

4. PEQMP for Ayutthaya

4 PEQMP for Ayutthaya

The PEQMP-KPI for Phra Nakhon Si Ayutthaya Province (AYP) has been submitted to the MNRE in October 2007 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, Fail), the PEQMP-KPI Evaluation Committee also required some improvements in its comments. 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 Phra Nakhon Si Ayutthaya Province” held on 27th December 2007, 13 March 2008 and 8th July 2008 respectively. This chapter presents the contents of this final PEQMP – KPI..

4.1 Part 1: Introduction

a. Background of PEQMP-KPI

Central Administration Act No. 5 Year 2002, Strategic Plan for Development of Thai Government System (Year 2003-2007) and Decree of Principles and Method of Good Governance Year 2003 mentions that central and local government offices must prepare annual working evaluations by using Key Performance Indicator (KPI) to evaluate working performances clearly.

The Office of the Public Sector Development Commission (OPDC) has modified indicators for NREM for fiscal year 2007, in addition to those made for fiscal year 2006, in order to reflect the importance of NREM as main factor for sustainable development in accordance with the concept of “sufficiency economy”. Formulation of the PEQMP-KPI is one of the indicators in fiscal year 2007 for each province. Support for the formulation of the PEQMP-KPI is also an indicator in fiscal year 2007 for the Ministry of Natural Resources and Environment (MNRE).

Hence, in order to formulate PEQMP-KPI efficiently, MNRE has assigned the Office of Natural Resources and Environmental Policy and Planning (ONEP) to prepare a manual for the formulation of a PEQMP-KPI for all agencies in each province such as the Provincial Environmental Office (PEO) to use as tool for the formulation of the PEQMP-KPI and to be one part of the Provincial Strategy Development Plan.

b. Principles and Importance of PEQMP-KPI

A PEQMP-KPI is a master plan for NREM in each province to be used as guideline for the appropriate conservation and rehabilitation of natural resources and environment in the province. This master plan is adapted to the local (provincial) situation with respect to natural resources and environment and governs NREM in each province for 4 years (2008-2011).

To formulate a PEQMP-KPI, an area-based approach is chosen which takes the situation of natural resources and environment in each province into consideration. The people and the social sector must also be offered an opportunity to take part in the planning process in the province, in order to reflect the needs of local residents as well as the director of Economic and Social Development of the province to the 4-year budget plan. Success of the plan will depend on participation by central, provincial and local administrations as well as local residents each fulfilling their respective roles, duties and responsibilities.

The PEQMP-KPI links with other NREM related plans and agencies at various levels in the following way as shown in Figure 4-1:

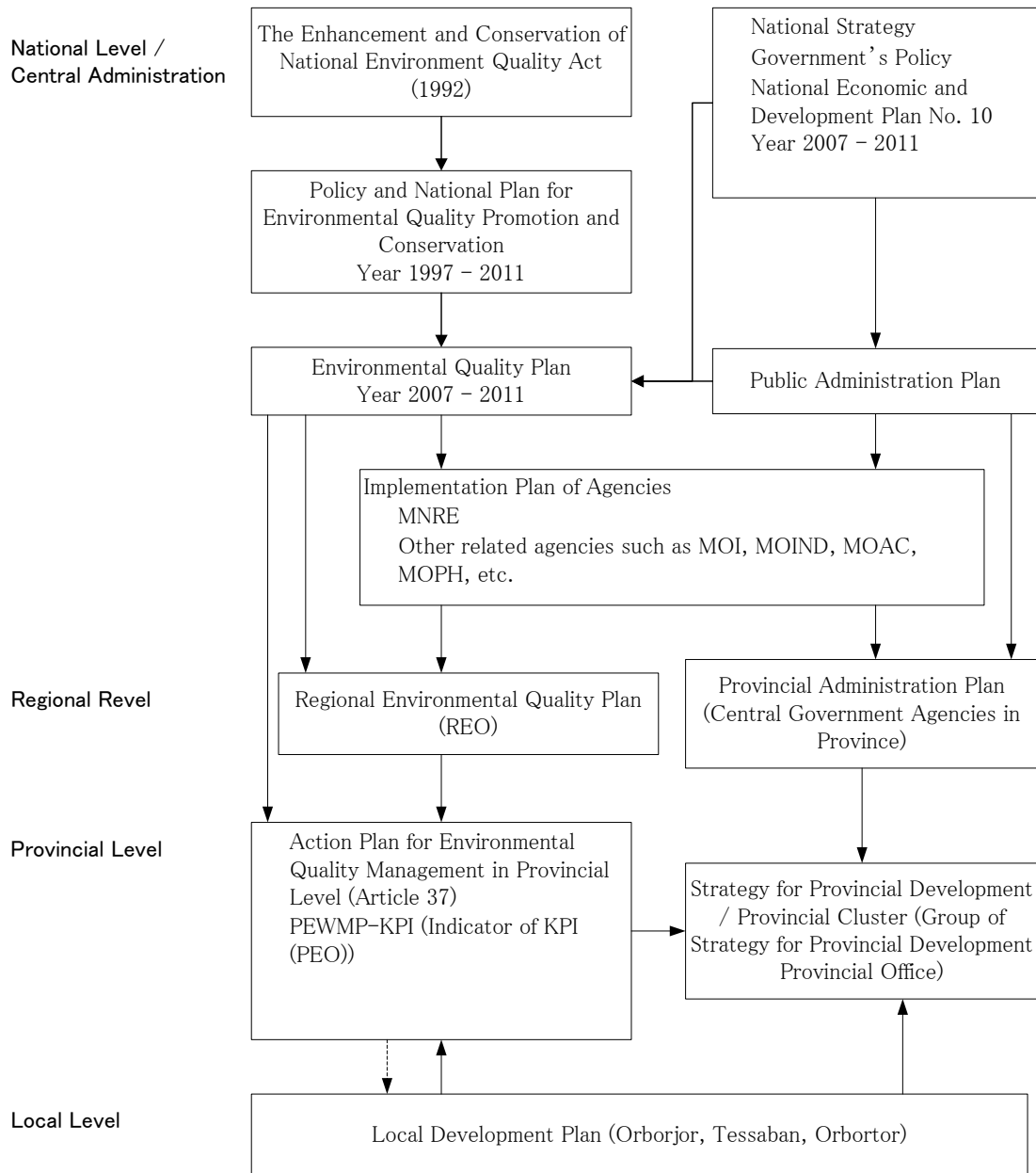


Figure 4-1: Linkage between all NREM Related Plans and Agencies at all Levels



c. Process of the Formulation of the PEQMP-KPI

The process of the formulation of the PEQMP-KPI has 7 steps in total as follows:

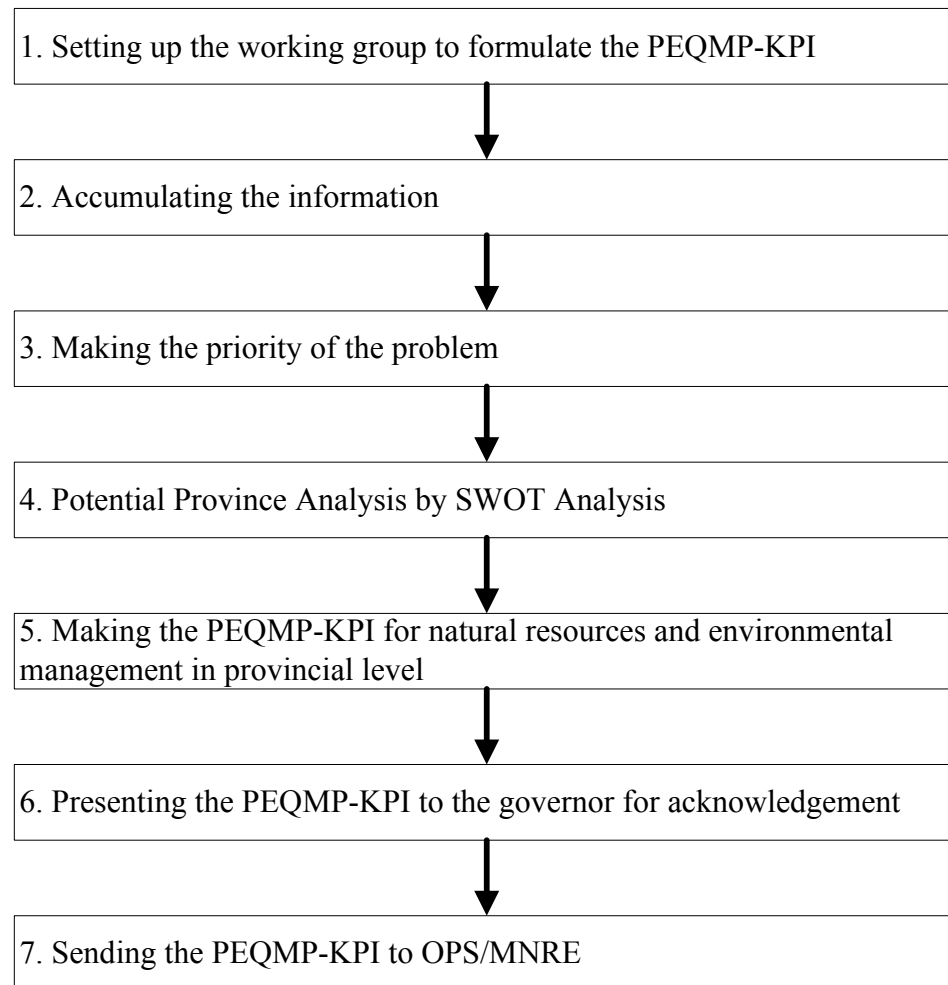


Figure 4-2: Procedure for formulation of PEQMP-KPI

4.2 Part 2: Situation and Issues on NREM

4.2.1 Part 2-1) Basic Data of the Province

a. Physical Condition

a.1 Location, Boundary and Area

Phra Nakhon Si Ayutthaya Province (AYP) is located in central Thailand at latitude 14° north, longitude 101° east having a total area of 2,556.64 km² or about 1,597,900 Rais. The elevation of the delta basin of the Chao Phraya, Pasak, Lopburi and Noi Rivers is 3.5 m above mean sea level. AYP is located north of Bangkok about 75 km away by land transportation (Asia Highway), 72 km by railway or 137 km by river transportation. AYP borders the following provinces:

North	Ang Thong Province and Lopburi Province,
East	Saraburi Province,
West	Supanburi Province,
South	Nonthaburi Province, Patum Thani Province and Nakhon Pathom Province.

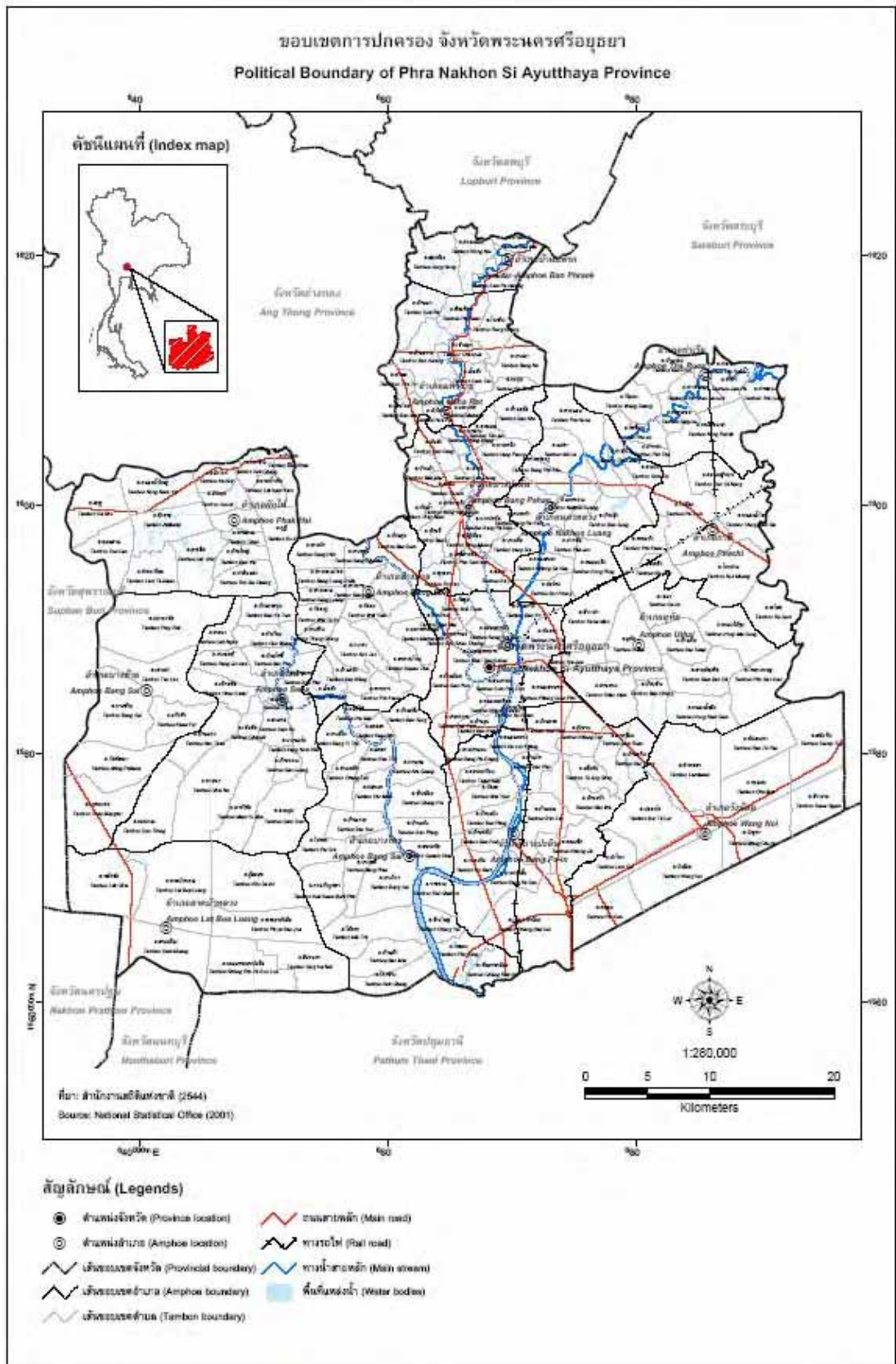


Figure 4-3: Location and Borders of AYP

a.2 Topography

AYP is a flood plain or delta area (of the Chao Phraya River) and higher than sea level by about 3.5 m. There are no mountains but there are four main rivers: Chao Phraya River, Pasak River, Lopburi River and Noi River, not to mention many small and large canals. In the rainy season, water will overflow the canals and flood the plain area of the province. Therefore, the area is suitable for agriculture.

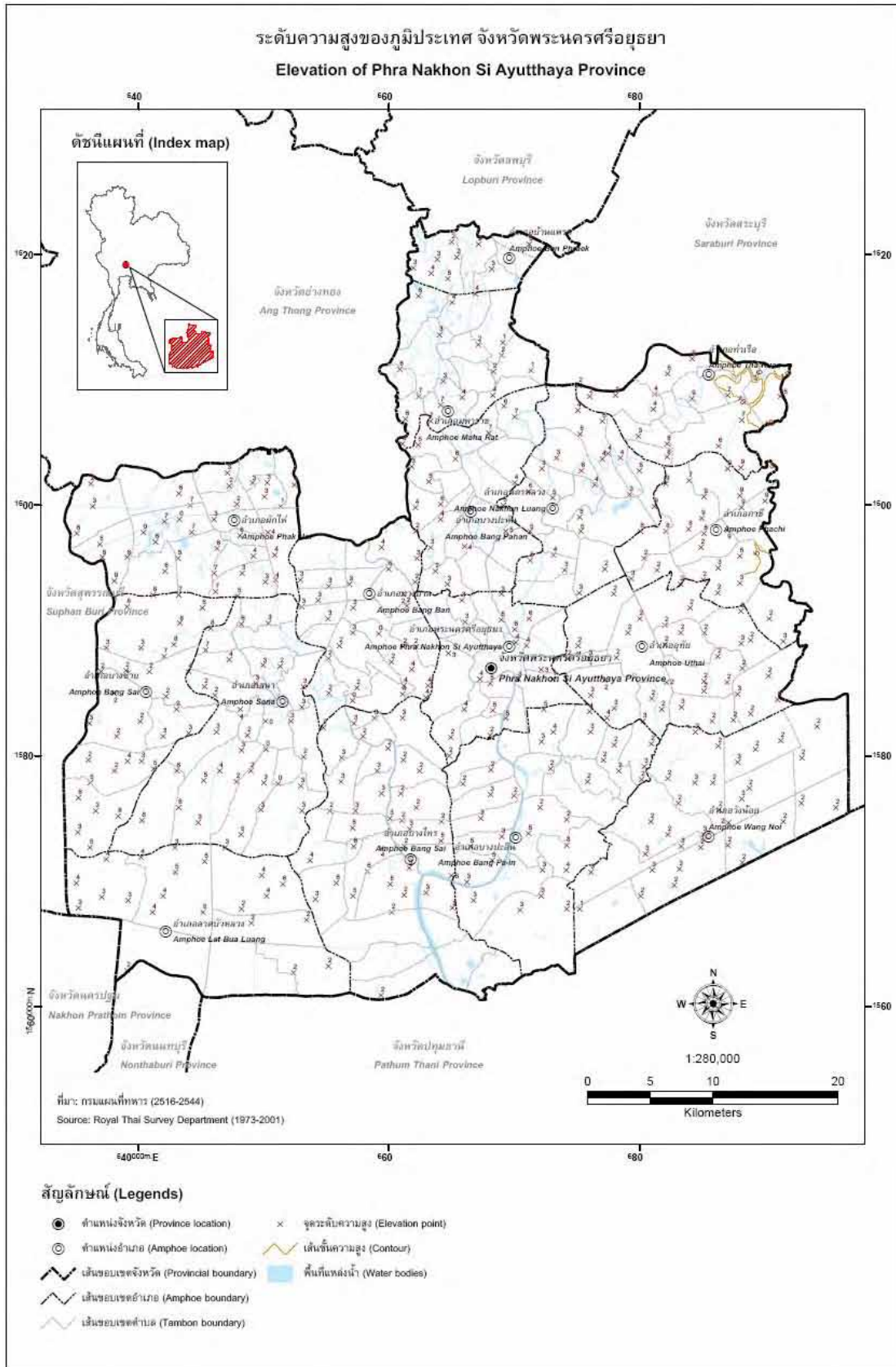


Figure 4-4: Elevation Map

b. Climate

In general, the climate of AYP is characterized by two types of monsoons: the northeast monsoon and west-south monsoon. There are three seasons:

Rainy season is during the middle of May to the middle of October. The average monthly precipitation (rainfall) from May-October in 2006 was about 191 mm/month.

Winter season is during the middle of October to the middle of February. Winter season lasts for about four months. The lowest temperature is in November at about 18.8 degrees Celsius.

Summer season is from the middle of February to the middle of May. During this period, southern winds and the east-south monsoon sweeps over the country and creates a hot climate. Maximum temperature at the present is 36.8 degrees Celsius.

There are 17 weather stations in AYP as follows:

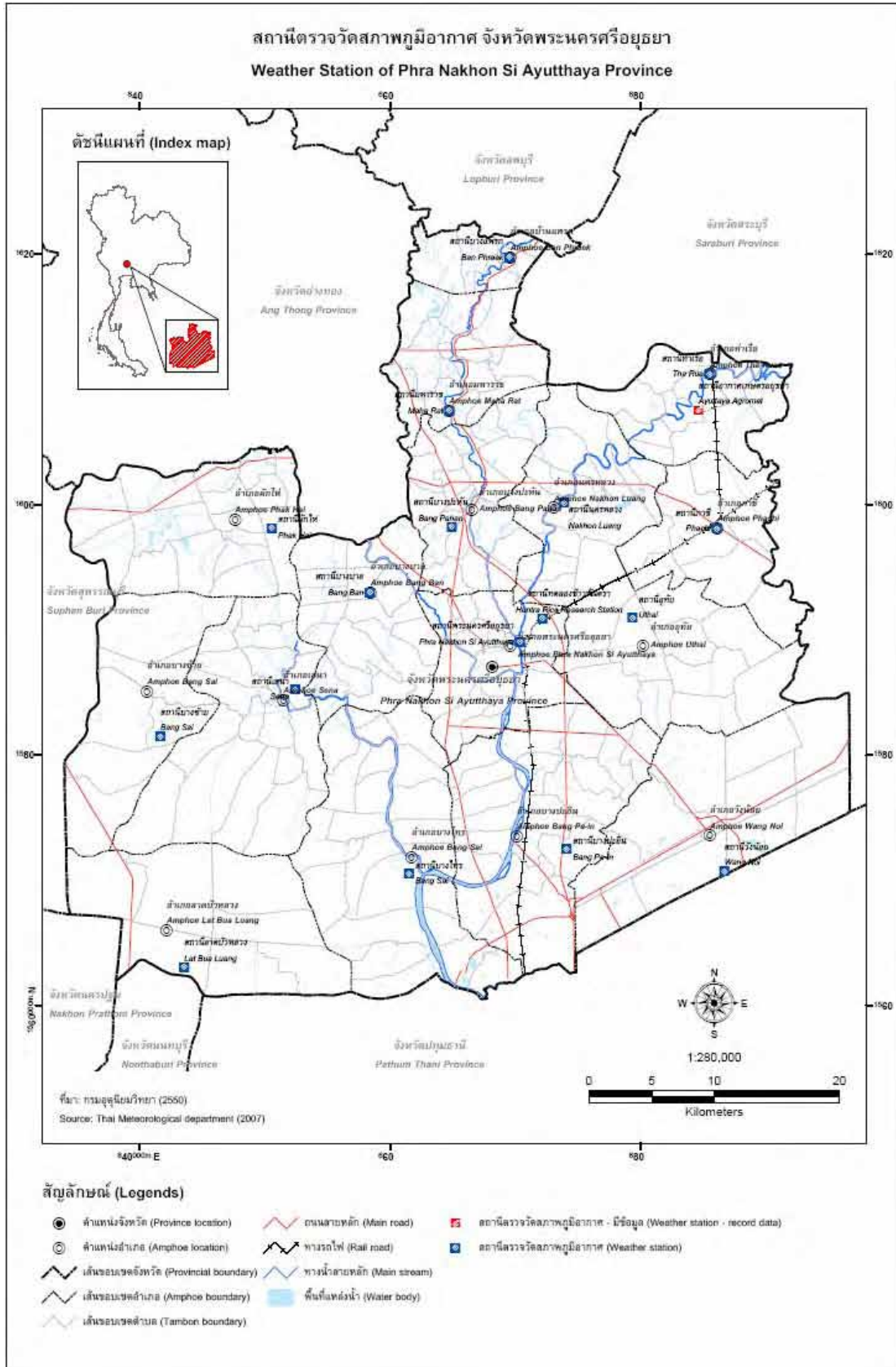


Figure 4-5: Location of Weather Stations in AYP

Average monthly temperature and precipitation are shown below.

