%	96.7%	0.0%	0.6%	0.0%	0.0%	0.0%	2.2%	100.0%
			Dry	0.6%	91.7%	0.6%	0.6%	0.0%	0.0%	0.0%	6.7%	100.0%
P-2	An Dinh	155	Rainy	0.0%	82.6%	15.5%	1.9%	0.0%	0.0%	0.0%	0.0%	100.0%
			Dry	0.6%	80.6%	16.8%	1.9%	0.0%	0.0%	0.0%	0.0%	100.0%
P-3	An Tho	74	Rainy	0.0%	66.2%	2.7%	0.0%	0.0%	0.0%	0.0%	31.1%	100.0%
			Dry	0.0%	58.1%	2.7%	0.0%	0.0%	0.0%	1.4%	37.8%	100.0%
P-4	An My	282	Rainy	0.0%	55.7%	42.2%	0.0%	0.0%	0.0%	0.0%	2.1%	100.0%
			Dry	0.0%	51.8%	45.7%	0.0%	0.0%	0.0%	0.0%	2.5%	100.0%
P-5	Son Phuoc	69	Rainy	5.8%	88.4%	0.0%	2.9%	0.0%	2.9%	0.0%	0.0%	100.0%
			Dry	5.8%	84.1%	0.0%	10.1%	0.0%	0.0%	0.0%	0.0%	100.0%
P-6	Ea Cha Rang	59	Rainy	0.0%	52.5%	0.0%	28.8%	0.0%	6.8%	0.0%	11.9%	100.0%
			Dry	0.0%	61.0%	0.0%	39.0%	0.0%	0.0%	0.0%	0.0%	100.0%
P-7	Suoi Bac	145	Rainy	21.4%	77.9%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	100.0%
			Dry	20.7%	76.6%	0.0%	2.8%	0.0%	0.0%	0.0%	0.0%	100.0%
P-8	Son Thanh Dong	189	Rainy	0.0%	33.3%	63.5%	0.0%	1.1%	1.6%	0.0%	0.5%	100.0%
			Dry	0.0%	34.9%	63.0%	0.5%	1.6%	0.0%	0.0%	0.0%	100.0%
K-1	Cam An Bac	117	Rainy	0.0%	94.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.0%	100.0%
			Dry	0.0%	90.6%	0.0%	0.0%	0.0%	0.0%	0.0%	9.4%	100.0%
K-2	Cam Hiep Nam	130	Rainy	0.0%	94.6%	2.3%	0.0%	0.0%	3.1%	0.0%	0.0%	100.0%
			Dry	0.0%	93.1%	3.1%	0.8%	0.0%	0.0%	2.3%	0.8%	100.0%
K-3	Cam Hai Tay	233	Rainy	0.0%	68.7%	0.0%	0.0%	0.0%	6.4%	24.9%	0.0%	100.0%
			Dry	0.0%	48.9%	0.0%	0.0%	0.0%	0.4%	50.6%	0.0%	100.0%
N-1	Nhon Hai	240	Rainy	0.0%	42.9%	0.0%	0.0%	0.0%	16.3%	40.8%	0.0%	100.0%
			Dry	0.0%	44.6%	0.0%	0.0%	0.0%	0.0%	55.4%	0.0%	100.0%
N-2	Cong Hai	149	Rainy	0.0%	83.9%	0.0%	9.4%	0.0%	6.0%	0.7%	0.0%	100.0%
			Dry	0.0%	79.9%	0.0%	13.4%	0.0%	0.7%	6.0%	0.0%	100.0%
N-3	Bac Son	130	Rainy	36.9%	24.6%	0.0%	19.2%	0.0%	14.6%	3.1%	1.5%	100.0%
			Dry	42.3%	20.0%	0.0%	24.6%	0.0%	0.0%	3.8%	9.2%	100.0%
N-4	Phuoc Minh	89	Rainy	2.2%	25.8%	0.0%	0.0%	0.0%	47.2%	24.7%	0.0%	100.0%
			Dry	2.2%	20.2%	0.0%	0.0%	0.0%	1.1%	76.4%	0.0%	100.0%
N-5	Phuoc Hai	230	Rainy	0.4%	71.7%	0.0%	1.3%	0.0%	0.0%	0.0%	26.5%	100.0%
			Dry	0.0%	72.2%	0.0%	1.7%	0.0%	0.0%	0.0%	26.1%	100.0%
N-6	Phuoc Dinh	158	Rainy	8.9%	50.0%	8.2%	0.0%	0.0%	1.3%	27.8%	3.8%	100.0%
			Dry	9.5%	48.7%	8.2%	0.0%	0.0%	0.0%	29.1%	4.4%	100.0%
B-1	Muong Man	140	Rainy	0.0%	39.3%	4.3%	0.0%	3.6%	34.3%	3.6%	15.0%	100.0%
			Dry	0.0%	52.1%	7.1%	1.4%	6.4%	5.0%	7.1%	20.7%	100.0%
B-2	Gia Huynh	118	Rainy	0.0%	97.5%	0.0%	0.0%	0.0%	2.5%	0.0%	0.0%	100.0%
			Dry	0.0%	99.2%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	100.0%
B-3	Nghi Duc	203	Rainy	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
			Dry	0.0%	98.5%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
B-4	Tan Duc	116	Rainy	1.7%	50.9%	4.3%	0.0%	0.0%	41.4%	0.9%	0.9%	100.0%
			Dry	1.7%	86.2%	6.0%	2.6%	0.0%	0.0%	3.4%	0.0%	100.0%
B-5	Me Pu	270	Rainy	0.0%	70.7%	24.1%	0.0%	0.0%	0.0%	0.0%	5.2%	100.0%
			Dry	0.0%	70.7%	24.1%	0.0%	0.0%	0.0%	0.0%	5.2%	100.0%
B-6	Sung Nhon	165	Rainy	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
			Dry	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
B-7	Da Kai	234	Rainy	0.0%	84.6%	6.8%	0.0%	0.0%	5.1%	0.0%	3.4%	100.0%
			Dry	0.0%	85.5%	4.3%	0.0%	0.0%	0.0%	1.7%	8.5%	100.0%
Total		3875	Rainy	2.7%	69.2%	9.6%	1.7%	0.2%	6.5%	6.0%	4.2%	100.0%
			Dry	2.8%	68.4%	10.0%	2.6%	0.3%	0.3%	10.3%	5.2%	100.0%

Source: Socio-economic survey by the JICA study team

Table 2.3.3 Condition of Water Charge in the Existing Water Supply System

Province	Commune	Code	O&M Organization	Water Charge (VND/m^3)
Phu Yen	An Tho	P-3	Private	Free
	Son Phuoc	P-5	CPC	700
	Ea Cha Rang	P-6	CPC	1800~2000
	Suoi Bac	P-7	Urban Water Supply	2200
Khanh Hoa	Cam An Bac	K-1	CPC	Pending approval
Ninh Thuan	Bac Son	N-3	DPC, CPC	2000
	Phuoc Hai	N-5	CPC	Free
	Phuoc Dinh	N-6	CPC	2500
Binh Thuan	Gia Huynh	B-2	Private	Uncollectible water charge
	Tan Duc	B-4	Urban Water Supply	-

Source: Result of field survey by JICA study team

(2) Water Demand

Per capita consumption

The per capita consumption in the Study area is shown in Table 2.3.4. As indicated in Table, average of per capita consumption in the Study area is 120 l/ day. Specifically for drinking, cooking and shower purposes only, the consumption is generally observed to be around 20 to 30 l/person/day. However, if other uses such as watering for garden washing for farm equipment and livestock are included, the volume rises to around 120 litter/person/day or beyond in some cases, depending on water availability and commercial demands in each location. The detailed results on the volume of water uses are shown in Supporting report.

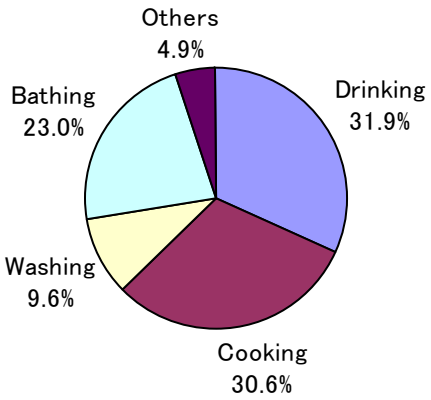
Table 2.3.4 Per capita Consumption in the Study Area

Province	Average of per capita consumption (l/person/day,)
Phu Yen	82.3
Khanh Hoa	122.0
Ninh Thuan	78.1
Binh Thuan	187.6
Average	120.0

Source: Socio-economic survey by the JICA study team

Water use allocation for additional clean water based on socio-economic survey

With the formulation and improvement of water supply system, additional amount of clean water will be available for use. From the viewpoint of water use allocation for additional clean water by purposes, the users priority goes to drinking, followed by cooking and bathing purposes. In last few years, the daily life style of people has changed gradually and accordingly their preferences on water use allocation have also changed. Significant change is observed in use of more water for bathing, because the people bathe more frequently than before. The detailed results on the water use allocation are shown in Supporting report.



Source: Socio-economic survey by the JICA study team

Figure 2.3.3 Preference of Users for Additional Available Water (average of four (4) provinces)

Pattern of water use in Communes

Table 2.3.5 shows the ratio of domestic and non-domestic water uses in the Study area. The water used for the retail business in the rural area is classified as non-domestic water. The rate of non-domestic water is geneerally small and the average of non-domestic water is approx. 12% in case when the rate of domestic water is 100%. Considering the feature of each commune, the ratio of non-domestic water is classified into three, 5%, 10% and 13% by quartiles of actual data. The detailed result of the ratio of domestic and non-domestic water uses in the Study area is shown in Supporting report.

Table 2.3.5 Rate of Domestic and Non-Domestic Water in the Study Area

Province	Code	Commune	Ratio of non-domestic water
Phu Yen	P-1	Xuan Phuoc	13%
	P-2	An Dinh	10%
	P-3	An Tho	10%
	P-4	An My	13%
	P-5	Son Phuoc	13%
	P-6	Ea Cha Rang	10%
	P-7	Suoi Bac	13%
	P-8	Son Thanh Dong	5%
Khanh Hon	K-1	Cam An Bac	10%
	K-2	Cam Hiep Nam	13%
	K-3	Cam Hai Tay	13%
Ninh Thuan	N-1	Nhon Hai	13%
	N-2	Cong Hai	13%
	N-3	Bac Son	13%
	N-4	Phuoc Minh	13%
	N-5	Phuoc Hai	5%
	N-6	Phuoc Dinh	13%
Binh Thuan	B-1	Muong Man	13%
	B-2	Gia Huynh	13%
	B-3	Nghi Duc	10%
	B-4	Tan Duc	10%
	B-5	Me Pu	5%
	B-6	Sung Nhon	10%
	B-7	Da Kai	5%

Source: Socio-economic survey by the JICA study team

(3) Water Quality

JICA Study Team conducted survey for existing wells from the view of water supply and also conducted inventory survey for existing wells from the view of groundwater. Table 2.3.6 summarizes both of results.

Table 2.3.6 Summary of Problems of Water Quality in Existing Wells

Province	Code	Commune	Problems of water quality						
			Turbidity*1	Fluoride	Salinity	Ca	High pH	Metallic Taste	Odor
Phu Yen	P-1	Xuan Phuoc	X	X		X		X	
	P-2	An Dinh	X	X				X	
	P-3	An Tho	X	X	X		X	X	
	P-4	An My	X	X	X				
	P-5	Son Phuoc	X						X
	P-6	Ea Cha Rang	X	X		X	X		
	P-7	Suoi Bac	X			X			
	P-8	Son Thanh Dong	X						
Khanh Hoa	K-1	Cam An Bac	X	X	X				
	K-2	Cam Hiep Nam	X	X					
	K-3	Cam Hai Tay	X	X	X				
Ninh Thuan	N-1	Nhon Hai	X		X				
	N-2	Cong Hai	X	X	X			X	
	N-3	Bac Son	X		X				
	N-4	Phuoc Minh	X		X				
	N-5	Phuoc Hai	X		X			X	
	N-6	Phuoc Dinh	X		X				
Binh Thuan	B-1	Muong Man	X	X	X	X		X	
	B-2	Gia Huynh	X	X				X	
	B-3	Nghi Duc	X	X					
	B-4	Tan Duc	X	X		X		X	
	B-5	Me Pu	X	X				X	
	B-6	Sung Nhon	X	X				X	
	B-7	Da Kai	X	X				X	

*1: Turbidity is indicated in rainy season.

According to the result of survey for existing wells from the view of water supply, CPC pointed out problems regarding water quality of primary water source, which people are currently using in their daily life. The summary of this result is shown in below.

- Contaminated water due to high turbidity in rainy season and turbidity is indicated in dug wells in all communes.
- High salinity and this has compelled users to purchase water in spite of water availability in dug wells.
- Presence of fluoride in water of dug well, which, people believe, is one of the reasons causing dental fluorosis.
- Presence of calcium in water, which, people believe, is one of the reasons for kidney stone formation.

2.3.4 Issues of Existing Drinking Water Source

Based on the result of socio-economic survey and survey for existing wells, some issues of existing drinking water source is identified in the targeted 24 communes. Table 2.3.7 shows issues of existing drinking water source. The detailed result is shown in Supporting report.

Table 2.3.7 Issues of Existing Drinking Water Source

Code	Commune	Necessity of water supply
P-1	Xuan Phuoc	44% of respondents answered that they need much more water than water volume available through primary water source. (51%, including "Slightly more", [7]) 58% of respondents feel unsatisfied with water quality in primary water source. ([2]) Furthermore, people have concerns on frequent occurrence of skin diseases. ([6]) According to the result of inventory survey of existing wells, presence of turbidity, fluoride, calcium and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 83% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 60% of respondents need additional water volume for drinking purposes. ([7]) 68% of respondents have concerns on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be key issues considering the results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
P-2	An Dinh	72% of respondents feel satisfied with current water volume in primary water source. ([7]) 97% of respondents feel satisfied with water quality in primary water source. ([2]) Furthermore, there is no report regarding water born disease. ([6]) Although, the monthly household expense is lower than average of all target communes (2,037), 83% of respondents purchase water for drinking. ([4] and [5]) According to the result of inventory survey of existing well, presence of turbidity, fluoride and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 69% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. Demand of drinking water and domestic water is not so high. ([8] and [9]) However, it is assumed that most of users purchase water for drinking because people have concern of water quality. Furthermore, the problem of water quality still remains in accordance with the result of inventory survey of existing wells. Therefore, **water quality** is evaluated to be major issue considering the results of survey as mentioned above and water supply, which can supply stable and safe water, is required.
P-3	An Tho	69% of respondents need much more water than water volume available in primary water source. (71%, including "Slightly more", [7]) 62% respondents feel unsatisfied with water quality in primary water source. ([2]) There is no report regarding water borne diseases. ([6]) According to the result of inventory survey of existing well, presence of turbidity, fluoride, salinity, high pH and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 91% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, influences water quality in dug wells. 57% of respondents need additional amount of water for drinking purposes. ([7]) 73% of respondents have concerns on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.

Code	Commune	Necessity of water supply
P-4	An My	68% of respondents feel satisfied with current water volume in primary water source. ([7]) 71% of respondents feel satisfied with water quality in primary water source. ([2]) Furthermore, there is no report regarding water borne disease. ([6]) However, according to the result of inventory survey for existing wells, presence of turbidity, fluoride and sanitary is reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 61% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 53% of respondents spend 10-30min for fetching water, and it is deplorable condition to get water. Demand of drinking water and domestic water is not high. However, the problem of water quality still remains in accordance with the result of inventory survey of existing wells. Therefore, **water quality** and **exertions for fetching water** are evaluated to be major issues considering results of survey as mentioned above and water supply, which can supply stable and safe water, is required.
P-5	Son Phuoc	54% of respondents need much more water than water volume available through primary water source. (71%, including "Slightly more", [7]) 64% of respondents feel satisfied with water quality in primary water source. ([2]) However, 78% of respondents have concern on frequent occurrence of diarrhea. ([6]) According to the result of inventory survey of existing wells, presence of turbidity and odor are reported by representative of commune. ([11]) In rainy season, turbidity is indicated in all dug wells. Since 96% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 75% of respondents need additional amount of water for drinking purposes. ([7]) 70% of respondents have concerns on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated as major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
P-6	Ea Cha Rang	66% of respondents need much more water than water volume available at present through primary water source. (85%, including "Slightly more", [7]) 54% of respondents feel unsatisfied with water quality in primary water source. ([2]) Furthermore, 80% of respondents have concern on frequent occurrence of diarrhea. ([6]) According to the result of inventory survey of existing wells, presence of turbidity, fluoride, calcium and high pH are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 95% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 37% of respondents spend about 10-30min for fetching water, it could be said that access to water is in deplorable condition.([3]) 97% of respondents need additional amount of water for drinking purposes. ([7]) 92% of respondents have concern on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume**, **water quality** and **work for fetching water** are evaluated as major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is necessary.
P-7	Suoi Bac	50% of respondents need much more water than water volume available at present through primary water source. (56%, including "Slightly more", [7]) 54% of respondents answered that they feel unsatisfied with water quality in primary water source. ([2]) According to the result of inventory survey of existing wells, presence of turbidity and calcium are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 55% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 59% of respondents need additional water volume for drinking purposes. ([7]) 72% of respondents have concern on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.

Code	Commune	Necessity of water supply
P-8	Son Thanh Dong	52% of respondents feel satisfied with current water volume in primary water source. ([7]) 92% of respondents feel satisfied with water quality in primary water source. ([2]) Furthermore, there is no report regarding water borne disease. ([6]) According to the result of inventory survey of existing wells, presence of turbidity is reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 87% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. Demand of drinking water and domestic water is not high. However, the problem of water quality still remains in accordance with the result of inventory survey of existing wells. Therefore, **water quality** is evaluated to be major issue considering results of survey as mentioned above and water supply, which can supply stable and safe water, is required.
K-1	Cam An Bac	43% of respondents need much more water than water volume available at present through primary water source. (81%, including "Slightly more", [7]) 59% of respondents feel unsatisfied with water quality in primary water source. ([2]) According to the result of inventory survey of existing wells, presence of turbidity, fluoride and salinity are reported by representative of commune. ([11]) In rainy season, turbidity is indicated in all dug wells. Since 60% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 91% of respondents need additional water volume for drinking purposes. ([7]) 77% of respondents have concern on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
K-2	Cam Hiep Nam	46% of respondents need much more water than water volume available at present through primary water source. (67%, including "Slightly more", [7]) 51% of respondents feel unsatisfied with water quality in primary water source. ([2]) Furthermore, 38% expressed concern on frequent occurrence of skin disease. ([6]) According to the result of inventory survey of existing wells, presence of turbidity and fluoride are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 32% of respondents spend 10-30min for fetching water, therefore it may be said that access to water is in deplorable condition. 67% of respondents need additional water volume for drinking purposes. ([7]) 65% of respondents concern on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume**, **water quality** and **work for fetching water** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
K-3	Cam Hai Tay	64% of respondents need much more water than water volume available at present through primary water source. (72%, including "Slightly more", [7]) 51% of respondents purchase drinking water at present, since water volume of primary water source is not enough. ([1]) 96% of respondents feel satisfied with water quality in primary water source. ([2]) According to the result of inventory survey of existing wells, presence of turbidity, fluoride and salinity are reported by representative of commune. ([11]) 88% of respondents need additional water volume for drinking purposes. ([7]) 73% of respondents concern on water volume and water quality of domestic water in daily lives. ([8]) Despite the fact that 96% of respondents feel satisfied with water quality, the problem of water quality still remains in accordance with the result of inventory survey of existing wells. Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.

Code	Commune	Necessity of water supply
N-1	Nhon Hai	73% of respondents need much more water than water volume available at present through primary water source. (81%, including "Slightly more", [7]) 55% of respondents purchase drinking water at present. ([1]) 78% of respondents feel satisfied with water quality in primary water source. ([2]) According to the result of inventory survey for existing wells, presence of turbidity and salinity are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 44% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 94% of respondents need additional water volume for drinking purposes. ([7]) 88% of respondents concern on water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
N-2	Cong Hai	73% of respondents need much more water than water volume available at present through primary water source. (93%, including "Slightly more", [7]) 50% of respondents feel unsatisfied with water quality in primary water source. ([2]) Furthermore, 55% of respondents concern on frequent occurrence of diarrhea. ([6]) According to the result of inventory survey of existing wells, presence of turbidity, fluoride, salinity and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 93% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 95% of respondents need additional water volume for drinking purposes. ([7]) 58% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
N-3	Bac Son	90% of respondents need much more water than water volume available at present through primary water source. (95%, including "Slightly more", [7]) 55% of respondents feel unsatisfied with water quality in primary water source. ([2]) Furthermore, 49% of respondents concern on frequent occurrence of diarrhea. ([6]) According to the result of inventory survey of existing wells, presence of turbidity and salinity are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 95% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. Despite the fact that commune has existing water supply system, available water volume is limited. ([1]) 54% of respondents need additional water volume for drinking purposes. ([7]) 94% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey, and water supply, which can supply stable and safe water, is required.
N-4	Phuoc Minh	91% of respondents need much more water than water volume available at present through primary water source. (98%, including "Slightly more", [7]) 90% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity and salinity are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 48% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 43% of respondents spend 10-30min for fetching water and it may be said that the access to water is in deplorable condition.([3]) 98% of respondents need additional water volume for drinking purposes. ([7]) 93% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume**, **water quality** and **work for fetching water** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.

Code	Commune	Necessity of water supply
N-5	Phuoc Hai	47% of respondents need much more water than water volume available at present through primary water source. (64%, including "Slightly more", [7]) 54% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity, salinity and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. 42% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 78% of respondents need additional water volume for drinking purposes. ([7]) 64% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
N-6	Phuoc Dinh	37% of respondents need much more water than water volume available at present through primary water source. (56%, including "Slightly more", [7]) 87% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity and salinity are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 47% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 50% of respondents need additional water volume for drinking purposes. ([7]) 61% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
B-1	Muong Man	58% of respondents need much more water than water volume available at present in primary water source. (80%, including "Slightly more", [7]) 60% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity, fluoride, salinity, calcium and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 46% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 32% of respondents need additional water volume for drinking purposes. ([7]) 69% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
B-2	Gia Huynh	72% of respondents need much more water than water volume available at present through primary water source. (86%, including "Slightly more", [7]) 60% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity, fluoride and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 66% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 98% of respondents need additional water volume for drinking purposes. ([7]) 81% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.

Code	Commune	Necessity of water supply
B-3	Nghi Duc	50% of respondents need much more water than water volume available at present through primary water source. (71%, including "Slightly more", [7]) 61% of respondents feel unsatisfied with water quality in primary water source. ([2]) According to the result of inventory survey of existing wells, presence of turbidity and fluoride are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since, 72% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 76% of respondents need additional water volume for drinking purposes. Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
B-4	Tan Duc	72% of respondents need much more water than water volume available at present through primary water source. (82%, including "Slightly more", [7]) 62% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity, fluoride, calcium and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 59% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 85% of respondents need additional water volume for drinking purposes. ([7]) 73% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.
B-5	Me Pu	51% of respondents feel satisfied with current water volume through primary water source. ([7]) 64% of respondents feel satisfied with water quality in primary water source. ([2]) Furthermore, there is no report regarding water borne disease. ([6]) However, according to the result of inventory survey of existing wells, presence of turbidity, fluoride and metallic taste is reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 50% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 42% of respondents need additional water for drinking purposes. ([7]) 52% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, especially, **water quality** is evaluated to be prime issue considering results of survey as mentioned above and water supply, which can supply stable and safe water, is required.
B-6	Sung Nhon	30% of respondents feel satisfied with current water volume through primary water source. ([7]) 67% of respondents feel satisfied with water quality in primary water source. ([2]) Furthermore, there is no report regarding water borne disease. ([6]) However, according to the result of inventory survey of existing wells, presence of turbidity, fluoride and metallic taste is reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 55% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 67% of respondents need additional water volume for drinking purposes. Therefore, especially, **water quality** is evaluated to be prime issue considering results of survey as mentioned above and water supply, which can supply stable and safe water, is required.

Code	Commune	Necessity of water supply
B-7	Da Kai	39% of respondents need much more water than water volume available at present through primary water source. (56%, including "Slightly more", [7]) 74% of respondents feel satisfied with water quality in primary water source. ([2]) However, according to the result of inventory survey of existing wells, presence of turbidity, fluoride, salinity and metallic taste are reported by representative of commune. ([11]) In rainy season, turbidity is observed in all dug wells. Since 48% of respondents don't have toilet ([10]) and they defecate outside, it is assumed that E coli, one of the reason for diarrhea, affects water quality in dug wells. 30% of respondents need additional water volume for drinking purposes. ([7]) 49% of respondents concern over water volume and water quality of domestic water in daily lives. ([8]) Therefore, **water volume** and **water quality** are evaluated to be major issues considering results of survey as mentioned above, and water supply, which can supply stable and safe water, is required.

Note: The detailed results from [1] to [11] are shown in Supporting report. Data source is mentioned below.
[1]: "Primary water source (Dry season)" in socio-economic survey.
[2]: "Local people's impression on water quality" in socio-economic survey.
[3]: "Fetching water (Dry season)" in socio-economic survey.
[4]: "Monthly household expense (average, 000VND)" in socio-economic survey.
[5]: "Percentage of expense on water among monthly budget in dry season" in socio-economic survey.
[6]: "Water related disease" in socio-economic survey.
[7]: "Demands on water use supply" in socio-economic survey.
[8]: "Demands on water use allocation" in socio-economic survey.
[9]: "Concerns/Demands of daily lives" in socio-economic survey.
[10]: "Type of toilet" in socio-economic survey.
[11]: Table 2.3.6

2.3.5 Existing Piped Water Supply System

There are eleven (11) existing piped water supply systems in eleven (11) communes out of twenty four (24) communes. The ratio of population served in these communes to their total population is 29%. Based on the pattern of management, the existing water supply system is categorized as:

(1) Private water supply : 2 systems
(2) Community water supply : 6 systems
(3) Urban water supply : 3 systems

Table 2.3.8 shows Outline of existing water supply system.

