5. PEQMP for Samut Songkhram

5 PEQMP for Samut Songkhram

The PEQMP-KPI for Samut Songkhram Province (SKP) has been submitted to the MNRE in October and subsequently accepted. Although it was evaluated at the second highest score (Very Good) in a 6-tiered system (Excellent, Very good, Good, Fair, Poor, Fair), the PEQMP-KPI Evaluation Committee also required some improvements in its comments, as described in Chapter 1, Section 1.2.2. This PEQMP has been compiled as a response to comments by the Evaluation Committee, and also reflects the questions and comments of seminar participants voiced at the "First, Second and Third Seminars for Formulation of PEQMP for Samut Songkhram Province" held on 17th January, 12th March 2008 and 11th July 2008 respectively. This chapter presents the contents of this PEQMP-KPI.

5.1 Part 1: Introduction

a. Samut Songkhram Provincial Order No.249/2007 (249/2550)

Subject: Appointing Samut Songkhram Provincial Action Plan for Natural Resources and Environmental Management for KPI (PEQMP-KPI) Committee 2552-2554 BE. (2009- 2011 AD.)

Samut Songkhram Province has formulated Key Performance Indicators (KPI) for provincial natural resources and environmental management. Operations according to the listed indicators require the accumulation of plans, projects, measures, and activities that different units in the province are working towards resolutions of natural resources and environmental problems. These units are operating in accordance with their allocated budgets received in Fiscal Year 2008 and are adapting PEQMP-KPI 2008-2011 to current situation of the province in order to prepare PEQMP-KPI 2009-2012.

To achieve objectives and goals with efficient operations, the province; therefore, appointed the Coordinating Committee which consisted of:

1.Samut Songkhram Deputy Governor	Chairman
2.Chief of Samut Songkhram Governor's Office or Representative	Member
3.Muang Chief District Officer or Representative	Member
4.Amphawa Chief District Officer or Representative	Member
5.Bang Khonti Chief District Officer or Representative	Member
6.Samut Songkhram Provincial Public Health Officer or Representative	Member
7.Samut Songkhram Provincial Industrial Officer or Representative	Member
8. Samut Songkhram Provincial Livestock Officer or Representative	Member
9. Samut Songkhram Provincial Agriculture and Cooperative Officer or Representative	Member
10.Samut Songkhram Provincial Office for Local Administration Officer or Representative	Member
11.Director of REO 8 Ratchaburi or Representative	Member
12.Chief of Mangrove Development Station 7 Samut Songkhram or Representative	Member

13.Chief of Water Transportation Office 3 Samut Songkhram or Representative	Member
14.Samut Songkhram Provincial Statistical Officer or Representative	Member
15.Director of Samut Songkhram Educational Service Area Office or Representative	Member
16.Mr, Banharn Chaiwat, President of Samut Songkhram Fishery Association	Member
17.Mrs. Boonsiri Juliang, Manager of Mae Klong Fishery Cooperative Office	Member
18.Mr. Kamchai Rasiyanant, Chairman of the Federal of Thai Industries Samut Songkhram Chapter	Member
19. Mr. Anek Sukaphuti, Chairman of Krom Luang Chumporn Khet Udomsak Shrine Foundation	Member
20. Samut Songkhram Provincial Fisher Officer	Member
21. Samut Songkhram Provincial Land Development Chief Officer	Member
22. Samut Songkhram Provincial Land Department Officer	Member
23. Samut Songkhram Provincial Public Works and Town Planning Officer	Member
24. Director of Conservation Area Management Office Area 3 (Ban Pong)	Member
25. Director of Forest Resources Management Office 14 (Ratchaburi)	Member
26. Head of Forest Resources Management Coordination Center (Samut Songkhram)	Member
27. Director of Regional Water Resources Office 7	Member
28. Director of Regional Groundwater Resources Center 10 (Ratchaburi)	Member
29. Samut Songkhram Provincial Land Transport Office	Member
30. Samut Songkhram Provincial Agriculture Office	Member
31. Samut Songkhram Chief of Provincial Administration Office	Member
32. Samut Songkhram City Municipality Mayor	Member
33. Ampahwa Subdistrict Municipality Mayor	Member
34. Muang Mai Subdistrict Municipality Mayor	Member
35. Bang Nok Kwaek Subdistrict Municipality Mayor	Member
36. Kradang Nga Subdistrict Municipality Mayor	Member
37. Wat Pradu TAO Chief	Member
38. Bang Kae TAO Chief	Member
39. Preak Namdaeng TAO Chief	Member
40. Bang Prom TAO Chief	Member
41. Kradaeng Nga TAO Chief	Member
42. Bang Chakreng TAO Chief	Member
43. Laem Yai TAO Chief	Member

44. Bang Kaeo TAO Chief	Member
45. Klong Khon TAO Chief	Member
46. Samut Songkhram Local Natural and Cultural Environment Conservation Division Chief	Member
47. Mr. Rawee Tabtimthong (President of Samut Songkhram NEV-Net)	Member
48. Mr. Awut Hae- preuk (Vice President of Samut Songkhram NEV-Net)	Member
49. Mr. Att Nonthalak (Vice President of Samut Songkhram NEV-Net)	Member
50. Samut Songkhram PEO Chief	Member/ Secretary
51. Mr, Manop Yanapisitkul Head of Environment Section, Samut Songkhram PEO	Member/Assist. Secretary
52. Mr. Weerachai Sinsuk Forest Administration Officer 6, Samut Songkhram PEO	Member/Assist. Secretary
53. Ms. Prapaipan Nampanwiwat Environmental Officer 5, Samut Songkhram PEO	Member/Assist. Secretary
54. Ms. Praweena Napatharathip Environmental Analyst, Samut Songkhram PEO	Member/Assist. Secretary

The Authorities and Responsibilities of the Committee include:

The committee is to consider, examine, and improve PEQMP-KPI 2008-2011 in accordance with current situation and issues. Formulation of Draft PEQMP-KPI 2009-2012 should be done by studying, considering, revising and improving existing PEQMP-KPI. The Committee is to be agreed and approve the PEQMP-KPI before submitting to the Governor within 30th September 2008. Responsibilities are also extended to any other tasks that Governor assigns.

Order is effective immediately.

21st April 2008

Signature
Acting Sub Lt. Ophat Sawetmani
Samut Songkhram Governor

5.2 Part 2: Situation and Issues on NREM

5.2.1 Part 2-1) Basic Data of the Province

a. Physical Condition

a.1 Location, Boundary and Area

Samut Songkhram Province (SKP) is located approx. 63 km southwest of Bangkok. In general the province is flat except for a hill 160 m-180 m in height in the southwest. The total area is 416 km^2 (260,000 Rai), which makes it the smallest province in Thailand. National trunk road No.35 from Bangkok runs through the province from east to west. The distance from Bangkok by car is about 1 hour 30 minutes. The areas surrounding the province are as follows and the location and boundary are shown below.

Southeast	Gulf of Thailand
East	Samut Sakhon Province
Northwest	Ratchaburi Province
Southwest	Petchaburi Province

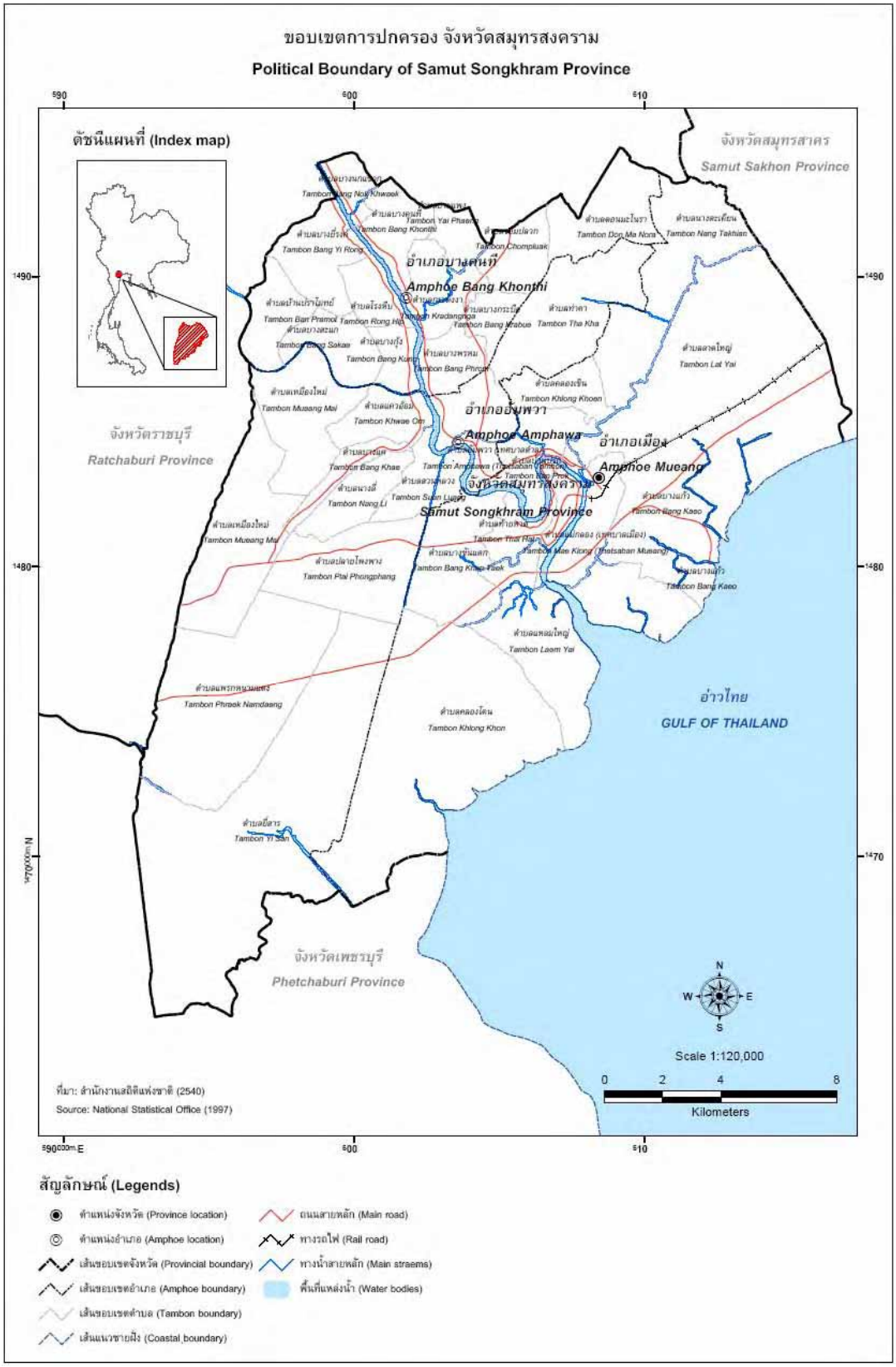


Figure 5-1: Location and Borders of SKP

a.2 Topography

In general, the area is a flat coastal plain consisting of sandy clay loam. SKP faces the Gulf of Thailand and does not have any islands. There is one hill named "Khao Yee Sarn" which is located on the southwest side of the province. The major river in SKP is the Mae Klong River which flows through Bang Khonthi District and Amphawa District before reaching the Gulf of Thailand in Mueang District. There are more than 300 natural and artificial canals linked together. Daily water levels in the canal fluctuate with the tide. Most of the areas in the province are flat with a slope of less than 1 degree.

Wetlands extend to the shore where mangrove forests grow and salt flats/shrimp farms are located. Tidal wetlands extend about 3 km inland from the shoreline.

The elevation map of SKP is shown below. Heights range from 1 m to 6 m above sea level.

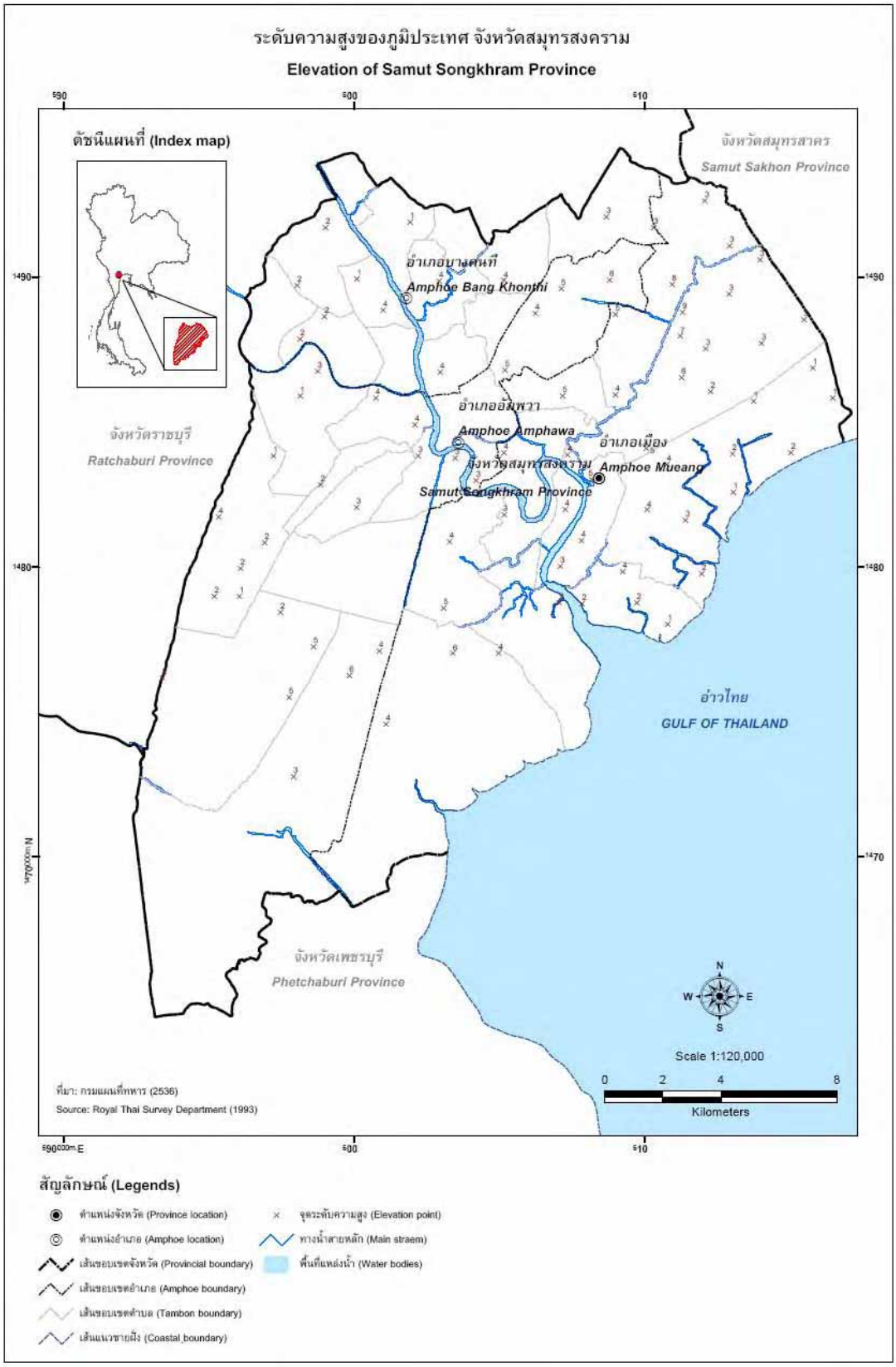


Figure 5-2: Elevation Map

b. Climate

There are three seasons in SKP:

Table 5-1: Seasons of SKP

Season	Month	Climate
Rainy Season	mid-May-mid-October	The amount of rainfall is less in the beginning of the season, and increases at the end of May to beginning of June. It rains a lot in August. September has the record high amount of rain.
Winter	mid-October-mid-Feb.	From middle October to middle November is a transition period from the rainy season to winter. It rains occasionally during this season. Usually temperatures drop in December and January. The winter period is caused by high pressure system over China and is short.
Hot Season	mid-February.-mid-May	April is the hottest month in general, because the sun shines directly from above at this latitude. Compared with other parts of the country it is less hot in SKP as it is located on the coast.

There is no weather station in SKP. Instead, the average monthly precipitation in Bangkok (Thailand Meteorological Department) is shown in the following table and figure.

Table 5-2: Average Monthly Precipitation in Bangkok

Unit: mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1998	0.0	30.0	0.0	34.5	75.5	218.9	182.5	248.3	371.8	177.8	55.9	7.4	1,402.6
1999	37.0	46.7	40.2	184.0	315.9	84.1	86.1	98.3	223.6	260.0	131.0	2.4	1,509.3
2000	0.0	29.5	14.8	124.6	76.9	130.9	159.0	83.2	222.4	367.2	9.6	28.2	1,246.3
2006	0.0	0.0	0.0	0.0	12.5	36.5	437.0	331.0	220.2	124.4	13.0	23.0	1,197.6
Ave.	9.3	26.6	13.8	85.8	120.2	117.6	216.2	190.2	259.5	232.4	52.4	15.3	1,339.3

Source: Meteorological Dept.、Note: Data from 2001-2005 are excluded because of incomplete data set.

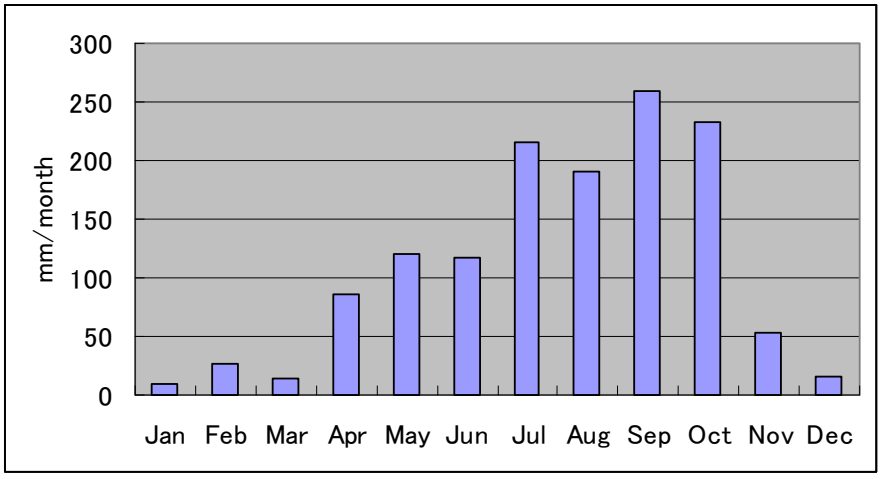


Figure 5-3: Average Monthly Precipitation in Bangkok

c. Population

c.1 Situation

Since 2003 the population in SKP has been decreasing constantly. Population of each Amphoe in SKP and its change from year 2001 to 2005 are shown below.

Table 5-3: Populations by Amphoe in SKP (2001-2005)

Amphoe		2001		2002		2003		2004		2005	
		person	%	person	%	person	%	person	%	Person	%
1	Mueang Samut Songkhram District	107,827	52.7	108,363	52.8	108,313	53.1	103,148	52.8	103,268	52.9
2	Bang Khonthi District	35,693	17.5	36,058	17.6	35,613	17.5	33,979	17.4	33,741	17.3
3	Amphawa District	60,886	29.8	60,714	29.6	60,072	29.4	58,091	29.8	58,059	29.8
	Total	204,406	100.0	205,135	100.0	203,998	100.0	195,218	100.0	195,068	100.0

Source: DOPA

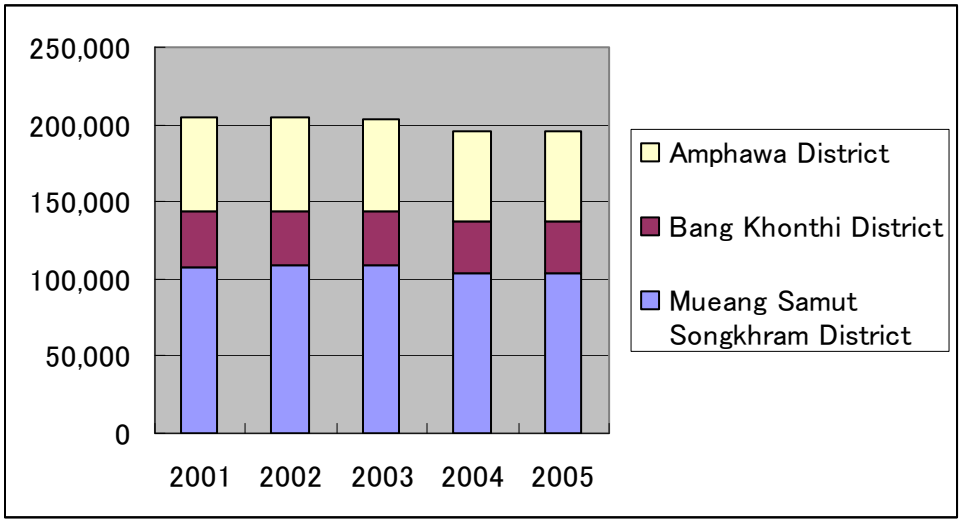


Figure 5-4: Change of Population in Each District

A general summary of population in SKP is as follows:

Table 5-4: Population in SKP

Population in 2001	204,406
Population in 2005	195,068
Population in Tessaban in 2005	43,184 (22.1%)
Population in Orbortor in 2005	151,884 (77.9%)
Male in 2005	93,893
Female in 2005	101,175
Ratio of Female/Male	1.08:1

c.2 Impact

c.2.1. Population Forecast by NEDSB

National Economic and Social Development Board (NESDB), which is responsible for collecting and updating the basic information necessary for the formulation of future plans, has published a forecast of the provincial population. The NESDB's forecast of future population is based on actual population data up to 2000.

Here, the Study Team and PEO of SKP updated the NESDB forecast using actual population data from 2005; the 2015 population forecast published by NESDB was linearly connected to the actual population figure in 2005. NESDB will publish a new population forecast in November 2007.

The future population which the Study team calculated is shown in

Table 5-5 and in Figure 5-5.

Table 5-5: Population Forecast used in PEQMP

Year	Actual Data	Forecasted Data
2001	204,406	
2002	205,135	
2003	203,998	
2004	195,218	
2005	195,068	
2006		192,245
2007		189,422
2008		186,599
2009		183,776
2010		180,953
2011		178,130
2012		175,307
2013		172,484
2014		169,661
2015		166,835

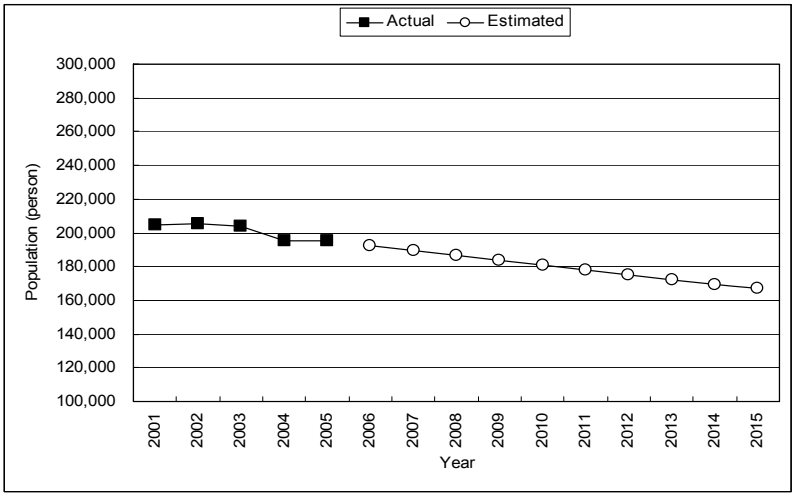


Figure 5-5: Population Forecast of SKP used in PEQMP

c.2.2. Impact

According to the future population forecast by NESDB, the average annual population growth of SKP from 2006 to 2015 is – 1.59%, decreasing. However, the rate does not include unregistered population.

c.3 Issues

- Registered population is declining in both actual figures from 2001 to 2005 and the estimated figure for 2015.
- The unregistered population is assumed to be fairly large, which compensates for the declining registered population, but this fact is unconfirmed.
- Stop outflow of population.

c.4 Measures to be Taken

- Study the number of unregistered residents in order to determine the actual population in SKP.
- Determine the actual population outflow.
- Promote a welcome-back-policy for people who emigrated from the province, (e.g. increase job opportunities / increase attractiveness of SKP).

d. Economy

d.1 Situation

Gross Provincial Product (GPP) from 2001 to 2005 is presented below. GPP from commerce contributes the largest portion with 3,062 million Baht and is almost one fourth of the total GPP in 2005. The next largest contributor is manufacturing followed by agriculture/hunting/forestry, which more than doubled within 5 years. GPP of fishery is ranked number 11 in 2005. Its GPP decreased to nearly half of its previous value within 5 years.

Table 5-6: Change of GPP in Each Sector

Unit: Million Baht

		2001	2002	2003	2004	2005
1	Commerce	2,388	2,417	2,608	2,840	3,062
2	Manufacturing	1,960	1,793	1,936	2,138	2,330
3	Agricultural/Hunting/Forestry	415	535	714	825	964
4	Education	760	785	778	832	928
5	Public/Social/Personal Services	688	699	800	915	902
6	Logistics/Warehouse/ Communication	616	614	633	737	764
7	Public Administration	577	449	506	566	615
8	Health and Social Works	485	515	483	540	612
9	Financial	413	443	427	466	597
10	Construction	173	278	310	441	471

		2001	2002	2003	2004	2005
11	Real Estate	368	385	396	396	391
12	Fishery	658	367	334	347	356
13	Electricity/Gas/Irrigation	226	234	246	259	265
14	Hotel/Restaurants	75	92	110	121	128
15	Quarry and Mining	61	106	59	66	71
16	Private Household Employee	9	10	11	13	13
Total		9,872	9,722	10,351	11,502	12,469

Source: NESDB 2001 – 2005

Table 5-7: GPP, Population, GPP per Capita (SKP, 2001-2005)

Item	Unit	Symbol	2001	2002	2003	2004	2005
GPP*1	Mil Baht	A	9,872	9,722	10,351	11,502	12,469
Population*1	Person	B	204,406	205,135	203,998	195,218	195,068
GPP per Capita*2	Baht	A/B x 10^6	48,296	47,393	50,741	58,919	63,921

Source *1: NESDB
*2: Calculation by the Study Team

The general situation regarding the economy in SKP is summarized as follows:

Table 5-8: Economy in SKP

GPP in 2005	12,469 Million Baht
GPP per capita in 2005	63,921 Baht
GPP in category of business	Manufacturing: 19.2% Commerce : 23.4% Agriculture : 8.3% Education : 6.8% Others : 42.3%
Employed Person	Manufacturing: 41% Commerce : 19% Agriculture : 17% Others: 23%

d.2 Impact

d.2.1. Forecast of GPP

Gross Provincial Product (GPP) was forecast in PEQMP as follows.

- Actual GPP per capita was calculated by using GPP data published by NESDB and population data of past 5 years (2001-2005). Based on this 5 year data, future GPP per capita was calculated through linear regression analysis.
- Future GPP was calculated as the product of future population multiplied by GPP per capita, computed above. Future population, calculated in the previous section, was utilized.

Future GPP was calculated as shown in the table below. GPP in SKP will rise 1.19 times by 2011 and 1.32 times by 2015 compared with GPP in 2005.

Table 5-9: Actual GPP and Future GPP (SKP)

---	Year	GPP per Capita	Population	GPP	Growth Rate
		Baht	Person	M Baht	%
		A	B	AxB/10^6	---
Actual	2001	48,296	204,406	9,872	---
	2002	47,393	205,135	9,722	-1.5
	2003	50,741	203,998	10,351	6.5
	2004	58,919	195,218	11,502	11.1
	2005	63,921	195,068	12,469	8.4
Estimated	2006	64,508	192,245	12,401	---
	2007	68,314	189,422	12,940	4.3
	2008	72,121	186,599	13,458	4.0
	2009	75,927	183,776	13,954	3.7
	2010	79,733	180,953	14,428	3.4
	2011	83,539	178,130	14,881	3.1
	2012	87,346	175,307	15,312	2.9
	2013	91,152	172,484	15,722	2.7
	2014	94,958	169,661	16,111	2.5
	2015	98,765	166,835	16,477	2.3

d.2.2. Impact

Although the population size is forecasted to decrease, the GPP in SKP will increase from 2006 to 2015 with annual growth rates between 2.3% and 4.3%.

d.3 Issues

- GPP of the entire province is increasing, but the GPP of fishery in 2005 decreased to half of its 2001 figures,
- Steering the balance between environmental conservation and industrial development,
- The number of complaints from residents about tourism sites are increasing along with the increasing number of tourists,
- Appropriate protection and exploitation of Don Hoi Lot,
- Stagnant prices of agricultural and marine products,
- Exploitation of sleeping assets of SKP.

d.4 Measures to be Taken

- Promote eco-tourism,
- Put emphasis on agriculture and fisheries as well as salt farming, which are the traditional industries of the province,
- Improve the environment, e.g., improvement of water quality and recovery of mangrove forests,
- Compatible development of industry, tourism, and daily life of people.
- Publicize and educate the significance of appropriate protection of natural resources, and study sustainable economic development,

- Support of traditional products (agriculture, fishery) by the administration by promoting sales and by guiding the production process,
- Efforts to breed agricultural products,
- Utilization of marine by-products,
- Invite pollution-free industry,
- Nourish traditional industry,
- Encourage the lifestyle of Sufficiency Economy.

e. Social Situation

e.1 Administration

e.1.1. Situation

a) Administrative Boundary (Central Government Line)

Samut Songkhram Province (Changwat) is divided into 3 districts (Amphoe) and 36 sub-districts (Tambon) as shown in Figure 5-1.

b) Administrative Boundary (Local Government Line)

Local Administrations comprise 1 Orborjor (PAO), 5 Tessaban (municipality), and 30 Orbortor (TAO). Locations of municipalities are shown the figure below.

Table 5-10: Municipalities and TAO in Each District

District	Tessaban	Orbortor
1. Mueang Samut Songkhram	1.1.1 Mueang Samut Songkhram	1.2.1 Khlong Kern 1.2.2 Khlong Khon 1.2.3 Tai Had 1.2.4 Nang Ta Kien 1.2.5 Bang Kaew 1.2.6 Bang Kan Taek 1.2.7 Bang Ja Kreng 1.2.8 Ban Prok 1.2.9 Lat Yai 1.2.10 Laem Yai
2. Bang Khonthi	2.1.1 Tambon Kra Dang Nga 2.1.2 Tambon Bang Nok Kaewg	2.1.1 Kra Dang Nga 2.2.2 Jom Pruak 2.2.3 Don Manora 2.2.4 Bang Kra Bue 2.2.5 Bang Khon Tee 2.2.6 Bang Prom 2.2.7 Bang Yee Rong 2.2.8 Bang Sakae 2.2.9 Rong Heeb
3. Amphawa	3.1.1 Tambon Amphawa 3.1.2 Tambon Mueang Mai	3.2.1 Kaew Aom 3.2.2 Tha Kha 3.2.3 Bang Kae 3.2.4 Bang Chang 3.2.5 Bang Nang Lee 3.2.6 Plai Pong Pang 3.2.7 Praek Nam Daeng 3.2.8 Yee Sarn

		3.2.9 Wat Pradoo 3.2.10 Suan Luang 3.2.11 Mueang Mai
Total	1 Orborjor and 5 Tessaban	30

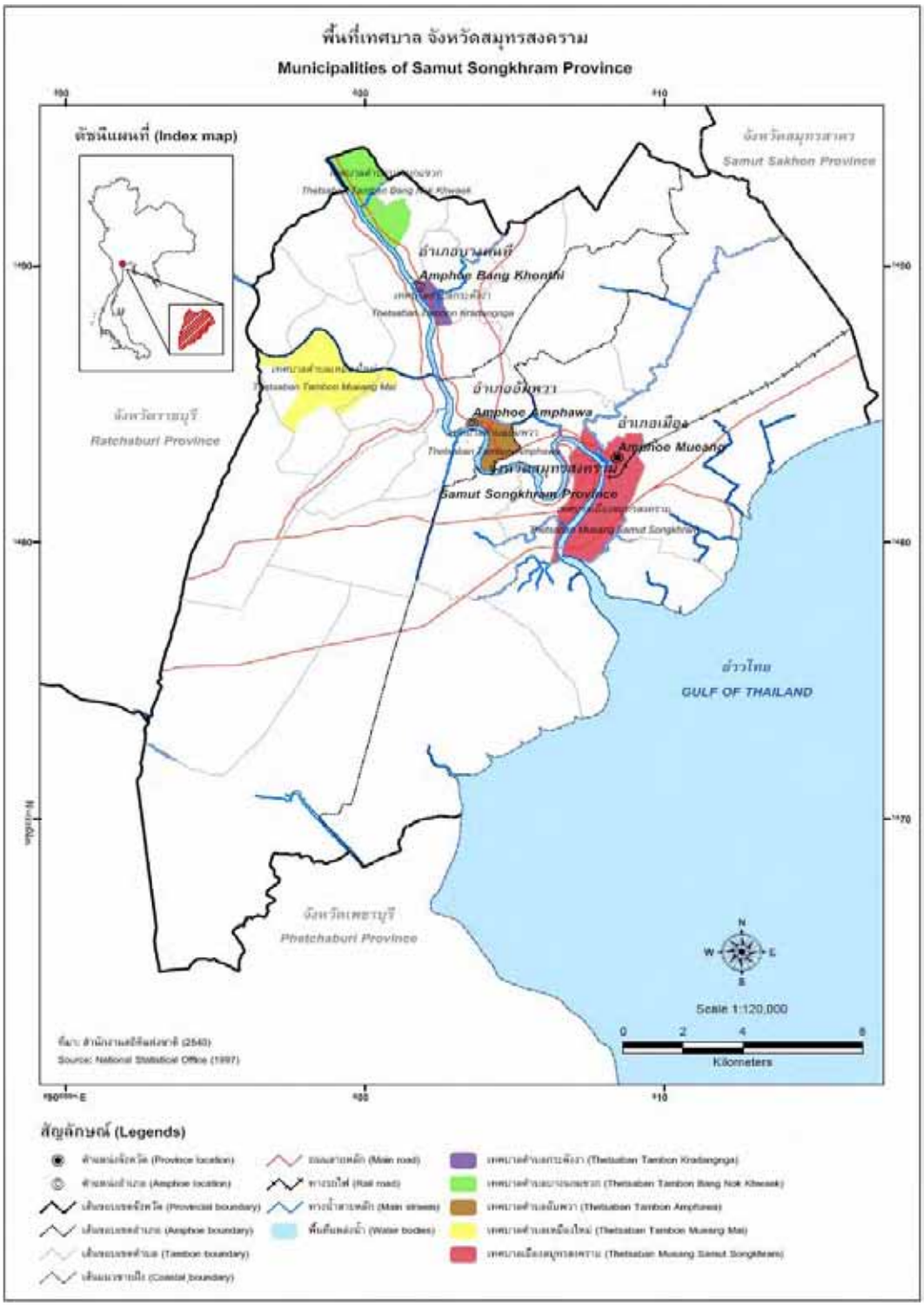


Figure 5-6: Location of Tessaban (Municipality) in SKP

c) Issues

- The LAs which shoulder local administration have personnel and financial vulnerabilities,
- The administrative scale of Orbortor is too small,
- Tessaban/Orbortor and Orborjor do not cooperate closely enough,
- The budget of LAs is low in comparison with that of the central government ,
- General subsidies to local administrations are distributed according to relative population.

d) Measures to be Taken

- Strengthening of LAs by central government,
- Advocate the integration of local administrations,
- Clarify the areas of jurisdiction, which are beyond the capacity of an Orbortor to administer, and grant these areas to Orborjor,
- Strengthen rights of LAs over budgetary usage,
- Raise the ratio between the local budget and the national budget,
- Distribute specific subsidies to LAs based on policy stated in the National EQMP.

e.2 Public Health

SKP has 4 hospitals -- 3 public and 1 private. Public hospitals, the Somdej Phra Phutthalertla Hospital, Amphawa Hospital, and Naphalai Hospital, provide 480 beds; Mae Klong Hospital, which is the only private hospital, provides 60 hospital beds. Numbers of doctors and nurses were 33 and 508, respectively, in 2006.

Table 5-11: Types of Public Health Service and Personnel

Types of Public Health Services and Personnel	Units	Year				
		2002	2003	2004	2005	2006
Public Hospital	Hospital	3	3	3	3	3
	Bed	480	480	480	480	480
Private Hospital	Hospital	1	1	1	1	1
	Bed	60	60	60	60	60
Health Station	Station	50	50	50	50	50
Doctor	Person	46	47	51	42	33
Dentist	Person	10	10	17	16	15
Pharmacist	Person	-	-	23	27	28
Nurse	Person	321	373	506	509	508
Public Health Officer	Person	-	-	-	123	118

Source: Samut Songkhram Provincial Public Health Office, 2002-2006
"-": no information available

e.3 Public Utilities/ Facilities

e.3.1. Electricity

Samut Songkhram Provincial Electricity Authority receives electricity services from the Electricity Generating Authority of Thailand, which it distributes to inhabitants both in

urban and rural areas. In fiscal year 2005, 46,967 persons received electricity services compared to only 45,814 persons in 2004 (2.5% increase). Total provincial electricity consumption was 218,853,615kWh.

e.3.2. Water Supply

Samut Songkhram Provincial Water Office and Amphawa Municipality Water Office are responsible for providing water supply to inhabitants of SKP. In fiscal year 2005, water was provided to 15,371 persons, an amount equivalent to 3,874,922.40 m^3 (excluding water supply for public uses and leakage).

e.3.3. Telephone/Post

In fiscal year 2005, there were 17,701 telephone numbers issued and 3 post offices available in SKP. Services are believed to cover all districts.

e.3.4. Labor

Labor force (aged 15 and older) in 2005 was 157,096 persons strong. Within this group, 110,124 persons were participating workers while 46,972 were not. The workforce in agricultural sector consisted of 18,994 persons (17.25%), and 90,548 persons (82.22%) worked in the non-agricultural sector. There were 583 unemployed persons (0.53%). The unemployment rate was 0.37% in 2005.

e.3.5. Groups/ Organizations/ Networks

There are various groups, organizations, and networks that have been participating in NREM in SKP, for example: Samut Songkhram Villages' Natural Resources and Environment Preservation Volunteering Network, Mae Klong Lovers Club, Samut Songkhram Conserving Natural Environment and Local Art Unit, Samut Songkhram Fishery Association, Mae Klong Fishery Cooperative, Samut Songkhram Chamber of Commerce, The Federation of Thai Industries Samut Songkhram Chapter, and Krom Luang Chumporn Khet Udomsak Shrine Foundation.

e.3.6. Religion

The majority of residents (98.9%) are Buddhists. Christian and Muslim populations are small. There were 113 places of worship in SKP -- 110 Buddhist, 2 Christian, and 1 Islamic. Details are shown in the table below.

Table 5-12: Number of Places of Worship in SKP

Districts	Buddhist	Christian	Islamic	Other Religions
Muang Samut Songkhram	39	1	0	0
Bang Khonthi	25	1	0	0
Amphawa	46	0	1	0
Total	110	2	1	0

Source: Samut Songkhram Provincial Cultural Office

5.2.2 Part 2-2) Situation and Issues of NRE of the Province

Natural Resources

a. Soil and Land Resources

a.1 Situation

SKP is located in a low lying coastal area. Its soil consists of a cohesive mix of sediment and pebbles deposited by rivers and the ocean. In areas near the seacoast some soil, such as Tha Chin Series and Samut Songkhram Series, does not support common plant growth due to high salinity. These areas exclusively support mangrove forests. Inland areas, which are not impacted by sea water, consist of fertile Bangkok Series soil on low land, good for rice and crops. Areas near rivers are made up of Thonburi Series soil used to cultivate vegetables and fruit orchards.

Inland areas with Dam Nuem Saduak Series soil are also used for vegetable production and fruit orchards.

The following table lists various form of land use in SKP based on satellite images from March 30, 2007.

Table 5-13: Land Use in SKP Based on Satellite Image from March 30, 2007

Land Utilization	Area (km^2)	Percentage
City, Town, Commercial and Services	11.79	2.84
Villages	8.22	1.98
Paddy Field	1.45	0.35
Mixed	213.94	51.48
Horticultural	5.45	1.31
Aquaculture Area	107.64	25.90
Mangrove Forest	26.30	6.33
Natural Water Bodies	9.83	2.36
Reservoirs (built-up)	0.38	0.09
Rangeland	2.72	0.65
Wetland	6.02	1.45
Salt flats	17.87	4.30
Beach, Mud	3.95	0.95
Total	415.56	100.00

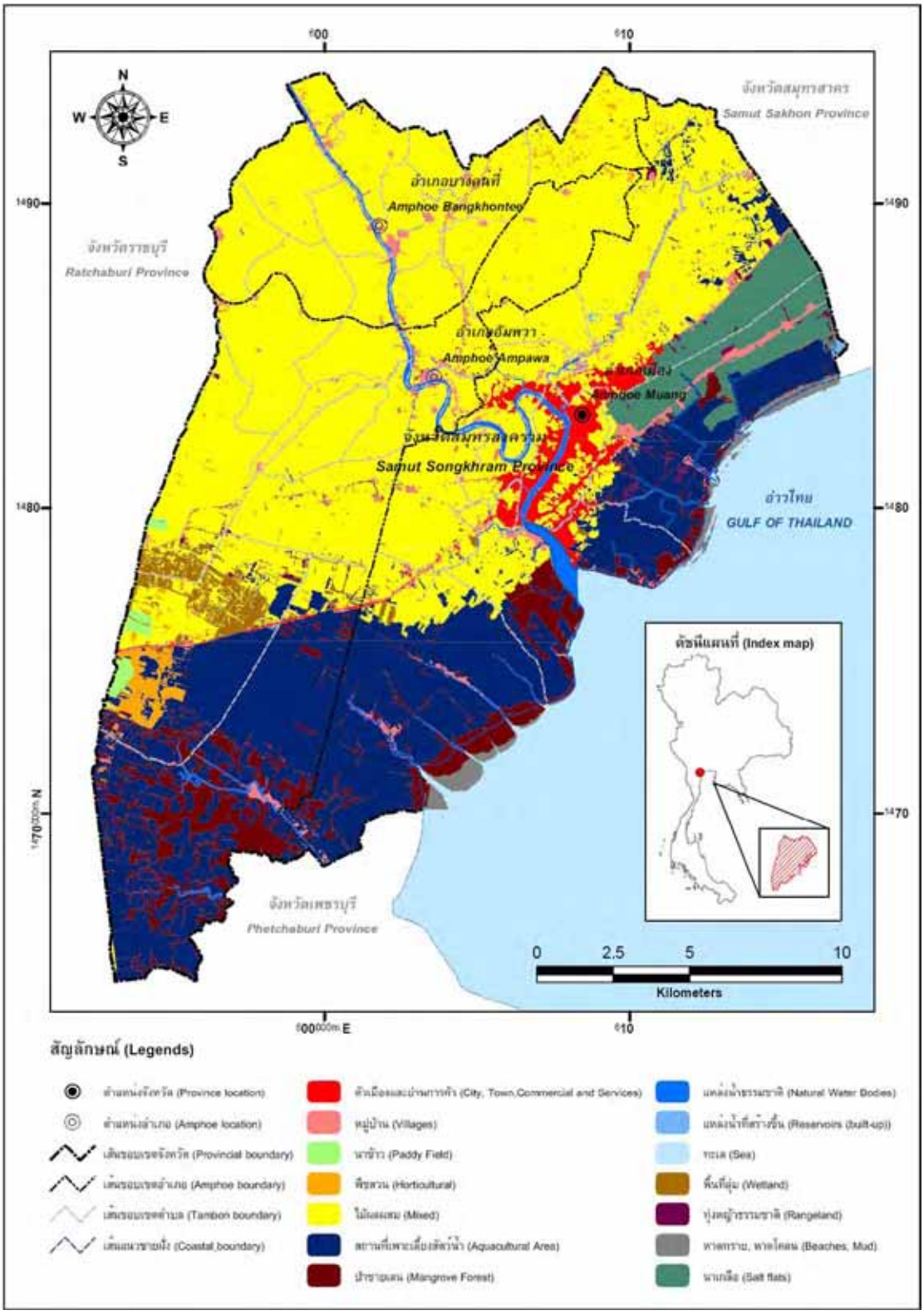


Figure 5-7: Land Use Map of SKP based on SPOT-5 Satellite Image from March 30, 2007

Changes in land use in SKP from 1988 to 2007 are shown in Table 5-14.

Table 5-14: Changes in Land Use in SKP from 1988 to 2007

Land use	Area (km^2)			Percent		
	1988	1997	2007	1988	1997	2007
Urban and Built-up Land	12.09	21.85	22.14	2.9%	5.3%	5.4%
Agricultural Land	235.08	220.48	223.98	57.0%	53.4%	54.3%
Aquaculture Area	95.38	104.32	100.6	23.1%	25.3%	24.4%
Mangrove Forest	34.2	23.15	26.97	8.3%	5.6%	6.5%
Water body	9.84	9.87	12.64	2.4%	2.4%	3.1%
Wetland	8.77	14.93	6.2	2.1%	3.6%	1.5%
Salt flats	17.3	15.61	19.45	4.2%	3.8%	4.7%
Total	412.64	410.22	411.98	100%	99.4%	99.8%

1) Urban and Built-up Land

There is a large increase from 1988 to 1997. Nearly 10 km^2 of land was converted into urban and built-up land. Since then, the area did not change significantly. Urban and built-up lands are mainly located along the Mae Klong River and the main road.

2) Agricultural Land

More than half of the land is used for agriculture. Its area decreased from 1988 to 1997, but increased slightly from 1997 to 2007. Most of the land is used for planting coconut trees and some fruit trees.

3) Aquaculture Area

The land within about 3 km along the coast is used mainly for aquaculture. The area slightly increased from 1988 to 1997 but it has been decreasing slightly from 1997 to 2007.

4) Mangrove Forest

Mangrove forests decreased from 1988 to 1997 mainly due to conversion into aquaculture areas. After 1997, the area has been increasing thanks to various campaigns and planting activities to protect mangrove forests.

5) Water bodies and Wetland

Bodies of water increased from 1997 to 2007. In contrast, the area of wetlands decreased significantly between 1997 and 2007. Through the land use map, it is obvious that the wetlands located southwest of Amphoe Ampawa decreased.

6) Salt Flats

The area of salt flats decreased from 1988 to 1997, and since then the area is increasing and expanding towards the sea coast.

7) Coastal Erosion

The total area of the province decreased from 1988 to 1997 but increased from 1997 to 2007. Therefore, it can be said that coastal erosion is not a serious problem in this province.

a.2 Impact Analysis

a.2.1. Result of the Opinion Survey

The result of the opinion survey on soil and land resources is shown below.

Table 5-15: Result of the Opinion Survey on Soil and Land Resources

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	56%	36%	8%	0%	0	0	100%
Resident	62%	2%	19%	2%	15%	0	100%
BE	73%	13%	9%	3%	2%	0%	100%

Source: JICA study opinion survey in 2007

According to the opinion survey, 64% of the residents, 92% of LAs and 86% of business enterprises considered that the soil and land resources have not serious or not very serious problems.

The residents and BE, who replied that problems were very serious, specified the following aspects and reasons for their concern. It is clear that concern for agriculture is the leading factor with respect to soil and land resources.

Table 5-16: Specific Aspects and Reasons for Concern about Soil and Land Resources

Target Group	Aspects of Concern	Reasons for Concern
Residents	Dryness of soil	Soil is not proper for agriculture
BE	Salinity of soil	Soil is not proper for agriculture
	Intrusion of public area	Conflict between government and people

a.2.2. Impact

According to the changes in land use in SKP from 1988 to 2007, mangrove forests decreased from 8.3% (34.2 km^2) in 1988 to 5.6% (23.2 km^2) in 1997 mainly due to conversion to aquaculture areas. Since 1997 the area has been increasing up to 6.5% (27.0 km^2) by campaigns and planting activities to rehabilitate mangrove forests; however, is has yet to recover to its 1988 size. The loss of mangrove forests may be one of the reasons for coastal erosion and the decrease in marine productivity.

a.3 Issues

In addition to decreases in mangrove forests, the following issues were also raised by the SWOT analysis meeting held on July 2nd, 2007:

- Improper land use; land use does not strike a balance between socioeconomic activity and environmental conservation,
- Deterioration of soil causes decrease in agricultural productivity and number of aquatic animals.

a.4 Measures to be Taken

- Protect and rehabilitate mangrove forests with community participation and public relation efforts to convey importance of mangrove forests to stakeholders,

- Develop and advocate an appropriate land use plan,
- Encourage farmers to use organic fertilizers instead of chemical fertilizers.

b. Forest Resources and Wildlife

b.1 Forest Resources

b.1.1. Situation

There is no National Forest Reserve in the inland portion of SKP, excluding coastal mangrove forest along the seashore.