Table 4-1: Average Monthly Temperature (AYP)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	25.3	28.2	29.7	30.2	31.0	30.5	29.7	29.1	28.3	28.5	27.5	27.3
1998	27.9	29.6	31.0	31.9	31.4	29.6	29.1	28.7	28.3	28.4	27.1	26.1
1999	26.7	27.8	30.2	29.4	28.8	28.7	28.8	28.5	28.3	27.9	27.2	23.8
2000	27.2	27.3	29.4	29.7	29.4	29.0	28.7	28.7	28.2	28.6		27.4
2001	28.2	28.5	28.4	31.3	29.7	29.3	29.4	29.0	29.2	28.6	26.0	26.6
2002	26.5	29.0	29.9	31.3	29.6	29.5	29.7	28.7	28.1	28.1	27.5	27.3
2003	25.9	28.2	28.9	30.4	30.1	29.4	28.8	29.1	28.3	28.2	28.0	25.3
2004	26.7	27.1	29.7	31.0	29.3	28.8	29.7	29.1	28.6	28.5	28.6	25.5
2005	26.3	29.6	29.4	30.7	30.9	29.5	29.4	29.5	28.6	28.5	27.4	25.3
2006	26.5	29.0	29.6	29.9	29.4	29.1	28.8	28.5	28.2	28.3	28.1	25.6
Ave	26.7	28.4	29.6	30.6	30.0	29.3	29.2	28.9	28.4	28.4	27.4	26.0

Table 4-2: Monthly Precipitation (AYP)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1997	0.1	0.0	18.0	38.2	67.0	77.3	41.5	183.8	192.5	104.0	18.7	0.0	741.1
1998	0.0	0.0	0.0	12.7	182.8	167.6	279.0	246.1	121.9	160.8	39.8	0.0	1,210.7
1999	29.8	8.5	7.2	168.3	287.9	121.5	190.3	189.6	206.7	188.8	21.7	0.0	1,420.3
2000	0.0	18.6	21.2	154.4	96.4	102.5	78.9	164.2	157.4	97.0	8.6	0.0	899.2
2001	2.1	4.5	171.1	1.4	230.8	87.2	84.6	112.8	84.5	87.5	3.3	10.8	880.6
2002	49.4	5.0	13.7	9.8	95.8	52.2	36.6	195.8	304.4	54.3	94.7	104.5	1,016.2
2003	0.0	0.0	147.2	14.1	76.2	126.8	288.8	101.5	282.0	107.4	0.0	0.0	1,144.0
2004	15.1	30.9	0.4	29.2	52.5	69.0	127.2	176.4	217.5	8.3	0.0	0.0	726.5
2005	0.0	0.0	30.6	39.4	33.1	169.3	73.6	54.1	331.0	98.3	295.5	39.7	1,164.6
2006	0.0	4.2	84.6	53.9	144.1	184.6	216.4	72.8	309.0	219.6	15.1	0.0	1,304.3
Ave.	9.7	7.2	49.4	52.1	126.7	115.8	141.7	149.7	220.7	112.6	49.7	15.5	1,050.8

Source: Meteorological Dept.

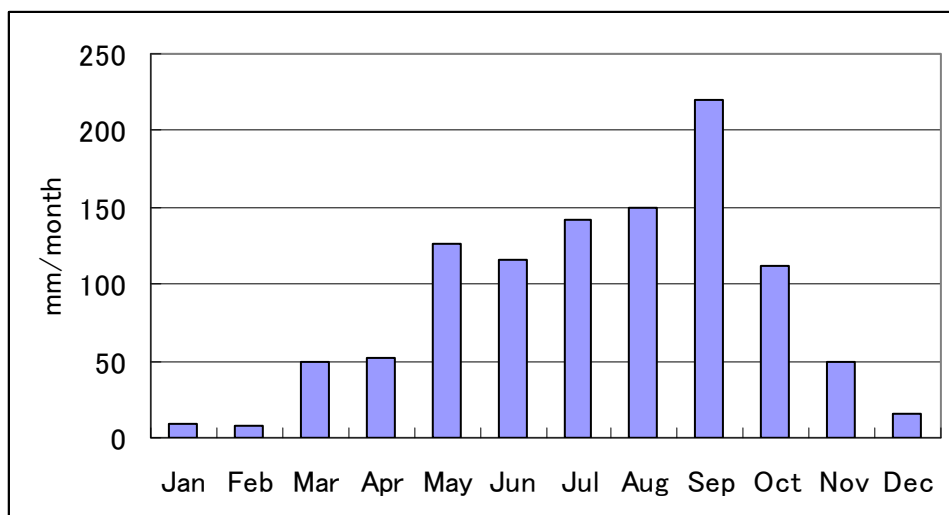


Figure 4-6: Average Monthly Precipitation (1997-2006)

c. Population

c.1 Situation

Population of AYP in each Amphoe and its change from year 2001 to 2005 are shown below. In 2005, Phra Nakorn Si Ayutthaya District had the largest population with 135,387 persons, followed by Bang Pa-in District with 78,699. The population in Phra Nakorn Si Ayutthaya has been decreasing slightly in the past few years.

Table 4-3: Population in Each Amphoe and its change from 2001 to 2005

Amphoe		2001		2002		2003		2004		2005	
		person	%	person	%	person	%	person	%	person	%
1	Phra Nakhon Si Ayuthaya	138,846	18.6	140,331	18.7	140,659	18.8	135,850	18.4	135,385	18.2
2	Tha Ruea	48,875	6.6	48,928	6.5	48,965	6.5	47,565	6.4	47,830	6.4
3	Nakhon Luang	33,830	4.6	34,075	4.6	34,141	4.5	33,638	4.5	33,873	4.5
4	Bang Saai	20,196	2.7	20,224	2.7	20,044	2.7	19,529	2.6	19,556	2.6
5	Bang Sai	45,296	6.1	45,651	6.1	45,706	6.1	45,384	6.1	45,783	6.1
6	Bang Ban	34,387	4.6	34,439	4.6	34,328	4.6	33,980	4.6	34,205	4.6
7	Bangpahan	39,772	5.4	40,154	5.4	40,228	5.4	40,239	5.4	40,523	5.4
8	Bang Pa-in	72,696	9.8	73,877	9.9	75,245	10.0	76,646	10.4	78,699	10.6
9	Bang Phraek	9,515	1.3	9,490	1.3	9,353	1.2	9,278	1.3	9,250	1.2
10	Phak Hai	44,206	6.0	44,239	5.9	43,862	5.8	42,956	5.8	42,870	5.7
11	Phachi	31,438	4.2	31,661	4.2	31,714	4.2	30,189	4.1	30,330	4.1
12	Maha Rat	23,633	3.2	23,794	3.2	23,672	3.2	23,528	3.2	23,492	3.1
13	Lat Bua Luang	36,934	5.0	37,170	5.0	37,171	4.9	35,800	4.8	36,504	4.9
14	Wang Noi	55,151	7.4	56,226	7.5	57,677	7.7	58,976	8.0	60,841	8.2
15	Sena	66,438	9.0	66,807	8.9	67,164	8.9	65,056	8.8	65,201	8.7
16	Uthai	40,561	5.5	41,177	5.5	41,330	5.5	41,783	5.6	42,577	5.7
Total		741,774	100.0	748,243	100.0	751,259	100.0	740,397	100.0	746,919	100.0

Source: DOPA

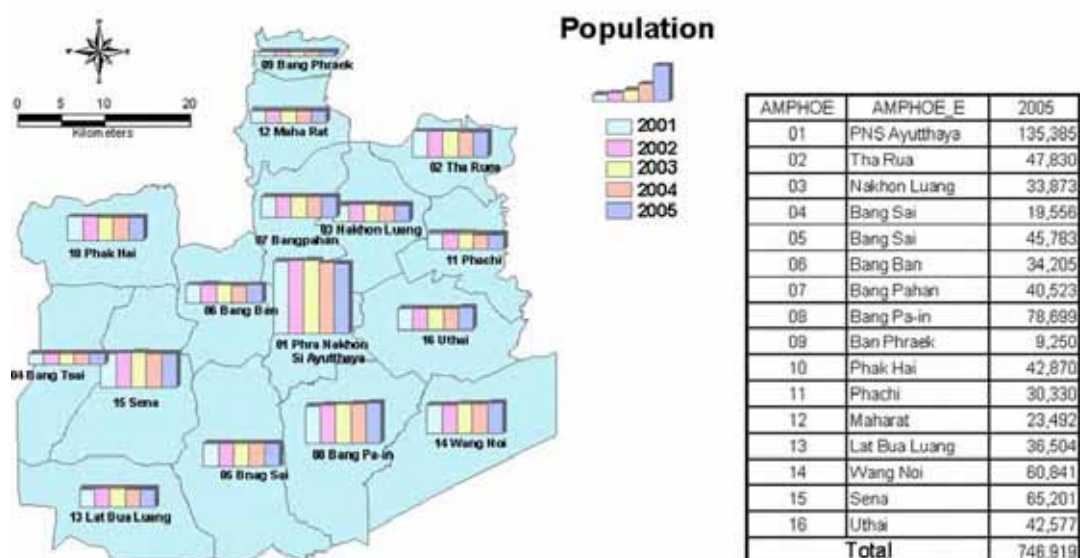


Figure 4-7: Change of Population of each Amphoe in AYP

The apparent population in 2004 declined from the previous year because double registration was rectified in the statistic record in 2004.

The demographics of AYP are summarized as follows:

Table 4-4: Population in AYP

Population in 2001	741,774
Population in 2006	754,595
Population in Tessaban in 2006	254,463
Population in Orbortor in 2006	500,132
Male in 2006	365,137
Female in 2006	389,422
Female/Male Ratio	1.06: 1

c.2 Impact Analysis

c.2.1. Population Forecast by NESDB

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

Here the Study Team 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 4-5 and in Figure 4-8.

Table 4-5: Population Forecast used in PEQMP

Year	Actual Data	Forecast Data
2001	741,774	
2002	748,243	
2003	751,259	
2004	740,397	
2005	746,919	
2006		747,969
2007		749,019
2008		750,069
2009		751,119
2010		752,169
2011		753,219
2012		754,269
2013		755,319
2014		756,369
2015		757,414

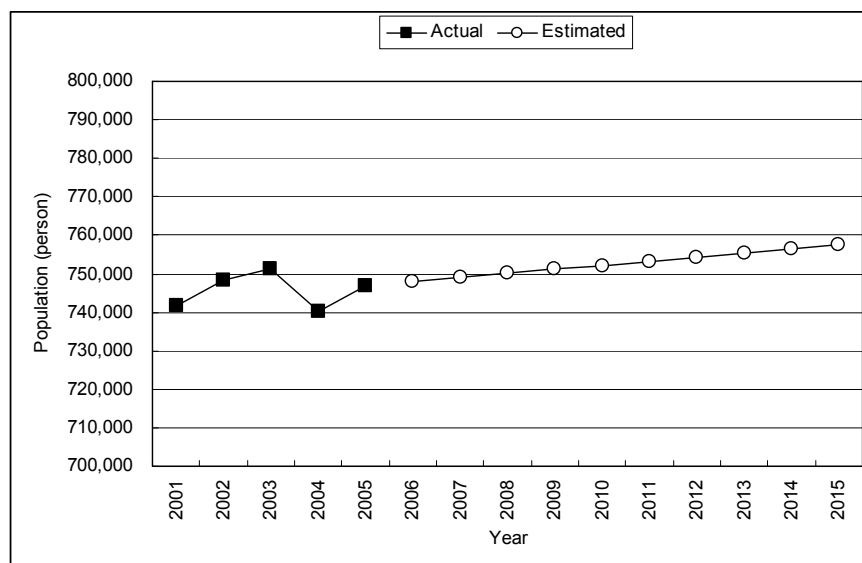


Figure 4-8: Population Forecast of AYP used in PEQMP

c.2.2. Impact

According to the population forecast by NESDB, the average annual population growth rate of AYP from 2006 to 2015 is only 0.14 %, which is very small. However, this rate does not include the unregistered population.

c.3 Issues

Population growth is quite slow. The unregistered population is assumed to be fairly large, but the actual facts are unknown.

c.4 Measures to be Taken

- Investigate the number of unregistered residents to determine the actual population in Ayutthaya.
- Investigate the actual number of population in- and outflow.

d. Economic Situation

d.1 Situation

Gross Provincial Product (GPP) and GPP per capita from 2001 to 2005 are presented below.

Table 4-6: GPP, Population, GPP per Capita (AYP, 2001-2005)

Item	Unit	Symbol	2001	2002	2003	2004	2005
GPP* ¹	M Baht	A	182,145	196,416	238,397	255,988	264,555
Population* ¹	person	B	741,774	748,243	751,259	740,397	746,919
GPP per Capita* ²	Baht	A/Bx10 ⁶	245,553	262,503	317,330	345,744	354,195

Source *¹: NESDB

*²: Calculation by the Study Team

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

Table 4-7: Economy in AYP

GPP in 2005	264,555 Million Baht
GPP per capita in 2005	354,195 Baht
GPP in category of business	Industry: 82.6% Commerce : 3.3% Agriculture : 2.1% Others: 12.0%
Employed Person	Manufacturing: 48% Service : 17% Commerce : 14% Agriculture : 9%

d.2 Impact Analysis

d.2.1. Forecast of GPP

GPP was forecast in PEQMP as follows:

- Actual GPP per Capita is calculated by using GPP data published by NESDB and population data of the past 5 years (2001-2005). Based on the 5-year data, the future GPP per Capita is calculated using regression analysis (linear).
- Future GPP is calculated as the result of future population multiplied by GPP per Capita computed above. Future population, which is calculated above, is utilized.

Future GPP is computed as shown in Table 4-8 and in Figure 4-9. GPP in AYP will be 1.55 times in 2011 and 1.91 times in 2015 compared with GPP in 2005.

Table 4-8: Actual GPP and Future GPP (AYP)

---	Year	GPP per Capita	Population	GPP	Growth Rate
		Baht	Person	Mil. Baht	%
		A	B	AxB/10 ⁶	---
Actual	2001	245,553	741,774	182,145	---
	2002	262,503	748,243	196,416	7.8
	2003	317,330	751,259	238,397	21.4
	2004	345,744	740,397	255,988	7.4
	2005	354,195	746,919	264,555	3.3
Estimated	2006	395,223	747,969	295,615	---
	2007	425,275	749,019	318,539	7.8
	2008	455,328	750,069	341,527	7.2
	2009	485,380	751,119	364,578	6.7
	2010	515,433	752,169	387,693	6.3
	2011	545,485	753,219	410,870	6.0
	2012	575,538	754,269	434,110	5.7
	2013	605,590	755,319	457,414	5.4
	2014	635,643	756,369	480,781	5.1
	2015	665,695	757,414	504,207	4.9

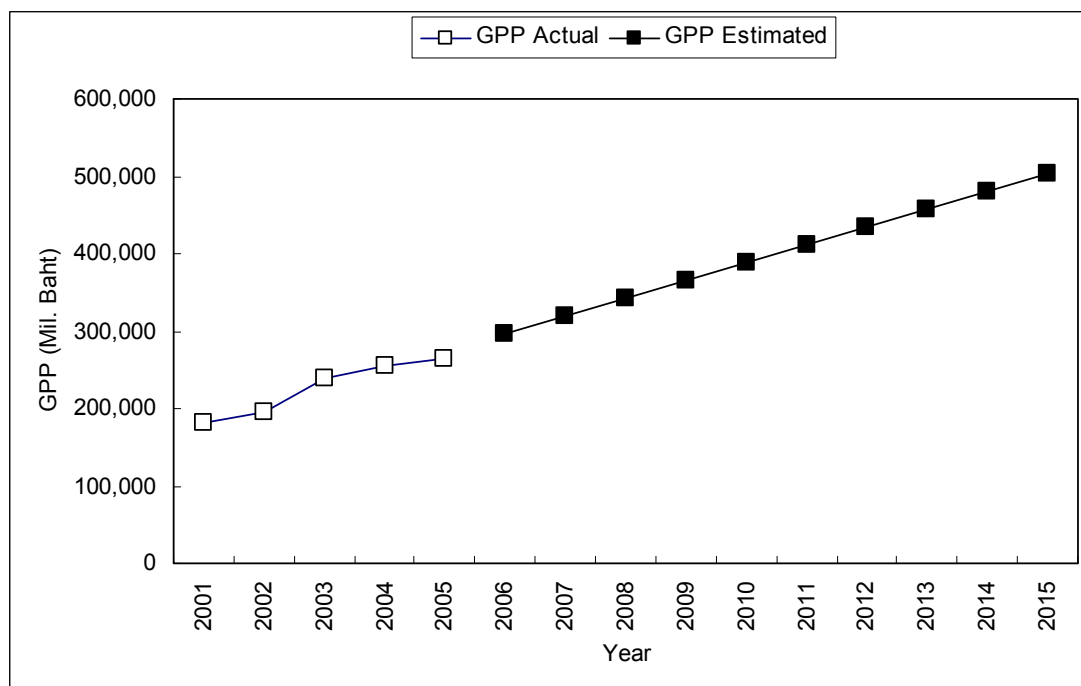


Figure 4-9: Actual GPP and Future GPP (AYP)

d.2.2. Impact

Compared to the annual growth rate of population, the growth of GPP in AYP is quite high, with growth rates between 4.9% and 7.8% per year between 2006 and 2015. In addition, GPP per capita in 2015 is forecasted to be 665,695 Baht, which is over US \$20,000 using the current exchange rate 1US\$ = 33 Baht.

d.3 Issues

- Industry is currently the main economic driving force of the province. GPP of the province as a whole is steadily growing, but the GPP of the agricultural sector grew only 2% in spite of its area occupying 80% of Ayutthaya. Its growth is practically stagnant.
- Personal income has declined, while consumer prices are increasing.
- There needs to be a balance between environmental conservation and industrial development.
- Environmental pollution increases as the number of tourists increases.

Table 4-9: Gross Domestic Product of Province

Gross Domestic Product	Amount (million Baht)		
	2003	2004	2005
Production Field			
Agriculture sector	4,380	5,264	5,178
Industrial sector	208,408	219,884	238,324
Commerce and service sector	33,618	39,531	43,853
Total Gross Domestic Product	246,403	264,679	286,954

Source: Provincial Statistic Report Year 2006

d.4 Measures to be Taken

- Reinforce the provincial NREM administration, e.g., the restriction of land use in agricultural area for industrial use, strengthen the regulation of industrial pollution.
- Properly controlled industrial development, e.g., attract pollution-free industry.
- Conserve agricultural land and prepare supporting mechanism of agriculture.
- Publicize and educate about the significance of appropriate protection of natural resources and study sustainable economic development.
- Support by the administration of traditional products (e.g. agriculture, handicrafts) by promoting sales and by guiding production process.
- Improve agricultural products.
- Balance environmental conservation and tourism development.

e. Social Situation

e.1 Administration

e.1.1. Situation

Administrative Boundary (Central Government Line)

Ayutthaya Province (Changwat) is divided into 16 districts (Amphoe) and 209 sub-districts (Tambon) as shown below.

Administrative Boundary (Local Government Line)

Local administrations comprise of 1 Orborjor (PAO), 34 Tessaban and 124 Orbortor (TAO). The locations of Tessaban are shown in the figure below.