Table 2.3.8 Outline of Existing Water Supply System

Province	Commune	Code	Organization for operation	Served population	Total population in commune	Ratio of served PP
Phu Yen	An Tho	P-3	Private	184	3,312	6%
	Son Phuoc	P-5	CPC	777	3,313	23%
	Ea Cha Rang	P-6	CPC	772	2,616	30%
	Suoi Bac	P-7	Urban Water Supply	600	5,678	11%
Khanh Hoa	Com An Bac	K-1	CPC (Under procedure of approval)	1,305	6,440	20%
Ninh Thuan	Bac Son	N-3	DPC/CPC	4,226	5,922	71%
	Phuoc Minh	N-4	Urban Water Supply (Plan)	3,509	3,509	100%
	Phuoc Hai	N-5	CPC	4,581	13,126	35%
	Phuoc Dinh	N-6	CPC	1,717	8,912	19%
Binh Thuan	Gia Huynh	B-2	Private	117	5,305	2%
	Tan Duc	B-4	Urban Water Supply	314	5,052	6%
Total				18,102	63,185	29%

Source: Field survey for water supply system by JICA study team

In general, the private water supply system is small scale and the ratio of population served in these cases is low with less than 6%. Many facilities such as intake and distribution reservoir are demolished or partially destroyed because of aging or defective maintenance.

The drinking water quality of some community water supply systems is unsatisfactory due to defects in treatment system. Turbidity is high compared to drinking water standards. In some of the water sources of dug well, there is lack of water in dry season for duration of 4 to 5 months. The distribution pipeline is roughly in favorable conditions. Rehabilitation or reconstruction of some intake facilities for water source is required. In Cam An Bac commune, construction of water supply facilities has been completed and this system is under procedure of approval for implementation of waterworks.

Two (2) communes are supplied water from urban water supply system. In this case, the water volume and quality is controlled under urban water supply company. However, it is expected that the diameter of distribution pipeline will not meet water flow requirements in future. In Phuoc Minh commune (N-4), there is water supply plan funded by ADB, will complete construction at the year 2011. Evaluation of the existing water supply system is presented in Table 2.3.9. The photographs of the existing water supply systems are shown in Supporting report.

Table 2.3.9 Evaluation of Existing System

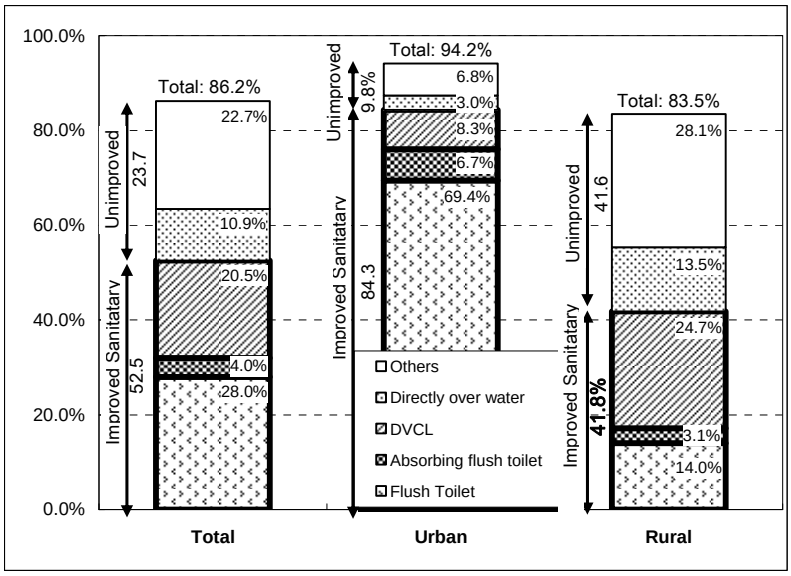
Province	Commune	Code	Available water sources	Supply capacity (l/c/d)	Treatment Process	Facility				Evaluation
						Intake	Treatment plant	Distribution Reservoir	Distribution pipe	
Phu Yen	An Tho	P-3	Good	33-50	Insufficiency	Deterioration	Aging	Deterioration	Aging	x
	Son Phuoc	P-5	Good	33-50	Sufficiency	Good	N/A	Good	Good	O
	Ea Cha Rang	P-6	Good	30-45	Sufficiency	Good	N/A	N/A	Good	O
	Suoi Bac	P-7	From urban water supply	20-30	Sufficiency	N/A	N/A	N/A	Good	O
Khanh Hoa	Com An Bac	K-1	Good	30-50 (Under procedure of approval)	Sufficiency	Good	Good	Good	Good	O
Ninh Thuan	Bac Son	N-3	Good	50-60	Sufficiency	Good	N/A	N/A	Good	O
	Phuoc Minh	N-4	From urban water supply	(Plan)	Sufficiency	N/A	N/A	N/A	Good	O
	Phuoc Hai	N-5	Good	40-50	Insufficiency	Aging	N/A	Deterioration	Defect	x
	Phuoc Dinh	N-6	Dry up in dry season	40-50	insufficiency	Defect	Good	Good	Good	x
Binh Thuan	Gia Huynh	B-2	Dry up in dry season	40-50	Insufficiency	Deterioration	N/A	Deterioration	Defect	x
	Tan Duc	B-4	From urban water supply	50-60	Sufficiency	N/A	N/A	N/A	Good	O

2.4 Sanitation

2.4.1 Current Situation on Sanitary Toilets in Rural Communes of Vietnam

(1) Rate of Access to Sanitary Toilets

According to the living standard survey (General Statistics Office, 2004), 83.43% of rural households are reported to have toilet. However, only about half of them are regarded as sanitary toilets, since toilet located directly over the water and other type of toilets should be excluded from improved sanitation. As a result, the rate of access to improved sanitation in rural area is assumed to be 41.8%.



Source: Living standard survey 2004, General Statistics Office of Vietnam

Figure 2.4.1 Share of Population having Toilet Access by type

Severer situation is reported in the "Rural Environmental Sanitation Survey in Vietnam (MOH, 2007)". The report describes overall picture of access to water supply and sanitation as well as personal hygiene of rural people through the extensive questionnaire survey of 37,306 households in 20 provinces. According to the survey, it was reported that only 22.5% of rural households have sanitary toilets constructed in accordance with the hygiene standards for various types of latrines (No. 08/2005/QD-BYT). Also, only 18% of rural households have toilets that meet the standards on construction, proper use and maintenance. It seems that the survey results by MOH (2007) reveal actual status of rural communes in Vietnam rather than the national living standard survey (2004). It is pointed out that main reason of the difference in figures between two surveys is that the hygiene standards were not promulgated before 2005.

The survey by MOH also shows results about personal hygiene of rural people and describes it to be insufficient, in terms of washing hands behavior, knowledge on safe water source and sanitation facility, proper composting technique, etc. It is reported that only 43% of households that do not possess any sanitary toilet have intention to build or improve toilets. In addition, lack of financial

resources is mentioned to be the main reason of not having toilets, as 74.6% of households not having sanitary toilet answered the reason as “No money”.

(2) Government’s Approach to Rural Sanitation

Since the national target of rural sanitation is prospected to be difficult to reach and personal hygiene of rural people is insufficient, priority subjects are to review the target ratio of access to sanitary toilet and to enhance IEC activities on sanitation.

In order to promote sanitary improvement further, the central government takes efforts towards better cooperation among agencies concerned. Also, the promotion of IEC on sanitation and increase of preferential loans to rural people are under discussion.

2.4.2 Socio-Economic Survey Result

(1) Pervasion of Toilet installation

Slightly more than half of the households have one of the kinds of toilet within their own yard. The ratio of households that have toilet provision, however, varies from communes to communes, depending on whether they received projects to promote installation of toilets or not, and on their own awareness of sanitation.

Table 2.4.1 Rate of Households to have installed Toilets

			Installed				Installed				Installed
Phu Yen	P-1	Xuan Phuoc	17%	Khanh Hoa	K-1	Cam An Bac	40%	Binh Thuan	B-1	Muong Man	54%
	P-2	An Dinh	31%		K-2	Cam Hiep Nam	64%		B-2	Gia Huynh	34%
	P-3	An Tho	9%		K-3	Cam Hai Tay	71%		B-3	Nghi Duc	28%
	P-4	An My	39%		**Total**		**62%**		B-4	Tan Duc	41%
	P-5	Son Phuoc	4%	Ninh Thuan	N-1	Nhon Hai	56%		B-5	Me Pu	50%
	P-6	Ea Cha Rang	5%		N-2	Cong Hai	7%		B-6	Sung Nhon	45%
	P-7	Suoi Bac	45%		N-3	Bac Son	5%		B-7	Da Kai	52%
	P-8	Son Thanh Dong	13%		N-4	Phuoc Minh	52%		**Total**		**44%**
	Total		**25%**		N-5	Phuoc Hai	58%	**TOTAL**		**40%**	
					N-6	Phuoc Dinh	53%				
					Total		**42%**				

Source: Socio-economic survey by the JICA study team

(2) Local Needs on Sanitary Condition

The Socio-economic survey confirmed that a great demand exists among households to install toilets, particularly in communes where the pervasion rate of toilets is smaller. The degree of the demands basically accords with the current pervasion rate, but is also affected by local people’s awareness of importance of toilet.

Table 2.4.2 Demands on Toilet Installation among Non-Toilet Holders at present*

	Strongly, need	If possible, need	Not so much, need	Total
Phu Yen	**417**	**163**	**161**	**741**
	56.3%	22.0%	21.7%	100.0%
Khanh Hoa	**59**	**28**	**111**	**198**
	29.8%	14.1%	56.1%	100.0%
Ninh Thuan	**400**	**85**	**10**	**495**
	80.8%	17.2%	2.0%	100.0%
Binh Thuan	**119**	**45**	**33**	**197**
	60.4%	22.8%	16.8%	100.0%
TOTAL	**995**	**321**	**315**	**1,631**
	61.0%	**19.7%**	**19.3%**	**100.0%**

Note: The data is obtained from persons only who do not have toilet at present.
Source: Socio-economic survey by the JICA study team

As to the types of the toilets, the most popular type is both Septic tank toilet and pour flush type toilet. Some of the lessons from the past governmental/international promotional activities on toilets are: DVCL type toilet has not been accepted so much as expected because it is more troublesome in handling, it has smell, and there is less incentives to use residue/human excremental matter as fertilizer.

2.4.3 Type of Sanitary Latrines

Four types of latrines are promulgated as the hygienic standards for latrine (08/2005/QD-BYT, MOH). Two more types are now being studied by MOH; including biogas toilet and toilet for flood area. On completion of the study, they are to be added to the standard.

According to the survey on rural water and sanitation (MOH, 2007), only 22.5% of total households meet the standards for construction, and 18% meet standards for both construction and maintenance. It should be noted that approximately 75% of total interviewees do not know well about the four types of toilets. In addition, only 13% of total respondents know correctly about composting of excreta, while only few rural people use excreta before composting which may cause high risk of disease. The MOH report concluded that personal hygiene of rural people is low in general. Also most of rural people seem to have low level of access to information.

The four types of sanitary toilets promulgated by MOH are tentatively evaluated by JICA Study Team, in terms of sanitation, economy and comfort.

Table 2.4.3 Evaluation on Four Types of Sanitary Toilets by MOH

Type	Outline	Evaluation			
		Sanitary	Economy	Comfort	Total
Double Vault Composting Latrine (DVCL)	Urine-feces separation type dry toilet. Two chamber for feces are used alternately (normally after every six to ten months for drying). Feces are used for fertilizer or soil improvement, after drying for compost. Urine is sprayed to field after dilution. Wood ash or lime is required. No possibility of groundwater pollution. Urine and compost work as effective as chemical fertilizer.	5	4	5	**14**
		Little smell and flies/mosquitoes. It is sanitarily sustainable without night soil treatment plant. Not applicable if wood ash or lime is not available.			

Ventilated Pit Latrine	Urine-feces separation type toilet with one chamber for feces. The chamber needs to be removed when it is full even in un-dried condition.	4	5	3	**12**
		Insufficient composting for short drying period, which may cause sanitary problem. Little possibility of groundwater pollution. Bad smell.			
Pour Flush Latrine	Flush toilet with single or two chambers for wastewater. Overflow from the chamber flows to the ground. It is necessary to keep distance of 10m from a well for domestic use. It is possible to prevent bad smell by maintaining distance from house.	2	4	4	**10**
		Comfort as septic tank toilet. Effluent from wastewater chamber may cause groundwater pollution. As capacity of chambers is small, wastewater without enough biological decomposition may easily run off. Not applicable if water source easily dries up.			
Pour Flush with Septic Tank	Flush toilet with three chambers for wastewater. Overflow from the third chamber penetrates to the ground. People are instructed about 4-5 years for a period of sucking sludge by vacuum car.	3	3	5	**11**
		Comfort and easy to use. Most popular among people. It is not sanitarily sustainable without night soil treatment plant. Groundwater pollution can be prevented by sucking sludge periodically before chambers becomes full Not applicable if water source easily dries up.			

2.4.4 Knowledge, Attitude and Practice on Sanitation

A nationwide KAP (Knowlede, Attitude and Practice) survey was carried out by MOH in 2007 (Vietnam Rural Environmental Sanitation, MOH). The survey discovered that knowledge and behavior of rural people is very limited level, although some progress is found since last a few years. Significant correlation factors are analyzed, such as education level, sex, ethnic group, income level and topographic condition. Clear tendency is found out that people having better access to information and education show better knowledge and practice, although they are still low level.

In Vietnam, diarrhea accounts for 18% of total disease and death in hospital. And it is estimated about 14,000 children die for diarrhea every year. In contrast, only 2.3% respondents know the fact that washing hand by soap is one way to prevent diarrhea and parasitic worm diseases and 12% respondents have behavior of hand-washing by soap after meal and toilet.

Regarding domestic water source, 11.6% of respondents have bad manner of drinking raw water, despite the fact that only 25.1% of domestic water samples met the water quality standard in coliform parameter (survey by MOH, in 2006).

Under the circumstances, importance of hygiene education is being reaffirmed, since behavioral change is caused firstly by education to raise personal hygiene.

<< BOX: KAP Survey Result (Abstract)>>

Knowledge, Attitude and Practice (KAP) survey on water and sanitation in rural areas was carried out by MOH in 2007 (“Vietnam Rural Environmental Sanitation”, MOH, 2007). In the survey, 37,306 rural households in 20 provinces were interviewed. The nationwide survey comprehensively shows clear situation that knowledge and behavior of rural people is still low level.

Figures below are abstraction from the report:

Knowledge about ways to prevent diarrhea and parasitic worm	
- Using hygienic latrine	18.3%
- Not to eat raw vegetable	28.8%
- Not to drink untreated water	48.1%
- Hand-washing by soap	2.3%
Practice of hand-washing by soap	
- Before meal	12%
- After urination	12.2%
- After defecation	15.6%
Practice of domestic water treatment	
- Filtering	20.8%
- Sedimentation	16.8%
- Chlorination	8.5%
- Drinking raw water (no treatment)	11.6%
Knowledge about diseases caused by unhygienic latrine	
- Diarrhea	56.7%
- Parasitic worm	21.5%
Knowledge about composting excreta	
- Necessity of composting excreta before using	52.3%
- Composting time over 6 months (correct)	13.1%
- Composting time under 6 months (not correct)	34.8%
- No idea about composting time	4.4%

(Source) Vietnam Rural Environmental Sanitation, Medical Publishing House, MOH, 2007

Significant correlation factors are analyzed in the survey.

- Education level:
  Clear tendency is found between KAP result and education level. E.g. compared to no education people, primary, secondary and college education level have hand-washing behavior of 2.7, 4.6 and 12.6 times higher rate.
- Sex:
  Female has better manner than male in general.
- Ethnic group:
  Compared to Kinh people, ethnic minority groups have much less hygienic behavior. Some groups still have custom of praying ceremony for curing diseases.
- Income:
  Lower income people has tendency to have poor hygienic practice. Some respondents pointed out that they do not wash hand because soap is expensive.
- Topographic condition:
  Rural people in remote and mountainous regions have less access to information that causes poor knowledge and hygienic practice.

2.5 Institutional Framework and Management

2.5.1 Institutional Framework

(1) Transition of RWSS in Vietnam

GOV has taken efforts toward RWSS improvement since year 1982 when WATSAN program supported by UNICEF was launched. It has been developed to NTP for RWSS. These programs have been supported by bilateral and international donor assistances in extensive forms of technical cooperation, loans and grants for construction, capacity building, institutional reform, etc.

The recent transitions in RWSS sector are derived from NRWSSS up to year 2020 and its action programs of NTPs for RWSS. The RWSS NTP II for 2006 – 2010 was launched in December 2006 to succeed and enhance the achievements of NTP I during 1999 – 2005.

Table 2.5.1 Chorological Table on RWSS Institution

Year	Major Event
1982	- GoV declared for promotion of "International Drinking Water Supply and Sanitation Decade (1981 – 1990)" by United Nations - "State committee for clean water supply and sanitation" was established under MOC in order to coordinate RWSS program. - UNICEF began WATSAN Program in three provinces, which was extended nationwide in the year 1996.
1993	- GoV formulated "Master Plan for Rural Drinking Water Supply in Vietnam"
1997	- Study on NRWSSS commenced by CERPAD with assistance from DANIDA - MARD took over administrative responsibility on RWSS that had belonged to MOC and MOLISA
1998	- GoV decided promotion of RWSS NTP I for 1999-2005 by Decree No.237/1998/QD-TTg, December 1998 - MARD was assigned as the management authority of RWSS NTP I - N-CERWASS was assigned as the implementing agency of RWSS NTP I - Law on Water Resources are formulated (No.08/1998/QH10, 20/5/1998)
2000	- NRWSSS for 2000-2020 was approved by Decision 104/2000/QD-TTg, 25/8/2000
2002	- Drinking water quality standard is revised by No. 1329/2002/QD-BTY
2005	- MARD was assigned to take lead in the development of RWSS NTP II by Letter No 6447/VPCP - Hygiene standards for various types of latrines was issued by No.08/2005/BYT - Hygiene standards for clean water was issued by No.09/2005/BYT
2006	- GoV approved RWSS NTP II for 2006-2010 by Decree 277/2006/QD-TTg, December 2006 - National Water Resources Strategy towards the year 2020 has been approved by Decision 81/2006/QD-TTg, 14/4/2006

(2) National Rural Water Supply and Sanitation Strategy (NRWSSS)

In August 2000, the GOV introduced the "National Rural Water Supply and Sanitation Strategy (NRWSSS) up to the year 2020" with support from DANIDA. It indicates a national goal on RWSS that aims to provide all rural people with clean water and sanitation facility. NRWSSS's basic underlying principles; sustainable development, demand responsive approach and socialization of RWSS, provides guidance to the whole sector as well as to all RWSS programs and projects. The objectives and strategies of NRWSSS are summarized below:

Table 2.5.2 Objectives and Strategies of NRWSSS

Objectives	
Development Objectives	- Improved Health of the Rural Population - Improved Living Conditions - Reduced Environmental Pollution from Human and Livestock Excreta
Immediate Objectives By Year 2020	- All rural people will use clean water with 60 L/c/d and use hygienic latrines - Universal good personal hygiene practice of rural people, good environmental sanitation of communes and villages
Immediate Objectives By Year 2010	- 85% of rural population will use clean water with 60 L/c/d - 70% of rural households will have hygienic latrines and have good personal hygienic practices
Strategies	
IEC and Community Participation	IEC will aim at: - Encouraging an increased demand for clean water and hygienic latrines - Making full use of people's internal strength, increasing their willingness to make financial contribution to construction of water supply facilities and hygienic latrines - Providing users with necessary and sufficient information to make informed choice between different WSS technologies - Creating a much higher awareness of hygiene and of the link between sanitation, hygiene practice, water supply and health
Organizational Strengthening, Strengthening of State Management and Human Resource Development	Strengthening the effectiveness of State Management includes: - To set up a favorable legal environment to mobilize the participation of different economic sectors and to manage the activities in RWSS well - To develop WSS master plans for rural residential areas, with adequate attention given to socio-economic conditions of each region - To prepare favorable conditions for the private sectors and SOEs who will be the provider of all RWSS construction and services in future - To improve business environment of private sectors, since water supply companies and SOEs participating in WSS will gradually assume more autonomy on asset management and financial matters. Human Resource Development (HRD) aims: - To supply adequate number of sector staff and to make reasonable reshuffling of staff - To train national and provincial staff in RWSS, their understanding and skills in setting up plans and programs, coordinating and managing considering the demand responsive approach for RWSS - To train staff responsible for implementation at district and commune levels to carry out their new job and new role effectively.
Renovation of Financial Mechanism, Mobilization of Various Funding Sources to Develop RWSS	- Mobilization of local funding and foreign investment to develop RWSS - Establishment of government grant system to support poor households and piped water supply scheme - Establishment of government loan system with low interest rate to support construction of facilities paid by users - Use of international assistance
Research and Development and Application of Appropriate Technologies	- To reconsider and improve traditional technologies - To take into account international experiences, adopting and applying these experiences selectively - To encourage application of advanced technologies to make contribution to rural industrialization and modernization - To develop typical models and to standardize different types of piped schemes of different scales using surface water and groundwater in different regions - To research approaches and systems for RWSS as well as IEC, HRD and management models

Source: NRWSSS up to 2020, August 2000

(3) NTP for RWSS

As the action plan of NRWSSS, GOV has implemented National Target Program for RWSS to follow principles of NRWSSS. Reviews of the first target program for RWSS NTP I (2000-2005) concluded that the approach and objectives of the national strategy are relevant but the principles are inconsistently implemented in practice. The RWSS NTP II (2006-2010) has been launched since December 2006 to succeed and enhance the achievements of NTP I.

In principle, most activities and investments for RWSS are to take place through the framework of RWSS NTP II (2006-2010). The outline of RWSS NTP II is summarized in the Project Design Matrix (PDM) as shown in Table 2. The objectives of NTP II by 2010 include 85% of rural population have access to hygienic water, and 70% of rural households have hygienic latrines. The total budget is estimated to be VND 22,600,000 million.

Significant changes introduced by NTP II mainly focus on demand-driven approaches, introducing market mechanism and socialization, increased attention to IEC and capacity building. Changes in institutional arrangements include transfer of the standing office for NTP and state management responsibility from N-CERWASS to MARD. This is attributed to the fact that closer coordination among related agencies is more important and coordination in central government is aimed by rising up the implementation agency to the ministry level.

Table 2.5.3 Project Design Matrix of RWSS NTP II

Project Summary	Index	Monitoring Method	External Condition
Super goal			
- Living conditions of rural people improved by improving rural water supply and sanitation services and raising community awareness of environment protection - Negative impacts on rural people's health due to poor water supply and sanitation conditions reduced and environment pollution in the community minimized.	- Number of water supply and sanitation facilities constructed - Number of people provided with IEC on RWSS - Percentage of water borne diseases reduced	- Quarterly and annual report - Survey data - Survey report	- Improvement in living conditions of rural people - Improvement in health of rural people - Improvement of environment of rural community
Project Objective			
- 85% of rural population use clean water by 2010 - 70% of rural households have hygienic latrines by 2010 - 70% of rural households have hygienic livestock pens by 2010 - All schools and public institutes have access to clean water and hygienic latrines by 2010	- Percentage of rural population using clean water - Percentage of rural population having hygienic latrines - Percentage of rural population having hygienic livestock pens - Number of schools and public institutes having clean water and hygienic latrines	- Quarterly and annual reports, survey data - Annual reports, survey data - Annual reports, survey data - Summary reports, evaluation reports	- O&M for RWSS are continued and regularly monitored
Achievement			
- Provision of 159,200 water supply systems - Provision of 2,601,000 household	- Number of rural people having access to clean water - Number of households	- Quarterly and annual reports - Quarterly and annual	- Operation and maintenance for RWSS facilities are continuously carried out - O&M costs for RWSS

hygienic latrines - Provision of 5,000,000 livestock pens and biogas systems - Provision of hygienic latrines for public institutions	having hygienic latrines - Number of households having livestock pens and biogas systems - Number of public institutions having access to clean water supply and hygiene latrines	reports - Quarterly and annual reports - Quarterly and annual reports	facilities are covered by users
Activities - Building and upgrading of 159,200 water supply systems - Building of 2,601,000 household hygienic latrines - Building and renovation of 5,000,000 livestock pens and biogas systems - Building hygienic latrines for public institutions	Input - Project financing of 22,600 billion VND 1) State government budget: 3,200 billion VND 2) Local government budget: 2,300 billion VND 3) International support: 3,400 billion VND 4) People's contribution: 8,100 billion VND 5) Preferential loans: 5,600 billion VND - Project management organizations to implement RWSS improvement		- Budget disbursement based on demand-driven approach - Project management and coordination - IEC and hygienic promotion Precondition - Sustainable water source are identified - Proper technology for RWSS improvement are applied - Land, water rights, other permissions are obtained

Source: NTP II Logical framework, modified and added by JICA Study Team

NTP II is implemented in two phases; 1st phase as the pilot phase for nine provinces from 2007-2008 and 2nd phase as the rolling out phase nationwide for the following three years. In the pilot phase, technical assistance to implementing organizations at national and provincial level are provided through the TBPS by 3 donors in order to improve institution, management and techniques to implement NTP II.

According to the senior advisor to NTP II in central provinces, recognition on concept and approach of NTP II by the local implementing agencies has been improved. On the other hand, technical assistance by the international experts is behind schedule due to interpretation of language and somehow insufficient recognition among related organizations at local levels about policies on RWSS and their roles. It was also pointed out that establishment of effective institutional framework is essential to cooperate between related agencies.

Under recognition that close coordination between 3 ministries; MARD, MOH and MOET, is significant to implement RWSS, the GOV expressed a policy of coordination among parties concerned by Joint Circular No. 93/2007/TTLT/BNN/BYT-BGDDT, which guides roles of each organization and principles of coordination.