Mangrove Forest

The mangrove forest is a resource with many functions such as providing breeding ground for fish and clams, materials for charcoal, and building material. Furthermore, mangrove forests act as a buffer zone to protect people, buildings, and farmland from high tides.

Concerning coastal mangrove forests, between 1984 and 1989, large areas of mangrove forest were destroyed in order to farm Black Tiger Shrimp, but from 1991 a Mangroves Rehabilitation Campaign was started and reforestation to regenerate mangroves took place. Various species of Mangroves can be found in the area such as: *Rhizophora apiculata, R.mucronata, Thespesia poplnea, Avicennia officinalis, A.alba, Bruguiera spp*.

Rhizophora apiculata

R.mucronata

Avicennia officinalis

Bruguiera spp

Figure 5-8: Mangrove Forest in Don Hoi Lot

Mangroves on private property in Yisan Subdistrict and Laem Yai Subdistrict (approx. 10,000 Rai) are mainly used to make charcoal. Mangrove forests on public land are on new mudflat land within Klong Khon Subdistrict of Muang District. The number of mangroves, especially in Klong Khon Subdistrict, has been increasing from 2002-2006 as the province has been conducting the Mangroves Rehabilitation Campaign since 1991. Exploration showed that there are 2,491 Rai or 3.99 sq. km. of new land which equals 0.96% of total provincial area. Details are provided in the table below.

Table 5-17: Mangrove forest on New Mudflat Areas within Klong Khon Subdistrict, Muang District

Year	Area (km^2)	Area (Rai)	% of Total Area
2002	3.68	2,300	0.88
2003	3.75	2,343	0.90
2004	3.83	2,393	0.92
2005	3.91	2,443	0.94
2006	3.99	2,491	0.96

Source: Samut Songkhram PEO, 2006

Change of Mangrove Forest Area

The study on changes in land use in SKP between today, ten, and twenty years ago were conducted through LANDSAT-5 satellite imagery interpretation. Satellite images were recorded on February 15, 2007, January 2, 1997 and March 30, 1988 and were processed by a computer program. The following table shows changes in land use. The area covered by mangrove forests was 34.29 km^2 in 1988, then reduced to 23.15 km^2 in 1997, and then increased to 26.97 km^2 in 2007. The area is increasing but has still not reached its 1988 size.

Table 5-18: Land Use by LANDSAT-5 Satellite Imagery Interpretation In SKP

Land use	March 30, 1988		January 2, 1997		February 15, 2007	
	Area Km^2	%	Area Km^2	%	Area Km^2	%
Urban and built-up land	12.09	2.93	21.85	5.33	22.14	5.37
Agricultural Land	235.08	56.97	220.48	53.75	223.98	54.37
Aquaculture Area	95.38	23.11	104.32	25.43	100.6	24.42
Mangrove Forest	34.20	8.29	23.15	5.64	26.97	6.55
Water body	9.84	2.38	9.87	2.41	12.64	3.07
Wetland	8.77	2.13	14.93	3.64	6.2	1.50
Salt flats	17.30	4.19	15.61	3.81	19.45	4.72
Total	412.66	100	410.21	100.00	411.98	100

The following figure shows the area where the width of the mangrove forest is sufficient to protect the sea shore and where the width is not thick enough and the risk for erosion exists.

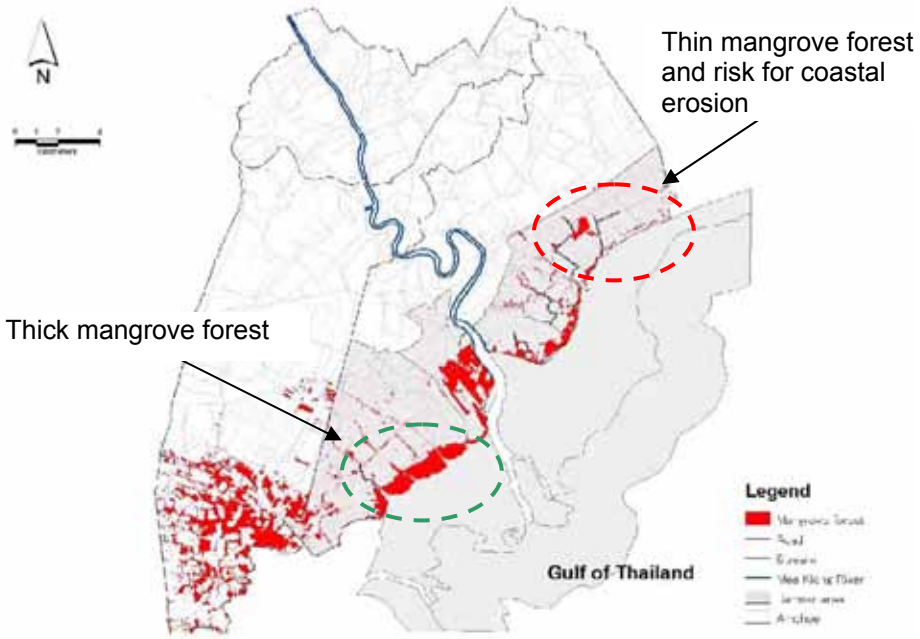


Figure 5-9: Mangrove Forest by SPOT-5 Satellite Image on March 30, 2007

b.1.2. Impact Analysis

Result of the Opinion Survey

The result of the opinion survey on mangrove forest resources is shown below.

Table 5-19: Result of the Opinion Survey on Mangrove Forest Resources

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	61%	17%	14%	8%	0	0	100%
Resident	53%	11%	17%	11%	9%	0	100%
BE	45%	19%	19%	6%	11%	0%	100%

Source: JICA study Opinion Survey in 2007

According to the opinion survey, 64% of the residents, 78% of Las, and 64% of Business Enterprises (BE) considered that the mangrove forest resources are not seriously or not very seriously threatened.

The residents and BE, who replied that problems were very serious, specified the following aspects and reasons for their concern. It is clear that concern for the fishery sector is the main factor with respect to mangrove forest resources.

Table 5-20: Specific Aspects and Reasons for Concern about Mangrove Forest Resources

Target Group	Aspects of Concern	Reason for Concern
Residents	Loss of mangrove	Loss of natural habitat for marine species
BE	Loss of mangrove	Loss of natural habitat for marine species

Impact

As described in the section on Soil and Land Resources, decrease of mangrove forest may be one of the causes for coastal erosion and decrease of marine productivity.

b.1.3. Issues

The central issue in the province is the task to protect, care for, and rehabilitate mangrove forests with community participation and to exploit natural resources in a sustainable manner.

b.1.4. Measures to be Taken

- Protect and rehabilitate mangrove forests with community participation and public relation efforts conveying the importance of mangrove forests to stakeholders.

b.2 Wildlife Resources

b.2.1. Situation

There are no special issues with wildlife resources with the exception of water monitors; an issue caused by the lack of appropriate wildlife habitats such as national parks, wildlife sanctuaries, and so forth, with the exception of mangrove forests whose wildlife is presented in the section on Marine and Coastal Resources.

b.2.2. Impact Analysis

N/A

b.2.3. Issues

- Damage to livestock and farmed aquatic resources caused by water monitors (common water monitor, *Varanus salvator*), a protected lizard,
- Conservation of wildlife resources, particularly preservation of wildlife that inhabits mangrove forests.

b.2.4. Measures to be Taken

- Propose to the related organization to change regulations for the protection of water monitors in order to commercially use this species and population control,
- Educate local people about importance of wildlife resources,
- Protection of habitat and cultivation environments for wild flora and fauna by designating provincial natural environment conservation districts,
- Hire and train wildlife conservation officers.

c. Water Resources

c.1 Situation

c.1.1. Mae Klong River Basin

SKP is located within the Mae Klong River Basin which covers an area of 30,836 km^2 (which accounts for 6.02% of the country area) or 19.27 million rai. Covering 39 districts in nine provinces, the river basin is situated in the west of Thailand, bordered by Myanmar in the west, the Salawin River Basin in the north, the Sakae Krang and Tha Chin River Basins in the east, and the Phetchaburi River Basin in the south, as shown in Source : Integrated Plan for Water Resources Management in the Mae Klong River Basin, Department of Water Resources, MNRE

Figure 5-10[1].

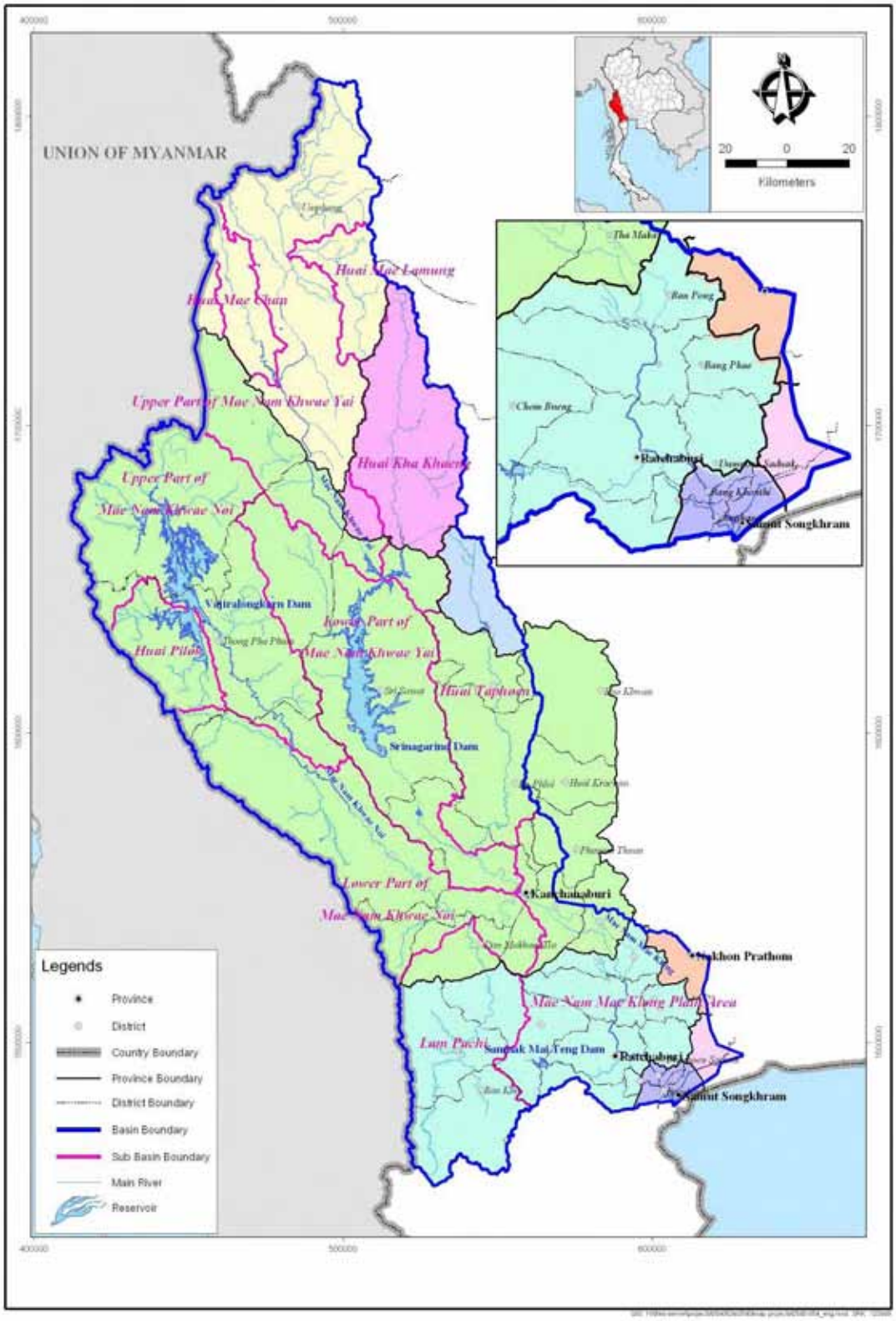
The river basin is divided into 11 sub-basins covering nine provinces, namely Tak, Uthai Thani, Kanchanaburi, Suphan Buri, Nakhon Pathom, Ratchaburi, Samut Songkhram, Samut Sakhon and Phetchaburi Provinces, as shown in Table 5-21. SKP is located within the Mae Nam Mae Klong Plain Area sub-basin.

Table 5-21: Sub-basins of Mae Klong River Basin

Sub-basin	Province and district	Area (km^2)
1. Upper Part of Mae Nam Khwae Yai	Tak Province: Um Phang District	5,070
2. Huai Mae Lamung	Tak Province: Um Phang District	686
3. Huai Mae Chan	Tak Province: Um Phang District	864
4. Huai Kha Khaeng	Uthai Thani Province: Ban Rai District	2,476
5. Lower Part of Mae Nam Khwae Yai	Kanchanaburi Province: Mueang and Si Sawat Districts	3,692
6. Huai Taphoen	Kanchanaburi Province: Bo Ploi and	2,479

[1] Integrated Plan for Water Resources Management in the Mae Klong River Basin, Department of Water Resources, MNRE

	Nong Prue Districts	
	Suphan Buri Province: Dan Chang District	
7. Upper Part of Mae Nam Khwae Noi	Kanchanaburi Province: Thong Pha Phum and Sankhla Buri Districts	4,802
8. Huai Pilok	Kanchanaburi Province: Thong Pha Phum District	946
9. Lower Part of Mae Nam Khwae Noi	Kanchanaburi Province: Dan Makham Tia, Tha Muang, Mueang and Sai Yok Districts	3,508
10. Lam Phachi	Kanchanaburi Province: Dan Makham Tia, Chom Bueng, and Suan Phueng Districts and Ban Kha Minor District	2,664
11. Mae Nam Mae Klong Plain Area	Kanchanaburi Province: Tha Maka, Tha Muang, Phanom Thuan, and Bo Phoi Districts	3,649
	Ratchaburi Province: Chom Bueng, Damnoen Saduak, Bang Phae, Ban Pong, Pak Tho, Wat Phleng, Meuang, and Photharam Districts	
	Samut Songkhram Province: Bang Khon Thi, Amphawa, and Mueang Districts	
Total basin area (6 provinces, 26 districts and 1 minor district)		30,836



Source : Integrated Plan for Water Resources Management in the Mae Klong River Basin, Department of Water Resources, MNRE

Figure 5-10: Mae Klong River Basin

c.1.2. Rainfall and Runoff

The annual rainfall ranges from 1,000 to 2,900 mm and the average annual rainfall is 1,377 mm, which is 42,461 MCM (million cubic meters) per year. The average annual rainfall in Huai Pilok, located at the west end of the Mae Klong River Basin and north of Vajiralongkorn Dam near the border between Thailand and Myanmar, amounts to almost 3,000 mm, whilst average rainfall at the east end of the river basin in the Mae Nam Mae Klong Plain Area sub-basin, where SKP is located, is only 1,000 mm. The average annual runoff in the Mae Klong River Basin is 15,130 MCM: 12,782 MCM (85%) in the wet season and 2,348 MCM (15%) in the dry season.

c.1.3. Groundwater

Groundwater sources in the Mae Klong River Basin area consist of consolidated rock aquifers in the west part of the basin area with low potential yields (less than 0.15 MCM per year), and unconsolidated rock aquifers in the east part of the basin area with higher potential yield (5-100 MCM per year). The water quality is at a fair level. Rainfall absorbed into groundwater sources amounts to 259 MCM per year while groundwater consumption amounts to 160 MCM per year. Therefore, the amount of additional groundwater that can be extracted without causing any adverse effects on the environment is approximately 100 MCM/year.

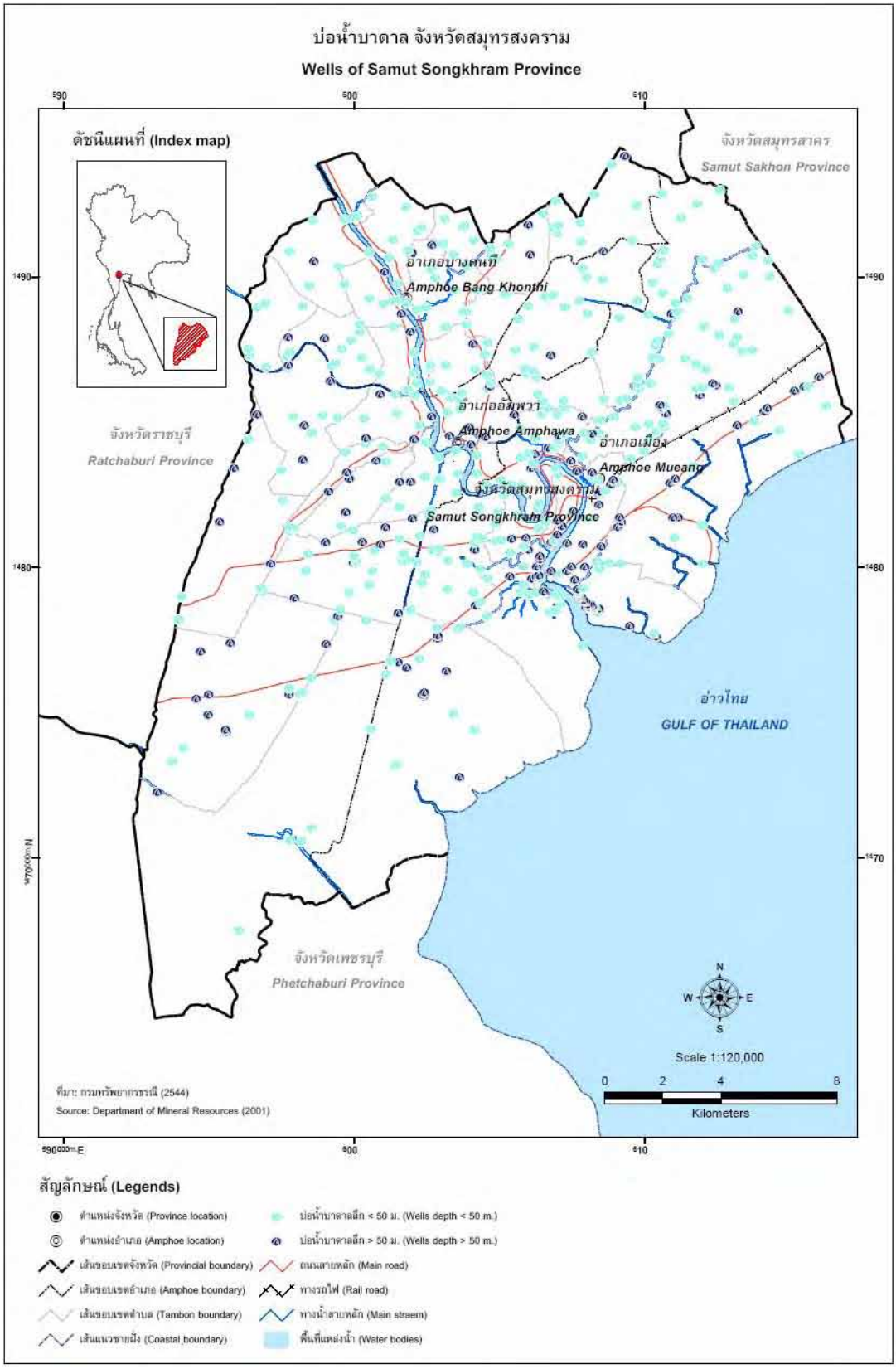


Figure 5-11: Location and Depth of Wells in SKP

c.1.4. Water Demand

Overall, the Mae Klong River Basin has ample potential to meet water demand in the basin area.

The controlled water volume in Srinagarind and Vajiralongkorn Dams accounts for 65% of total water volume, and provides sufficient water for consumption outside the basin area (for dry-season irrigation of Lower Western Chao Phraya Project and for waterworks in Bangkok and peripheral provinces).

Water demand in the Mae Nam Mae Klong Plain Area is the highest among all sub-basins. Water shortage has not been observed in areas of the Greater Mae Klong Irrigation Project in contrast to non-irrigation areas which lack reservoirs and efficient aqueduct system, where water shortage was observed.

c.1.5. Main Rivers and Canals in SKP

The main river in SKP is the Mae Klong River and there are over 300 canals, among them, the Mae Klong Canal, Yisan Canal, Prudu Canal, Pracha Chomchuen Canal, Amphawa Canal, and Bang Noi Canal.

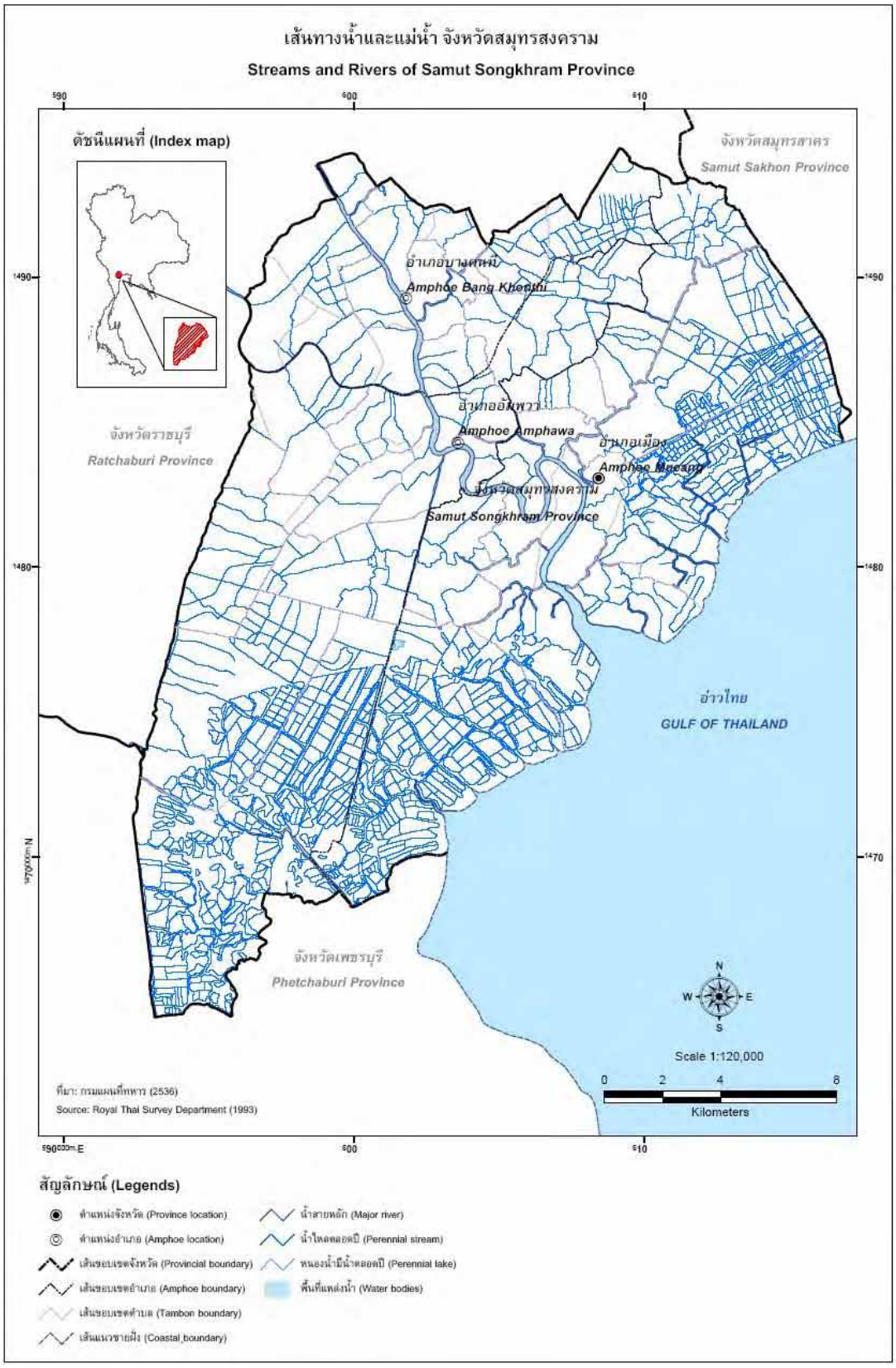


Figure 5-12: Main Rivers and Canals in SKP

c.1.6. Flood Risk Areas

Flood risk areas are illustrated below.

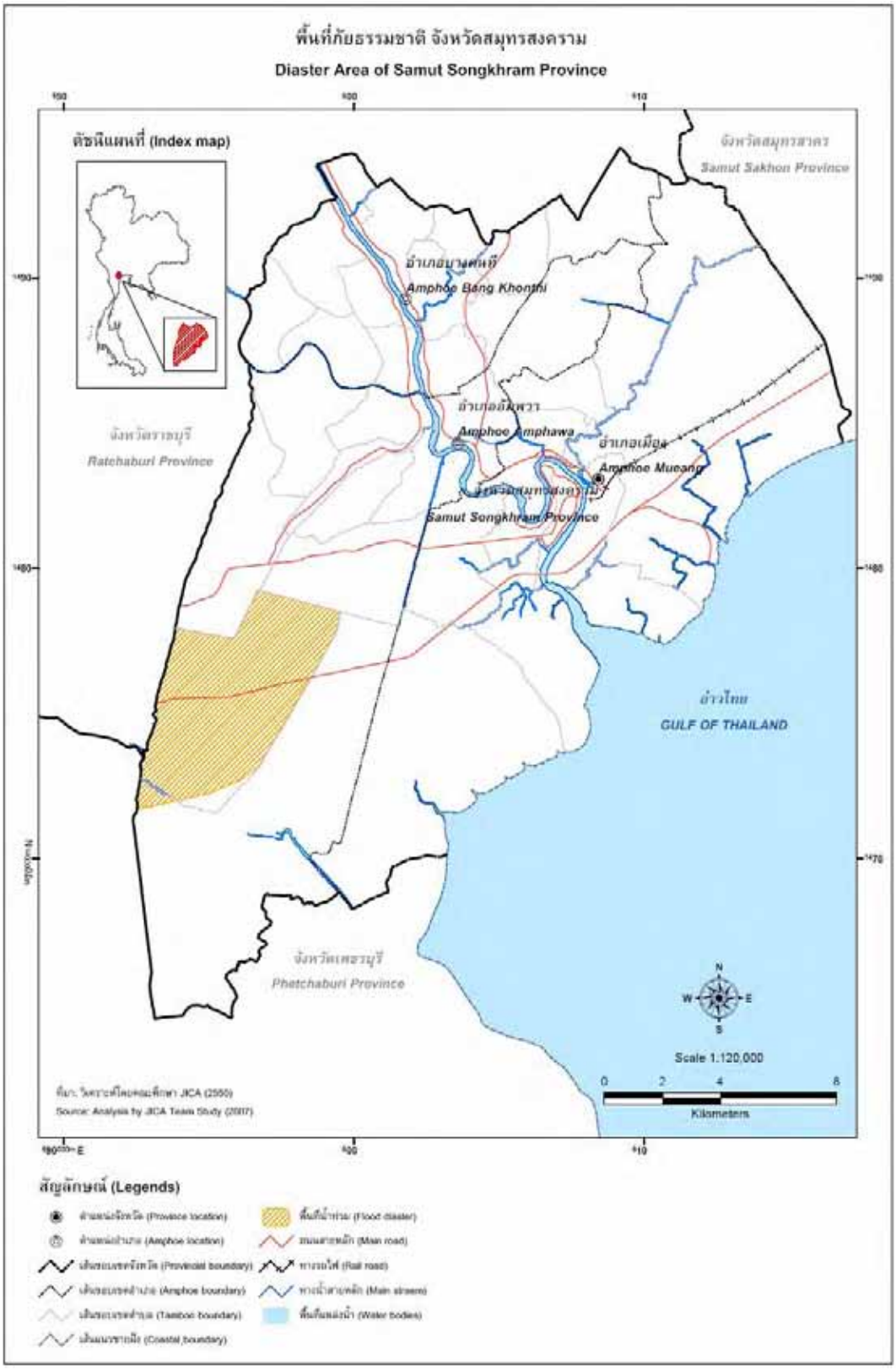


Figure 5-13: Flood Risk Area

c.2 Impact Analysis

c.2.1. Result of the Opinion Survey

The result of the opinion survey on water resources is shown below.

Table 5-22: Result of the Opinion Survey on Water Resources

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	58%	31%	6%	6%	0%	0%	100%
Resident	58%	16%	19%	11%	5%	0%	100%
BE	53%	21%	17%	4%	4%	0%	100%

Source: JICA study in 2007

According to the opinion survey, 74% of the residents, 89% of Las, and 74 % of business enterprises replied that the problems with water resources are "Not serious at all" or "Not very serious".

The LAs, residents and business enterprises, who replied that problems were very serious, specified the following aspects and reasons for their concern. According to their statements, flood is the main problem with water resources in SKP.

Table 5-23: Specific Aspects and Reasons for Concern about Water Resources

Target Group	Aspects of Concern	Reasons for Concern
LAs	Flood	Damage to agricultural areas
Residents	Flood	Obstacle for transportation and agriculture
BEs	Flood	Obstacle for transportation

c.2.2. Impact

Although SKP is very rich in terms of water resources because of its location within the Mae Klong River Basin, there are some water shortage problems due to a lack of reservoirs, the lack of an efficient water supply system, and the intrusion of saline water.

With heavy rains, low lying areas near the estuary and coastline, where agricultural, residential, and commercial areas can be found, will flood.

c.3 Issues

c.3.1. Water Shortage

Water shortage is an issue in areas without an efficient water supply system as well as areas suffering from intrusion of saline water.

c.3.2. Flooding

Estuary and costal areas of the Mae Klong River Basin flood regularly. These low lying areas are comprised of agricultural, residential, and commercial areas. The floods are mainly caused by heavy rainfall in the area, or in areas downstream of Vajiralongkorn and Srinagarind Dams, which causes a large amount of floodwater to gather in the estuary before being discharged into the sea. Because there are a lot of canals in these areas, some water will overflow from the canals. The problem worsens when water levels in the Mae Klong River rise at high tides. The flooding problem in these low-lying areas relates to poor drainage and rising seawater levels.

c.3.3. Water Quality

Water quality problems are evident in the downstream parts of Mae Klong River, partiularly due to wastewater from pig farms in Ratchaburi Province, which ultimately gathers in Khlong Wat Pradu before flowing to coastal areas.

c.3.4. Three Types of Water

SKP is situated at the mouth of the Mae Klong River, and the province has three water types, i.e., freshwater, brackish water, and saltwater. Due to the complexity of the canal system, which is composed of hundreds of canals including those connecting to the Tha Chin River, e.g., Damnoen Saduak and Sunak Hon Canals, the province lacks a clearly designed and appropriate management of water resources.

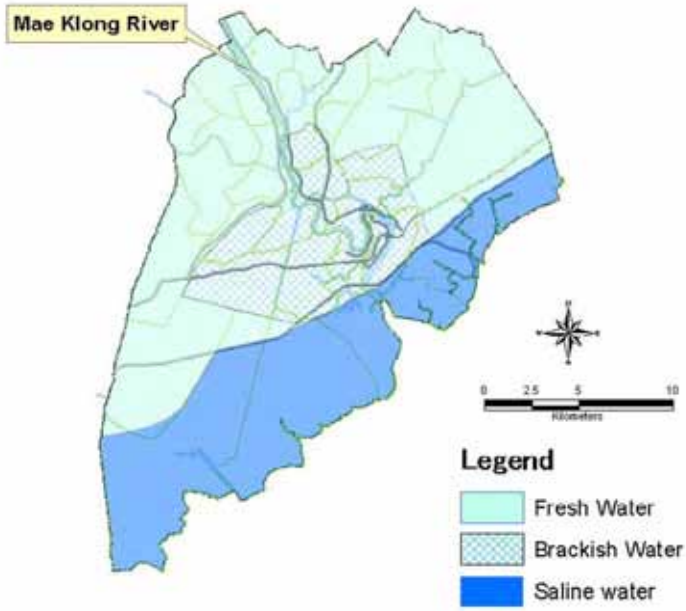


Figure 5-14: Three Types of Water

c.3.5. Land Subsidence and Saline Intrusion of Groundwater

Land subsidence and saline intrusion into groundwater is caused by the excessive use of groundwater, which results in seashore flooding of aquifers at high tide.

c.4 Measures to be Taken

- Complete a water supply system and irrigation network,
- Regularly dredge beds of water canals,
- Formulate a compulsory master plan on prevention and mitigation of flood.

d. Mineral Resources

SKP is located on the Bangkok Plain formed by alluvial soil deposited by rivers and the ocean under brackish and freshwater conditions. The plain was formed in the Holocene or Late Quaternary Age. Without mineral deposits, SKP has only one ore processing factory in Phreak Nam Daeng Sub-district (materials are imported from other provinces).

e. Marine and Coastal Resources

e.1 Situation

e.1.1. Costal Erosion

SKP faces the Gulf of Thailand. Coastal erosion occurs on both eastern and western ends of its coastline. Erosion is evident on the flood plain in mangrove forest areas and along sand beaches frequented by tourists and residents or used for industrial purposes.

Investigations revealed that there is a moderate amount of erosion, at a rate of 1 to 5 meters per year along the northeast coastline along the Gulf of Thailand, and that this is not a serious issue[2].

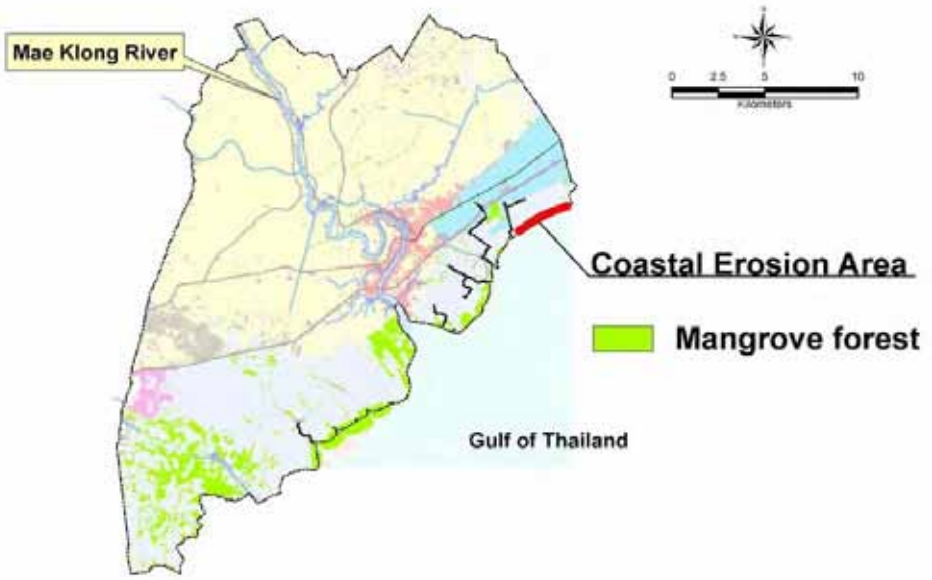


Figure 5-15: Location of Coastal Erosion along the Gulf of Thailand

e.1.2. Don Hoi Lot

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 157 contracting parties to the convention, with 1,702 wetland sites, totaling 153 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

Don Hoi Lot was designated as a Ramsar Site in July 2001. The total area is 87,500 ha[3]. The Don Hoi Lot conservation area consists of the coastal zones of four Amphoe and extends 3 km into the Gulf of Thailand from the shoreline at low tide.

[2] Biweekly meeting no 9 on Nov 26, 2007 by PEO of SKP
[3] The List of Wetlands of International Importance in http://www.ramsar.org/

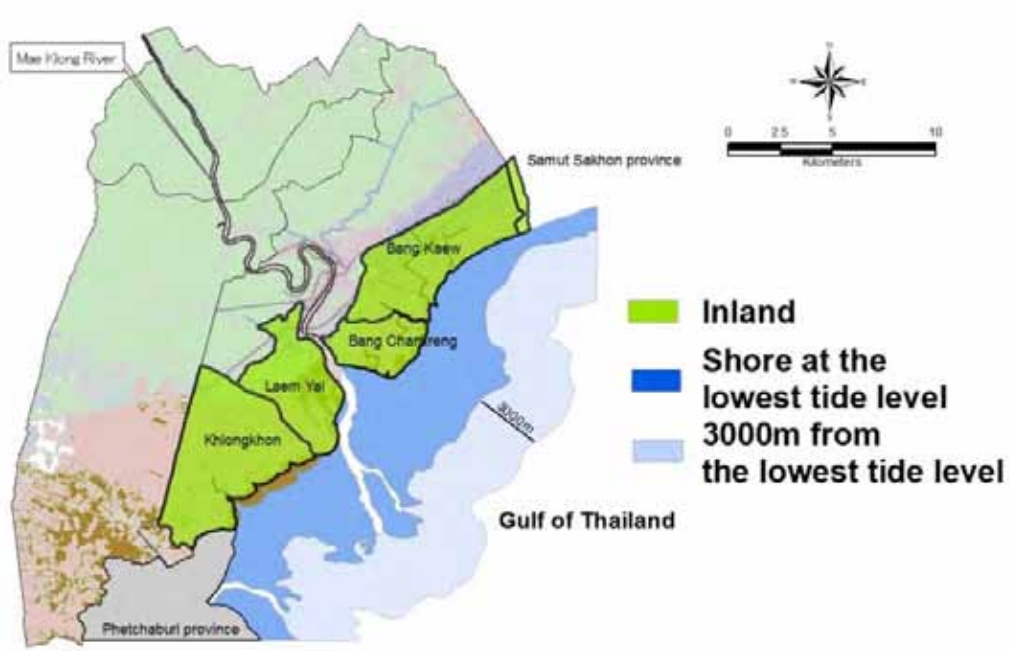


Figure 5-16: Boundary of Don Hoi Lot Conservation Area

Don Hoi Lot is one of the very rare coastal wetlands formed by alluvium at the mouth of the Mae Klong River. The mudflat area extends for 8 km into the sea. The flat surface is a composition of sandy mud sediment. A tidal flat about 4 km in width is exposed at low tide.

Don Hoi Lot

Razor Clam

Figure 5-17: Don Hoi Lot

The mudflat beach is home to razor clams (*Solen regularis*) which are rarely found in other areas along the Gulf of Thailand, so it is considered a very unique place.

In Don Hoi Lot and nearby mangrove forest areas, at least 18 species of seabirds and mangrove birds are found. Among them are the endagered *Ardea cinerea* and the near-threatened *Haliastur indus, Sterna albifrons,* and *Aerodramus ficiphagus*. Other birds found are the *Ardeola speciosa* and the *Chidonias hybridus.*


Ardea cinerea


Haliastur indus


Sterna albifrons


Ardeola speciosa

Figure 5-18: Birds found in Mangrove Forest

Don Hoi Lot helps to hold the alluvium in place. It provides a home for aquatic species such as razor clams, ark shells, and mussels; the razor clam in particular is a major economic source which brings in both money and fame to the area.


Razor clam


Ark shell


Mussel

Figure 5-19: Clams in Don Hoi Lot

Don Hoi Lot is a suitable place for ecological studies. Many schools visit the area on field trips, for taxonomic data collection, ecology, and evolutionary studies. Besides being a study area, Don Hoi Lot is also famous as a tourist attraction.

e.2 Impact Analysis

e.2.1. Result of the Opinion Survey

The result of the opinion survey on water resources is shown below.

Table 5-24: Result of the Opinion Survey on Marine and Coastal Resources

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	53%	11%	14%	22%	0%	0%	100%
Resident	41%	3%	23%	14%	19%	0%	100%
BE	40%	19%	19%	11%	11%	0%	100%
NGO	0%	20%	20%	60%	11%	0%	100%

Source: JICA study in 2007

According to the opinion survey, 37% of the residents, 36% of LAs, 30% of the business enterprises, and 80% of NGOs replied that the problems with marine and coastal resources are "Somewhat serious" or "Very serious".

The LAs, residents, and business enterprises, who replied that problems were very serious, specified the following aspects and reasons for their concern. Coastal erosion and declining marine/coastal resources are the main aspects of the problem on marine and coastal resources in SKP.

Table 5-25: Specific Aspects and Reasons for Concern about Marine and Coastal Resources

	Aspects of Concern	Reasons for Concern
Las	Coastal erosion	Loss of land
	Excessive tourism	Degradation of natural resources
		Extinction of marine species
	Use of poison to catch shrimp	Extinction of marine species
Residents	Use caustic soda to catch Razor Clam	Razor Clam decrease drastically
	Overfishing of Razor Clam	Razor Clam decrease drastically
	Degradation and intrusion of coastal area	Loss of land and fishery resources
BEs	Decreasing population of Razor Clam	Loss of tourist attraction and income
	Many restaurants around Don Hoi Lot	Causes pollution in the area
	Coastal erosion	Loss of land and property

e.2.2. Impact

While GPP of the entire province is increasing, but the GPP of fishery in 2005 decreased to half of its 2001 figures as shown in Table 5-6: Change of GPP in Each Sector.

All four target groups polled in the opinion survey pointed out that the most serious problem of NREM in SKP is Marine and Coastal Resources.

The reasons why the respondents regarded this as the most serious problem are given in the table below.

Table 5-26: Reason for Selecting Most Serious Problem

Most Serious Problem	Item	Reason
Marin/Coastal/Fishery Resources	• Unregulated and illegal fishing methods • Decrease of fishery resources • Overharvesting of Razor Clams • Coastal erosion • Too many tourists	• Extreme decrease of fishery resources and less income for fishermen • Extreme reduction of Razor Clam • Loss of land • Deterioration of natural environment

e.3 Issues

- Due to improper fishing methods and overfishing, the number of fish and shellfish has declined,
- Tidal erosion of sea coast,
- Conservation of shellfish inhabiting Don Hoi Lot wetland,
- Preservation of Ramsar Convention Wetland site,
- Conservation of mangrove forest**.**

e.4 Measures to be Taken

- Research and development of proper fishing methods to prevent overfishing, and instruction in proper fishing methods,
- Mangrove afforestation and study on coastal erosion mechanisms,
- Clarification and conservation of Ramsar Convention Wetland area,
- Provide opportunities for local people to become familiar with wetlands, for example through annual games (e.g. "Gatalympics" event played on mudflats in Kashima City, Japan),
- Enhanced enforcement of laws against illegal fishing by LAs,
- Support the development of a voluntary network between fishermen and encourage them to be involved in conservation activities of marine and costal resources,
- Educate local people about the importance and role of mangrove forests with the goal of achieving environmental conservation.

f. Biodiversity

f.1 Situation

Thailand has a wide range of biological diversity, with a plenitude of forest resources and wildlife because it is positioned at a unique crossroads of three main floristic regions, have variable climates which range from ever-wet in the lower southern peninsula to the seasonal in the north, and have varying altitudes from zero to 2,565m.

Thailand's abundant and diverse marine and coastal biodiversity has suffered from destructive fishing gears and fishing methods in the open sea and coast. Conversion of coastal mangrove into intensive shrimp farms created conflicts of interest among small-scale fishermen and between fishermen and shrimp farmers.

In SKP, mangrove forests were commonly converted into fish and shrimp farms up until 10 years ago, but conservation campaigns have since supported well performing afforestation activities. Therefore, the area of mangrove forest is increasing in recent years.

Below is a list of birds, fish and mammals listed in the Thailand Red Book which are **Extinct in the Wild (EW)**, **Critically Endangered (CR)**, **Endangered (EN)**, **Vulnerable (VU)**, **Near Threatened (NT)** that have been identified in and around SKP.

f.1.1. Birds

According to "Thailand Red Book: Birds", published by ONEP in 2005, there are three **Endangered (EN)**, seven **Vulnerable (VU)**, and thirty-one **Near Threatened (NT)** species in and around SKP as shown in Table 5-27:

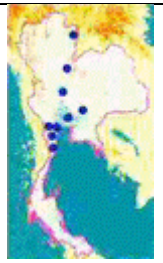
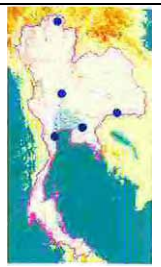
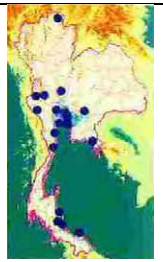
f.1.2. Fish

There is one **Endangered**, and twenty **Endemic** species in and around SKP as shown in Table 5-28.

f.1.3. Mammals, Reptiles and Amphibians

There is one species of mammal **Vulnerable (VU)**, one reptile species **Near Threatened (NT)** and fourteen listed as **Least Concern**. One amphibian species **Near Threatened (NT)** and nine listed as **Least Concern** in and around SKP as shown in Table 5-29.

Table 5-27: RED Data: Birds in and around SKP

No	Status	Scientific name	Common name	Thai name	Habitat	Site	
1	**EW**	*Aqua heliaca*	Imperial Eagle	นกอินทรีหัวไหล่ขาว	Marshy open country cultivations		
2	**EN**	*Phalacrocotax carbo*	Great Cormorant	นกกาน้ำใหญ่	Various wetlands, fresh and salt water		
3	**EN**	*Pelecanus philippensis*	Spot-billed Perican	นกกระทุง	Lake, large rivers		

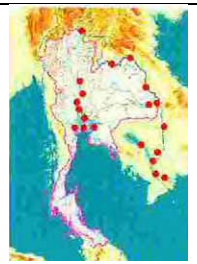
No	Status	Scientific name	Common name	Thai name	Habitat	Site
4	**VU**	*Anas formosa*	Baikal Teal	เป็ดหน้าเหลือง	Freshwater lake	Very rare winter visitor, recorded from N to S.
5	**VU**	*Aythya nyroca*	Ferruginous Pochard	เป็ดดำหัวสีน้ำตาล	Freshwater lake	Regularly over-wintering in NW, NE, and C.
6	**VU**	*Columba punicea*	Pale-capped Pigeon	นกลุมพูแดง	Various forests, up to 1,400m.	Rare winter visitor and migrant throughout the country, frequent seen along coasts.
7	**VU**	*Vanellus duvaucelii*	River Lapwing	นกกระแตหาด	Large rivers and surrounds.	Uncommon resident throughout in suitable habitats, threatened by human persecution.
8	**VU**	*Rynchops albicollis*	Indian Skimmer	นกกรีดน้ำ	Lakes, large rivers, rarely coasts.	Historically records NW, now very rare visitor in C and W.
9	**VU**	*Mycteria leucocephala*	Painted Stork	นกกาบบัว	Marshy areas	Uncommon resident and winter visitor in NE, W, C, and S.
10	**VU**	*Rhinomyias brunneata*	Brown-chested Jungle-Flycatcher	นกจับแมลงอกสีน้ำตาลอ่อน	Evergreen forest, up to 1,000 m	Rare passage migrant in W, C, and S.
11	**NT**	*Coturnix coromandelica*	Rain Quail	นกคุ่มอกดำ	Grassland, cultivation	Uncommon resident in NW, W, NE, C, and SE.
12	**NT**	*Dryocopus javensis*	White-bellied Woodpecker	นกหัวขวานใหญ่สีดำ	Deciduous forest, evergreen forest, mangrove.	Uncommon resident throughout, now much reduced due to habitat destruction.
13	**NT**	*Mulleripicus pulverulentus*	Great Slaty Woodpecker	นกหัวขวานใหญ่สีเทา	Mixed deciduous forest, evergreen forest	Uncommon resident throughout, threatened by habitat destruction.
14	**NT**	*Buceros bicornis*	Great Hornbill	นกกก นกกาฮัง	Mixed deciduous forest, evergreen forest, up to 1,525 m.	Uncommon resident throughout, now much reduced due to habitat destruction.
15	**NT**	*Aceros undulatus*	Wreathed Hornbill	นกเงือกกรามช้าง	Mixed deciduous forest, evergreen forest	Uncommon resident throughout, threatened by habitat destruction.
16	**NT**	*Tyto alba*	Barn Owl	นกแสก	Urban and open areas, cultivations	Uncommon resident throughout, threatened by human persecution.
17	**NT**	*Treron bicincta*	Orange-breasted Green Pigeon	นกเปล้าอกสีม่วงน้ำตาล	Beach forest, various dry open forest	Uncommon resident in NE, W, C, SE, and S.
18	**NT**	*Treron pompodora*	Pompadour Green Pigeon	นกเปล้าหน้าเหลือง	Evergreen forest, up to 800 m.	Uncommon to rare resident in NW, NE, W, C, and SE.
19	**NT**	*Ducula aenea*	Green Imperial Pigeon	นกลุมพู	Island forest, evergreen forest	Uncommon resident throughout, Much reduced.
20	**NT**	*Rallina eurizonoides*	Slaty-legged Crake	นกอัญชันป่าขาเทา	Wet areas in forest	Uncommon to rare in NW, NE, W, C, and S. Status uncertain.
21	**NT**	*Gallicrex cinerea*	Watercock	นกอีลุ้ม	Freshwater marshes,	Uncommon resident and breeding visitor

No	Status	Scientific name	Common name	Thai name	Habitat	Site
					rice paddies.	throughout, very much reduced by hunting pressure.
22	**NT**	*Numenius madagascariensis*	Eastern Curlew	นกอีก๋อยตะโพกน้ำตาล	Coastal mudflats, sandflats	Rare winter visitor and passage migrant C, W(s), S.
23	**NT**	*Burhinus oedicnemus*	Eurasian Thick-knee	นกกระแตผีเล็ก	Dry open areas, cultivations	Uncommon resident and winter visitor in NW, NE, W, and C.
24	**NT**	*Vanellus cinereus*	Grey-headed Lapwing	นกกระแตหัวเทา	Marshes, wet paddies	Uncommon visitor throughout.
25	**NT**	*Glareola lactea*	Small Pratincole	นกแอ่นทุ่งเล็ก	Large rivers, dry lake margins	Uncommon resident and non-breeding visitor in NW, NE, C, and W.
26	**NT**	*Aviceda jerdoni*	Jerdon's Baza	เหยี่ยวกิ้งก่าสีน้ำตาล	Evergreen forest, up to 1,700 m	Uncommon resident throughout.
27	**NT**	*Gyps himalayensis*	Himalayan Griffon	อีแร้งสีน้ำตาลหิมาลัย	Open country, lowlands	Rare passage migrant and winter visitor, recorded from NW, W, C, and S, threatened by hunting pressure.
28	**NT**	*Aegypius monachus*	Cinerous Vulture	อีแร้งดำหิมาลัย	Open country, lowlands	Rare passage migrant and winter visitor, recorded from NW, W, C, and S, threatened by hunting pressure.
29	**NT**	*Ictinaetus malayentis*	Black Eagle	นกอินทรีดำ	Evergreen forest, 800-2,565 m.	Uncommon resident throughout, now very much reduced by habitant destruction.
30	**NT**	*Hieraaetus kienerii*	Rufous-bellied Eagle	เหยี่ยวท้องแดง	Evergreen forest	Uncommon resident throughout
31	**NT**	*Phalacrocorax fuscicollis*	Indian Cormorant	นกกาน้ำปากยาว	Freshwater wetlands	Uncommon local resident in C and NE.
32	**NT**	*Gorsachius melanolophus*	Malayan Night-Heron	นกยางลายเสือ	Wetlands in forest	Uncommon resident and breeding visitor throughout
33	**NT**	*Terpsiphone atrocaudata*	Japanese Paradise-flycatcher	นกแซวสวรรค์หางดำ	Evergreen forest, migrants in various habitat	rare passage migrant, recorded from W, C, SE, and S.
34	**NT**	*Muscicapa williamsoni*	Brown-steaked Flycatcher	นกจับแมลงสีน้ำตาลท้องลาย	Evergreen forest	Uncommon resident in W, C, and S.
35	**NT**	*Gracula religiosa*	Hill Myna	นกขุนทอง	Mixed deciduous forest, evergreen forest	Fairly common resident throughout, threatened by bird trade.
36	**NT**	*Pycnonotus jocosus*	Red-whiskered Bulbul	นกปรอดหัวโขน	Secondary growth, open areas	Common resident throughout, very much reduced and possibly extirpated from southern peninsula, threatened by bird trade.