Table 4-10: Tessaban in Each District

District (Amphoe)	Tessaban (Municipality)
1. Phra Nakhon Si Ayutthaya	1.1 Nakhon Si Ayutthaya 1.2 Mueang Ayothaya
2. Tha Ruoa	2.1 Tambon Tha Ruoa 2.2 Tambon Tha Luang
3. Nakhon Luang	3.1 Tambon Nakhon Luang 3.2 Tambon Aran Yik
4. Bang Sai	4.1 Tambon Bang Sai 4.2 Tambon Ratchakram
5. Bang Ban	5.1 Tambon Bang Ban 5.2 Tambon Maha Pram
6. Bang Pa-in	6.1 Tambon Khlong Jik 6.2 Tambon Ban Laen 6.3 Tambon Phra-intraracha 6.4 Tambon Ban Sang 6.5 Tambon Prasart Thong 6.6 Tambon Bang Kra San 6.7 Tambon Chieng Rak Noi

District (Amphoe)	Tessaban (Municipality)
7. Bang Pahan	7.1 Tambon Bang Pahan
8. Phak Hai	8.1 Tambon Lat Cha Do 8.2 Tambon Phak Hai
9. Phachi	9.1 Tambon Phachi
10. Lat Bua Luang	10.1 Tambon Lat Bua Luang 10.2 Tambon Sam Mueang
11. Wang Noi	11.1 Tambon Lam Ta Sao
12. Sena	12.1 Mueang Sana 12.2 Tambon Chao Jet 12.3 Tambon Hua Wieng 12.4 Tambon Bang Nom Ko 12.5 Tambon Sam Ko
13. Bang Shai	13.1 Tambon Bang Shai Nai
14. Uthai	14.1 Tambon Uthai
15. Maharat	15.1 Tambon Maharaj 15.2 Tambon Rong Chang
16. Ban Phraek	16.1 Tambon Ban Prek
Total	34

e.1.2. Issues

- The Local Administration (LA) which shoulders the local administration has personnel and financial vulnerabilities.
- The administrative scale of Orbortor is too small.
- Tassaban /Orbortor and Orborjor do not cooperate closely enough.
- Using the general subsidies from the central government is subject to approval by the Provincial Governor or Chief of Amphoe.
- The budget of LAs is low in comparison with central government budget.
- General subsidies to LAs are distributed according to relative population.

e.1.3. Measures to be Taken

- The central government strengthens LAs.
- Advocate integration of LAs.
- Clarify the areas of jurisdiction, which are beyond the capacity of an Orbortor to administer, and grant these areas to Orborjor.
- Raise the ratio between local budget and national budget.
- Distribute specific subsidies to LAs based on policy of the national EQMP.

e.2 Public Health

The public health service in AYP is summarized in the following table:

Table 4-11: Type of Public Health Service and Staff

Type of Public Health Service/Staff	Unit	Year		
		2003	2004	2005
State Hospital	Hospital	16	16	16
	Bed	993	993	1,015
Private Hospital	Hospital	3	3	3
	Bed	-	-	-
Health Station	Station	206	206	206
Doctor	Person	252	252	145
Dentist	Person	43	43	45
Pharmacist	Person	82	82	74
Nurse	Person	1,077	1,077	1,104
Public Health Officer	Person	1,362	1,362	1,543

e.3 Utilities System

e.3.1. Electricity

In fiscal year 2005 there were 17 electricity stations serving residents, business and industry, government agencies and public sector. The total number of users was 192,697 and total consumption was 4,113.122 million kWh.

e.3.2. Water supply

In fiscal year 2005 groundwater was used as source for the public water supply serving customers in Phra Nakhon Si Ayutthaya, Tha Rue, Bang Pa-in, Phak Hai, Phashe, Wang Noi, Sena and U-thai Districts. Total production was 21,033,055 cubic meters and 45,143 customers were served¹.

e.4 Labor

- Total labor force 385,008 persons
- Persons with jobs 378,077 persons (98.20%)
- Jobless persons 6,931 persons (1.80%)
- Ratio of working to jobless 54.55 : 1

e.5 Group/Organization/Network

Table 4-12: Number and Percent of Group/Organization/Network of Social Sector

Type of Group/Organization/Network	Number	Percent (%)
Field of Occupation	3	9.7
Field of Public Health	10	32.2
Field of Education	5	16.1
Field of Community Development	6	19.3
Field of Natural Resources and Environment	3	9.7
Field of Disaster	4	13.0
Other Field (specify)	-	
Total	31	100.0

Year: 2006

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

Natural Resources

a. Soil and Land Resources

a.1 Situation

AYP is located in the fertile delta of the Chao Phraya River basin and central plains formed by the surrounding alluvial cone. Areas with irrigation facilities are expanding in Thailand's old agricultural center, and more than 80% of the surface area is used for agriculture. Average elevation in this province is four meters above sea level, which makes flooding during the rainy season the biggest problem of this province.

The following table shows land use in AYP based on a satellite image taken on December 13th, 2005.

¹ Source: Provincial Statistic Report Year 2006

Table 4-13: Land Use in AYP based on Satellite Image from December 13th, 2005

Land Utilization	Area(km ²)	percentage
City, Town, Commercial and Services	44.81	1.8
Villages	142.83	5.6
Industrial	41.37	1.6
Paddy Field	2,076.24	81.6
Mixed Plantation	68.95	2.7
Aquaculture Area	12.71	0.5
Forest Plantation	4.36	0.2
Natural Water Bodies	39.12	1.5
Reservoirs – Built-up	19.71	0.8
Rangeland	47.50	1.9
Wetland	46.50	1.8
Others	1.92	0.1
Total	2,546.00	100.0

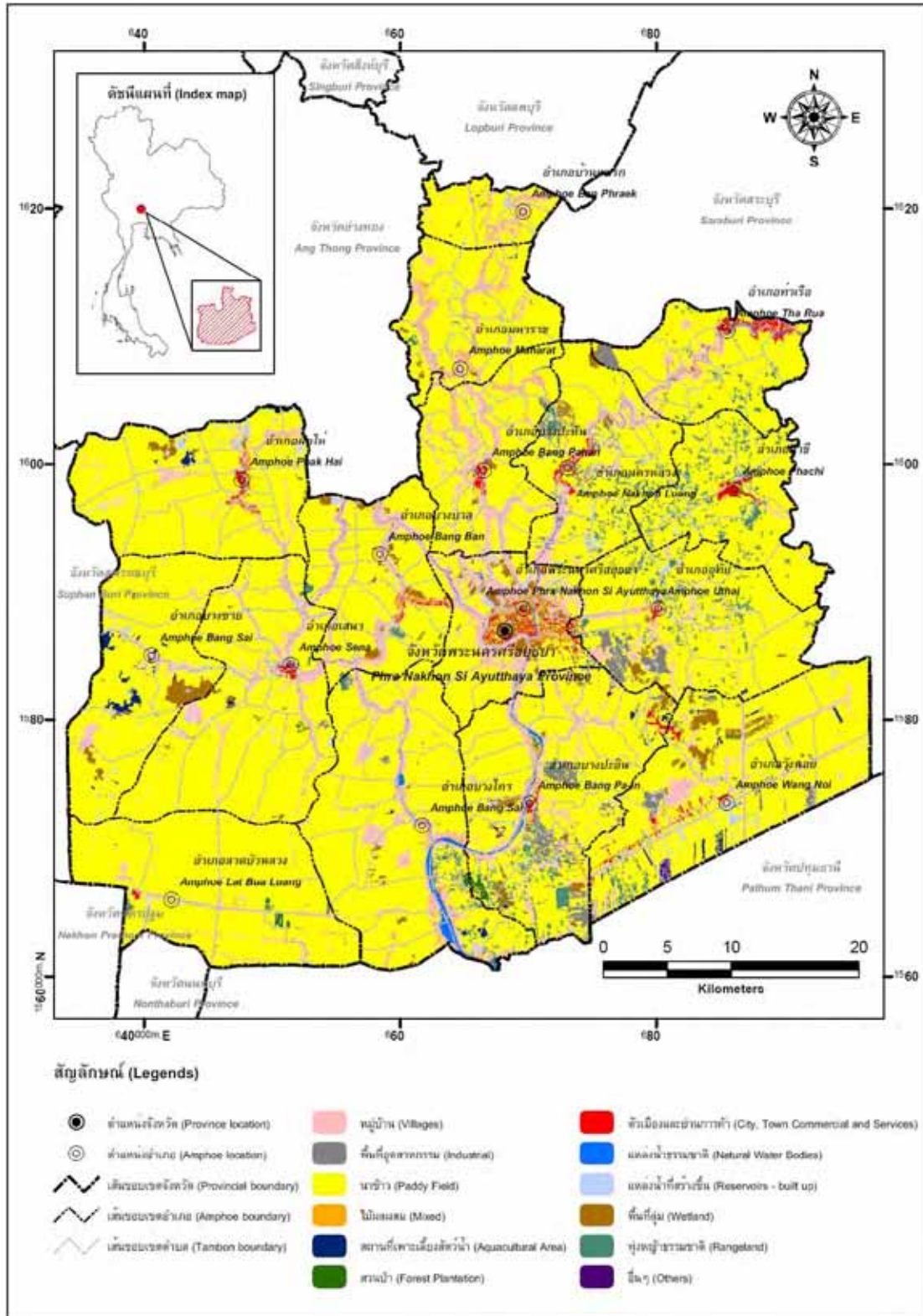


Figure 4-11: Land Use Map based on SPOT Satellite Image from 2005
Changes in land use in AYP from 1988 to 2007 are shown in Table 4-14.

Table 4-14: Changes in Land Use in AYP from 1988 to 2007

Land use	Area (km ² .)			Percentage (%)		
	1988	1998	2007	1988	1998	2007
Urban and Built-up Land	170.81	170.79	219.18	6.7%	6.7%	8.6%
Agricultural Land	2,228.39	2,219.11	2,222.85	87.4%	87.1%	87.2%
Aquaculture Area	6.60	12.38	14.08	0.3%	0.5%	0.6%
Forest Plantation	6.07	8.09	4.06	0.2%	0.3%	0.2%
Water Body	39.61	39.39	42.61	1.6%	1.5%	1.7%
Wetland/Rangeland	95.99	91.41	39.18	3.8%	3.6%	1.5%
Extraction (soil pits/sand pits)	1.37	7.68	6.88	0.1%	0.3%	0.3%
Total	2,548.84	2,548.84	2,548.84	100%	100%	100%

1) Urban and Built-up Land

There was no increase of urban and built-up land from 1988 to 1998, but a significant increase was observed from 1998 to 2007; around 50 km² was converted to urban and built-up area in the last 10 years. According to the land use map, development of industrial sites was the main factor of increase.

2) Agricultural Land

This is the biggest use of land in AYP with over 87% of land used for agricultural purposes. This percentage has shown no change since 1988.

3) Aquaculture Area

The area doubled from 1988 to 1998 as new aquaculture land was developed near the border to Pathum Thani Province. There was a slight increase from 1998 to 2007, but the area dedicated for this purpose in all AYP amounted to less than 1 percent.

4) Forest Plantation

There are very small forested areas in AYP but their size is merely 0.2 to 0.3% of the entire province. The biggest forest plantation is located in Amphoe Bang Sai. Forest cover decreased by half from 1998 to 2007.

5) Water body

There is no significant change observed in the area.

6) Wetland and Rangeland

There was a big change from 1998 to 2007 and the area decreased to less than half its previous size. As indicated on the 1988 land use map, there were expansive wetlands in Amphoe Phachi and Uthai, but the area shrunk and were converted to agricultural land.

7) Extraction

There was a significant increase from 1988 to 1998 but extraction areas have been stable from 1998 to 2007. Extraction pits were created to supply construction materials.

a.2 Impact Analysis

a.2.1. Result of Opinion Survey

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

Table 4-15: Result of Opinion Survey on Soil and Land Resources

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	35%	28%	24%	13%	0	0	100%
Resident	62%	8%	5%	4%	21%	0	100%
BE	5%	7%	3%	6%	23%	56%	100%

According to the opinion survey, 70% of the residents and 63% of LAs considered that problems with soil and land resources are not serious or not very serious.

The LAs and residents, who replied that problems were very serious, specified the following aspects and reasons for their concern. It is clear that the agricultural sector was of highest concern with respect to soil and land resources.

Table 4-16: Specific Aspects and Reasons for Concern about Soil and Land Resources

	Aspects of Concern	Reasons for Concern
LAs	Cargo ships on the river	Erosion of riverbank
	Sand mining and top soil digging	Loss of fertile soil
	Quality of soil	Low agricultural production
Residents	Low quality of soil	Soil is not proper for agriculture
	Too much urban development	Loss of agriculture area
	Dig top soil for sale	Loss of fertile soil
	Use of chemical substances	Loss of fertile soil

a.2.2. Impact

According to the changes in land use in AYP from 1988 to 2007 as shown in Table 4-14, the total “wetland and rangeland” area has decreased from 3.8% in 1988 to 1.5% in 2007, less than half of its former size, while an area of same size has been converted to “urban and built-up land”. Also, although the proportion is small, the extraction area for soil/sand increased fivefold and the area used for aquaculture doubled from 1988 to 2007. These facts indicate that:

- Urban and built-up land will increase while natural areas like wetland and rangeland will decrease further through extraction of soil and sand.
- “Wetland and rangeland” are the only remaining natural areas in AYP, and these areas also contribute to the mitigation of flood damage. Their decrease indicates a degradation of natural resources and loss of nature’s flood mitigation function.

Deterioration of soil is pointed out by LAs and residents according to the opinion survey. It may occur for the following reasons:

- Continuous overuse of chemical fertilizer.
- Salt damage to soil from ocean water invading groundwater due to overdrawing of groundwater by industries.

a.3 Issues

The following issues were identified through discussions with relevant personnel working in NREM in AYP:

- Decrease of natural areas such as “wetland and rangeland” and active extraction of soil/sand.
- Deterioration of soil quality.
- Erosion of river and canal embankments, and sedimentation of eroded soil in river and canal beds.

a.4 Measures to be Taken

- Promotion of appropriate land use in consideration of both environmental protection and social and economic activities.
- The understanding of benefits from proper land use and soil conservation shall be disseminated to the residents.
- Develop a standard for groundwater usage to control overpumping.
- Protection of riverbanks such as protection of slopes.

b. Forest Resources and Wildlife

b.1 Forest Resources

b.1.1. Situation

There are no forest resources in AYP according to the definition in the Forest Act of 1941.²

Generally in Thailand, there has been no legal logging of natural forests since 1989 because all concessions were revoked. In recent years, forest cover throughout Thailand is stabilizing.

b.1.2. Impact Analysis

Number of Complaints

There are no complaints relating to forest resources.

Result of Opinion Survey

None of the stakeholders considered that forest resources are facing serious problems.

Impact

At this moment there is no impact associated with forest resources in AYP. But there are limited green areas in towns as a result of poorly planned urban environment.

b.1.3. Issues

- Green areas in towns need to be increased.

b.1.4. Measures to be Taken

- Support for increasing green spaces in urban areas.

b.2 Wildlife Resources

There are no habitats for wildlife resources in AYP such as national parks, wildlife sanctuaries and so forth.

² Article 4 of the Act says “Forest” means land which no one owns in accordance with land law.

c. Water Resources

c.1 Situation

Most of AYP is located in the Chao Phraya River Basin, and most of the western part of AYP is located in the Tha Chin River Basin. Connecting to the Chao Phraya River further upstream is the Sakae Krang River, in whose basin the northern part of AYP is located. The Chao Phraya, Tha Chin and Sakae Krang River Basins cover a catchment area of 39,998 km² (24.37 million rai). These are the major basins among the eight river basins of Thailand, namely the Ping, Wang, Yom, Nan, Chao Phraya, Sakae Krang, Pasak and Tha Chin River Basins, with an area of 157,925 km². A large number of water resources and irrigation systems have been developed in the Chao Phraya River Basin and its sub-basins, which totals an irrigated area of 11.76 million rai (59.3% of the agricultural area) and an agricultural area of 19.84 million rai (81.4% of the river basin area).

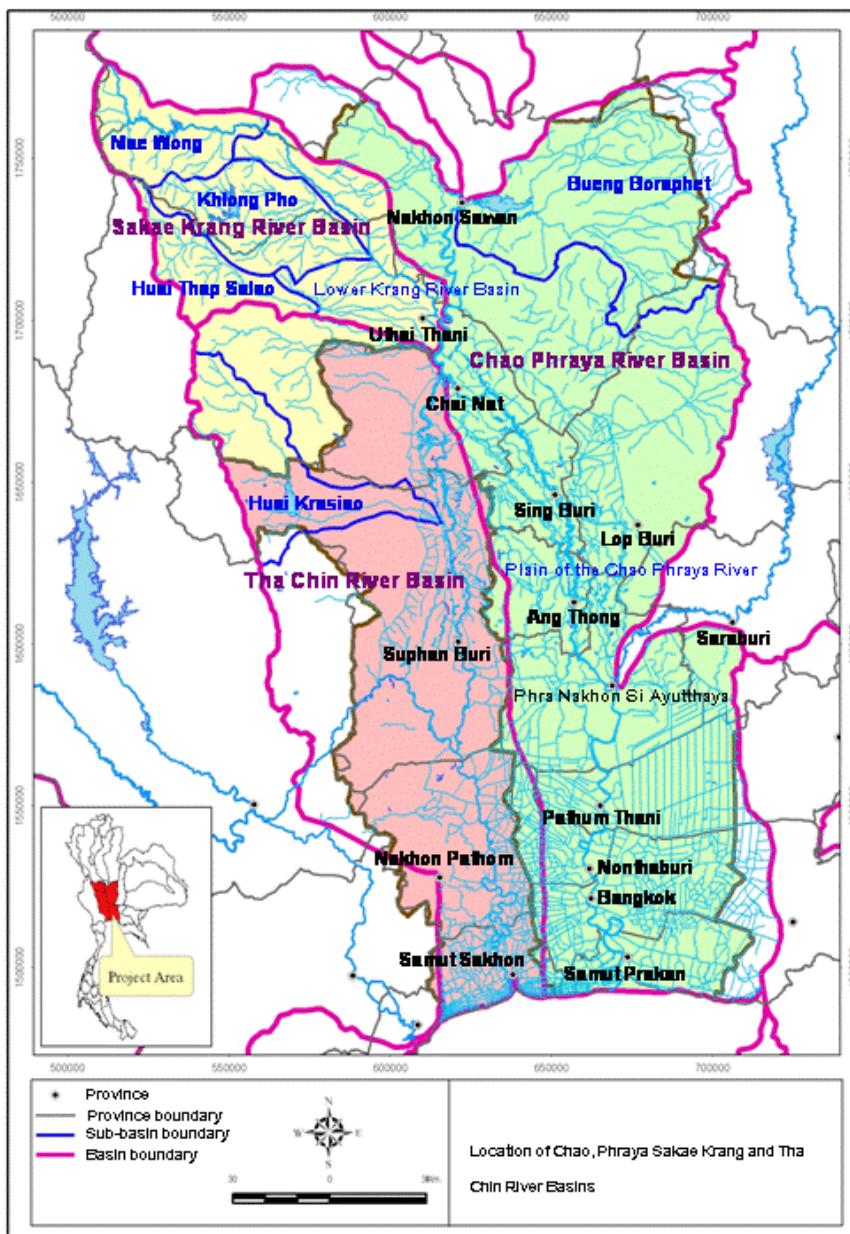


Figure 4-12: Chao Phraya, Tha Chin, and Sakae Krang River Basins

c.1.1. The Chao Phraya River

The Chao Phraya River starts at the confluence of the Ping and Nan Rivers in Nakhon Sawan Province (Pak Nam Pho Sub-district, Mueang District). Its main sub-basin is Bueng Boraphet. The upper eastern part in Nakhon Sawan and Lop Buri Provinces features a plateau with a hillock while the lower eastern part is made up of inland and coastal plains, situated in Samut Prakan Province. The western area is a plain connecting to the Tha Chin River Basin. The Chao Phraya River is the main river of the Chao Phraya basin. Its main tributaries include: 1) the **Noi River**, which diverges from the Chao Phraya River in Chai Nat Province and converges with the Chao Phraya River again in AYP, 2) the **Tha Chin River**, which diverges from the Chao Phraya River and flows parallel with it and then discharges into the Gulf of Thailand, and 3) **Khlong Bang Kaew**, which is a short canal diverging from the Chao Phraya River in Ang Thong Province and converging with the **Lop Buri River**, which diverges from the Chao Phraya River in Sing Buri Province and then converges with the Chao Phraya River in Maha Rat District, AYP before discharging into the sea in Samut Prakan Province.

c.1.2. The Sakae Krang River

The Sakae Krang River originates in the Mokochu mountain range. Its important tributaries include the **Nam Mae Wong, Huai Khlong Pho and Huai Thap Salao** and the lower part of **Mae Nam Sakae Krang**. Nam Mae Wong passes through Mae Wong and Lat Yao Districts, Nakhon Sawan Province and then converges with Huai Khlong Pho, which comes from the mountain range at the border between Nakhon Sawan and Uthai Thani Provinces at Sawang Arom District, Uthai Thani Province, where it is named the Tak Daet River. The Tak Daet River then converges with Huai Thap Salao in Thap Than District before entering Mueang District in Uthai Thani Province and flows along Sakae Krang Mountain, where it is re-named **Sakae Krang** before flowing into the Chao Phraya River upstream of Chao Phraya Dam in Manorom District, Chai Nat Province.

c.1.3. The Tha Chin River

The Tha Chin River diverges from the right side of the Chao Phraya River in Makham Thao Sub-district, Wat Sing District, Chai Nat Province. Its main sub-basin is the Huai Krasiao, which flows through Suphan Buri and Nakhon Pathom Provinces and discharges into the Gulf of Thailand in Samut Sakhon Province. The Tha Chin River is known by different names from origin to estuary, as follows: the **Khlong Makham Thao, Suphan Buri, Nakhon Chai Si, and Tha Chin Rivers**, respectively.

c.1.4. Basin and Sub-basins

The boundary of the Chao Phraya, Sakae Krang and Tha Chin is shown in Figure 4-12. According to the Department of Water Resources, AYP is an area within the Chao Phraya River Basin, which is defined as follows:

Table 4-17: River Basin and its Sub Basin

River basin	Catchment area (km ²)	Sub-basin	Number of provinces
1. The Chao Phraya River Basin	20,125 (12.58 million rai)	1) Bueng Boraphet 2) Mae Nam Chao Phraya Plain Area	11

c.1.5. Rainfall and Runoff

Rainfall

The average annual rainfall is as follows:

Table 4-18: Rainfall in the Chao Phraya River Basin

River basin	Range of rainfall (mm)	Average annual rainfall (mm)	Province	
			Low rainfall	High rainfall
The Chao Phraya River Basin	700-1,500	1,076	Lop Buri	Bangkok

Runoff

The average annual runoff is as follows:

Table 4-19: Runoff of the Chao Phraya River Basin

River basin	Catchment area (km ²)	Average annual runoff		Annual runoff (MCM)		Percentage of total runoff (%)	
		(MCM)	(mm)	Wet season	Dry season	Wet season	Dry season
The Chao Phraya River Basin	20,125	1,732	86	1,645	87	95	5

MCM: Million Cubic Meters

c.1.6. Groundwater

Most of AYP is located in Lower Chao Phraya River Basin, which is the largest and most important groundwater source of Thailand. Unconsolidated aquifers and hard-rock aquifers are found in the area. The annual average amount of water absorbed into groundwater sources of the Chao Phraya River Basin is 1,517 MCM.