(4) Poverty Reduction Supporting National Program (Program 134, 135)

The GOV promulgated National Decrees No. 134/2004/QD-TTg and 135/1998/QT-TTg, also called Program 134 and 135, respectively, in order to improve living standards and support socio economic development of poor people, ethnic minorities and residents in remote areas. The programs provide agricultural lands and houses through the government budget. It also supports construction of housing facilities including water supply and sanitation facilities. The investments are provided directly by Committee for Ethnic Minorities (CEMA) besides NTP II.

(5) VBSP's Preferential Loan to RWSS

VBSP (Vietnam Bank for Social Policy) is a government-affiliated financial institution established under the decision No. 131/2002/QD-TTg by the Prime Minister on the basis of reorganization from Vietnam Bank for the Poor, in order to support poor households and small business households in remote areas. It has 64 provincial level branches and 597 district-level transaction offices and 8,076 transaction points at commune level (as of January 2008).

Under the Decision No. 62/2004/QD-TTg by the Prime Minister on credits for Clean Water and Rural Sanitation National Target Program, VBSP provides credits to rural households to construct RWSS facilities with the upper limit of VND 4 million at a preferential interest rate of 0.65% per month. After pilot phase in 10 provinces in years 2004-2005, the loan is applicable nationwide. As of August 2007, the loan had been financed for construction of approximately 510,000 numbers of RWSS facilities.

According to VBSP report (October 2007), several issues are pointed out; e.g. (i) lower amount of credit compared to demands of customers, (ii) many defects found in design specifications and building techniques, and (iii) few involvement of MARD/N-CERWASS in the business transaction which causes insufficient dissemination and technical guidance to rural people.

(6) Laws and Regulations

There is no law for water supply and sanitation in Vietnam which stipulates requirements of WSS and duties of waterworks, etc. Instead of laws, several standards and roles of related organizations are stated by Decisions by the GOV. Sector standards are to be applied for RWSS by Decisions 08/2005/QD-BYT and 09/2005/QD-BYT for hygienic latrines and clean water, respectively. Other water quality standards also exist, such as national drinking water quality standard (Decision 1329/2002/QD-BYT and National Standard; TCVN 5505-2003) and domestic wastewater standards (TCVN6772, 2000), and it is pointed out that they should be integrated. Related laws and standards are listed in table below.

Table 2.5.4 Related Laws and Standards in RWSS

Title	Code
Law on the Water Resources	20/5/1998
Law on Environmental Protection	17/12/2003
Drinking Water Quality, MOH	Decision 1329/2002/QD-BYT, 18/4/2002
National standard	TCVN5505, 2003
Sector Standards: Hygiene Standards for Various Types of Latrines, MOH	Decision 08/2005/QD-BYT, 11/3/2005
Sector Standards: Hygiene Standards for Clean Water, MOH	Decision 09/2005/QD-BYT, 11/3/2005
Water quality standards; Surface Water	TCVN5942, 1995
Water quality standards; Coastal Water	TCVN5943, 1995
Water quality standards; Groundwater	TCVN5944, 1995
Domestic wastewater standards	TCVN6772, 2000

2.5.2 Organization

(1) Administrative Organization

There are two administrative ministries in relation to water supply and sanitation; MARD for rural areas and MOC for urban areas. MARD delegates responsibility for RWSS implementation to N-CERWASS (Decision 122/2003/QD-BNN). N-CERWASS is a public administration agency with income belonging to MARD, specializing in RWSS nationwide.

Other ministries are also involved and play key roles in RWSS, coordinating with MARD. MOH regulates water quality standards as well as standard for hygienic latrine and plays important role in IEC. MOET is in charge of school sanitation, education and construction of water supply and sanitation facilities in schools. In addition, MONRE is in charge of water resources management including groundwater development, wastewater treatment and solid waste management.

Under the government policy of decentralization, local governments administrate in accordance with guidance by the central government. Local governments, at all levels of provincial, district, commune and village, have significant roles to play in every phase of planning, financing, implementation and O&M of services and facilities. Administration in provincial level is governed by PPC which has similar structure and roles corresponding to the central ministries. In principle, RWSS in provincial level is implemented by P-CERWASS under DARD. DPC and CPC are administration authorities at district and commune level respectively, who can manage and coordinate any public activities at local level. In some provinces, DPC and CPC are engaged in O&M of public water supply system. Roles of organizations concerned are summarized in Table 2.5.5.

Table 2.5.5 Summary of Roles of Organizations Concerned

Organization	Role
Ministry of Agriculture and Rural Development (MARD)	MARD is the designated lead agency for the RWSS NTP II and is responsible for coordinating with relevant ministries.
N-CERWASS (National Center for Rural Water Supply and Environmental Sanitation)	N-CERWASS is a public administration agency with income belonging to MARD, specializing in RWSS nationwide. Its roles are to prepare national program on RWSS, to coordinate international donor projects, to provide technical assistance to P-CERWASS, etc.
Ministry of Health (MOH)	MOH is responsible for developing awareness on hygiene and health and for setting and monitoring water quality standards.
Ministry of Education and Training (MOET)	MOET is responsible for health and hygiene programs in schools including provision of water and sanitation facilities.
Ministry of Natural Resources and Environment (MONRE)	MONRE plays a role in relation to environment, water quality and water resources management.
Ministry of Planning and Investment (MPI)	MPI is responsible for the overall management and supervision of NTPs; coordination of budgets and evaluation of effectiveness. MPI in consultation with MOF proposes budget allocations for approval by GOV.
Ministry of Finance (MOF)	MOF is responsible for recurrent budget allocations to NTPs, financial controls and the release of funds to provinces.
Committee for Ethnic Minorities and Mountainous Areas (CEMA)	Committee for Ethnic Minorities and Mountainous Areas is responsible for implementation of Program 135, which has a focus on poor and marginalized communities. Program 135 includes rural water (but little in the way of sanitation). In some provinces Program 135 is a larger source of funding than RWSS NTP.

Organization	Role
Provincial People's Committee (PPC)	PPC is the agency with highest mandate and responsibility to implement NRWSSS in each province. PPC will establish appropriate organizations and structures at local level, prepare program and plan for RWSS, steer and coordinate different departments within the province and direct districts to implement RWSS program and ensure adequate provincial funding for this purpose. PPC is also responsible to coordinate with different ministries and sectors at national level and donors to attract funds and technical assistance.
Department of Agriculture and Rural Development (DARD)	DARD is an administrative organization belonging to PPC to implement policies and guidance by MARD.
P-CERWASS (Provincial CERWASS)	P-CERWASS is an implementing authority of RWSS at provincial level, which belongs to DARD. Major roles of P-CERWASS are water supply project planning, construction supervision, IEC activities, etc. Not a small number of P-CERWASS carry out O&M of facilities, depending on policy of province.
Department of Health (DOH)	DOH is an administrative organization belonging to PPC to implement policies and guidance by MOH. Preventive medical section of DOH is responsible to carry out water quality monitoring and IEC on sanitation.
Department of Education and Training (DOET)	DOET is an administrative organization belonging to PPC to implement policies and guidance by MOET.
Department of Natural Resources and Environment (DONRE)	DONRE is an administrative organization belonging to PPC to implement policies and guidance by MONRE.
District People's Committee (DPC)	The districts will be the main level of implementation with the following functions: detailed planning and organizing implementation of WSS within the districts, giving advice to users about different technological options, mechanism and procedures for financial support or other kinds of support through district WSS advisory service centers, managing systems of grants and loans through banks at the district, giving guidance to user groups to manage construction and operation of piped scheme.
Communal People's Committee (CPC)	CPC is the lowest administrative level which is closest to the people. CPC will work in close coordination with individual users, user groups, mass organizations, in particular the Women's Union and banks to carry out most of government support function for RWSS. CPC will act as coordinator and advisor to users, and organizer of implementation of commune's RWSS plan.
Village level	Although villages and hamlets are not an administrative level they are the main units of rural residents in close connection with rural community. This level will be an important link between the commune level and users and will mobilize active participation of rural community in RWSS; at the same time village or hamlet will be the most appropriate unit for which mini piped scheme is built.
Local associations	Local associations are organized in a commune, such as women's union, youth union, farmer's union, etc. Cooperation from the unions is expected in implementing IEC and campaigns on RWSS.
Private water vendor	In areas of scarcity of water, people get water from neighbors or buy from water vendors who are unauthorized private business entity. In this case water quality is not guaranteed for its safe consumption.

(2) Implementing Organization (P-CERWASS)

P-CERWASS is an implementing authority of RWSS at provincial level, which belongs to DARD of the province. Annual budget of P-CERWASS is proposed by P-CERWASS, submitted through DARD to PPC and approved by PPC. Directors of P-CERWASS are appointed by PPC. In some cases, director level personnel are sent from DARD, while personnel changes seldom occur between

N-CERWASS and P-CERWASS. N-CERWASS provides technical guidance and training courses to P-CERWASS. In projects funded by international donor, N-CERWASS is responsible for project coordination between international donors and Vietnamese authorities.

Organizational profiles of P-CERWASS in the Study areas are presented in Supporting report.

2.5.3 International Cooperation

(1) Vietnam Rural Water Supply and Sanitation Partnership

In response to "Hanoi Core Statement on Aid Effectiveness" signed in 2005, the Memorandum of Understanding (MOU) was signed in May 2006 between MARD and interested donors, including World Bank, ADB, UNICEF, Australia, Denmark and Netherlands.

The partnership sets a framework in accordance with the policy of NRWSSS and aims to maximize effectiveness and to harmonize assistance schemes to RWSS sector by means of establishing information sharing and coordinating structure among partners.

(2) Joint Donor Support to RWSS NTP II

AusAid, DANIDA and Netherlands are cooperating with the GOV in RWSS through provision of targeted budget support program (TBSP) for NTP II. The supporting fund is transferred to the GOV, then it is to be allocated through budget executing channel of Vietnam, as the budget for NTP II.

As of November 2007, standing offices are established in MARD and DARD (or P-CERWASS) of the nine pilot provinces. Accordingly international advisors are assigned to assist preparation of TOR for technical assistance.

(3) UNICEF

RWSS in Vietnam was practically initiated in 1982 when WATSAN program started with assistance by UNICEF. Approximately 170 thousands of rural water supply facilities have been constructed and provided under the program from the year 1982 to 1996, that contributed largely to improved rate of access to water supply in rural areas. Approximately, 80% of total investment on rural water supply during 1992 to 1997, which amounts to approximately US$ 54 million, was contributed in the form of the WATSAN program. Thus, WATSAN is the core program on RWSS.

Compared to water supply sector, sanitation sector seemed to get less attention and achievements since little coordination were made among parties concerned while many organizations are involved. In implementing the WATSAN program, capacity development was also provided to the counterpart agency of CERPAD (current CERWASS). The technical assistance continues in the form of training and IEC activities.

UNICEF started WES (Water, Environment and Sanitation) program in year 2001 to improve RWSS and environmental protection. Under the WES program for 2006 to 2010, "RWSS and environment project" and "Environmental sanitation project" are carried out. The project budget is approximately US$10 million and most of them are used for training, IEC and capacity development. WES principle is to focus on children and poor/ethnic minorities.

(4) World Bank

The World Bank is supporting the RWSS sector through the Red River Delta Water Supply and Sanitation Project (2005-2009). The project components include construction of RWSS facilities of 12 provinces, IEC on sanitation, capacity development on institutional strengthening and assistance to project management. According to the project appraisal report (August 2005), RWSSEs (Rural Water Supply and Sanitation Enterprises) are to be established as the management entities instead of P-CERWASS, which is a public entity of the province and currently provides water supply services, from the viewpoints of management efficiency and transparency. The equities and assets of RWSSE are to be jointly owned by PPC and target communes.

(5) ADB

The ADB provides support for rural water and sanitation indirectly through broad based rural infrastructure projects. The ADB is committed to the principles of the NTPII in the preparation of future RWSS interventions.

2.5.4 Decision Making and Water Charge Collection System

(1) Decision Making System

RWSS project is basically initiated by CPC and requested to DPI through DPC (process [1], [2]). DPI consults with P-CERWASS to evaluate project and forwards/proposes/report to PPC (process [3], [5]). In planning phase, P-CERWASS is involved to prioritize target commune to implement by rating from criteria; water demand, water scarcity, population density, and poverty reduction (process [4]).

In every phase, final decision is made by PPC. In most cases, state and provincial budget is allocated to RWSS implementation, so that project ownership is mostly held by PPC (process [6],[8]). It is some cases that CPC would contribute its land or a part of project cost (process [9]). PPC assigns P-CERWASS to design and construct the facilities (process [7]). P-CERWASS, in charge of project implementation, employs state owned enterprises or private firms for facility design and construction (process [10]).

It is PPC that decides O&M entity; P-CERWASS, DPC, CPC, village, users group or others including private firms (process [11], [12]).

Table 2.5.6 Roles of Organization Concerned by Project Phase

Phase	Organization Concerned				
	CPC	DPC	DPI	P-CERWASS	PPC
Planning	[1] Plan and apply to DPC	[2] Collect and convey requests from CPC to DPI	[3] Consult with N-CERWASS [5] Evaluate project and report to PPC	[4] Advise to DPI on priority communes to implement	[6] Decide target commune and budget preparation
Implementation	[9] Sometime contribution from CPC for land, project cost			[10] Design and construct facility, by employing SOEs or private firms	[7] Assign P-CERWASS as the implementation agency

Phase	Organization Concerned				
	CPC	DPC	DPI	P-CERWASS	PPC
					[8] Budget allocation
O&M	[12] O&M under decision of PPC	[12] O&M under decision of PPC		[12] O&M under decision of PPC	[11] Decide O&M entity

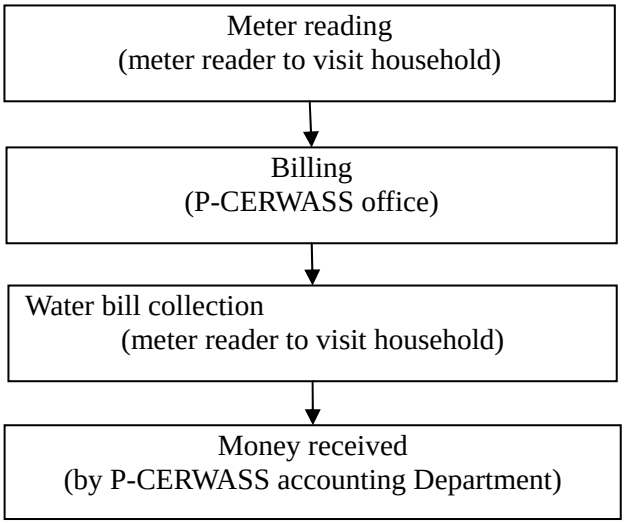
(Source) Information from Binh Thuan P-CERWASS, July 2007

(2) Tariff

Water tariff is proposed by water management entity and approved by PPC. In most provinces where P-CERWASS manages RWSS systems, uniform tariff is applied to the whole province. Tariff is set to cover operation and maintenance cost, not including capital cost. Remedial measures are considered for poor households.

(3) Metering and Bill Collection

For the piped scheme with house connection, water meter is equipped for individual households. Currently meter reading and bill collection is performed through the following procedures:



2.5.5 Financial Plan

(1) Central Government Budget

The budget for rural water supply service in Vietnam is basically allocated by the MARD and via the MOF to the PPC in each province in due course. It is then distributed to the DPC and the CPC. N-CERWASS and P-CERWASS formulate and request budget proposals but are not involved in financial flow relating to water supply projects.

Also, some PPCs and DPCs operate projects directly under the assistance of a donor organization or the central government, so that N-CERWASS or P-CERWASS does not know or monitor all rural water supply projects.

Table 2.5.7 summarizes the investment trend in rural water supply projects in the past six years. As seen in table, the rate of dependency on donor funds has risen appreciably in the recent few years.

Table 2.5.7 Investment Trend in Rural Water Supply Projects (2000 – 2005)

Fiscal Year	Vietnamese government fund		Donor fund		Total Amount	
	Billion VND	(=Million US$)	Billion VND	(=Million US$)	Billion VND	(=Million US$)
2000	144	(9.1)	92	(5.8)	236	(14.9)
2001	269	(17.0)	60	(3.8)	329	(20.8)
2002	215	(13.6)	85	(5.4)	300	(19.0)
2003	222	(14.1)	266	(16.8)	486	(49.9)
2004	226	(14.3)	209	(13.2)	435	(27.5)
2005	300	(19.0)	295	(18.7)	595	(37.7)

Source: N-CERWASS

(2) Investment in Water Supply Projects by the Four Provinces

Table 2.5.8 (A) to (D) present the investment trend in rural water supply projects under jurisdiction of P-CERWASS in the four provinces and activities of P-CERWASS during the recent three years, by fund source. In general, budget for P-CERWASSs comes from the Central and/or Provincial government, except Khan Hoa P-CERWASS which received 445 million VND from the UNICEF and other international agencies in 2005.

Table 2.5.8 Rural Water Supply Investment Trend (2005 – 2007)

(A) Khan Hoa P-CERWASS

(Unit: Million VND)

Year	Total Amount	Investment of Water Supply System by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	User & Others
2005	9,371	2,534	445	5,139	-	1,253
2006	12,760	4,236	-	6,943	-	1,581
2007	4,500	4,500	-	-	-	

Source: Khan Hoa P-CERWASS

(B) Phu Yen P-CERWASS

(Unit: Million VND)

Year	Total Amount	Investment of Water Supply System by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	User & Others
2005	3,117	3,000	-	-	-	117
2006	6,200	6,200	-	-	-	
2007	13,580	13,580	-	-	-	

Source: Phu Yen P-CERWASS

(C) Binh Thuan P-CERWASS

(Unit: Million VND)

Year	Total Amount	Investment of Water Supply System by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	User & Others
2005	28,902	20,041	-	8,861	-	-
2006	40,287	29,240	-	11,047	-	-
2007	33,043	31,003	-	2,040	-	-

Source: Binh Thuan P-CERWASS

(D) Ninh Thuan P-CERWASS

(Unit: Million VND)

Year	Total Amount	Investment of Water Supply System by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	User & Others
2005	11,428	6,045	-	4,333	-	1,050
2006	15,390	10,940	-	2,288	752	1,410
2007	55,599	11,550	34,649	6,400	-	3,000

Source: Ninh Thuan P-CERWASS

(3) Budget for P-CERWASS

Same as Investment in the water supply projects, each P-CERWASS has a different financial structure. For instance, budget for P-CERWASS in Khan Hoa and Phu Yen are primarily composed of labor costs and their fund sources are mainly the central and provincial budgets, and donor agencies. On the other hand, P-CERWASS in Binh Thuan and Ninh Thuan are managed by the self-support accounting system since they directly operate and manage water supply facilities, which earn revenues mainly from water charges and appropriate them to a part of the operation budget. As shown in Table 2.5.9, budget for Binh Thuan P-CERWASS stands out from the rest of P-CERWASSs due to the large number of employees and a variety of activities.

Table 2.5.9 Budgetary Trend for P-CERWASSs (2005 – 2007)

(A) Khan Hoa P-CERWASS

(Unit: Million VND)

Year	Total Amount	Budget by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	From Business
2005	250	200	50	-	-	-
2006	217	200	17	-	-	-
2007	200	200	-	-	-	-

Source: Khan Hoa P-CERWASS

(B) Phu Yen P-CERWASS

(Unit: Million VND)

Year	Total Amount	Budget by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	From Business
2005	198	-	-	198	-	-
2006	198	-	-	198	-	-
2007	198	-	-	198	-	-

Source: Phu Yen P-CERWASS

(C) Binh Thuan P-CERWASS

(Unit: Million VND)

Year	Total Amount	Budget by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	From Business
2005	10,144	34	84	-	-	10,026
2006	12,008	-	4	-	-	12,004
2007	12,800	-	-	-	-	12,800

Source: Binh Thuan P-CERWASS

(D) Ninh Thuan P-CERWASS

(Unit: Million VND)

Year	Total Amount	Budget by Fund sources				
		Central Government	Donor Agencies	Provincial Government	District Government	From Business
2005	460	-	-	-	-	460
2006	610	-	-	-	-	610
2007	1,134	-	-	-	-	1,134

Source: Ninh Thuan P-CERWASS

2.6 Legal System concerning Environmental and Social Considerations

Construction of new water supply facilities with groundwater development and new operation works are certain to cause some effects on the natural and social environment. In general, most impacts are considered to be positive, but some might be negative, and monitoring and mitigation measures would be required. Environmental and social impacts caused by the projects are identified according to their relations with existing environmental conditions at the planning sites.
In this section, the legal systems concerning the environmental and social considerations and others in Vietnam are described.

(1) Environmental and Social Considerations in Vietnam

1) The Legal Systems of the Environmental and Social Considerations

Environmental concerns and developments of environmental legislation and policies in Vietnam began in the early 1990s. The system of the environmental impact assessment of Vietnam was provided in the "Environment Protection Law" on 1993 (defunct law) and "Providing Guidance for the Implementation of the Law on Environmental Protection" (Government Decree No. 175/CP, defunct Decree). These specify the requirements of an EIA at different stages of the project development.

However, the following problems ware pointed out on environmental impact enforcement at that time.

- The definition of the object project was not clear.
- There were discordance between the law and the degree.
- In spite of having specified recognition of the EIA report as one of the requirements for project approval, many cases of irregularities were recognized after implementation of project.

Review of laws was required for solving the above issues, and the Environment Protection Law (1993) was amended as the new Environment Protection Law on November 29, 2005 that was passed by the eleventh National Assembly of the Socialist Republic of Vietnam in its eighth session. Subsequently the Decree No. 80/ 2006/ ND-CP was issued on the 9th August 2006 providing details and guidance for the implementation of a number of articles of the Environment Protection Law, and the Decree No. 140/260/ND-CP was issued on the 22nd November 2006 to provide guidance for the

environmental protection at stages of elaboration, evaluation, approval and implementation of development strategies, plannings, plans, programs and projects. In the new Environment Protection Law, improvement and the strengthened point are described below compared to old Environment Protection Law.

- Introduction of Strategic Environmental Impact Assessment (SEA)
- Clear notification of projects with requirement of the Environmental Impact Assessment
- Consistency between the Law and Regulations
- Introduction of citizens' participation and information disclosure

2) Contents of Environmental and Social Considerations in Vietnam

The environmental and social considerations for implementation of Project in Vietnam consist of mainly three items that are Strategic Environmental Impact Assessment (SEA), Environmental Impact Assessment (EIA), and Environmental Protection Commitments (EPC). These environmental considerations are required according to the contents of plans and projects and its scale. Outlines of SEA, EIA and EPC are listed in Table 2.6.1 and Table 2.6.2, and flowchart of environmental and social considerations procedure is shown in Figure 2.6.1.