No	Status	Scientific name	Common name	Thai name	Habitat	Site
37	**NT**	*Ploceus hypoxanthus*	Asian Golden Weaver	นกกระจาบทอง	Marshes, rice paddies, grassland near water	Uncommon resident in NE, W and C, mush reduced by human persecution.
38	**NT**	*Ploceus manyar*	Steaked Weaver	นกกระจาบอกลาย	Marshes, rice paddies, grassland	Uncommon resident in NW and C, mush reduced by human persecution.
39	**NT**	*Ploceus philippinus*	Baya Weaver	นกกระจาบธรรมดา	Marshes, rice paddies, grassland	Common resident throughout, very much reduced by human persecution and bird trade.
40	**NT**	*Amandava amandava*	Red Avadavat	นกกระติ๊ดแดง	Marshes, rice paddies, grassland	Common resident throughout, very much reduced by human persecution and bird trade.
41	**NT**	*Erythrura prasina*	Pin-tailed Parrotfinch	นกกระติ๊ดเขียว	Bamboo, evergreen forest up to 1,500 m	Uncommon resident throughout.
42	**DD**	*Sterna bergii*	Great Crested Tern	นกนางนวลแกลบหงอนใหญ่	Open areas, islets, seacoasts, sandy beaches	C (coastal), SE, S.

Data Source : Sanguansombat, W.(2005). Thailand Red Data: Birds. ONEP, Thailand

Table 5-28: Red Book Data: Fishes in and around SKP

No	Status	Scientific name	Common name	Thai name	Habitat	Site	
1	**EN**	*Himantura chaophraya*	Giant Stingray	กระเบนราหู,กระเบนน้ำจืดยักษ์	Carnivorous, fishes and crustacean, mainstream to estuaries. Uncommon food fish in the markets. Over-fishing.		

No	Status	Family	Scientific name	Thai name	Habitat	Site
2	**Endemic**	***Dasyatidae***	*Himantura kittipongi*	กระเบนแม่กลอง	Mainstream, estuary	Lower Meklong
3		***Cyprinidae***	*Rasbora sp. 3*	ซิวหางไหม้แม่กลอง	Hill stream	Meklong/ WeFCOM
4		***Cyprinidae***	*Trigonostigma somphongsi*	ซิวสมพงษ์	Forest stream	Meklong/ WeFCOM

No	Status	Family	Scientific name	Thai name	Habitat	Site
5		***Cyprinidae***	*hypsibarbus suvattii*	จาด	Hill stream	Meklong/ WeFCOM
6		***Cyprinidae***	*Epalzeorhynchos bicolor*	ทรงเครื่อง, ฉลามหางแดง	Mainstream, marshland	Meklong/ WeFCOM
7		***Cyprinidae***	*Garra sp. 3*	มูด)คลองงู(	Hill stream	Meklong/ WeFCOM
8		***Balitoridae***	*Namacheilus troglocataractus*	ค้อตาบอด, ค้อถ้ำ	Cave	Meklong/ WeFCOM
9		***Balitoridae***	*Schistura jaruthanini*	ค้อถ้ำจารุธานินทร์	Cave	Meklong/ WeFCOM
10		***Cobitidae***	*Acanthopsis thiemmethdi*	รากกล้วย	Hill stream	Chaophraya, Meklong basin
11		***Cobitidae***	*Yasuhikotakia sidthimunki*	หมูอารีย์	Hill stream	Meklong/ WeFCOM
12		***Bagridae***	*Batasio tigrinus*	แขยงเขา	Hill stream	Meklong/ WeFCOM
13		***Bagridae***	*Batasio sp. 1*	แขยงเขา	Hill stream	Meklong/ WeFCOM
14		***Bagridae***	*Kryptopterus heperius*	ปีกไก่หนวดยาว	Mainstream	Meklong/ WeFCOM
15		***Bagridae***	*Pterocryptis buccata*	ชะโอนถ้ำ	Cave	Meklong/ WeFCOM
16		***Amblycipitidae***	*Amblyceps variegatum*	ดักแม่กลอง	Hill stream	Meklong/ WeFCOM
17		***Akysidae***	*Acrochordonichthys septemtrionalis*	ขยุยยักษ์แม่กลอง	Hill stream	Meklong/ WeFCOM
18		***Olyridae***	*Olyra sp. 1*	ดุกบอนหางแหลม	Hill stream	Meklong/ WeFCOM
19		***Mastacembelidae***	*Macrognathus meklonggensis*	หลดแม่กลอง	Hill stream	Meklong/ WeFCOM
20		***Badidae***	*Badis khwae*	หมอแคระแม่กลอง	Hill stream	Meklong/ WeFCOM
21		***Gobiidae***	*Rhinogobius sp. 2*	บู่น้ำตกแม่กลอง	Hill stream	Mekolng/ WeFCOM

Source : Vidthayanon, C., (2005). *Thailand Red Data: Fishes.* ONEP, Thailand. WeFCOM = Western Forest Complex

Table 5-29: Red Book Data: Mammals, Reptiles, and Amphibians in and around SKP

MAMMALS

Status VU: Vulnerable

	Scientific Name	Common Name	Thai Name	Habitat	Site
1	*Stenella longirostris*	Spinner Dolphin	โลมากระโดด	Gulf of Thailand	Bangkok Harbor, Chantaburi, **SKP**, Samut Sakhon, Phuket, Trat, Chantaburi, Rayong, Songkhla

REPTILES

Status NT: Near Threatened

	Scientific Name	Common Name	Thai Name	Habitat	Site
1	*Calotes versicolor*	Changeable Lizard	กิ้งก่ารั้ว, กิ้งก้าหัวแดง	From beach forest to deciduous forest, including urban and agricultural areas	All provinces

Status LC: Least Concern

	Scientific Name	Common Name	Thai Name	Habitat	Site
1	*Gehyra mutilada*	Common Four-clawed Gecko	จิ้งจกหินสีจาง	Inhabit all types of forests and other plantations, including houses and gardens	All provinces
2	*Gekko gecko*	Tokey Gecko	ตุ๊กแกบ้าน	Forest and other plantations, including houses and gardens in towns	All provinces
3	*Hemidactylus frenatus*	Spiny-tailed House Gecko	จิ้งจกหางหนาม	Found in all types of forests and plantations, also in human houses	All provinces
4	*Hemidactylus garnotii*	Garnot's House Gecko	จิ้งจกหางเรียบ	Found in all types of forests and plantations, also in human houses	All provinces
5	*Mabuya novemcarinata*	-	จิ้งเหลนเกล็ดสั้น	Evergreen forest	All provinces

6	*Varanus salvator*	Common Water Monitor	เหี้ย	Lowland wetlands and lowland forests, including urban areas. Also found in canals, swamps, streams, and rivers.	All provinces
7	*Python reticulatus*	Reticulated Python	งูเหลือม	Lowland wetlands and evergreen forests	All provinces
8	*Chrysopelea ornata ornatissima*	Golden Tree Snake	งูเขียวดอกหมาก	Evergreen forest	All provinces
9	*Coelognathus radiatus*	Copperheaded Racer	งูทางมะพร้างลายขีด	From beach forest to hill forest, including urban areas such as parks, gardens, paddy field, and other crop plantations	All provinces
10	*Dendrelaphis pictus*	Common Bronzeback	งูสายม่านพระอาทิตย์	From home gardens to hill forest	All provinces
11	*Ptyas korros*	Indochinese Rat Snake	งูสิงบ้าน	From agricultural areas to hill forest	All provinces
12	*Ptyas mucosus*	Oriental Rat Snake	งูสิงหางลาย	From agricultural areas to hill forest	All provinces
13	*Xenochrophis flavipunctatus*	Common Keelback	งูลายสอสวน	From lowland wetlands to lowland evergreen forest	Thai locality
14	*Naja kaouthia*	Siamese Cobra	งูเห่าหม้อ	From agricultural areas to deciduous and evergreen forest	All province

AMPHIBIANS

Status NT: Near Threatened

	Scientific Name	**Common Name**	**Thai Name**	**Habitat**	**Site**
1	*Kaloula mediolineata*	Medium-striped Bullfrog	อึ่งอ่างก้นขีด	Deciduous and secondary forest. Usually found in mass breeding in same areas with other edible species	Known from Thailand and Laos

Status LC: Least Concern

	Scientific Name	Common Name	Thai Name	Habitat	Site
1	*Bufo melanostictus*	Black-spined Toad	คางคกบ้าน	Mainly in disturbed areas, uncommon in closed forest	All provinces
2	*kaloula pulchra*	Banded Bullfrog	อึ่งอ่างบ้าน	All beach forest and urban areas	All provinces
3	*Microhyla heymonsi*	Dark-sided chorus Frog	อึ่งข้างดำ	Disturbed areas such as gardens, crop plantations, secondary forests and primary forests	All provinces
4	*Hoplobatrachus chinensis*	Chinese Bullfrog	กบนา	Plain wetlands	All provinces
5	*Occidozyga lima*	Common Puddle Frog	เขียดจะนา	Lowland wetlands including wet paddy areas	All provinces
6	*Occidozyga martensii*	Marten's Puddle Frog	เขียดทราย	Primarily occurs in streamside puddles, seepages and other damp patches along streams and rivers, as well as rain puddles and pools	All provinces
7	*Rana erythraea*	Green Paddy Frog	เขียดจิก	Lowland wetlands including garden ponds	All provinces
8	*Rana macrodactyla*	Long-toed Frog	กบหลังขีด	Lowland Wetlands	All provinces
9	*Polypedates leucomystax*	Four-lined Tree Frog	ปาดบ้าน	Widespread in all habitats, from beach vegetation to primary evergreen forest as well as urban areas	All provinces

Data Source : Vidthayanon, C.Nabhitabhata, J., Chan-ard, T. (2005). *Thailand Red Data: Mammals, Reptiles and Amphibians*. ONEP, Thailand

f.1.4. Flora

The flora of Thailand is one of the richest among the tropical floras, containing about 1,900 genera and 10,000 species of vascular plants of which about 10% are endemic to the Kingdom. The wealth of Thai floras is due to the fact that the country is positioned at a unique crossroads of the three main floristic regions, namely Indo-Himalaya, Indo-china, and Malaysia. Diverse environments with climates ranging from ever-wet in the lower southern peninsula to seasonal in the north, and varying altitudes from zero to 2,565m undoubtedly support the existence and development of various types of vegetation[4].

SKP is located in central Thailand in terms of the floristic region. There is no flora particular to SKP, but there are dozens of rare species in the central Thailand floristic region.

f.2 Impact Analysis

f.2.1. Result of the Opinion Survey

The result of the opinion survey on biodiversity is shown below.

Table 5-30: Result of the Opinion Survey on Biodiversity

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	61%	11%	14%	14%	0%	0%	100%
Resident	58%	14%	23%	2%	3%	0%	100%
BE	55%	19%	17%	6%	2%	0%	100%

Source: JICA study in 2007

f.2.2. Impact

According to the opinion survey, 72% of the residents, 72% of LAs and 74% of the business enterprises replied that the problems with biodiversity are "Not serious at all" or "Not very serious".

The LAs, residents and business enterprises, who replied that problems were very serious, specified the following aspects and reasons for their concern. Decrease of fishery resources is the main aspects for both LA and residents.

Table 5-31: Specific Aspects and Reasons for Concern about Biodiversity

	Aspects of Concern	Reasons for concern
LAs	Extinction of fish species	Loss of biodiversity
	Loss of mangrove	Extinction of marine species
Residents	Decrease of fishery resources	Loss of income
BEs	Waste water	Loss of biodiversity

f.3 Issues

- Preservation of wildlife habitats and breeding environments, and ensure biological diversity.

f.4 Measures to be Taken

- Formulate conservation plan,

[4] Thailand Red Data: Plants

- Conduct a campaign to educate local people on importance of biodiversity,
- Monitor and restrict phenomena that affect biodiversity,
- Biodiversity conservation with participation of local people.

Environment

g. Water Quality

g.1 Situation

g.1.1. Mae Klong River Water Quality

Location of Continuous River Water Quality Monitoring Stations

There are four water quality monitoring points in SKP, which are MK01 at Mae Klong River mouth in Amphur Mueang, MK02 at Somdej Phra Bhuddha Lertlah (Rama2) Hospital in Amphur Amphawa, MK03 at Bang Khonthi in Amphur Office, and MK04 at Somdej Phra Ammarin Bridge.

The quality of water falls between class 3 and class 4.

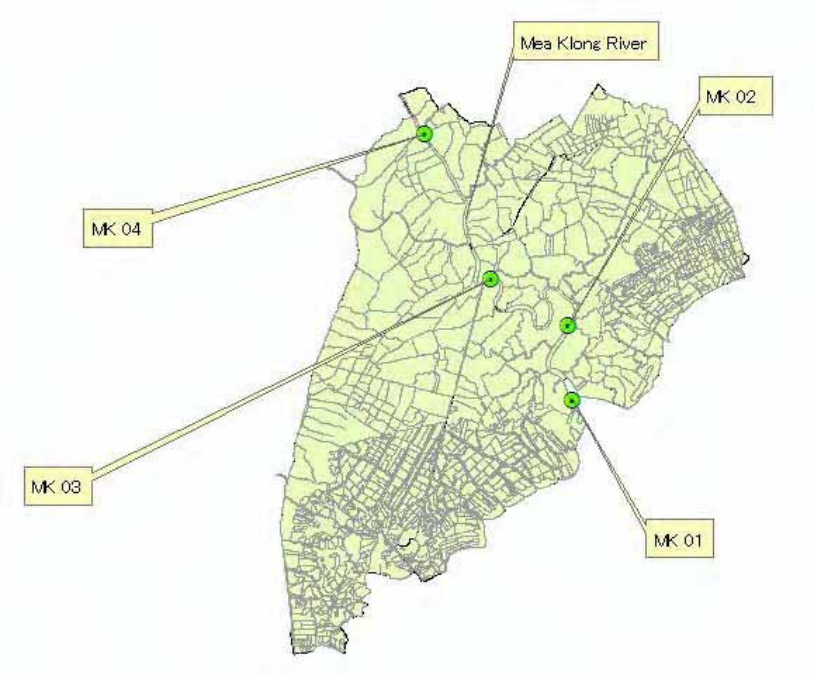


Figure 5-20: River water quality monitoring stations in SKP

Monitored Values

21 basic values for the monitoring of the living environment, and other values such as heavy metals are being monitored at the monitoring stations.

Table 5-32: Items for Water Quality Monitoring

Basic Values		Heavy Metals etc.	
1	Temp(a) (C)	1	Fe (mg/l)
2	Temp(w) (C)	2	Cd (ug/l)
3	pH	3	Cr (ug/l)
4	Tur (NTU)	4	Mn (mg/l)
5	Cond (uS/cm)	5	Ni (ug/l)
6	Sal (ppt)	6	Pb (ug/l)
7	DO (mg/l)	7	Zn (mg/l)
8	BOD (mg/l)	8	Cu (ug/l)
9	TCB (MPN/100 ml)	9	Hg (ug/l)
10	FCB (MPN/100 ml)	10	As (ug/l)
11	TP (mg/l)		
12	NO_3-N (mg/l)		
13	NO_2-N (mg/l)	11	CN (mg/l)
14	NH_3-N (mg/l)		
15	TS (mg/l)		
16	TDS (mg/l)		
17	SS (mg/l)		
18	Flow (cms)		
19	Hardness (mg/L as CaCO3)		
20	Depth (m)		
21	Color (pt-Co Unit)		

However, in light of the environmental standards for the water quality of surface water given in the table below, values currently being monitored are insufficient, as they do not include radioactive materials and agricultural chemicals.

Table 5-33: Environmental Standards for Water Quality of Surface Water

Parameter[1/]	Units	Statistics	Standard Value for Class					Methods for Examination
			Class 1	Class2	Class3	Class4	Class 5	
1. Colour,Odour and Taste	-	-	n	n'	n'	n'	-	-
2. Temperature	C°	-	n	n'	n'	n'	-	Thermometer
3. pH	-	-	n	5-9	5-9	5-9	-	Electrometric pH Meter
4. Dissolved Oxygen (DO)	mg/l	P20	n	≥6.0	≥4.0	≥2.0	-	Azide Modification
5. BOD (5 days, 20°C)	mg/l	P80	n	≤1.5	≤2.0	≤4.0	-	Azide Modification at 20°C , 5 days
6. Total Coliform Bacteria	MPN/100 ml	P80	n	≤5,000	≤20,000	-	-	Multiple Tube Fermentation Technique
7. Fecal Coliform Bacteria	MPN/100 ml	P80	n	≤1,000	≤4,000	-	-	Multiple Tube Fermentation Technique
8. NO_3 -N	mg/l	-	n	5.0			-	Cadmium Reduction
9. NH_3 -N	mg/l	-	n	0.5			-	Distillation Nesslerization
10.Phenols	mg/l	-	n	0.005			-	Distillation,4-Amino antipyrene
11.Copper (Cu)	mg/l	-	n	0.1			-	Atomic Absorption -Direct Aspiration
12.Nickle (Ni)	mg/l	-	n	0.1			-	Atomic Absorption -Direct Aspiration
13.Manganese (Mn)	mg/l	-	n	1.0			-	Atomic Absorption -Direct Aspiration
14.Zinc (Zn)	mg/l	-	n	1.0			-	Atomic Absorption -Direct Aspiration
15.Cadmium (Cd)	mg/l	-	n	0.005* 0.05**			-	Atomic Absorption -Direct Aspiration
16.Chromium Hexavalent	mg/l	-	n	0.05			-	Atomic Absorption -Direct Aspiration
17.Lead (Pb)	mg/l	-	n	0.05			-	Atomic Absorption -Direct Aspiration
18.Total Mercury (Total Hg)	mg/l	-	n	0.002			-	Atomic Absorption-Cold Vapour Technique
19.Arsenic (As)	mg/l	-	n	0.01			-	Atomic Absorption -Direct Aspiration
20.Cyanide (Cyanide)	mg/l	-	n	0.005			-	Pyridine-Barbituric Acid
21.Radioactivity - Alpha - Beta	Becqurel /l	-	n	0.1 1.0			-	Gas-Chromatography
22.Total Organochlorine Pesticides	mg/l	-	n	0.05			-	Gas-Chromatography
23.DDT	µg/l	-	n	1.0			-	Gas-Chromatography
24.Alpha-BHC	µg/l	-	n	0.02			-	Gas-Chromatography
25.Dieldrin	µg/l	-	n	0.1			-	Gas-Chromatography
26.Aldrin	µg/l	-	n	0.1			-	Gas-Chromatography
27.Heptachlor & Heptachlorepoxide	µg/l	-	n	0.2			-	Gas-Chromatography
28.Endrin	µg/l	-	n	None			-	Gas-Chromatography

Remarks
P: Percentile value, N: naturally, n': naturally but changing not more than 3°C,
* : when water hardness not more than 100 mg/l as $CaCO_3$, **: when water hardness more than 100 mg/l as $CaCO_3$
Based on Standard Methods for the Examination of Water and Wastewater recommended by APHA : American Public Health Association, AWWA : American Water Works Association and WPCF : Water Pollution Control Federation

Source: PCD Web page: http://www.pcd.go.th/info_serv/en_reg_std_water05.html#s3

The definition of each class in the environmental water quality standards is given in the following table.

Table 5-34: Class Definitions of Environmental Water Quality Standards

Classifications	Objectives / Conditions and Beneficial Usage
Class 1	Extra clean fresh surface water resources used for: (1) conservation not necessary pass through water treatment process require only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
Class 2	Very clean fresh surface water resources used for: (1) consumption which requires ordinary water treatment process before use (2) aquatic organism of conservation (3) fisheries (4) recreation
Class 3	Medium clean fresh surface water resources used for: (1) consumption, but passing through an ordinary treatment process before using (2) agriculture
Class 4	Fairly clean fresh surface water resources used for: (1) consumption, but requires special water treatment process before using (2) industry
Class 5	The sources which are not classification in class 1-4 and used for navigation

Source: PCD Web page: http://www.pcd.go.th/info_serv/en_reg_std_water05.html#s3

The Water Quality Class of Rivers

The values arranged in the table below show the classes as they are defined for water quality environmental standards. According to the environmental standards, an annual 20th percentile value (P20) for DO and 80th percentile value (P80) for BOD, TCB and FCB were used in determining the classifications.

Table 5-35: Summary of Water Quality Class Results (2006) for Mae Klong River

Point	DO P20	BOD P80	TCB P80	FCB P80
MK 01	Class3	Class2	Class3	Class3
MK 02	Class3	Class2	Class2	Class3
MK 03	Class3	Class4	Class2	Class3
MK04	Class3	Class3	Class3	Class3

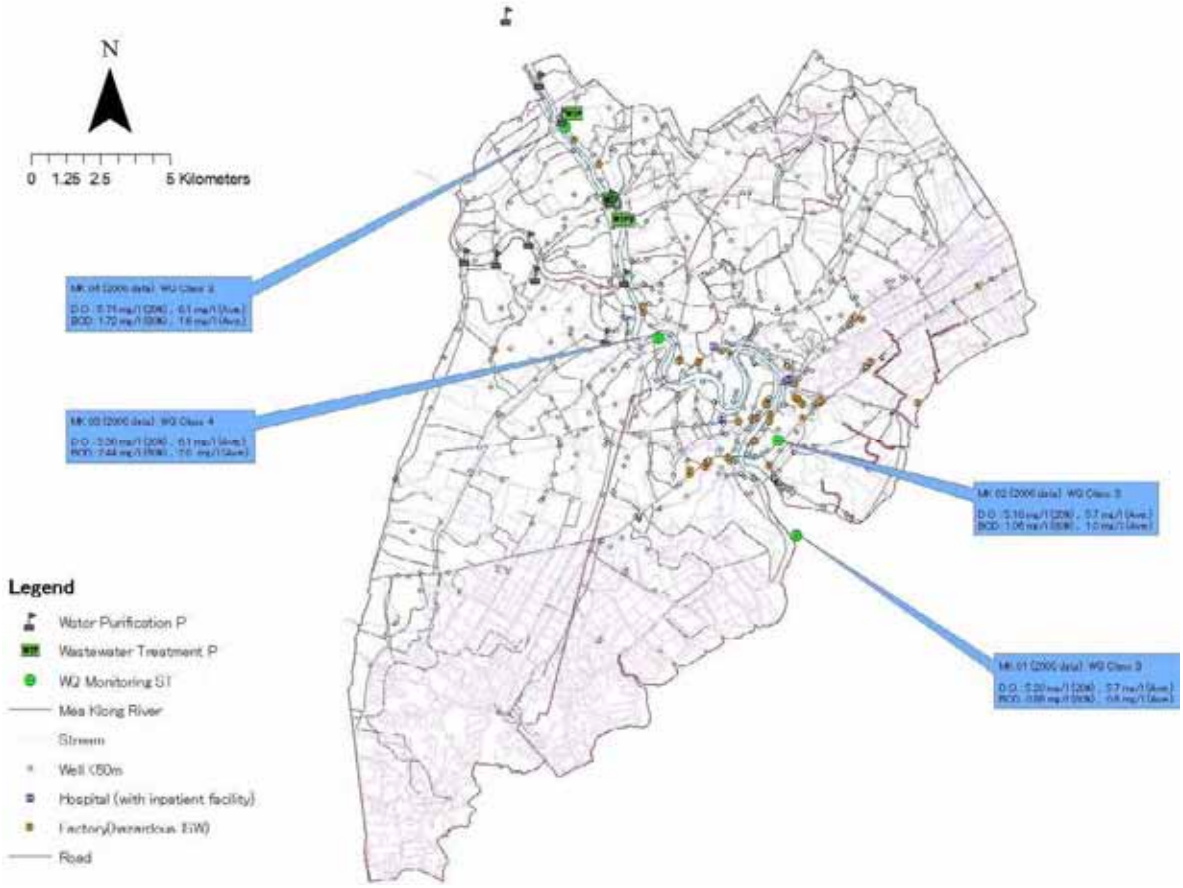
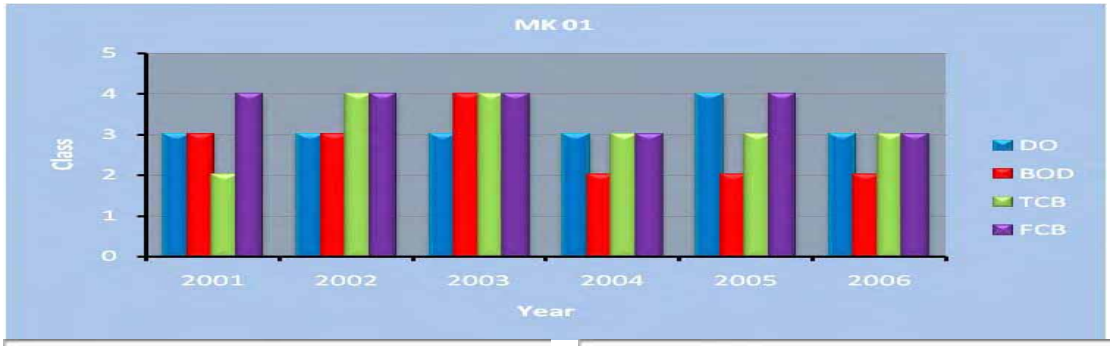


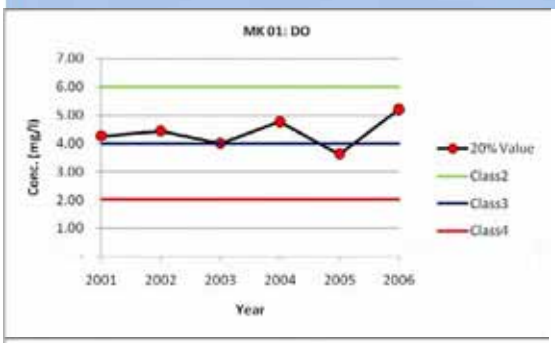
Figure 5-21: Summary of Monitoring Results (year 2006)

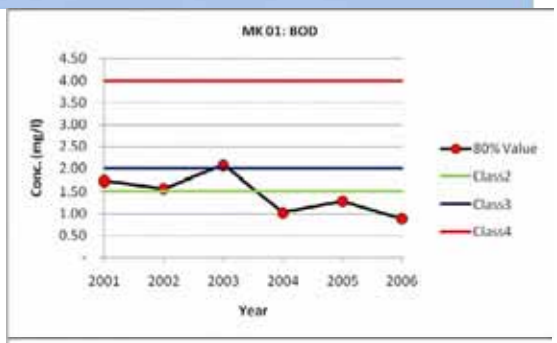
Characteristics of Mae Klong River

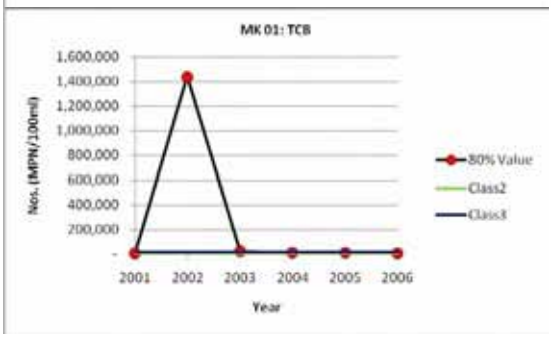
i. Monitored Values

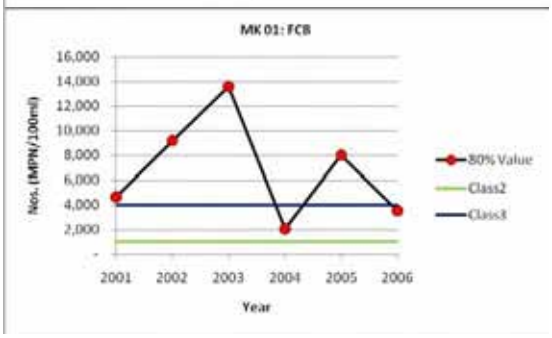
Changes in yearly water quality classification-related variables of the Mae Klong River from 2001 to 2006 are shown in the figures below.

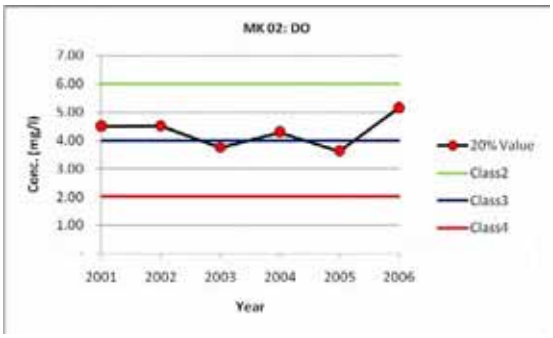


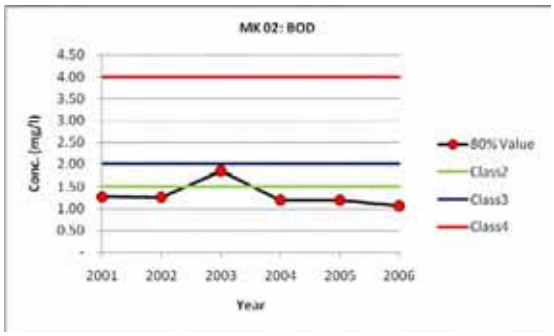


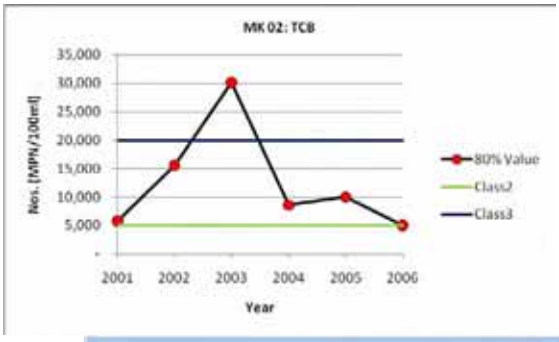


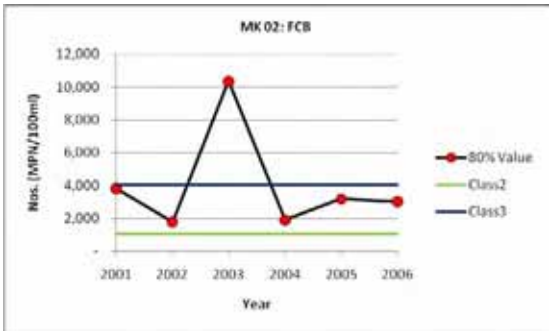


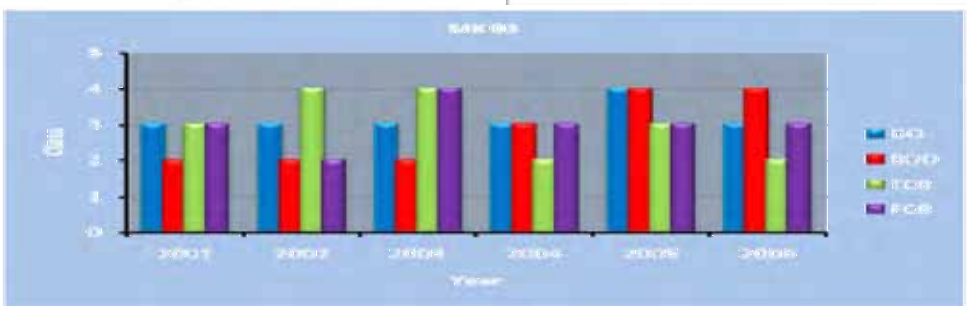


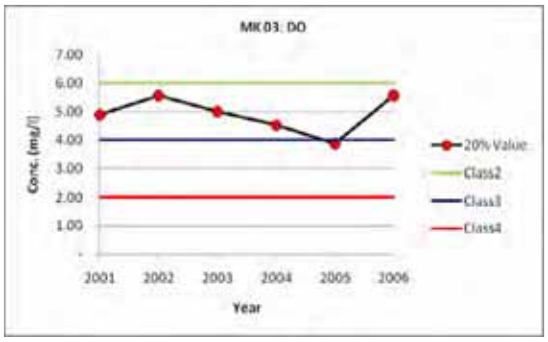

MK 02: DO
Conc. (mg/l)
Year
20% Value
Class2
Class3
Class4

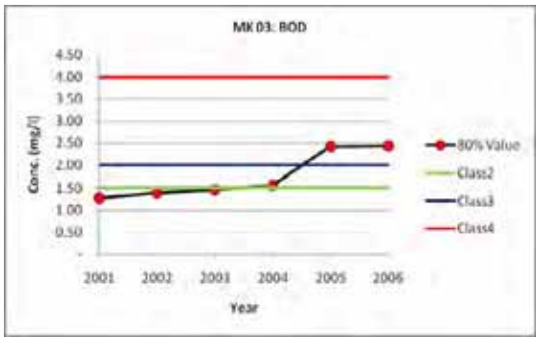

MK 02: BOD
Conc. (mg/l)
Year
80% Value
Class2
Class3
Class4

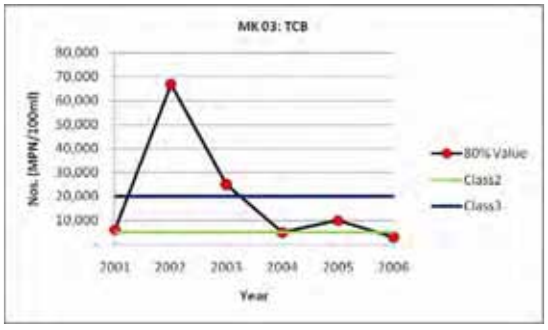

MK 02: TCB
Nos. (MPN/100ml)
Year
80% Value
Class2
Class3

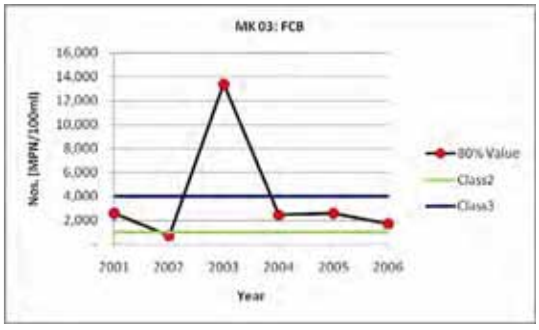

MK 02: FCB
Nos. (MPN/100ml)
Year
80% Value
Class2
Class3


Year


MK 03: DO
Conc. (mg/l)
Year
20% Value
Class2
Class3
Class4


MK 03: BOD
Conc. (mg/l)
Year
80% Value
Class2
Class3
Class4


MK 03: TCB
Nos. (MPN/100ml)
Year
80% Value
Class2
Class3


MK 03: FCB
Nos. (MPN/100ml)
Year
80% Value
Class2
Class3

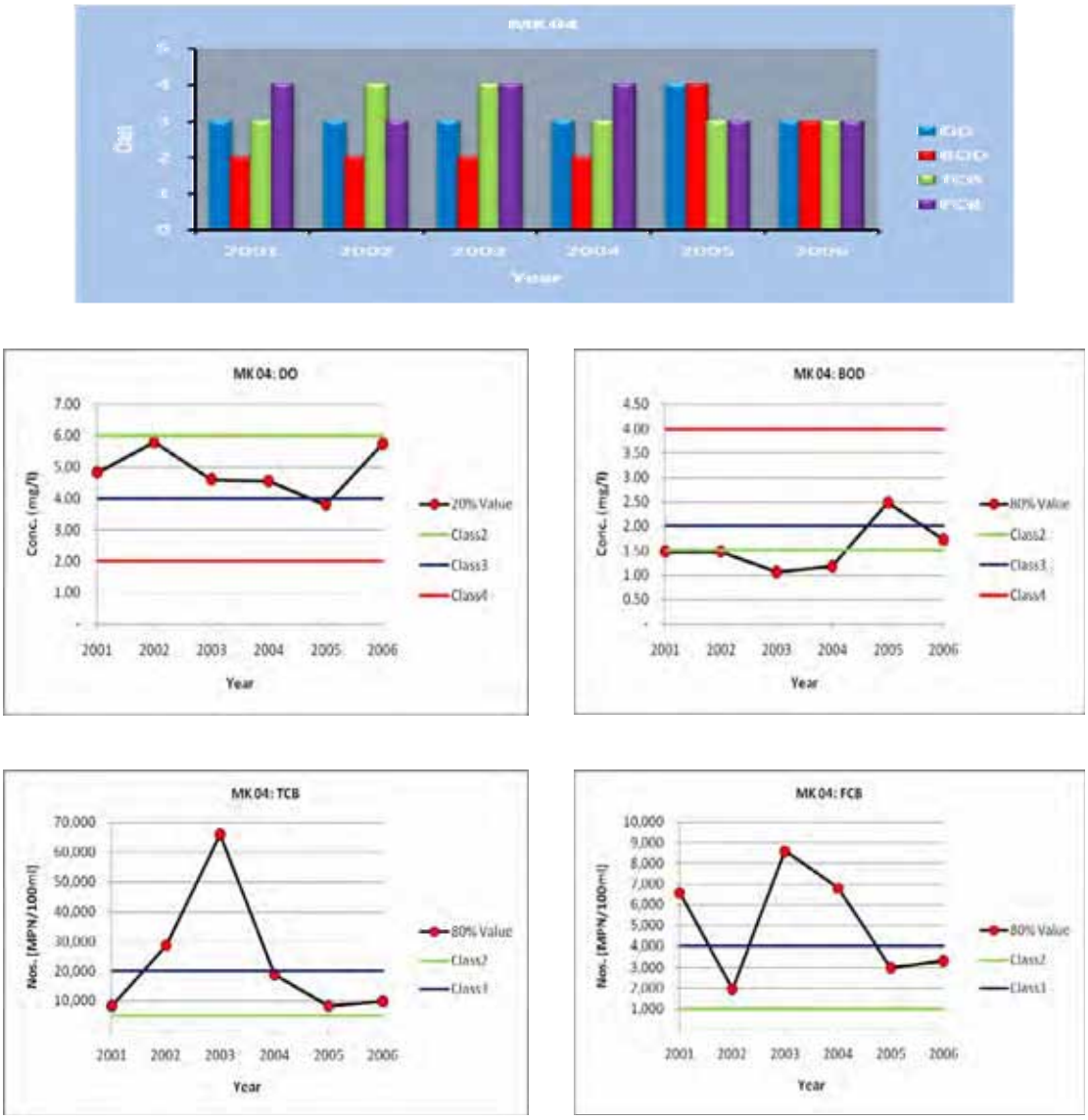


Figure 5-22: Change in Water Quality Classification in Mae Klong River

As indicated by the figure above, water quality shows little change or a tendency to worsen at each monitoring point.

ii. Heavy Metals

10 heavy metals and cyanide was analyzed. Results confirmed that all measurements were below the limits set by environmental standards, with the exception of Cd at MK 02 in 1999 (0.065mg/l, environmental standard: 0.005 mg/l) and at MK 01 in 2002 (0.01mg/l, environmental standard: 0.01 mg/l).

However, as these high values came up only once in the entire dataset per monitoring point, they can perhaps be ascribed to human error, such as database entry error or confusion in data management.

g.1.2. Coastal Sea Water Quality

PCD has examined the coastal sea water quality in 2006 at 3 stations in SKP, 500 meters from the coastal line. Testing was conducted twice -- February 25th, 2006 (hot season) and June 17th 2006 (rainy season). Tests found that DO levels were at standard level but Coliform

levels (for both hot and rainy season) were over limit. Details are provided in the following tables.

Table 5-36: Results of Coastal Sea Water Quality Examination 2006

Testing Stations (Coastal)	Test Results			
	DO (mg/l)		TCB (MPN/100 ml)	
	Hot Season	Rainy Season	Hot Season	Rainy Season
1. West of Mae Klong River Mouth	5.1	4.7	1,600	5,400
2. Mae Klong River Mouth	5.3	4.8	3,500	3,500
3. East of Mae Klong River Mouth	6.4	6.5	5,400	3,500

Table 5-37: Environmental Standards for Water Quality of Costal Water

Parameter	Unit	Methods for Examination	Type of Usage					
			Class1	Class2	Class3	Class4	Class5	Class6
1.FloatableSolids	-	Visual Testing	Not Objectionable					
2.Color	-	Visual Testing compare to Forel-Ule color scale	Not Objectionable					
3.Odour	-	Smell with measurement members not less than 3 persons and collect sample in glass bottle or TFE-line 2 bottles for 1 point. It should be measured immediately and comment of all member measurement must be unanimously	Not Objectionable					
4.Temperature	Degree Celcius	1) Thermometer	Change to increase not more than 1	Not change	Change to increase not more than 1	Change to increase not more than 2		
		2) Electrical Sensor Method						
5.pH	-	pH meter	7.0 - 8.5					
6.Transparency	-	Secchi disc for sea water measurement	Reduce from natural conditions not more than 10% from minimum point					
7.Suspension	-	Gravimetric Method	See Remark 1					
8.Salinity		1) Argentometric	Can be changed not more than 10% from minimum point					
		2) Electrical Conductivity Method						
		3) Density						
		4) Refractometer						
9.FloatableOil&Grease	-	Visual Testing	Not Visible					
10.PetroleumHydrocarbon	ug/l	Fluorescence Spectrophotometry	Not more than 0.5			Not more than 1	Not more than 5	
11.DO	mg/l	1) Azide Modification Method	Not less than 4	Not less than 6	Not less than 4			
		2) Membrane Electrode Method						
		3) Wrinkler Method						
12TotalColiformBacteria	MPN/100ml	Multiple Tube Fermentation Technique	Not more than 1000					
13.FecalColiformBacteria	CFU/100ml	Membrane Filter Technique	Not more than 70			Not more than 100		
14.EnterococciBacteria	CFU/100ml	Membrane Filter Technique	-	Not more than 35	-	Not more than 35	-	-
15.NO3-N	ug-N/l	Cadmium Reduction Method to NO2- and follow by Colorimetric Method	Not more than 20	Not more than 60				
16.PO4-P	ug-P/l	Colorimetric Method	Not more than 15		Not more than 45	Not more than 15	Not more than 45	
17.NH3-N	ug-N/l	Phenol-Hypochlorite Method	Not more than 70		Not more than 100	Not more than 70		
18.TotalHg	ug/l	1) Cold-Vapor/Hydride GenerationAtomic Absorption Spectrometric Method	Not more than 0.1					
		2) Cold-Vapor/Hydride Generation-Atomic Fluorescence Spectrometric Method						
		3) Inductively Coupled Plasma						
19.Cadmium(Cd)	ug/l	1) Electrothermal Atomic Absorption Spectrometric Method	Not more than 5					
20.Chromium(Cr)	ug/l	2) Inductively Coupled Plasma Method	Not more than 100					
21.CromiumHexavalent	ug/l	1) Pre-concentration follow by Electrothermal Atomic Absorption Spectrometric Method	Not more than 50					
(Cr-Hexavalent)		2) Inductively Coupled Plasma Method						
22.Lead(Pb)	ug/l	1) Electrothermal Atomic Absorption Spectrometric Method	Not more than 8.5					
23.Copper(Cu)	ug/l	2) Inductively Coupled Plasma Method	Not more than 8					
24.Manganese(Mn)	ug/l	1) Pre-concentration follow by Flame Atomic Absorption Spectrometric Method	Not more than 100					
25.Zinc(Zn)	ug/l	2) Electrothermal Atomic Absorption Spectrometric Method	Not more than 50					
26.Iron(Fe)	ug/l	3) Inductively Coupled Plasma Method	Not more than 300					
27.Fluoride(F)	ug/l	SPADNS Colorimetric Method	Not more than 1					
28.ResidualChlorine	ug/l	N,N-diethyl-p-phenylenediamine Method	-	-	-	-	Not more than 0.01	
29.Phenols	ug/l	Distillation follow by 4-Aminoantipyrine Colorimetric Method	Not more than 0.03					
30.Sulfide	ug/l	Methylene Blue Colorimetric Method	Not more than 10					
31.Cyanide	ug/l	Pyridine-Barbituric Acid Colorimetric Method	Not more than 7					
32.PCB	ug/l	Gas Chromatography with Electron capture Detector	Could not detect					
33.TotalOrganochlorine Pesticides	-	1) Gas Chromatography with Mass Spectrophotometry	See Remark 2					
		2) Highly Performance Liquid Chromatography (HPLC)						
34.Arsenic	ug/l	1) Hydride Generation Atomic Absorption Spectrometric Method the sample must be crushed before measurement	Not more than 10					
		2) Electrothermal Atomic Absorption Spectrometric Method						
		3) Inductively Coupled Plasma Method with free Chloride disturbance system						
35.Radioactivity(Becquerel/l)	ug/l	o-precipitation	Not more than 0.1					
-AlphaGross		Evaporation Method	Not more than 1.0					
-BetaGross(naturalpotassium40notincluded)		Method						
		Gamma Spectrometry (USEPA) Method or calculate from						
		Salinity						
36.Tributyltin	ng/l	1) Gas Chromatography with Flame Photometric Detector	Not more than 10					
		2) Gas Chromatography with Mass Spectrophotometry						
		3) Highly Performance Liquid Chromatography -ICPMS						

1/ Standard value of suspension can be increased not more than sum of average value 1 day or 1 year plus standard deviation of the average value. For ex ample, average value of 1 day has to measure every hour or at least 5 times with the same time period, average value of 1 month has to measure every day or at least 4 times (at the same time period in 1 month), average value of 1 year has to measure every month on same day and same time.
2/ Hazardous Chemicals and Pesticides with Chlorine

- Standard value of Aldrin for all usages must not more than 1.3 microgram/l
- Standard value of Chlordane for all usages must not more than 0.004 mg/l
- Standard value of DDT for all usages must not more than 0.001 mg/l
- Standard value of Dieldrin for all usages must not more than 0.0019 mg/l
- Standard value of Aldrin for all usages must not more than 0.0023 mg/l
- Standard value of Endosulfan for all usages must not more than 0.0087 mg/l
- Standard value of Heptacror for all usages must not more than 0.0036 mg.l
- Standard value of Lindane for all usages must not more than 0.16 mg/l
- Standard value of Alachlor, Ametryn, Atrazine, Carbaryl, Carbendazim, Chlorpyrifos, Cypermethrin, 2,4-D, Diuron Glyphosate, Malathion, Mancozeb, Methyl parathion, Parathion, and Propanil must not detect with assigned analysis method

Source : Notification of the National Environmental Board No. 27 (Year 2006) on Coastal Water Quality Standard, published in the Royal Government Gazette Vol. 124, Part 11 ngor, dated February 1st, 2007

The definition of each class in the environmental water quality standards are given in the following Table.