Groundwater use amount and potential of the Chao Phraya River Basin is as follows:

Table 4-20: Balance of Groundwater

Unit: MCM/year

Item	Chao Phraya River Basin
Groundwater Source	1,517
1. Groundwater Use	936
Water supply of private groundwater wells and shallow wells	255
Industry	214
Agriculture	466
2. Potential	581

c.1.7. Main Rivers and Canals in AYP

Ayutthaya province is abundant with water resources. There are four main rivers, the Chao Phraya River, Pasak River, Lop Buri River and Noi River.

- **Chao Phraya River** starts from Pak Nam Pho in Nakhon Sawan Province and passes Chao Phraya Dam in Chai Nat Province, Singha Buri Province, Ang Thong Province and enters AYP in the Bang Bal District. Then, the river is divided into two branches. The first branch passes Bang Bal District at a distance of about 26 km. The second branch passes Bang Bal District, Phra Nakhon Si Ayutthaya District and Bang Pa-in

District at a distance of 55 km. The two branches of the river come to meet again at Bang Sai district, AYP.

- **Pasak River** originates in Phetchabun Province and passes Chai Badal District in Lop Buri Province, Kang Koi District and Sao Hai District in Sara Buri Province, Tha Rue District and Nakhon Luang District in AYP. It meets the Chao Phaya River at Pom Phet Sub-district, Phra Nakhon Si Ayutthaya District, AYP. The total distance of the Pasak River that passes through AYP is about 52 km.
- **Lopburi River** starts from Muang Moo Sub-district, Muaeng District in Singha Buri Province and passes Ban Prak District, Maharat District, Bang Pahan District and Phra Nakhon Si Ayutthaya District. It meets with Pasak River at Dong Poo Temple in Phra Nakhon Si Ayutthaya District, covering a total distance of about 85 km.
- **Noi River** starts from Chao Phaya River at Boram That water gate and passes Chainat Province, Singha Buri Province, Ang Thong Province and enters AYP in Pak Hai district. The total distance covered is about 27 km. It meets the Chao Phaya River in Bang Sai District.

Moreover, natural and artificial waterways interconnect the rivers, forming an extensive network of rivers and canals throughout the entire province providing water transportation and irrigation. These canals include the Bang Bal, Bang Luang, Maharat, Bang Kaew and Bang Phra Khru canals.

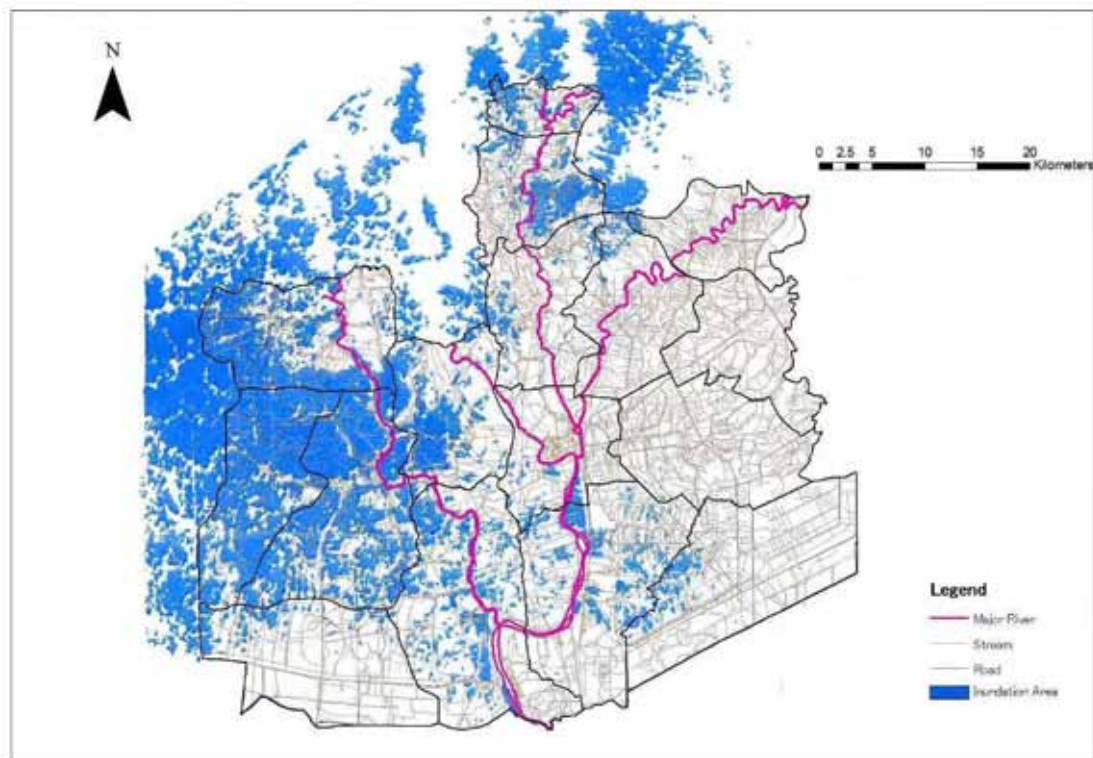


Figure 4-13: Main Rivers/Canals and Flood Disaster Area in AYP (2006)

c.1.8. Wells

AYP is located in the Lower Chao Phraya Basin, an area in Thailand where the rich groundwater supply traditionally played an important part. The following figure shows the location of wells and their depth.

According to the figure shown below, deep wells with a depth of more than 200 m are located in the southern part of AYP while shallower wells with a depth of less than 200 m are located in central AYP.

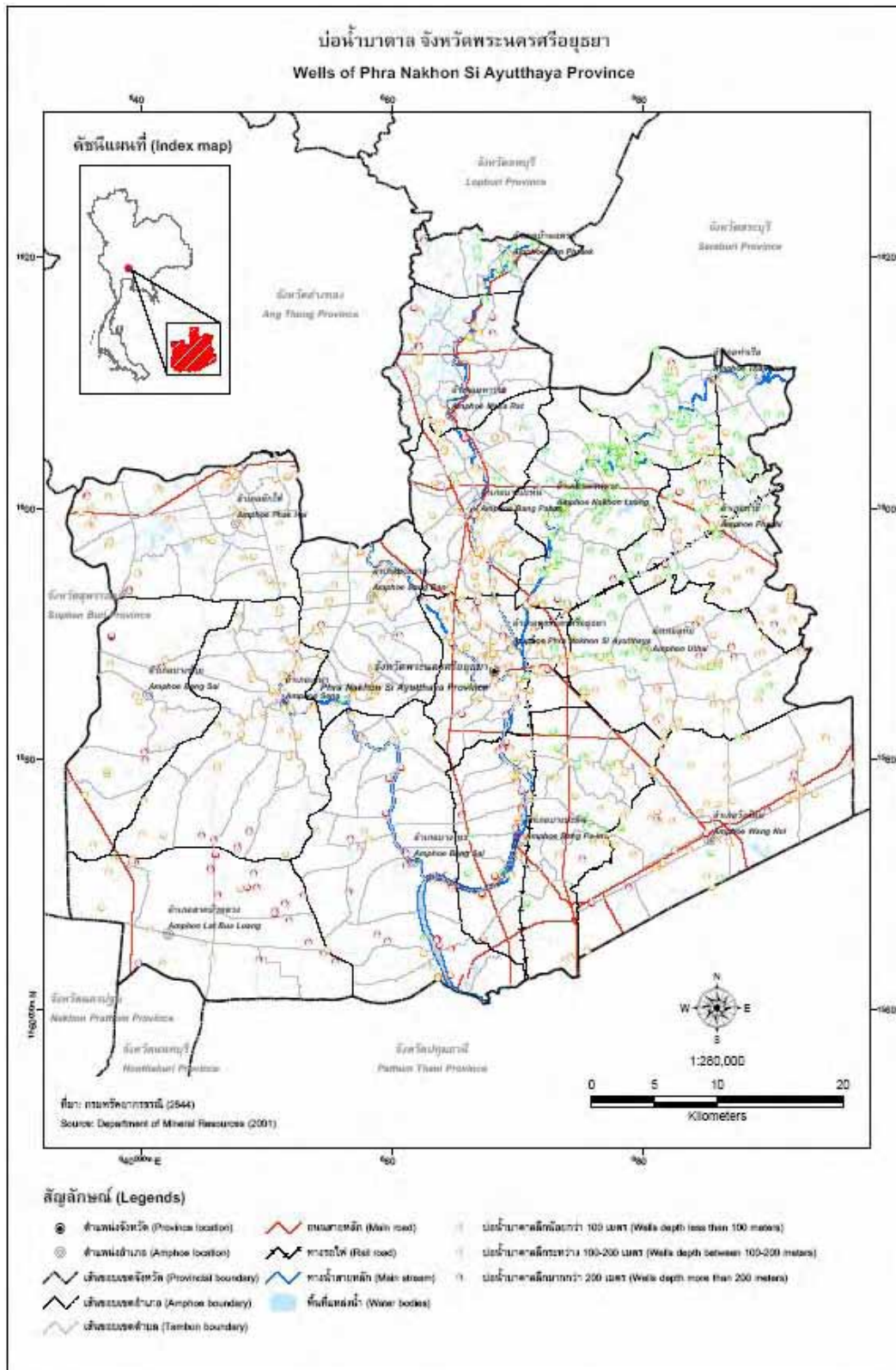


Figure 4-14: Location of Wells and their Depth

c.2 Impact Analysis

c.2.1. Number of Complaints

There has been an increase in the number of complaints regarding water. In 2003 there were only two such complaints, but this increased to 14 in 2006. This number is around one third of all complaints the PEO received regarding the environment.

Most complaints are about untreated wastewater from households followed by complaints about pumping water from sand or soil pits.

Table 4-21: Number of Complaints to PEO Regarding Water (AYP)

Year	Total No of Complaints on Environment	No of Complaints on Water	%
2003	7	2	28.6
2004	14	5	35.7
2005	30	11	36.7
2006	42	14	33.3

Source: PEQMP-KPI 2007

c.2.2. Result of Opinion Survey

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

Table 4-22: Result of Opinion Survey on Water Resources

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	7%	15%	24%	54%	0%	0%	100%
Resident	31%	15%	15%	38%	1%	0%	100%
BE	38%	14%	11%	34%	0%	0%	100%

Source: JICA study in 2007

According to the opinion survey, 53% of the residents, 78% of LAs and 45 % of the Business Enterprises (BEs) considered that there are very serious or somewhat serious problems regarding water resources.

The LAs, residents and business entities, who replied that problems were very serious, specified the following aspects and reasons for their concern. Everybody specified that flood is the main aspect of the problem with water resources in AYP.

Table 4-23: Specific Aspects and Reasons for Concern about Water Resources

	Aspects of Concern	Reasons for Concern
LAs	Flood	Loss of agricultural area and property
Residents	Flood	Obstacle for transportation Loss of agriculture areas and property
BEs	Flood	Obstacle for transport and agriculture

c.2.3. Impact

According to the opinion survey, LAs, residents and Business Enterprises replied that the most serious problem with regard to NREM in AYP is flood management, which is part of water resources management. Floods cause “Loss of Agricultural Land and Property” and “Disruption of Transportation”.

AYP suffered considerable damage caused by floods as shown in the table below according to the Office of Disaster Prevention and Mitigation of MOI in AYP.

Table 4-24: Flood Damage in AYP

Year	Number of People Affected	Deaths	Damaged Homes	Affected Agriculture Area (rai)
2006	378,891	70	10,252	303,507
2007	50,140	7	1,879	42,432

c.3 Issues

- Floods caused by high water levels of the four main rivers are the biggest NREM issue.
- Natural and artificial canals are not well maintained.

c.4 Measures to be Taken

- Comprehensive provincial flood prevention and mitigation plans should be formulated.
- Rehabilitation and improvement of natural and artificial canals in order to ensure efficient in- and outflow of water.
- Support the activities for removing water hyacinth growth.

d. Mineral Resources

d.1 Situation

Soil is an abundant resource in AYP due to its availability as deposited soil in the delta basin. Soil types in AYP consist of muddy soil (which is the main soil type in AYP), sand, sandy soil, etc. Sand is supplied as building material to construction sites. No other mineral resources are noteworthy. There are number of “borrow pits” for soil and sand in AYP as shown in the figure below.

d.2 Impact Analysis

- Since many of the excavated pits are used as waste disposal sites without proper protective measures, they have adverse impact on the surroundings.
- The neighboring areas can also be affected by landslides.

d.3 Issues

- Usage of excavated pits after extracting soil and sand is a major environmental issue because many of the holes are used as waste disposal sites without proper protective measures.

d.4 Measures to be Taken

- Evaluate and approve appropriate development plans for “borrow pit” sites. Monitor their current and future use.

e. Marine and Coastal Resources

AYP is an inland province and there are no marine and coastal resources.

f. Biodiversity

f.1 Situation

Thailand has a wide range of biological diversity, and has a plentitude of forest resources and wildlife because it is positioned at a unique crossroads of three main floristic regions namely: Indo-Himalaya, Indo-china, and Malaysia. This is also thanks to Thailand's diverse environment with varying climates from tropical-wet in the lower southern peninsula to seasonal in the north, and altitudes from zero to 2,565 m.

In AYP, there is a bird sanctuary of national importance located at Wat Tan En Temple in Bang Pahan District. It can be reached by taking highway #32 (Asia highway) and turning into highway #3196 (Bang Pahan – Ban Phraek – Lopburi). After about 5 km the entrance to the temple is on the right. The sanctuary houses many big bats and numerous water birds including teals and herons. It is a pleasant, tranquil environment, including an irrigation canal which is home to a variety of fish.

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

f.1.1. Birds

According to "Thailand Red Data: Birds" published by ONEP in 2005, there is one species of bird **Extinct in the Wild (EW)**, one **Critically Endangered (CR)**, seven **Endangered (EN)**, seven **Vulnerable (VU)**, and thirteen **Near Threatened (NT)** in and around AYP as shown in Table 4-25.

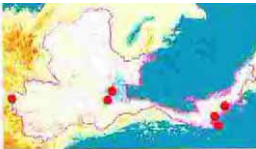



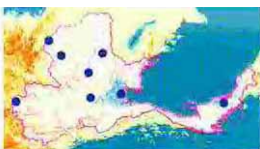

f.1.2. Fish



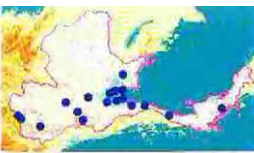



There is one **Endangered (EN)**, and five **Endemic** species of fish in and around AYP as shown in Table 4-26.

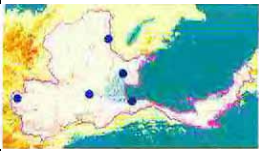

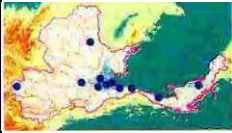

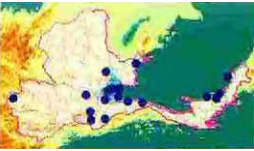

f.1.3. Mammals, Reptiles and Amphibians

There is one species of mammal **Near Threatened (NT)**, one reptile species **Near Threatened (NT)** and fifteen listed under **Least Concern (LC)**, two amphibians **Near Threatened (NT)** and nineteen listed under **Least Concern (LC)** in and around AYP as shown in Table 4-27.

Table 4-25: Red Book Data: Birds in AYP

No	Status	Scientific name	Common name	Thai name	Habitat	Site	
1	EW	<i>Pseudibis davisoni</i>	White-shouldered Ibis	นกช้อนทองดำ	Pools and Marshy areas in open forest		
2	CR	<i>Mycteria cinerea</i>	Milky Stork	นกกระสาปากเหลือง	Tidal mudflats, mangrove, marshy areas in open country		
3	EN	<i>Aythya baeri</i>	Bare's Pochard	เป็ดดำหัวดำ	Lakes, large river, pool, up to 400m		
No	Status	Scientific name	Common name	Thai name	Habitat	Site	

4	EN	<i>Milvus migrans</i>	Black Kite	เหยี่ยวดำ	Open country, cultivated areas, marshes		
5	EN	<i>Aquila clanga</i>	Greater spotted Eagle	นกอินทรีปีกลาย	Open country, cultivation, often favours marshy areas.		
6	EN	<i>Anhinga melanogaster</i>	Oriental Darter	นกฮ้ำงจ้าว	Lakes, large rivers, up to 800m		
No	Status	Scientific name	Common name	Thai name	Habitat	Site	

7	EN	<i>Phalacrocorax carbo</i>	Great Cormorant	นกทมิฬใหญ่	Various wetlands, fresh and salt water		
8	EN	<i>Treskiornis melanocephalus</i>	Black-headed Ibis	นกช้อนทองขาว	Marshy wetland, mudflats, mangrove, sometime coastal lowland		
9	EN	<i>Pelecanus philippensis</i>	Spot-billed Pelican	นกกระทุง	Lake, large rivers		

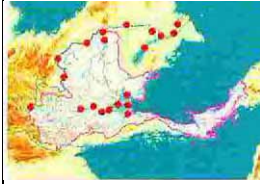

No	Status	Scientific name	Common name	Thai name	Habitat	Site
10	VU	<i>Anas formosa</i>	Baikal Teal	เป็ดชานันท์เหลือง	Freshwater lake	Very rare winter visitor, recorded

11	VU	<i>Aythya nyroca</i>	Ferruginous Pochard	เป็ดหัวสีน้ำตาล	Freshwater lake	from N and S Regularly overwintering in NW, NE, and C
12	VU	<i>Columba punicea</i>	Pale-capped Pigeon	นกคolumพุแดง	Various forests, up to 1,400m.	Rare winter guest and passage migrant throughout the country, frequent seen along coasts.
13	VU	<i>Vanellus duvaucelii</i>	River Lapwing	นกกระเต้เทา	Large river and surroundings.	Uncommon resident throughout in suitable habitats, threatened by human persecution.
14	VU	<i>Rynchops albicollis</i>	Indian Skimmer	นกกรีดน้ำ	Lake, large river, rarely coasts.	Historically recorded in NW, now very rare visitor in C and W.
15	VU	<i>Mycteria leucocephala</i>	Painted Stork	นกท้าวบัว	Marshy areas	Uncommon resident and winter visitor in NE, W, C, and S.
16	VU	<i>Rhinomyias brunneata</i>	Brown-chested Jungle-Flycatcher	นกกับแครงอกสีน้ำตาลอ่อน	Evergreen forest, up to 1,000 m.	Rare passage migrant in W, C, and S.
17	NT	<i>Coturnix coromandelica</i>	Rain Quail	นกขมิ้นอกค้า	Grassland, cultivation	Uncommon resident in NW, W, NE, C, and SE.
18	NT	<i>Dryocopus javensis</i>	White-bellied woodpecker	นกหัวขวานใหญ่สีดำ	Deciduous forest, evergreen forest, mangrove.	Uncommon resident throughout, now much reduced due to habitat destruction.
19	NT	<i>Mulleripicus pulverulentus</i>	Great Slaty Woodpecker	นกหัวขวานใหญ่สีเทา	Mixed deciduous forest, evergreen forest	Uncommon resident throughout, threatened by habitat destruction
20	NT	<i>Buceros bicornis</i>	Great Hornbill	นกกา นกกาฮัง	Mixed deciduous forest, up to 1,525 m.	Uncommon resident throughout, now much reduced due to habitat destruction.
21	NT	<i>Aceros undulatus</i>	Wreathed Hornbill	นกเงือกสามข้าง	Mixed deciduous forest, evergreen forest	Uncommon resident throughout, threatened by habitat destruction.
22	NT	<i>Tyto alba</i>	Barn Owl	นกเค้า	Urban and open areas, cultivations	Uncommon resident throughout, threatened by human persecution.
23	NT	<i>Treron bicaincta</i>	Orange-breasted Green Pigeon	นกเป็ดสีออกสีม่วงน้ำตาล	Beach forest, various dry open forest	Uncommon resident in NE, W, C, SE, and S.
24	NT	<i>Treron pompadora</i>	Pompadour Green Pigeon	นกเป็ดสีหน้าเหลือง	Evergreen forest, up to 800 m.	Uncommon to rare resident in NW, NE, W, C, and SE.
25	NT	<i>Ducula aenea</i>	Green Imperial Pigeon	นกขุนพู	Island forest, Evergreen forest	Uncommon resident throughout, much reduced.