Table 2.6.1 Outlines of Strategic Environmental Impact Assessment (SEA) and Environmental Impact Assessment (EIA)

Item	Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Objects	**Objects subject to elaboration of the SEA reports** • National socio-economic development strategies, plannings and plans; • Strategies, planning and plans for development of branches or domains on a national scale; • Socio-economic development strategies, planning and plans of provinces, centrally run cities (hereinafter collectively referred to as provinces or provincial level) or regions; • Planning for land use, forest protection and development; exploitation and utilization of other natural resources in inter-provincial or inter-regional areas; • Planning for development of key economic regions; • General planning of inter-provincial river watersheds. (The Environment Protection Law (EPL), Articles 14)	**Objects subject to elaboration of the EIA reports** • Projects of national importance; • Projects planned to use part of land of or exerting adverse impacts on, the natural sanctuaries, national parks, historical and cultural relic sites, natural heritages or beautiful landscapes which have been ranked; • Projects to potentially exert adverse impacts on the river watershed, coastal areas or areas of protected ecosystems; • Projects to construct new urban centers or concentrated residential areas; • Projects to exploit and use groundwater or natural resources on a large scale; • Other projects having potential risks or adverse impacts on the environment; • Projects to exploit groundwater with a capacity of 10,000m^3/day or more. (EPL, Articles 18-1, 65-1 and Decree 80/2006 /ND -CP)
Execution phase	SEA report constitutes an important content of the project and must be made at **the time of project formulation.** (EPL, Articles 15-2, and Decree 140/2006/ND -CP, Articles 6-1.c)	EIA reports must be elaborated simultaneously during formulation of **the Feasibility Study report of projects**. (EPL, Articles 19-2)

(Continue)

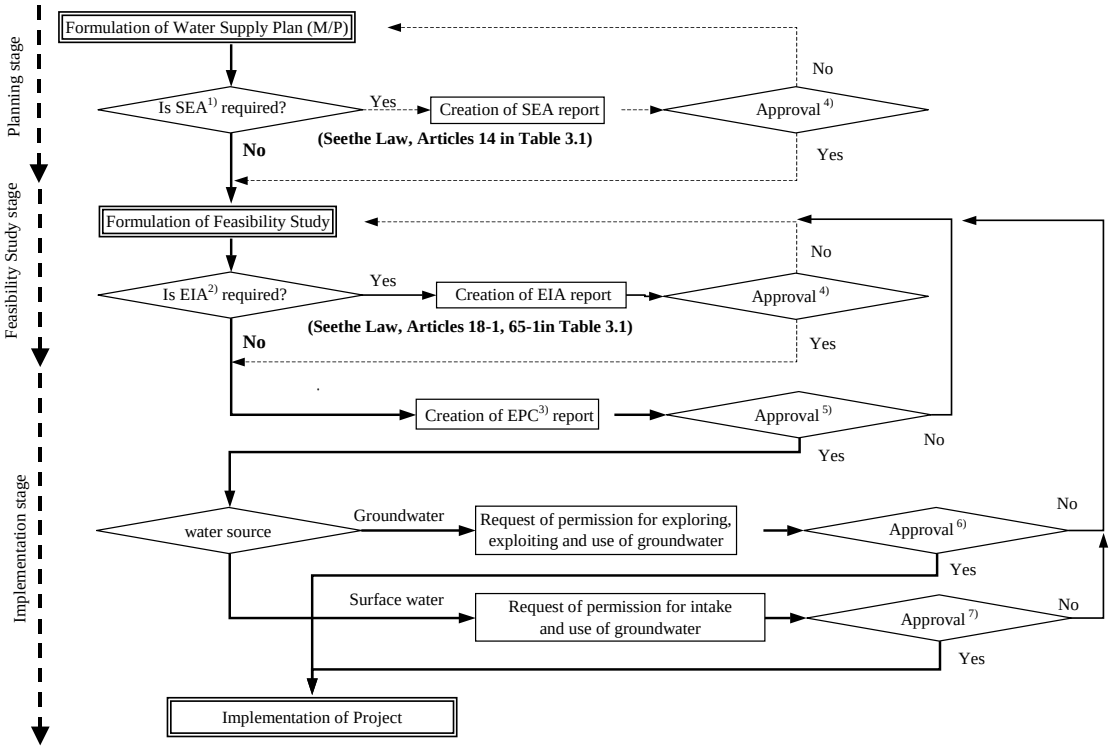
Item	Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Contents	**Contents of the SEA reports** • Overview of the project's objectives, size and characteristics related to the environment • General description of natural, socio-economic and environmental conditions related to the project • Forecasts for possible negative environmental impacts when the project is executed • Proposed orientations and measures to address environmental issues during project execution (EPL, Articles 16)	**Contents of the EIA reports** • Enumeration and detailed description of the project • Overall assessment of the environmental status at the project site • Detailed assessment of possible environmental impacts when the project is executed • Specific measures to minimize negative environmental impacts, and commitments to take environmental protection measures • Lists of project items, the program on management and supervision of environmental issues during project execution • Cost estimates for building establishment of environmental protection works within the total cost estimate of the project. • Opinions of the commune-level People's Committees and people in the project site must be presented in this report. (EPL, Articles 20)
Responsibilities for organizing councils	**Responsibilities for organizing councils for appraisal of the SEA reports are defined as follows:** • The Ministry of Natural Resources and Environment shall organize councils for appraisal of the SEA reports of projects subject to approval by the National Assembly, the Government or the Prime Minister; • Ministries, ministerial-level agencies or Government-attached agencies shall organize councils for appraisal of the SEA reports for projects falling under their approving competence; • Provincial-level People's Committees shall organize councils for appraisal of the SEA reports for projects falling under their deciding competence or under the competence of the People's Councils of the same level. (EPL, Articles 17-7)	**Responsibilities for organizing councils for appraisal of the EIA reports are defined as follows:** • The Ministry of Natural Resources and Environment shall organize councils or choose service organizations for appraisal of the EIA reports of projects decided or approved by the National Assembly, the Government or the Prime Minister; inter-branch or inter-provincial projects; • Ministries, ministerial-level agencies or Government-attached agencies shall organize councils or choose service organizations for appraisal of the EIA reports for projects falling under their respective deciding or approving competence, excluding inter-branch or inter-provincial projects; • Provincial-level People's Committees shall organize councils or choose service organizations for appraisal of the EIA reports for projects located in their localities and falling under their respective deciding or approving competence and under the competence of the People's Councils of the same level. (EPL, Articles 21-7)

(Continue)

Item	Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Term of limitation for appraisal	• Projects subject to approval by the National Assembly, the Government or the Prime Minister, and project of inter-provincial or inter-sector (branches): **within 45 days** after documents receipt • Others: **within 30 days** after documents receipt (Decree 80/2006/ND-CP, Articles 12)	
Publication, conference and others	Hearing of opinions and comments from relevant province, department and agency, authority, People's committee and resident in the project site must be carried out at the time of formation of the development strategies and plans. (Decree 140/2006/ND-CP, Articles 6-1.e)	The announcement of the environmental protection measures is carried out in the project implementation site. (EPL, Articles 23-1b)

Table 2.6.2 Outlines of the Environmental Protection Commitments (EPC)

Item	Environmental Protection Commitments (EPC)
Objects	**Subjects obliged to make written environmental protection commitments** Household-based production, business or service establishments and entities not defined in Articles 14 and 18 of the Environment Protection Law i.e., project without SEA or EIA requirement must make written environmental protection commitments. (EPL, Articles 24)
Execution phase	The above-mentioned project may commence production, business or service activities after registration of written environmental protection commitments. (EPL, Articles 26-3)
Contents	**Contents of environmental protection commitments** • Location of execution. • Type and scale of production, business or service, and materials and fuel used • Kinds of generated wastes • Commitments to apply measures to minimize negative environmental impacts, and strictly comply with the provisions of law on environmental protection. (EPL, Articles 25)
Appraisal & approval	**Registration of written environmental protection commitments** 1. District-level People's Committees shall have to organize registration of written environmental protection commitments; when necessary, they may authorize this work to commune-level People's Committees. 2. The time limit for acceptance of written environmental protection commitments shall be five working days after the date of receipt of valid written commitments. (EPL, Articles 26-1,2)



Note:
1) SEA: Strategic Environmental Impact Assessment
2) EIA: Environmental Impact Assessment
3) EPC: Environmental Protection Commitments
4) Appraisal and approval in organized council by MONRE, Ministries or PCP
5) Appraisal and approval in organized council by DPC
6) Appraisal and approval by MONRE or DONRE
7) Appraisal and approval by MARD or DARD

Figure 2.6.1 Flowchart of Environmental and Social Consideration Procedure

(2) Permission for Exploring, Exploiting and Use of Groundwater and Surface Water in Vietnam

The implementation of the EIA for water supply project with water services of 10,000 m3/day or more is one of requirements for project authorization request, and the Environmental Protection Law obliges the formulation of EIA Report and its approval by appraisal councils or appraisal service organizations before implementation of project. In case of a small-scale rural water supply project where EIA is not necessary, the start of approval procedure requires that project owner prepares EPC and submits to district people's committee.

Similar regulations related to acquisition of permission for exploring, exploiting and use of groundwater and surface water are provided in the Law on Water Resource (No.8/1998/QH10 of May 20, 1998). According to this Law, the water supply project with groundwater and surface water development must obtain the permission for exploring, exploiting and use of groundwater and surface water before implementation of project. This is one of important requirement for project authorization. The outline of the Law on Water Resource in Vietnam is described below.

The Law on Water Resources (No.8/1998/QH10 of May 20, 1998) passed in the Xth National Assembly, 3rd session on May 20, 1998, and the unified and comprehensive management as well as rational exploitation and stringent protection of water resources are stipulated in the Law. The main

items are listed below:

- Introduction of a management system for every river basin unit
- Introduction of approval system for exploring, exploiting and use of water sources
- State control of water resources
- Establishment of the National Water Resource Council
- Establishment of the River Basin Organization as substructure of the Ministry of Agricultural and Rural Development

Following this, a series of legal documents on the water resource protection have been promulgated, including:

- Decree No. 179/1999/ND-CP of December 30, 1999 providing for the implementation of the Water Resources Law;
- Decree No. 149/2004/ND-CP of July 27, 2004 providing for the licensing of exploration, exploitation and use of water resources and discharge of wastewater into water sources.

In the above-mentioned Decrees, it is specified that MARD and MONRE undertake duty concerning preservation of water resources.

Agrarian System in Vietnam

The agrarian system in Vietnam is governed by the following Law and five Decrees related to land.

- **Law on Land (No 13/2003/QH11)**
- Decree No. **181/2004/ND-CP** of October 29, 2004 on the implementation of the Land Law.
- Decree No. **182/2004/ND-CP** of October 29, 2004 on administrative sanctioning in the land domain.
- Decree No. **188/2004/ND-CP** of November 16, 2004 on methods to determine land prices and land price categories.
- Decree No. **197/2004/ND-CP** of December 3, 2004 on compensations, supports and resettlement upon the State recovery of land.
- Decree No. **198/2004/ND-CP** of December 3, 2004 on the collection of land use levies.

The above Government's Decrees, together with a number of guiding documents of the Ministry of Natural Resources and Environment and the Ministry of Finance, have created an important breakthrough in land management. The outline of the Law on Land (the agrarian system of Vietnam) and five Decrees is described below.

1) Land Law of Vietnam

A new Land Law was passed on November 26, 2003 by the XIth National Assembly of the Socialist Republic of Vietnam at its 4th session. It became effective on July 01, 2004.

The following items are mentioned as salient features of the agrarian system of Vietnam.

- Land is under the ownership of the entire people, and the State is the representative of the owner. The State performs uniform management of land.

- The laws of Vietnam also recognize ownership deriving from holding Land Use Rights.
- The State shall recover the land when the State needs to use it for the purposes of national defense and security, national interests, public interests, or economic development.

2) Procedure of Land Recovery for Public Projects

As mentioned above, as for land acquisition in the public project in Vietnam, required land for the project will be arranged under the responsibility of the state government. The procedure of land recovery for public projects is shown in Figure 2.6.2. The main point concerning this procedure is described below.

- The state shall recover the land when the state needs to use it for the purposes of national defense and security, national interests, public interests, or economic development.
- The project owner submits a project document to the competent state authorities (province, district and commune-level people's committees), and needs to obtain approval.
- After obtaining approval, the competent state authorities establish compensation, assistance, and re-settlement council, and starts preparation of land recovery.
- At least ninety days prior to the recovery of agricultural land or one hundred and eighty days prior to the recovery of non-agricultural land, the competent state authorities shall notify the land users of the reasons for which the land is to be recovered; the time; the plan for movement; and the master plan for compensation, site clearance and relocation.
- Persons who have land recovered shall be compensated with new land having the same use purpose. If there is no land for compensation, they shall receive compensation equal to the land use right value at the time of issuance of the recovery decisions.
- After the decision on recovery has been issued and the plan for compensation, site clearance and relocation has been approved by the competent state authorities it is publicly announced. This decision takes effects, and the person whose land is recovered must comply with the decision.
- If the person whose land is recovered does not comply with the land recovery decision, the people's committees which have issued such decision shall decide to enforce its decision. The person subject to the enforcement decision shall comply with the enforcement decision and have the right to lodge complain against such decision.

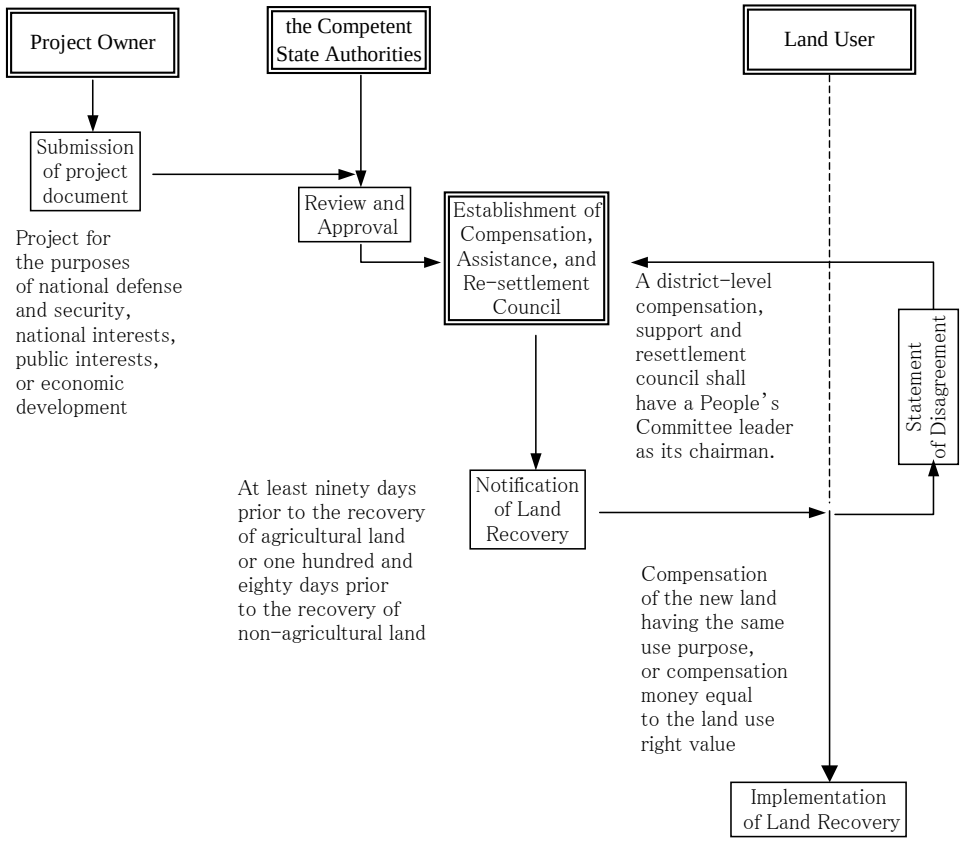


Figure 2.6.2 Procedure of Land Recovery for Public Projects

(3) Drinking and Domestic Water Quality Standards and Others

List of water quality standard relevant to water supply and other standards for environmental condition are shown in Table 2.6.3. The drinking and domestic water quality standards are shown in Table 2.6.4 and Table 2.6.5, and other standards are described in Supporting report.

Three water quality standards in Table 2.6.4 are applied as follows.

a) Drinking water hygienic standards (No 1329/2002/BYT/QD dated April 18, 2002)

This water quality standard for drinking water is provided by Ministry of Health (MOH), and number of water quality parameters included in this standard is 112.

b) Domestic supply water quality requirements (TCVN 5502-2003)

The Vietnam standard of TCVN 5502-2003 is applied for domestic use water of water supply system in urban area, and number of water quality parameters included in this standard is 34.

c) Clean water hygienic standards (No 09/2005/QD/BYT dated March 11, 2005)

According to the MOH's Decision No. 09/2005/QD-BYT on clean water hygienic standards, water from small-scale water supply system in rural area will be tested and monitored. Total number of water quality parameters included in this standard is 22.

Considering these points, the MOH's Decision No. 1329/2002/BYT/QD is applied as the water quality standards for drinking water. However, of total parameters defined in the standard provided

by the MOH's Decision of No. 1329/2002/BYT/QD and No. 09/2005/QD-BYT, only 12 to 20 water quality parameters are considered for monitoring in water supply systems of four provinces are due to the reason described below.

- The laboratory, which can perform analysis of all the parameters of the drinking water standards, is not yet established.
- High cost is required to carry out water quality analysis of all the parameters of the drinking water standards.

On application of water quality standards for selected water supply project of the Feasibility Study, the following policies will be proposed.

a) The water quality standards of TCVN 5502-2003 (Domestic supply water quality requirements) are set as target values for water treatment facilities design.
b) The MOH's Decision No. 1329/2002/BYT/QD is applied as the water quality standards for drinking water.

However, the monitoring of water quality parameters and its frequency should be set on consultations with Department of Health in province before operation of water supply service.

Table 2.6.3 List of Drinking and Domestic Water Quality Standards and Others

Item	Name of Standards
Drinking and domestic water quality standards	Drinking water hygienic standards (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002)
	TCVN 5502-2003 Domestic supply water quality requirements
	Clean water hygienic standards (Issued in accordance with the Decision No 09/2005/QD/BYT Dated March 11, 2005 of Minister of Health)
Standards related to water quality	TCVN 5942-1995 - Water quality - Quality standard of surface water
	TCVN 5943-1995 - Water quality - Quality standard of coastal seawater
	TCVN 5944-1995 - Water quality - Quality standard of underground water
	TCVN 5945-1995 - Industrial waste water - Waste standard
	TCVN 6772:2000 - Water quality - Daily-life wastewater - Permitted pollution limit
	TCVN 6773:2000 - Water quality - Quality of water used for irrigation
	TCVN 6774:2000 - Water quality - Quality of fresh water for protection of aquatic life
	TCVN 6980:2001 - Water quality - Standard of industrial wastewater discharged into river sections used for supply of water for daily life
	TCVN 6981:2001 - Water quality - Standard of industrial wastewater discharged into lakes used for supply of water for daily life
	TCVN 6982:2001 - Water quality - Standard of industrial wastewater discharged into river sections used for water sport and entertainment purposes
	TCVN 6983:2001 - Water quality - Standard of industrial wastewater discharged into lakes used for water sport and entertainment purposes
	TCVN 6984:2001 - Water quality - Standard of industrial wastewater discharged into river sections used for protection of aquatic life
	TCVN 6985:2001 - Water quality - Standard of industrial wastewater discharged into lakes used for protection of aquatic life
	TCVN 6986:2001 - Water quality - Standard of industrial wastewater discharged into coastal seawater areas used for protection of aquatic life
	TCVN 6987:2001 - Water quality - Standard of industrial wastewater discharged into coastal seawater areas used for water sport and entertainment purposes
Standards related to air quality	TCVN 5937-1995 - Air quality - Quality Standard of Surrounding Air
	TCVN 5938-1995 - Air quality - Permitted maximum concentrations of a number of hazardous matters in surrounding air
	TCVN 5939-1995 - Air quality - Industrial waste gas standard for dust and inorganic matters.

	TCVN 5940-1995 - Air quality - Industrial waste gas standard for organic matters
Standards related to noise	TCVN 5949-1998 - Acoustics - Noise in Public and Residential Areas Maximum Permitted Noise Level
	TCVN 5948-1999 - Acoustics - Road Motor Vehicle Noise Maximum Permitted Noise Level
Standards related to soil quality	TCVN 5941-1995 - Soil quality - Permitted maximum limit of residues of plant protection chemicals in the soil.

Table 2.6.4 Drinking and Domestic Water Quality Standards (1)

Water Quality Standards / Items			DRINKING WATER HYGIENIC STANDARD (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002)			VIETNAMESE STANDARD (TCVN) TCVN 5502: 2003 DOMESTIC SUPPLY WATER-QUALITY REQUIREMENTS			CLEAN WATER HYGIENIC STANDARD (Issued in accordance with the Decision No 09/2005/QD/BYT Dated March 11, 2005 of Minister of Health)		
I. Perceptive standard and inorganic component	Color	1	15	TCU	1	15	Mg/l Pt	1	15	TCU
	Taste	2	No strange taste		2	No strange taste		2	No strange taste	
	Turbidity	3	2	NTU	3	5	NTU	3	5	NTU
	pH	4	6.5-8.5		4	6.0-8.5		4	6.0-8.5	
	Hardness	5	300	mg/l	5	300	mg/l	5	350	mg/l
	Dissolved oxygen content		-		6	6	mg/l		-	
	Total dissolved substance (TDS)	6	1,000	mg/l	7	1,000	mg/l	13	1,200	mg/l
	Aluminum content	7	0.2	mg/l	19	0.5	mg/l		-	
	NH_4^+ content	8	1.5	mg/l (as N)	8	3	mg/l (as NH_4^+)	6	3	mg/l (as N)
	Antimony content	9	0.005	mg/l	10	0.005	mg/l		-	
	Arsenic content	10	0.01	mg/l	9	0.01	mg/l	10	0.05	mg/l
	Barium content	11	0.7	mg/l		-			-	
	Bo content (including borate and boric acid)	12	0.3	mg/l		-			-	
	Cardimi (Cd) content	13	0.003	mg/l		-			-	
	Chloride content	14	250	mg/l	11	250	mg/l	9	300	mg/l
	Chrome content	15	0.05	mg/l	13	0.05	mg/l		-	
	Copper (Cu) content	16	2	mg/l	14	1	mg/l	14	2	mg/l
	Cyanide content	17	0.07	mg/l	24	0.07	mg/l	15	0.07	mg/l
	Fluoride content	18	0.7-1.5	mg/l	15	0.7-1.5	mg/l	16	1.5	mg/l
	Hydro sulfur content (Hydrogen sulfide ?)	19	0.05	mg/l	17	0.05	mg/l		-	
	Fe content	20	0.5	mg/l	22	0.5	mg/l	11	0.5	mg/l
	Lead content	21	0.01	mg/l	12	0.01	mg/l	17	0.01	mg/l
	Manganese content	22	0.5	mg/l	18	0.5	mg/l	18	0.5	mg/l
	Mercury content	23	0.001	mg/l	23	0.001	mg/l	19	0.001	mg/l
	Molybdenum content	24	0.07	mg/l		-			-	
	Niken (nikon) content (Nickel ?)	25	0.02	mg/l		-			-	
	Nitrate content	26	50	mg/l (as NO_3)	20	10	mg/l (NO_3-N)	7	50	mg/l (as NO_3)
	Nitrite content	27	3	mg/l (as NO_2)	21	1.0	mg/l (NO_2-N)	8	3	mg/l (as NO_2)
	Selenium content	28	0.01	mg/l		-			-	
	Natrium content	29	200	mg/l		-			-	
	Sulphate content	30	250	mg/l		-			-	
	Zinc content	31	3	mg/l	16	3	mg/l	20	3	mg/l
	Oxygenation degree (Pottassium permanganate consumption)	32	2	mg/l		-			-	
II. Organic content	Carbon tetrachloride	33	2	µg/l		-			-	
a. Chlorination alkan group	Dichloromethane	34	20	µg/l		-			-	
	1,2 Dichloroethane	35	30	µg/l		-			-	
	1,1,1-Trichloroethane	36	2000	µg/l		-			-	
	Vinyl chloride	37	5	µg/l		-			-	
	1,2 Dichloroethene	38	50	µg/l		-			-	
	Trichloroethene	39	70	µg/l		-			-	
	Tetrachloroethene	40	40	µg/l		-			-	
b. Hydrocarbures aromatiques	Benzene	41	10	µg/l	26	0.01	mg/l		-	
	Toluene	42	700	µg/l		-			-	
	Xylene	43	500	µg/l		-			-	
	Ethylbenzene	44	300	µg/l		-			-	
	Styrene	45	20	µg/l		-			-	
	Benzo (a) pyrene	46	0.7	µg/l		-			-	
c. Chlorination benzene group	Monochlorobenzene	47	300	µg/l		-			-	
	1,2-dichlorobenzene	48	1000	µg/l		-			-	
	1,4-dichlorobenzene	49	300	µg/l		-			-	
	Trichlorobenzene	50	20	µg/l		-			-	
d. Complicated organic group	Di (2-ethylhexyl) adipate	51	80	µg/l		-			-	
	Di (2-ethylhexyl) phthalate	52	8	µg/l		-			-	
	Acrylamide	53	0.5	µg/l		-			-	
	Epichlohydrine	54	0.4	µg/l		-			-	
	Hexachloro butadiene	55	0.6	µg/l		-			-	
	Adetic acid (EDTA) Ethylendiamine tetraacetic acid ?	56	200	µg/l		-			-	
	Nitrilotriacetic acid	57	200	µg/l		-			-	
	Tributyl oxide	58	2	µg/l		-			-	

Table 2.6.5 Drinking and Domestic Water Quality Standards (2)

Items \ Water Quality Standards		DRINKING WATER HYGIENIC STANDARD (Promulgated together with the Decision of Minister of Health No 1329/2002/BYT/QD dated April 18, 2002)			VIETNAMESE STANDARD (TCVN) TCVN 5502: 2003 DOMESTIC SUPPLY WATER-QUALITY REQUIREMENTS			CLEAN WATER HYGIENIC STANDARD (Issued in accordance with the Decision No 09/2005/QD/BYT Dated March 11, 2005 of Minister of Health)		
III. Botanical protection chemical	Alachlo	59	20	µg/l		-			-	
	Aldicarb	60	10	µg/l		-			-	
	Aldrin/dieldrin	61	0.03	µg/l		-			-	
	Atrazine	62	2	µg/l		-			-	
	Bentazone	63	30	µg/l		-			-	
	Carbofuran	64	5	µg/l		-			-	
	Chlodane	65	0.2	µg/l		-			-	
	Chlorotoluron	66	30	µg/l		-			-	
	DDT	67	2	µg/l		-			-	
	1,2-Dibromo-3 C(h)loropropan	68	1	µg/l		-			-	
	2,4-D	69	30	µg/l		-			-	
	1,2-Dicloropropan	70	20	µg/l		-			-	
	1,3-Dichloropropen	71	20	µg/l		-			-	
	Heptaclo and heptaclo epoxide	72	0.03	µg/l		-			-	
	Haxaclorobenzene	73	1	µg/l		-			-	
	Isoproturon	74	9	µg/l		-			-	
	Lindane	75	2	µg/l		-			-	
	MCPA	76	2	µg/l		-			-	
	Methoxychlor	77	20	µg/l		-			-	
	Methachlor	78	10	µg/l		-			-	
	Molinate	79	6	µg/l		-			-	
	Pendimetalin	90	20	µg/l		-			-	
	Pentaclorophenol	81	9	µg/l		-			-	
	Permethrin	82	20	µg/l		-			-	
	Propanil	83	20	µg/l		-			-	
	Pyridate	84	100	µg/l		-			-	
	Simazine	85	20	µg/l		-			-	
	Trifuraline	86	20	µg/l		-			-	
	2,4 DB,	87	90	mg/l		-			-	
	Dichloprop	88	100	µg/l		-			-	
	Fenoprop	89	9	µg/l		-			-	
	Mecoprop	90	10	µg/l		-			-	
	2,4,5-T	91	9	µg/l		-			-	
IV. Disinfection chemical and by-product	Monocloramin (Mono-chloramine	92	3	µg/l		-			-	
	Residual chlorine	93	0.3 - 0.5	mg/l		-			-	
	Bromat	94	25	µg/l		-			-	
	Chlorite	95	200	µg/l		-			-	
	2,4,6 trichlorophenol	96	200	µg/l		-			-	
	Formaldehyt	97	900	µg/l		-			-	
	Bromofoc	98	100	µg/l		-			-	
	Dibromcloromethane	99	100	µg/l		-			-	
	Bromodicloromethane	100	60	µg/l		-			-	
	Chlorofoc	101	200	µg/l		-			-	
	Dicloroaxetic acid	102	50	µg/l		-			-	
	Tricloroaxetic acid	103	100	µg/l		-			-	
	Cloral hydrate(tricloroaxetonitril)	104	10	µg/l		-			-	
	Dicloroaxetonotril	105	90	µg/l		-			-	
	Dibromoaxetonitril	106	100	µg/l		-			-	
	Tricloroaxetonitril	107	1	µg/l		-			-	
	Xyanua chlorite (as per CN)	108	70	µg/l		-			-	
V. Radioactive effect level	Total activity α	109	0.1	Bq/l	33	3	pCi/l		-	
	Total activity β	110	1	Bq/l	34	30	pCi/l		-	
VI. Microorganism	Total coliform	111	0	MPN/100ml	30	2.2	MPN/100ml	21	50	MPN/100ml
	E. Coli or Thermotolerance	112	0	MPN/100ml	31	0	MPN/100ml	22	0	MPN/100ml
Others	Surface activate object, as per Linear Alkyl Benzene Sulphonate (LAS)		-		25	0.5	mg/l		-	
	Phenol and derivative of phenol		-		26	0.01	mg/l		-	
	Oil and oil compounds		-		27	0.1	mg/l		-	
	Organic phosphate pesticide		-		28	0.01	mg/l		-	
	Organic Chlorine pesticide		-		29	0.1	mg/l		-	
	Oxygenation (counted by $KMnO_4$)		-			-		12	4	mg/l

P = provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited; T = provisional guideline value because calculated guideline value is below the level that can be achieved through practical treatment methods, source protection, etc.; A = provisional guideline value because calculated guideline value is below the achievable quantification level; D = provisional guideline value because disinfection is likely to result in the guideline value being exceeded; C = concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, leading to consumer complaints.
b: For substances that are considered to be carcinogenic, the guideline value is the concentration in drinking-water associated with an upper-bound excess lifetime cancer risk of 10-5 (one additional cancer per 100,000 of the population ingesting drinking-water containing the substance at the guideline value for 70 years). Concentrations associated with upper-bound estimated excess lifetime cancer risks of 10-4 and 10-6 can be calculated by multiplying and dividing, respectively, the guideline value by 10.