Table 5-38: Classification of Costal Water

Class	Description
1	Natural resources conservation
2	Coral conservation
3	Water for Coastal Farms
4	For recreation (water contact sports, swimming)
5	Nearby industrial estate and/or port
6	Nearby populated area

Although the environmental standards for coastal water quality lists 36 items, only two measurements, DO and TCB, are available. The evaluation of the two items is presented below.

- DO: Results show the coastal water quality of SKP is Class 1, or between Class 3 to 6. Since Class 2 of DO is for coral conservation, and as the coastal area of SKP do not have coral reef, results of DO measurement satisfy the environmental standards.
- TCB (total coliform bacteria): Results show TCB levels over 1,000MNP/100ml, and the coastal sea water quality of SKP does not satisfy the environmental standards. This fact indicates that huge amounts of human and animal fecal matter/urine are discharged into the coastal area without treatment.

g.1.3. Water Pollution Sources

The largest water pollution sources are considered to be as follows:

- Sources of domestic wastewater; densely populated areas like urban areas,
- Sources of highly polluted industrial wastewater; factories, slaughterhouses, livestock barns, etc.,
- Leachates from final solid waste disposal sites.

As for the problems with domestic wastewater, it is common for developers to circumvent the wastewater discharge standard by building less than 100 houses per development project. Through such a manouver, the construction of a central domestic wastewater treatment facility can be avoided, which would have been required for larger projects[5]. Consequently housing development projects have become large pollution sources of domestic wastewater.

[5] Housing Estate Standards, PCD, http://www.pcd.go.th/info_serv/en_reg_std_water04.html#s4

The coverage rate of the sewerage system in SKP is only about 6%[6]. However, 22% of human feces and urine is treated by septic tanks according to the opinion survey.

There is no solid waste disposal site in SKP.

Main water pollution sources are shown in the figure below:

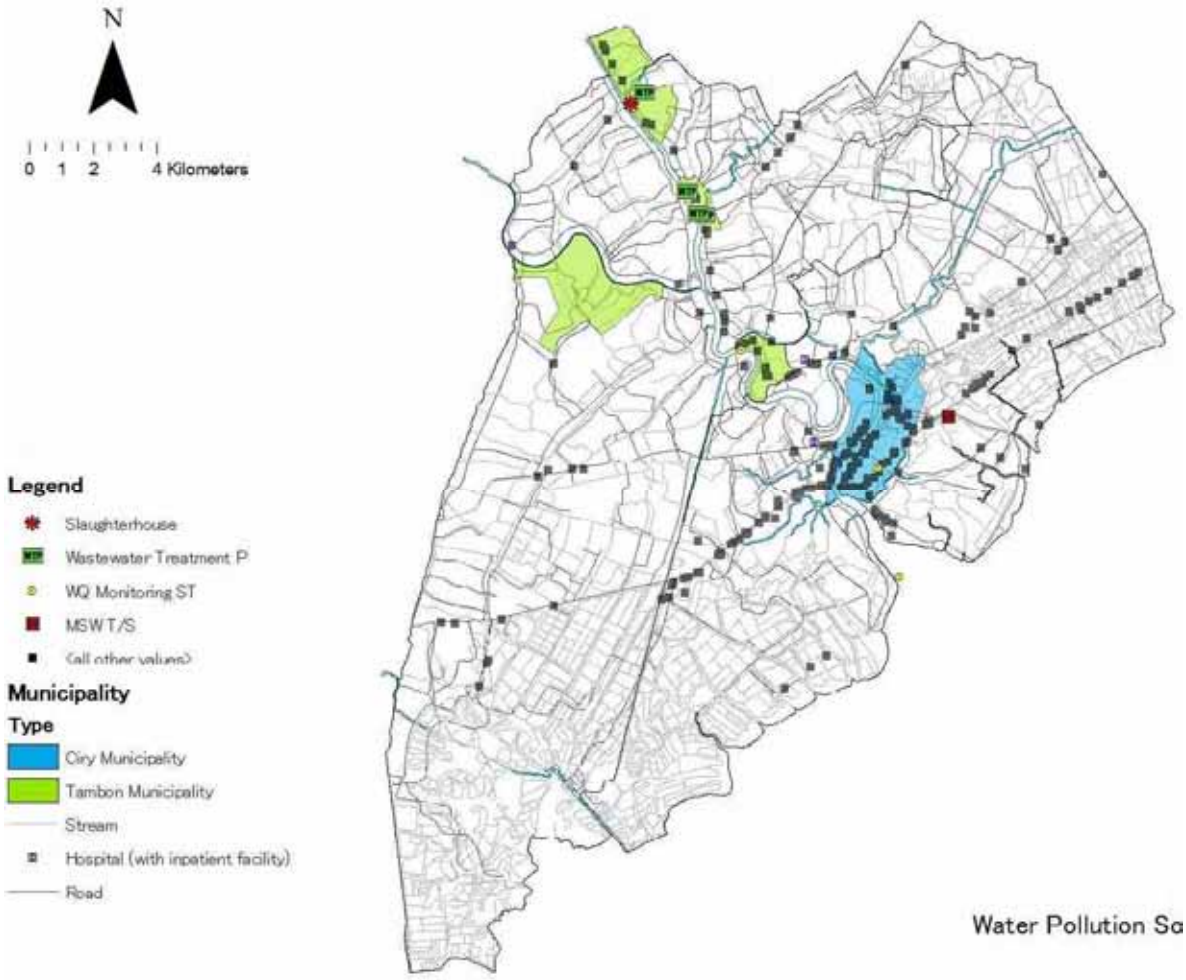


Figure 5-23: Location Map of Water Pollution Sources in SKP

g.1.4. Water Utilization Facilities

River water and groundwater are utilized as sources of potable, irrigation and industry water. The following figure shows interrelation between water pollution sources, mentioned above, and water utilization facilities.

[6] Opinion Survey to LA in AYP /JICA Study Team/2007

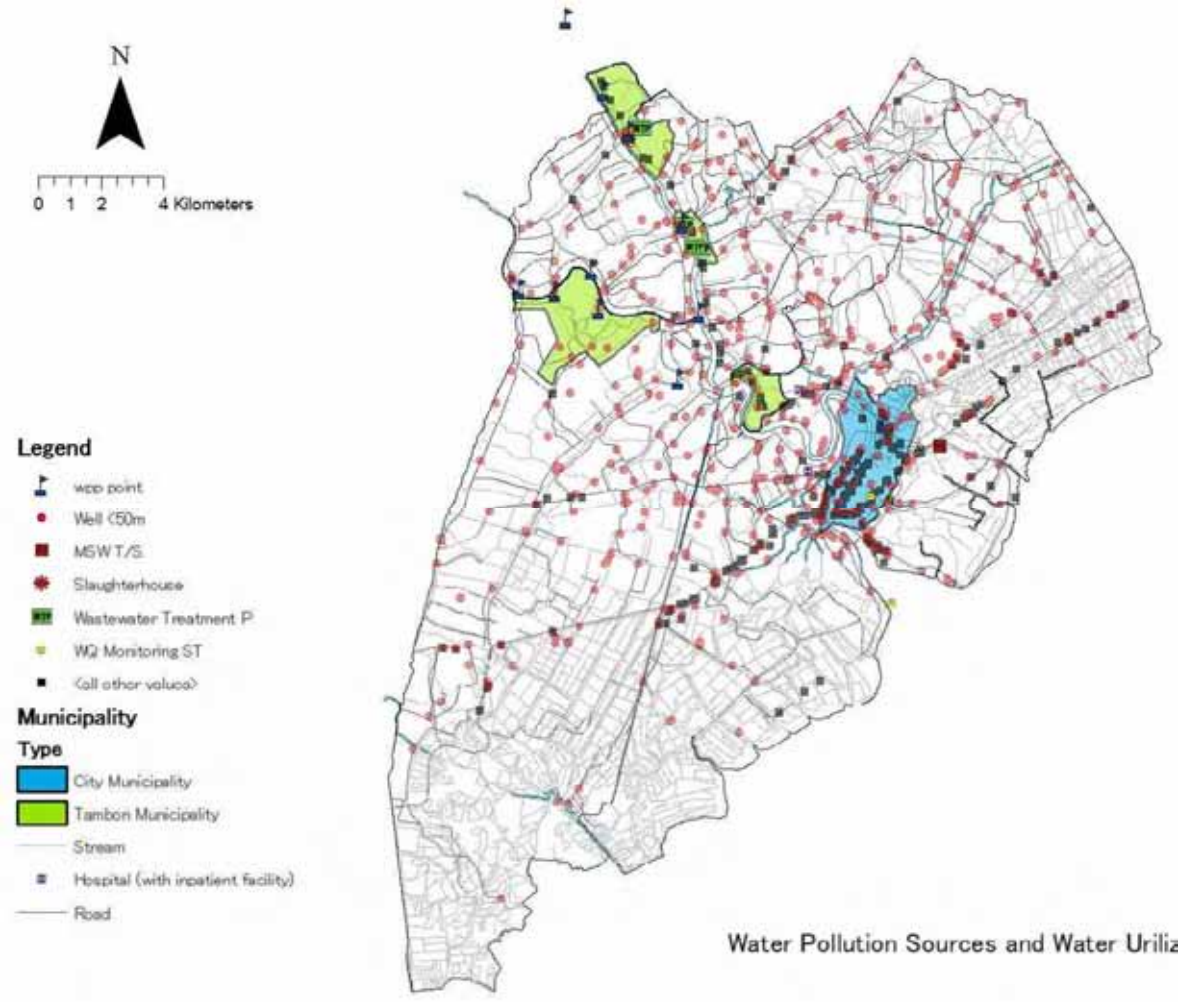


Figure 5-24: Location Map of Major Water Utilization Facilities in SKP

g.2 Impact Analysis

g.2.1. Number of Complaints

Most of the complaints submitted to the PEO were related to water. 13 out of 16 complaints were on water issues. Out of 13 complaints, all were about wastewater. 3 complaints were about wastewater from housing estates and 9 complaints were about wastewater from small factories, such as coconut processing factories and fish processing factories.

Table 5-39: Number of Complaints Regarding Water Quality

Year	Total No of Complaints on NRE	No of Complaints on Water Issues	%
2002	0	0	0
2003	2	2	100
2004	1	1	100
2005	7	5	71.4
2006	16	13	81.2

g.2.2. Result of the Opinion Survey

Results of the opinion survey on water quality are shown below.

Table 5-40: Result of the Opinion Survey on Water Quality

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	44%	36%	19%	0%	0%	0%	100%
Resident	55%	13%	23%	10%	2%	0%	100%
BE	51%	13%	23%	11%	1%	0%	100%

Source: JICA study in 2007

According to the opinion survey in the JICA study, 80% of LAs, 68% of the residents, and 64% of business enterprises (BE) replied that problems with water quality are "Not serious at all" or "Not very serious".

Among those who replied that problems are very serious, the reasons indicated were as follows.

Table 5-41: Specific Aspects and Reasons for Concern about Water Quality

Target Group	Aspects of Concern	Reasons for Concern
LA	Wastewater from neighboring province	Loss of marine species
	Factory discharged wastewater to the Mae Klong River	Loss of marine species
Resident	Garbage dumped into canals	Causes water pollution
	Waste water	Causes damage to aquaculture
	Low quality of ground water	Groundwater cannot be used
BE	Garbage dumped into canals	Causes water pollution
	Waste water	Causes damage to aquaculture
	Low quality of ground water	Groundwater cannot be used

g.2.3. Impact

Water quality shows little change or slight worsening at each monitoring point, MK 01, MK 02 and MK 03. On the assumption that the same conditions (amount of pollutant, treatment, etc.) continue into the future, water quality in Mae Klong River will worsen compared with the current situation.

g.3 Issues

Figure 5-23 and Figure 5-24 show the proximity of water pollution sources to water utilization facilities. Polluted water taken from public water bodies and passed on to customers (via water supply facilities such as water purification plants and wells) can seriously affect human health. If water pollution becomes serious, either higher costs of purification have to be paid or the water remains unsuitable for human consumption.

The river water quality in SKP is maintained at Class 3 or 4, not Class 5 at which point the water quality is not suitable for water supply. However, it is feared that the water source will have to be switched from Mae Klong River to groundwater if water quality worsens further. Since the scale of the water purification plants are small, with capacities of about 1,000 m^3/day on average, switching the water source will not be difficult. However, it will be

difficult to switch water sources for a larger-scale plant, with a capacity of more than several ten thousand m^3/day. Thus it is important to preserve river water from pollution. Accordingly, the following priority issues are pointed out:

- Provision of safe and qualified water supply
- Preservation of water quality of public water bodies

g.4 Measures to be Taken

For the provision of safe and qualified water supply, the following measures need to be taken:

- Study on current water supply system,
- Study the current and future water demand and supply,
- Formulation of an integrated water supply plan,
- Improvement of the water supply system in accordance with the integrated water supply plan.

For the preservation of water quality of public water bodies, the following measures are required for each major pollution source:

- Appropriate treatment of domestic wastewater,
- Appropriate treatment of factory wastewater, agricultural and livestock wastewater, etc.,
- Prevent water bodies from contamination by illegal dumping of solid waste.

The measures mentioned above consist of short and long term measures as follows:

Short term:

- Effective use of water quality monitoring results (information disclosure and increased understanding of the condition of water bodies through monitoring),
- Study of current wastewater management system,
- Formulation of an integrated wastewater management plan,
- Support the use of septic tanks for basic treatment of wastewater,
- Control of housing development and building construction projects by LAs, in accordance with Housing Estate and Building Effluent Standards, for increased wastewater treatment from housing estates and buildings,
- Prevent business enterprises from discharging wastewater into public water bodies without treatment,
- Raise awareness of residents in order to prevent illegal dumping into canals.

Long term:

- Improvement of wastewater management system in accordance with the integrated wastewater management plan.

h. Air Quality

h.1 Situation

h.1.1. Location of Air Monitoring Point

There is no continuously operating air monitoring station in SKP, but REO 8 is monitoring PM-10 at two air quality stations. PM-10 levels were recorded five times at the first station and four times at the second station from February 2006 to July 2007. The locations of monitoring points are shown in the figure below.

Station No.1	In front of Samut Songkhram City Hall, along Samut Songkhram-Bang Pae Rd.
Station No.2	Police booth at Somdej Phra Si Suriyen Bridge Intersection, Amphawa District

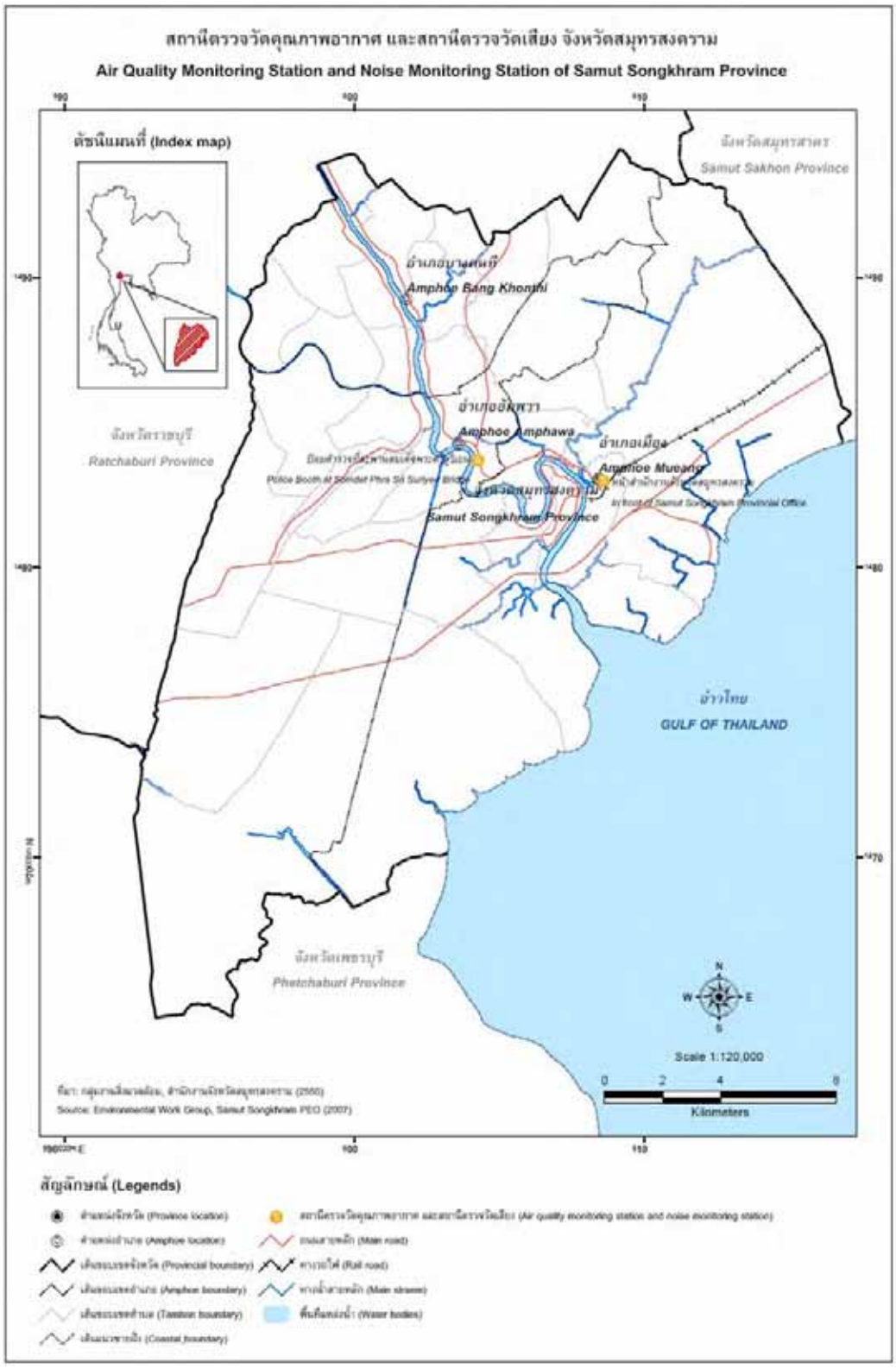


Figure 5-25: Locations of Air Quality Monitoring Stations in SKP

h.1.2. Monitored Values

PM-10 (24-hour average) is the only value monitored in SKP. Noise was also monitored at the same time.

h.1.3. Environmental Standard for Air Quality

The environment standard for PM-10 is set as follows.

24-hour average < 0.12 mg/m^3 (ref. in Japan, 24-hour average < 0.10mg/m3),

1 year average < 0.05 mg/m^3 (no comparative standard in Japan)

h.1.4. Monitoring Results

The monitoring results of PM-10 (24-hour average) are shown in the table below. Concentrations of PM-10 at Station No.1 were between 0.042 - 0.100 mg/m^3, those at Station No.2 were between 0.032 - 0.078 mg/m^3. All the results are below the limit of 0.12 mg/m^3.

Table 5-42: Monitoring Results of PM-10 (24-Hour Average)

Date	10 Feb 2006	25 May 2006	21 Sep 2006	10 Jan 2007	19-20 July 2007	Standard for 24-hour average
	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3
Station No.1	0.067	0.044	0.042	0.100	0.081	0.12
Station No.2	---	0.038	0.032	0.078	0.068	

Source : Samut Songkhram PEO

Monitoring results from February 2006 to August 2007 are shown below. The number of monitoring events is quite low, but all data points satisfy the environmental standard. PM-10 levels at Station No.1 were worse than those at Station No.2. It is difficult to assess the trends by year or season because of the sparse dataset. Other values for assessing air quality were not measured.

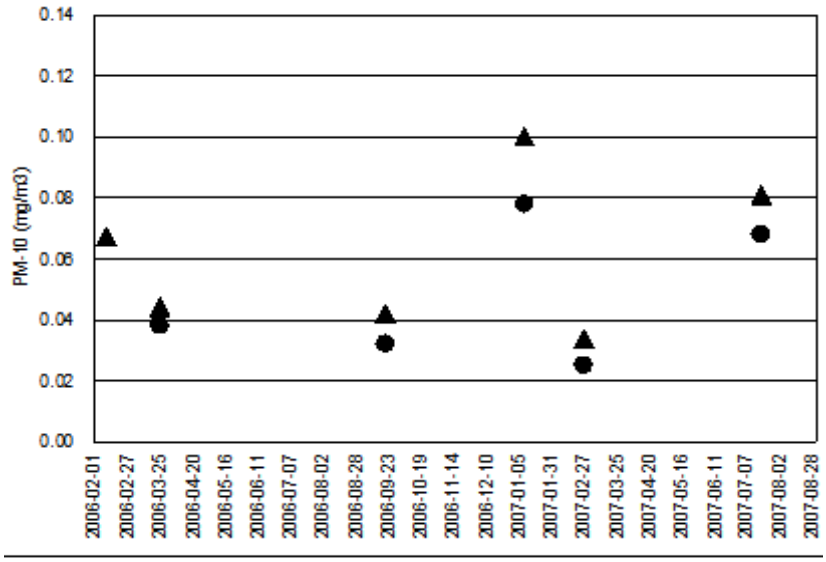


Figure 5-26: PM-10 (24-Hour Average) Values in SKP

h.2 Impact Analysis

h.2.1. Number of Complaints

There were two complaints regarding air quality in 2005 and one in 2006. Air quality does not seem to be a problem in SKP.

Table 5-43: Number of Complaints Regarding Air Quality

Year	Total No of Complaints on NRE	No of Complaints on Air Quality	%
2002	0	0	0
2003	2	0	0
2004	1	0	0
2005	7	2	28.6
2006	16	1	6.3

h.2.2. Result of the Opinion Survey

Results of the opinion survey on air quality are shown below.

Table 5-44: Result of the Opinion Survey on Air Quality

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	89%	8%	3%	0%	0%	0%	100%
Resident	73%	14%	13%	0%	0%	0%	100%
BE	74%	6%	19%	0%	0%	0%	100%

Source: JICA Study in 2007

Based on an opinion survey of LAs, residents and business enterprises (BE) regarding natural resources and environment, the number of people who replied that air quality is a serious problem is zero.

h.2.3. Impact

There is no problem relating to air quality in SKP at this moment. It is recommended that a portable monitoring unit is used and that air quality be monitored regularly.

h.3 Issues of Air Quality

- Because the only item regularly measured is PM-10, there is no other data for air quality items,
- Air quality has low priority in terms of environment management in SKP.

h.4 Measures to be Taken

- Use a Movable Air Monitoring Unit to grasp the condition of air pollution,
- Monitor more values listed in air quality environmental standards items (carbon monoxide, nitrogen dioxide, sulphur dioxide, dust (PM-10), ozone, lead and VOCs) using moveable air monitoring unit.

i. Noise and Vibration

i.1 Situation

i.1.1. Locations of Noise Measurements

There are no stations to take regular measurements of noise and vibration in SKP. Noise at major roads is measured regularly at two locations (together with air quality). No measurements are taken for vibration.

There two locations where noise is measured is shown in Figure 5-25.

i.1.2. Results of Measurements

Results of noise level measurements are shown below. All measurements were within limits set by the standard.

Table 5-45: Noise Levels (24-Hour Average) in SKP

Date	10 Feb 2006	25 May 2006	21 Sep 2006	10 Jan 2007	19-20 July 2007	Standard for 24-hour average
	dB A	dB A	dB A	dB A	dB A	dB A
Station No.1	59.8	66.2	65.8	68.5	70.0	70
Station No.2	---	67.9	68.9	66.2	68.9	

Source: Samut Songkhram PEO

i.2 Impact Analysis

i.2.1. Number of Complaints

The following number of complaints was received by the PEO concerning noise.

Table 5-46: Number of Complaints regarding Noise (SKP)

Year	Total No. of Complaints on NRE	No. of Complaints on Noise	%
2002	0	0	0
2003	2	0	0
2004	1	0	0
2005	7	0	0
2006	16	2	12.5

i.2.2. Result of the Opinion Survey

Result of the opinion survey on noise and vibration is shown below.

Table 5-47: Result of the Opinion Survey on Noise and Vibration

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	81%	8%	8%	3%	0%	0%	100%
Resident	73%	17%	6%	0%	0%	0%	100%
BE	74%	11%	15%	0%	0%	0%	100%

Source: JICA study in 2007

In general, sources of noise and vibration are factories with crushing machines, large vehicles or building construction. However, responses to the opinion survey did not indicate any problems except for noise complaints about boats with outboard motors used for viewing fireflies.

i.2.3. Impact

Impact by noise is felt through noise from outboard motors on boats used for firefly viewing.

Vibration was not assessed because no measurements were carried out.

i.3 Issues

There is a problem with noise from outboard motors on boats used for firefly viewing. It is necessary to come up with a measure for this problem.

i.4 Measures to be taken

- The province will cooperate with the central administration offices and REO to set up standards on when, where, and how much noise can be tolerated and come up with measures to prevent problems before they happen.
- Promote the use of low-noise emitting outboard motors for firefly-viewing boats and provide support through subsidies etc. as necessary.

j. Solid Waste

j.1 Situation

j.1.1. Solid Waste Management Facilities

There are no final disposal sites located inside SKP, but there is one transfer station in Amphoe Mueang Samut Songkhram. All colleted wastes are transported to the disposal site in neighboring Ratchaburi and Samut Sakhon Province.

A final disposal site was constructed in 1997 in Tambon Ladjai using the Environmental Fund, but it was closed in 2001 due to the opposition from surrounding residents.

Below are the locations of solid waste management-related facilities in SKP.

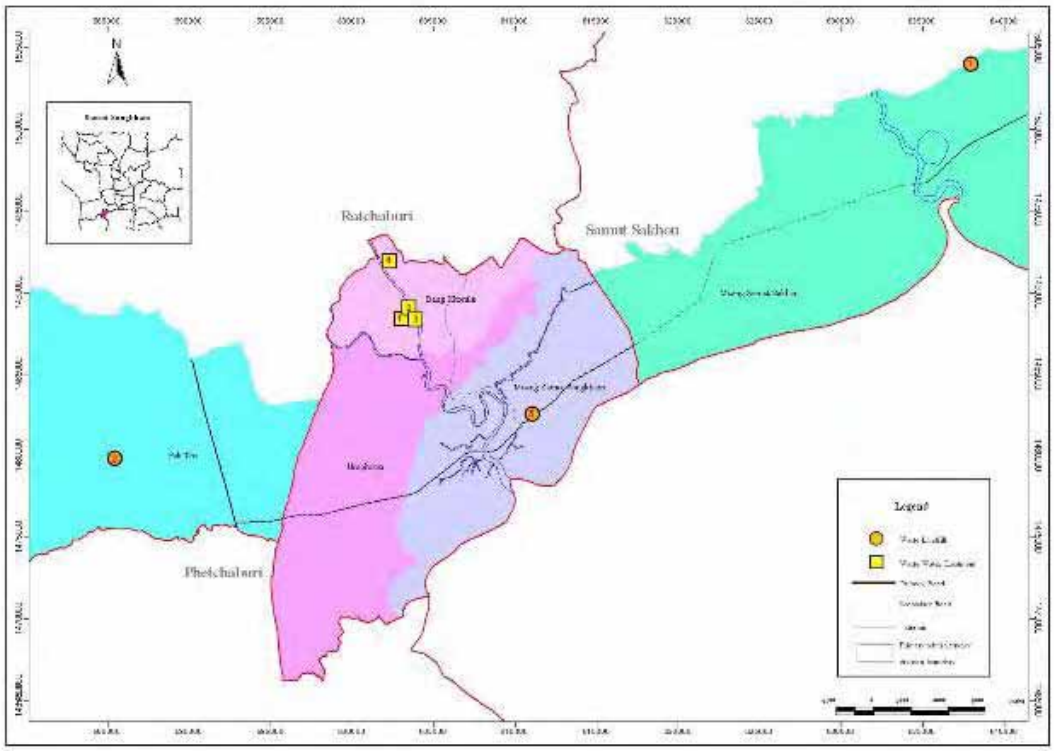


Figure 5-27: Location of Transfer Stations and Disposal Sites in Neighboring Provinces

j.1.2. Generation Amount

The amount of waste generated and collected is described in the report "State of Environment 2006 by REO 8". An opinion survey was conducted with all five Tessaban, but not with Orbortor. The amount of waste generated in Tessaban is 43 ton/day as shown in the following table.

Table 5-48: Waste Generation in Municipalities

Tessaban Name	Registered Population (person)	Nonregistered Population (person)	Total Population (person)	Waste Generation (ton/day)	Waste Collection (ton/day)	Waste Collection Rate (%)	Waste Generation Rate (kg/person/day)
Tessaban Mueang Samut Songkram	35,168	0	35,168	30	30	100	0.85
Tessaban Tambon Mhueangmai	2,242	0	2,242	1	1	100	0.45
Tessaban Tambon Bang Nok Kwaag	1,855	200	2,055	2	2	100	0.97
Tessaban Tambon Kradang-nga	2,372	0	2,372	2	2	100	0.84
Tessaban Tambon Amphawa	5,871	400	6,271	8	5	62.5	1.28
Total	**47,508**	**600**	**48,108**	**43**	**40**		**0.88**

Source: State of Environment 2006 by REO 8

Furthermore, the following data was given in the PEQMP-KPI:

Table 5-49: Solid Waste Amount in SKP

Item	Tessaban		Orbortor		Total	
	Ton/day	%	Ton/day	%	Ton/day	%
Waste Generation	41.3		-		-	
Waste Collection	38.5	93	-		-	
Uncollected Waste	2.8	7	-		-	

This table excludes the amount of waste generated in Orbortor, and therefore the waste generation rate was estimated using the unit generation amount of 0.5 kg/person/day[7] as follows:

Table 5-50: Waste Generation Amount in SKP

Item	Unit	Tessaban	Orbortor	Total
Waste Generation	(t/day)	41.3	75.9*[1]	117.2
Population in 2005	(Person)	43,184	151,884	195,068
Waste Generation Rate	(kg/day/person)	0.956	0.500	0.601

*[1]: estimated using the unit waste generation amount.

Based on the above table, the amount of waste generated per day is around 41 ton/day in Tessaban and around 76 ton/day in Orbortor. The amount of waste generated overall in SKP is around 117 ton/day.

j.1.3. Collection Rate

The collection rate in Tessaban is 93% according to PEO. There is no data available for waste collection in Orbortor, but based on information that almost all waste in SKP is transported to a transfer station, and that the daily amount of waste taken to the transfer station reportedly is around 100 ton/day, the collection rate in Orbortor was estimated as follows:

Table 5-51: Waste Amount and Collection Rate in SKP

Item	Tessaban		Orbortor		Total	
	Ton/day	%	Ton/day	%	Ton/day	%
Waste Generation	41.3		75.9		117.2	
Waste Collection	38.5	93	61.5	81.0	100	85.3
Uncollected Waste	2.8	7	14.4	19.0	17.2	14.7

Accordingly, the collection rates in SKP are estimated to be 93% in Tessaban and 81% in Orbortor, with an overall average of 85%.

According to the opinion survey among LAs, 25 LAs out of 35 are providing collection services in their entire area, while seven LAs provide service for parts of their area. Therefore, 91% of LAs are providing collection services at least in part.

j.1.4. Waste Generation Rate per Person per Day

Waste generation rates per person per day is 0.956 kg/person/day in Tessaban and 0.50 kg/person/day in Orbortor, with an overall average of 0.601 kg/person/day.

[7] Unit generation amount of 0.5 kg/person/day is usually used for Orbortor, according to PEO of SKP.

j.1.5. Transfer Station

There are no final disposal sites in SKP, but one transfer station exists. It is located in Amphoe Mueang, Tambon Bang Kae and is owned an operated by a private company (Siripaiboon Pattanakan Ltd.). This company also transports wastes from the transfer station to the final disposal site which is located in Ratchaburi Province.

Figure 5-28: General View of Transfer Station in SKP

The storage area at this transfer station was surrounded by a net fence to prevent waste from scattering in high winds. Another facility at the transfer station was the leachate collection pond sealed at the bottom and sides with plastic sheeting.

j.1.6. Waste Collection and Transportation

82% of LAs use a private company to collect and transport waste, while only 8% of LAs provide their own waste collection services.[8]

j.1.7. Final Disposal Site

There is one final disposal site, which is now closed, in Tambon Ladjai in Amphoe Mueang Samut Songkhram. The site has an area of 60 rai and was constructed in 1997 using the Environmental Fund subsidy of MOSTE (predecessor to MNRE). The site has a weigh bridge, water tank, and a parking area for heavy machinery for sanitary operations. However, improper operation, such as the leakage of leachate into surrounding shrimp farms, caused large protests from surrounding residents and its existence became a political issue. Site operation stopped in 2001. The site is located in a suitable place with the nearest house around 700 meters away. There are currently no final disposal sites within SKP and all wastes are transported to neighboring provinces, such as Ratchaburi or Samut Sakhon.

[8] OP-LA-SKP


Entrance Gate


Weigh Bridge


Leachate Pond


Storage Area for Heavy Machinery

Figure 5-29: Tambon Ladjai Disposal Site

According to the opinion survey, 65% of LAs opposed the construction of a disposal site within their area and 26% replied that it is quite difficult to construct.[9]

The final disposal site in Ratchaburi Province is located around 20 km west from the centre of SKP. A large borrow pit left after excavating soil was used as the disposal site and wastes are simply dumped into the pit without any soil cover or leachate treatment.

j.2 Impact Analysis

j.2.1. Number of Complaints

The number of complaints reported to the PEO regarding natural resources and environment is increasing year by year, but none of the 16 complaints received in 2006 were related to odor. It is assumed that one of the reasons why there are no complaints about odor is that there are no disposal sites in SKP.

Table 5-52: Number of Complaints regarding Natural Resources and Environment

Year	Number of Complaints				Total Number
	Water	Air	Noise	Odor	
2002	0	0	0	0	0
2003	2	0	0	0	2
2004	1	0	0	0	1
2005	5	2	0	0	7
2006	13	1	2	0	16

[9] OP-LA-SKP

j.2.2. Result of Opinion Survey

The results of the opinion survey on solid waste are shown below.

Table 5-53: Result of the Opinion Survey on Solid Waste

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	14%	31%	28%	28%	0%	0%	100%
Resident	50%	23%	23%	3%	0%	0%	100%
BE	51%	13%	23%	11%	2%	0%	100%

Source: JICA study in 2007

According to the opinion survey by the Study Team, 73% of the residents and 64% of business enterprises replied that problems with waste management are "Not serious at all" or "Not very serious". In contrast, 56% of the LAs replied that the problems with waste management are "Very serious" or "Somewhat serious".
Among those who replied that problems are very serious, the reasons indicated were as follows.

Table 5-54: Specific Aspects and Reasons for Concern about Solid Waste

Target Group	Aspects of Concern	Reasons for Concern
LAs	Large amounts of garbage are not managed properly	Causes serious environmental problems
	Private contractor does not manage the transfer station properly	Causes serious environmental problems
Residents	Dump garbage into canals	Causes water pollution
	Large amounts of garbage are not managed properly	Causes serious environmental problems
BE	Dump garbage into canals	Causes water pollution
	Large amounts of garbage are not managed properly	Causes serious environmental problems

j.2.3. Impact

Future Generation

The rate of generation of municipal waste was forecast under the following conditions:

- The rate at which waste is generated does not increase. Therefore, the amount of generation is in proportion to the increase of population,
- The figures of 0.956kg/person/day for Tessaban and 0.500kg/person/day for Orbortor are used as the rate of generation,
- Proportion of population in Tessaban and Orbortor are 22.1% and 77.9% respectively and will not change from 2005 to 2011.

Table 5-55: Forecast of Generation Amount of Municipal Waste (SKP)

Year	Population			Generation Amount of Municipal Waste		
	Tessaban	Orbortor	Total	Tessaban	Orbortor	Total
				ton/day	ton/day	ton/day
2005	43,184	151,884	195,068	41.3	75.9	117.2
2006	42,486	149,759	192,245	40.6	74.9	115.5
2007	41,862	147,560	189,422	40.0	73.8	113.8
2008	41,238	145,361	186,599	39.4	72.7	112.1
2009	40,614	143,162	183,776	38.8	71.6	110.4
2010	39,991	140,962	180,953	38.2	70.5	108.7
2011	39,367	138,763	178,130	37.6	69.4	107.0

j.2.4. Impact

Although the forecasted increase in the amount of municipal waste is small due to the slow increase of the registered population, the actual amount may be larger than the forecast if the unregistered population and increase in tourism are included. Therefore, municipal SWM will become a more serious problem in future if SKP continues its current mode of SWM. Particularly important is the fact that, due to a lack of disposal site within the province, all collected wastes are transported to final disposal sites in neighboring provinces. If the neighboring provinces refuse to accept waste collected in SKP, the province will have many waste heaps in every urban area. This so-called "Waste War" has occurred in many cities in the world, including Tokyo, Japan.

j.3 Issues

According to the National Solid Waste Management Plan (Draft), targets for waste generation rate, collection rate, and recycling are set as follows:

Table 5-56: Targets for thee Waste Management Indicators

	Unit	Tessaban Nakorn	Tessaban Mueang	Tessaban Tambon	Orbortor
Waste Generation Rate	Kg/person/day	0.8	0.6	0.6	0.4
Collection rate	%	95	95	95	90
Recycling Rate	%	30	30	30	30

Source: National Solid Waste Management Plan (Draft): PCD MNRE Jun 2003.

j.3.1. Waste Generation Rate per Person per Day

The rate of waste generated per person per day in SKP is 0.956 kg/person/day in Tessaban, and 0.50 kg/person/day in Orbortor. The target set for the amount of waste generated in the National Solid Waste Management Plan calls for a reduction of around 20 to 40%.

j.3.2. Collection Rate

The waste collection rate in Tessaban is 93%, and in Orbortor 81%, so that the average in the province is 85%. In order to fulfill the target, Orbortor should increase their collection rate by around 10%.

In Orbortor, residents are settled along rivers, canals and roads. Since residents are not densely located in one place, efficiency of collection of wastes will be low.

j.3.3. Final Disposal

One of the most significant issues in SKP related to solid waste management is that there are no final disposal sites within the province. Furthermore, due to the fact that most local administrations contract waste management services to a private company, there is a possibility that no environmental measures are taken at the disposal site.

j.4 Measures to be Taken

j.4.1. Reduction of Waste Generation

The waste generation rate per person per day exceeds the target set by the National Solid Waste Management Plan. In order to meet the target, a 3R (Reduce, Reuse and Recycle) approach to waste management should be promoted. Environmental education of the public, especially at schools, is an important tool to reduce the amount of waste generated and introduce a collection system incorporating separation of recyclable waste at the generation source.

Horticultural land, where coconuts trees and pomelo trees are grown, occupy more than half of SKP. Therefore it is estimated that a large portion of waste in SKP is made up of cuttings or lumber. This puts the recycling and composting of these types of agricultural wastes in the spotlight, as one of the most important issues in SKP.

j.4.2. Improvement of Waste Collection Rate

According to the National Solid Waste Management Plan, the target waste collection rate is set at 95% in Tessaban and 90% in Orbortor.

Tessaban in SKP have nearly achieved its target. The question of whether it is necessary to increase the collection rate in Orbortor must be examined carefully by considering the conditions of self-disposal in Orbortor areas.

j.4.3. Final Disposal

One of the biggest issues in SKP is that there is no disposal site in the province. Most of the waste services - such as collection, transportation, and operation of the disposal site - are contracted out to private companies. Furthermore, the lack of a monitoring system for these operations means there is a distinct possibility that the disposals are not done in a sanitary manner.

A committee to discuss solid waste problems in SKP was formed and several discussions were held on the issue of constructing a disposal site inside SKP under the leadership of Orborjor. The procedure or site selection shall be fair and open to the public, encouraging public participation in order to utilize the lessons learned through the closing of the Tambon Ladjai disposal site.

k. Hazardous Waste and Toxic Substances

k.1 Situation

k.1.1. Categories of Hazardous Waste (HW)

Hazardous waste (HW) is categorized into the following groups according to the generation sources and type of hazardous waste.

HW	Generation Sources	Type of Hazardous Waste
Domestic HW	Household, Offices, etc.	1. Fluorescent lamp containing mercury 2. Lamp ballasts containing PCB 3. Cleaning liquid containing ammonia 4. Insecticide spray 5. Oil, dry cell batteries, etc.
Medical Waste	Medical institution	1. Infectious waste 2. Hazardous waste
Hazardous Industrial Waste (HIW)	Factory	1. Hazardous industrial waste

There is no facility to properly treat domestic hazardous waste (dry cell batteries, florescent bulbs). There is no special disposal site for domestic HW. As for the infectious wastes from medical institutions, they are treated by a private company in the incineration plant in Samut Sakhon Province.

The amount of hazardous industrial waste (HIW) is limited; more than 50% are generated by garages as waste oil.

The following figure indicates the location of factories and hospitals which may become sources of hazardous industrial wastes and medical wastes.

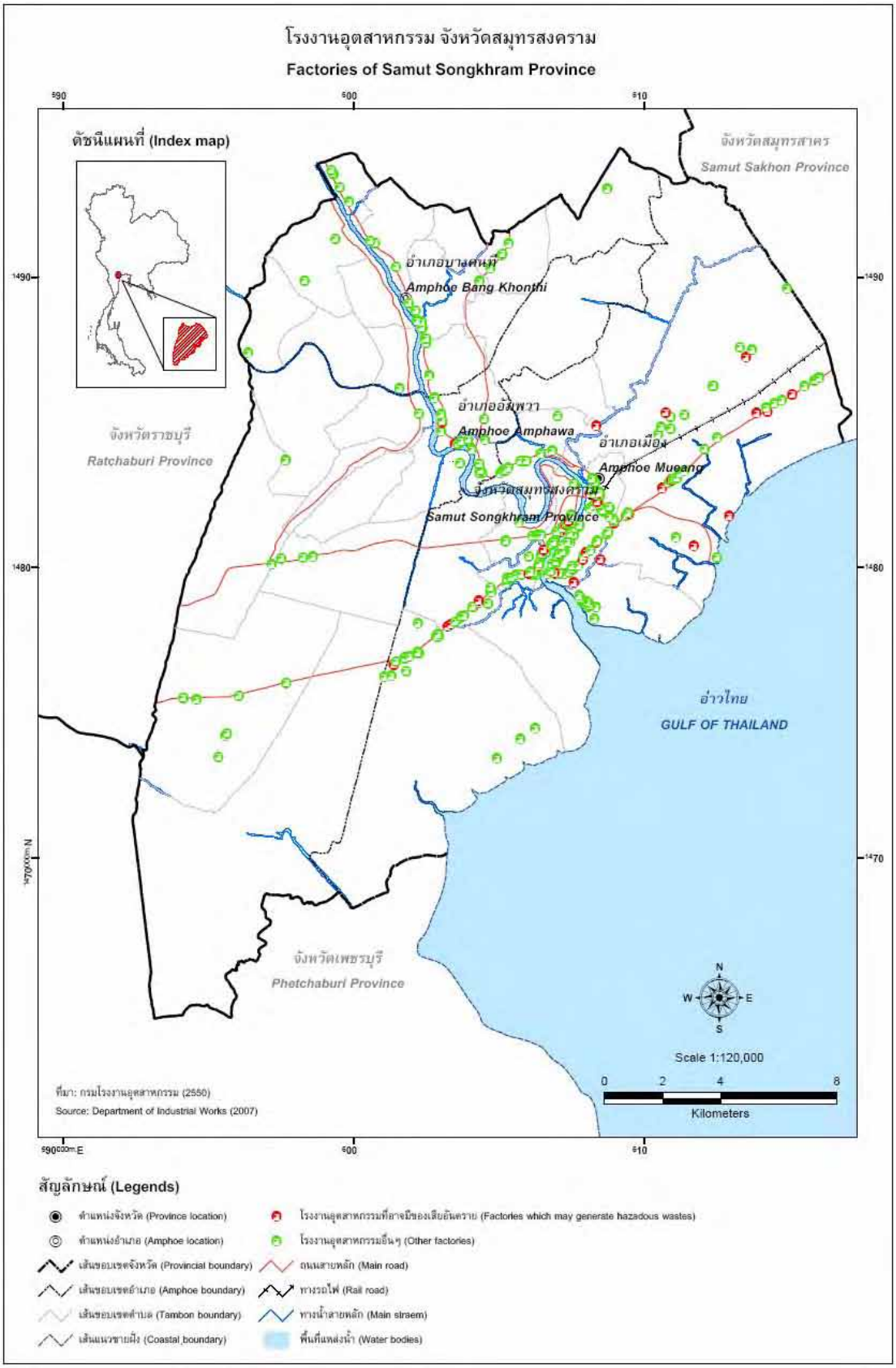


Figure 5-30: Location of Factories in SKP

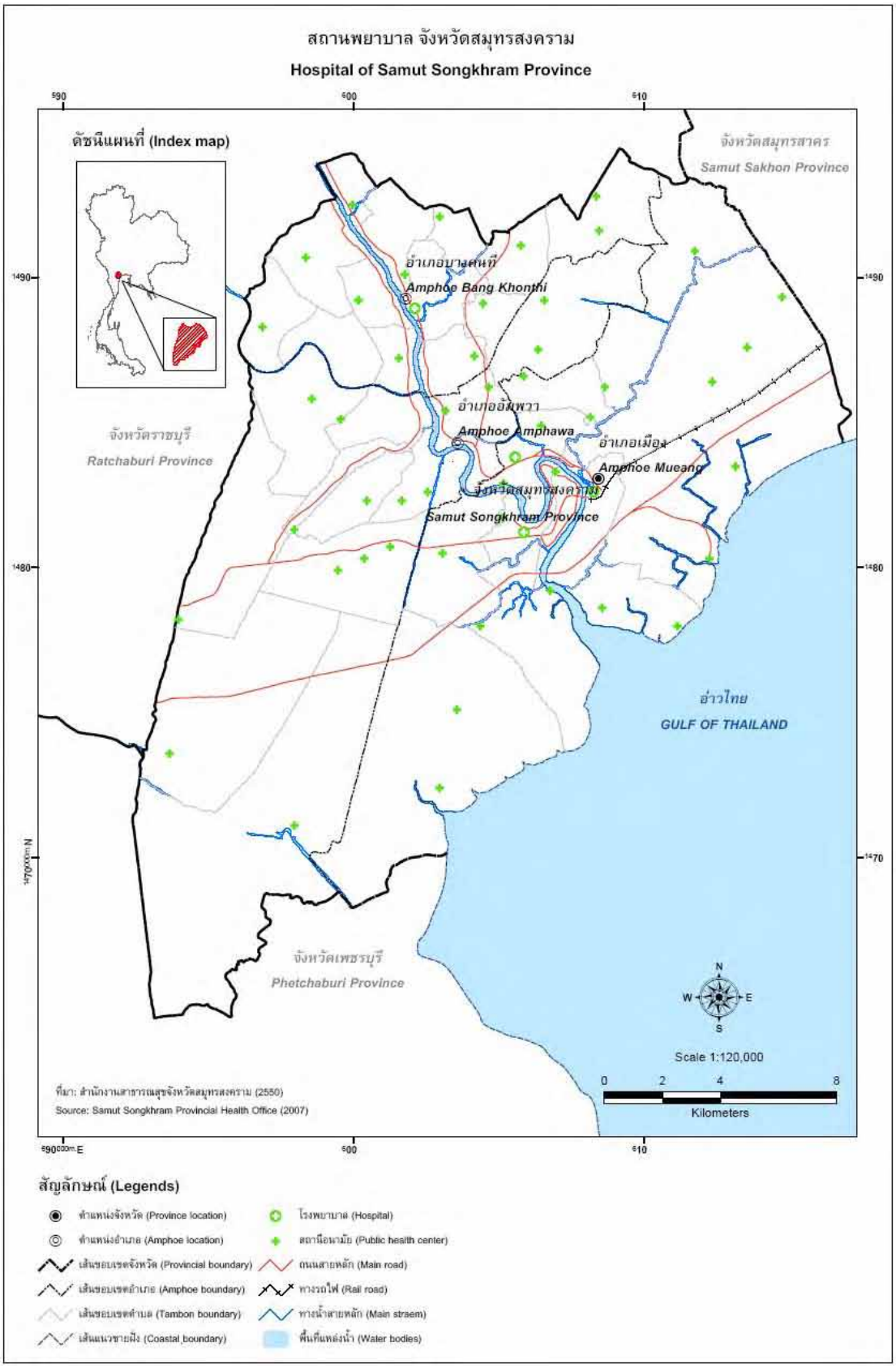


Figure 5-31: Location of Hospitals and Health Stations in SKP

k.1.2. Generation Amount of Hazardous Waste

Domestic Hazardous Waste (HW)

No reports were available regarding the amount and quality of domestic hazardous substances contained in municipal wastes in SKP. Therefore, the ratio of domestic HW was adopted from the REO 8 study report, of which rate is 0 to 0.07 % of HW. In the study, batteries, light bulbs, and chemical containers were categorized as domestic HW.