26	NT	<i>Rallina eurizonoides</i>	Slaty-legged Crane	นกอินทรีมีปากยาว	Wet areas in forest	Uncommon to rare in NW, NE, W, C, and S. Status uncertain.
27	NT	<i>Gallinix cinerea</i>	Watercock	นกอินทรี	Freshwater marshes, rice paddies.	Uncommon resident and breeding visitor throughout, very much reduced by hunting pressure.
28	NT	<i>Numenius madagascariensis</i>	Eastern Curlew	นกอินทรีทะเลปากน้ำตาล	Coastal mudflats, sandflats	Rare winter visitor and passage migrant C, W(s), S.
29	NT	<i>Burhinus oedicephalus</i>	Eurasian Thick-knee	นกกระแตที่เล็ก	Dry open areas, cultivations	Uncommon resident and winter visitor in NW, NE, W, and C.
30	NT	<i>Vanellus cinereus</i>	Grey-headed Lapwing	นกกระแตหัวเทา	Marshes, wet paddies	Uncommon visitor throughout.
31	NT	<i>Glareola lactea</i>	Small Pratincole	นกเขินทุ่งเล็ก	Large river, dry lake margins	Uncommon resident and non-breeding visitor in NW, NE, C, and W(s).
32	NT	<i>Aviceda jerdoni</i>	Jerdon's Baza	เหยี่ยวกิ่งก้าน้ำตาล	Evergreen forest, up to 1,700 m.	Uncommon resident throughout.
33	NT	<i>Gyps himalayensis</i>	Himalayan Griffon	อินทรีสีน้ำตาลหินลี้	Open country, lowlands	Rare passage migrant and winter visitor, recorded from NW, W(s), C, and S, threatened by hunting pressure.
34	NT	<i>Aegypius monachus</i>	Cinereous Vulture	อินทรีดำหินลี้	Open country, lowlands	Rare passage migrant and winter visitor, recorded from NW, W(s), C, and S, threatened by hunting pressure.
35	NT	<i>Ictinaetus malayensis</i>	Black Eagle	นกอินทรีดำ	Evergreen forest, 800-2,565 m.	Uncommon resident throughout, now very much reduced by habitat destruction.
36	NT	<i>Hieraetus kienerii</i>	Rufous-bellied Eagle	เหยี่ยวท้องแดง	Evergreen forest	Uncommon resident throughout.
37	NT	<i>Phalacrocorax fuscicollis</i>	Indian Cormorant	นกปากน้ำเขียว	Freshwater wetlands	Uncommon local resident in C and NE.
38	NT	<i>Gorsachius melanolophus</i>	Malayan Night-Heron	นกยางกลางเสือ	Wetlands in forest	Uncommon resident and breeding visitor throughout.
39	NT	<i>Terpsiphone atrocaudata</i>	Japanese Paradise-flycatcher	นกเขาสวรรค์หางดำ	Evergreen forest, migrants in various	Rare passage migrant, recorded from W, C, SE, and S.

					habitat	
40	NT	<i>Muscicapa williamsoni</i>	Brown-streaked Flycatcher	นกจับแมลงสีน้ำตาลท้องลาย	Evergreen forest	Uncommon resident in W, C, and S.
41	NT	<i>Gracula religiosa</i>	Hill Myna	นกขุนทอง	Mixed deciduous forest, evergreen forest	Fairly common resident throughout, threatened by bird trade.
42	NT	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	นกปรอดหัวโขน	Secondary growth, open areas	Common resident throughout, very much reduced and possibly extirpated from southern peninsular, threatened by bird trade.
43	NT	<i>Ploceus hypoxanthus</i>	Asian Golden Weaver	นกกระจ่างทอง	Marshes, rice paddies, grassland near water	Uncommon resident in NE, W(s) and C, much reduced by human persecution.
44	NT	<i>Ploceus manyar</i>	Steaked Weaver	นกกระจ่างนอกลาย	Marshes, rice paddies, grassland	Uncommon resident in NW and C, much reduced by human persecution.
45	NT	<i>Ploceus philippinus</i>	Baya Weaver	นกกระจ่างบริเวณเตา	Marshes, rice paddies, grassland	Common resident throughout, very much reduced by human persecution and bird trade.
46	NT	<i>Amandava amandava</i>	Red Avadavat	นกกระจาดสีแดง	Marshes, rice paddies, grassland	Common resident throughout, very much reduced by human persecution and bird trade.
47	NT	<i>Erythrura prasina</i>	Pin-tailed Parrotfinch	นกกระจาดเขียว	Bamboo, evergreen forest up to 1,500 m.	Uncommon resident throughout.

Table 4-26: Red Book Data: Fishes in AYP

No	Status	Scientific name	Common name	Thai name	Habitat	Site
1	EN	<i>Himantura chaophraya</i>	Giant Stingray	กระเบนราหู, กระเบนน้ำจืดยักษ์	Carnivorous, fishes and crustacean, mainstreams to estuaries. Uncommon foodfish in the markets. Overfishing.	 

No	Status	Family	Scientific name	Thai name	Habitat	Site
2	Endemic	Cyprinidae	<i>Thryssocypris sp. 1</i>	จิ้งกาะดัก	Mainstream river	Chao Phraya Basin
3	Endemic	Cyprinidae	<i>Cyclocheilichthys lagleri</i>	ไล่ต้น	Stream, marshland	Chao Phraya River
4	Endemic	Cobitidae	<i>Acanthopsis thiemethdi</i>	รากถั่ว	Hillstream	Chao Phraya, Meklong Basin
5	Endemic	Schilbidae	<i>Platytrapius siamensis</i>	สาบ, หัวปลี, เตด	Mainstream, marshland	Chao Phraya- Bangkok Basin
6	Endemic	Phallostethidae	<i>Neostethus siamensis</i>	ปูโต	Estuaries	Chao Phraya Basin

Source: Vidthayanon, C., (2005). Thailand Red Data: Fishes. ONEP, Thailand

Table 4-27: Red Book Data: Mammals, Peptiles, and Amphibians in AYP

MAMMALS

Status NT: Near Threatened

Scientific Name	Common Name	Thai Name	Habitat	Site
1 <i>Pteropus lylei</i>	Lyle's Flying Fox	ค้างคาวแม่ไก่ภาคกลาง	Around human dwelling and temples	Bangkok, Chachoengsao, Anghong, Nakhon Nayok, Chon Buri, Suphan buri, Phra Nakhon Si Ayutthaya (Wat Tan En)

REPTILES

Status NT: Near Threatened

Scientific Name	Common Name	Thai Name	Habitat	Site
1 <i>Calotes versicolor</i>	Changeable Lizard	กิ้งก่าหัวแดง	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
2 <i>Gehyra mutilada</i>	Common Four-clawed Gecko	จิ้งก่าหินสี่ขา	Inhabits all types of forests and other plantations, including houses and gardens	All provinces
3 <i>Gekko gekko</i>	Tokey Gecko	ตุ๊กแกบ้าน	Forest and other plantations, including houses and gardens in towns	All provinces
4 <i>Hemidactylus frenatus</i>	Spiny-tailed House Gecko	จิ้งก่าหางหนาม	Found in all types of forests and plantations, also in human houses	All provinces
5 <i>Hemidactylus garnotii</i>	Garnot's House Gecko	จิ้งก่าหางเรียบ	Found in all types of forests and plantations, also in human houses	All provinces
6 <i>Mabuya novemcarinata</i>	-	จิ้งก่าหกนิ้ว	Evergreen forest	All provinces

7	<i>Varanus salvator</i>	Common Water Monitor	เหี้ย	Lowland wetlands and lowland forests, including urban areas. Also found in canals, swamps, streams, and rivers.	All provinces
8	<i>Python reticulatus</i>	Reticulated Python	งูเหลือม	Lowland wetlands and evergreen forests	All provinces
9	<i>Chrysopelea ornata ornatissima</i>	Golden Tree Snake	งูเขียวดอกหมาก	Evergreen forest	All provinces
10	<i>Coelognathus radiatus</i>	Copperheaded Racer	งูทางมะพร้าวลายขีด	From beach forest to hill forest, including urban areas such as parks, gardens, paddy field, and other crop plantations	All provinces
11	<i>Dendrelaphis pictus</i>	Common Bronzeback	งูสามบ้านพร้าวทึดดำ	From home gardens to hill forest	All provinces
12	<i>Ptyas korros</i>	Indochinese Rat Snake	งูคิงบ้าน	From agricultural areas to hill forest	All provinces
13	<i>Ptyas mucosus</i>	Oriental Rat Snake	งูสิงหางลาย	From agricultural areas to hill forest	All provinces
14	<i>Xenochrophis flavipunctatus</i>	Common Keelback	งูลายขอสวน	From lowland wetlands to lowland evergreen forest	Thai locality
15	<i>Naja kaouthia</i>	Siamese Cobra	งูเห่าหม้อ	From agricultural areas to deciduous and evergreen forest	All provinces
16	<i>Daboia russelii siamensis</i>	Siamese Russell's Viper	งูแมวเซา	Lowland paddy fields	Nakhon Sawan, Chi Nat, Lop Buri, Saraburi, Ang Thong, Phra Nakhon Si Ayutthaya (Bang Pa-in) , Pathum Thani, Nonthaburi, Nakhon Pathom, Samut Prakan

AMPHIBIANS

Status NT: Near Threatened

	Scientific Name	Common Name	Thai Name	Habitat	Site
1	<i>Glyphoglossus molossus</i>	Truncate-snouted Spadefoot Frog	อึ่งฟ้า, อึ่งปากขวด	Deciduous and secondary forest	Sakon Nakhon, Nong bua Lampoo, Nakhon Ratchasima, Srakaew, Kamphaeng Phet, Uthai Thani, Phra Nakhon Si Ayutthaya , Chon Buri, Chanthaburi, Ratchaburi
2	<i>Kaloula medilineata</i>	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
3	<i>Bufo melanostictus</i>	Black-spined Toad	คางคกบ้าน	Mainly in disturbed areas, uncommon in closed forest	All provinces
4	<i>kaloula pulchra</i>	Banded Bullfrog	อึ่งอ่างบ้าน	All beach forest and urban areas	All provinces
5	<i>Microhyla heymonsi</i>	Dark-sided Chorus Frog	อึ่งข้างดำ	Disturbed areas such as gardens, crop plantations, secondary forests and primary forests	All provinces
6	<i>Hoplobatrachus chinensis</i>	Chinese Bullfrog	กบนา	Plain wetlands	All provinces
7	<i>Occidozyga lima</i>	Common Puddle Frog	เขียดจระนา	Lowland wetlands including wet paddy areas	All provinces
8	<i>Occidozyga martensii</i>	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
9	<i>Rana erythraea</i>	Green Paddy Frog	เขียดจิก	Lowland wetlands including garden ponds	All provinces

10	<i>Rana macrodactyla</i>	Long-toed Frog	กบหลังเขียด	Lowland Wetlands	All provinces
11	<i>Polypedates leucomystax</i>	Four-lined Tree Frog	ปาดบ้าน	Widespread in all habitats, from beach vegetation to primary evergreen forest as well as urban areas	All provinces

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 comprising about 1,900 genera and 10,000 species of vascular plants of which about 10% are endemic to the country. 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 tropical-wet in the lower southern peninsula to seasonal in the north, and varying altitude zones from zero to 2,565 m undoubtedly support the existence and development of various types of vegetation³.

There is one **Rare (R)** and one **Vulnerable (VU)** plant in and around AYP.

Table 4-28: Rare and Vulnerable Flora in AYP

Order		ANGIOSPERMAE (DICOTYLEDONAE)					
Family		Asclepiadaceae					
Botanical Name	Local Name	Habit	Distribution	Habitat	Status		
					Endemic	Criteria (Pre 1994)	Criteria (1994-2001)
<i>Heterostemma siamicum</i> Craib	เครือเขาขมน้อย	HC (Herbaceous climber)	N, C & SW of Thailand: Chiang Mai, Phra Nakhon Si Ayutthaya, Ratchaburi, Phetchaburi, and Prachuab Khiri Khan	Mixed deciduous forest, limestone.	+	R (Rare)	
Family		Labiatae					
Botanical Name	Local Name	Habit	Distribution	Habitat	Status		
					Endemic	Criteria (Pre 1994)	Criteria (1994-2001)
<i>Paravortex siamica</i> Fletcher	ต่ากุ้ง	S (Shrub)	C & E of Thailand: Ang Thong, Ayudhaya, Suphanburi, Sa Kaeo	Dry evergreen forest, along streams.	+	VU (Vulnerable)	

Source: Santisuk T., Chayamarit, K., Pooma, R., Suddee, S. (2006). *Thailand Red Data: Plants*. Office of Natural Resources and Environment Policy and Planning

f.2 Impact Analysis

f.2.1. Result of Opinion Survey

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

Table 4-29: Result of Opinion Survey on Biodiversity

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	78%	6%	7%	6%	3%	0	100%
Resident	66%	11%	9%	4%	9%	0	100%
BE	84%	5%	5%	2%	4%	0%	100%

Source: Opinion survey by the Study Team

f.2.2. Impact

According to the opinion survey, 77% of the residents, 84% of LAs and 89% of business enterprises considered that the biodiversity is not seriously or not very seriously threatened.

³ Thailand Red Data: Plants by ONEP 2006

The LAs and residents, who replied that problems were very serious, specified the following aspects of and reasons for their concern. Decrease of fish species is the main concern among all stakeholders with respect to biodiversity.

Table 4-30: Specific Aspects and Reasons for Concern about Biodiversity

	Aspects of Concern	Reasons for Concern
LAs	Extinction of fish species	Degradation of biodiversity and loss of income
Residents	Decreased number of fish species	Loss of biodiversity
BEs	Loss of fish species	Loss of income

f.3 Issues

- Lack of supervision and awareness in regard to preservation of biodiversity, especially wetland and sanctuary.

f.4 Measures to be Taken

- Formulate conservation plan.
- Conduct a campaign to educate local people on importance of biodiversity.
- Monitor and restrict phenomena that affect biodiversity.
- Support the people or organizations who are involved in biodiversity conservation.
- Support the exchange of information between communities involved in biodiversity conservation.
- Protection of habitat and cultivation environments for wild flora and fauna by designating provincial natural environment conservation districts.
- Encourage understanding of biodiversity.

Environment

g. Water Quality

g.1 Situation

g.1.1. Location of Continuous River Water Quality Monitoring Station

There are nine water quality monitoring stations in AYP: two in Noi, two in Chao Phraya, three in Pasak, and two in Lopburi River.

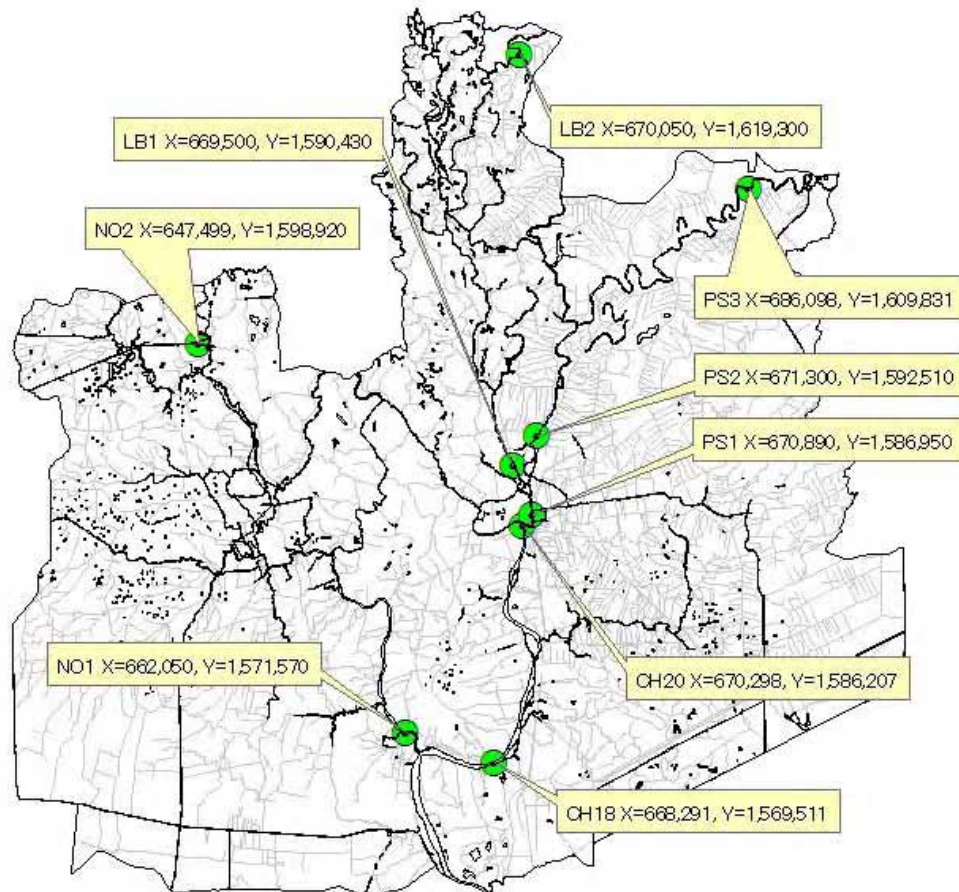


Figure 4-16: River Water Quality Monitoring Stations in AYP

g.1.2. Monitored Values

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

Table 4-31: Values under Water Quality Monitoring in AYP

Basic Values		Heavy Metal 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 CaCO ₃)		
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, the values currently being monitored are insufficient, as they do not include radioactive materials and agricultural chemicals.

Table 4-32: Environmental Standards for Water Quality of Surface Water

Parameter ^{1/}	Units	Statistics	Standard Value for Class					Methods for Examination
			Class1	Class2	Class3	Class4	Class5	
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 antipyrine
11. Copper (Cu)	mg/l	-	n		0.1		-	Atomic Absorption -Direct Aspiration
12. Nickel (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	Becquerel/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 & Heptachlorepoxyde	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 CaCO₃, **: when water hardness more than 100 mg/l as CaCO₃
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 4-33: 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

g.1.3. 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 4-34: Summary of Water Quality Class Results (2006) for Each River

River name	Point	DO P20	BOD P80	TCB P80	FCB P80
Noi	NO 01	Class4	Class2	Class3	Class3
	NO 02	Class4	Class4	Class4	Class4
Lopburi	LB 01	Class5	Class4	Class4	Class4
	LB 02	Class4	Class5	Class4	Class4
Pasak	PS 01	Class4	Class4	Class4	Class4
	PS 02	Class4	Class4	Class3	Class4
	PS 03	Class4	Class4	Class4	Class4
Chaophraya	CH 18	Class4	Class3	Class3	Class3
	CH 20	Class4	Class4	Class3	Class3

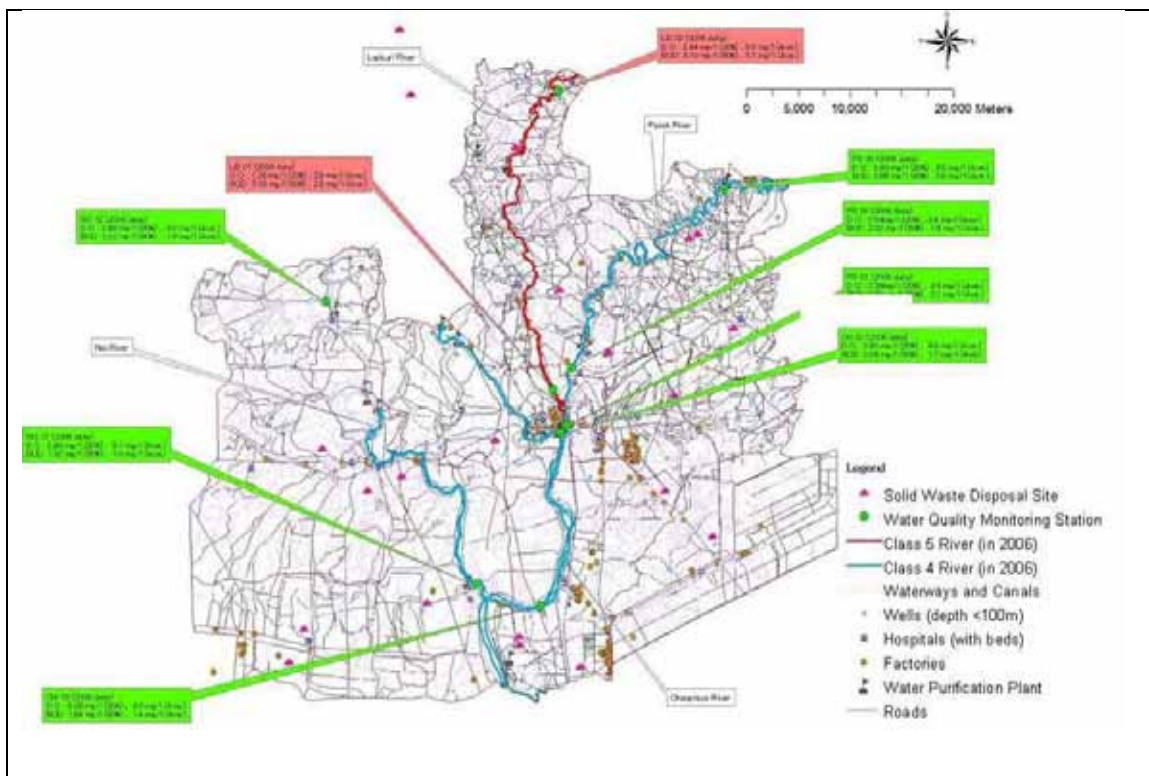


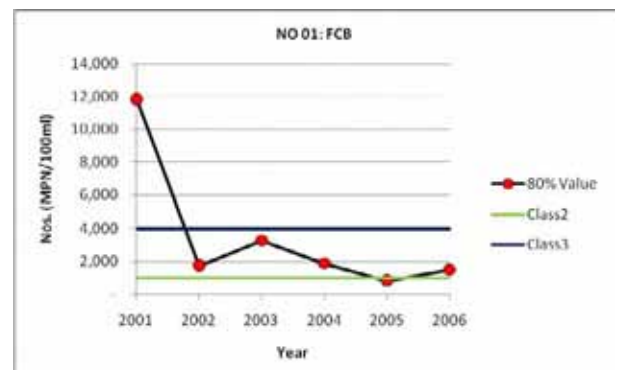
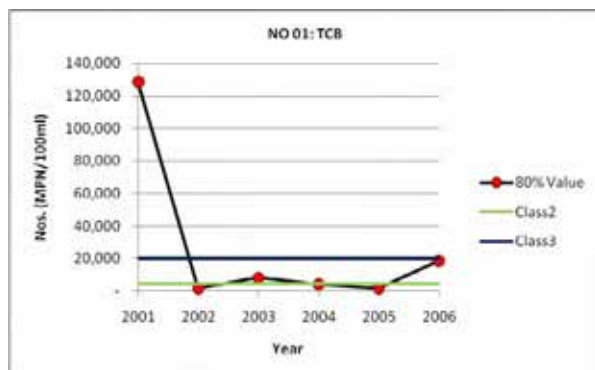
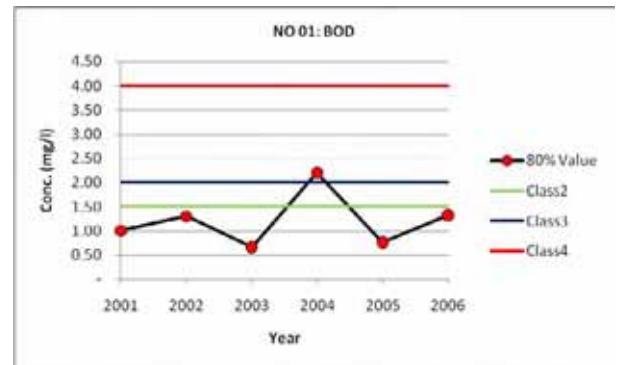
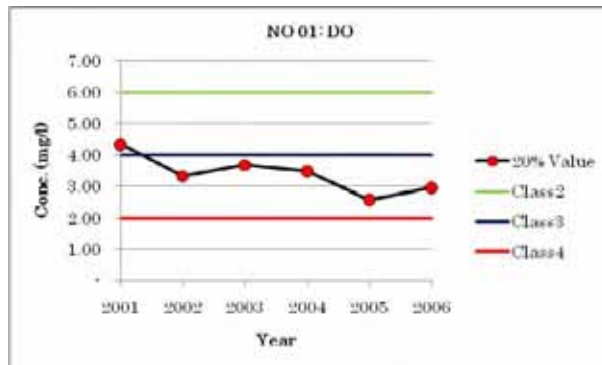
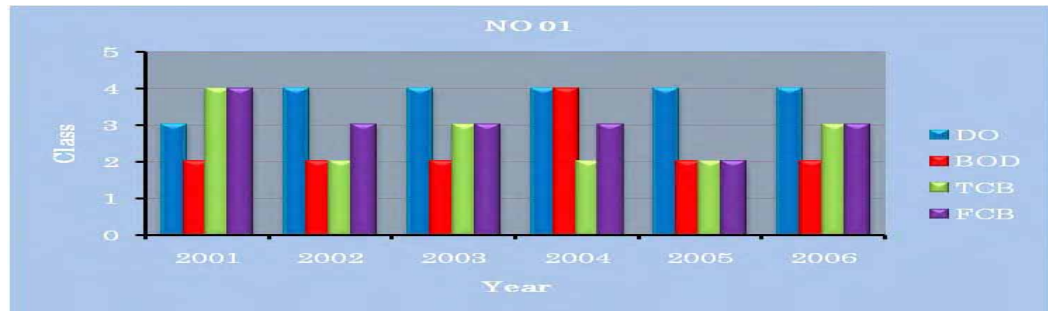
Figure 4-17: Summary of Monitoring Results (2006)

g.1.4. Characteristics of Each River

Noi River

i. Basic Variables

Changes in yearly water quality classification-related variables of the Noi River from 2001 to 2006 are shown in the figures below. Water quality has a tendency to worsen at monitoring point NO 02.