1) For total chromium
2) Staining of laundry and sanitary were may occur below guideline value
3) Volume of water consumed and intake from other sources should be considered when setting national standards
4) For total mercury (inorganic plus organic)
5) Short-term exposure
6) Applies to the free acid
7) Applies to aldicarb sulfoxide and aldicarb sulfone
8) For combined aldrin plus dieldrin
9) Applies to the free acid

2.7 Groundwater Resources Condition

2.7.1 Hydrogeological Conditions of the Study Area

Hydrogeological conditions of the study area: four provinces and 24 target communes can be overviewed by the existing hydrogeological maps of each province as shown in Figure 2.7.1 to Figure 2.7.4. The maps indicate potential level for groundwater exploitation with several classifications: namely, "rich", "average", "poor" and "very poor to no potentiality" by aquifer types: intergranular type and fissure type.

(1) Phu Yen Province

Hydrogeological map of Phu Yen province is shown in Figure 2.7.1. There's no "rich" level but "average" and "poor" exist. It is clear that Cai River and Da Rang River catchment have relatively high potential areas in Phu Yen province but other mountainous areas have "poor" and "very poor" potential areas. According to the map, P-2(An Dinh), P-3(An Tho), P-8(Son Thanh Dong) are located relatively in high potential area but others in low potential areas.

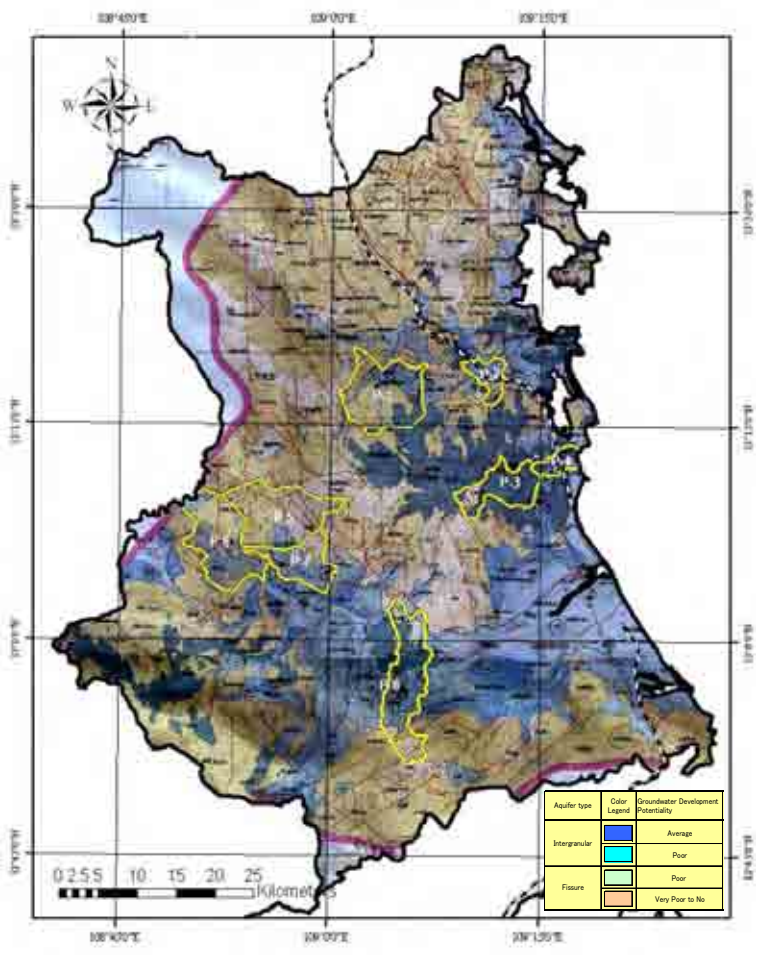


Figure 2.7.1 Hydrogeological Map of Phu Yen Province

Source: "Hydrogeological Map" assembled by P-CERWASS based on Geological and Hydrogeological Map 1:200,000 by CEVIHEGEO

(2) Khanh Hoa Province

Groundwater potential map of Khan Hoa province are shown in Figure 2.7.2. This map indicates not only groundwater potential evaluation but fluoride contaminated areas and seawater intrusion areas. There are high or middle potential areas along Tan Lam River in the northern part of Khanh Hoa province and along Cai River in the southern part of the province. However, greater part of the province where is mountainous area consisted of granitic basement rocks is low potential area. The three target communes in Khanh Hoa province; K-1, 2, and 3 are regarded almost as the middle potential area.

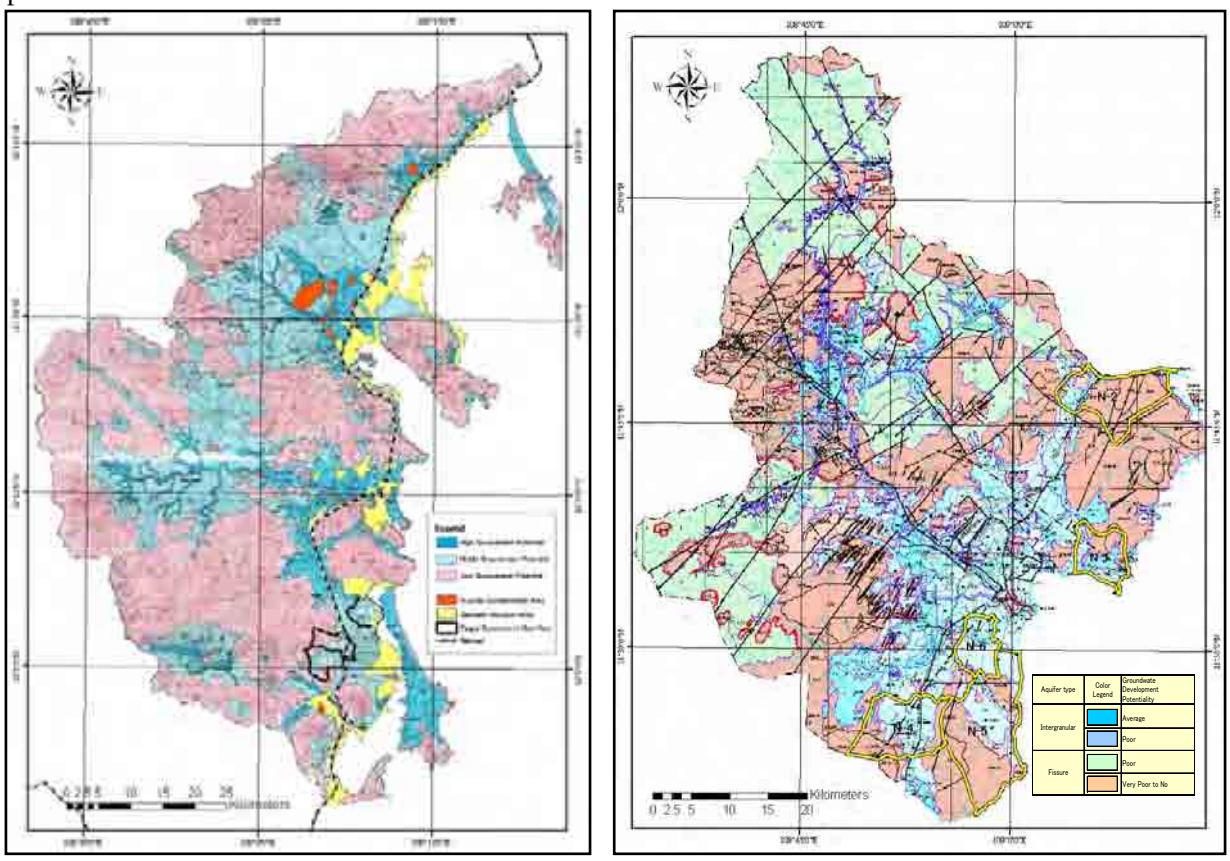


Figure 2.7.2 Groundwater Potential Map of Khanh Hoa Province (left)

Figure 2.7.3 Hydrogeological Map of Ninh Thuan Province (right)

Source: "Hydrogeological Map" assembled by P-CERWASS based on Geological and Hydrogeological Map 1:200,000 by Central Vietnam Division of Hydrogeology and Engineering (CEVIHEGEO)

(3) Ninh Thuan Province

Figure 2.7.3 shows hydrogeological map of Ninh Thuan province. According to the map, average to "poor" potential area is spreading along Dinh River in the central part of the province. On the other hands, mountainous areas which consist of granitic rocks or Jurassic sedimentary rocks are classified into "poor" to "very poor" potential area. Since several target communes in Ninh Thuan province are facing the ocean, they are concerned about not only scarce of groundwater resources but seawater intrusion.

(4) Binh Thuan Province

Hilly terrene is well-developed in Binh Thuan province facing to the South China Sea and low land is also developed along La Nga River. These areas are mainly covered by Quaternary and classified into average to low groundwater potential area. Meanwhile, the inland area of the province which consists of granitic rocks and Jurassic sedimentary rocks are regarded as low to very low groundwater potential area. Based on the map, B-1, 2 and the southern part of B-3, 5, 6 and 7 have average potentiality, however, B-4 has very poor groundwater potentiality.

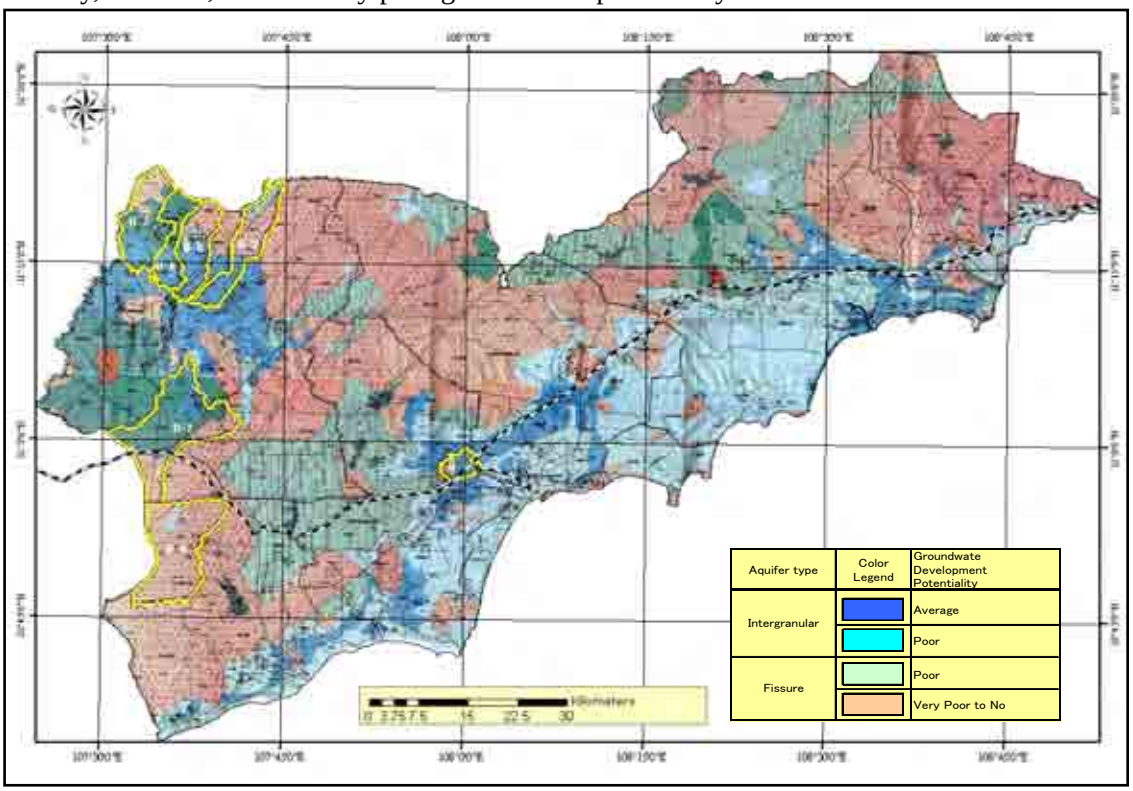


Figure 2.7.4 Hydrogeological Map of Binh Thuan Province

Source: "Hydrogeological Map" assembled by P-CERWASS based on Geological and Hydrogeological Map 1:200,000 by Central Vietnam Division of Hydrogeology and Engineering (CEVIHEGEO)

2.7.2 Hydrogeological Conditions of the Target Communes

(1) Results of Field Reconnaissance

The field reconnaissance was conducted to know geomorphologic and hydrogeological conditions, and surface water conditions in the targeted 24 communes.

The field survey conducted from June 2007 to July 2007. Phu Yen, Khanh Hoa and Nin Thuan province were in the dry season but Binh Thuan province was in the rainy season. Each survey result was shown in data sheets with tabular forms (refer to the Databook). The results are summarized in Table 2.7.1 and Table 2.7.2 by commune.

The main outputs of the survey result are as follows:

- Four communes (P-2: An Dinh, N-2: Cong Hai, N-3: Bac Son and B-4: Tan Duc) have perennial rivers in their communes; however, the river waters are used for irrigation, not for drinking water because of agricultural chemical pollution.
- One commune (B-3: Nghi Duc) has perennial spring in the commune: however the quantity is small, and not enough for the users.
- Five communes (P-1: Xuan Phuoc, P-7: Suoi Bac, P-8: Son Thanh Dong, N-4: Phuoc Minh, B-6: Sung Nhon) have reservoirs or ponds for irrigation.
- Many surface waters in the communes dry up in the dry season.

The main water resource for drinking in the 24 target communes are dugwells during the dry season. Eight communes (P-2: An Dinh, P-8: Son Thanh Dong, K-1: Cam An Bac, N-1: Nhon Hai, N-3: Bac Son, N-4: Phuoc Minh, B-1: Muong Man and B-4: Tan Dac) buy drinking water in the dry season. Two communes (K-2: Cam Hiep Nam, K-3: Cam Hai Tay) use rainwater as drinking water in the rainy season.

(2) Inventory Survey of Existing Wells

Based on the existing data analysis, a provisional inventory of existing wells in the targeted 24 communes was prepared. However, the quality of existing well inventory which the Study Team could obtain was very poor because of incorrect location and few numbers of wells in the study area.

As a result of review of existing information about wells in the target communes, it became apparent that there were no existing well inventories on dugwells. Therefore, The Study Team visited the target 24 communes, conducted interviews to representatives of the communes about existing wells, and identified the representative wells with the highest water quality, richest water quantity and the deepest depth in each target commune and so on. The coordinate of the existing wells were measured with GPS. The each survey result was shown in data sheets with tabular forms for identified dugwells and drilling wells. The result is summarized in Table 2.7.3.

The main findings of the survey are as follows:

- Many of households in the target communes have dug wells in their garden. Many dugwells dry up in the dry season. They have custom to share groundwater of dugwells in water scarce season.
- The main groundwater quality problem in the target communes are salination and fluoride, especially all target communes in Ninh Thuan province have salination problem.
- The fluoride problem concentrates in Phu Yen and Khanh Hoa provinces.
- An Tho and Ea Cha Rang communes have high pH problem. Groundwater with high pH may cause fluoride elution from rocks.

Table 2.7.1 Hydrogeological Conditions in the Target Communes (1)

Province	Commune Name		Geomorophology				Geology				
			Plain/low land	Hill	Mountain-ous area	Lineament	Sediment	Rocks			
								Sedimentary	Plutonic	Ignious	Basaltic
Phu Yen	P-1	Xuan Phuoc	x		x		x		x	x	x
	P-2	An Dinh	x		x		x		x		x
	P-3	An Tho		x	x				x		x
	P-4	An My	x	x			x		x		x
	P-5	Son Phuoc		x		x	x		x		x
	P-6	Ea Cha Rang		x					x		x
	P-7	Ea Cha Rang		x	x	x			x		x
	P-8	Son Thanh Dong		x	x	x		x	x		x
Khanh Hoa	K-1	Cam An Bac	x		x	x	x	x	x		
	K-2	Cam Hiep Nam	x			x	x		x		
	K-3	Cam Hai Tay	x				x		x		
Ninh Thuan	N-1	Nhon Hai	x		x	x	x		x		
	N-2	Cong Hai	x		x	x	x		x		
	N-3	Bac Son	x		x	x	x		x		
	N-4	Phuoc Minh	x		x	x	x		x		
	N-5	Phuoc Dinh	x				x		x		
	N-6	Phuoc Hai	x	x	x		x		x		
Binh Thuan	B-1	Muong Man	x		x		x	x	x		
	B-2	Gia Huynh	x	x			x		x		
	B-3	Nghi Duc	x		x	x	x		x		
	B-4	Tan Duc		x	x				x		
	B-5	Me Pu	x		x	x	x	x	x		
	B-6	Sung Nhon	x		x	x	x	x	x		
	B-7	Da Kai	x		x	x	x		x		x

Source: JICA Study Team x; relevant index

Table 2.7.2 Hydrogeological Conditions in the Target Communes (2)

Province	Commune Name		Current Groundwater Aquifer for Drinking		Target Aquifer Type of Groundwater					Surface Water Condition			
					Sedimenata-ry Deposit	Rocks				Dam/ Reservoir	Swamp/ Pond	Perennial	
			Shallow	Deep		Weathered	Fissure	Fractured	Porus			River	Spring
Phu Yen	P-1	Xuan Phuoc	x			x	x		x	1			
	P-2	An Dinh	x		x		x		x			1	
	P-3	An Tho	x			x	x		x				
	P-4	An My	x			x	x				1		
	P-5	Son Phuoc	x			x			x				
	P-6	Ea Cha Rang	x			x			x				
	P-7	Ea Cha Rang	x			x			x	1			
	P-8	Son Thanh Dong	x			x			x	2			
Khanh Hoa	K-1	Cam An Bac	x			x	x	x					
	K-2	Cam Hiep Nam	x			x	x	x					
	K-3	Cam Hai Tay	x			x	x						
Ninh Thuan	N-1	Nhon Hai	*Buying water*		x	x				1			
	N-2	Cong Hai	x		x	x		x				2	
	N-3	Bac Son	x				x	x				1	
	N-4	Phuoc Minh	x				x			3			
	N-5	Phuoc Dinh	x		x	x							2
	N-6	Phuoc Hai	x					x			1		1
Binh Thuan	B-1	Muong Man	x				x						
	B-2	Gia Huynh	x				x				1		
	B-3	Nghi Duc	x				x						1
	B-4	Tan Duc	x				x						1
	B-5	Me Pu	x				x						
	B-6	Sung Nhon	x				x				2		
	B-7	Da Kai	x				x						

Source: JICA Study Team x; relevant index

Table 2.7.3 Survey Results of Existing Wells and Water Quality

Province	No.	Commune	Information on Existing Wells				Water Quality of Existing Wells						
			No. of Dug wells	No. of Drilling wells	Households	Own Ratio (%)	Salinity	F	Ca	High pH	Metallic Taste	Turbi -dity	Odor
Phu Yen	P-1	Xuan Phuoc	1,500 - 1,600	few	2,051	75		●	●		●		
	P-2	An Dinh	700		1,400	50		●			●		
	P-3	An Tho	150		700	20	●	●		●	●		
	P-4	An My	2,500	few	2,816	90	●	●					
	P-5	Son Phuoc	250	few	769	30							●
	P-6	Ea Cha Rang	50	few	589	85		●	●	●			
	P-7	Suoi Bac	296		1,393	20			●				
	P-8	Son Thanh Dong	500 - 600		more than 1,000	55							
Khanh Hoa	K-1	Cam An Bac	1,000	few	1,216	80	●	●					
	K-2	Cam Hiep Nam	650	few	1,003	65		●				●	
	K-3	Cam Hai Tay	1,400	few	2,051	70	●	●					
Ninh Thuan	N-1	Nhon Hai	Almost all		2,573	----	●						
	N-2	Cong Hai	unknown		1,473	----	●				●		
	N-3	Bac Son	unknown	1	1,141	----	●						
	N-4	Phuoc Minh	Almost all		900	----	●						
	N-5	Phuoc Hai	1,500		2,302	65	●				●		
	N-6	Phuoc Dinh	120	5	1,650	5	●						
Binh Thuan	B-1	Muong Man	400	300			●				●		
	B-2	Gia Huynh	(irrigation)	1,380	30						●		
	B-3	Nghi Duc	Almost all	3	1,214	----						●	
	B-4	Tan Duc	Almost all	2	2,050	----		●			●		
	B-5	Me Pu	Almost all	3~5	1,600	----					●		
	B-6	Sung Nhon	2,600		2,600	100					●		
	B-7	Da Kai	1,692		1,692	100					●		

Note: "●" expresses that the groundwater in existing wells of each commune has the problems captured above.

(3) Geophysical Survey

Geophysical survey was carried out by Vertical Electrical Sounding (VES) and Horizontal Electrical Profiling (HEP) for the following purposes;

- To figure out the geological and hydrogeological conditions in the target communes for groundwater exploitation

- To decide just one site for the test borehole drilling survey in each commune.

The VES points were selected four to six points in each commune based on topographic and geological conditions, accessibility or trafficability for the mobilization of a drilling machine and CPC's reference information. The HEP locations were selected in the mountainous or high land area in order to select a suitable point for carrying out the VES. Detailed results of geophysical survey are described in the Supporting report.

(4) Test Borehole Drilling Survey

Test borehole drilling survey consists of drilling work, geophysical logging, well construction, pumping test and water quality analysis. This survey was carried out to obtain hydrogeological information and to monitor groundwater level and water quality.

The above mentioned information is utilized for consideration of the groundwater potential evaluation.

The survey was carried out in 24 communes as shown in Figure 2.7.5.

1) Decision of Test Borehole Location

The test borehole locations were decided through the following procedures.

Utilization of Information of the Existing Wells

The information of existing wells was very few in the target communes; however, those are very important for grasping hydrogeological conditions. Therefore the information was collected and be analyzed.

Utilization of the Existing GIS Data

The GIS data generated on Mapinfo by Vietnam side was utilized in combined with the below mentioned remote sensing in order to effectively analyze hydrogeological conditions.

Utilization of Remote Sensing

Topographic map of the communes was prepared and, geomorphological and geological structure analysis was conducted using the data of digital elevation model (DEM) by the shuttle radar topographic mission (SRTM).

Utilization of Results of the Geophysical Survey

Five (5) candidate sites for the groundwater source per one (1) commune were selected on average based on the results of hydrogeological analysis including the field reconnaissance. Then, geophysical survey was conducted at the selected sites.

Evaluation of the Candidate Locations for the Test Boreholes and Selection

Candidate locations for test boreholes were evaluated on the basis of the results of the above mentioned analyses. Five indices: namely, lineaments, catchment area, aquifer thickness, electric resistivity (permeability) and water quality (saline intrusion) were selected. Then, the Study Team evaluated the scores for each index and summed up the total scores, and the location with highest score in each target commune was selected as the test borehole drilling location.