- Generation amount of municipal solid waste: 117 ton/day
- Ratio of Domestic HW: 0.00 – 0.07 %-municipal SW[10]
- Amount of Domestic HW: 0 – 0.08 ton/day

Medical Waste

There are four hospitals and 50 health stations in SKP, and the number of beds is 540 in total[11]. The amount of waste generated from these medical institutions was studied by REO 8, and their units generation amounts were used to calculate the amount generated in SKP, as shown in the table below.

Table 5-57: Generation Amount of Medical Waste (SKP)

	Unit Generation Amount	No of Bed or Place	Amount Discharged
Hospital	0.26 kg/bed/day	540 bed	140 kg/day
Health Station	0.28 kg/place/day	50 place	14 kg/day
		Total	154 /kg/day

Note: Unit generation amounts from REO 8

Hazardous Industrial Waste (HIW)

There are 284 factories in SKP according to the DIW factory list. Industrial wastes generated from factories differ according to the categories of the business.

The amount of industrial waste generated is calculated as follows.

- Number of factories: 284[12]
- Number of employees: 7,958
- Category of factories: 33 categories
- Category of waste: 14 categories for Non-HIW
  12 categories for HIW
- Rate of recycling: Non-HIW 86.5%, HIW 33.3%
- Generation rate: Per employee of each category of factory

Generation Amount

[10] Data source : PCD 2003, Muang District Municipality's Waste Components
[11] PEQMP for KPI by SKP
[12] The number of factories in the NREM GIS Database is less than this. These data are obtained from DIW in 2007 as excel data without information about factory location.

The amount of waste generated categorized as HIW and non-HIW from factories are estimated as 60.8 ton/day for non-HIW and 3.3 ton/day for HIW, as shown in the table below.

The recycling rate for industrial wastes is generally high since the purity of these wastes is high compared with household wastes. The recycling rate used in the following table is 86.5% for non-hazardous wastes and 33.3% for hazardous wastes[13].

Table 5-58: Generation Amount of Industrial Waste (IW) (SKP)

Amphoe		No of Factories	No of Employees	Non-HIW (ton/day)	HIW (ton/day)	Total (ton/day)
1	Muang Samut Songkhram	216	5,348	35.0	2.2	37.2
2	Bang Khonthi	27	399	5.0	0.1	5.1
3	Amphawa	42	2,211	20.8	1.0	21.8
Total Generation Amount		285	7,958	60.8	3.3	64.1
Recycling Rate				86.5	33.3	-
Recycle Amount				52.6	1.1	53.7
Treated & Disposal Amount				8.2	2.2	10.4

k.2 Impact Analysis

k.2.1. Result of the Opinion Survey

The results of the opinion survey on hazardous and toxic substances are shown below.

Table 5-59: Result of the Opinion Survey on Hazardous and Toxic Substances

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	89%	6%	0%	6%	6%	0	100%
Resident	86%	9%	5%	0%	0%	0	100%
BE	81%	11%	9%	0%	0%	0%	100%

Source: JICA study in 2007

According to the opinion survey, 95 % of the residents, 95% of LAs and 92 % of the business enterprises replied that problems with hazardous and toxic substances are "Not serious at all" or "Not very serious".

The LAs who replied that problems were very serious, specified the following aspects and reasons for their concern. No separate collection of hazardous wastes and mixture with other domestic wastes caused risks to municipal staff.

Table 5-60: Specific Aspects and Reasons for Concern about Hazardous and Toxic Substances

	Aspects of Concern	Reasons for Concern
LAs	Illegal dumping of hazardous waste from private clinics in municipality's waste containers	Causes hazardous conditions to municipality staff

[13] The study on industrial wastes in Bangkok and its vicinity carried out by the JICA in 2002

k.2.2. Impact

Forecast of Medical Waste Generation

Infectious/hazardous medical waste was forecast on the following conditions:

- The generation rate of 0.26 kg/bed/day in hospitals and 0.28 kg/place/day for health stations, indicated in the Regional EQMP 2007-2011 formulated by REO 8 is applied.
- The rate of generation does not change, but the number of beds and health stations increase in proportion to population.

Table 5-61: Forecast of Generation Amount of Medical Waste (SKP)

Year	Hospital			Health station			Total
	Bed	Generation rate kg/bed/day	Amount kg/day	Station	Generation rate kg/station/day	Amount kg/day	kg/day
2005	540	0.26	140	50	0.28	14	154
2006	532	0.26	138	49	0.28	14	152
2007	524	0.26	136	49	0.28	14	150
2008	517	0.26	134	48	0.28	13	147
2009	509	0.26	132	47	0.28	13	145
2010	501	0.26	130	46	0.28	13	143
2011	493	0.26	128	46	0.28	13	141

Forecast of Industrial Waste (IW) Generation

Generation amount of industrial waste (IW) was forecast on the following condition based on the study result of "The Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity in the Kingdom of Thailand (JICA 2002)".

- The Number of factories: 284[14]
- Category of factories: 33 categories
- Category of waste: 14 categories for Non-HIW
  12 categories for HIW
- Rate of recycling: Non-HIW 86.5%, HIW 33.3%
- Generation rate: Per employee of each category of factory
- The number of employees increases in proportion to economic growth, but generation rate will not change.

[14] The number of factories in the GIS database of DEQP/MNRE is less than this. These data are obtained from DIW in 2007 and excel data without information of factory location.

Table 5-62: Forecast of Non-HIW（SKP）

		Unit	2005	2006	2007	2008	2009	2010	2011
1	Muang Samut Songkhram	ton/day	35.0	35.9	37.5	39.0	40.4	41.8	43.1
2	Bang Khonthi	ton/day	5.0	5.1	5.3	5.5	5.7	5.9	6.1
3	Amphawa	ton/day	20.8	21.4	22.3	23.2	24.1	24.9	25.7
Generation Amount		ton/day	60.8	62.4	65.1	67.7	70.2	72.6	74.9
Rate of Recycling		%	86.5	86.5	86.5	86.5	86.5	86.5	86.5
Recycled Amount		ton/day	52.6	54.0	56.3	58.6	60.7	62.8	64.8
Treated and Disposed Amount		ton/day	8.2	8.4	8.8	9.1	9.5	9.8	10.1

Table 5-63: Forecast of HIW（SKP）

		Unit	2005	2006	2007	2008	2009	2010	2011
1	Muang Samut Songkhram	ton/day	2.2	2.3	2.4	2.5	2.6	2.6	2.7
2	Bang Khonthi	ton/day	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	Amphawa	ton/day	1.0	1.0	1.0	1.1	1.1	1.2	1.2
Generation Amount		ton/day	3.3	3.4	3.5	3.7	3.8	3.9	4.0
Rate of Recycling		%	33.3	33.3	33.3	33.3	33.3	33.3	33.3
Recycled Amount		ton/day	1.1	1.1	1.2	1.2	1.3	1.3	1.3
Treated and Disposed Amount		ton/day	2.2	2.3	2.3	2.5	2.5	2.6	2.7

Summary

Current and future generation of hazardous waste and toxic substances is summarized in the table below.

Table 5-64: Current and Future Generation of Hazardous Waste (HW)

HW	2005	2011
Domestic HW	less than 0.08 tons/day	Not available
Medical waste	about 0.154 tons/day	0.141 tons/day
Total Hazardous Industrial Waste (HIW)	about 3.3 tons/days	about 4.0 tons/days
Treated and Disposed HIW	about 2.2 tons/day	about 2.7 tons/days

Although there are many assumptions made for estimating HW generation, and the estimate thus may not be accurate, the table above indicates that the impact of HW in SKP might not be serious in the future, if the province will not have that many factories that generate HIW in future as is currently the case. Nevertheless, proper management of HW is quite an important issue for the preservation of environment of the province.

k.3 Issues

- The amount of hazardous wastes generated from factories is estimated as 3.3 tons/day, but information on their disposal has not been identified. Although the amount of HIW generated is very little, the impact by improper HIW management on the environment of SKP is significant,

- Although the amount of medical waste generated is limited, information about their disposal has not been identified,
- The amount of domestic HW is very limited, but domestic HW is not separated and properly treated or disposed.

k.4 Measures to be Taken

- • Investigate industrial wastes, especially hazardous wastes, with cooperation from Provincial DIW,
- • Prioritize proper treatment of HIW in dealing with industrial wastes,
- Promote proper disposal of infectious waste/hazardous waste by giving intensive education to generation sources,
- First determine the disposal system (collection, treatment and final disposal) for domestic hazardous waste. Then introduce the separate collection of domestic hazardous waste, together with intensive education activities.

l. Urban Environment

l.1 Situation

SKP is generally topographically flat, except for a small area. The province is heavily affected by the infiltration of sea water into its water resources. Three-quarters of the province contains mangrove, coconut, orchards, aquaculture ponds for fish and shrimp, and salt flats. An urban area developed along the Mae Klong River, (see Figure 5-33). The capital of SKP, Amphoe Mueang Samut Songkhram, is situated at the mouth of the Mae Klong River.

The lives of the people are closely related with rivers and canals that crisscross the province (see Figure 5-34). The rivers and canals rise and fall with the tide. In this situation, it can be said that the urban environment of SKP largely depends on the surrounding natural environment. Therefore, it is important for the people to maintain good harmony with nature in order to improve the urban environment and make it comfortable for them.

Currently, urban and commercial sectors are expanding without direction and causing both physical and visual congestion, and damages objects that are worthy of conservation. Operations aimed directly at the development of quality of life are necessary. The PEQMP requires the participation of all sectors in its formulation, and the integration of town planning and infrastructure management.

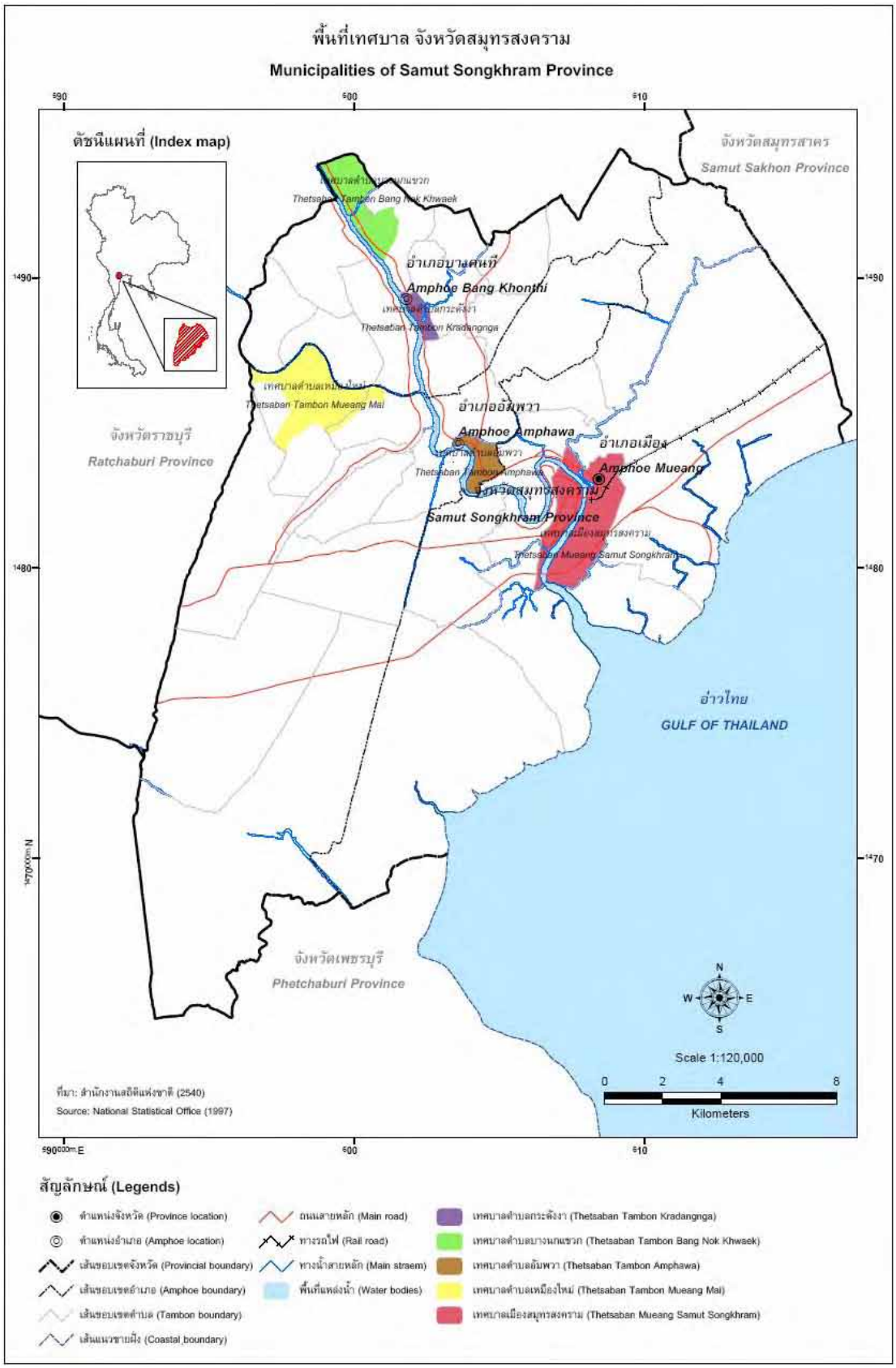


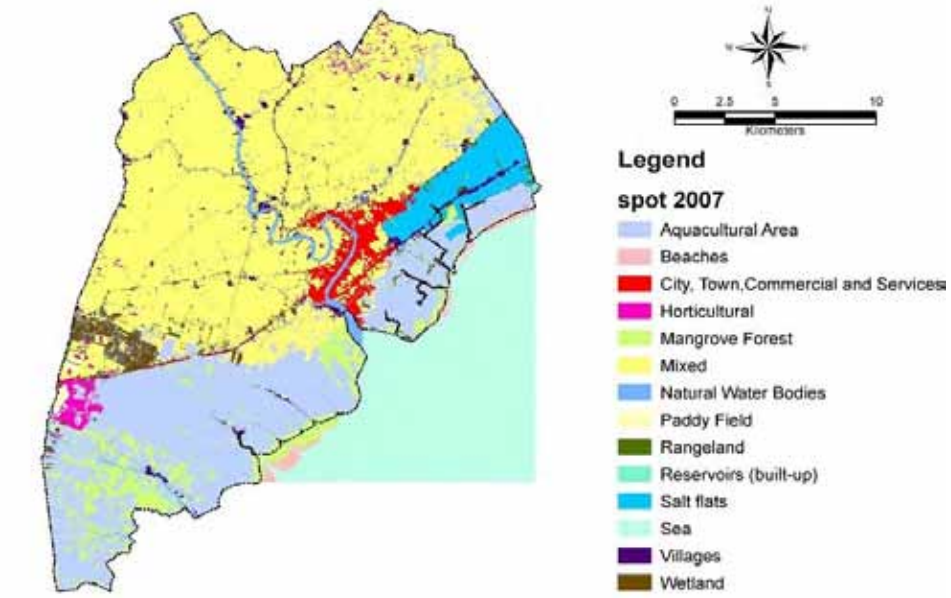
Figure 5-32: Urban Areas (Tessaban) in SKP

The following table shows the current land use in SKP.

Table 5-65: Land Use in SKP (2007)

Land Use	Area (Km2)	%
Urban and Built-up Land	22.14	5.37
Agricultural Land	223.98	54.37
Aquaculture Land	100.6	24.42
Mangrove Forest	26.97	6.55
Water Body	12.64	3.07
Wet Land	6.2	1.50
Salt Flats	19.45	4.72
Total	411.98	100

The land use pattern from satellite imagery analysis by the Study Team and rivers and canals of SKP are shown in the following figures.



Source: Satellite Image (SPOT) 2007

Figure 5-33: Current Land Use Map of SKP

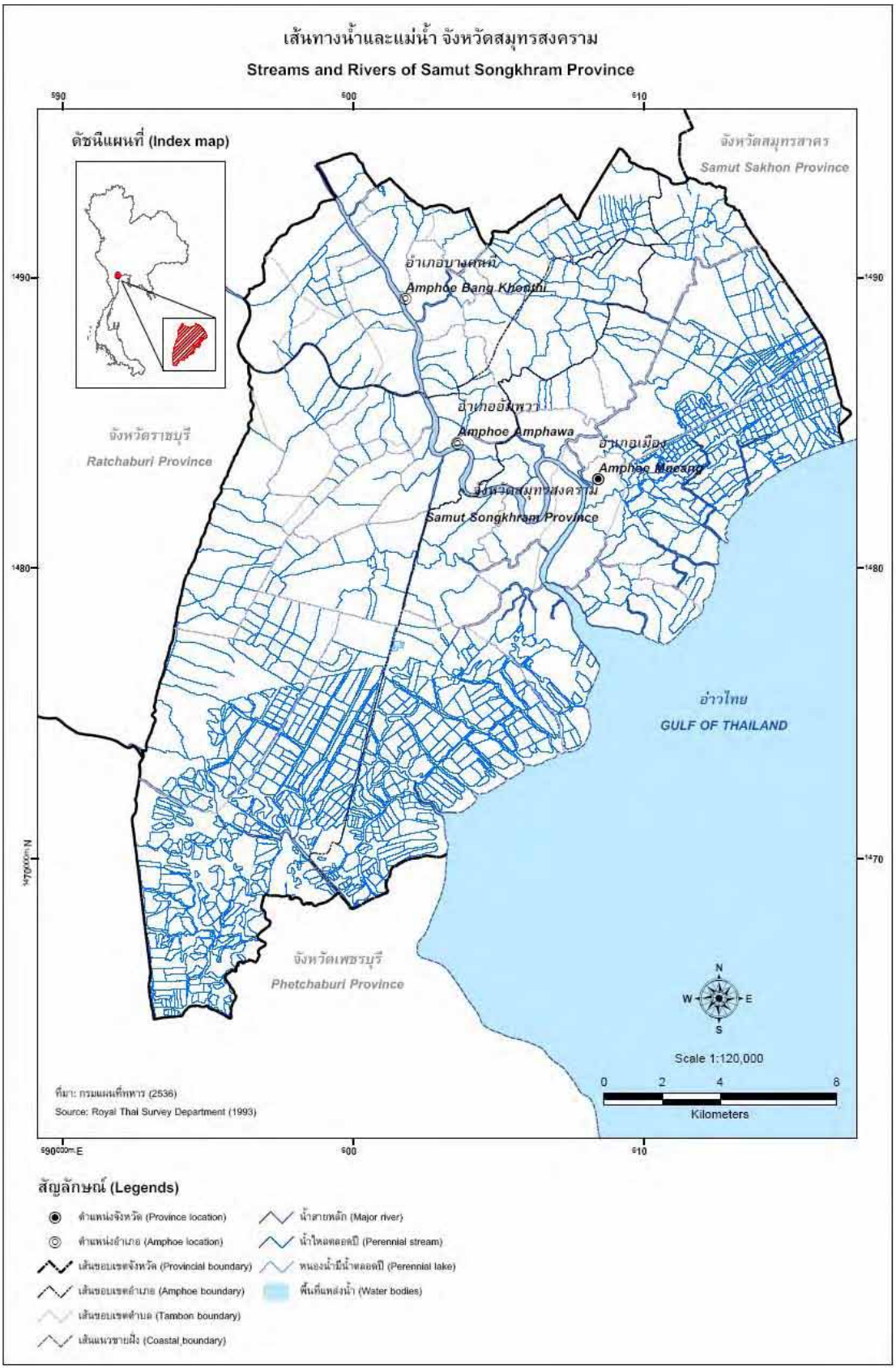


Figure 5-34: Rivers and Canals in SKP

l.2 Impact Analysis

l.2.1. The result of the opinion survey

The result of the opinion survey on urban environment is shown below.

Table 5-66: Result of the Opinion Survey on Urban Environment

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	64%	25%	11%	0%	0%	0%	100%
Resident	78%	5%	11%	0%	6%	0%	100%
BE	64%	13%	15%	0%	9%	0%	100%

Source: JICA Study in 2007

According to the opinion survey, 83% of the residents, 89% of LAs and 77% of Business Enterprise (BE) replied that the problems with urban environment are "Not serious" or "Not very serious".

None of the LAs, residents and BEs replied that the problems with urban environment are "Very Serious".

l.2.2. Impact

According to Table 5-14, there was a large increase in area by urban and built up lands from 1988 to 1997; nearly 10 km^2 of land (2.4% of total area of SKP) was converted. Since then, the coverage area has not changed significantly. The changes in are occupied by urban and built-up land may correspond with population and economic growth.

l.3 Issues

- In urban areas there are some road signs and advertising boards that spoil the townscape. It is important that the administration and LAs make a joint effort to eliminate boards which degrade the townscape of SKP,
- There are numerous canals that crisscross the province. People's lives are closely related with these canals. However, sediment from upstream sources has accumulated on the bottom of the canals. It would be of great benefit to dredge the canals, which will also result in cleaner water. Then, these canals can be used more actively by people, and would also become an attractive tourism resource,
- There are few tree-lined roads in urban areas. The development of tree-lined roads would take advantage of the climate, contribute to the prevention of global warming, and it would be wonderful to have huge trees providing ample shade which protects people from the heat,
- A large part of the province is covered with trees. The opinion survey by the Study Team indicates that there is a desire for more neighborhood parks and sport grounds. King Rama II Memorial Park and Queen Sirikit Park are located in the suburbs and are located too far from urban areas to be of use to the residents on a daily basis,
- The road network is well established in the province, but many roads are not well paved. It will be necessary to up-grade these secondary roads.

l.4 Measures to be Taken

- Investigate the situation of unregulated billboards in urban areas and set up a solution,
- Develop a plan and allocate funds for the development of a provincial water transportation network,
- Create public understanding that a good urban environment significantly contributes not only towards population growth but also towards economic and cultural prosperity,
- The government and private sectors make a joint effort to create urban amenities, e.g. planting trees along roads and creating neighborhood parks.

m. Natural and Cultural Heritage

m.1 Situation

m.1.1. Natural Assets

SKP is known as the last Venice of Thailand. The province is situated in a lower central region of country, on the west shore of the Gulf of Thailand. Geographically the province is located on a flat coastal plain. Topographically, it is very flat with a slope of less than 1 degree, with the exception of Khao Yee Sarn Hill in the southwest.

The province can be divided into two areas: sea side and land side. The sea side is low and includes a Ramsar Wetland site, and is mainly composed of mangrove forests, aquaculture lands, and salt flats.

The land side is mainly covered with coconut and mixed orchards of pomelo, lychee, banana, etc. In the middle of these two areas the Mae Klong River flows, across Amphoe Bang Khonthi and Amphoe Amphawa. The mouth of the Mae Klong and its banks have been built up and developed.

There are more than 300 canals linked together like a fish net across the province. Their water levels rise and fall with the tide. The area of paddy fields in the province is comparatively small (2.6%), due to sea water which has infiltrated the area. Instead, coconut palms, citrus trees, and mangrove forests occupy the majority (62%) of the province.

The main features of natural scenery in SKP consist of forests, rivers and canals, and salt flats. The abundance of coconut palms makes the area unusually lush in spite of its proximity to Bangkok. Another major attraction is the low-lying wetland of Don Hoi Lot Ramsar site, an area with a great difference in tidal levels. At low tide, 3 to 5 km of tidal flats become exposed.

The natural assets mentioned by the residents of SKP in the opinion survey by the Study Team include:

- Mangrove
- Rivers
- Don Hoi Lot
- Canals
- Salt farms, etc.

m.1.2. Cultural Assets

The province maintains a traditional lifestyle closely related with rivers and the sea, and water levels fluctuating with the tides. In Amphawa Community is a group of villages which has kept to a traditional lifestyle along the river. In older times, this used to be the center of commerce. An award for "Townscape Conservation" was given to this community by the Royal Thai Institute of Architecture.

SKP is also the birthplace of the wives of both King Rama I and King Rama II. In commemoration of this fact, there are memorial parks for King Rama II and Queen Sirikit. In King Rama II Memorial park, there is a museum exhibiting arts, crafts, and cultures. There is also an open space for classical performances and dances.

The floating market is another cultural asset in the province. The province is crisscrossed with canals intersected by the gentle flow of the Mae Klong River, creating an ideal environment for traditional Thai floating markets. Especially in Amphoe Amphawa there are reputable floating markets that attract many tourists.

Cultural assets mentioned by the residents of SKP in the opinion survey by the Study Team include:

- Temples
- Parks
- Shrines
- Church
- Tha Kha floating market
- Amphawa community, etc.

The details of natural and cultural heritage in SKP are shown on Table 5-67. Locations of heritage are shown in Figure 5-35. Not all of the sites on the map are listed in the table shown below.

Table 5-67: Location of Natural and Cultural Assets

No in Figure 5-35	Site Name	Points of Interest	Location
21	Assanawiharn Wat Pramae Bangkerd (Cathedral of the Nativity of Our Lady)	Gothic church with stained glass windows	16 km. from Samut Songkhram city area
39	Autthayan King Rama II (King Rama II Park)	Museum of King Rama II	Follow highway 325 for 6 km.
18	Don Hoi Lot (Razor Clam Mound)	Located at the mouth of Mae Klong River, named after razor clam which is found only in this area	15 minutes from shore
38	Talad Nam Amphawa (Amphawa Floating Market)	Floating market	Amphawa Sub-District, Amphawa District
29	Talad Nam Bang Noi (Bang Noi Floating Market)	Floating market	Follow Highway 325 to Milestone 32, keep on to Wat Koh Kaew intersection
28	Talad Nam Tha Kha (Tha Kha Floating Market)	Floating market	Follow Highway 325 to Milestone 32, keep on to Wat Koh Kaew intersection

No in Figure 5-35	Site Name	Points of Interest	Location
30	Tao Tan (Coconut Stove)	Place for making sugar from coconut	Follow Highway 325, it is in the area of Bang Praeu, Amphawa Sub-District, Amphawa District
36	Wat Alongkorn	Boad, antique book on Pra Malai (name of a great monk) written in Khmer language	Moo 1 Bang Chang Sub-District, Amphawa District
31	Wat Amphawa Jetiyaram	Pagoda	Amphawa Sub-District, Amphawa District
15	Wat Bang Kaphom	Wiharn in Chinese style	Amphawa Sub-District, Amphawa District
23	Wat Bang Kluay	Boad, Sermon hall	Moo 8 Kradang-nga Sub-District, Bang Khonthi District
25	Wat Bang Kung	Boad, Wiharn, King Taksin shrine	Moo 4 Bang Kung Sub-District, Bang Khonthi District
8	Wat Bang Nang Chine Klang	Golden box of King Chak Krapat	Moo 1 Klong Khoen Sub-District, Muang District
24	Wat Bang Plap	Boad, Wiharn of Sukhothai period	Moo4 Bang Phrom Sub-District, Bang Khonthi District
6	Wat Bang Prachan	Standing Buddha made of brass	Moo 1 Lat Yai Sub-District, Muang District
27	Wat Bang Sakea	Boad, Wiharn	Moo 6 Bang Sakae Sub-District, Bang Khonthi District
34	Wat Bang Wanthong	Sitting Buddha image under Naga Covering, Laterite Buddha image	Moo 9 Mueang Mai Sub-District, Amphawa District
26	Wat Boad	Boad, Wiharn of Ayutthaya period	Moo 5 Bang Kung Sub-District, Bang Khonthi District
19	Wat Chang Paeuk	Old boad, beautiful Buddhist Canon of Scriptures building	Moo5 Bang Chang Sub-District, Amphawa District
20	Wat Charoen Sukkaram Worawiharn	Historical site and antiques	Moo 5 Bang Nok Khwaek Sub-District, Bang Khonthi District
14	Wat Chula Manee	Sermon hall	Moo 9 Bang Chang Sub-District, Amphawa District
5	Wat Dao Dong	Buddha image with teaching gesture	Moo 4 Klong Khoen, Muang District
33	Wat Kao Yisarn	Wiharn, Reclining Buddha	Moo 1 Khao Yisarn Sub-District, Amphawa District
22	Wat Kohkaew	Laterite Buddha image with Subduing Mara gesture	Moo 5 Bang Nok Khwaek Sub-District, Bang Khonthi District
12	Wat Ku Sanam Chan	Buddha's Footprint, Buddha image, boad	Moo 3 Ban Prok Sub-District, Muang District

No in Figure 5-35	Site Name	Points of Interest	Location
11	Wat Mae Nam	Wiharn, Buddha image of Sukhothai period	Moo 2 Bang Khan Taek Sub-District, Muang District
37	Wat Muaeng Mai	Boad, Wiharn, Buddhist Canon Scriptures cabinet, Oil painting	Moo 2 Mueang Mai Sub-District, Amphawa District
13	Wat Nangpim	Buddhist Canon of Scriptures building, Sermon hall, Boad	Bang Khan Taek Sub-District, Muang District
9	Wat Nang Takien	Buddha image with Subduing Mara gesture, Brass Buddha image	Moo 3 Lat Yai Sub-District, Muang District
16	Wat Nangwang	Buddha image inside boad	Amphawa Sub-District, Amphawa District
1	Wat Phetsamut Worawiharn	Luangphor Ban Laem (name of a Buddha image), Oil painting of King Rama V)	Mae Klong Sub-District, Muang District
32	Wat Phummarin Kudi Thong	Shadow puppetry, Royal belongings	Moo 8 Suan Luang Sub-District, Amphawa District
7	Wat Phongphang	Maha Aud Chedi	Moo 2 Bang Khan Taek Sub-District, Muang District
35	Wat Pracha Kositaram	Wiharn, Reclining Buddha	Moo 2 Plai Phongphang Sub-District, Amphawa District
17	Wat Pradu	Dharmma puzzle, Royal bead made of Teakwood, Laterite Buddha image	Moo 2 Wat Pradu Sub-District, Amphawa District
3	Wat Puang Malai	Wall painting, stucco, Hongsawadi Chedi	Mae Klong Sub-District, Muang District
10	Wat Suankaew Auttayan	Square chedi with16 Wa in height	Moo 1 Bang Khan Taek Sub-District, Muang District
2	Wat Thammanimit	Reclining Buddha image, Buddha's Footprint decorated with pearl, large chedi	Mae Klong Sub-District, Muang District
4	Wat Yai	Laungphor Kaenchan (name of a standing Buddha image)	Mae Klong Sub-District, Muang District

Source: PEQMP GIS data base

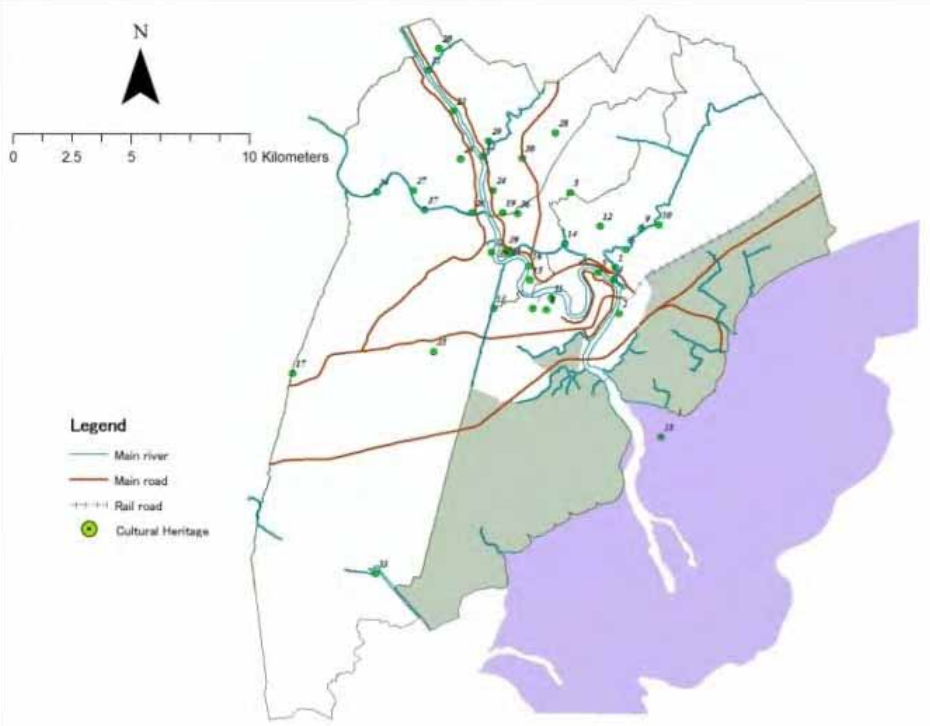


Figure 5-35: Locations of Natural and Cultural Heritage Sites in Samut Songkhram

m.2 Impact Analysis

m.2.1. Result of the Opinion Survey

The results of the opinion survey on natural and cultural heritage are shown below.

Table 5-68: Result of the Opinion Survey on Natural and Cultural Heritage

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	78%	17%	3%	0%	3%	0%	100%
Resident	83%	8%	5%	2%	3%	0%	100%
BE	72%	4%	13	0%	11%	0%	100%

Source: JICA Study in 2007

According to the opinion survey, 91% of the residents, 95% of LAs and 76 % of business enterprises (BE) replied that problems with natural and cultural assets are "Not serious" or "Nor very serious".

Residents, who replied that problems were very serious, specified the following aspects and reasons for their concern.

Table 5-69: Specific Aspects and Reasons for Concern about Natural and Cultural Heritage

	What aspects	Reasons why very serious
Residents	Government does not take care of natural assets seriously	Degradation of natural assets

m.2.2. Impact

Although residents in SKP indicated that problems with natural and cultural heritage are not serious or not very serious in the opinion survey, conditions surrounding natural and cultural assets may worsen yearly, without proper maintenance.

m.3 Issues

- Natural and cultural assets are not sufficiently maintained,
- It is uncertain whether natural and cultural assets are fully utilized.

m.4 Measures to be Taken

- Public education, administrative support, and budget allocation for the conservation of natural and cultural assets,
- Conduct a publicity campaign for the preservation of natural and cultural heritage in SKP in order to attract tourists, and use tourism income for their preservation.

n. Global Warming

n.1 Situation

According to the results of the opinion survey, residents and business enterprises (BE) replied that global warming/climate change is the second most serious problem in natural resources and environment following marine/coastal/fishery resources. The reasons given for its seriousness were “adverse impact on agriculture”, “decrease of fishery resources”, “change of season” and “influence on health due to the rise in temperature”. LA and NGO indicated that this issue was less serious than others.

“The National Strategy on Climate Change (NSOCC)” reported that the amount of greenhouse gas (GHG) emission in Thailand increased 20% from 1997 to 2003. Especially, the increase of GHG from “waste” is very significant. The emission amount from waste increased thirty-six-fold from 1997 to 2003, and the contribution of waste-based GHG in total GHG emission rose from 0.3% in 1997 to 7.8% in 2003. Although SKP does not have a solid waste disposal site, it disposes of its waste in neighboring provinces through open dumping operations which emit methane gas.

n.2 Impact Analysis

n.2.1. Result of the Opinion Survey

The result of the opinion survey on global warming is shown below.

Table 5-70: Result of the Opinion Survey on Global Warming

Target Group	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can’t Choose	No Response	Total
LAs	44%	36%	19%	0%	0%	0%	100%
Resident	17%	22%	46%	19%	1%	0%	100%
BE	23%	14%	45%	23%	0%	0%	100%

80% of LAs replied that the problems on global warming are “not serious” or “not very serious”. On the contrary, 55% of the residents and 68% of business enterprises (BE) replied that problems of global warming are “very serious” or “somewhat serious”.

Those who replied "very serious" suggested following aspects and reasons.

Table 5-71: Specific Aspects and Reasons for Concern about Global Warming/ Climate Change

	Aspects of Concern	Reason for Concern
Residents	Rising of temperature	Cannot do gardening work as long as before Causes health problems
BE	Rising of temperature	Cannot do gardening work as long as before Decrease of marine assets Climate change

n.2.2. Impact

According to the changes in land use in SKP from 1988 to 2007, mangrove forests decreased from 8.3% (34.2 km^2) in 1988 to 5.6% (23.2 km^2) in 1997 mainly due to conversion to aquaculture areas. Since 1997 the area has been increasing up to 6.5% (27.0 km^2) by campaigns and planting activities to rehabilitate mangrove forests; however, is has yet to recover to its 1988 size.

Although SKP does not have a solid waste disposal site, it disposes of its waste in neighboring provinces through open dumping operations which emits methane, a strong greenhouse gas (GHG).

n.3 Issues

- The NSOCC reported that SKP is one of the most vulnerable provinces in Thailand to the rise of sea levels by climate change. However, sufficient countermeasures have not been taken,
- According to changes in land use from 1988 to 2007, mangrove forests increased to 6.5% in 2007 from 5.6% in 1997. It has not, however, recovered to 8.3%, its size in 1988,
- Although GHG emission from waste is significant, final disposal sites are operated as open dumps which emit methane gas. Very little is done in terms of 3R activities (Reduce, Reuse and Recycle).

n.4 Measures to be Taken

Implement countermeasures which are set up in "The National Strategy on Climate Change (NSOCC)", especially the following two aspects:

- Further recovery of the mangrove forests by afforestation,
- Conduct sanitary landfill operations, and promote 3R through public relations and education in cooperation with REO 8,
- Develop a sea-level monitoring system.

5.2.3 Part 2-3) Summary of Situation and Issues of NRE

a. Summary of Issues, Cause, Impact and Measures for Solving Issue

In the previous section, current issues and impact from socio-economic development were analyzed based on data on the situation and issues in the province, in order to show the seriousness and trend of each issue. The summary of issues, area in which the issues occur, their cause, impact and past/future measures for solving issues are presented in the following table:

Table 5-72: Summary of Issues, Cause, Impact and Measures for Solving Issue, for Natural Resources

Natural Resources	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
1. Soil and Land Resource	Decrease of mangrove forest	• See Figure 5-7 in Main Report (Land Use) • See Figure 5-9 in Main Report (Mangrove Forests)	Converting mangrove forest to aquaculture fields	May cause coastal erosion and decrease of marine products	Campaigns and planting activities to rehabilitate mangrove forest	• Protect and rehabilitate mangrove forest with community participation • Advertise the importance of mangrove forest to stakeholders
	Improper land use	Whole SKP	Due to economic reasons, land is sold to developers some of whom use the land improperly	Industries in areas where they are not wanted, e.g. metal factories	Relevant organizations/authorities temporarily stop or withdraw permission for development of lands	Develop and advocate appropriate land use plan
	Deterioration of soil	Agricultural land within Muang, Amphawa, Bang Khonthi District, i.e. Moo 1-8 of Don Manora Subdistrict	• Use of chemical substances/ pesticide to get rid of insects/ weeds • Surface soil erosion	• Decrease of agricultural products and aquatic animals • Toxic residues in animals/ plants	• Promote organic fertilizers • Reduce the use of chemical substances • Promote the growing of Vetiver grass to prevent erosion	Encourage farmers to use organic fertilizers instead of chemical fertilizers
2. Forest Resource and Wildlife	Decrease of mangrove forest	See “1. Soil and Land Resource”				
	Damage to livestock and farmed aquatic resources by water	Prawn and fish farms in Nang Takhian Subdistrict	Overpopulation of water monitors due to protected status	Decrease of agricultural and aquaculture products	Catch and release at appropriate place	Propose a change in regulation to relevant organizations, to allow commercial

Natural Resources	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
	monitors					use and population control of water monitors, to relevant organizations
3. Water Resource	Insufficient water for consumption and agriculture	Yisan, Nang Takhian, Lat Yai, Plai Phongphang, Phraek Nam Daeang subdistricts	• No irrigation system • Saline water intrusion	• Insufficient water for consumption • Damage to agriculture	• Provide wells, water towers, strainers • Dredge canals	Completion of water supply system and irrigation network
	Flooding due to sediment in canal	Tambon Phraek Namdaean	Not enough capacity of canal due to sediments	Damage to land and property	Periodical dredging	• Regularly dredge bed of water canals • Formulation of compulsory master plan for flood prevention and mitigation
4. Mineral Resource	There are no notable mineral resources					
5. Marine and Coastal Resource	Number of aquatic animals is decreasing	Marine and coastal areas i.e. Bang Chakrang, Laem Yai, Klong Khon subdistrict	• Inappropriate fishing methods i.e. inappropriate tools/ substances • Large amount of wastewater discharge	• Decrease in the population of aquatic animals • Damage to coastal farming	• Release aquatic animals back to nature on special occasions • Inform fish farmers to sell only mature fishes; warn fishermen about illegal fishing methods through Orbortor, local cable TV, Fishery network	• Conduct research, development and guidance in proper fishing methods in order to prevent over-fishing • Enforcement of law by LAs for illegal fishing • Support the

Natural Resources	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
						development of voluntary network among fishermen and encourage them to be involved in marine and costal resources conservation • Educate local residents about the role and importance of mangrove forests in overall environmental conservation
	Tidal erosion of seashore	Tambon Bang Kaeo	Tidal force and inappropriate land use	Loss of land and property	Coastal protection	Mangrove afforestation and study on coastal erosion mechanisms
6. Biodiversity	Lack of preservation of wildlife habitats and breeding environments, and care for sustaining biological diversity	Whole SKP, and especially in mangrove forest	Lack of awareness of importance of biodiversity	Loss of biodiversity	Afforestation of mangrove forests	• Formulate conservation plan • Educate residents on importance of biodiversity • Monitor and restrict phenomena that affect biodiversity

Table 5-73: Summary of Issues, Cause, Impact and Countermeasure for Solving Issue, for Environment

Environment	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
1. Water Quality	Safe and quality water supply is not assured	Water supply facilities which use water that is affected by water pollution sources as shown in Figure 5-24 in Main Report (Location Map of Major Water Utilization Facilities)	Inappropriate treatment and/or lack of treatment of wastewater from various sources	• Increase in water purification costs • Deterioration of quality of purified water	-	Formulation of master plan on domestic water supply • Research of current conditions of domestic water supply • Investigation of domestic water demand • Formulation of domestic water supply plan
	Water quality of public water bodies is not preserved	Various public water bodies affected by water pollution sources as shown in Figure 5-23 in Main Report (Location Map of Water Pollution)	Inappropriate treatment and/or lack of treatment of wastewater from various sources	• Increase in water purification costs • Deterioration of purified water quality	-	• Pollution source survey • Formulation of Water Quality Preservation Plan in Public Bodies

Environment	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
2. Air Quality	No regular monitoring station for air quality (except PM10 measurements)	Whole SKP, especially urban areas	Air quality has low priority in terms of environmental management	Actual condition of air quality is not well understood	Several instances of PM10 measurement	• Mobile Air Monitoring Unit shall be used to grasp condition of air pollution • Monitor air quality indicators established by environmental standards
3. Noise Quality	Level of noise emitted by outboard engines on boats over limit	Eco-tourism sites, Mae Klong River, Amphawa Canal	Outboard motors on boats	Conflict with residents near eco-tourism sites	None	• Set up regulation of outboard engines on boats • Promote the use of low-noise outboard motors for eco-tourism boat and provide support through subsidies
4. Solid Waste	Improper municipal SWM	Most LAs in SKP	Lack of knowledge of proper and sustainable SWM	• Unsanitary conditions in LAs e.g. heaps of waste • Inactive 3Rs (Reduce, Reuse and Recycle) activities • Illegal dumping of waste	• Hire private company • Promote waste sorting • Purchase more garbage trucks • Employ more staff • Provide collection more often	Formulate comprehensive master plan of SWM, and implement the plan

Environment	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
	Lack of a final disposal site in SKP	Whole SKP	Closure of the Ladjai disposal site due to opposition of people nearby	If the landfills in the neighboring provinces refuse to accept waste from SKP, there will be many waste heaps in the province	-	• Selection of a disposal site • Formulate comprehensive master plan of SWM
5. Hazardous waste and toxic substance	The amount of hazardous wastes generated from factories (HIW) is estimated at 3.3 tons/day in 2005 and information on their disposal is not available	Whole SKP	Lack of studies to assess the current situation	Significant negative impact on environment of SKP by improper HIW management	-	• Carry out investigation on industrial wastes, especially hazardous wastes, with cooperation from Provincial DIW • Prioritize HIW treatment among industrial waste issues
	Information on medical waste disposal is not available; but the amount of medical waste generated is limited to less than 0.2 ton/day in 2005	Whole SKP	Lack of studies to assess the current situation	• Significant negative impact on environment of SKP by improper medical waste management	-	• Intensive education activities for the promotion of proper disposal, aimed at sources of medical waste generation
6. Urban Environment	Disorderly advertising signs/ billboards	Main streets and intersections	• No control • No permit system	• Cause accidents • Hideous scenery	Zoning control e.g. in Muang District	Investigate the situation of unregulated city area billboards and find a

Environment	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
						solution
	Failing canals	Whole SKP	Sediments and illegal dumping	Loss of value for whole SKP	-	Formulate plan and allocate budget for development of provincial water transportation network
	Lack of green zones in congested urban areas	Urban areas of SKP	Lack of awareness	Loss of value for whole SKP	-	Government and private sectors make a joint effort to create urban amenities e.g. planting trees along roads, neighborhood parks
7. Natural Environment and Culture	Natural and cultural assets are not sufficiently maintained	See Table 5-67 and Figure 5-35 in Main Report (Locations of Natural and Cultural Heritage Sites in SKP)	Lack of resident awareness about natural and cultural assets	Deterioration of natural and cultural assets	-	Public education, administrative support, and budget allocation for the conservation of natural and cultural assets
	Natural and cultural assets are not fully utilized	See Table 5-67 and Figure 5-35 in Main Report (Locations of Natural and Cultural Heritage Sites in SKP)	Lack of resident awareness about richness of natural and cultural assets in SKP	Loss of potential income from tourism	-	Conduct a publicity campaign so that natural and cultural assets in SKP will attract tourism, in order to increase income from tourism

Environment	Summary of Issue	Area in which Issue Occurs	Causes	Impact	Measures Taken	Measures to be Taken
8. Global Warming	The countermeasures set up in the National Strategy on Climate Change (NSOCC) are not implemented well	Whole SKP	Lack of knowledge in global warming issues	Deterioration of environment	-	Implement countermeasures which are set up in NSOCC, especially the following: • Further recover mangrove forest area by afforestation • Implement sanitary landfill operation measures and promote 3Rs through public relations and educational activities in cooperation with REO 8
	Final disposal sites in neighboring provinces are operated using open dumping methods despite significant GHG emissions from waste, and 3Rs (Reduce, Reuse and Recycle) activities are hardly taking place					

b. Vision, Goal, Issue and Measure of NREM in AYP

It is impossible to implement all of the issues and measure to be taken discussed in the section above by the PEQMP target year of 2011. Therefore, the ideal state of NREM that the Province should aspire to on the long term was expressed through Vision and Goals, and the Issues and Direction of Measures sorted accordingly. Vision and Goals must reflect the opinions of as many stakeholders as possible, and it is only presented here to stimulate discussion. In this summary version, Visions, Goals, and Strategies are presented below.

b.1 Vision and Strategy

b.1.1 Vision

The vision is to realize a favorable environment for society and life to exist in symbiosis with fertile natural resources with a rich water environment at its nexus, and attain social and economic development which is in harmony with the environment.

b.1.2 Goals

1. Social and economic development in harmony with the conservation of a rich water environment.

   The following issues should be resolved to realize this:

   - Decrease the outflow of registered population.
   - Breakaway from stagnation in sales of the fishery sector.
   - Development is promoted in harmony with conservation of natural resources and environment.
   - Prevent environmental deterioration due to an increase in tourism.
   - Industry is promoted using local wisdom and property efficiently.