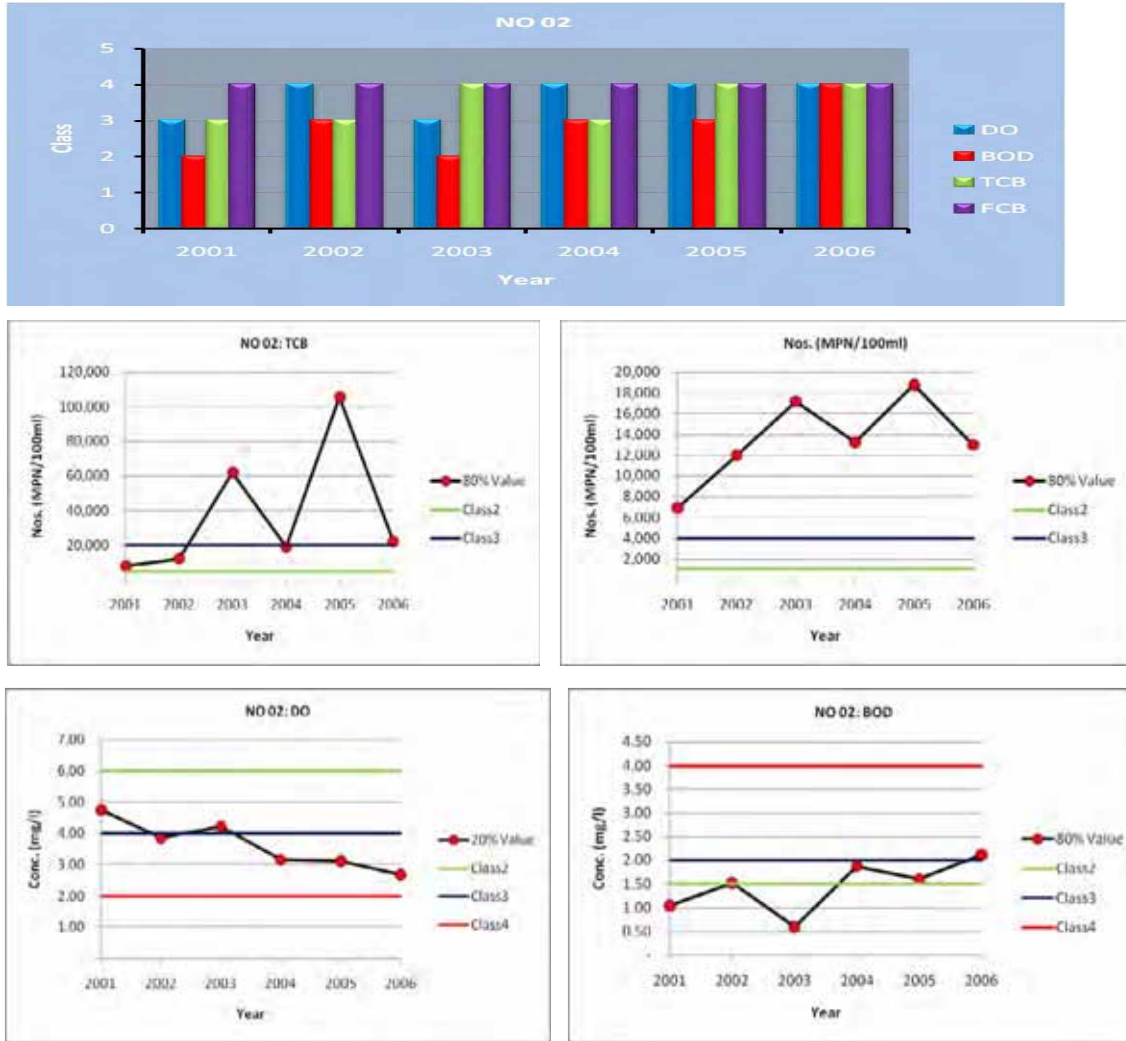


Figure 4-18: Change in Water Quality Classification in Noi River

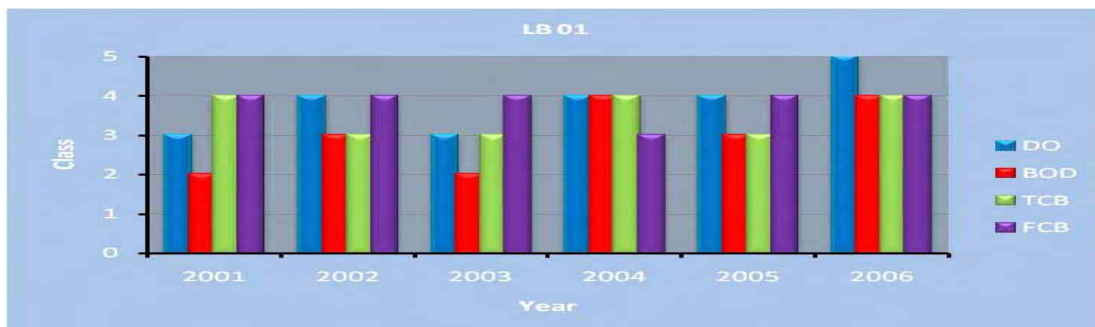
ii. Heavy Metals etc.

For heavy metals and cyanide, results confirmed that they were all below the limits set by the environmental standard.

Lopburi River

i. Basic Values

Changes in yearly water quality classification-related variables in Lopburi River from 2001 to 2006 are shown in the figures below. Water quality has a tendency to become worse at each monitoring point, LB 01 and LB 02. Note that the river fell to Class 5 in 2006.



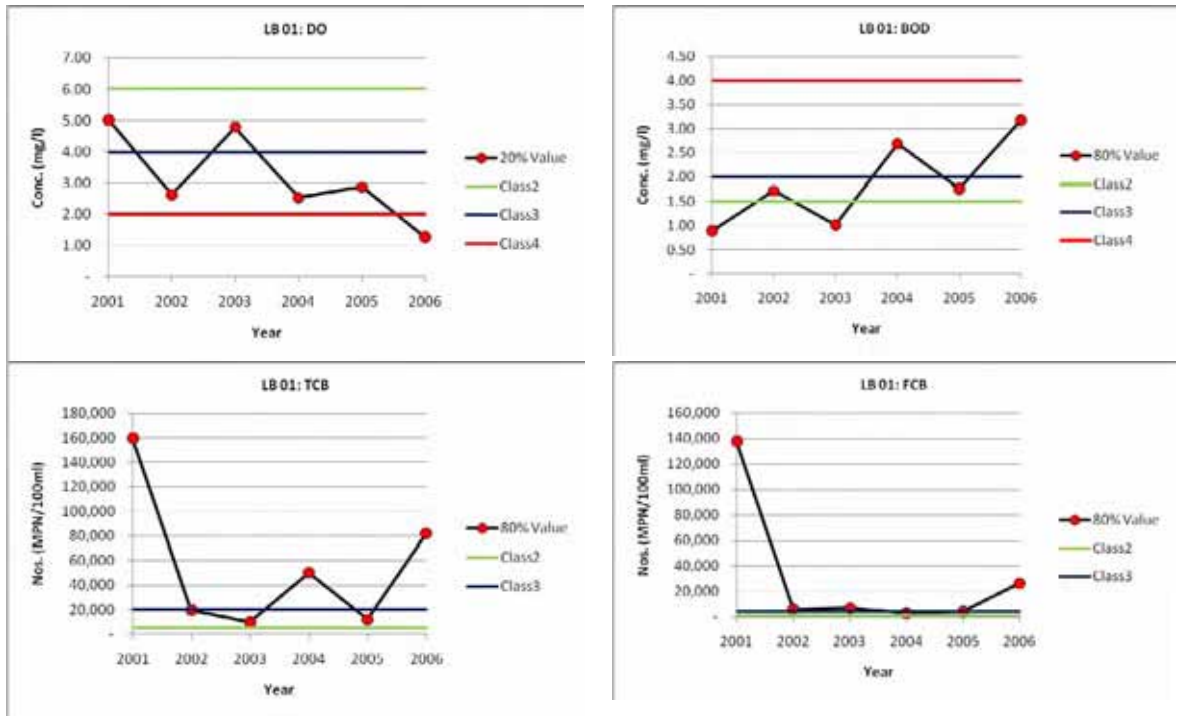


Figure 4-19: Change in Water Quality Classification in Lopburi River

ii. Heavy Metals

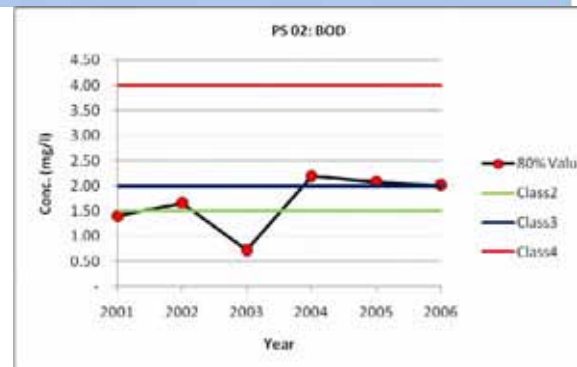
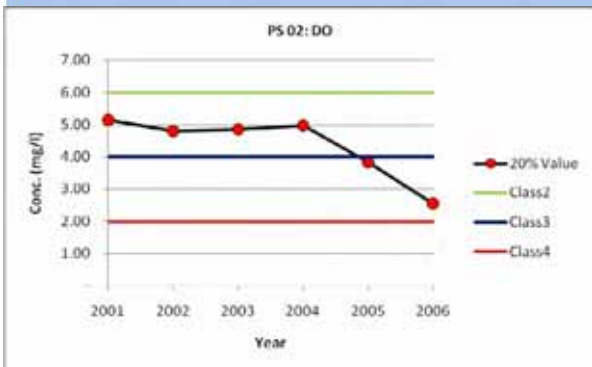
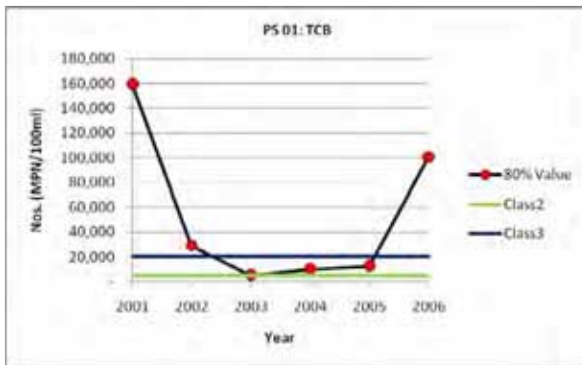
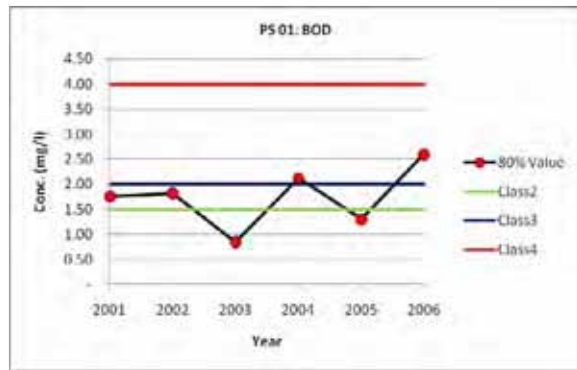
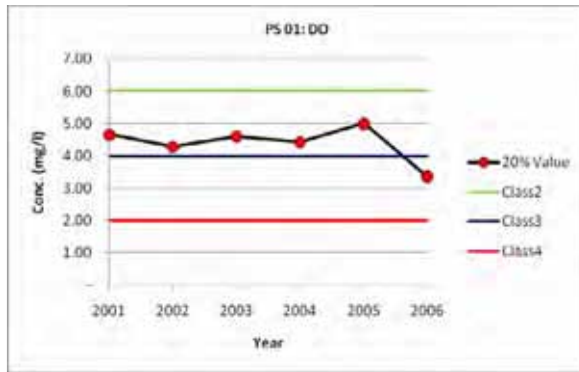
For heavy metals and cyanide, results confirmed that they were all below the limits set by the environmental standard.

Pasak River

i. Basic Values

Changes in yearly water quality classification-related variables in Pasak River from 2001 to 2006 are shown in the figure below. Water quality has a tendency to become worse at each monitoring point, i.e., PS 01, PS 02 and PS 03.





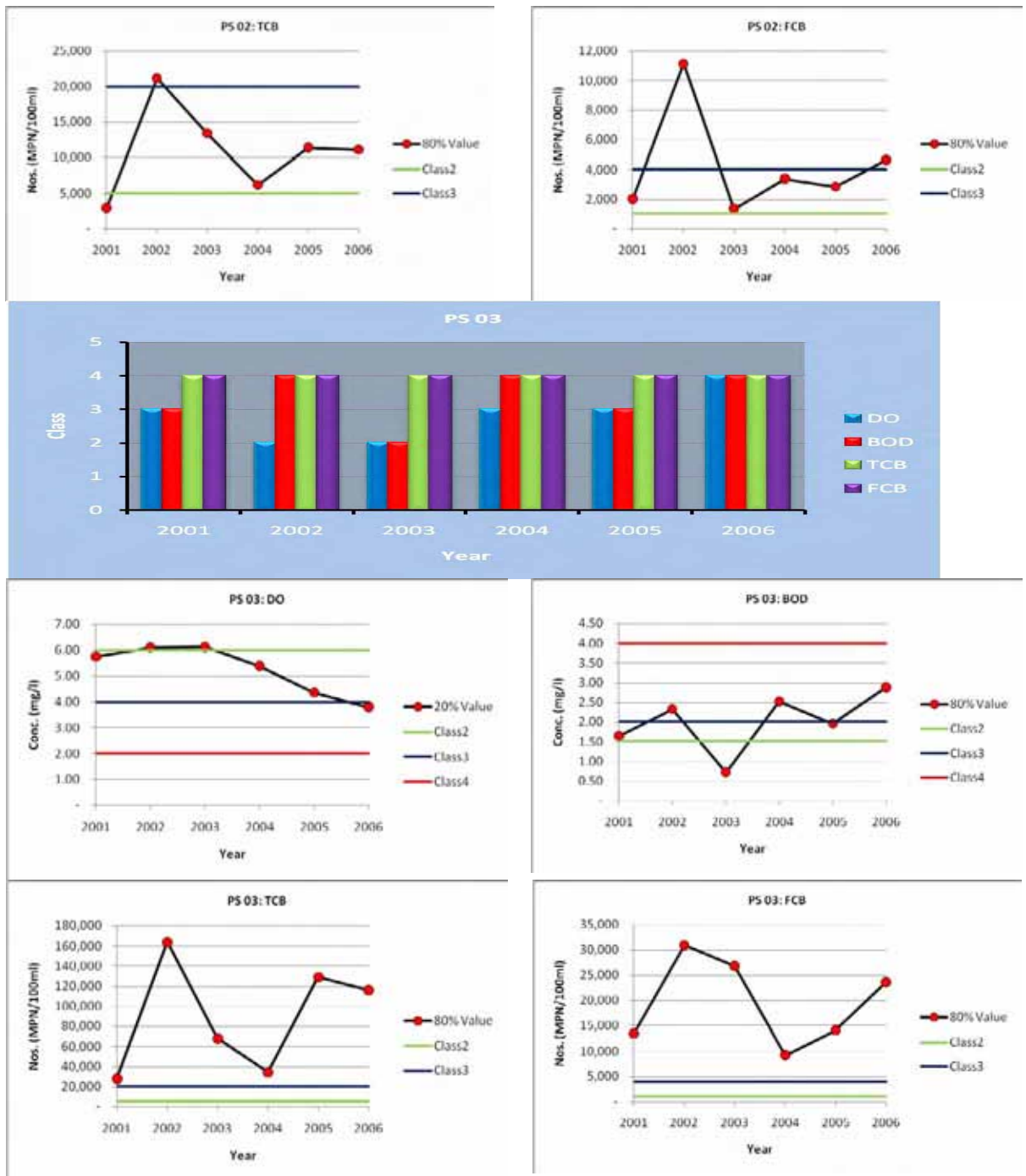


Figure 4-20: Change in Water Quality Classification in Pasak River

ii. Heavy Metals

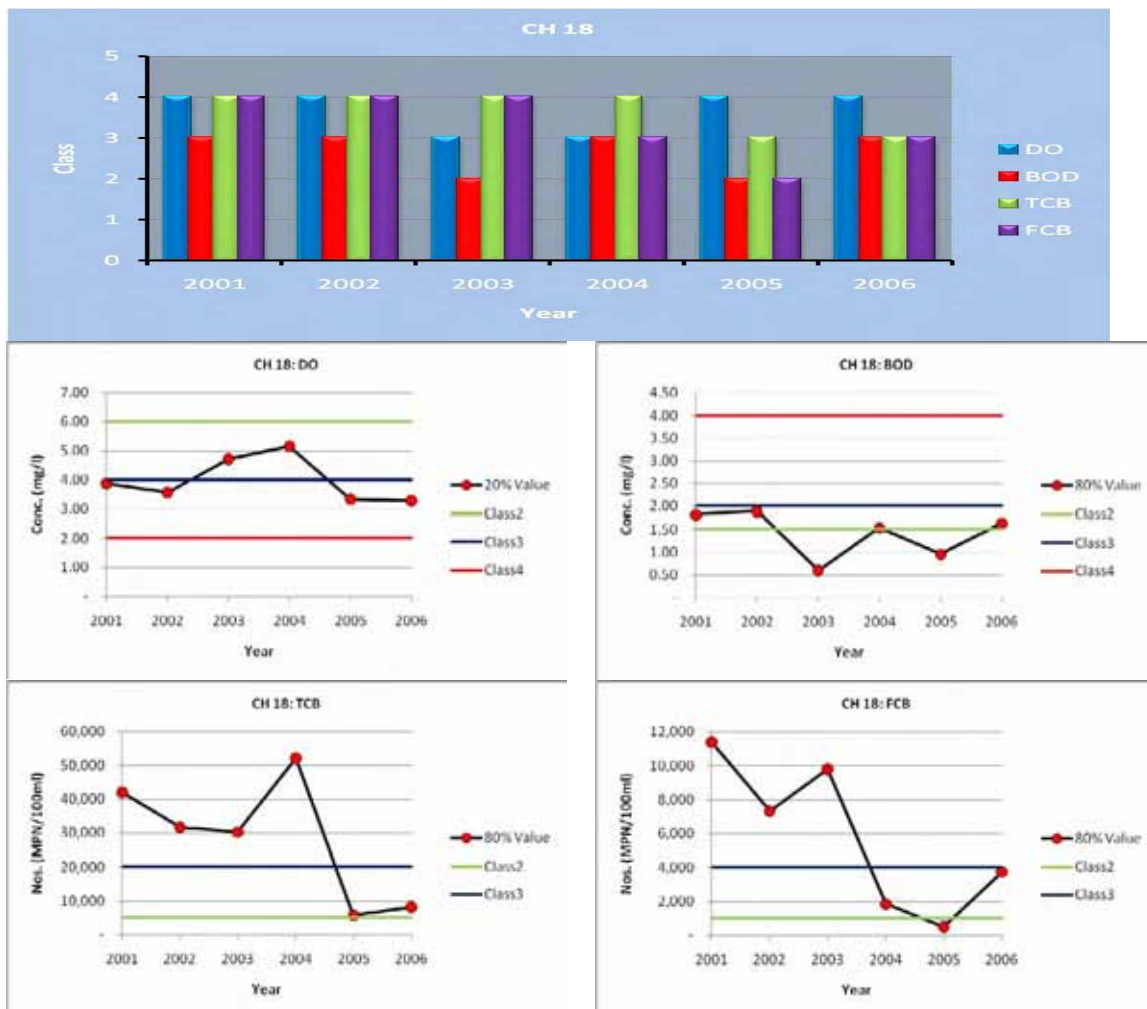
For heavy metals, results confirmed that they were all below the limits set by the environmental standard. Cyanide concentrations were generally below the standard with one exception in 1999 when CN at PS 02 measured 0.007 mg/l (environmental standard: 0.005mg/l).