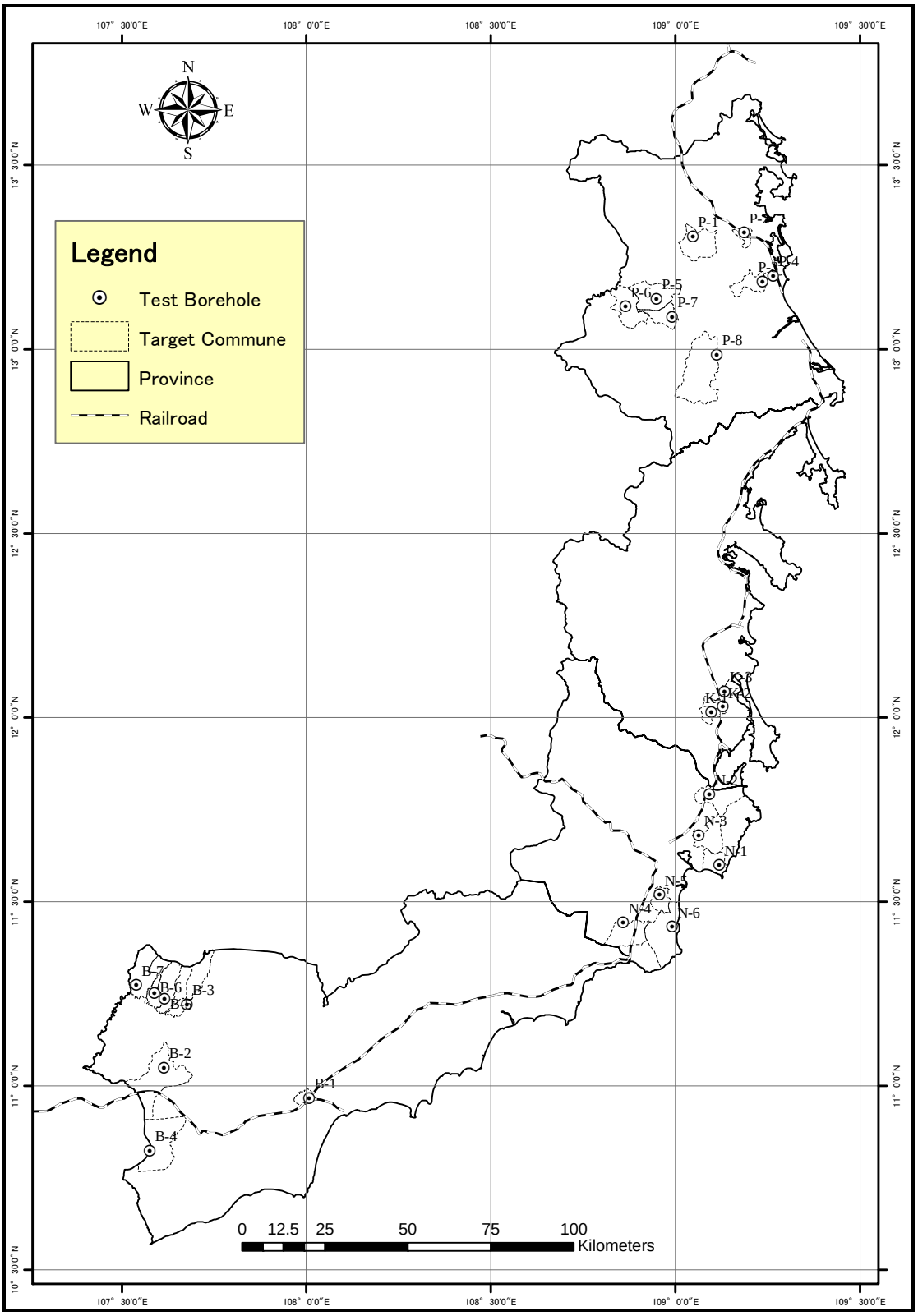


Figure 2.7.5 Location Map of Test Boreholes

2) Indices for Evaluation of Possible Test Borehole Location

Lineament

Lineament in important index for fissure type aquifer because a place with lineament structure has a possibility to have groundwater in the fissure zone or fractured zone.

Catchment Area

Catchment area is efficient index to evaluate the groundwater potential. The candidate location with large catchment area generally has high groundwater potentiality.

Aquifer Thickness

Aquifer thickness is fundamental index which has direct influence to well yield. This index was evaluated with the geophysical survey results.

Electric Resistivity (permeability)

Permeability of aquifer is also fundamental data which has direct influence to well yield. This index was evaluated with electric resistivity.

Water Quality (seawater intrusion)

Salinity by seawater intrusion is the most important index for groundwater development in the study area. Allocation of evaluation score for the index was decided to double scores of the other indices.

3) Results of Evaluation of Test Borehole Location

Candidates of test borehole locations were evaluated by using the indices above mentioned. The scores were relatively allocated to the candidates because the condition of those indices was different from commune by commune. Table 2.7.4 shows evaluation results. The locations with the highest score in each commune were decided as the final drilling sites of the test boreholes in this study. The results of the test borehole drilling survey are summarized in Table 2.7.6 and described in Chapter 5 of the Supporting Report.

Table 2.7.4 Decision of Proper Test Borehole Locations (1)

Point No.			Commune	Geology	Geomorphology						Water Quality			Aquifer Conditions							Total Score
					Linewments			Catchment Area			Saline Intrusion			Aquifer Thickness			Electric Resistivity				
					Significant	Midium	Low	Large	Middle	Small	Low	Midium	Significant	Thick	Medium	Thin	Low(Clay)	Low	Midium	Hight	
					5	3	1	5	3	1	10	5	1	5	3	1	0	5	3	1	
Phu Yen	P1	P1-V01	Xuan Phuoc	Granitic Rock		X		X			x			X				X			28
		P1-V02		Granitic Rock		X		X			x					X			X		22
		P1-V03		Granitic Rock		X		X			x				X				X		24
		P1-V04		Granitic Rock		X		X			x					X			X		22
		P1-V05		Granitic Rock			X	X			x				X				X		22
	P2	P2-V01	An Dinh	Basalt		X		X			x			X				X			28
		P2-V02		Basalt		X		X			x				X				X		24
		P2-V03		Basalt			X	X			x					X			X		20
		P2-V04		Basalt		X		X			x				X				X		24
		P2-V05		Basalt		X		X			x				X			X			26
	P3	P3-V01	An Tho	Basalt/Plutonic rock			x		x		x			x				x			24
		P3-V02		Basalt/Plutonic rock			x			x	x				x			x			20
		P3-V03		Basalt/Plutonic rock			x			x	x					x		x			18
		P3-V04		Basalt/Plutonic rock			x		x		x					x	x				15
		P3-V05		Basalt/Plutonic rock			x		x		x			x				x			24
	P4	P4-V01	An My	Sediment			x	x				x				x		x			17
		P4-V02		Sediment			x	x					x			x		x			13
		P4-V03		Basalt/Plutonic rock			x	x			x					x		x			22
		P4-V04		Sediment			x	x				x			x			x			19
		P4-V05		Sediment			x	x				x				x		x			17
	P5	P5-V01	Son Phuoc	Basalt/Plutonic rock			x			x	x					x			x		16
		P5-V02		Basalt/Plutonic rock			x			x	x					x			x		16
		P5-V03		Basalt/Plutonic rock			x			x	x					x			x		16
		P5-V04		Basalt/Plutonic rock			x		x		x				x			x			22
		P5-V05		Basalt/Plutonic rock			x		x		x					x			x		18
	P6	P6-V01	Ea Cha Rang	Basalt/Plutonic rock			x			x	x					x			x		16
		P6-V02		Basalt/Plutonic rock			x			x	x					x			x		16
		P6-V03		Basalt/Plutonic rock			x			x	x				x			x			20
		P6-V04		Basalt/Plutonic rock			x		x		x					x				x	16
		P6-V05		Basalt/Plutonic rock			x		x		x					x			x		18
	P7	P7-V01	Suoi Bac	Basalt/Plutonic rock			x		x		x					x			x		18
		P7-V02		Basalt/Plutonic rock			x		x		x					x			x		18
		P7-V03		Basalt/Plutonic rock			x		x		x					x			x		18
		P7-V04		Basalt/Plutonic rock		x			x		x			x				x			26
		P7-V05		Basalt/Plutonic rock			x		x		x				x			x			22
	P8	P8-V01	Son Thanh Dong	Basalt			x		x		x					x			x		18
		P8-V02		Basalt		x			x		x				x			x			24
		P8-V03		Basalt			x		x		x					x			x		18
		P8-V04		Basalt			x		x		x					x			x		18
		P8-V05		Basalt			x		x		x				x			x			22
Khanh Hoa	K1	K1-V01	Cam An Bac	Sediment/Granite			X	X			x					X				X	18
		K1-V02		Sediment/Granite			X		X		x				X				X		20
		K1-V03		Sediment/Granite		X				X	x					X				X	16
		K1-V04		Sediment/Granite			X		X		x					X				X	16
	K2	K2-V01	Cam Hiep Nam	Sediment/Granite			X		X		x					X				X	16
		K2-V02		Sediment/Granite			X	X			x					X				X	18
		K2-V03		Sediment/Granite		X				X	x				X				X		20
		K2-V04		Sediment/Granite			X		X		x					X				X	16
		K2-V05		Sediment/Granite			X	X			x			X				X	X		29
	K3	K3-V01	Cam Hai Tay	Sediment/Granite			X	X					x			X			X		11
		K3-V02		Sediment/Granite		X		X					x			X			X		13
		K3-V03		Sediment/Granite			X	X					x			X			X		11
		K3-V04		Sediment/Granite			X	X				x		X					X		19
		K3-V05		Sediment/Granite			X	X					x		X				X		13
		K3-V06		Sediment/Granite			X	X					x			X			X		11

Table 2.7.5 Decision of Proper Test Borehole Locations (2)

Point No.			Commune	Geology	Geomorphology						Water Quality			Aquifer Conditions							Total Score
					Linewments			Catchment Area			Saline Intrusion			Aquifer Thickness			Electric Resistivity				
					Significant	Midium	Low	Large	Middle	Small	Low	Midium	Significant	Thick	Medium	Thin	Low(Clay)	Low	Midium	Hight	
					5	3	1	5	3	1	10	5	1	5	3	1	0	5	3	1	
Ninh Thuan	N1	N1-V01	Nhon Hai	Sediment/Granite			X		X			x			X				X		15
		N1-V02		Sediment/Granite			X		X			x		X					X		17
		N1-V03		Sediment/Granite			X		X			x			X				X		15
		N1-V04		Sediment/Granite			X			X		x		X					X		15
	N2	N2-V01	Cong Hai	Sediment/Sedimentary Rock			X		X				x	X						X	11
		N2-V02		Sediment/Sedimentary Rock			X		X			x		X					X		17
		N2-V03		Sediment/Sedimentary Rock			X		X			x				X				X	11
		N2-V04		Sediment/Sedimentary Rock			X		X			x				X				X	11
		N2-V05		Sediment/Sedimentary Rock		X			X			x				X			X		15
	N3	N3-V01	Bac Son	Sediment/Granite		X			X		x				X				X		22
		N3-V02		Sediment/Granite		X			X		x				X				X		22
		N3-V03		Sediment/Granite		X			X		x					X			X		20
		N3-V04		Sediment/Granite			X		X				x		X			X			13
		N3-V05		Sediment/Granite			X	X			x				X				X		22
	N4	N4-V01	Phuoc Minh	Sediment/Granite		X		X			x					X			X		22
		N4-V02		Sediment/Granite			X	X					x			X			X		11
		N4-V03		Sediment/Granite			X	X				x				X			X		15
		N4-V04		Sediment/Granite			X	X				x			X				X		17
	N5	N5-V01	Phuoc Dinh	Sediment/Granite			X	X					x		X				X		13
		N5-V02		Sediment/Granite			X		X			x			X				X		15
		N5-V03		Sediment/Granite			X	X				x				X			X		15
		N5-V04		Sediment/Granite			X		X				x		X			X			13
		N5-V05		Sediment/Granite			X		X			x			X				X		15
	N6	N6-V01	Phuoc Hai	Sediment/Granite			X			X	x				X				X		18
		N6-V02		Sediment/Granite			X			X			x			X			X		7
		N6-V03		Sediment/Granite	X				X		x				X				X		24
		N6-V04		Sediment/Granite			X	X				x				X			X		15
		N6-V05		Sediment/Granite			X			X			x			X			X		7
Binh Thuan	B1	B1-V01	Muong Man	Sediment/Sedimentary Rock			X	X				x				X			X		15
		B1-V02		Sediment/Sedimentary Rock			X	X					x		X				X		13
		B1-V03		Sediment/Sedimentary Rock			X	X				x			X				X		17
		B1-V04		Sediment/Sedimentary Rock			X	X					x		X				X		13
		B1-V05		Sediment/Sedimentary Rock			X	X				x			X				X		17
	B2	B2-V01	Gia Huynh	Sediment/Granite			X	X			x					X			X		20
		B2-V02		Sediment/Granite			X		X		x					X				X	16
		B2-V03		Granite			X			X	x					X				X	14
		B2-V04		Granite			X			X	x					X			X		16
		B2-V05		Sediment/Granite			X	X			x					X				X	18
		B2-V06		Sediment/Granite			X	X			x					X			X		20
	B3	B3-V01	Nghi Duc	Sediment/Granite			X	X			x					X				X	18
		B3-V02		Sediment/Granite			X	X			x					X				X	18
		B3-V03		Sediment/Granite			X	X			x					X				X	18
		B3-V04		Sediment/Granite			X	X			x					X				X	18
		B3-V05		Sediment/Granite			X	X			x					X				X	18
		B3-V06		Sediment/Granite		X		X			x					X			X		22
	B4	B4-V01	Tan Duc	Granite			X		X		x					X			X		18
		B4-V02		Granite			X		X		x					X			X		18
		B4-V03		Granite			X			X	x					X			X		16
		B4-V04		Granite			X		X		x					X			X		18
		B4-V05		Granite		X		X			x					X			X		22
		B4-V06		Granite		X		X			x					X				X	20
	B5	B5-V01	Me Pu	Sediment/Granite			X	X			x					X				X	18
		B5-V02		Sediment/Granite			X	X			x					X			X		20
		B5-V03		Sediment/Granite			X	X			x					X				X	18
		B5-V04		Sediment/Granite			X	X			x					X			X		20
		B5-V05		Sediment/Granite		X		X			x					X			X		22
	B6	B6-V01	Sung Nhon	Sediment/Granite			X	X			x					X				X	18
		B6-V02		Sediment/Granite			X	X			x					X				X	18
		B6-V03		Sediment/Granite			X	X			x					X				X	18
		B6-V04		Sediment/Granite			X	X			x				X					X	20
	B7	B7-V01	Da Kai	Sediment/Granite			X	X			x					X			X		20
		B7-V02		Sediment/Granite			X		X		x					X				X	16
		B7-V03		Sediment/Granite			X		X		x					X			X		18
		B7-V04		Sediment/Granite			X		X		x					X				X	16
		B7-V05		Sediment/Granite			X	X			x					X				X	18

Table 2.7.6 Summary of Test Borehole Drilling Survey

Province	Test well No.	Commune	Thickness of Alluvium (m)	Type* of Bedrock	Aquifer Type	Pumping Test Results				**Water Quality							
						Static Water Level (GL m)	Draw -down (m)	Safe Yield		F	Cl^-	Fe	Mn	$KMnO_4$	$CaCo_3$	TDS	Zn
								(l/min)	(m^3/day)								
Phu Yen	P-1	Xuan Phuoc	10.0	Gr	Fracture	-2.00	-22.63	4.0	6								
	P-2	An Dinh	3.5	Gr	Alluvium, Fracture	-3.00	-9.30	200.0	288	M	X					X	
	P-3	An Tho	-	Ba, SR	Fracture	-43.50	-6.08	80.0	115					X			
	P-4	An My	8.0	Ba, SR	Fracture	0.80	-14.06	480.0	691								
	P-5	Son Phuoc	1.0	Ba, Gr	Fracture	-6.00	-17.00	4.0	6	X							
	P-6	Ea Cha Rang	4.0	Gr	Fracture	-6.00	-33.81	15.0	22				M				
	P-7	Suoi Bac	2.5	Gr	Fracture	-7.00	-30.10	5.0	7	X							
	P-8	Son Thanh Dong	-	Ba, An	Joint, Fracture	-12.70	-0.91	300.0	432								
Khanh Hoa	K-1	Cam An Bac	11.0	Gr	Weathering , Fracture	-1.60	-9.76	250.0	360			M	M				
	K-2	Cam Hiep Nam	15.0	Gr	Weathering , Fracture	-6.70	-25.17	40.0	58			X					X
	K-3	Cam Hai Tay	10.0	Gr	Intrusive, Fracture	0.60	-15.00	200.0	288								
Ninh Thuan	N-1	Nhon Hai	5.0	Gr	Fracture	-7.00	-29.62	90.0	130		X		M		X	X	
	N-2	Cong Hai	8.7	An	Fracture	-3.50	-11.37	35.0	50								
	N-3	Bac Son	5.0	Gr	Weathering , Fracture	-2.50	-14.10	90.0	130		X	X	X		X	X	
	N-4	Phuoc Minh	2.0	Gr	Fracture	-4.00	-36.00	1.0	1	M	X			M		X	
	N-5	Phuoc Hai	8.0	Gr	Weathering	-1.30	-13.65	60.0	86		X		X	X	X	X	
	N-6	Phuoc Dinh	15.0	Gr	Weathering	-6.80	-13.67	35.0	50	X				X			
Binh Thuan	B-1	Muong Man	10.0	SR	Fracture	-5.30	-7.47	25.0	36								
	B-2	Gia Huynh	5.7	Gr	Fracture	-1.64	-26.41	30.0	43								
	B-3	Nghi Duc	8.0	Gr	Fracture	-1.10	-10.03	3.0	4								
	B-4	Tan Duc	10.0	Gr	Weathering , Fracture	-2.50	-5.87	12.0	17						X		
	B-5	Me Pu	8.0	Gr	Weathering	-1.90	-21.30	45.0	65								
	B-6	Sung Nhon	8.0	Gr	Fracture	-0.80	-19.00	45.0	65								
	B-7	Da Kai	3.0	Ba, Gr	Alteration, Fracture	-5.60	-52.90	4.8	7								

* Gr: Granite, Ba: Basalt, SR: Sedimentary Rock, An: Andesite

** X:Dissatisfy Drinking Water Standards, M: Marginal of Drinking Water Standards

2.7.3 Fluctuation of Groundwater Level

Groundwater level of the test boreholes constructed in the Study had been monitored in order to evaluate potentiality of groundwater development for the rural water supply in 24 communes.

(1) Location of Test Borehole

Test boreholes constructed during the phase I of the study are located as shown in Figure 2.7.5.

(2) Monitoring Period

The monitoring was carried out for more than half a year: March 2008 to September 2008.

(3) Frequency and Timing of Monitoring

Since groundwater monitoring in Vietnam has been conducted daily in the rainy season and every 5 days in the dry season by MONRE (Ministry of Natural Resources & Environment), the monitoring in this study was compliance with it. Division of seasons is set as follows. The monitoring was done simultaneously around 7 am.

Table 2.7.7 Division of Season

Target Province	Rainy Season	Dry Season
Phu Yen	September to December (4 month)	January to August （8 month）
Khanh Hoa	September to December (4 month）	January to August （8 month）
Ninh Thuan	September to December (4 month）	January to August （8 month）
Binh Thuan	May to October (6 month)	November to April (6 month)

(4) Monitoring Equipment

Twenty-four “Portable Water Level Gauges” procured by JICA were used for the monitoring.

(5) Groundwater Fluctuation

Monitored data were input as an excel data file and used for drawing fluctuation curve of groundwater level to evaluate potentiality of groundwater development and so on.

Groundwater fluctuation of each test borehole is shown in Figure 2.7.6 to Figure 2.7.9 and its characteristic is described as follows by province.

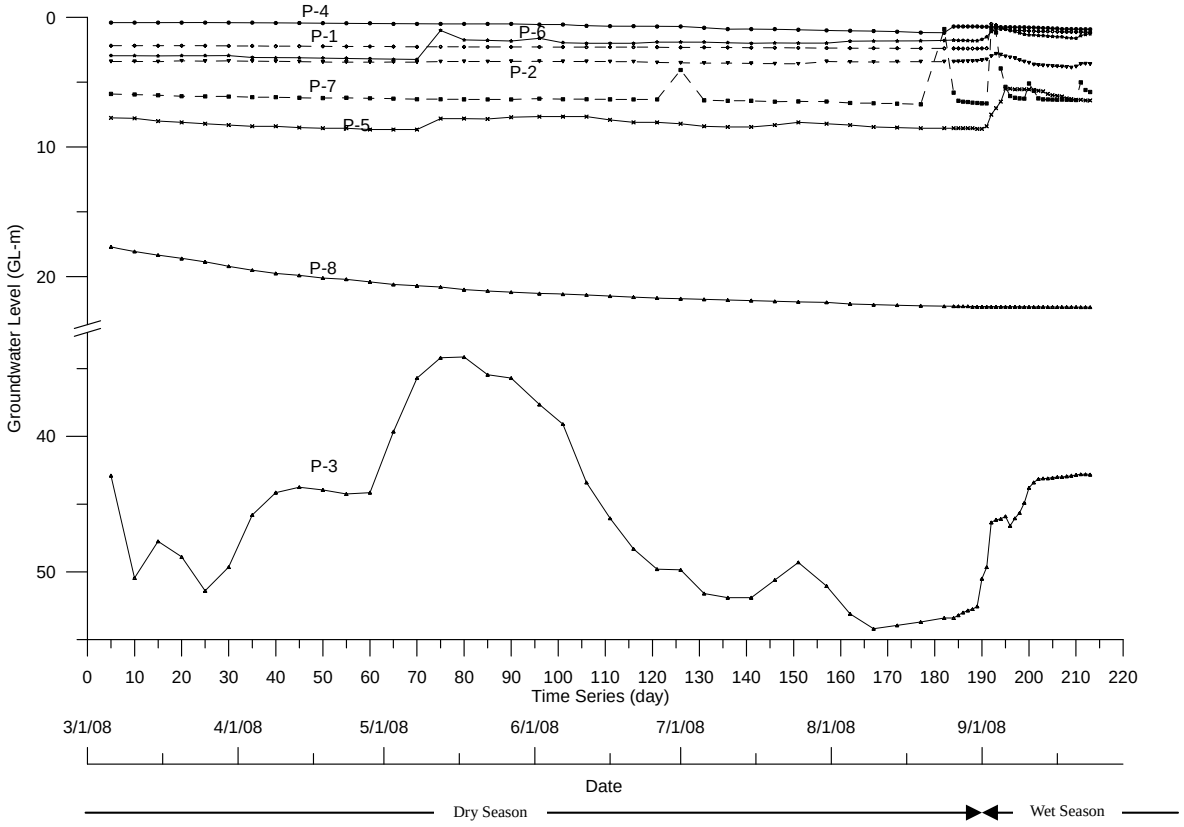


Figure 2.7.6 Fluctuation of Groundwater Level at Test Boreholes in Phu Yen Province

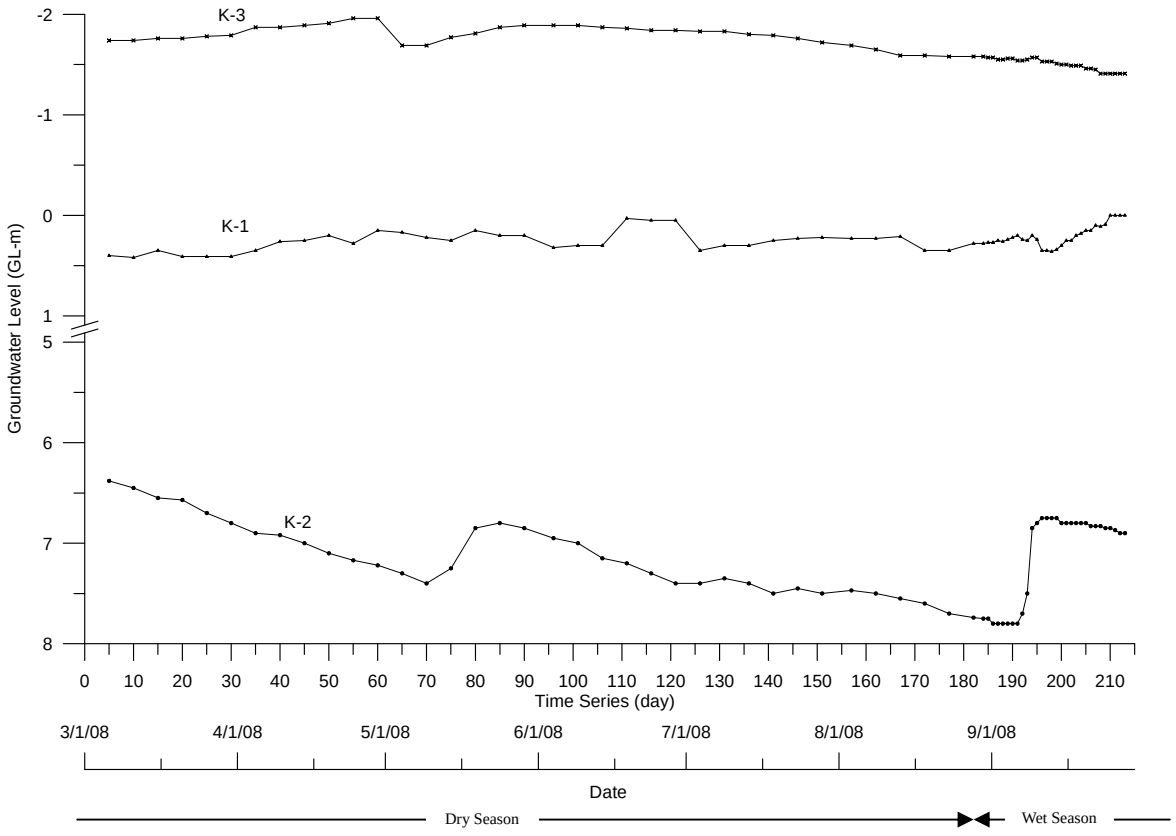


Figure 2.7.7 Fluctuation of Groundwater Level at Test Boreholes in Khanh Hoa Province