2. Conservation of fertile natural resources in harmony with provincial development.

   The following issues should be resolved to realize this:

   - Soil and land resources are used effectively and conserved according to local features.
   - Forest resources (mangrove forest) are conserved where marine resources are preserved and biodiversity is protected.
   - Biodiversity is conserved and rehabilitated.
   - Abundant water resources are conserved and managed efficiently and used effectively.
   - Deterioration of marine/coastal resources is stopped and they are rehabilitated.

3. The conservation of an abundant social and living environment in symbiosis with a rich natural environment.

   The following issues should be resolved to realize this:

   - Safe and good water is provided to all people in the province.
   - Safe and good quality of water is secured.
   - Proper and sustainable system of solid waste management is established.

- Good air quality is preserved.
- Adverse impact by noise and vibration is prevented.
- Appropriate system for hazardous waste management is developed.
- Favorable urban environment is developed.
- Natural and Cultural Heritage is maintained properly and used effectively.
- The system for confronting global warming problems is established.

b.1.3 Strategies

The following six strategies were established based on National EQMP in order to reach the goals shown above.

Strategy 1: Allow joint ownership of environmental data, public access to information and knowledge of NREM, and encourage public participation in NREM.

Basic information of NREM is disseminated to residents in the province, residents' awareness is developed and they are encouraged to participate in NREM. Especially facts on adverse impact on health and living by degradation of environmental quality are clarified so that residents may monitor and protect local natural resources and environment by themselves. In order to realize this, the opening of information on natural resources and environment to the public is promoted. Moreover, a monitoring committee is set up including representatives of local residents and Business Enterprises so that they can join the meeting for evaluation of the progress of PEQMP implementation.

Strategy 2: Improve the efficiency of NREM and develop stakeholder capacity.

Jurisdiction of the organizations related to NREM is made clear and duplication of activities can be avoided in addition to strengthening the linkage among each organization. Information of NREM is unified and owned in common, and the capacity of the organizations and their staff is developed.

Strategy 3: Support local administrations to manage NREM.

The organization for NREM in local administration is strengthened and its administrative capacity is developed. Local administrations are given support to establish their regulations to strengthen the organization for NREM. Moreover, in order to support and strengthen weak local administrations, joint investment and cooperative management are driven forward for NREM with Orborjor at its nexus.

Strategy 4: Reduce poverty through the fair utilization of natural resources so that they reach grassroots society.

Win-Win measures by which all stakeholders can gain profit are introduced by promoting empowerment to local residents based on the principle that beneficiaries should pay part of cost.

Strategy 5: Promote efficient and sustainable use of natural resources with consideration to environmental conservation.

The mechanism of cost burden is developed to rehabilitate natural resources and environment (NRE), in cooperation with local residents and relevant organizations, by setting up rules and regulations prescribing the provision for payment to an agency to manage NRE.

Through a variety of study processes, whether official or unofficial, education is conducted for all members of the younger generation and knowledge of natural resources and environment is disseminated. In order to set up the production target taking a serious view of natural balance, research and development are actively conducted regarding sustainable and effective use of natural resources.

Strategy 6: Conduct balanced and sustainable environmental development through conservation, monitoring and the rehabilitation of nature.

Based on Social Measurement, which applies the Polluter Pays Principle (PPP) and Beneficiary Pays Principle (BPP) and published information of impact on natural resources and environment, etc., conservation, monitoring and rehabilitation of the natural environment are conducted. Protected areas are managed according to the principle of biodiversity, and wildlife habitats are managed according to forest classifications.

b.2 Ideal State of NREM, Issues, and Direction of Measures

All of the above suggestions are represented in the following figure, which depicts the ideal state of NREM that SKP should aspire to on the long term, current issues, and the direction of measures:

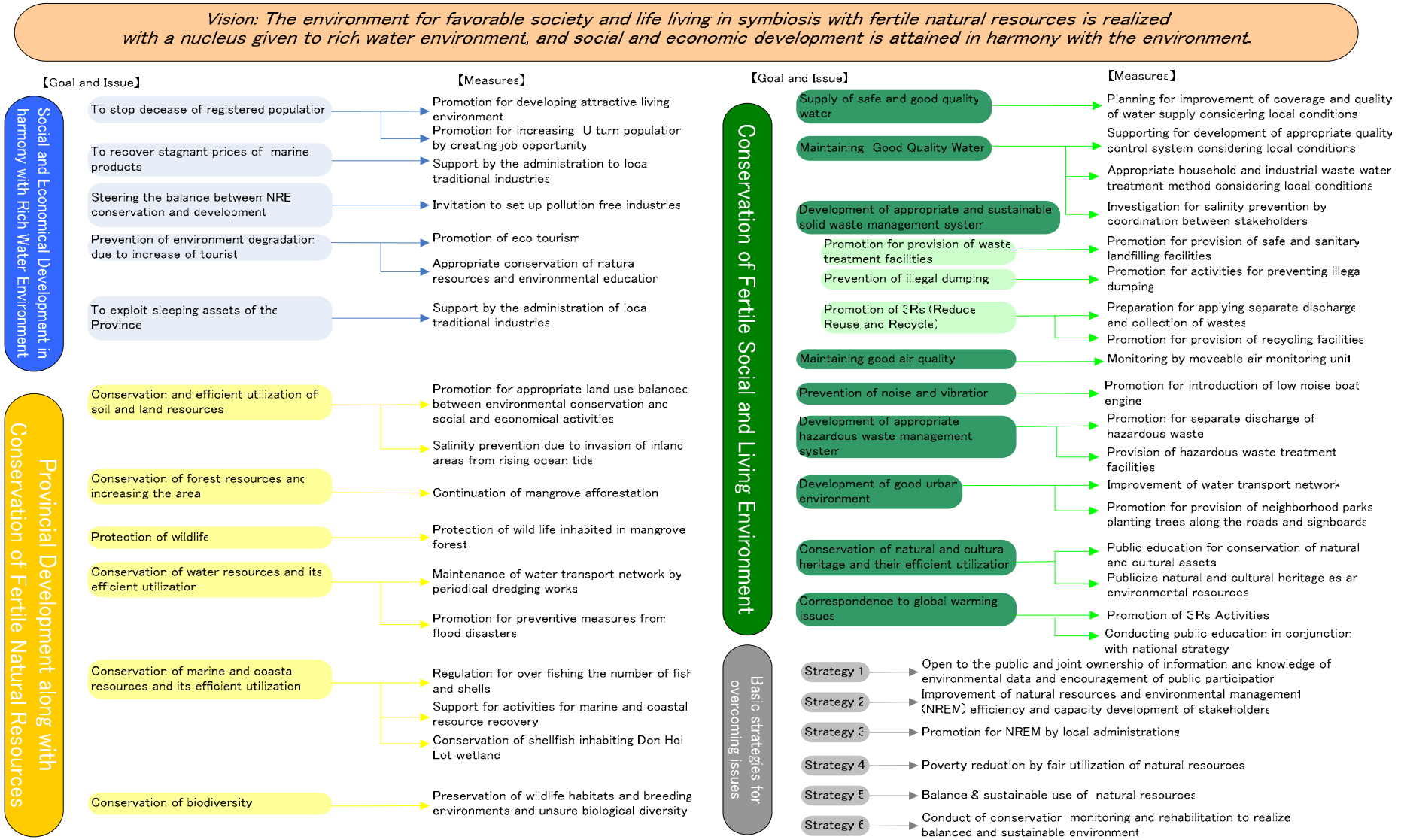


Figure 5-36: Vision, Goals, Issues and Direction of Measures for NREM in SKP

5.2.4 Priority of Issues

As mentioned above, there are many issues to be resolved in NREM in SKP. However, there are limited financial and human resources available. In this section, we examine the priority issues to be resolved by the target year 2011 in PEQMP (2008-2011) for SKP.

a. Opinion Survey of Stakeholders

a.1 Target Groups

An opinion survey was conducted among the following four stakeholder groups. Their answers were collected, added and analyzed according to target group.

Table 5-74: Target Group for Opinion Survey

Target Group	Abbreviation	Number
Local Administration	OP-LA-SKP	36 LA
Resident	OP-RE-SKP	64
Business Enterprise	OP-BE-SKP	47
NGO	OP-NGO-SKP	5 NGO

a.2 Problems within Local Administration (LA)

The most serious problems within LAs were indicated as follows:

Table 5-75: Problem in LA

Target Group	Most Serious Problem	Reply Rate (%)	Second Most Serious Problem	Reply Rate (%)
LA	Deterioration of NRE	41.7	Stagnation of Economy	33.3
Resident	Deterioration of NRE	65.6	Stagnation of Economy	20.3
Business Enterprise	Deterioration of NRE	48.9	Deterioration of NRE	40.4
NGO	• Deterioration of NRE • Development Plan by Government does not take local knowledge into account	40.0 40.0	Stagnation of Economy	20.0

a.3 Problems of NREM

Serious problems of NREM according to each target group are listed in the following table. The percentage value shown in the table is the ratio of respondents who selected “4 Very Serious” among six possible choices (1 Not serious at all, 2 Not very serious, 3 Somewhat serious, 4 Very serious, 5 Can’t choose, 6 No response).

Table 5-76: Problem of NREM

Target Group	Most Serious Problem	Reply Rate (%)	Second Most Serious Problem	Reply Rate (%)
LA	Marine/Coastal/Fishery Resources	38.9	Solid Waste Management	27.8
Resident	Marine/Coastal/Fishery Resources	25.0	Global Warming	23.4
Business Enterprise	Marine/Coastal/Fishery Resources	25.5	Global Warming	17.0
NGO	Marine/Coastal/Fishery Resources	100.0	• Solid Waste Management • Water Quality	60.0 60.0

The respondents indicated the following reason for their choice of which item was the most serious problem, as follows:

Table 5-77: Reason for Selecting Most Serious Problem

Most Serious Problem	Specific issue	Reason for choice
Marine /Coastal /Fishery Resources	• Disordered and illegal fishing methods • Decrease of fishery resources • Over harvesting of Razor clams • Coastal erosion • Too many tourists	• Extreme decrease of fishery resources and less income for fishermen • Extreme reduction of razor clam population • Loss of land • Deterioration of natural environment

The respondents indicated the following reason for their choice of which item was the second most serious problem, as follows:

Table 5-78: The Reason for Selecting the Second Most Serious Problem

Second Serious Problem	Specific issue	Reason for choice
Solid Waste Management	• Improper treatment of huge amount of solid waste • Improper management of transfer station by private company • Dumping waste into waterways	• Occurrence of serious environmental problem • Obstacles to fishery
Global Warming	• Rise in temperature	• Adverse impact on agriculture • Decrease of fishery resources • Change of season

		• Influence on health
Water Quality	• Polluted water flowing from neighbouring provinces • Polluted water flowing from fishery ponds	• Decrease of fishery resources • Adverse impact on agricultural land

a.4 Resident Request to LA

There are 34 LAs to which residents require improvement of the local area (94.4% of all LAs). The request for "Construction of infrastructure like roads and bridges" is the most common request (requested in 85.3% of LAs) and "Water supply infrastructure" is the second one (35.3% of all LAs), with "Lighting of public areas" as the third (29.4% of all LAs).

b. Priority examined in SWOT Analysis

The PEQMP-KPI Formulation Committee was held at a resort hotel in SKP on 2nd July 2007 chaired by the Vice Governor, and a SWOT Analysis was conducted with 20 relevant participants directed by a moderator from a university. SWOT Analysis analyzes the Strengths (S), Weaknesses (W), Opportunities (O) and Threats (T) of SKP to resolve the problem of NREM.

In addition to SWOT Analysis, the priority among issues to be resolved for NREM was examined in the PEQMP-KPI Formulation Committee.

The results of the latter discussion are as shown below:

Table 5-79: Priority Issues on Natural Resource Management in SKP Discussed in SWOT Analysis Meeting

Priority	NREM Problems	Suggestion for Preventive Measures and/or Solution
1.	Amount of aquatic animals is decreasing	• Build habitat for marine animals (artificial coral) • Release fresh water aquatic animals into natural water source • Publicize warnings to fishermen to stop illegal fishery • Encourage people and fishermen to participate in protection e.g. support creation of voluntary fishermen's network in the entire area
2.	Deteriorated soil	• Reduce the use of chemical fertilizers • Promote the use of biological/ organic fertilizers • Promote planting of Vetiver Grass • Provide knowledge on soil conservation
3.	Water Monitor lizards eat villagers' pets/ livestock	• Decide upon a responsible agency for catching and releasing water monitors in a controlled area • Propose to relevant organizations to reconsider law on water monitors as a protected animal

Priority	NREM Problems	Suggestion for Preventive Measures and/or Solution
4.	Lack of water for domestic use/ consumption and agriculture	• Expand water supply to cover whole area • Repair/ maintenance of water supply system • Dredge canals • Build saline water prevention block i.e. water control facility, collect opinions from all sectors in order to meet requirement of area and thus operate properly
5.	Lands are sold to investors	• Campaign to create awareness for love of hometown • Promote "sufficiency economy" philosophy

Source: PEQMP-KPI (2008-2011), SKP

Table 5-80: Priority Issues on Environmental Management in SKP Discussed in SWOT Analysis Meeting

Priority	Prioritized Problem	Suggestion for Measurement and Solution
1	Uncollected waste	• Promote waste separation • Reduce waste generation • Increase capacity of collection and disposal
2	Wastewater	• Construct proper wastewater treatment system for the area • Create awareness among residents to stop discharging waste and night soil into natural water sources
3	No waste disposal site	• Build acceptance among local residents • Provide quality management by government
4	Household hazardous wastes	• Promote waste separation • Provide guidelines in integrated disposal system
5	Disorderly advertising billboards	• Strict and serious enforcement of law • Survey on advertising billboards in the Province
6	Noise level is above standard	• Set measures for tourism boats to have standard engine noise levels • Changing tourism boat engines to models within noise standard
7	Infectious waste from hospital/clinics	• Collect and dispose of medical waste using proper technology

Source: PEQMP-KPI (2008-2011), SKP

c. Examination of Priorities

Since NREM encompasses a wide-ranging variety of sectors, it is quite difficult to decide the priority ranking among projects from differing sectors. Additionally, individual NREM projects routinely require a huge sum of money to implement. Thus it becomes important to conduct sufficient survey, research, and planning activities and to exhaustively consider the feasibility of each project, in order to make each individual NREM project cost-effective. Specifically, priority among projects should be determined only after extensive comparative analyses between sector *master* plans. SKP lacks these basic master plans in various NREM sectors. Therefore, the Study Team suggests the following regarding priorities:

- First of all, top priority should be given to the formulation of master plans for each NREM sector.
- For master plan formulation, the priority ranking is as follows, based on the result of the opinion survey among stakeholders and examination of priority issues conducted during SWOT analysis.
  - Conservation and rehabilitation of marine/coastal/ fishery resources
  - Establishment of proper solid waste management system
  - Tackling global warming
  - Preservation of water quality
  - Conservation of soil/land resources
- Finally, strengthening the NREM administrative capacities of LAs has equal priority with any urgent individual issue, as they hold responsibility over NREM in their respective localities.

5.2.5 Provincial Potential Analysis by SWOT Analysis

Both internal and external factors can effect on the provincial natural resources and environment administration/ management, strategies, and action plan. It is; therefore, very important to analyze both internal factors which are Strengths (S) and Weaknesses (W), and external factors which are Opportunities (O) and Threats (T) thoroughly in order to evaluate and develop framework for solving problems and action plan. Details of each factor are provided in Table 5-81, Table 5-82, and Table 5-83.

Table 5-81: Provincial Internal Factors and External Factors

Provincial Internal Factors	Strengths (S) 1) Clear environmental policy 2) Governor pays much attention to the issue. 3) Small area 4) Good economic condition 5) Low cost of living 6) Simple life style following Sufficiency Economic Philosophy 7) Cooperation of people 8) People are nice and friendly 9) Eco-tourism sites 10) Fertilized natural resources 11) Biodiversity 12) Pleasant Environment 13) People are independent (rely on themselves)	Weaknesses (W) 1) People are independent (rely on themselves) 2) Rapid growth of tourism 3) Location is on mouth of river area/ gulf area 4) Plenty alien workers provided 5) Roads are narrow/ difficult to expand/widen 6) Disagreement of people 7) People's lack of awareness on environmental issue 8) Small area 9) Fertilized land 10) Good economic condition 11) Biodiversity provided 12) Pleasant environment

	14) Location is on mouth of the river area/ Gulf area 15) Plenty alien workers provided	
Provincial External Factors	Opportunities (O) 1) Near Bangkok 2) Convenience in communication/ traveling	Threats (T1) 1) Limited budget 2) Discontinuous policy 3) Near Bangkok

Table 5-82: Result of Internal Factors Analysis

Internal Factors Analysis	Values			
	Strengths ①	Weaknesses ②	Total ① + ② = ③	Average ③ / ④ = ⑤
1. Clear environmental policy	3	0	3	0.16
2 . Governor pays much attention to the issue	3	0	3	0.16
3) Small area	2	-2	0	0
4) Good economic condition	3	-2	1	0.05
5) Low cost of living	3	0	3	0.16
6) Simple life style following Sufficiency Economic Philosophy	3	0	3	0.16
7) Cooperation of people	3	0	3	0.16
8) People are nice and friendly	3	0	3	0.16
9) Eco-tourism sites	3	0	3	0.16
10) Fertilized natural resources	3	-2	1	0.05
11) Biodiversity	3	-2	1	0.05
12) Pleasant Environment	3	-3	0	0
13) People are independent (rely on themselves)	2	-3	-1	-0.05
14) Location is on mouth of the river area/ Gulf area	2	-3	-1	-0.05
15) Plenty alien workers provided	1	-3	-2	-0.11
16) Rapid growth of tourism	0	-3	-3	-0.16
17) Roads are narrow/ difficult to expand/widen	0	-2	-2	-0.11
18) Disagreement of people	0	-3	-3	-3

19) People's lack of awareness on environmental issue	0	-2	-2	-0.16
④ = Total Factors = 19				
Total			10	0.52

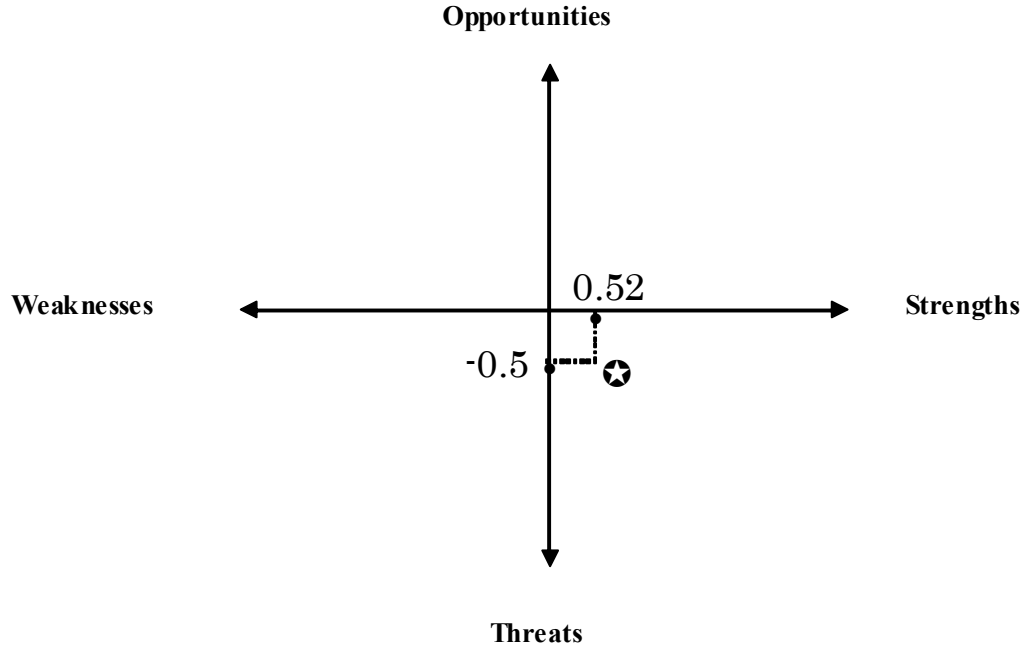
Remark: Internal Factors Scoring (X or Y)
Strengths: Most=3 Average=2 Least=1 Not Available=0
Weaknesses: Most=3 Average=2 Least=1 Not Available=0

Table 5-83: Result of External Factors Analysis

External Analysis	Values			
	Opportunities ①	Threats ②	Total ① + ② = ③	Average ③ / ④ = ⑤
1) Near Bangkok	3	-2	1	0.25
2) Convenience in communication / traveling	3	0	3	0.75
3) Limited budget	0	-3	-3	-0.75
4) Discontinuous policy	0	-3	-3	-0.75
④ = Total Factors = 4				
Total			-2	-0.50

Remark: External Factors Scoring (X or Y)
Opportunities: Most=3 Average=2 Least=1 Not Available=0
Threats: Most=3 Average=2 Least=1 Not Available=0

Summary on Provincial Analysis



From provincial analysis on both internal and external factors, results showed that internal factors provided positive outcome (+ 0.52) when external factors provided negative outcome (-0.5). When plotting values on to the graph, result was in lower right which indicated that the province has strengths, though facing problems. The capacity to manage natural resources and environment effectively is showed.

5.2.6 Selection of Priority Programs

Priority Projects in PEQMP are projects that will be implemented by year 2011, and can be sorted into two major categories:

- Improvement in individual NREM sectors
- Strengthening of NREM administrative capacities in SKP

All the contents of this chapter above have been used as a basis for discussion with relevant stakeholders, and through such discussions, the following Priority Programs (common-goal clusters of related Priority Projects) were chosen for implementation by year 2011:

a. Improvement in individual NREM sectors

1. Program for Conservation and Rehabilitation of Aquatic Resources
2. Program for Appropriate and Sustainable Solid Waste Management
3. Program for Water Quality Preservation in Public Water Bodies
4. Program for Safe and Quality Water Supply

b. Strengthening NREM administration capabilities in SKP

1. Program to Strengthen Linkage between Central Government Agencies and LAs
2. Program to Strengthen NREM capacities of LAs

5.3 Part 3: Details of the PEQMP

Utilizing the sample formats given in the PEQMP-KPI Formulation Manual, and acting upon the comments of the PEQMP-KPI Evaluation Committee, the following relationships are first shown in Project Design Matrix (PDM) format:

- Priority Programs (common-goal clusters of individual projects) selected for each Priority Issue (i.e. NREM sectors with priority)
- Relationship between priority issue and individual projects (i.e. Priority Projects) formulated to solve these issues
- The indicators to monitor and evaluate each individual project (i.e. Priority Project)
- The responsible and supporting agencies for each individual project (i.e. Priority Project)

Then, the corresponding implementation and budget plan for each Priority Project is shown in a single corresponding table.

5.3.1 Priority Programs and Priority Projects

a. Program for conservation and rehabilitation of aquatic resources

Although the GPP for the whole Province is on the increase, the GPP for the fishery sector in 2005 (356 million Baht) has decreased to half of the 2001 figures (658 million Baht).

All of four opinion survey target groups pointed out that the most serious problem of NREM in SKP is “Marine and coastal resources”. The reasons why the respondents regarded this as the most serious problem are given in Table 4-7 above.

Investigation revealed that there is a moderate amount of erosion, at a rate of 1 to 5 meters per year, at the northeast coast of the Gulf of Thailand[15].

The following figure indicates the area where the width of mangrove forest is enough to protect the sea shore, and where the width is not enough and thus the risk for erosion exists.

[15] Source: Biweekly Meeting No. 9 on 26th November 2007, PEO of SKP

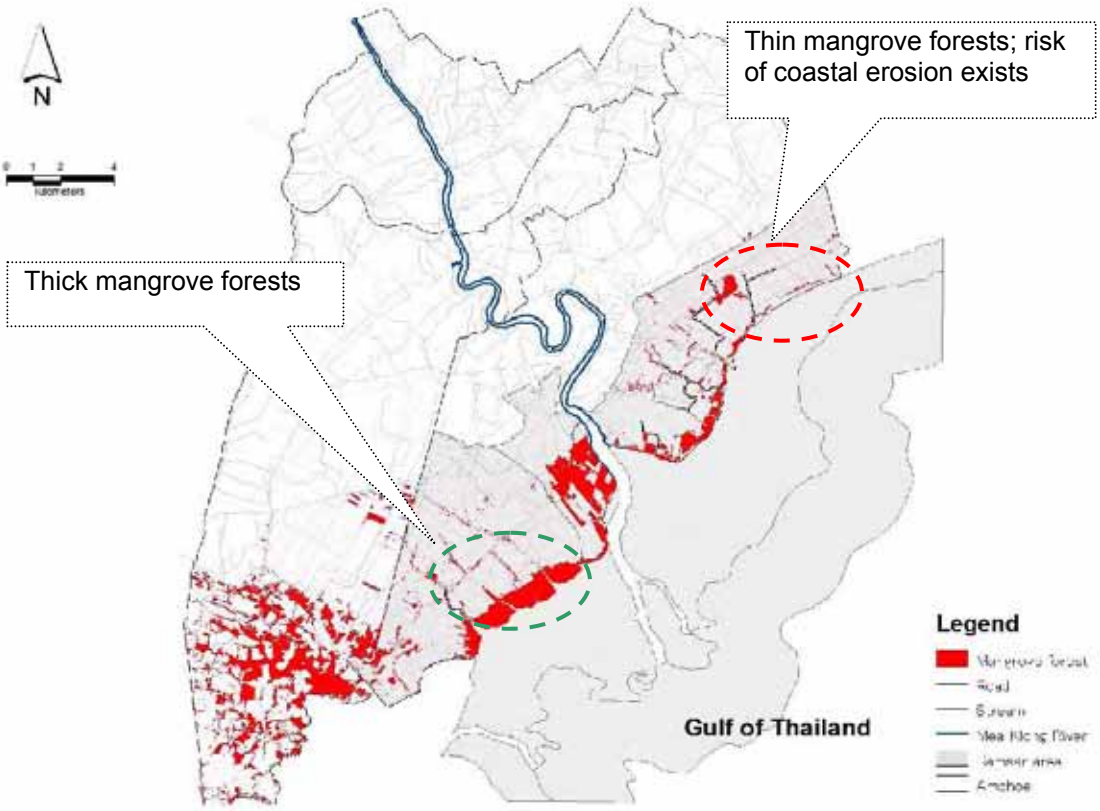


Figure 5-37: Mangrove Forests by SPOT-5 Satellite Image on March 30, 2007

Table 5-84: Program for Conservation and Rehabilitation of Aquatic Resources in SKP PDM

Program Name: Program for Conservation and Rehabilitation of Aquatic Resources in Samut Songkhram Province (SKP)
Target Area: Coastal Areas in SKP and the Mae Klong River Basin
Target Group: Fishermen and residents in SKP who make a living off aquatic resources

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Marine and coastal resources of coastal areas in SKP and the Mae Klong River Basin are conserved and rehabilitated.	Catch per Unit Effort will increase.	Interview Survey	
Program Purpose Establish a sustainable form of aquatic resource usage in SKP	Awareness improves among residents who make a living off aquatic resources	Questionnaire	Registration of foreigners is actively promoted
Outputs 1. A conservation and rehabilitation plan suited to SKP is formulated	1.1 Fishery statistics by species/type and location 1.2. Detailed plan for conservation and rehabilitation	1.1. Study report 1.2. Conservation and Rehabilitation of Aquatic Resources Master Plan	
2. A sustainable form of fishing is established	2.1. Number of warnings and arrests over illegal fishing practices 2.2. Number of workshops and other educational events, number of participants of the same	2.1. Interviews 2.2. Interviews	
3. Habitats for aquatic resources are established through afforestation of mangrove forests	3. Afforestation area statistics and total area statistics of mangrove forest	3. Survey and satellite imagery analysis	
Individual Priority Projects (Numbers correspond to Output numbers)	**Responsible Agency**	**Supporting Agency**	**Input (Baht)**
1. Formulation of a conservation and rehabilitation plan	PFO, Orborjor	PEO MFDS7 FFKU MSRDC	1,000,000
2. Control illegal fishing practice and dissemination of sustainable fishing practice	PFO, LA	PEO, DOLA of PA	750,000
3. Conservation of natural habitats for fish, i.e. coastal mangrove forests, and increase in safe habitats through afforestation	MFDS7 PEO LA	PFO	1,000,000

PFO: Provincial Fishery Office,

PEO: Provincial Environment Office,

MFDS7: Mangrove Forest Development Station No7

PO: Provincial Office

FFKU: Fishery Faculty, Kasetsart University

MSRDC: Marine Shrimp Research and Development Center of SKP

DOLA: Department of Local Administration of MOI

b. Program for appropriate and sustainable solid waste management

There is no final disposal site located within Samut Songkhram Province (SKP) but there is one transfer station. All colleted wastes from the transfer station are transported to disposal sites in neighboring Ratchaburi and Samut Sakhon Provinces as shown in the following figure. If the neighboring Provinces refuse to accept the waste collected in SKP, SKP could end up with many waste heaps in every urban area. This kind of "Waste War" has occurred in many cities in the world, including Tokyo, Japan.

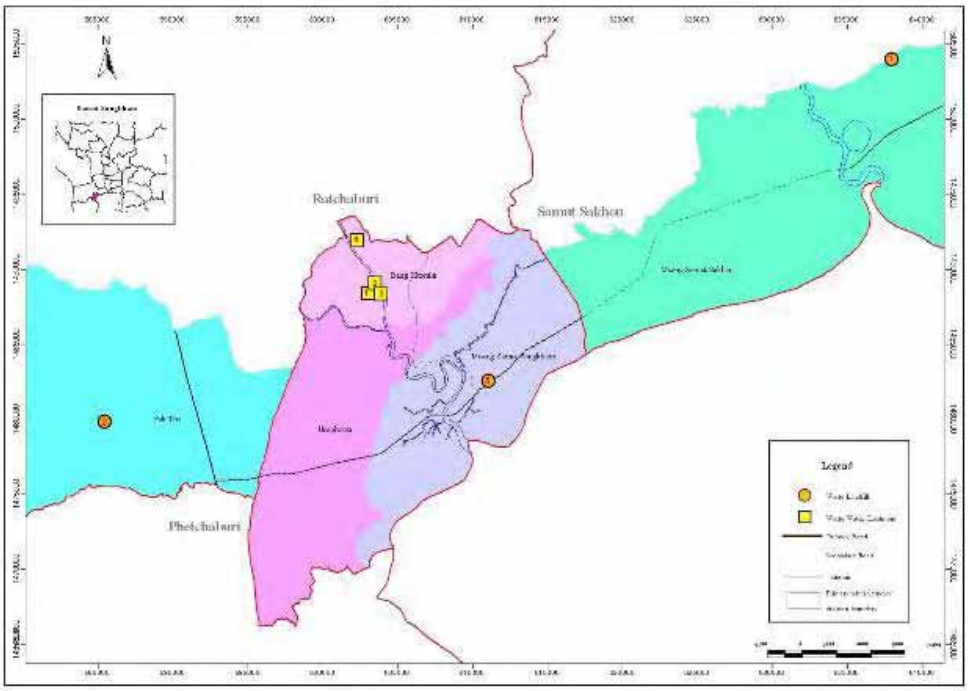


Figure 5-38: Location of Transfer Station and 2 Disposal Sites in Neighboring Provinces

The final disposal site in Ratchaburi province is located around 20 km west from the center of SKP. A large borrow pit left after excavating soil was used as the disposal site. The disposal site is having serious adverse impacts to the surrounding environment due to open dumping as shown in the photos below.

Ratchaburi Disposal Site in Rainy Season

Ratchaburi Disposal Site in Dry Season

Table 5-85: Program for Appropriate and Sustainable Solid Waste Management in SKP
PDM

Program Name: Program for Appropriate and Sustainable Solid Waste Management in Samut Songkhram Province (SKP)
Target Area: SKP
Target Group: Solid Waste Management-related administrations, private companies, and all residents of SKP

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal The establishment of sustainable waste management that is appropriate to the environment of SKP,	Extermination of illegal dumping practices and the implementation of hygienic waste treatment and disposal	Questionnaire	The waste management policy of SKP stays the same
Program Purpose 1. Waste generation is reduced in SKP, 2. waste generated is finally disposed in sanitary manner within SKP	1. Waste generation rate per capita 2. Conditions of final disposal site and environment	Questionnaire	
Outputs 1. Site for final disposal site is selected and sustainable SWM Master Plan in Provincial level is formulated. 2. Final disposal site is constructed within the Province. 3. An awareness on appropriate SWM is raised.	1. Contents of SWM Master Plan in Provincial level 2. Contents of Construction Record 3-1 Waste generation rate per capita 3-2 Volume of separate discharge and collection, number of LAs 3-3. Number of schools which implemented school composting 3-4. Number of seminars for administration staff	1. SWM Master Plan in Provincial level 2. Construction Record 3. Interviews Survey	Stakeholders agree to construct a final disposal site in SKP
Individual Priority Projects (Numbers correspond to Output numbers)	**Responsible Agency**	**Supporting Agency**	**Input (Baht)**
1. Formulation of SWM Master Plan in Provincial Level 1-1 Site Selection for Final Disposal Site 1-2 Formulation of Sustainable SWM Master Plan in Provincial Level	Orborjor in collaboration with all LAs	Provincial Committee (PC), Pollution Control Department (PCD) PEO, REO	1,000,000 3,000,000
2. Construction of Final Disposal Site 2-1. Detailed Design 2-2. Construction of Final Disposal Site	Orborjor in collaboration with all LAs	PC, PCD, Decentralization Committee	5,000,000 90,000,000

3.	Raising awareness on an appropriate SWM			
3-1	Public education in order to reduce waste generation rate.	LA	PEO, REO, PA , Schools	950,000
3-2	Promotion of separate collection among LAs by organizing a competition between LAs and initiating a campaign program	LA	PEO, REO, DEQP	492,000
3-3	Dissemination of school composting among schools that do not currently implement such a program	Schools	PEO, REO, LA	900,000
3-4	Training seminars for administration staff on appropriate and environmentally friendly waste management	LA, PEO	REO, PCD, DEQP	80,000

PC: Provincial Committee

PCD: Pollution Control Department/MNRE

PEO: Provincial Environment Office

REO Regional Environment Office

DEQP: Department of Environmental Quality and Promotion/MNRE

c. Program for water quality preservation in public water bodies of SKP

There are four water quality monitoring points in SKP along the Mae Klong River. According to the water quality class of PCD, the quality of water falls between class 3 and class 4.

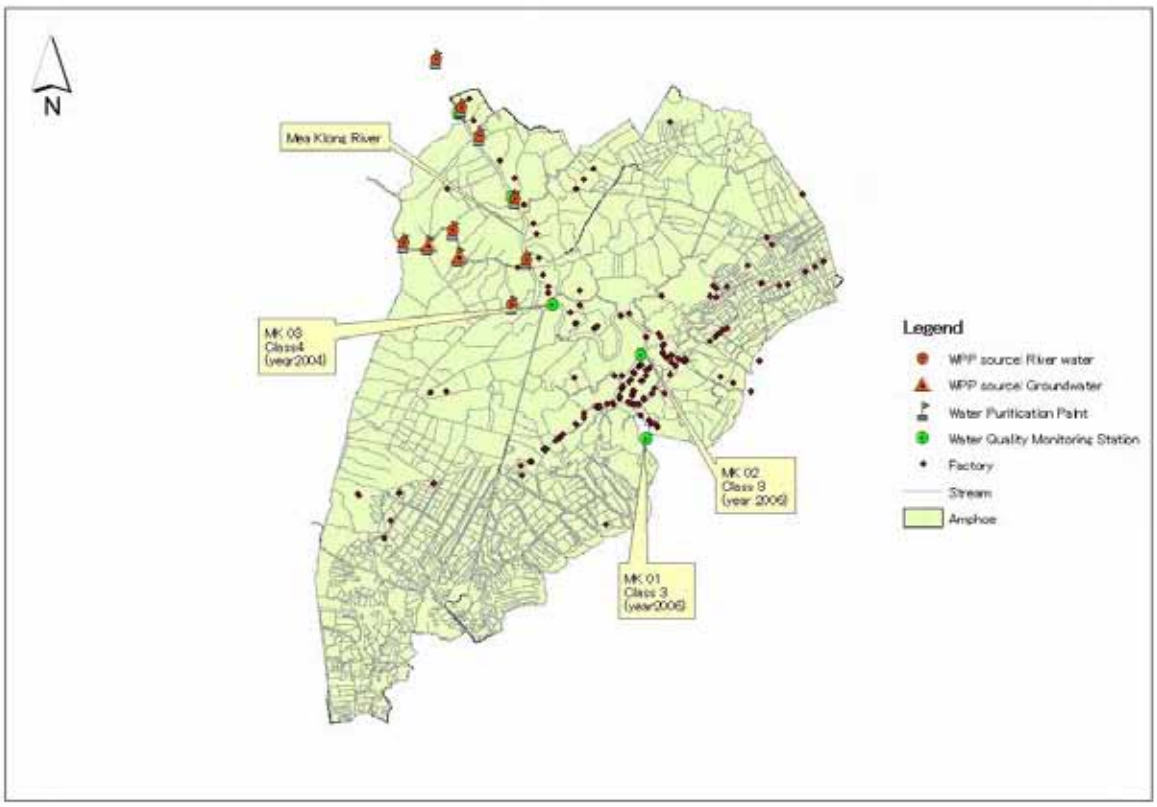


Figure 5-39: River Water Quality Monitoring Stations in SKP and Water Quality Class

According to past monitoring results, water quality trends towards small but worsening conditions at all monitoring points. On the assumption that the same conditions (amount of pollutant, treatment, etc.) continue in the future, the water quality of the Mae Klong River will worsen compared to the current situation.

Water pollution of public water bodies can seriously affect human health through water utilization facilities, in particular water supply facilities such as water purification plants and wells. If water pollution becomes serious, it raises the cost of purification or makes the water unsuitable for consumption and use.

The river water quality in SKP is still holding at Class 3 or 4; not Class 5 in which water becomes unsuitable for consumption and use. However, it is feared that the water source for water purification plants will have to be changed from the Mae Klong River to underground water sources, if water quality continues to deteriorate. Since the scale of these water purification plants are small (about 1,000 m^3/day capacity on average), it is not difficult to change the water source. However, the water source will be very difficult to change for a large scale plant with a capacity of more than several ten thousand m^3/day.

The following figures present major water pollution sources and water utilization facilities in SKP and in the upper reaches of Mae Klong River, where the main water purification plants are located:

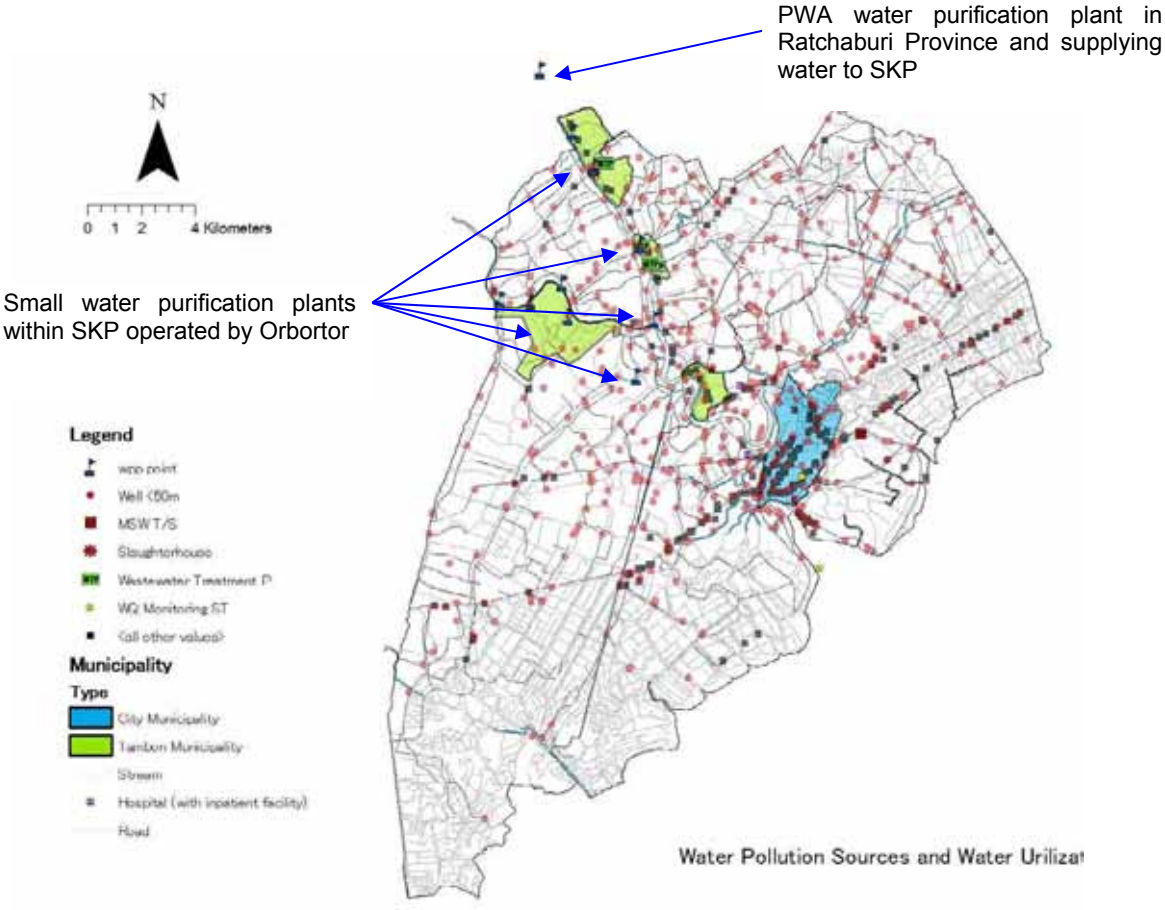
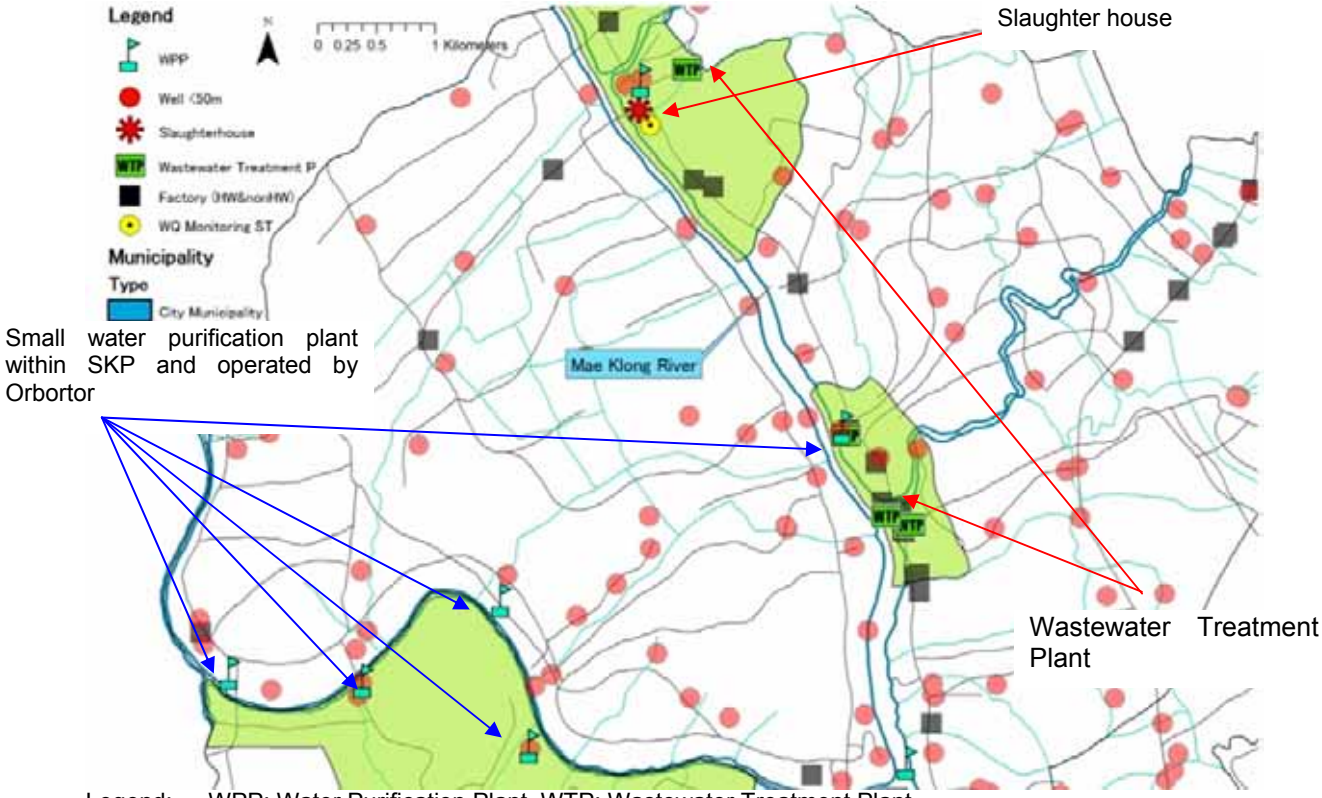


Figure 5-40: Location Map of Major Water Pollution Sources and Water Utilization Facilities in SKP

Domestic water to the Tessaban in SKP is supplied by the Provincial Water Authority (PWA) in Ratchaburi Province, located upstream of SKP, and its purification capacity is 24,000m^3/day. The source of water is surface water from the Mae Klong River. There are also small purification plants operated by Orbortor within SKP. Priority must be given to the preservation of water quality especially upstream of these water purification plants.

In order to formulate a water quality preservation plan, information will be required such as the amount of pollution load, location of discharge into public water bodies, amount of water inflow at the location, amount of river water flow from upstream (special consideration must be given to river water flow during the dry season due to the critical effect of pollutants). Nevertheless, there is no such information in the existing database.

The following figure shows an enlarged view of part of SKP as a sample highlighting the relationship between small water purification facilities and various possible pollution sources.



Legend: WPP: Water Purification Plant, WTP: Wastewater Treatment Plant

Figure 5-41: Location Map of Major Water Pollution Sources and Water Utilization Facilities in Upper Stream of Mae Klong River

As shown in the figure, there are various possible pollution sources located upstream of the water purification facilities, such as a waste water treatment plant, some slaughterhouses, and so on. Furthermore, the residential area might be one of the pollution sources given the fact that the treatment of waste water from residential areas is not up to the required level.

Given these conditions, applying ad hoc countermeasures on individual pollution sources would require excessive amounts of money and time to achieve the final target of water quality preservation at public water bodies. In order to improve the water quality at public water bodies, to maintain quality of drinking water and to implement appropriate water quality management, it is important to investigate and plan at the regional level including

upstream of the Mae Klong River instead of each Tessaban and Orbortor level. Then a plan for reduction of the pollution load at the provincial level shall be formulated.

It is impossible to formulate the plan outlined above without information such as the amount of pollution load, location of discharge into public water bodies, amount of water inflow at the location, amount of upstream river water flow, and so on.

Therefore, the program for water quality preservation in public water bodies shall be implemented.

This program consists of two priority projects. One is a survey of pollution sources, and the other is the formulation of a water quality preservation plan for public water bodies.

1. Pollution Source Survey

   Under this survey, first an investigation will be conducted of types of pollution sources, their locations, and the amount of pollution load generated and discharged. Then the ratio of pollution contributed by each pollution source will be examined. The results will be utilized as basic information to formulate a water quality preservation plan for public water bodies.

2. Water Quality Preservation Plan for Public Water Bodies

   A water quality preservation plan for public water bodies consists of a plan for the reduction of pollution load, confirmation of improvement effects, and maintenance of improved water quality.

   The plan for reduction of pollution load is made up of the following:

   - Set a water quality target at each monitoring point of public water bodies together with a target date for achievement,
   - The amount of pollution load that must be reduced from each pollution source will be calculated in order to achieve the target, along with an examination of reduction methods for each type of pollution source,
   - Priority to reduce pollution load will be determined based on the pollution contribution ratio and investment effect considering the above results,
   - The plan to reduce pollution load will be formulated. Upon the formulation of the plan, activities for raising awareness among stakeholders in order to reduce the pollution load will be implemented.