Because CN was analyzed only two times (year 1998 and 1999) between year 1997 and 2006, it is difficult to establish the significance of the elevated cyanide concentration at PS 02 in 1999 (0.007mg/l). It is necessary to monitor and accumulate data continuously for proper environmental quality management.

Chao Phraya River

i. Basic Values

Changes in yearly water quality classification-related variables in the Chao Phraya River from 2001 to 2006 are shown in the figures below. The Chao Phraya River has a larger river basin than the other three rivers, so that the water quality has a tendency to worsen at a slower rate at each monitoring point, i.e., CH 18 and CH 20, compared to monitoring points in other rivers.



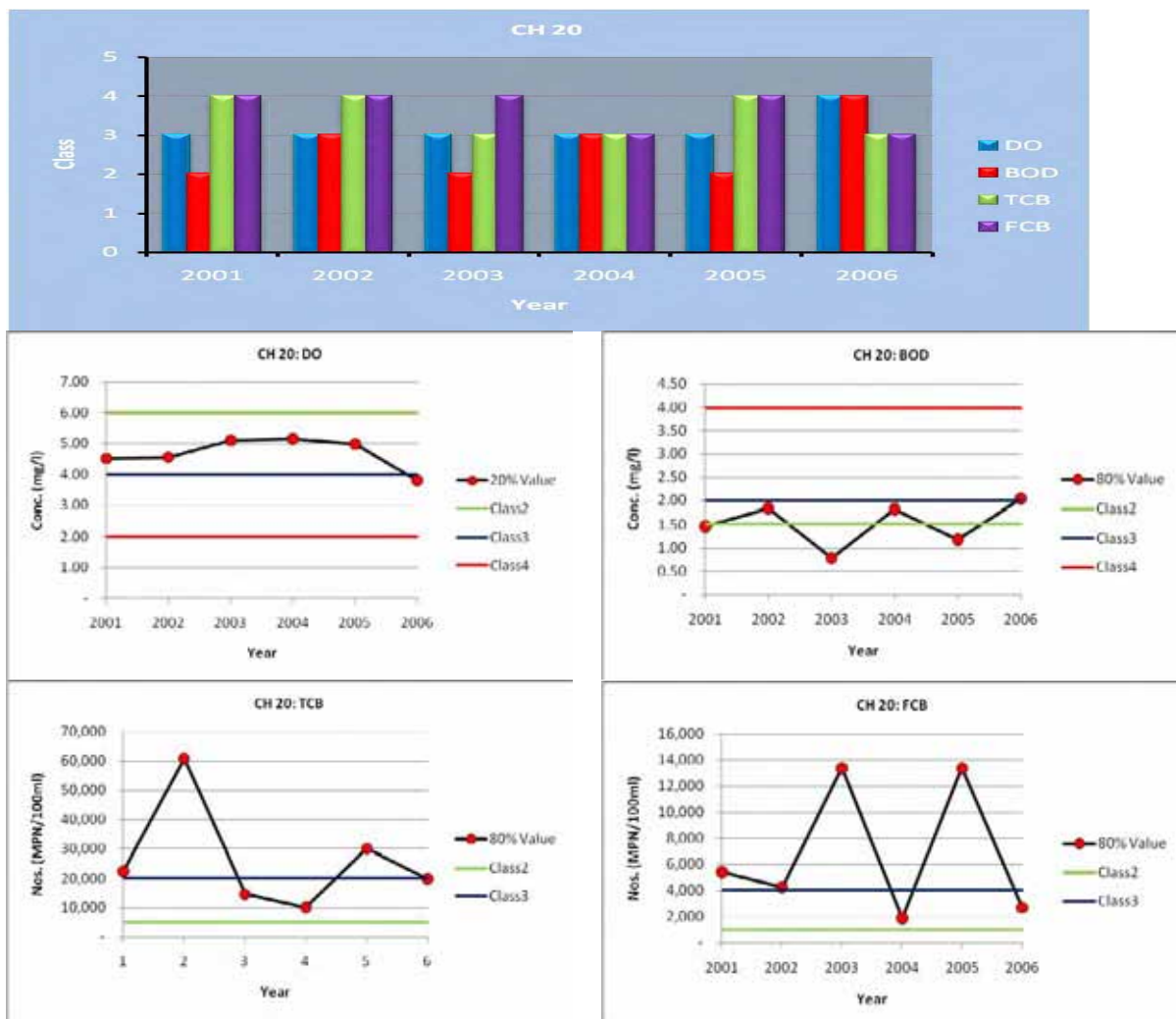


Figure 4-21: Change in Water Quality Classification in Chao Phraya River

ii. Heavy Metals

For heavy metals and cyanide, results confirmed that they were all below the limits set by the environmental standard, with the exception of mercury (Hg) at monitoring point CH 20 in 1997 (0.0023mg/l, environmental standard: 0.002mg/l).

Analysis of Hg was conducted up until 2000. Measured concentrations were very low after 1998. The PCD (Pollution Control Department) suspended Hg analysis from 2001 onward. However, from the viewpoint of environmental monitoring, it is necessary to continuously monitor and accumulate data of Hg concentrations for proper environmental quality management.

g.1.5. 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 projects⁴. Consequently housing development projects have become large pollution sources of domestic wastewater. Because sewerage covering rate in AYP is only about 4%⁴. However, 75% of human feces and urine is treated in septic tanks according to the opinion survey.

Industrial wastewater from industrial estates in AYP is treated in central wastewater treatment facilities of the estates to comply with the “Industrial Effluent Standards”. This requirement is in fact followed according to the results of the Water Quality Analysis conducted by the JICA Study Team. It is, however, said that small and medium sized factories other than those located in industrial estates discharge their wastewater into public water bodies without treatment.

There is no leachate (wastewater from solid waste final disposal sites) treatment facility in AYP. It is either discharged into public water bodies or seeps into the groundwater without treatment.

Main water pollution sources are shown in the figure below.

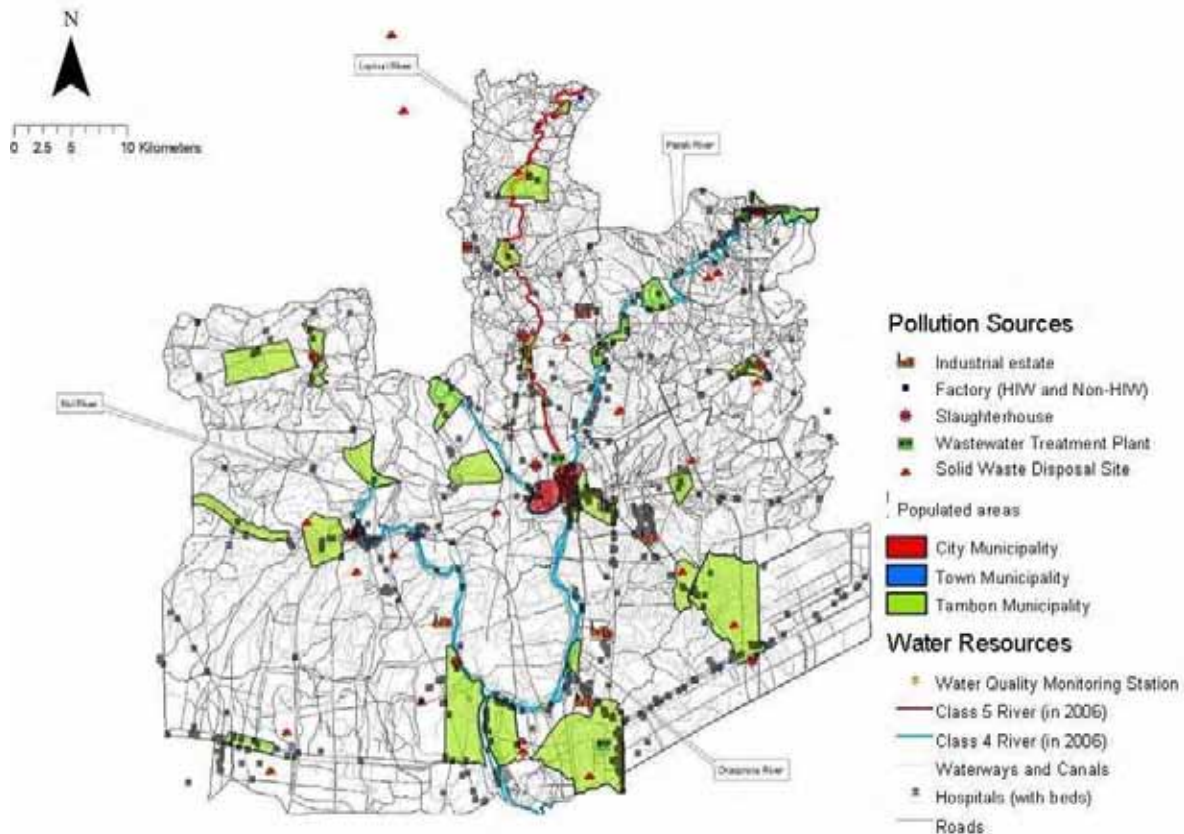


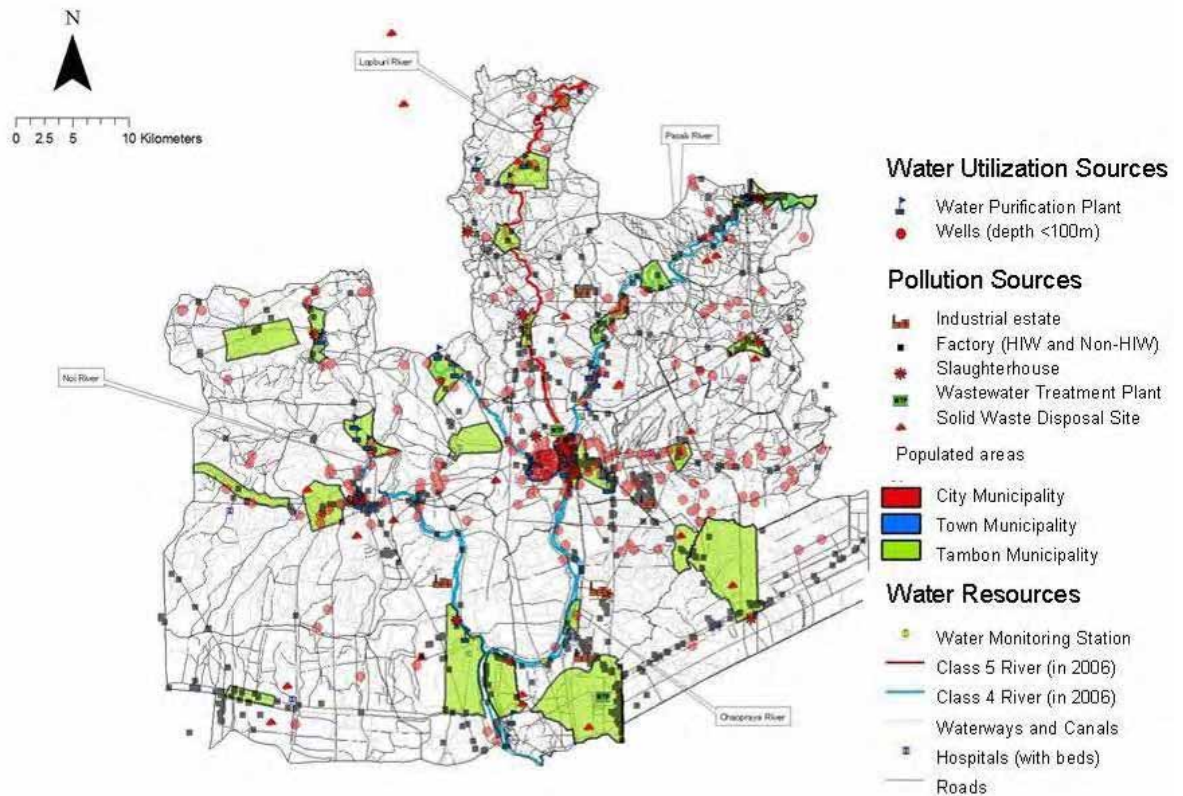
Figure 4-22: Location Map of Water Pollution Sources in AYP

⁴ Housing Estate Standards, PCD, http://www.pcd.go.th/info_serv/en_reg_std_water04.html#s4

⁴ Opinion Survey to LA in AYP /JICA Study Team/2007

g.1.6. 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.



g.2 Impact Analysis

g.2.1. Number of Complaints

As mentioned in the section on Water Resources (4.2.2 c.2.1), there has been an increase in the number of complaints regarding water. In 2003 there were only two such complaints, but the number increased to 14 in 2006, which is around 33% of all complaints the PEO received regarding the environment. Half of those were about wastewater discharged by housing estates.

Table 4-35: Number of Complaints to PEO Regarding Water Quality (AYP)

Year	Total No of Complaints about Environment	No of Complaints about Water Quality	%
2003	7	2	28.6
2004	14	5	35.7
2005	30	11	36.7
2006	42	14	33.3

(Source) PEQMP-KPI 2007

g.2.2. Result of Opinion Survey

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

Table 4-36: Result of Opinion Survey on Water Quality

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	41%	30%	17%	13%	%	0	100%
Resident	49%	11%	17%	21%	2%	0	100%
BE	54%	9%	20%	18%	0%	0%	100%

Source: JICA study in 2007

According to the interviews with local residents in the JICA study, 30% of LAs, 38% of residents, and 38% of the business entities replied that the problems with water quality are “very serious” or “somewhat serious.” Among those who replied that problems are very serious, aspects and reasons for their concern are shown below. All of them replied that wastewater from agriculture, industries, and solid wastes are the cause of problems.

Table 4-37: Specific Aspects and Reasons for Concern about Water Quality

	Aspect of Concern	Reasons for Concern
LAs	Wastewater from agriculture and industry	Water pollution
Residents	Wastewater from solid waste and factories	Causes water pollution and health problems
BEs	Wastewater from solid waste and factories	Causes water pollution and health problems

g.2.3. Impact

Noi River

The water quality of the upstream section of the Noi (at NO 02) steadily decreases. Under the assumption that the same conditions (amount of pollutant, treatment, etc.) would continue into the future, the water quality in Noi River will be worse compared with the current situation.

Lopburi River

The water quality steadily decreases at each monitoring point, LB 01 and LB 02. Under the assumption that the same conditions (amount of pollutant, treatment, etc.) would continue into the future, water quality in Lopburi River will be worse compared with the current situation. Note that the river fell to Class 5 in 2006.

Pasak River

The water quality steadily decreases at each monitoring point, PS 01, PS 02, and PS 03. Under the assumption that the same conditions (amount of pollutant, treatment, etc.) would continue into the future, the water quality in Pasak River will be worse compared with the current situation.

Chao Phraya River

The Chao Phraya River has a larger river basin than the other three rivers, so water quality has a tendency to decrease at a slower rate at each monitoring point, CH 18 and CH 20, compared to the monitoring points in other rivers. Under the assumption that the same conditions (amount of pollutants, treatment, etc.) would continue into the future, water quality in the Chao Phraya River will slowly worsen compared to the current situation.

Moreover, because the volume of river water and the pollution load are both large due to the size of the basin, it would take quite a long time and significant effort (human resources, funds, etc.) to rehabilitate the river after it has been contaminated.

g.3 Issues

Figure 4-22 and Figure 4-23 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.

In fact there are several water purification plants along the Lopburi River (such as three plants in Tessaban Tambon Rong Chang), which already switched their water source from Lopburi River to groundwater. Because the sizes of those plants are small, with an average capacity of about 1,000 m³/day, changing the water source was not difficult. For a large scale plant like the one in Tessaban Nakhon Si Ayutthaya, however, it will be very difficult to switch sources as the capacity of the plant is about 40,000 m³/day. Thus, preserving river water from pollution is important. Accordingly the following priority issues are pointed out:

- Provision of safe and good quality 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 Continuous Air Monitoring Station

A continuous air monitoring station is located at Ayutthaya Witthayalai School in the center of AYP. This location is appropriate to monitor air quality because it is close to the main area for business and commercial activities. However, because the station is not located alongside a main road, pollution from moveable sources such as vehicles remains undetected.

The location of the continuous monitoring station is shown below.

h.1.2. Monitored Values

The following values and weather data are monitored continuously at the monitoring station. The measuring point is 3 m above ground level. Lead (Pb), Particulate matter (<100µ) and VOCs (volatile organic compounds) are not included in the set of monitored values. All values listed below can be checked at the PCD web site, including data archives. Data for PM-10 is available dating back to June 1998 and other data are available from March 2004.

Table 4-38: Monitored Values at AYP Air Monitoring Station

No.	Pollutants/Meteorology	Measurement Method	Height (m)	Range
1	Carbon Monoxide (CO)	Non-Dispersive Infrared Detection	3	0 - 50 ppm
2	Nitric Oxide (NO)	Chemiluminescence	3	0 - 500 ppb
3	Oxides of Nitrogen (NO _x)	Chemiluminescence	3	0 - 500 ppb
4	Nitrogen Dioxide (NO ₂)	Chemiluminescence	3	0 - 500 ppb
5	Sulphur Dioxide (SO ₂)	UV Fluorescence	3	0 - 500 ppb
6	Ozone (O ₃)	Chemiluminescence or UV Absorption Photometry	3	0 - 500 ppb
7	Particulate Matter (>10µm) [PM-10]	Taper Element Oscillating Microbalance (TEOM)	3	0 - 1000 µg/m ³
8	Temperature	Thermometer	3	-10 - 50 °C
9	Wind Speed	Cup propeller	3	0 - 100 m/s
10	Wind Direction	Vanes that use precision potentiometer	3	0 - 360 deg
11	Relative Humidity	Capacitive sensor	3	0- 100 %RH
12	Solar Radiation	Pyranometer	3	W/m ²
13	Net Radiation	Net Radiometer	3	W/m ²
14	Barometric Pressure	Capacitance or strain gauge pressure transducer	3	mmHg
15	Rain	Tipping bucket rain gauge	3	mm/h

h.1.3. Results at AYP Monitoring Station

Assessment of air quality in AYP was carried out based on the following available data between March 2004 and August 2007.

Carbon Oxide (CO)
Nitrogen Dioxide (NO₂)
Ozone (O₃)
Sulfur Oxide (SO₂)
Particulate Matter (<10µ) [PM-10]
Air Quality Index (AQI)*

*Note Air Quality Index (AQI)

The Air Quality Index (AQI) is an index, or rating scale, for reporting the daily ambient air pollution recorded at the monitoring sites.

The AQI informs the public about the quality of air and associated health effects that result from inhaling polluted air. The higher the AQI value the greater the level of air pollution.

The following table indicates six AQI levels and the meaning of each condition.

For instance, the numerical value of "0-50" means good and clean conditions, and hence

"over 300" means hazardous and risky conditions.

It is compulsory to indicate AQI in cities which have a population of more than 350 thousand people. AQI was adopted in Thailand as well as Malaysia and Singapore in South East Asia.

Table 4-39: AQI Levels and Relevance

Air Quality Index Levels of Health Concern	Numerical Value	Meaning	Colors
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk	Green
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Yellow
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Orange
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Red
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.	Purple
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.	Maroon

h.1.4. Carbon Monoxide (CO)

Annual average concentrations of CO from 2004-2007 are shown in the following table. Average CO concentrations, for both 1-hour and 8-hour periods, are far below standard. There are no significant changes from year to year. Figures for 1-hour and 8-hour averages are almost same. Therefore, daily changes are thought to be minor.

The main source of CO is from vehicles. However, the monitoring station is not alongside a main road so that CO from traffic can be assumed to be higher than the figures given below. But the figures given below are far below the standard value, so that CO at roadside might also be below standard level. Monthly records indicate an increase in CO levels between November and March.

Table 4-40: Annual Average of CO (AYP, Mar.2004 – Aug.2007)

Year	1 hr Average			8hr Average		
	Number of Samples	Average	Standard for 1-hr average of CO	Number of Samples	Average	Standard for 8-hr average of CO
	day	ppm	ppm	day	ppm	ppm
2004	188	0.6	30	280	0.7	9
2005	316	0.5		314	0.5	
2006	343	0.7		336	0.7	
2007	217	0.6		213	0.6	

h.1.5. Nitrogen Dioxide (NO₂)

Annual average concentrations of NO₂ from 2004-2007 are shown in the following table. Average amount of NO₂ over any 1-hour period is far below (less than 1/10) standard and thus the impact on health is not significant. Monthly records indicate higher NO₂ levels between November and March.

Table 4-41: Annual Average of NO₂ (AYP, Mar.2004 – Aug.2007)

Year	Number of Samples	Average	Standard for 1-hr average of NO ₂
	day	ppm	ppm
2004	279	0.011	0.17
2005	332	0.013	
2006	337	0.014	
2007	187	0.014	

h.1.6. Ozone (O₃)

Annual O₃ levels from 2004-2007 are shown below. Average concentration over any 1-hour period is far below standard. Monthly records indicate higher O₃ levels between November and March. There is no yearly increase or decrease.

Table 4-42: Annual Average of O₃ (AYP, Mar 2004-Aug 2007)

Year	Number of Samples	Average	Standard for 1-hr average of O ₃
	day	ppm	ppm
2004	283	0.026	0.10
2005	326	0.023	
2006	347	0.023	
2007	238	0.022	

h.1.7. Sulfur Dioxide (SO₂)

The annual SO₂ levels from 2004-2007 are shown below. Average concentrations over any 1-hour period are far below standard. There are no annual or monthly changes.

Table 4-43: Annual Average of SO₂ (AYP, Mar.2004-Aug.2007)

Year	Number of Samples	Average	Standard	
			1-year average	1-hr average
	day	ppm	Ppm	ppm
2004	282	0.004	0.04	0.30
2005	328	0.002		
2006	339	0.003		
2007	234	0.002		

h.1.8. Particulate Matter (< 10 μ) [PM-10]

The annual average levels of PM-10 in 2004-2007 are shown below. Concentrations are between 0.056 and 0.066 mg/m³. They are slightly over the standard of 0.05 mg/m³.