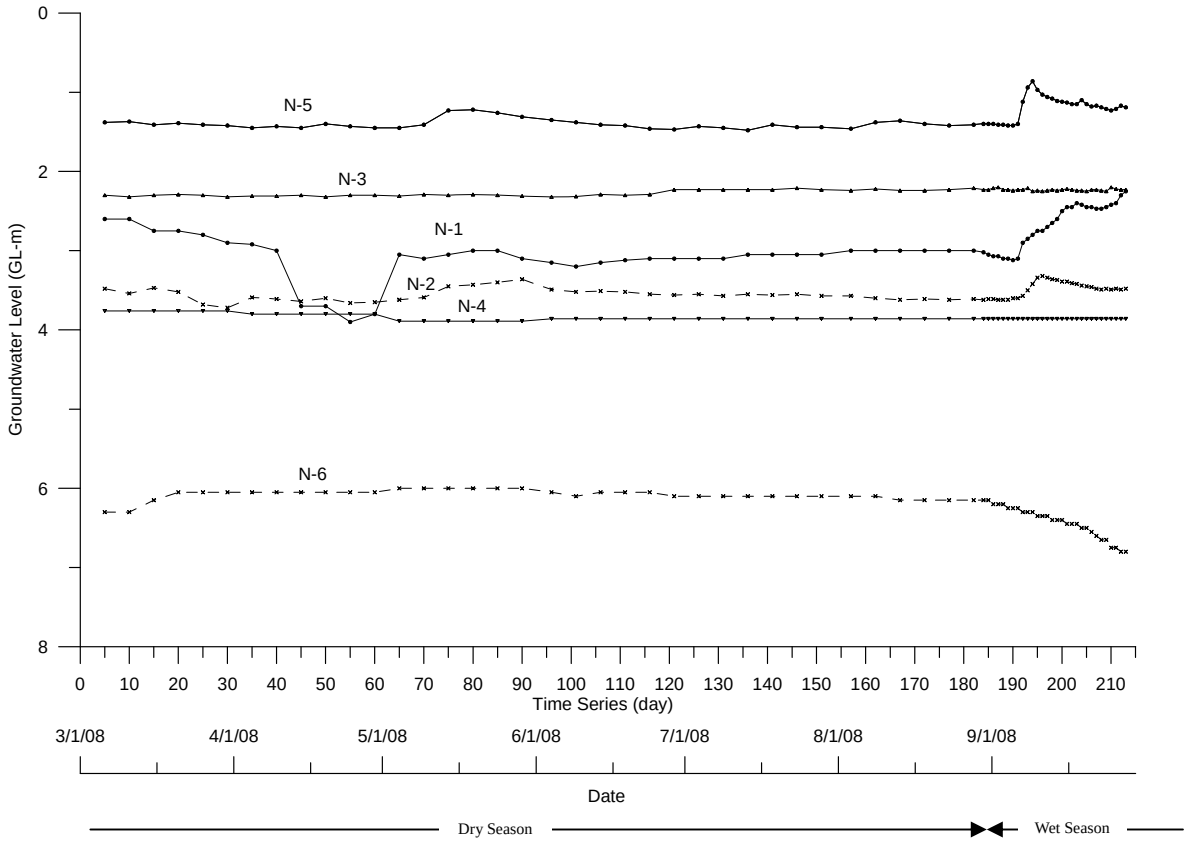


Figure 2.7.8 Fluctuation of Groundwater Level at Test Boreholes in Ninh Thuan Province

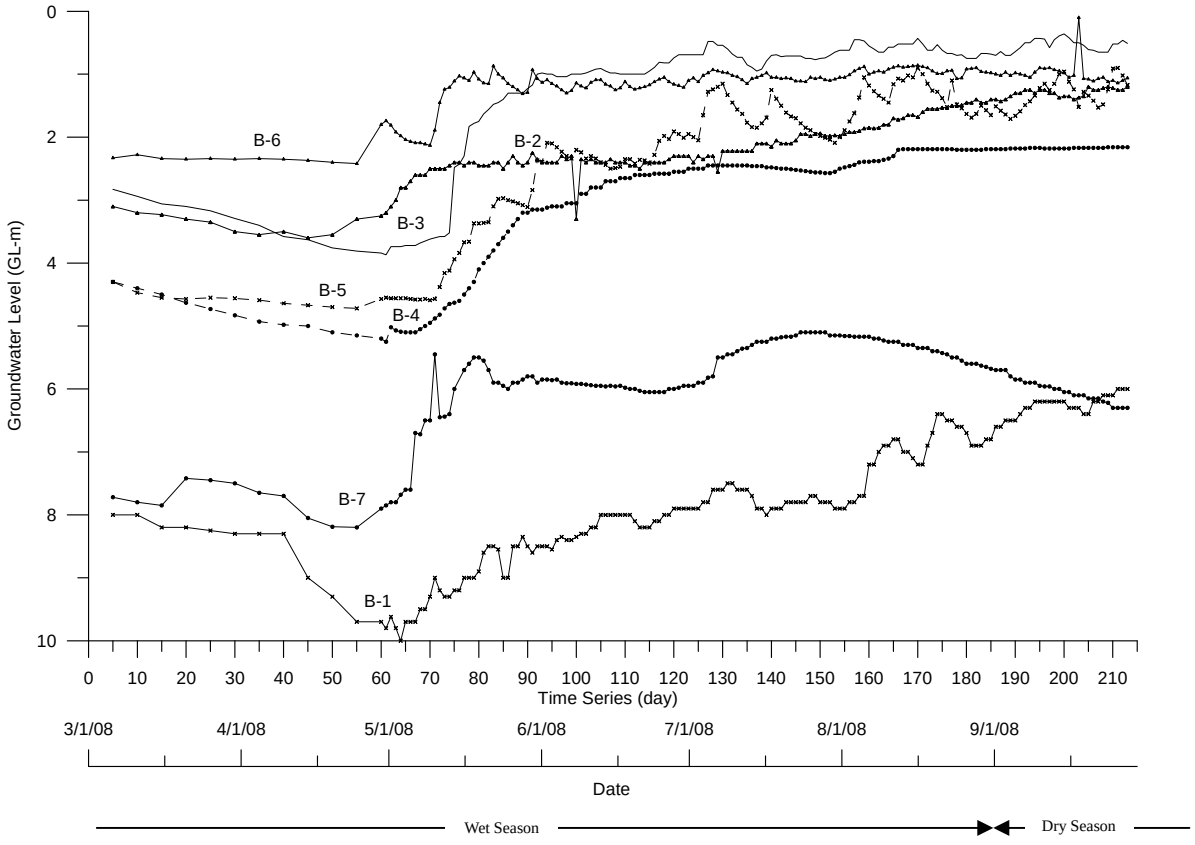


Figure 2.7.9 Fluctuation of Groundwater Level at Test Boreholes in Binh Thuan Province

- Phu Yen province

  Although fluctuation of groundwater level in the dry season is small except P-3, rising up of it from the beginning of the rain season in September is recognized. P-3 has deeper groundwater level and shows greater fluctuation than others do. The reason why P-3 shows the great water level rising of in the dry season is not clear. On the other hand, since P-8 has no seasonal fluctuation of water level, it may be under different hydrogeological conditions from others.

- Khanh Hoa province

  K-1 and K-3 have fracture type of aquifer and fluctuation of their water level is stable during the monitoring period. In contrast, K-2 has weathered granite aquifer and greater seasonal change than they do, and besides, have only one fifth of their withdrawal.

- Ninh Thuan province

  In general, water level fluctuation of all test boreholes in Ninh Thuan province is very small. Drawdown of N-1 in April seems to be withdrawn by water usage. N-1, 2 and 5 show water level rising at the starting of the rainy season. However, N-3 and 4 has almost no reaction. For some reason, N-6 shows reverse of them after the rainy season.

- Binh Thuan province

  Since Binh Thuan province had much longer the rainy season than other three provinces during the monitoring period, a dynamic movement of water level was recorded. The annual fluctuation of groundwater level of the test boreholes in this province ranges from two meter to three.

2.7.4 Impact of Seawater Intrusion

(1) Seawater Intrusion Survey along Coastal Zone of the Study Area

1) Purpose of Survey

This survey was conducted to study the current state of seawater intrusion to groundwater along coastal zone of the Study area. Salt accumulation issues, which sometimes happen in inland area with no outlet to the sea, are excluded from the objective of this survey.

2) Survey Points

Five hundred survey points were selected from the coastal plain along the shoreline of the study area. The survey areas lower than 20m A.S.L (above seawater level) were selected by DEM data analysis as shown in Figure 2.7.11. Figure 2.7.10 is an example of topographic analysis for selection of survey points.

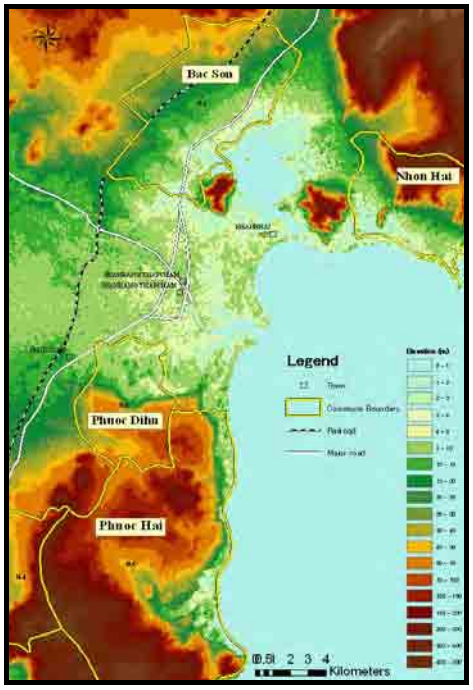


Figure 2.7.10 Topographic Classification of the Central of Nihh Thuan Province and the Location of the Targeted Commune

3) Survey Schedule and Survey Item

The survey was conducted in August 2007: the dry season in Phu Yen, Khanh Hoa and Ninh Thuan province and the wet season in Binh Thuan, and November to December 2007: the dry season in Binh Thuan and the wet season for the rest three provinces. Survey items are “Well Structure”, “Temperature”, “Electric Conductivity (EC)”, “pH” and “Taste”.

4) Survey Results

Affection degree of seawater intrusion was presented in Figure 2.5.12 and 13 based on the following category for evaluation.

- Less than 250 mg/L: Satisfy TCVN 5942-1995 (Drinking Water Standard for whole Vietnam)
- 250 to 400 mg/L: Satisfy TCVN 5943-1995（Drinking Water Standard for Coastal area）
- Over 400 mg/L: Dissatisfy Drinking Water Standards

Seasonal change was not clear as long as the two survey results were analyzed. Regional characteristics on seawater intrusion base on the survey are described below.

- Phu Yen Province

Affection of seawater intrusion is found within seven km from shoreline of Song Cau and Tuy district. P-4 (An My) belongs to this area. Although the affected wells are found locally in Da Rang river delta which extends to Phu Hoa and Tuy Hoa district, almost whole area of the delta contains non saline groundwater because of enough recharge from Da Rang River.

- Khanh Hoa Province

Affection of seawater intrusion is found considerably in Tan Lam River basin and Cai river basin. Contaminated wells are found up to 18 to 27 km landward. Main reason for this is poor recharge condition caused by small scaled catchment. Coastal zone of Cam Ranh district is generally affected by seawater intrusion. K-3 (Cam Hai Tay) belongs to this zone.

- Ninh Thuan Province

Almost whole coastal zone where is lower then 20 A.S.L.m is affected by seawater intrusion. Especially, such affected area extends up to approximately 22 km in Dinh River basin. All target communes; N-1 to 6 belong to this area. Main reason for this is poor recharge condition much severe than Khanh Hoa as shown in Figure 3.2.8 caused by little precipitation as shown Figure 2.1.3.

- Binh Thuan Province

Although affected areas by seawater intrusion are found in lowland of Luy river basin in the eastern part of Binh Than province, and Tre river basin in the central part of the province where Phan Thiet is located, it’s not so much than Ninh Thuan province. Only B-1 (Muong Man) is located near the affected area.

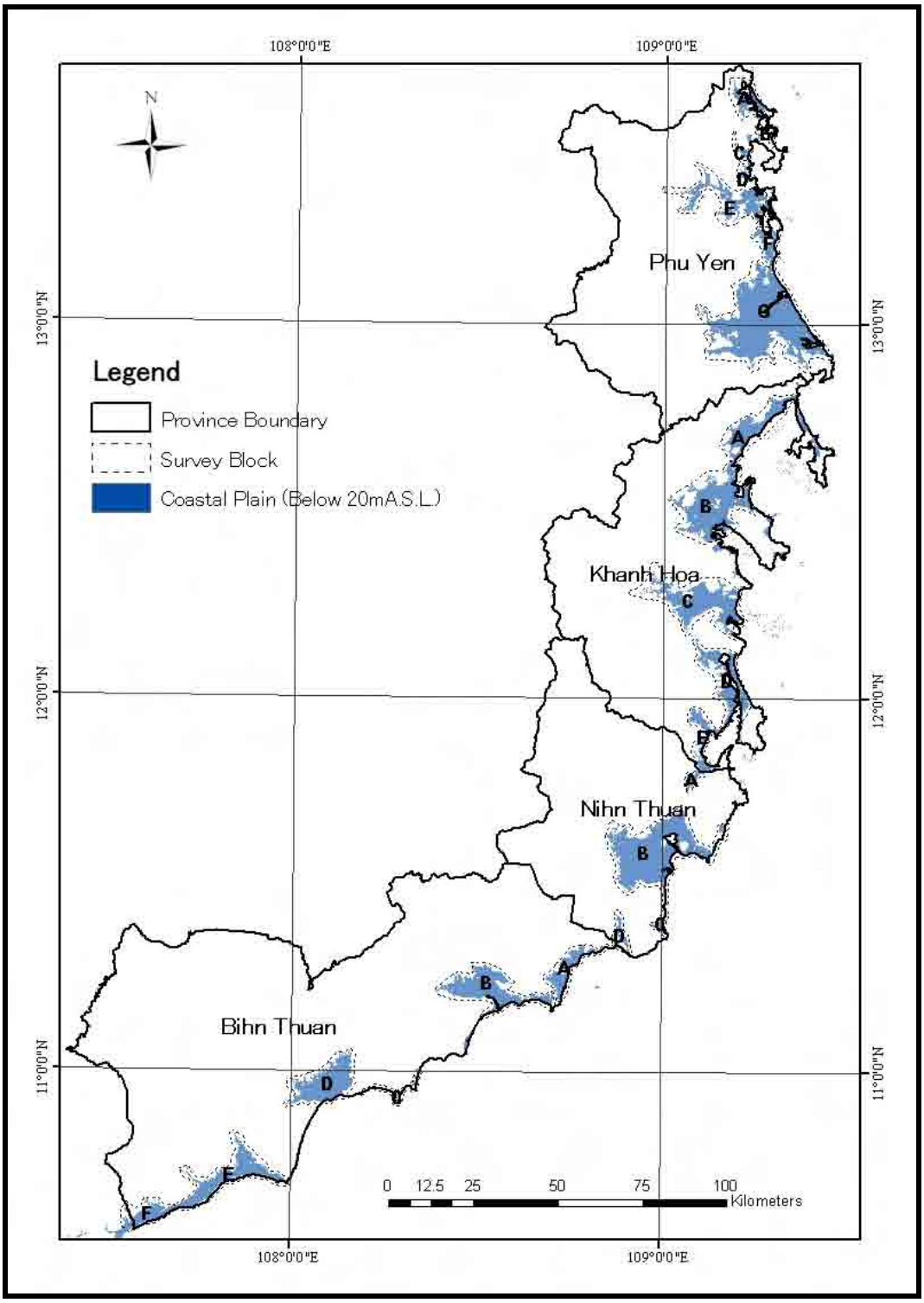


Figure 2.7.11 Survey Blocks for Preparatory Suvey on Seawater Intrusion along Coastal Line in the Study Area

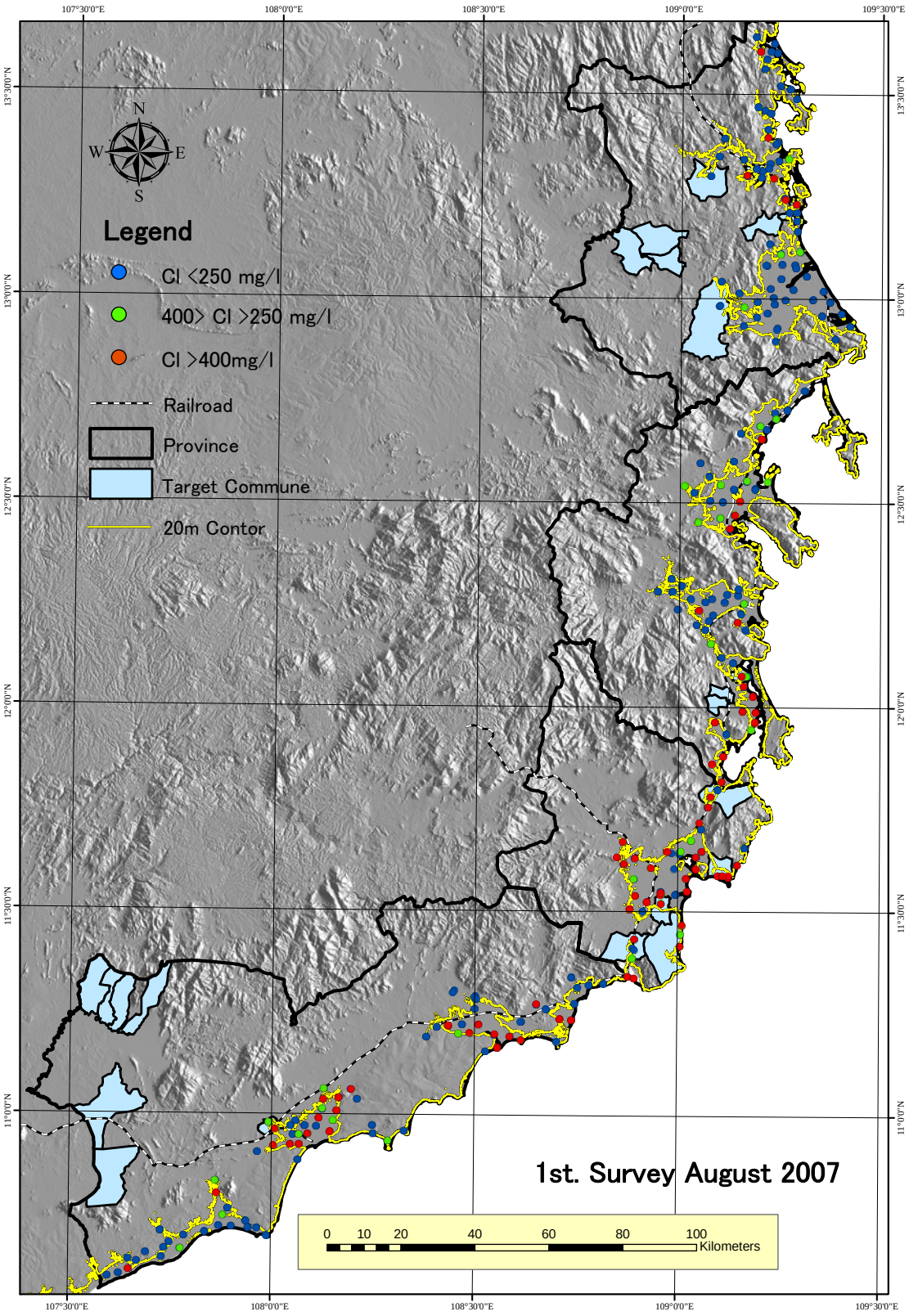


Figure 2.7.12 Results of Seawater Intrusion Survey in August 2007

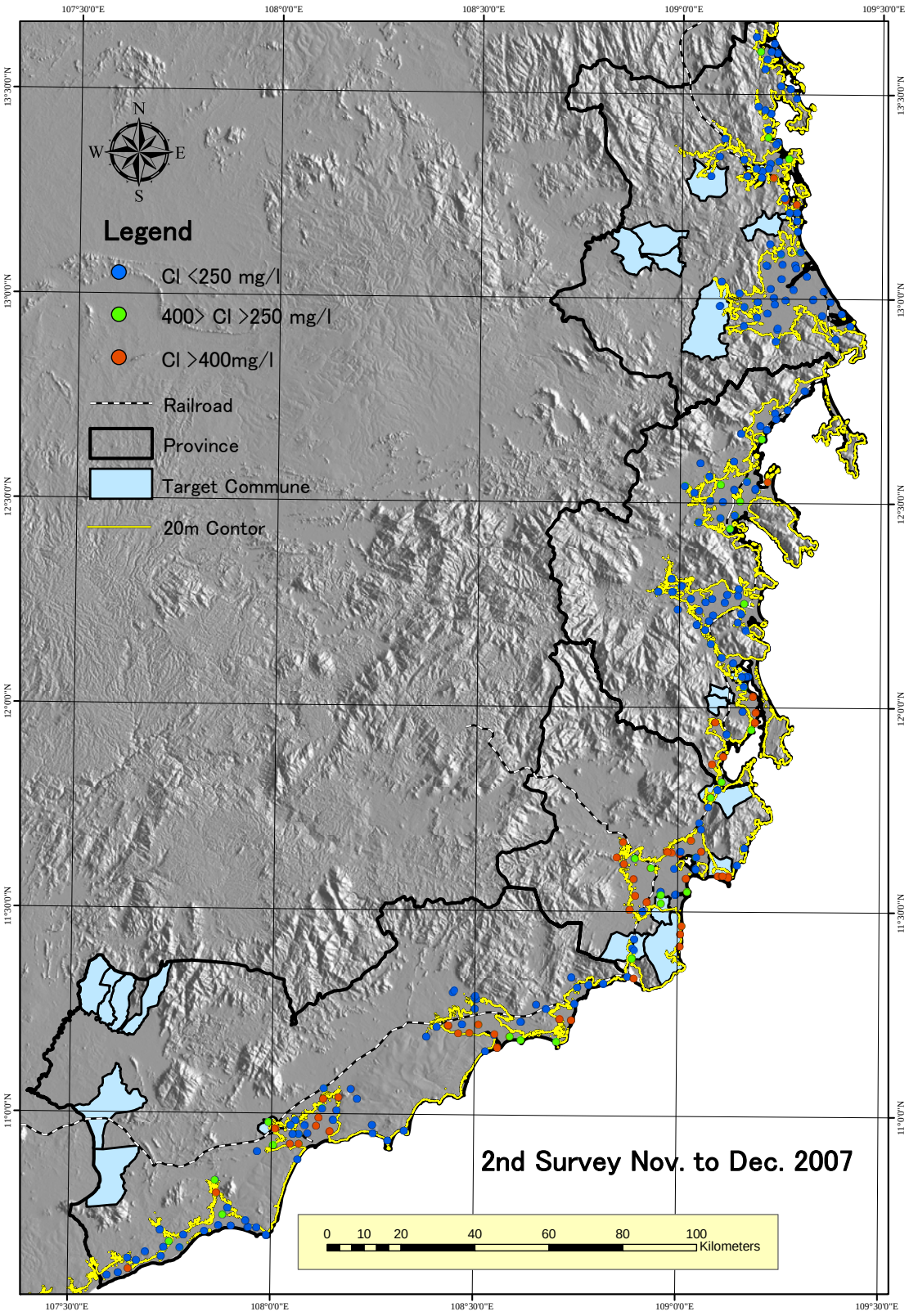


Figure 2.7.13 Results of Seawater Intrusion Survey in December 2007

(2) Seawater Intrusion Survey in the Selected Communes

More detailed survey on seawater intrusion was conducted in the selected nine communes: P-4, K-3, N-1 to 6 and B-1, where seemed to be affected by seawater intrusion based on the above-mentioned preparatory survey.

1) Survey Point

Twenty wells: mainly dugwells, in each commune were selected for this survey in view of the distance between well and the coastline.

2) Survey Period

The survey was conducted full day during the spring tide on 18th to 19th February 2008 and the measurements were done every hour.

3) Survey Items

This survey consists of groundwater level measurement, water quality measurement (temperature, conductivity, salinity and pH) and geodetic survey.

4) Survey Results

Figure 2.7.14 to Figure 2.7.16 presents cross-sections of the selected nine communes. Each figure consists of ground surface, average groundwater level of dugwells, bottom elevation of dugwells and average electric conductivity by bar graph. Electric conductivity (EC), 2,500 μS/cm is nearly equivalent to chloride 400 mg/l. Therefore, there is a possibility that groundwater is affected by seawater intrusion in case it has higher EC value than 2,500 μS/cm.

- P-4

  Cross-section is running from the south to the north along the shoreline of P-4 commune. Elevation of ground surface is approximately five meter above seawater level (A.S.L) and groundwater level is 2.5 to 4.0 m A.S.L. Since EC values of all dugwells are low, the impact of seawater intrusion seems to be slight.

- K-3

  According to the cross-section of inland side, there is no affection of seawater intrusion at all. However, seaside cross-section reveals some dugwells are affected by seawater intrusion. Elevation of their well bottoms is lower than 0m A.S.L and delicate balance between fresh water and seawater makes much difference of EC value.

- N-1

  Two cross-sections running shoreline to inland are prepared. They present prominent impact in the lowland area due to seawater intrusion.

- N-2

Cross-section is located along a valley of hinterland. Bottom level of dugwells is 0m A.S.L to 8m A.S.L. Most of all dugwells are not affected by seawater intrusion based on EC values except No.10 dugwell, which has an extremely high value. According to its elevations of surface or well bottom and EC value of neighboring dugwells, saline water of No.10 is not caused by sweater intrusion but other sources.

- N-3

Lowland of N-3 is affected by seawater intrusion.

- N-4

Lowland of N-4 is affected considerably by seawater intrusion. Although No.2 dugwell, which is located at 30m elevation, records approximately EC 6,000 μS/l, it is not caused by seawater intrusion.

- N-5

Only No.6 dugwell shows affection of water salination; however, EC value of this commune generally is low and the affection of seawater intrusion is slight.

- N-6

Some dugwells near shoreline have high EC values caused by seawater intrusion.

- B-1

No.2 dugwell in the eastmost of B-1 commune seems to be affected by seawater intrusion but there is no water salination in the western side of this commune, where the ground surface is gradually coming upward.