   Under the examination methods to confirm improvement of water quality, the water quality monitoring plan will be formulated in order to confirm whether or not the quality of water has been improved according to the plan.

   Methods for revision of the plan will be examined and prepared in case the water quality goals are not reached.

   These procedures are presented below.

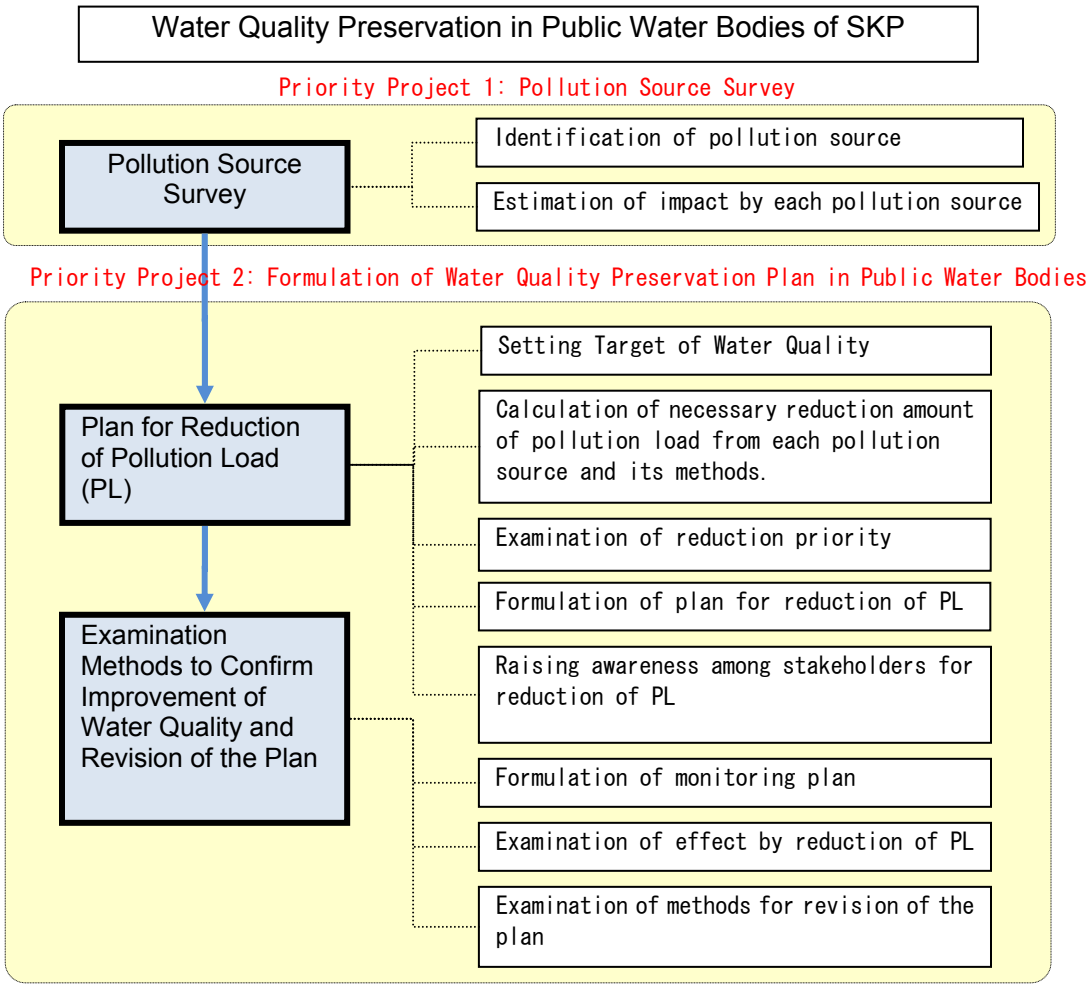


Figure 5-42: Relation between Program for Water Quality Preservation in Public Water Bodies in SKP and Priority Projects

Table 5-86: Program for Water Quality Preservation in Public Water Bodies of SKP PDM

Program Title: Program for Water Quality Preservation in Public Water Bodies of Samut Songkhram Province (SKP)
Target Area: Samut Songkhram Province
Target Group: Beneficiaries of public water bodies Samut Songkhram Province (administration, Business Enterprises, and residents)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Preserve high water quality in public water bodies of SKP	Water quality monitoring results	Water quality monitoring study	SKP does not change its water quality management policy
Program Purpose Formulate an appropriate, province-wide water quality management plan in SKP	water quality management plan	Water quality management plan report	

Outputs 1. Pollution contribution from each pollution source is determined 2. Water quality preservation plan in province is formulated.	1. Contents of pollution source survey report. 2. Contents of water quality preservation plan	1. Pollution source survey report 2. Water quality preservation plan	
Individual Priority Projects (Numbers correspond to Output numbers	**Responsible Agency**	**Supporting Agency**	**Input（Baht）**
1. Pollution source survey	PEO REO PCD	PAgO, PFO, PLO, PIO,LA	1,000,000
2. Formulation of Water Quality Preservation Plan in Public Bodies	PEO, REO PCD	PAgO, PFO, PLO, PIO,LA	2,000,000

PCD: Pollution Control Department/MNRE
PEO: Provincial Environment Office
REO Regional Environment Office
PIO: Provincial Industrial Office
PAgO: Provincial Agricultural Office
PLO: Provincial Livestock Office
PFO: Provincial Fishery Office

d. Program for Safe and Quality Water Supply

As for the domestic water supply, there are several water supply organizations such as Provincial Water Authority (PWA), and each local administration in different service areas. There is no comprehensive plan to control and manage water supply in order to supply safe and quality water after investigating individual water sources and water demands in the whole province.

Domestic water to most of parts of SKP is supplied by PWA and its water intake is located in Ratchaburi Province, which is upstream of SKP. Some Orbortors are operating small water purification facilities by themselves. Operation of those facilities may be below standard and the quality of the water they supply is unknown.

Hence, the water purification plant of PWA is operated appropriately and the plant's capacity is fairly large. Therefore, clean and safe water is supplied.

Currently, domestic water in SKP is supplied either from PWA or small, Orbortor operated purification plants. The following alternatives must be considered:

- Current water supply system shall be maintained, or
- Service area of PWA will be extended and PWA will supply the whole Province..

First, investigation shall be carried out under a comprehensive point of view such as examining water sources, water demand, and economic conditions. The most appropriate domestic water supply plan shall then be formulated based on these results. Finally, concrete projects will be implemented according to the plan and a safe and quality water supply will be achieved.

These procedures are presented as following.

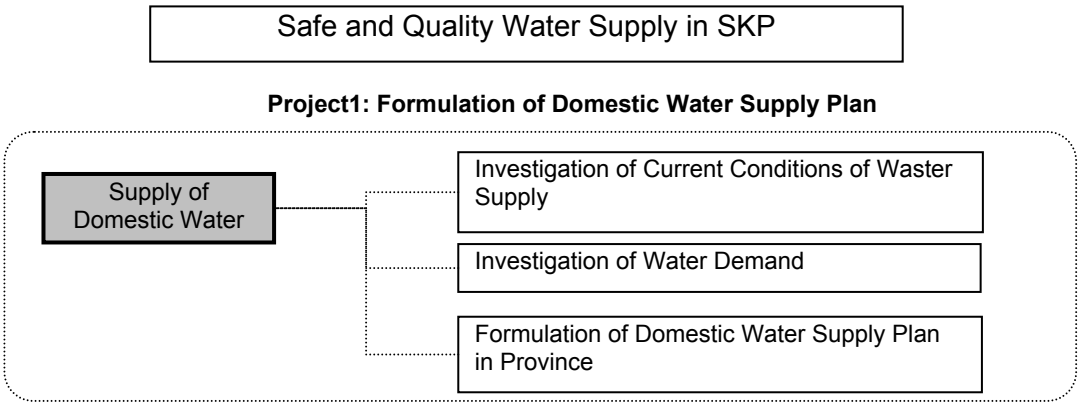


Figure 5-43: Safe and Quality Water Supply in SKP

Table 5-87: Program for Safe and Quality Water Supply in SKP PDM

Program Title: Program for Safe and Quality Water Supply in Samut Songkhram Province (SKP)
Target Area: Samut Songkhram Province (SKP)
Target Group: Residents of Samut Songkhram Province

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Safe and quality water will be supplied for all SKP	Water quality, amount, and pressure data	Samut Songkhram Water Authority Office records	SKP does not change its safe and quality water supply policy.
Program Purpose Necessary actions by each stakeholder will be determined	Contents of domestic water supply plan	Examination of the plan	
Outputs A domestic water supply plan is formulated	Contents of domestic water supply plan	Domestic water supply plan	
Individual Priority Projects (Numbers correspond to Output numbers)	**Responsible Agency**	**Supporting Agency**	**Inputs (Baht)**
1. Formulation of master plan on domestic water supply • Research of current conditions of domestic water supply • Investigation of domestic water demand • Formulation of domestic water supply plan	PWA and other water supply organizations	PHO PEO PO	1,500,000

PWA: Provincial Water Authority

PEO: Provincial Environment Office

PHO: Provincial Public Health Office

PO: Provincial Office in Provincial Administration

e. Program to Strengthen Linkage between Central Government Organizations, Provincial Administration and LAs in Samut Songkhram Province (SKP)

Many Tasks related to NREM have been decentralized and devolved onto Local Administrations (LAs), but the LAs put in charge of these tasks do not realistically have the capacity to execute these tasks. Therefore, for the time being, problem-solving in NREM will be difficult without the strong support of Central Government organizations and Provincial Administrations (PAs). Thus the following program is proposed as a priority program:

Table 5-88: Project Design Matrix (PDM) for Program to Strengthen Linkage between Central Government Organizations, Provincial Administration and LAs in SKP

Program Name: Program to Strengthen Linkage between Central Government Organizations, Provincial Administration and LAs in Samut Songkhram Province (SKP)
Target Area: Central Government and Samut Songkhram Province
Target Group: MNRE in Central Government, Provincial Administration and LAs in Samut Songkhram Province

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal NREM administrative capabilities of LAs in SKP are strengthened	Number of NREM projects started by government organizations in SKP, for example solid waste management or wastewater treatment	Interview survey with government organizations in SKP	The Governor (MOI official) supports such a program
Program Purpose Strengthen linkage for NREM between central government Organizations, Provincial Administration and LAs in SKP	NREM awareness increases among Provincial Administration and LA staff in SKP	Questionnaire survey to PA and LA	Central Government seriously promotes the decentralization of NREM
Outputs 1.1 NREM capacities of PEO, a NREM supporting team in PA (Changwat) and the Environmental Division in Orborjor increases 1.2 The link between REO 8 and regional offices still held by the five non-ex-MOSTE departments within MNRE shall be strengthened. 1.3 The existing NREM GIS Database of REO 8 is strengthened, and periodically updated and well maintained. The updated information on NREM is provided to PEOs and other administrative organizations under REO 8. 2.1 The linkages between central/ provincial/ and local administrations is strengthened. 2.2 Departments within MNRE grasp the current actual state of NREM in PAs and LAs 3.1 NREM awareness in preserving NRE, increases among administrative officers in LAs.	1.1 Number of training for PEO, a NREM supporting team in PA (Changwat) and the Environmental Division in Orborjor 1.2 Number of cooperation activities between REO 8 and 5 Regional Offices 1.3 Number of information on NREM provided to PEOs and other administrative organizations under REO 8. 2.1 Number of inquires to "PA/LA Central Support Center for NREM" 2.2 Number of inquiries dealt with by MNRE departments 3.1 Amount of budget for NREM and number of officers for it in LAs 3.2 Awareness and interest in	1.1 Annual report of REO 8 1.2 Annual report of REO 8 and5 Regional Offices 1.3 Annual report of REO 8 and NREM GIS Database Center 2.1 Activity report of "PA/LA Central Support Center for NREM" 2.2 Annual report of various departments of MNRE 3.1 Budget and annual report of LAs 3.2 Interview survey to residents and annual report of PEO	OPS/MNRE actively supports the program

3.2 NREM awareness, and interest in preserving NRE, increases among residents	preserving NRE among residents and number of complaints		
Individual Priority Projects (Numbers correspond to Output numbers)	**Responsible Agency**	**Supporting Agency**	**Input (Baht)**
1. Strengthening of the local NREM support capacities of REO 6	REO 8	OPS and ONEP of MNRE	5,600,000
2. Establishment of "PA/LA Central Support Center for NREM" in MNRE	ONEP/MNRE	OPS, DEQP, PCD, RFD, DNP, DMR, DMCR, DWR, DGR in MNRE	11,570,000
3. Promotion of awareness regarding NREM among administrator of LAs and resident and publication of environmental information	DEQP/MNRE, PEO/SKP	ONEP/MNRE PO Cable TV, local radio stations	3,480,000

REO: Regional Environmental Office

PEO: Provincial Environmental Office

PO: Provincial Office

All other organizations: departments within MNRE

f. Program to Strengthen NREM Capacities of LAs in Samut Songkhram Province (SKP)

There are three kinds of Local Administrations (LAs); the Orborjor, which shares their sphere of governance (i.e. the province) with Provincial Administration (PA: Changwat); the Tessaban, in charge of cities and municipalities; and the Orbortor, in charge of villages. These are organizations given new power under the Constitution of 1997 and the Decentralization Act of 1999. Many types of authority that have previously belonged to the Central Government have already been handed over to LAs, but the LAs often do not possess enough administrative capacity, including NREM capacities, due to the rapid pace in which decentralization occurred. Thus the following program is proposed as a priority program:

Table 5-89: Project Design Matrix (PDM) for Program to Strengthen NREM capacities of LAs in SKP

Program Name: Program to Strengthen NREM Capacities of Local Administrations (LAs) in Samut Songkhram Province (SKP)

Target Area: Samut Songkhram Province

Target Group: LAs in Samut Songkhram

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal NRE in SKP are properly managed	Level of satisfaction towards NRE among local residents	Questionnaire survey to local residents	Decentralization continues
Program Purpose NREM capacities of LAs in SKP are strengthened	Awareness among LA staff in SKP	Questionnaire survey to LA staff	Decentralization of NREM is promoted
Outputs 1.1 The Environmental Division in Orborjor is strengthened. 1.2 PA supports NREM of Orborjor 1.3 The Environmental Division of the Orborjor conducts NREM activities that are beyond the scope of Tessaban and Orbortor Orborjor, e.g.	1.1 Number of Staff in the Environmental Division in Orborjor and budget of it 1.2 Establishment of a NREM supporting team in PA (Changwat) 1.3Number of NREM projects at	1.1 Annual report and budget of Orborjor 1.2 Annual report of PA 1.3 Budgets and annual reports of Orborjor, Tessaban, and Orbortor	The understanding of DLA (MOI) and the Governor is obtained

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
implementation of PEQMP Priority Programs 2. Opinions of local residents are reflected in PEQMP formulation and implementation, and NREM status is monitored by local residents 3. NREM information is used effectively by PA (Changwat), LAs, and local residents	the provincial level started by LAs 2-1 Number of public notices 2-2 Number of resident opinions recorded 2-3 Appointment of local resident representative(s) to monitoring committee 3. Number of inquiries to Environmental Information Center	2.1 Interviews with PEO and Amphoe 2.2 Interviews with PEO 2.3 Interviews with monitoring committee 3. Annual report of NREM Information Center, or Interviews with PEO	
Individual Priority Projects (Numbers correspond to Output numbers)	**Responsible Agency**	**Supporting Agency**	**Input (Baht)**
1. Strengthening of NREM capacity of Orborjor in SKP	Orborjor of Samut Songkhram and Provincial Office of SKP	MOI, PA (Changwat) of SKP and ONEP of MNRE	10,760,000
2. Construct ion of resident participatory system for NREM in SKP	PO, PEO, LA of SKP	ONEP and Amphoe of SKP	1,000,000
3. Establishment of an Environmental Information Center in PEO/ SKP	PEO/ SKP	OPS and ONEP of MNRE	1,900,000

DLA: Department of Local Administration, MOI

MOI: Ministry of Interior

PA: Provincial Administration

PO: Provincial Office

All other organizations: departments within MNRE

5.3.2 Implementation and Budget Plan of Priority Projects

In accordance with the PEQMP-KPI manual, the corresponding implementation and budget plan for each Priority Program/Project is shown in a single corresponding table below:

Table 5-90: Implementation and Budget Plan of Priority Projects in SKP

Program/Project	Budget (Baht)				Total Budget (Baht)	Implementation Schedule in Fiscal Year (Baht)				Responsible Agency
	Province	LA	DC	Other		2008	2009	2010	2011	
1. Conservation and Rehabilitation of Aquatic Resources	**2,750,000**				**2,750,000**	**1,500,000**	**800,000**	**400,000**		
1-1 Investigation of current conditions and past catch of aquatic animals	500,000				500,000	500,000				PFO, Orbortor
1-2 Formulation of a conservation and rehabilitation plan based on study results	500,000				500,000	250,000	250,000			PFO, Orbortor
2-1 Control of illegal fishing practices and dissemination of sustainable fishing practices	500,000				500,000	250,000	250,000			PFO, LA
2-2 Education of fishermen in the importance of conservation	250,000				250,000	250,000				PFO, LA
3 Conservation of natural habitats for aquatic resources, and afforestation	1,000,000				1,000,000	300,000	300,000	400,000		MFDS7, PEO, LA
2 Appropriate and Sustainable Solid Waste Management	**900,000**	**8,392,000**	**60,000,000**	**80,000**	**69,372,000**	**860,000**	**4,292,000**	**2,175,000**	**32,095,000**	
2-1 Formulation of SWM master plan un SKP										
2-1-1 Site selection for final disposal site		1,000,000			1,000,000		1,000,000			Orborjor
2-1-2 Formulation of master plan		3,000,000			3,000,000		1,500,000	1,500,000		Orborjor
2-2 Construction of Final Disposal Site										
2-2-1 Detailed Design		5,000,000			5,000,000			5,000,000		Orborjor
2-2-2 Tender and Construction			90,000,000		90,000,000				90,000,000	Orborjor

Program/Project	Budget (Baht)				Total Budget (Baht)	Implementation Schedule in Fiscal Year (Baht)				Responsible Agency
	Province	LA	DC	Other		2008	2009	2010	2011	
2-3 Raising Awareness on an appropriate SWM										
2-3-1 Public education		950,000			950,000	360,000	230,000	210,000	150,000	LA
2-3-2 Promotion for separate collection		492,000			492,000		182,000	165,000	145,000	LA
2-3-3 Dissemination of school composting	900,000				900,000		300,000	300,000	300,000	Schools
2-3-4 Capacity development of SWM for LA staff				80,000	80,000			80,000		PEO,LA
3. Program for Water Quality Preservation in Public Water Bodies	**3,000,000**				**3,000,000**		**1,000,000**	**2,000,000**		
3-1 Pollution source survey	1,000,000				1,000,000		1,000,000			PEO,REO,PCD
3-2 Formulation of water quality preservation plan in public water bodies	2,000,000				2,000,000			2,000,000		PEO, REO,PCD
4. Program for Safe and Quality Water Supply in AYP	**1,500,000**				**1,500,000**		**750,000**	**750,000**		
4.1 Formulation of comprehensive domestic water supply plan	1,500,000				1,500,000		750,000	750,000		PWA and Other water supply organizations
5. Program to Strengthen Linkage between Central, Provincial and Local Administrations in SKP	**3,480,000**			**17,170,000**	**20,650,000**		**13,170,000**	**9,250,000**	**26,050,000**	
5-1 Strengthening of the local NREM support capacities of REO 8				5,600,000	5,600,000		180,000	2,710,000	2,710,000	REO

Program/Project	Budget (Baht)				Total Budget (Baht)	Implementation Schedule in Fiscal Year (Baht)				Responsible Agency
	Province	LA	DC	Other		2008	2009	2010	2011	
5-2 Establishment of "PA/LA Central Support Center for NREM" in MNRE				11,570,000	11,570,000		810,000	5,380,000	5,380,000	ONEP/MNRE
5-3 Promotion of awareness regarding NREM among administrators of LAs and resident and publication of environmental information in AYP	3,480,000				3,480,000		1,160,000	1,160,000	1,160,000	PEO,DEQP
6. Program to Strengthen NREM capacities of LAs in SKP	**6,680,000**	**6,980,000**			**13,660,000**		**300,000**	**6,680,000**	**6,680,000**	
6-1 Strengthening of NREM capacity of Orborjor in SKP	4,780,000	5,980,000			10,760,000			5,380,000	5,380,000	PO, Orborjor
6-2 Construction of resident participatory system for NREM		1,000,000			1,000,000			500,000	500,000	PO, PEO,LA
6-3 Establishment of an Environmental Information Center in PEO/SKP	1,900,000				1,900,000		300,000	800,000	800,000	PEO

DC: Decentralization Committee Budget

The Amount in budget column is estimated only

5.4 Part 4: Details of the Priority Projects

Details of the priority projects are explained according to the following format of the table.

Table 5-91: Format of the Detailed Information of the Priority Projects

1. Name of Program	
2. Name of Project	
3. Sector in NREM	
4. Responsible Agency	
5. Supporting Agency	
6. Monitoring and Evaluation Agency	
7. Background of the Project	(Note): Summary of issues, area that issue occurs, causes and impacts are to be described.
8. Justification of the Project	(Note): Relations with the national, regional and provincial policy and strategy shall be described
9. Objectives of the Project	(Note): Outcomes of the project implementation are to be described.
10. Objectively Verifiable Indicators	(Note): An indicator corresponds with an objective mentioned above.
11. Main Components of the Project	(Note): Scope of the work has to be described.
12. Implementation Schedule	(Note): Time frame of the project shall be described according to the main components of the project.
13. Budgetary Plan	(Note): Budgetary plan shall be prepared according to the time frame mentioned above.
14. Benefit to be achieved	(Note): Benefits of the project shall be described.

(Note)

Table 5-92: Sector in NREM:

1. Social and Economic	2. Natural Resources Management	3. Social and Living Environment Management
SE.1.1. Population SE.1.2. Economy SE.1.3. Local Administration SE.1.4. NERM Administration SE.1.5. Others	SE.1.6. Land and Soil Resources SE.1.7. Forestry Resources SE.1.8. Wildlife Resources SE.1.9. Water Resources SE.1.10. Mineral Resources SE.1.11. Marine and Coastal Resources SE.1.12. Biodiversity	SE.1.13. Water Quality SE.1.14. Solid Waste SE.1.15. Air Quality SE.1.16. Noise/Vibration SE.1.17. Toxic and Hazardous Substances SE.1.18. Urban Environment SE.1.19. Natural and Cultural Assets SE.1.20. Global Warming

5.4.1 Program for Conservation and Rehabilitation of Aquatic Resources in SKP

The term 'resources' usually means 'raw or processed materials for industrial purposes'. Major examples are bio resources, aquatic resources, and mineral resources.

Mineral resources including minerals and petroleum are non-renewable resources, which will eventually disappear due to consumption. The important management issue for non-renewable resources is resource *use* management. The management of the processes after its extraction (such as developing methods to use smaller amounts, to recycle more efficiently, and to develop alternative resources) is important, as it is impossible to increase the amount of the resource itself. Eventually, the resource will be completely used up.

On the other hand are renewable resources, such as aquatic resources. 'Aquatic resource' is a collective term for fish and other aquatic animals and plants, which will keep growing, laying eggs etc., and increase in number within the aquatic environment. Theoretically, we can continue fishing forever without using up the resource, i.e. finding no fish in the seas and rivers. Resource *extraction* management becomes important for renewable resources.

Renewable resources are characterized by the ability for the resource to increase through reproduction. Aquatic resources can be efficiently extracted forever, if one takes care to control excessive exploitation, the exploitation of the young of each species, and by maintaining a suitable catch amount.

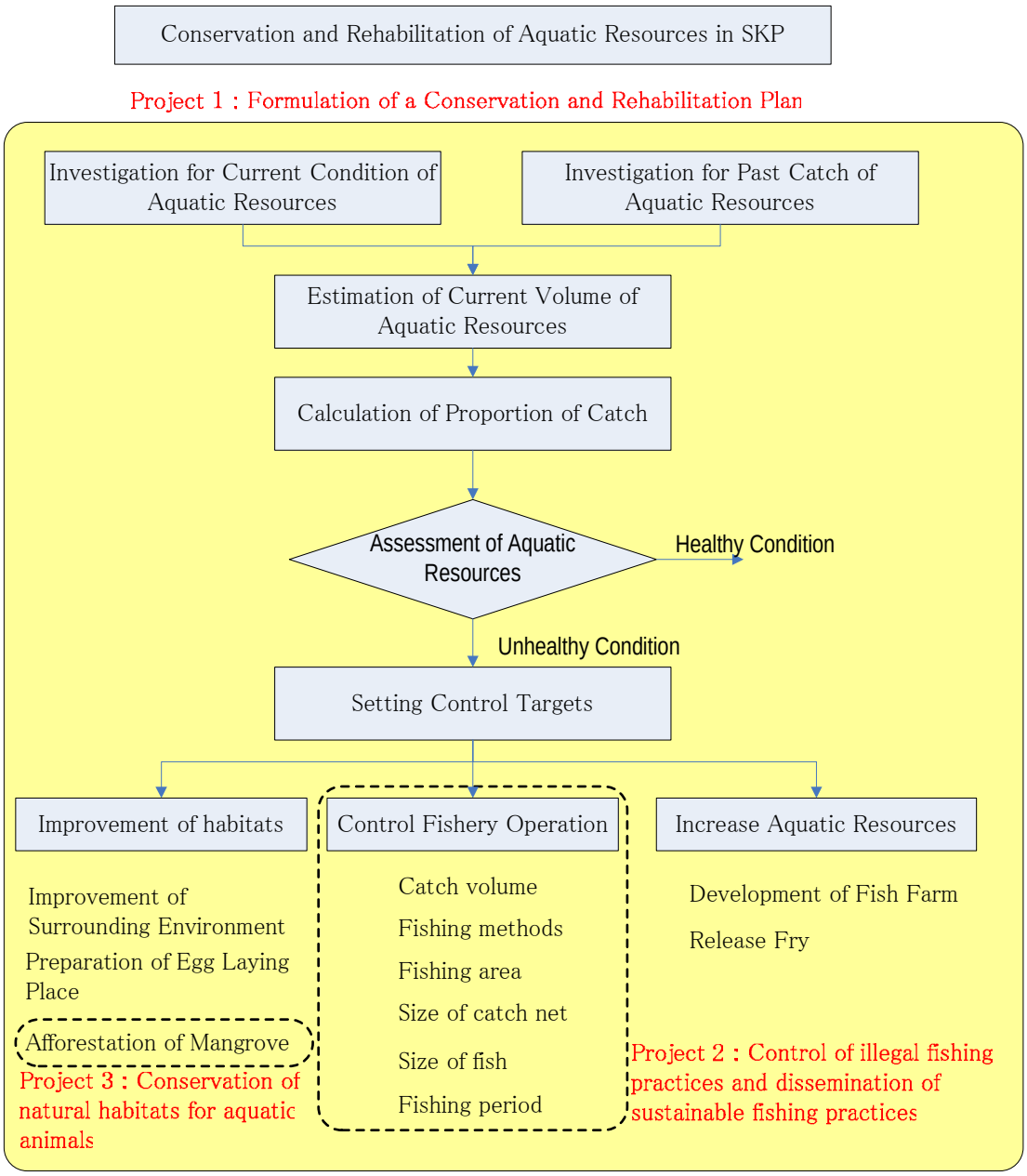


Figure 5-44: Relation between Each Project and Process of Conservation and Rehabilitation of Aquatic Resources

a. Project 1: Formulation of a conservation and rehabilitation plan

1. Name of Program	Conservation and Rehabilitation of Aquatic Resources in SKP
2. Name of Project	Formulation of a conservation and rehabilitation plan
3. Sector in NREM	Marine and Coastal Resources
4. Responsible Agency	Provincial Fishery Office (PFO)、Orbortor
5. Supporting Agency	Provincial Environment Office (PEO), Mangrove Forest Development Station No 7 (MFDS7), Fishery Faculty, Kasetsart University (FFKU), Marine Shrimp Research and Development Center of SKP (MSRDC)
6 Monitoring and Evaluation Agency	PEO with all the stakeholders

<table>
<tr><td>7. Background of the Project</td><td>Although the GPP for the whole province is on the increase, the GPP for the fishery sector in 2005 (356 million baht) has decreased to half of the 2001 figures (658 million baht).
All of four opinion survey target groups pointed out that the most serious problem of NREM in SKP is “Marine and Coastal Resources”.
Therefore the investigation for current conditions of marine and coastal resources and formulate the comprehensive master plan in order to conserve and rehabilitate aquatic resources is urgently required.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with Upper Plans: To be confirmed</td></tr>
<tr><td>9. Objectives of the Project</td><td>Formulation of master plan for conservation and rehabilitation of aquatic resources in SKP</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>Contents of master plan for conservation and rehabilitation of aquatic resources in SKP</td></tr>
<tr><td>11. Main Components of the Project</td><td>• Investigation for current condition of aquatic resources
• Investigation for past catch of aquatic resources
• Assessment of current condition of aquatic resources and set control targets
• Formulation of comprehensive master plan for conservation and rehabilitation of aquatic resources.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Investigation for current condition and past catch of aquatic animals</td><td>2008</td></tr><tr><td>Formulation of master plan</td><td>2008-2009</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th><th>Source</th></tr><tr><td>Investigation for current condition and past catch of aquatic animals</td><td>500,000</td><td>Province</td></tr><tr><td>Formulation of master plan</td><td>500,000</td><td>Province</td></tr></table></td></tr>
<tr><td>14 Benefit of the Project</td><td>Beneficiary: Population earning living from aquatic resources</td></tr>
</table>

b. Project2: Control Illegal Fishing Practice and Dissemination of Sustainable Fishing Practice

1. Name of Program	Conservation and Rehabilitation of Aquatic Resources in SKP
2. Name of Project	Control Illegal Fishing and Dissemination of Sustainable Fishing Practice
3. Sector in NREM	Marine and Coastal Resources
4. Responsible Agency	Provincial Fishery Office (PFO), LA
5. Supporting Agency	Provincial Environment Office (PEO), Provincial Office (PO), under Ministry of Interior (MOI)
6 Monitoring and Evaluation Agency	PEO with all the stakeholders
7. Background of the Project	Although the GPP for the whole province is on the increase, the GPP for the fishery sector in 2005 (356 million baht) has decreased to half of the 2001 figures (658 million baht).

<table>
<tr><td></td><td>All of four opinion survey target groups pointed out that the most serious problem of NREM in SKP is “Marine and Coastal Resources”.
Aquatic resources can be efficiently extracted forever, if one takes care to control excessive exploitation, the exploitation of the young of each species, and by maintaining a suitable catch amount.
Therefore the control of fishery operation in a sustainable manner and dissemination of that is urgently required.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with Upper Plans: To be confirmed</td></tr>
<tr><td>9. Objectives of the Project</td><td>A sustainable form of fishing is established.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>1. Number of warnings and arrests over illegal fishing practice
2. Number of workshops and other educational events, number of participants of the same.</td></tr>
<tr><td>11. Main Components of the Project</td><td>1. Control of illegal fishing practices and dissemination of sustainable fishing practices
2. Education of fisherman in the importance of conservation and recovery of aquatic resources and increase their awareness.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Control of illegal fishing practices</td><td>2009-2010</td></tr><tr><td>Education of fisherman</td><td>2008-2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th><th>Source</th></tr><tr><td>Control of illegal fishing practices</td><td>500,000</td><td>Province, LA</td></tr><tr><td>Education of fisherman</td><td>250,000</td><td>Province, LA</td></tr></table></td></tr>
<tr><td>14 Benefit of the Project</td><td>Beneficiary: Whole population including earning living from aquatic resources</td></tr>
</table>

c. Project 3: Conservation of natural habitats for aquatic resources, and afforestation

1. Name of Program	Conservation and Rehabilitation of Aquatic Resources in SKP
2. Name of Project	Control Illegal Fishing and Dissemination of Sustainable Fishing Practice
3. Sector in NREM	Marine and Coastal Resources
4. Responsible Agency	Mangrove Forest Development Station No 7 (MFDS7), Provincial Environment Office (PEO), Local Administration (LA)
5. Supporting Agency	Provincial Fishery Office (PFO)
6 Monitoring and Evaluation Agency	PEO with all the stakeholders
7. Background of the Project	Although the GPP for the whole province is on the increase, the GPP for the fishery sector in 2005 (356 million baht) has decreased to half of the 2001 figures (658 million baht). All of four opinion survey target groups pointed out that the most serious problem of NREM in SKP is “Marine and Coastal Resources”. Due to the development of coastal area, important natural habitats for aquatic animals, which is mangrove forest, has decreased significantly in last decades. Investigation revealed that there is moderate amount of erosion, at a rate of 1 to 5 meters per year, at

<table>
<tr><td></td><td>the northeast coast of the Gulf of Thailand.
Therefore the conservation and rehabilitation of mangrove forest is urgently required both for coastal erosion protection and conservation of natural habitat of the aquatic resources.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with Upper Plans: To be confirmed</td></tr>
<tr><td>9. Objectives of the Project</td><td>Habitats of aquatic resources are established and risk of coastal erosion will be decreased through afforestation of mangrove forest.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>Afforestation area statistics and total area statistics of mangrove forest.</td></tr>
<tr><td>11. Main Components of the Project</td><td>Conservation of natural habitats for aquatic resources, i.e. coastal mangrove forests, and increase in safe habitats through afforestation.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Afforestation of mangrove</td><td>2008-2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th><th>Source</th></tr><tr><td>Afforestation of mangrove</td><td>1,000,000</td><td>Province</td></tr></table></td></tr>
<tr><td>14 Benefit of the Project</td><td>Beneficiary: Whole population including earning living from aquatic resources</td></tr>
</table>

5.4.2 Program for Appropriate and Sustainable Solid Waste Management in SKP

The following Figure shows the process of Solid Waste Management (SWM), and the position of Priority Projects within that process.

To briefly explain, waste is discharged/generated by residents and enterprises; collected and transported by Local Administrations and private companies; intermediately processed by recycling facility operators, and finally processed at final disposal sites.

The objective of *Project 1: Formulation of SWM Master Plan in Provincial Level* is to formulate an appropriate and master plan for all these processes of SWM.

The objective of *Project 2: Construction of Final Disposal Site* is to construct a final disposal site, which is an unavoidable part of the SWM process, within the Province – following the principle of processing one's own waste.

The objective of *Project 3: Raising Awareness on an Appropriate SWM* is to support the waste-reducing or –recycling efforts that can be taken by various stakeholders such as residents, enterprises, and administrations in each process of SWM.

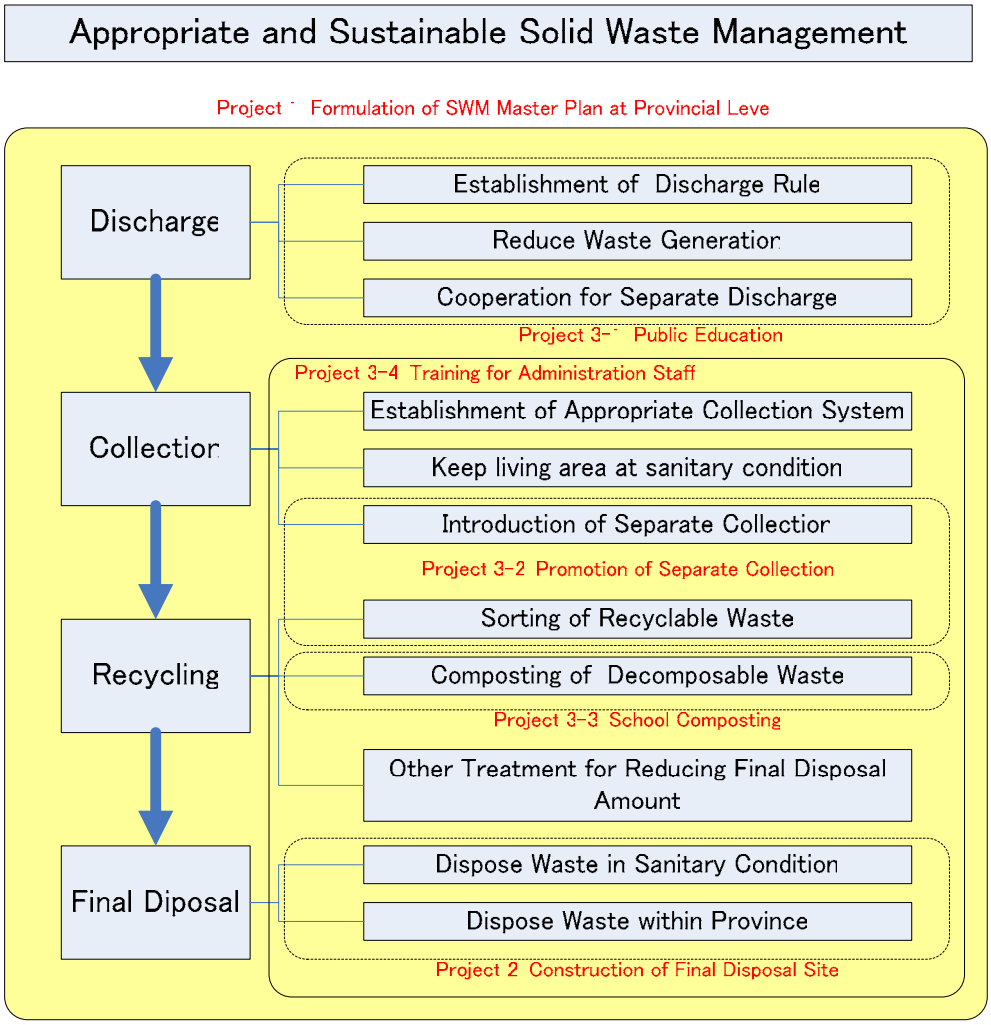


Figure 5-45: Relation between Each Project and Process of Solid Waste Management

a. Project 1: Formulation of SWM Master Plan at Provincial Level

1. Name of Program	Appropriate and Sustainable Solid Waste Management (SWM) in SKP
2. Name of Project	Formulation of SWM Master Plan in Provincial Level
3. Sector in NREM	Solid Waste
4. Responsible Agency	Orborjor in collaboration with all LAs in SKP
5. Supporting Agency	Provincial Committee (PC), Pollution Control Department in MNRE (PCD), PEO, REO
6. Monitoring and Evaluation Agency	PEO with all the stakeholders in SKP
7. Background of the Project	The National Solid Waste Management Plan was drafted by PCD MNRE in June 2003. This plan is a master plan at the national level, and national policy and strategy are specified. At present, there is no master plan at the provincial level in order to follow policy and strategy specified in the national master plan. In other words, there is no concrete and comprehensive plan to improve on the current SWM practices in the Province. Master plan in provincial level should cover not only the issue of

<table>
<tr><td></td><td>final disposal, but also other aspects such as improvement of waste collection, reduction of waste generation, promotion of recycling, etc.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with Upper Plans: To be confirmed</td></tr>
<tr><td>9. Objectives of the Project</td><td>Site for final disposal site will be selected and sustainable SWM master plan in provincial level is formulated.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>Contents of SWM master plan.</td></tr>
<tr><td>11. Main Components of the Project</td><td>• Site selection of final disposal site
➢ Formation of final disposal site selection committee
➢ Formulation of selection and exclusion criteria
➢ Selection of candidate locations
➢ Public hearings and getting agreement from nearby residents.
➢ Selection of final disposal site
• Formulation of sustainable SWM master plan including priority project such as construction of final disposal site</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Site Selection for final disposal site</td><td>2009</td></tr><tr><td>Formulation of SWM master plan</td><td>2009-2010</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th><th>Source</th></tr><tr><td>Site selection for final disposal site</td><td>1,000,000</td><td>Local Administration</td></tr><tr><td>Formulation of SWM master plan</td><td>3,000,000</td><td>Local Administration</td></tr></table></td></tr>
<tr><td>14 Benefit of the Project</td><td>Beneficiary: Whole population in SKP</td></tr>
</table>

b. Project 2: Construction of Final Disposal Site

1. Name of Program	Appropriate and Sustainable Solid Waste Management in SKP
2. Name of Project	Construction of Final Disposal Site
3. Sector in NREM	Solid Waste
4. Responsible Agency	Orborjor in collaboration with all LAs in SKP
5. Supporting Agency	Provincial Committee (PC), Pollution Control Department in MNRE (PCD), Decentralization Committee (DC)
6. Monitoring and Evaluation Agency	PEO with all the stakeholders in SKP
7. Background of the Project	There is no final disposal site located within SKP, but there is one transfer station in Amphoe Mueang Samut Songkhram. All collected wastes are transported to the disposal site in neighboring Ratchaburi and Samut Sakhon Province, either from the transfer station or directly from generation sources. One final disposal site was constructed in 1997 using the Environmental Fund in Tambon Ladjai, but it was closed in 2001 due to the opposition from surrounding residents. Since then, there has been no final disposal site within the Province.

<table>
<tr><td></td><td>There is an urgent need to construct a final disposal site within the Province, since the neighboring provinces may oppose to the import of solid wastes from SKP in near future.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with upper Plans: To be confirmed</td></tr>
<tr><td>9. Objectives of the Project</td><td>Wastes generated are finally disposed in a sanitary manner within the Province.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>Conditions of new final disposal site and surrounding environment.</td></tr>
<tr><td>11. Main Components of the Project</td><td>• Detailed design study for the final disposal site
• Selection of construction contractors through tender process.
• Construction of final disposal site.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Detailed Design</td><td>2010</td></tr><tr><td>Tender and Construction of disposal site</td><td>2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th><th>Source</th></tr><tr><td>Detailed Design</td><td>5,000,000</td><td>Local Administration</td></tr><tr><td>Tender and Construction</td><td>90,000,000</td><td>Decentralized Committee Budget</td></tr></table></td></tr>
<tr><td>14 Benefit of the Project</td><td>Beneficially: Whole Population in SKP</td></tr>
</table>

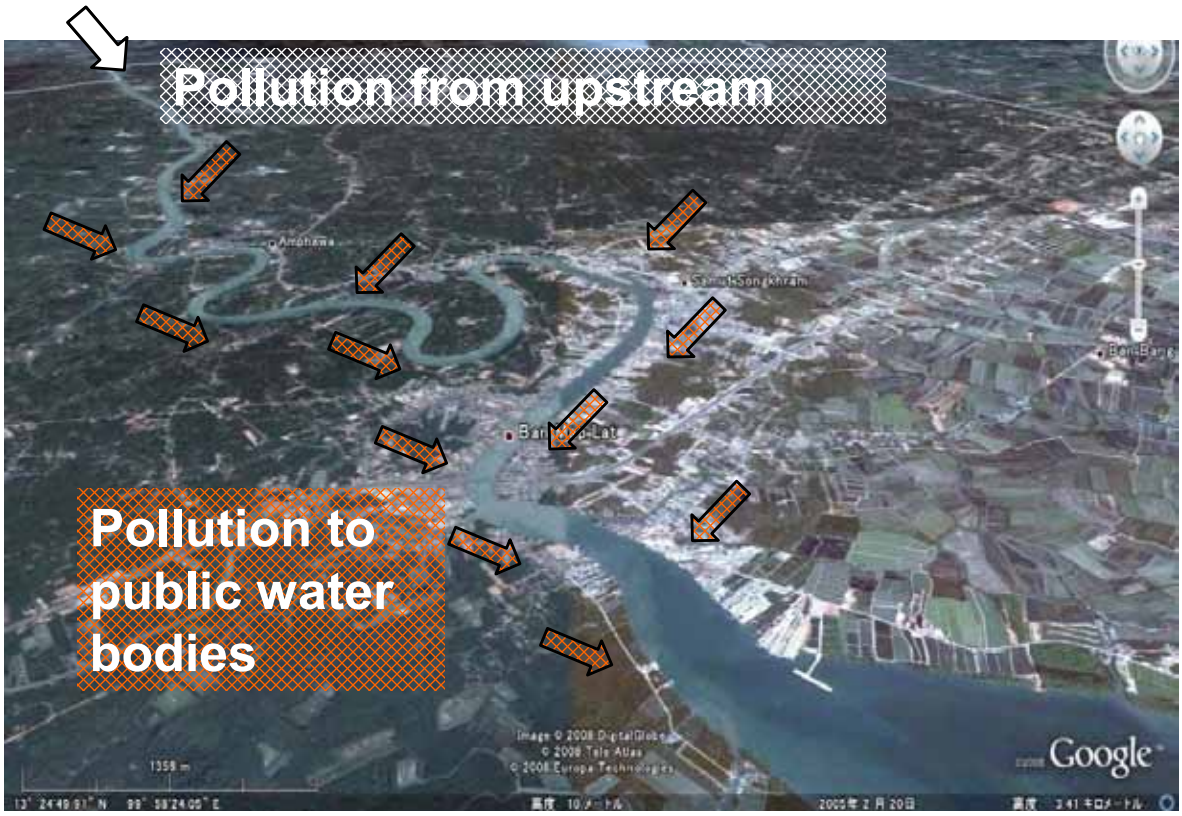
c. Project 3: Raising Awareness on an Appropriate SWM

1. Name of Program	Appropriate and Sustainable Solid Waste Management (SWM) in SKP
2. Name of Project	Raising Awareness on an Appropriate SWM
3. Sector in NREM	Solid Waste
4. Responsible Agency	Local Administration (LA), Schools, PEO
5. Supporting Agency	Provincial Environment Office (PEO), Schools, Regional Environment Office(REO), Department of Environment Quality Promotion(DEQP), PCD, Province, LA
6 Monitoring and Evaluation Agency	PEO with all the stakeholders
7. Background of the Project	There are many stakeholders involved in solid waste management such as residents and enterprises as waste generators, private transportation companies as waste collectors and disposal site operation, and local administration as waste management and operation of disposal site, waste collection and, sometime, recycling activities. Raising awareness among those stakeholders is essential in order to achieve sustainable solid waste management. Therefore several pilot projects are proposed as below.
8. Justification of the Project	Relation with Upper Plans: To be confirmed

<table>
<tr><td>9. Objectives of the Project</td><td>An awareness on appropriate SWM is raised</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>1. Waste generation per capita,
2. Volume of separate discharge and collection,
3. number of schools which implement school composting,
4. number of seminar and workshop for administration staff.</td></tr>
<tr><td>11. Main Components of the Project</td><td>1. Public education in order to reduce waste generation rate.
2. Promotion of separate collection among LAs by organizing a competition between LAs and initiating a campaign program.
3. Dissemination of school composting among schools that do not currently implement such a program.
4. Training a seminars for administration staff on appropriate and environment friendly waste management.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Public Education</td><td>2008-2011</td></tr><tr><td>Promotion for Separate Collection</td><td>2009-2011</td></tr><tr><td>School Composting</td><td>2009-2011</td></tr><tr><td>Training for LA staff on SWM</td><td>2010</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th><th>Source</th></tr><tr><td>Public Education</td><td>950,000</td><td>LA</td></tr><tr><td>Promotion for Separate Collection</td><td>492,000</td><td>LA</td></tr><tr><td>School Composting</td><td>900,000</td><td>Province</td></tr><tr><td>Training for LA staff on SWM</td><td>80,000</td><td>Other</td></tr></table></td></tr>
<tr><td>14 Benefit of the Project</td><td>Beneficiary: Whole population in SKP</td></tr>
</table>

5.4.3 Program for Water Quality Preservation in Public Water Bodies of SKP

SKP is located at the mouth of the Mae Klong River. Therefore, both the pollution sources at upstream provinces and within SKP will affect the water quality in SKP as illustrated below.



To preserve the water quality in public water bodies, it is important to understand the situation surrounding each water pollution source and to reduce the pollution load for each source. Furthermore, even after such activities improve the water quality, it is important to maintain the improved conditions.

Project 1 investigates and identifies the sources of water pollution. Utilizing these results, Project 2 formulates the Public Water Body Water Quality Preservation Plan, which includes setting the amount of pollution load target reduction, the method to do so, determining ways to inspect the effect of pollution load reduction, and monitoring water quality in public water bodies.

The following Figure shows the position of each Project in the effort to preserve water quality in public water bodies.