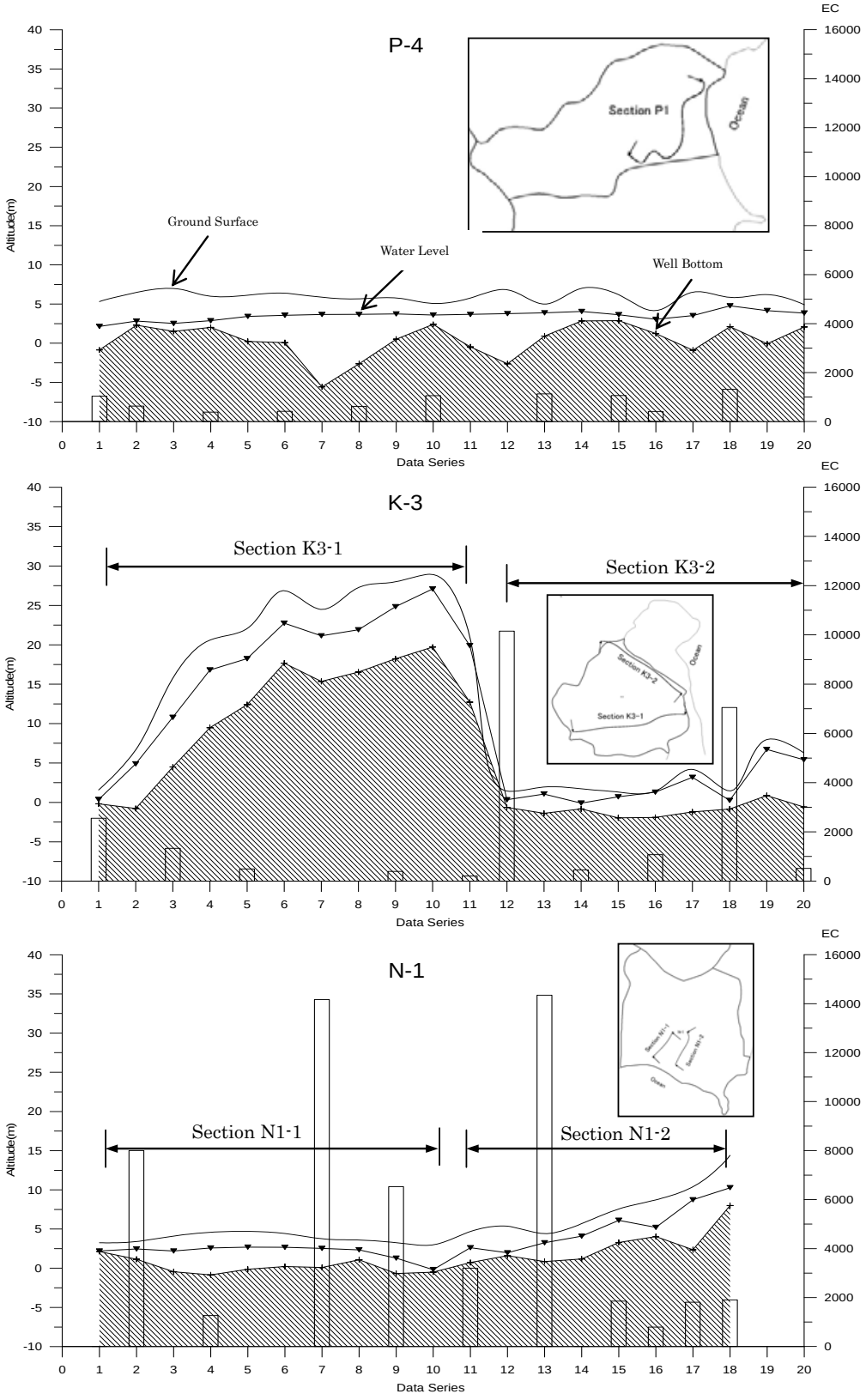


Figure 2.7.14 Relationship among Ground Level, Water Level, Well Depth and EC (1)

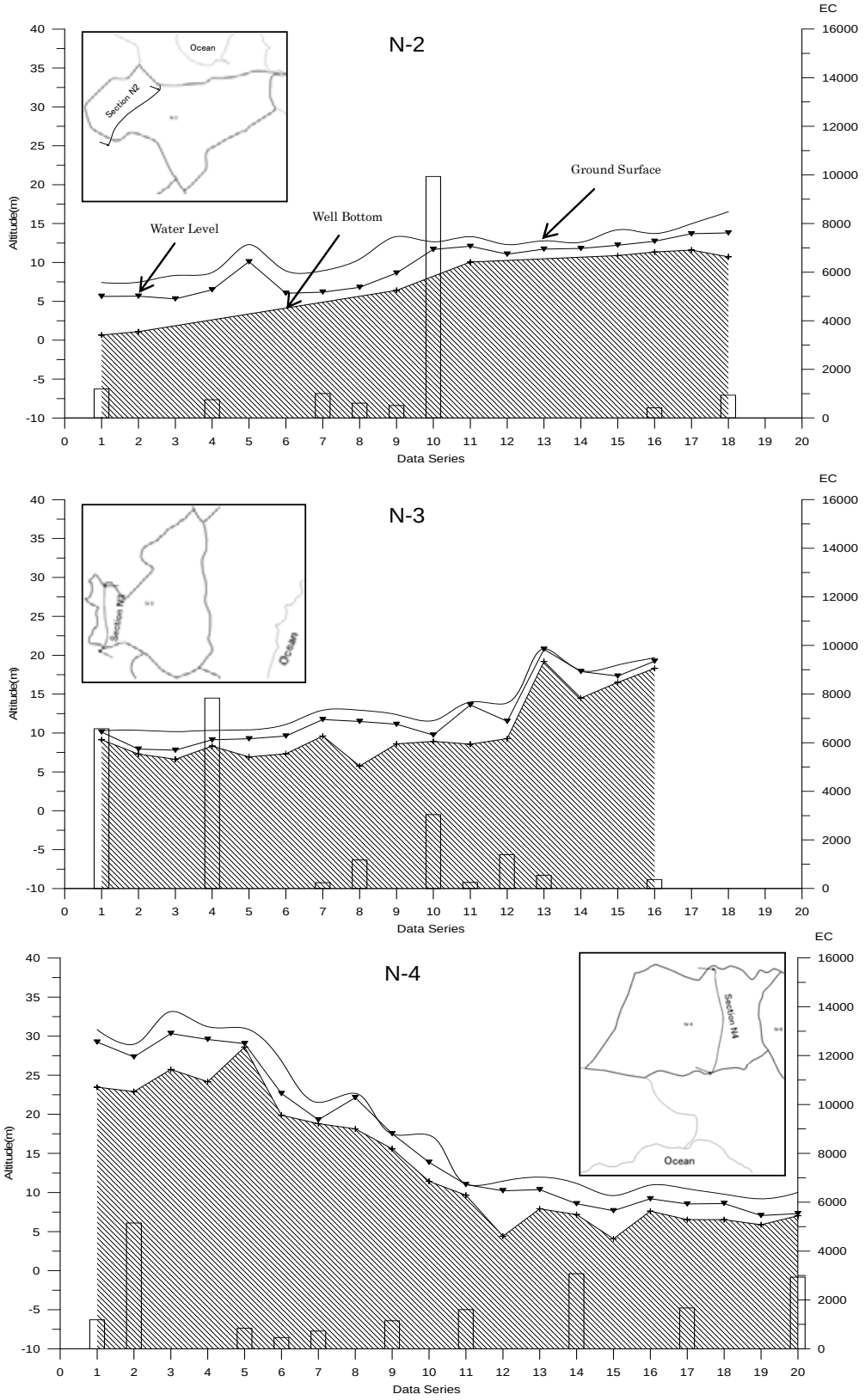


Figure 2.7.15 Relationship among Ground Level, Water Level, Well Depth and EC (2)

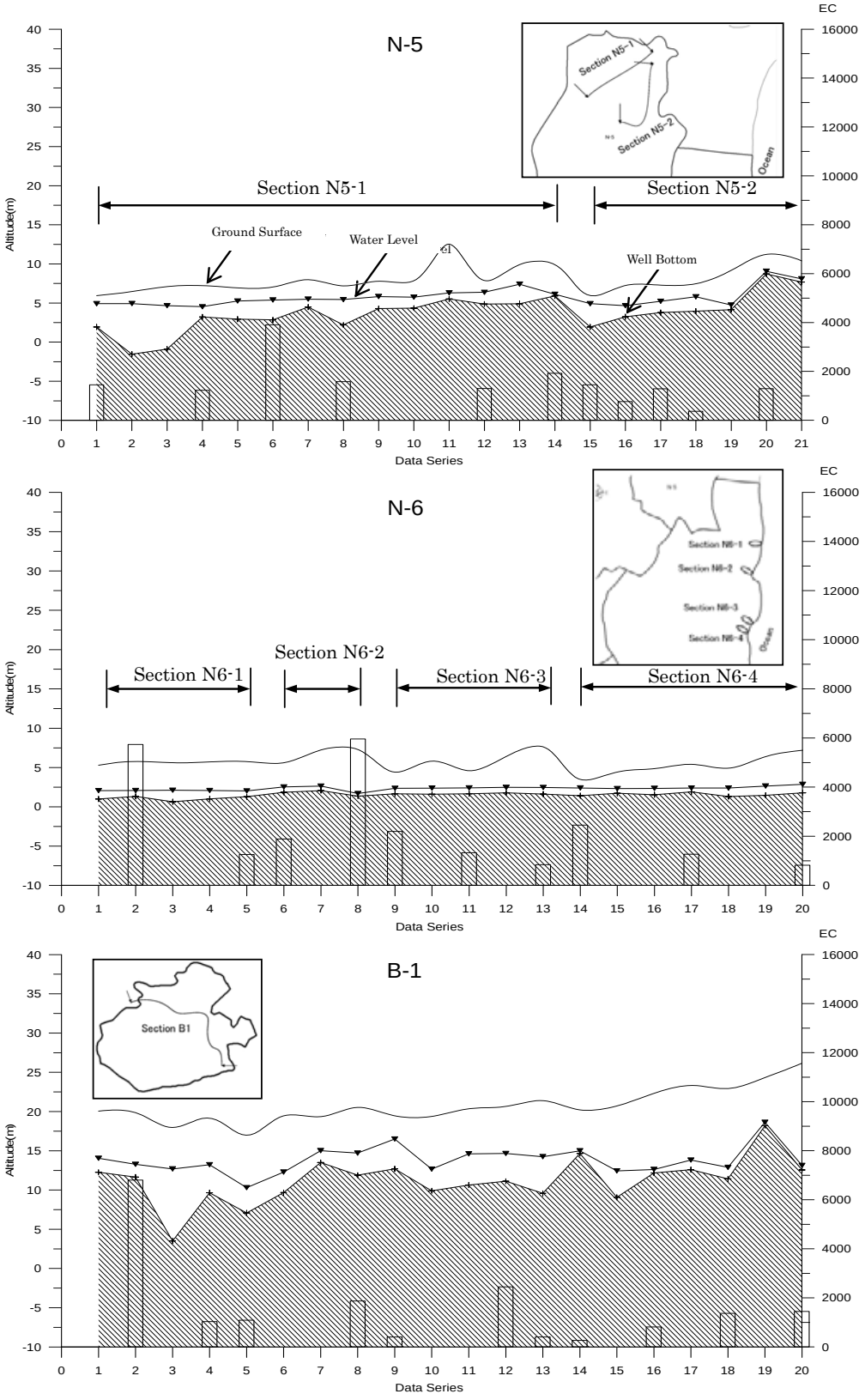


Figure 2.7.16 Relationship among Ground Level, Water Level, Well Depth and EC (3)

(3) Seawater Intrusion Analysis by Tri-linear Diagram

Tri-linear diagram was applied in order to classify water type of water sources and to know water source or in other words, groundwater recharge conditions in the target communes. Key diagram can identify five kinds of water type as shown in Figure 2.7.17 and described below.

- Type I: $Ca(HCO_3)_2$ type

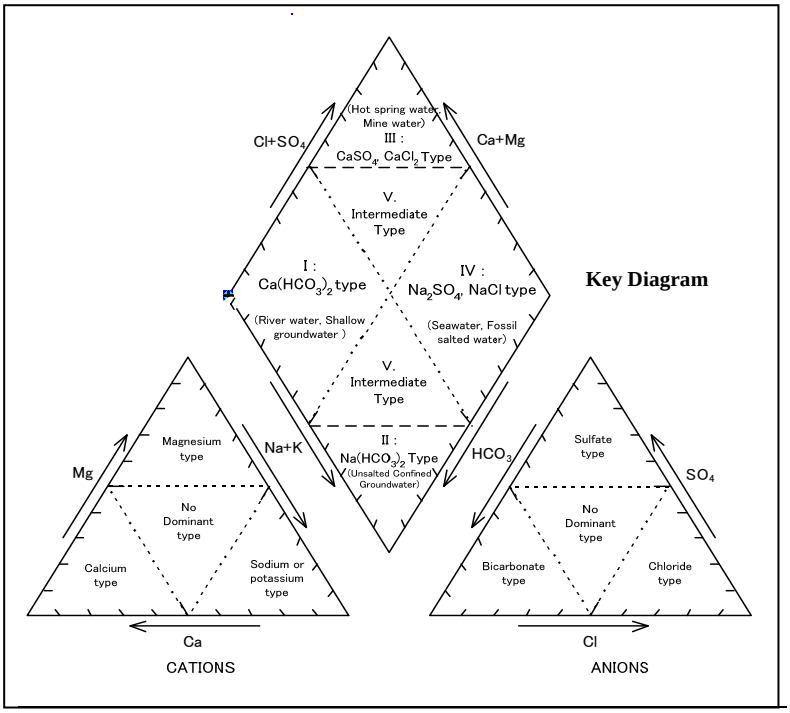
  River water and circularity groundwater fall under this type. Groundwater in limestone area is typical example.

- Type II: $Na(HCO_3)_2$ type

  Unsalted confined groundwater which is stagnating under relatively deep from ground surface is classified into this type.

- Type III: $CaSO_4$, $CaCl_2$ type

  Hot spring, mineral spring and salted fossil water correspond to this type. In the case of river water or groundwater, it is possible to be contaminated with hot spring or polluted by industrial wastewater.



Source: Partially modified "Ground-Water Quality" by USGS: (http://pubs.usgsgov/wri/wri0245045/htms/report2.htm)

Figure 2.7.17 Water Type Classification by Tri-linear Diagram

- Type VI: NaCl, Na_2SO_4 type

  Seawater or groundwater and hot spring contaminated by seawater are classified into this type. Groundwater affected by seawater intrusion in the study area corresponds to this type.

- Type V: Intermediate type

  This type is intermediate of each type above mentioned. Many of river water, river-bed water and circularity groundwater are classified into Type V.

a) Existing Water Sources

Tri-linear diagrams of existing water sources, which are mainly groundwater, by target province are shown in Figure 2.7.18. Differences of water type among four provinces are clearly found as descried below.

- Phu Yen Province

  Both groundwater and surface water belong to Type I (Ca(HCO_3 type) with no impact by seawater intrusion, except several dugwells and swamps near shoreline.

- Khanh Hoa Province

  In comparison with Phu Yen province, water type of each water source in Khanh Hoa province is shifted from Type I (Ca(HCO_3 type) to Type IV (Na_2SO_4, NaCl type). This indicates that existing wells near shoreline in Khanh Hoa are affected by seawater intrusion.

- Ninh Thuan Province

  Most of all wells in Ninh Thuan province belong to Type IV. It seems to be most severely affected by seawater intrusion among four provinces.

- Binh Thuan Province

  Water type of each water source in Binh Thuan province is distributed in all four types, because water sources are located in inland. Since the surveyed communes except B-1 are located at more than 50m elevation, salinity of wells in Type IV is not caused by seawater intrusion but other reasons.

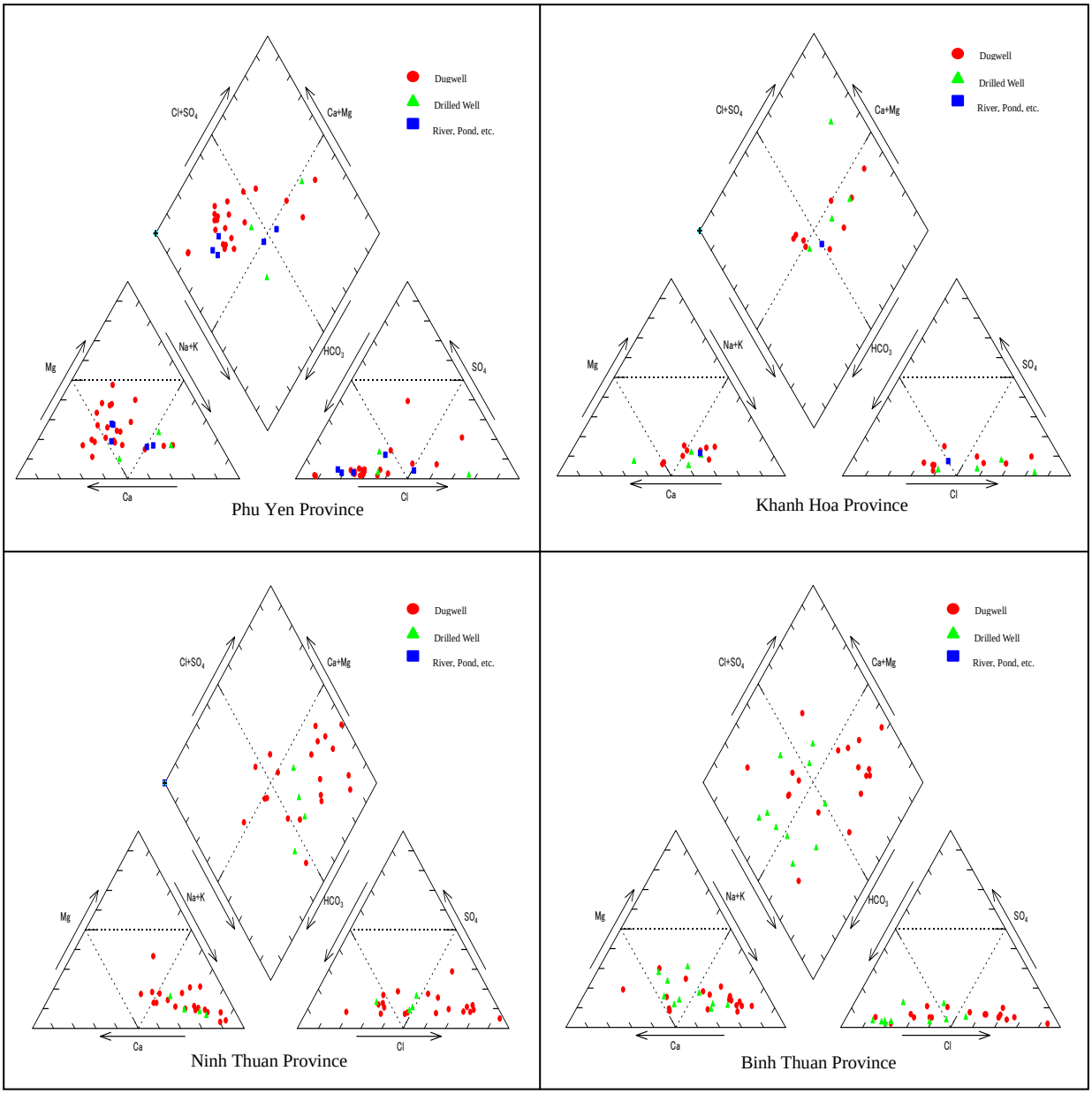


Figure 2.7.18 Tri-linear Diagrams of each Water Sources in Four Provinces

b) Test Boreholes

Tri-linear diagrams of 24 test boreholes are shown in Figure 2.7.19. Several test boreholes of Phu Yen and Khanh Hoa province, and all of Binh Thuan province are classified into Type I. Most of all in Ninh Thuan and three in Phu Yen and one in Khan Hoa belong to Type-IV. Others are Type V. This tendency is almost same as the case of existing water sources.

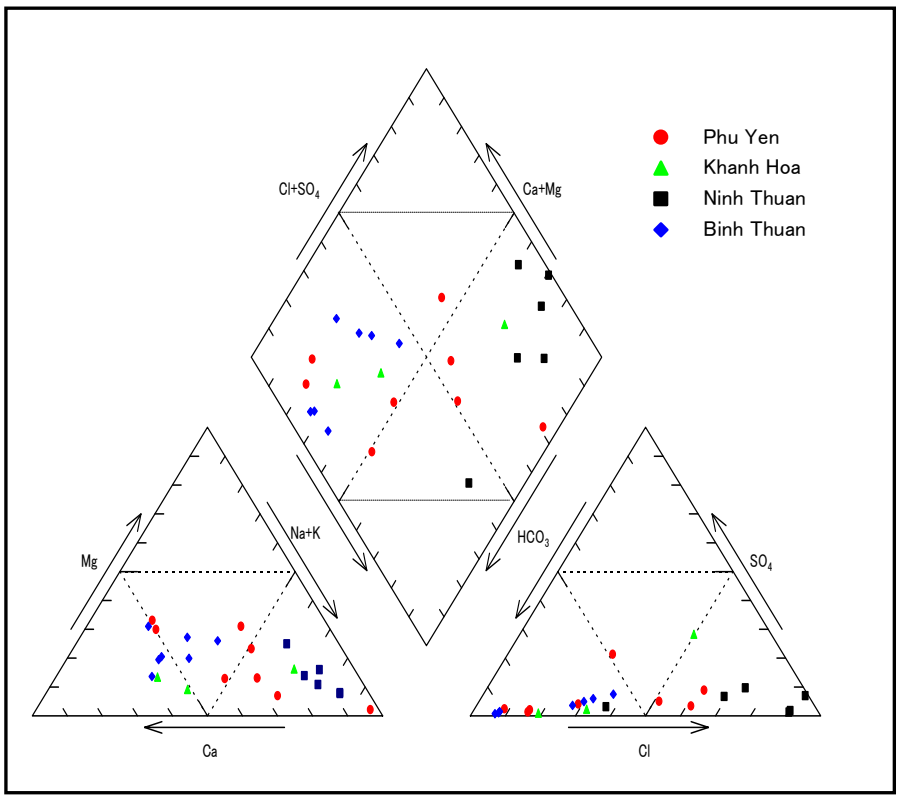


Figure 2.7.19 Tri-linear Diagrams of Test Boreholes

(4) Consideration on Seawater Intrusion and Groundwater Recharge

Water type and salinity condition of all survey points in this study is summarized in Table 2.7.8. The results of consideration are described below.

- Phu Yen Province

Although a swamp in P-4 commune seems to be slightly affected by seawater intrusion, most of all surface water in this province is categorized into Type I and there is no impact of seawater intrusion. As to groundwater, dugwells penetrated into the shallowest aquifer are also fall into Type I because the aquifer is mainly recharged with rainwater or river water. One of the dugwells in P-7 is classified into Type IV having chloride concentration of 390mg/l; however, it is not as a result of seawater intrusion because the elevation of ground surface is approximately 60m A.S.L. Three test boreholes out of eight in this province are classified into Type IV. According to chloride concentration, only P-2 Test Borehole, which is located in lowland at 9.0m A.S.L, is affected by seawater intrusion because the well reaches to the wedge.

- Khanh Hoa Province

Stream water in K-2 commune is fall into Type IV; however, affection of seawater intrusion seems to be slight since the concentration of chloride is 50ml/l only. Many of existing drilling wells and dugwells in this province are Type IV and an existing drilling well in K-3 is the only case of Type III. Since the aquifer of two test boreholes in K-1 and K-3, is not layer aquifer but fissure aquifer in the

basement rocks, they have no influence of seawater intrusion at all.

- Ninh Thuan Province

There is most severe impact by seawater intrusion among four provinces. Most of all existing wells are fall into Type IV and five out of six test boreholes in Ninh Thuan province are also Type IV. Furthermore, the chloride concentration of them is extremely higher than other provinces.

- Binh Thuan Province

All test boreholes and existing drilling wells are classified into Type I which means the “First Stage” of groundwater recharge process. On the other hand, many dugwells of this province are Type IV, however their chloride concentration are very low except one of the dugwells in B-1. With taking their elevation: more than 100m A.S.L, into consideration, the cause is not seawater intrusion but elution of salinity from geological formations under the groundwater recharge process.

Table 2.7.8 Water Type of Existing Water Soueces in Target Commune

Province	Commune No.	Commune	Water Source																			
			Test Borehole					Dug Well					Drilled Well					Surface Water				
			Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V	Type I	Type II	Type III	Type IV	Type V
Phu Yen	P-1	Xuan Phuoc	○					2									1					
	P-2	An Dinh				○		1			1	1						1				
	P-3	An Tho					○	3				1										
	P-4	An My					○	3					1			1					1	
	P-5	Son Phuoc	○					2														
	P-6	Ea Cha Rang				○		3										1				
	P-7	Suoi Bac				○		2			1							2				
	P-8	Son Thanh Don	○					2														
	Total		**3**			**3**	**2**	**18**			**2**	**2**	**1**			**1**	**1**	**4**			**1**	
Khan Hoa	K-1	Cam An Bac	○					1			1	1				1	1					
	K-2	Cam Hiep Nam				○					2					1					1	
	K-3	Cam Hai Tay	○					1			1	1			1							
	Total		**2**			**1**		**2**			**4**	**2**			**1**	**2**	**1**				**1**	
Nihn Thuan	N-1	Nhon Hai				○					4											
	N-2	Cong Hai					○				1	3										
	N-3	Bac Son				○						2				1						
	N-4	Phuoc Minh				○					4											
	N-5	Phuoc Hai				○		1			3											
	N-6	Phuoc Dinh				○		1								2	1					
	Total					**5**	**1**	**2**			**12**	**5**				**3**	**1**					
Binh Thuan	B-1	Muong Man	○					1			1		1				1					
	B-2	Gia Huynh	○					3					1									
	B-3	Nghi Duc	○								2		2									
	B-4	Tan Duc	○						1			1					2					
	B-5	Me Pu	○					1			3											
	B-6	Dung Nhon	○								4											
	B-7	Da Kai	○									1					3					
	Total		**7**					**5**	**1**		**10**	**2**	**4**				**6**					

*__Type I:__ $Ca(HCO_3)_2$ type (River water, Shallow groundwater), __Type II__: $Na(HCO_3)_2$ type (Unsalted Confined Groundwater),
__Type III__ $CaSO_4$, $CaCl_2$ type (Hot spring water, Mine water), __Type IV__: Na_2SO_4, NaCl type (Seawater, Fossil salted water), __Type V__: Intermidiate type
**Number means water source number.