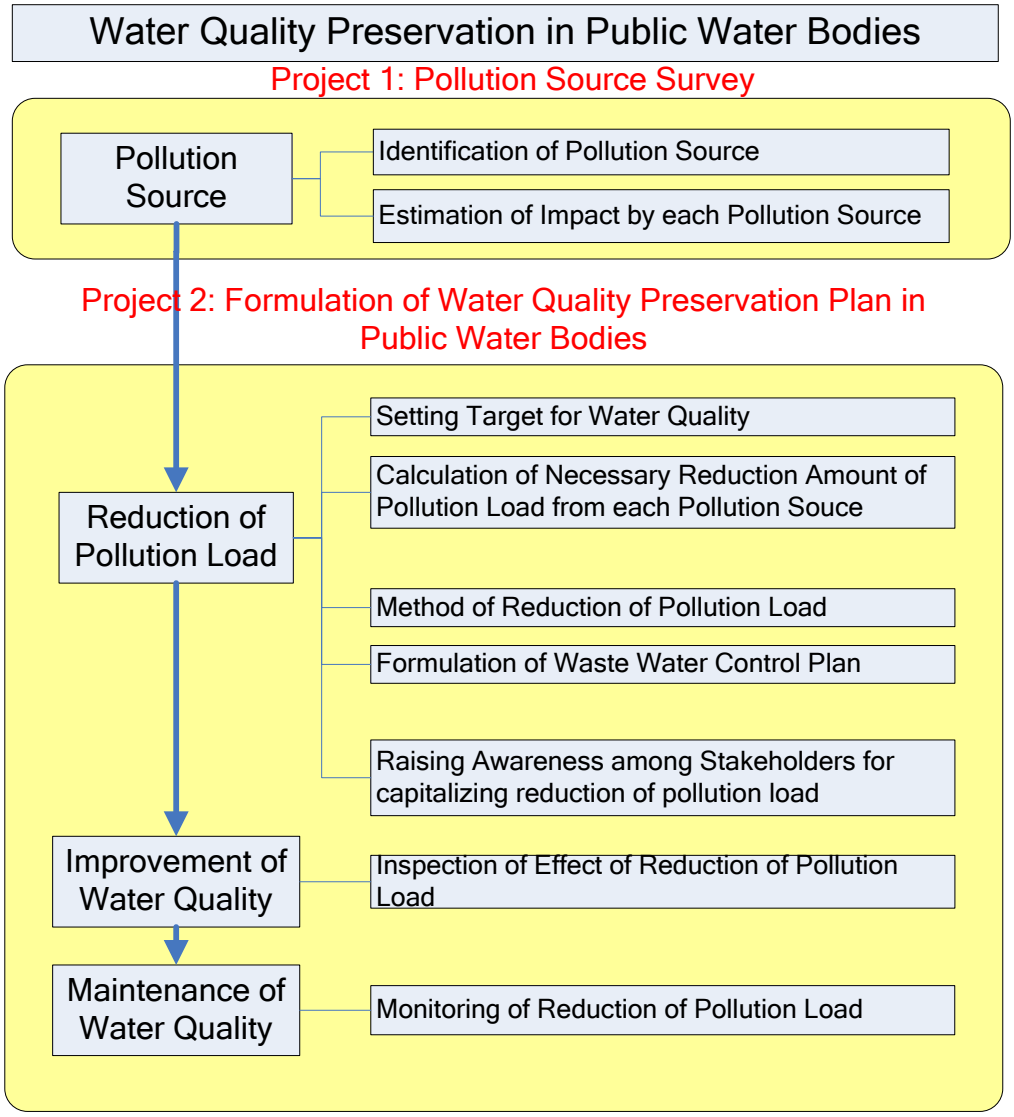
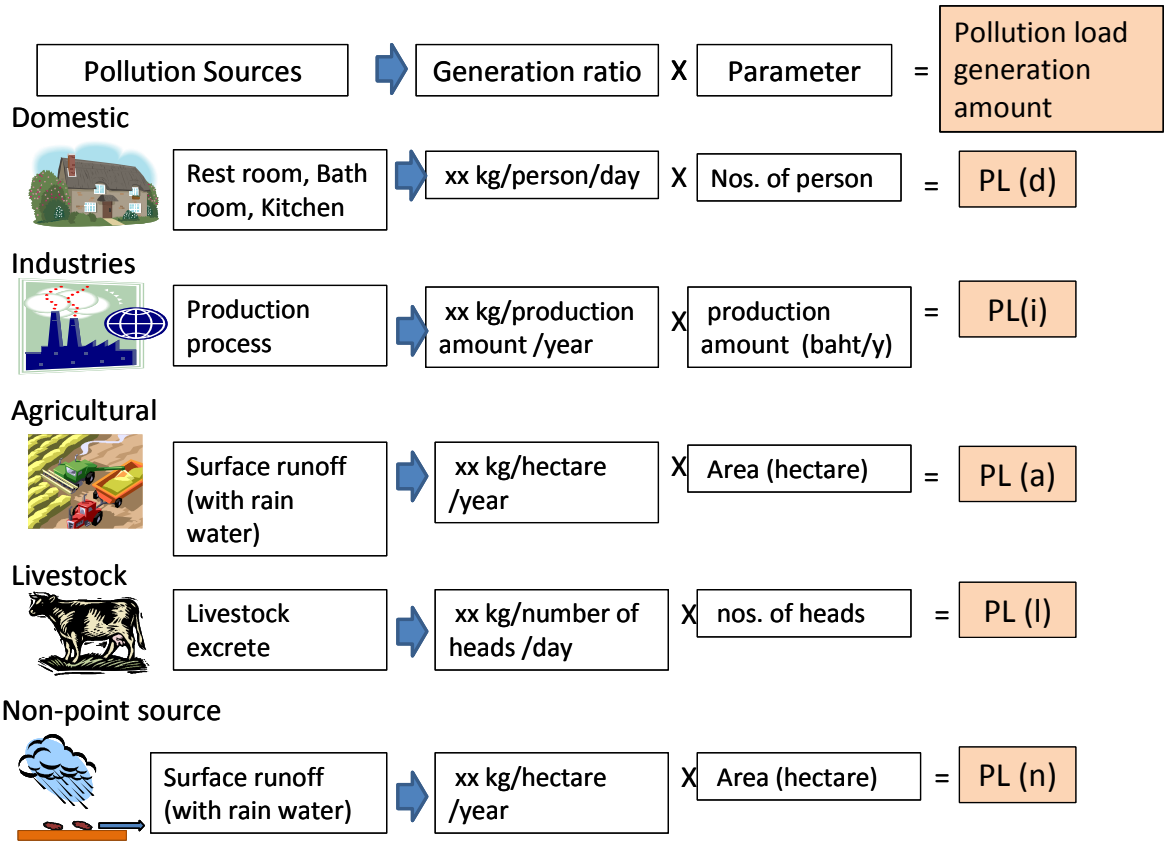


Figure 5-46: Relation between Water Quality Preservation in Public Water Bodies and each Project

Procedure of pollution source survey is explained according to the following steps.

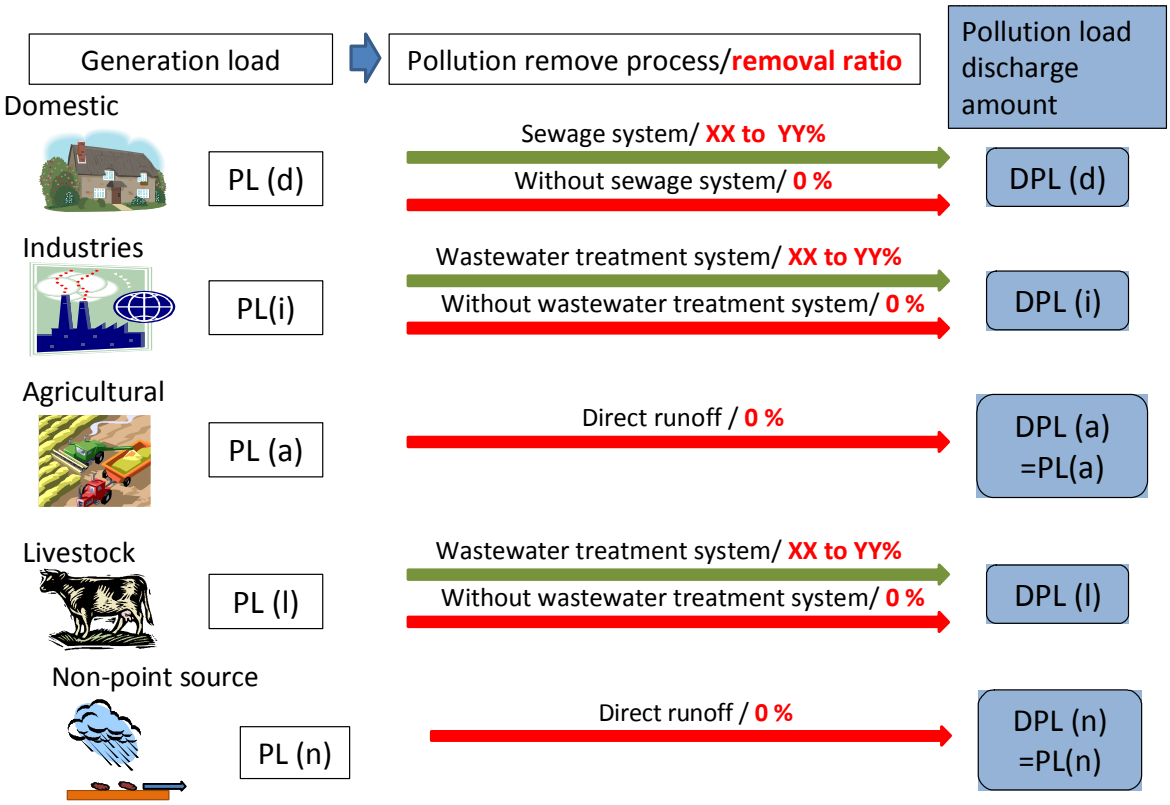
Step1: Identification of pollution source and calculation of pollution load from each source.

In SKP, pollution sources are categorized into 5 types: domestic, industry, agriculture, livestock and non-point sources. The generation amount of pollution load will be calculated as unit generation amount multiplied by number of each generation source as follows.



Step2: Calculation of discharge amount from each pollution sources

Upon the application of waste water treatment system, discharge amount of pollution load from each pollution source is calculated as follows.



A few examples of pollution generation ratio of each pollution source in Japan are presented as follows.

Domestic

Rest room, Bath room, Kitchen → BOD 0.058 kg/person/day

Industries

Production process → e.g. Fishery processing industry
BOD : 1.51kg/shipment value (million yen) /year

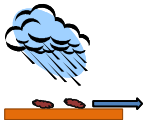
Agricultural

Surface runoff (with rain water) → e.g. Rice paddy
*COD_{Mn}: 111.1kg/hectare /year, (*COD_{Mn} = BOD/2)

Livestock

Livestock excrete → Pig: BOD : 0.09 to 0.18 kg/number of heads /day
Cattle : BOD : 0.58 kg/number of heads /day

Non-point source



Surface runoff (with rain water) → e.g. Urban area
BOD : 128 kg/hectare /year

Pollutants from each pollution source will be removed by the waste treatment system and the percentage of pollutant removed is based on the discharge limit set by the relevant law. In Japan, 90 to 99 % of pollutant is removed through this waste water treatment process.

The relation between the pollution load and concentration of pollutant is given below.

$$\text{Concentration of pollutant (mg/l)} = \frac{\text{Pollution load (kg)}}{\text{Water amount (m}^3\text{)}} \times 1{,}000$$

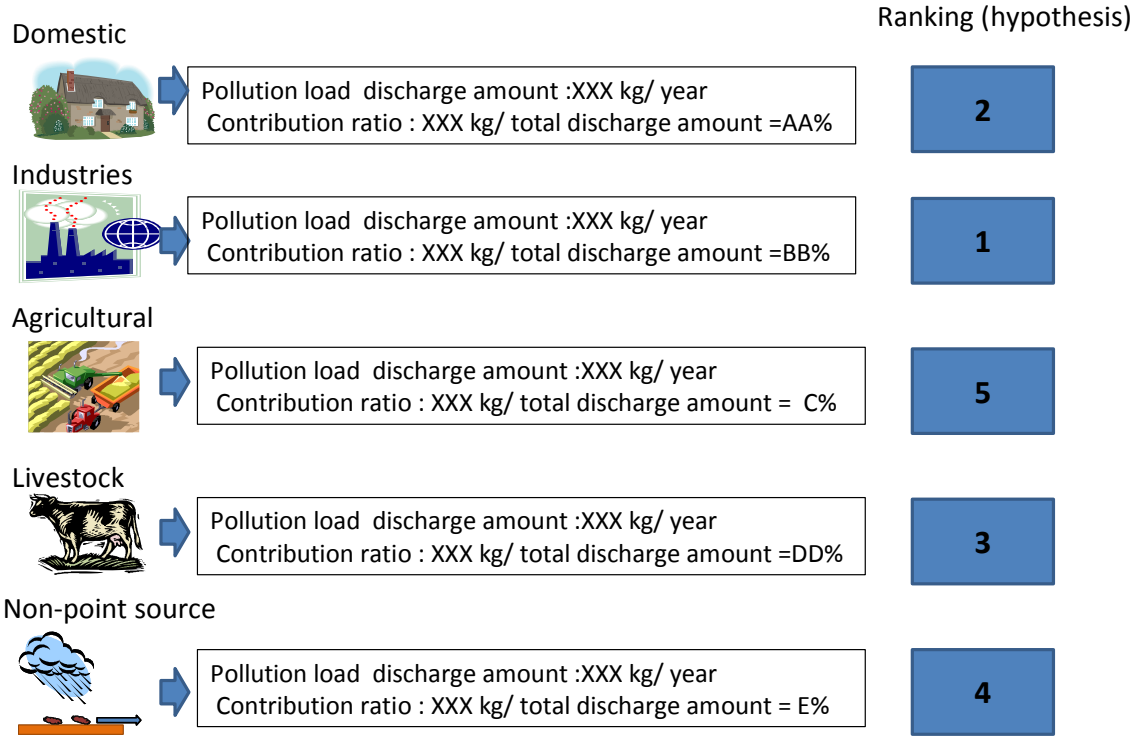
e.g. MK-01
- BOD average value at MK-01 in 2006 is 0.63 (mg/l)
- Water amount *1,576 million cubic meter per year=4,317,808 m^3/day

(* -Ecosystem balance maintenance water amount, Integrated Plan for Water Resources Management in the Mae Klong River Basin , DWR, 2006)

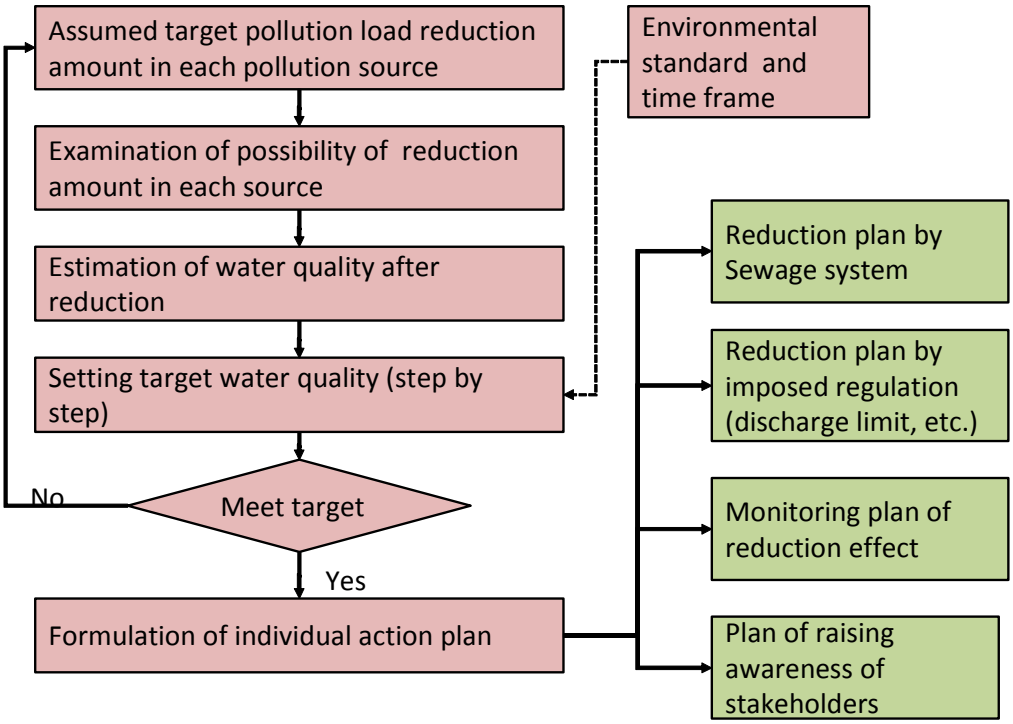
$$\text{BOD concentration 0.63 (mg/l)} = \frac{\mathbf{2{,}720\ (kg/day)}}{4{,}317{,}808\ (m^3/day)} \times 1{,}000$$

Step3: Determination of pollution contribution ratio from each pollution sources

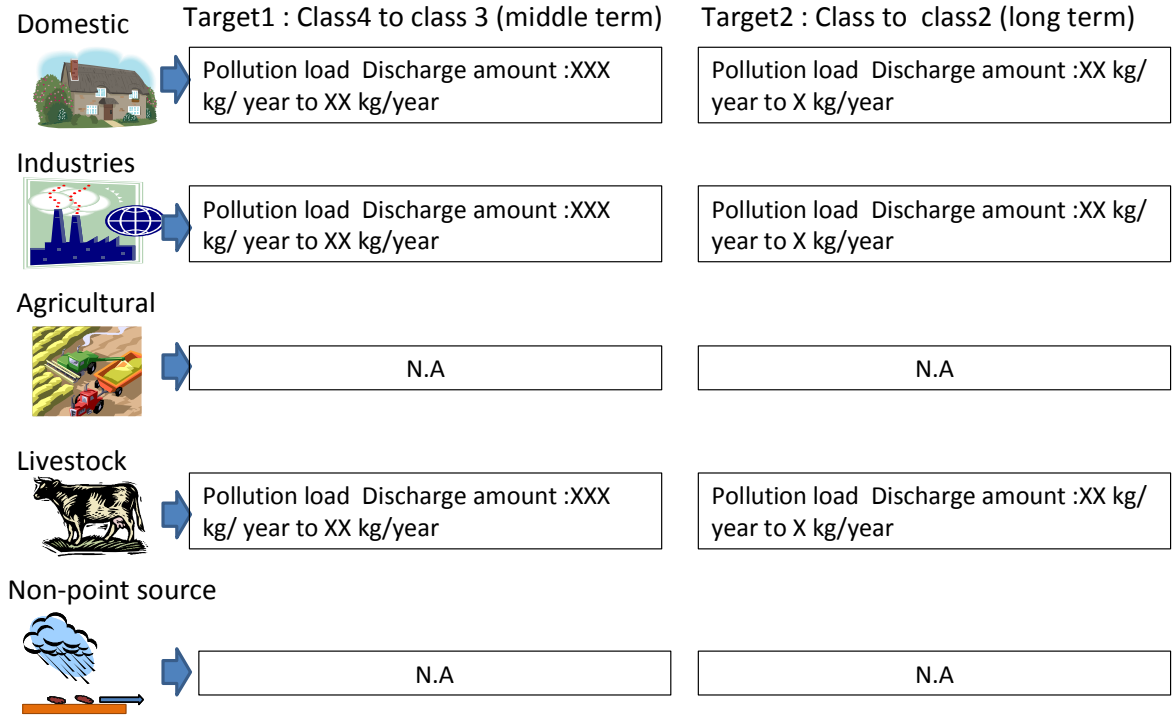
After calculation of discharged pollutant load from each pollution source, it will become clear which sectors discharge what amount as follows.



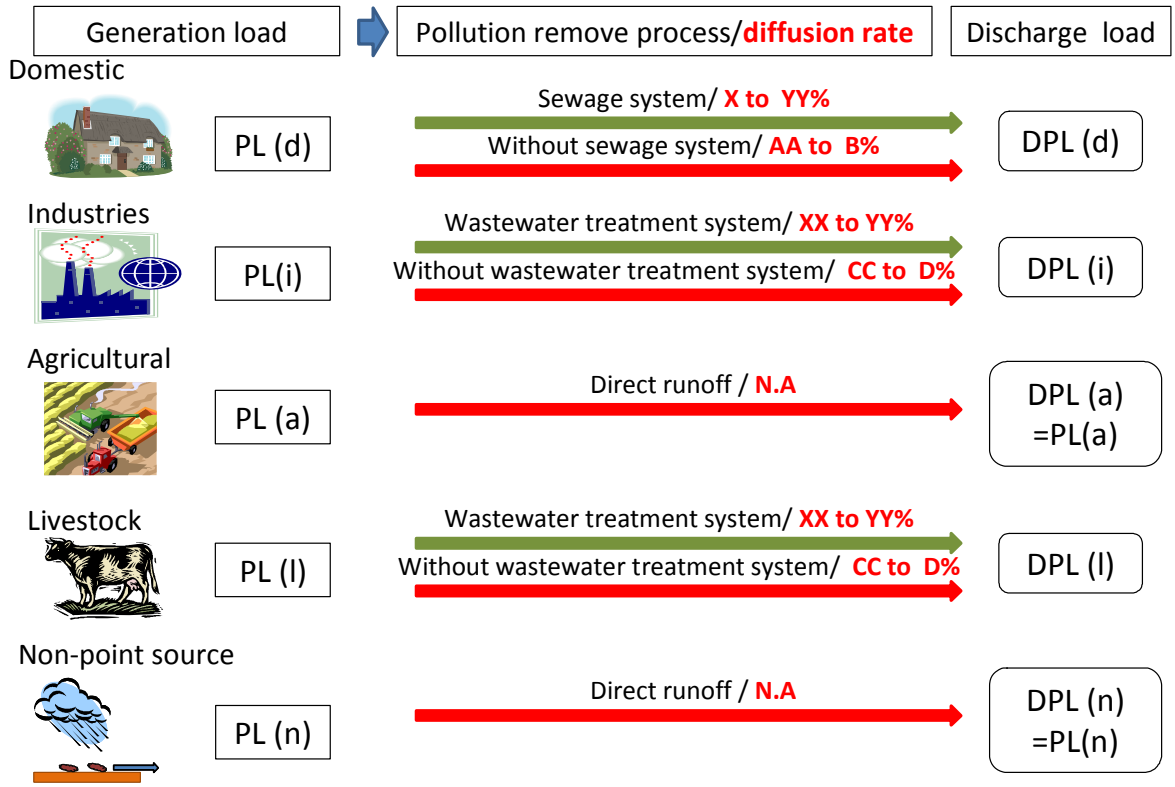
Based on the results shown above, methods to reduce the pollution load will be examined and the water quality preservation plan in public water bodies will be formulated. The Procedure of formulating the water quality preservation plan is explained according to the following flow chart



At first, the target of water quality in public water bodies will be set considering the time frame. Then, the necessary reduction amount of pollutant from each sector will be calculated. These steps are illustrated as follows.



Following these steps, the amounts of pollution load to be reduced from each pollution source will be fixed and individual action plans for reducing pollution load will be formulated.



The followings are the Project details of Priority Projects summarized according to the manual of PEQMP-KPI.

a. Project 1: Pollution Source Survey

1. Name of Program	Program for Water Quality Preservation in Public Water Bodies of SKP
2. Name of Project	Pollution Source Survey
3. Sector in NREM	Water Quality
4. Responsible Agency	Provincial Environment Office (PEO), Regional Environment Office (REO), Pollution Control Department (PCD)
5. Supporting Agency	Provincial Agricultural Office (PAgO), Provincial Fishery Office (PFO), Provincial Livestock Office (PLO), Provincial Industrial Office (PIO), Local Administration(LA)
6. Monitoring and Evaluation Agency	Pollution Control Department (PCD)
7. Background of the Project	There are four water quality monitoring stations in SKP: The quality of water falls between class 3 and class 4. According to the results of past monitoring data, the water quality is slightly tending towards the worse. On the assumption that the same condition (amount of pollutant, treatment, etc.) would continue in the future, water quality of the Mae Klong River will be worsen compared to the current situation. In order to improve above situation, determination of pollution contribution from each pollution source to the public water bodies is required.
8. Justification of the Project	Relation with upper plans : To be confirmed
9. Objectives of the Project	Identification of pollution source and its contribution to the public water bodies.
10. Objectively Verifiable Indicators	Contents of pollution source survey report.
11. Main Components of the Project	• Generation and discharge of pollution load from each pollution source • Incoming pollution load from upstream province. • Pollution load at target point of the River • Pollution contribution from each pollution source
12. Implementation Schedule	• Selection of the Consultant: December 2008 • Commencement: January 2009 • Completion: December 2009
13. Budgetary Plan	1,000,000 Baht
14 Benefit of the Project	Beneficiary: Whole population in SKP

b. Project 2: Formulation of Water Quality Preservation Plan in Public Water Bodies

1. Name of Program	Program for Water Quality Preservation in Public Water Bodies of SKP
2. Name of Project	Formulation of Water Quality Preservation Plan in Public Water Bodies
3. Sector in NREM	Water Quality
4. Responsible Agency	Provincial Environment Office (PEO), Regional Environment Office (REO), Pollution Control Department (PCD)
5. Supporting Agency	Provincial Agricultural Office (PAgO), Provincial Fishery Office (PFO), Provincial Livestock Office (PLO), Provincial Industrial Office (PIO), LA
6. Monitoring and Evaluation Agency	Pollution Control Department (PCD)
7. Background of the Project	There are four water quality monitoring stations in SKP: The quality of water falls between class 3 and class 4. According to the results of past monitoring data, the water quality is slightly tending towards the worse. On the assumption that the same condition (amount of pollutant, treatment, etc.) would continue in the future, water quality of the Mae Klong River will be worsen compared to the current situation. In order to improve above situation, water quality preservation plan in public water bodies shall be formulated.
8. Justification of the Project	Relation with upper plan : To be confirmed
9. Objectives of the Project	Formulation of water quality preservation plan in public water bodies
10. Objectively Verifiable Indicators	Contents of water quality preservation plan in public water bodies.
11. Main Components of the Project	• Reduction of pollution load in each pollution source. • Possibility of reduction of pollution load in each pollution source • Estimated water quality in the river and target quality • Formulation of water quality preservation plan - Reduction plan by development of waste water treatment - Reduction plan by imposed regulation to industrial waste water discharge - Monitoring plan of reduction effect - Plan for raising awareness among stakeholders
12. Implementation Schedule	• Selection of the Consultant: December 2009 • Commencement: January 2010 • Completion: December 2010
13. Budgetary Plan	2,000,000 Baht
14 Benefit of the Project	Beneficiary: Whole population in SKP

5.4.4 Program for Safe and Quality Water Supply in SKP

The supply of domestic water involves two elements; the appropriation of water sources based on the analysis of water demand for various activities, and the formulation of a domestic water supply plan suitable for those water sources. In SKP, the main water source of domestic water supply is located at Ratchaburi Province where there is a PWA water purification plant as shown in the figure below indicated by a blue mark.

Figure 5-47: Location of Water Purification Plant in SKP

Hence there are many small water supply organizations owned and operated by LAs, which are indicated by red marks, and main water source is from groundwater. A comprehensive domestic water supply plan shall be formulated considering whether PWA will supply water to the enture area or to remain utilizing those small water supply organizations.

Under the project, the most appropriate domestic water supply plan will be formulated in order to achieve safe and quality water supply conditions upon the investigation, and analysis of existing water supply organizations and estimation of future water demand.

The procedure to formulate a safe and quality water supply plan is performed according to the following steps.

Step 1: Research current conditions.

Current conditions of water supply companies including small water supply organizations owned and operated by LAs. Conditions include potential amount of water as well as quality control measures taken.

Step 2: Investigation of water demand.

In this step, future water demand will be estimated based on current consumption and socio economic conditions.

Step 3: Formulation of comprehensive water supply plan

Evaluation of water sources including surface water and ground water, and amount of water which is extracted from each water source with consideration to water quality, will be carried out and a comprehensive master plan will be formulated.

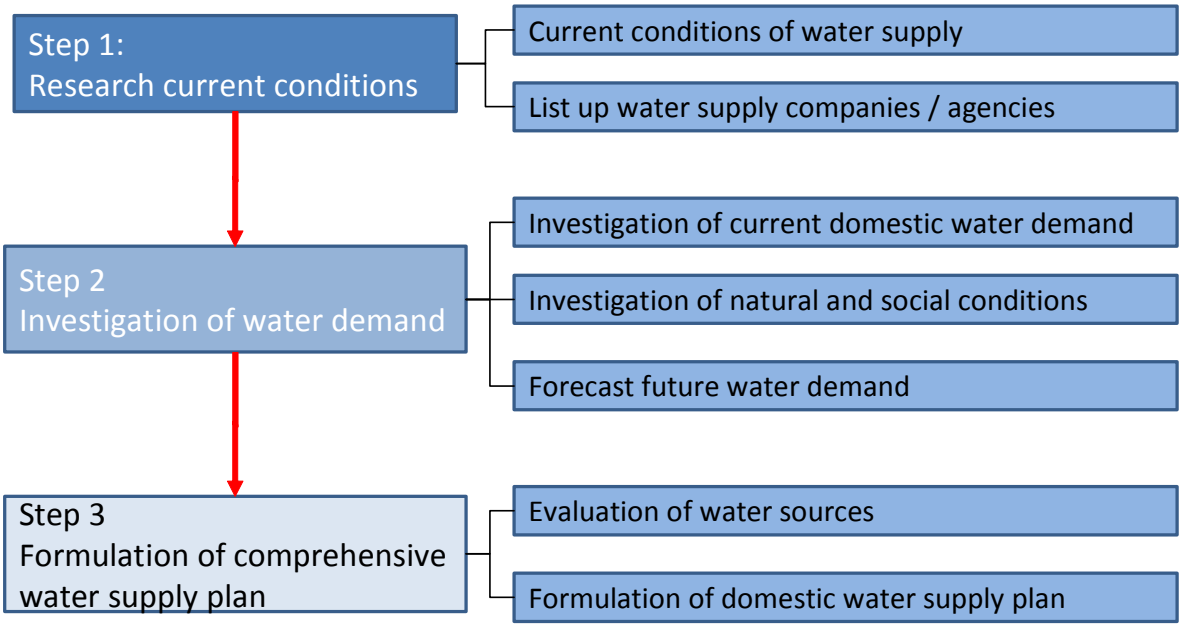


Figure 5-48: Explanation of Safe and Quality Water Supply

Project details of each priority project are shown below according to the format set in the PEQMP manual.

a. Project 1: Formulation of Master Plan on Domestic Water Supply

1. Name of Program	Program for Safe and Quality Water Supply in Samut Songkhram Province (SKP)
2. Name of Project	Formulation of Master Plan on Domestic Water Supply
3. Sector in NREM	Water Quality
4. Responsible Agency	Provincial Waterworks Authority (PWA) and other water supply companies/agencies
5. Supporting Agency	Provincial Environment Office (PEO), Provincial Office (PO) in Provincial Administration, Provincial Health Office (PHO)
6. Monitoring and Evaluation Agency	PWA, PEO with all the stakeholders in SKP
7. Background of the Project	The supply of domestic water involves two elements; the appropriation of water sources based on the analysis of water demand for various activities, and the formulation of a domestic water supply plan suitable for those water sources. In SKP, main water source of domestic water supply is located at Ratchaburi Province where there is a water purification plan of PWA. Hence there are many small water supply organizations owned and operated by LAs and main water source is from underground. Comprehensive domestic water supply plan shall be formulated

	considering whether PWA will supply water to all the area or to remain and utilize those small water supply organizations. Under the project, most appropriate domestic water supply plan will be formulated in order to achieve safe and quality water supply conditions upon the investigation, analysis of existing water supply organizations and estimation of future water demand.
8. Justification of the Project	Relation with Upper plans : To be confirmed
9. Objectives of the Project	Supply of safe and quality domestic water supply in the province
10. Objectively Verifiable Indicators	Contents of Master Plan on Domestic Water Supply
11. Main Components of the Project	• Research of current conditions of domestic water supply - Identification of domestic water supply companies/agencies - Investigation of contents of domestic water supply • Investigation of domestic water demand - Demand for domestic water - Natural and social conditions - Future domestic water demand • Formulation of comprehensive domestic water supply plan - Assessment of water source - Formulation of comprehensive domestic water supply plan
12. Implementation Schedule	• Selection of the Consultant: December 2009 • Commencement: January 2010 • Completion: July 2010
13. Budgetary Plan	1,500,000 Baht ,
14 Benefit of the Project	Beneficiary: Whole population in SKP

5.4.5 Program to Strengthen Linkage between Central, Provincial and Local Administrations in SKP

a. Establishment of "PA/LA Central Support Center for NREM" in MNRE

1. Name of Program	Program to Strengthen Linkage between Central, Provincial and Local Administrations in SKP
2. Name of Project	Establishment of "PA/LA Central Support Center for NREM" in MNRE
3. Sector in NREM	NREM Management
4. Responsible Agency	ONEP/OPS
5. Supporting Agency	DEQP, PCD, RFD, DNP, DWR, DGR, DMCR
6. Monitoring and Evaluation Agency	REO and PEO
7. Background of the Project	Tasks related to NREM have been comprehensively decentralized and devolved onto Local Administrations (LAs), but the LAs put in charge of these tasks do not realistically have the capacity to execute these tasks. Therefore, for the time being, problem-solving in NREM will be difficult without the strong support of Central Government agencies and Provincial Administrations (PAs). On the

<table>
<tr><td></td><td>other hand PAs do not have sufficient capability to support LAs due to lack of technical knowledge on proper NREM.
Furthermore, although REO supports NREM being conducted by Provincial and Local Administrations, it could not support some part of NREM due to lack of expertise and resources. Therefore it requires assistance from departments of MNRE. It is, therefore, necessary to establish a support center in MNRE to support both LAs and PAs for proper NREM.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with the upper plans:
• Decentralization of NREM is the national policy.
• In all aspects LAs do not have enough capability to conduct proper NREM in their administrative areas and they require strong technical assistances from MNRE.</td></tr>
<tr><td>9. Objectives of the Project</td><td>Objectives are as follows:
• The linkages between central/ provincial/ and local administrations is strengthened.
• Departments within MNRE grasp the current actual state of NREM in PAs and LAs.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>• Number of inquires to “PA/LA Central Support Center for NREM”
• Number of inquiries dealt with by MNRE departments</td></tr>
<tr><td>11. Main Components of the Project</td><td>• The Support Center is established in ONEP/MNRE with several staffs and facilities.
• The Support Center is a focal point of inquires from PA and LA on NREM.
• The Support Center requests PA and LA assistance to all departments of MNRE when necessary.
• All departments of MNRE assist PAs and LAs by providing the latest scientific theories and technical information, technical instruction, sector-based training, dispatch of and instruction by experts, assistance of formulating plans in their various responsible fields
• The Support Center supports the assignment of NREM advisors to the Governor and provides trainings for them.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Establishment of the Center</td><td>2009</td></tr><tr><td>Support of PA and LA on NREM</td><td>2010-2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th></tr><tr><td>Establishment of the Center</td><td>810,000</td></tr><tr><td>Support of PA and LA on NREM</td><td>10,760,000</td></tr></table></td></tr>
<tr><td>14. Benefit of the Project</td><td>Beneficiary: Whole population in the country</td></tr>
</table>

b. Strengthening the capacity of NREM GIS Database within REO 8

<table>
<tr><td>1. Name of Program</td><td>Program to Strengthen Linkage between Central, Provincial and Local Administrations in SKP</td></tr>
<tr><td>2. Name of Project</td><td>Strengthening the capacity of NREM GIS Database within REO 8</td></tr>
<tr><td>3. Sector in NREM</td><td>NREM Management</td></tr>
<tr><td>4. Responsible Agency</td><td>REO 8</td></tr>
<tr><td>5. Supporting Agency</td><td>OPS, ONEP</td></tr>
<tr><td>6. Monitoring and Evaluation Agency</td><td>PEOs under REO 8</td></tr>
<tr><td>7. Background of the Project</td><td>At present REO 8 supports NREM being conducted by Provincial and Local Administrations within its region but it is not enough due to insufficient capacity of REO 8 and very weak capacity of LAs. Therefore, it is necessary to strengthen the local NREM support capacities of REO 8 to provide technical assistance and information for the improvement of NREM among PA (Changwat) and LAs within its region, or in other words, so that REO functions as a ‘PA/LA Regional Support Center for NREM’. Specifically, the REO’s capacity to provide training/ information and conduct public relations activities through its GIS Database Center should be strengthened.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with Upper Level Plans:</td></tr>
<tr><td>9. Objectives of the Project</td><td>Objectives are:
• To improve, maintain and update NREM GIS Database of REO 8
• To provide up-to-date information to PEO and related organizations within REO 8 area</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>• Amount of information that REO 8 provides for PEO and other related organizations within its area</td></tr>
<tr><td>11. Main Components of the Project</td><td>• The NREM GIS Database Center in REO 8 is strengthened with several facilities such as upgrading PCs, GIS software, X-Y plotters, color printers, etc. to provide information on NREM in the province to PEO and other administrative organizations under REO 8.
• The NREM GIS Database is updated periodically with the information provided by PEO, the PA and LA Support Center for NREM in MNRE and other agencies under REO 8.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Strengthening of the Database</td><td>2009</td></tr><tr><td>Provision of the updated information on NREM</td><td>2010-2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th></tr><tr><td>Strengthening of the Database</td><td>180,000</td></tr><tr><td>Provision of the updated information on NREM</td><td>5,420,000</td></tr></table></td></tr>
<tr><td>14. Benefit of the Project</td><td>Beneficiary: Whole population within REO 8 area</td></tr>
</table>

c. Promotion of Awareness regarding NREM among Resident; and Publication of Environmental Information in SKP

<table>
<tr><td>1. Name of Program</td><td>Program to Strengthen Linkage between Central, Provincial and Local Administrations in SKP</td></tr>
<tr><td>2. Name of Project</td><td>Promotion of awareness regarding NREM among resident and publication of environmental information in SKP</td></tr>
<tr><td>3. Sector in NREM</td><td>NREM Management</td></tr>
<tr><td>4. Responsible Agency</td><td>DEQP of MNRE and PEO/ SKP</td></tr>
<tr><td>5. Supporting Agency</td><td>ONEP, PO/ SKP, Local cable TV and Radio Stations</td></tr>
<tr><td>6. Monitoring and Evaluation Agency</td><td>REO 8</td></tr>
<tr><td>7. Background of the Project</td><td>Public participation plays major role in monitoring the operations of PEQMP. People's awareness on NREM can also support such operations. Promoting knowledge, and creating NREM awareness are; therefore, very important issues.
To create NREM awareness among residents, results of PEQMP operations and other NRE information must be provided and publicized through variety of media.</td></tr>
<tr><td>8. Justification of the Project</td><td>Relation with the upper plans:</td></tr>
<tr><td>9. Objectives of the Project</td><td>Objective is:
• To raise NREM awareness in preserving NRE among residents.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>• Awareness and interest in preserving NRE among residents
• Number of complaints to PEO/SKP</td></tr>
<tr><td>11. Main Components of the Project</td><td>• Exhibition and seminar
• The existing teaching aids and TV programs for environmental awareness education, created mainly by DEQP/MNRE, be actively used, upgraded and localized.
• The results of PEQMP monitoring and other information on NREM be published in bulletins and/or through cable TV, radio stations, and websites.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Education event and seminar</td><td>2009 - 2011</td></tr><tr><td>Upgrade and localization of existing teaching aids and TV programs</td><td>2009 - 2011</td></tr><tr><td>Publication of PEQMP monitoring and other information on NREM</td><td>2009 - 2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th></tr><tr><td>Education event and seminar</td><td>1,500,000</td></tr><tr><td>Upgrade and localization of existing teaching aids and TV programs</td><td>990,000</td></tr><tr><td>Publication of PEQMP monitoring and other information on NREM</td><td>990,000</td></tr></table></td></tr>
<tr><td>14. Benefit of the Project</td><td>Beneficiary: Whole population in SKP</td></tr>
</table>

5.4.6 Program to Strengthen NREM Capacities of LAs in Samut Songkhram Province (SKP)

a. Strengthening of NREM Capacity of Orborjor in SKP

1. Name of Program	Program to Strengthen NREM Capacities of LAs in SKP
2. Name of Project	Strengthening of NREM Capacity of Orborjor in SKP
3. Sector in NREM	NREM Management
4. Responsible Agency	Orborjor of Samut Songkhram and Provincial Office of SKP
5. Supporting Agency	MOI, PA (Changwat) of SKP and ONEP of MNRE
6. Monitoring and Evaluation Agency	REO 8 and PEO/ SKP
7. Background of the Project	Tasks related to NREM have been comprehensively decentralized and devolved onto Local Administrations (LAs) including Orborjor, but the LAs put in charge of these tasks do not realistically have the capacity to execute these tasks. A Province-wide viewpoint is a requirement in finding a solution to pollution control problems; thus the Orborjor plays an especially important role in this sector. There is no environmental division in the Orborjor of SKP. Although the MNRE has instructed LAs to commit 8% of the total budget to environment in the National EQMP, the environmental budget of SKP Orborjor for FY2006 was only 0.1% of the total budget of it[16]. Though NREM is clearly written as one of the main responsibilities of Orborjor, it is dubious that it is successfully functioning as an environmental administration unit. Consequently, many projects related to the environment at the provincial level, i.e. beyond the scope of Tessaban and Orbortor have not been implemented. It is, therefore, necessary to strengthen NREM Capacity of SKP Orborjor.
8. Justification of the Project	Relation with the upper plans: • Decentralization of NREM is the national policy. • MNRE has instructed LAs including Orborjor to commit 8% of the total budget to environment in the National EQMP • The Orborjor of SKP does not have enough capability to conduct proper NREM in its administrative areas and it requires strong technical assistances from PA (Changwat) offices.
9. Objectives of the Project	Objectives are as follows: • An Environmental Division in Orborjor is established. • The PA supports NREM of Orborjor. • The Environmental Division of the Orborjor conducts NREM activities that are beyond the scope of Tessaban and Orbortor Orborjor, e.g. implementation of PEQMP Priority Programs such as Improvement of Solid Waste Management.
10. Objectively Verifiable Indicators	• Number of staff in the Environmental Division of the Orborjor and budget of it • Establishment of a NREM supporting team in PA (Changwat) • Number of NREM projects at the provincial level started by LAs
11. Main Components of the Project	• A NREM supporting team, of which members are recruited from staff of various PA (Changwat) offices with cooperation from PA (Changwat), is created and the Team supports the Environmental Division of SKP Orborjor on NREM.

[16] Source: Opinion survey among LAs

<table>
<tr><td></td><td>• The Environmental Division of SKP Orborjor is established by allocating number of staff and budget of it.
• The Environmental Division of SKP Orborjor promote NREM activities that are beyond the scope of Tessaban and Orbortor, i.e. implementation of the priority programs like “Program for Appropriate and Sustainable Solid Waste Management in SKP”, etc.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Creation of and support by the NREM supporting team</td><td>2009</td></tr><tr><td>Establishment of the Environmental Division in SKP Orborjor</td><td>2010 - 2011</td></tr><tr><td>Promotion of NREM activities</td><td>2010 - 2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th></tr><tr><td>Creation of and support by the NREM supporting team</td><td>4,780,000</td></tr><tr><td>Establishment of the Environmental Division in SKP Orborjor</td><td>3,980,000</td></tr><tr><td>Promotion of NREM activities</td><td>2,000,000</td></tr></table></td></tr>
<tr><td>14. Benefit of the Project</td><td>Beneficiary: Whole population in SKP</td></tr>
</table>

b. Construction of Resident Participatory System for NREM in SKP

1. Name of Program	Program to Strengthen NREM Capacities of LAs in SKP
2. Name of Project	Construction of Resident Participatory System for NREM in SKP
3. Sector in NREM	NREM Management
4. Responsible Agency	Provincial Office, PEOs and LAs of SKP
5. Supporting Agency	ONEP and District Offices of SKP
6. Monitoring and Evaluation Agency	REO 8
7. Background of the Project	The main executors of the PEQMP would be the individuals and organizations who make direct impact on their natural resources and environment during the course of their everyday activities. Therefore, the participation at plan formulation, understanding of plan contents, and building of a system of cooperation for the execution/implementation of the plan by all interest-bearing parties, i.e. stakeholders, is a necessary precondition for the successful and realistic plan. In the wide-ranging and widely-affecting field of natural resources and environmental management (NREM), NREM cannot move forward without public/stakeholder participation. It is, therefore, necessary to construct resident participatory system for NREM in SKP.
8. Justification of the Project	Relation with the upper plans:
8. Objectives of the Project	Objectives is as follows: • Opinions of local residents are reflected in PEQMP formulation and implementation, and NREM status is monitored by local

<table>
<tr><td></td><td>residents</td></tr>
<tr><td>9. Objectively Verifiable Indicators</td><td>• Number of public notices on PEQMP
• Number of resident opinions recorded on PEQMP and NREM
• Appointment of local resident representative(s) to monitoring committee for PEQMP and NREM</td></tr>
<tr><td>10. Main Components of the Project</td><td>• The draft PEQMP formulated by the Formulation Committee be posted and made available to the public in branch government offices (for example, Amphoe offices) for 45 days, the same way zoning regulation changes are handled. At the same time, the posting period of the draft PEQMP should be publicized through cable TV, radio stations, and websites, with the purpose of attracting as wide a range of local resident opinions as possible, in order to reflect such opinions on the plan itself.
• The Monitoring Committee includes environmental experts, representatives of NGOs, and representatives of local residents, so that various stakeholders can jointly monitor the implementation of NREM.</td></tr>
<tr><td>11. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Public notification of the draft PEQMP</td><td>2009</td></tr><tr><td>Operation of the Monitoring Committee</td><td>2010-2011</td></tr></table></td></tr>
<tr><td>12. Budgetary Plan</td><td><table><tr><th>Component</th><th>Budget</th></tr><tr><td>Public notification of the draft PEQMP</td><td>660,000</td></tr><tr><td>Operation of the Monitoring Committee</td><td>340,000</td></tr></table></td></tr>
<tr><td>13. Benefit of the Project</td><td>Beneficiary: Whole population in SKP</td></tr>
</table>

c. Establishment of an Environmental Information Center in PEO/SKP

1. Name of Program	Program to Strengthen NREM Capacities of LAs in SKP
2. Name of Project	Establishment of an Environmental Information Center in PEO/ SKP
3. Sector in NREM	NREM Management
4. Responsible Agency	PEO/ SKP
5. Supporting Agency	OPS and ONEP of MNRE
6. Monitoring and Evaluation Agency	REO 8
7. Background of the Project	Many requests that “the information on current NREM is hardly at hand and it shall be provided by the public sector” were voiced in the Opinion Survey to the Stakeholders and the Seminars. In SKP, an Environmental Information Center has not been established. The Environmental Information Center in PEO shall be established to provide NREM information supply services; that the information provided are in paper medium and PDF file format; and that the information should come from databases maintained and updated by the REO 8.

<table>
<tr><td>8. Justification of the Project</td><td>Relation with Upper Level Plans:</td></tr>
<tr><td>9. Objectives of the Project</td><td>Objectives are:
• To provide the information on NREM to local residents, LAs, developers and organizations in general in SKP.
• To collect information on NREM from local residents, LAs, developers and organizations in general in SKP.</td></tr>
<tr><td>10. Objectively Verifiable Indicators</td><td>• Number of information provided to local residents, LAs, developers and organizations in general in SKP.
• Number of information collected from local residents, LAs, developers and organizations in general in SKP.</td></tr>
<tr><td>11. Main Components of the Project</td><td>• The Environmental Information Center in PEO/SKP shall be established with several facilities such as upgrading PCs, copy machines, color printer and so on, to provide information on NREM in the province to local residents, LAs, developers and organizations in general.
• The Environmental Information Center in PEO/SKP collects information on NREM in the province from local residents, LAs, developers and organizations in general. Then send the information to the NREM GIS Database Center in SKP.</td></tr>
<tr><td>12. Implementation Schedule</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Establishment of an Environmental Information Center</td><td>2009</td></tr><tr><td>Provision and collection of the information on NREM</td><td>2010-2011</td></tr></table></td></tr>
<tr><td>13. Budgetary Plan</td><td><table><tr><th>Component</th><th>Implementation</th></tr><tr><td>Establishment of an Environmental Information Center</td><td>300,000</td></tr><tr><td>Provision and collection of the information on NREM</td><td>1,600,000</td></tr></table></td></tr>
<tr><td>14. Benefit of the Project</td><td>Beneficiary: Whole population in SKP</td></tr>
</table>