Table 4-44: Annual Average of PM-10 (AYP, Mar.2004-Aug.2007)

Year	Number of Samples	Average	Standard	
			1-year average	24-hr average
	day	mg/m ³	mg/m ³	mg/m ³
2004	266	0.066	0.05	0.12
2005	330	0.056		
2006	351	0.060		
2007	227	0.058		

Levels of PM-10 averaged over 24-hour periods are shown in the figure below. Figures from November to March are higher than those from other periods and exceed the environmental standard (24-hr average, 0.12 mg/m³). There are many emitters of PM-10 such as factories with boilers, incineration, construction sites, motor vehicles, dust from road surfaces, burning agricultural wastes, soil surfaces and so on. However, burning of agricultural wastes is usually done during the dry season, which is from December to February, and, therefore, this is considered one of the main causes of high PM-10 levels.

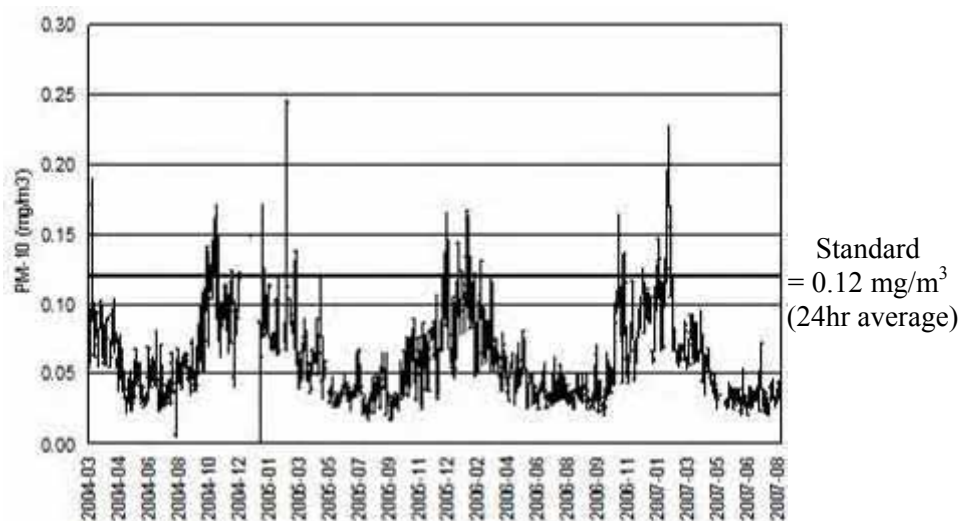


Figure 4-25: Average Amount of PM-10 in 24 hours (AYP)

The numbers of days when PM-10 levels exceeded standard have been calculated and are shown in the table below. The standard was exceeded on at least 11 to 17 days per year.

Table 4-45: Number of Days Exceeding Standard of PM-10

Year	Number of Sample	Number of days exceeded	Percentage
	day	day	%
2004	266	16	6.0
2005	330	11	3.3
2006	351	17	4.8
2007	227	12	5.3

There are around 50 river ports along the Chao Phraya River and Pasak River. According to the interview survey, residents nearby complain about noise and dust generated by loading and unloading activities at the river port.

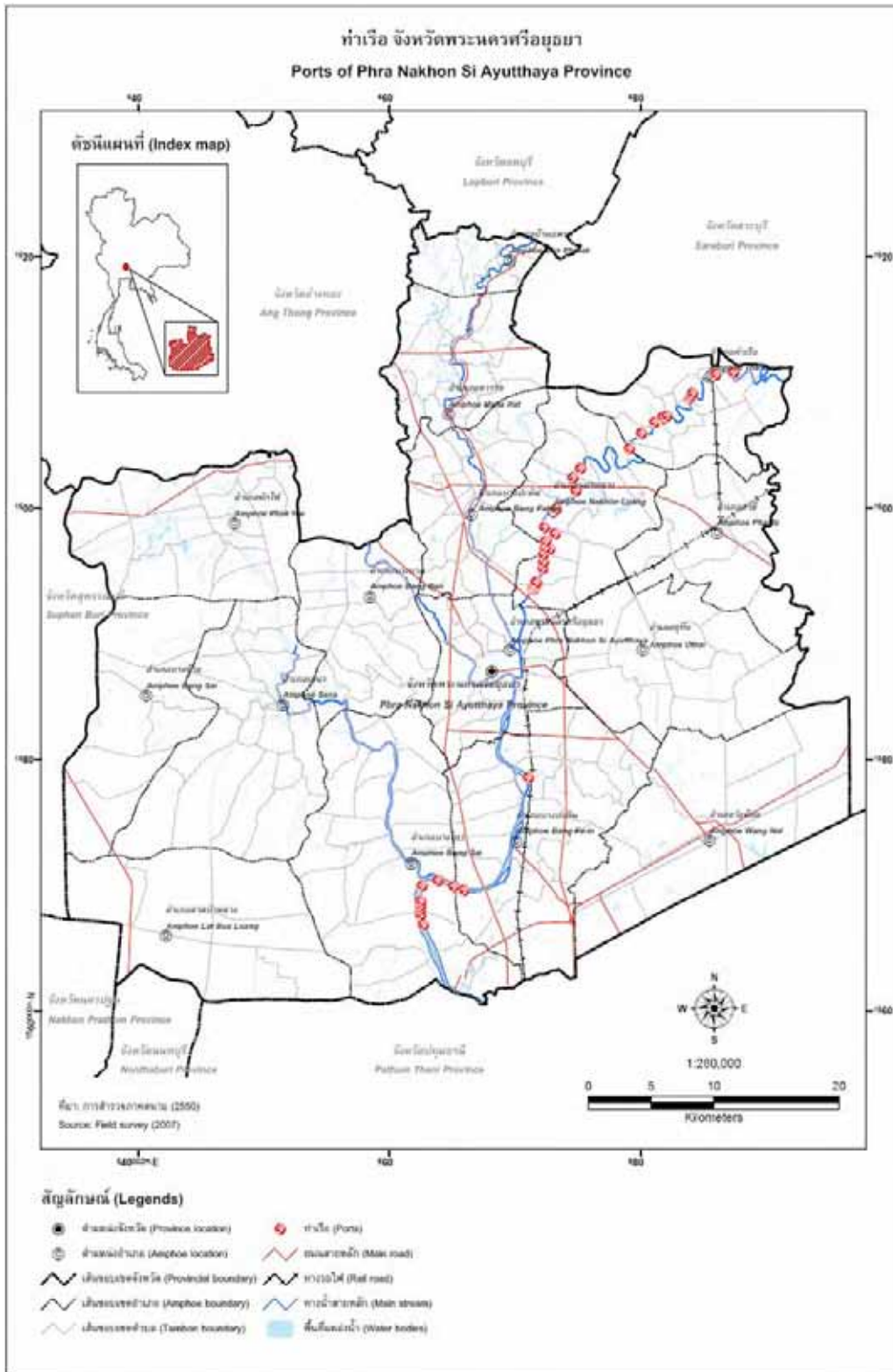


Figure 4-26: Location Map of River Ports

h.1.9. Air Quality Index (AQI)

Annual AQI averages from 2004 to 2007 are shown in the table below. The air quality in each of these years is classified as “Moderate”, only slightly below the threshold to “Good”.

Table 4-46: Annual Average AQI (AYP, Mar 2004-Aug 2007)

Year	Number of Samples	Average	Standard for 24-hr average of AQI
2004	286	71	100
2005	346	66	
2006	357	67	
2007	239	65	

The daily AQI is shown in the following figure. During November to March, AQI figures sometimes rise above the standard of 100 (AQI = 100 is the threshold between classifications “Unhealthful” and “Moderate”).

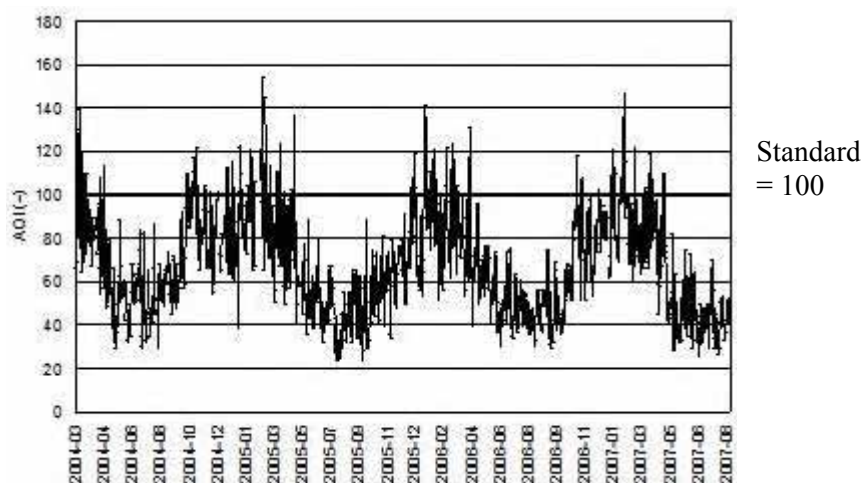


Figure 4-27: Daily AQI

The number of days when the AQI exceeded the standard is shown in the table below. Around 21 to 26 days per year are over standard.

Table 4-47: Number of Days Exceeding AQI Standard

Year	Number of Samples	Number of days exceeded	Percentage
	day	day	%
2004	286	23	8.0
2005	346	24	6.9
2006	357	26	7.3
2007	239	21	8.8

h.1.10. Conditions of Compliance to the Standard

Air pollution sources mainly consist of: 1) SO₂ from stationary sources of industrial activity such as factories, and 2) NO₂ from both stationary and moveable sources such as vehicles. The figures for both SO₂ and NO₂ are far below the standard. Therefore, there is little air

pollution caused by factories and vehicles. The figures for CO, O₃ are below the standard and no problems are observed. CO, NO₂, SO₂ and O₃ show no annual changes. The annual average of PM-10 does not comply with the standard, due to the fact that levels exceed the standard at times from November to March. The number of days which exceed the standard is between 11 to 17 days per year. The assumed causes of over-standard PM-10 levels are open burning of agricultural wastes and adverse weather conditions in the dry season. AQI is calculated from five major parameters for air monitoring and once one of them exceeds the standard, AQI tends to show high figures. Therefore, periods when PM-10 and AQI exceed their standards are correlated. AQI exceeds the standard between 21 to 26 days per year.

h.2 Impact Analysis

h.2.1. Number of Complaints

There has been an increase in the number of complaints regarding air quality. In 2003 there were only two such complaints, but this increased to 15 in 2006. This number is around 36% of the total complaints the PEO receives regarding the environment. Half of the complaints, however, are considered to be specific local problems due to dust from loading works at river ports and rice mills.

Table 4-48: Number of Complaints to PEO Regarding Air Quality (AYP)

Year	Total No of Complaints about Environment	No of Complaints about Air Quality	%
2003	7	2	28.6
2004	14	6	42.9
2005	30	8	26.7
2006	42	15	35.7

(Source) PEQMP-KPI 2007

h.2.2. Result of the Opinion Survey

The result of the opinion survey on air quality is shown below.

Table 4-49: Result of Opinion Survey on Air Quality

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	33%	37%	17%	11%	%	0	100%
Resident	68%	9%	9%	12%	1%	0	100%
BE	63%	7%	18%	10%	1%	0%	100%

Source: JICA study in 2007

According to the survey, 70% of the LAs, 77% of residents, and 63% of business entities replied that the problems with air pollution are “not serious” or “not very serious”. The cause of air pollution problems is dust and smoke from transportation including ships and from factories.

h.2.3. Impact

Data analysis of air quality monitored at an air quality monitoring station reveals seasonal changes but no annual change in air quality. Only PM-10 exceeds environmental standards and then only on 3-6% of days per year. This occurs during the dry season when there is little rain from November to February. The causes of high PM-10 levels are assumed to be: 1) open burning of agricultural wastes in paddy fields, and 2) dust from road traffic, 3) dust from loading and unloading cargo at river ports.

The monitoring station is located away from the road and, therefore, air quality influenced by mobile pollution sources cannot be analyzed at the station. Areas along the trunk roads may be influenced by mobile pollution sources, judging from claims of local people.

With the economy growing, the number of stationary and mobile pollution sources will increase. However, if environmental protection measures are introduced in parallel with an increase in the number of factories and vehicles, it is assumed that air quality will not worsen.

Therefore, air quality will remain unchanged in AYP if reasonable environmental protection measures, including the control of agricultural waste burning, are introduced. However, regarding trunk roads with heavy traffic, countermeasures including monitoring of air quality are considered necessary.

h.3 Issues

- PM-10 concentrations exceed the environmental standard for 11-17 days per year. Proper disposal of agricultural wastes is needed,
- The situation with respect to air pollution from mobile emission sources like automobiles is unclear. A station is established for continuous air quality measurements which can detect trends in air pollution conditions, but air pollution from mobile emission sources (i.e. automobiles) can not be accurately measured at the location of the monitoring station,
- It is necessary to deal with the problem of dust and smoke from river ports, and dust, smoke and odor emitted by factories.

h.4 Measures to be Taken

- Develop a cooperative system among stakeholders to treat agricultural wastes appropriately,
- Organizations who issue business licenses to river ports should give warning to port operators to take preventive measures such as installing a dust collector or planting trees for protection,
- Regularly analyze air quality of major roadways to investigate impact of automobiles, a mobile emission source,
- Deal with traffic jams, limit use of old vehicles and so on to reduce air pollution from automobiles. Also, as an antipollution measure for stationary emission sources like factories and workplaces, regulate the amount of nitrogen oxides and dust emissions and enact total pollutant control in cooperation with central administration offices or REO,
- Use the policy put forth in “Air and Noise Quality Management in Thailand Master Plan 2007-2016 (Draft)”,

- In areas where it is difficult to immediately realize environmental standards, take effective measures according to the condition of the area,
- Raise the awareness of local residents with an educational campaign about pollution prevention and air quality,
- Make the placement of building ventilation, dust eliminating devices or wind fences and such obligatory, through management of permission granting authorities.

i. Noise and Vibration

i.1 Situation and Impact Analysis

i.1.1. Data for Noise and Vibration

No station regularly takes measurements of noise and vibration in the province, near roads, or emitted by factories.

There are no data available for vibration in AYP.

i.1.2. Location of Noise Measurements

Noise was measured at the Bang Pa-in Industrial Estate in August 2006, shown in the figure below. The exact location of the measurement is the Klong Putra Temple within the Industrial Estate.

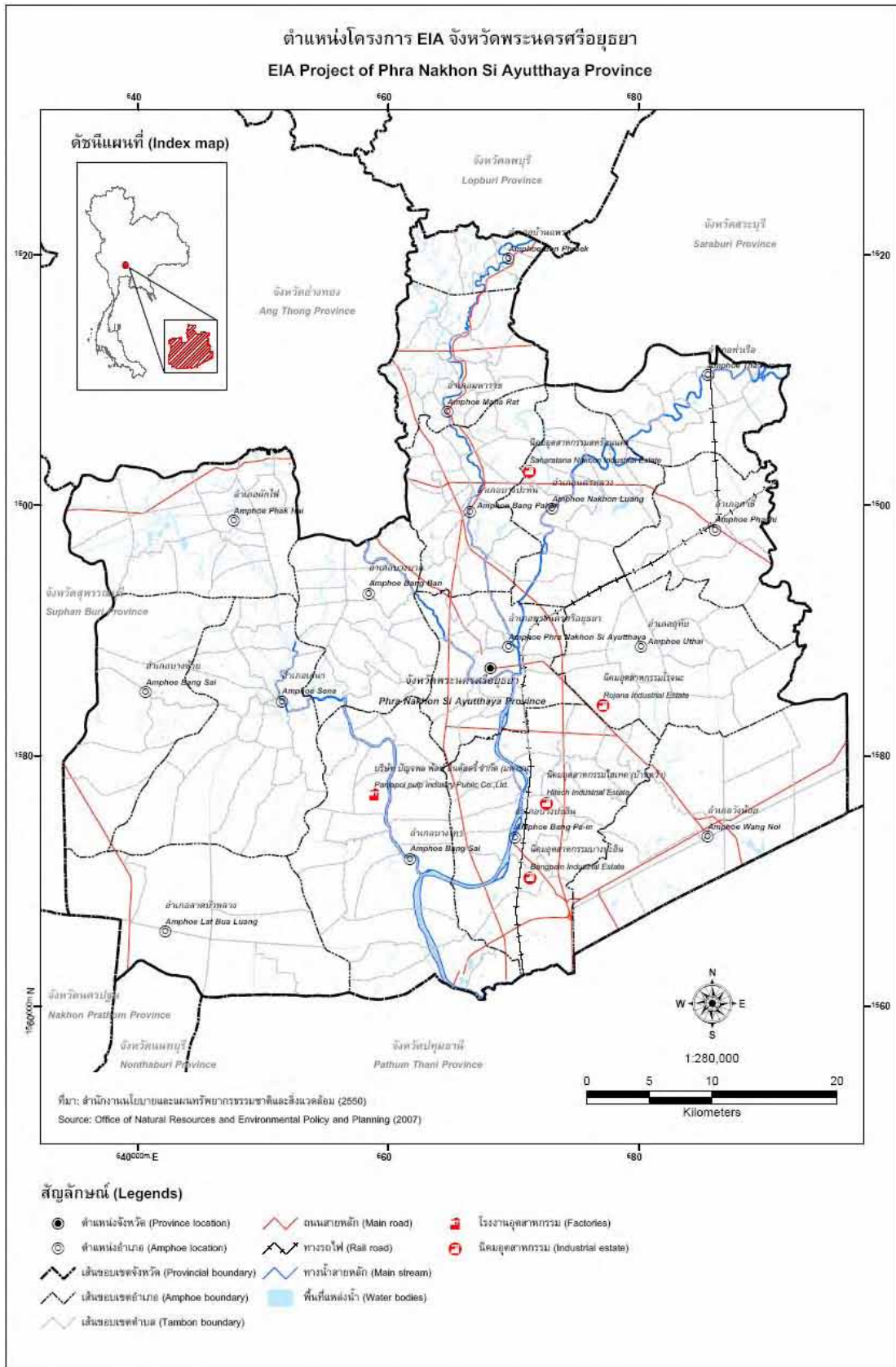


Figure 4-28: Location of Bang Pa-in Industrial Estate

i.1.3. Measurement Results

Measurement results are shown below. All the results are below standard.

Table 4-50: Results of Noise Quality Monitoring

Noise Monitoring Location	Maximum Noise	Average Value for 24 hrs.
1. Klong Putra Temple, Bang Pa-in	87.0	65.5
2. Community near Bang Pa-in Industrial Estate	90.7	55.3
Noise Standard Value	Less than 115 dB A	Leas than 70 db A

Data Source: Environmental Quality Monitoring Report of Bang Pa-in Industrial Estate, 22 August 2006.

i.2 Impact Analysis

i.2.1. Number of Complaints

The following complaints were received by the PEO concerning noise.

Table 4-51: Number of Complaints regarding Noise (AYP)

Year	Total No. of Complaints on Environment	No. of Complaints on Noise and Vibration	%
2003	7	0	0.0
2004	14	2	14.3
2005	30	3	10.0
2006	42	4	9.5

i.2.2. Results of the Opinion Survey

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

Table 4-52: Result of Opinion Survey on Noise and Vibration

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	52%	33%	11%	4%	0%	0%	100%
Resident	74%	11%	8%	5%	1%	0%	100%
BE	72%	7%	15%	4%	1%	0%	100%

According to the opinion survey, 85 % of the LAs, 85% of residents, and 79 % of business entities replied that problems with noise and vibrations are “not serious” or “not very serious”. Those who replied that noise and vibrations are very serious problems stated that transport agencies are the causes.

i.2.3. Impact

Inpacts on the living environment by noise and vibration are felt locally and irregularly and are caused by backhoe operations and truck and boat engines at river ports.

i.3 Issues

- Loud noise from cargo river port and factories,
- Although noise standards for the general environment and work environments have been established, the law does not have standards according to districts and time as stipulated in Japanese law on noise.

i.4 Measures to be Taken

- Requirement and strict enforcement of noise control measures by Provincial Water Transport authorities as condition before granting permission to operate river ports,
- 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.
- Concerning noise, use the policy put forth in “Air and Noise Quality Management in Thailand Master Plan 2007-2016 (Draft)”.

j. Solid Waste

j.1 Situation

j.1.1. Generation Amount

The amount of waste generated and collected in AYP was investigated by REO 6 and reported in PEQMP for KPI. These amounts were obtained based on the opinion survey by REO 6 of the Tessaban and Orbortor.

Table 4-53: Waste Amount in AYP

Item	Tessaban		Orbortor		Total	
	Ton/day	%	Ton/day	%	Ton/day	%
Waste Generation	252		297		549	
Waste Collection	229	91	223	75	452	82
Uncollected Waste	23	9	74	25	97	18

Data Source: REO 6 Nonthaburi, 2006

According to the table shown above, the amount of waste generated in all Tessaban was 252 ton/day, and in all Orbortor 229 ton/day, giving a total generation amount in AYP of 549 ton/day.

j.1.2. Waste Collection Rate

The waste collection rate in Tessaban is 91%, and in Orbortor 75% giving an average in AYP of 82%.

According to the opinion survey⁵ with LAs, 87% of them replied that “Wastes are collected in all areas” or “Wastes are collected in some areas”.

j.1.3. Waste Generation Amount per Person per Day

The amount of waste generated per person per day is obtained based on the registered population in 2005 in AYP as follows.

⁵ Opinion survey conducted by the JICA Study Team.

Table 4-54: Waste Generation Rate in AYP

Item	Unit	Tessaban	Orbortor	Total
Waste Generation	(Ton/day)	252	297	549
Population in 2005	(Person)	253,316	493,603	746,919
Waste Generation Ratio	(kg/day/person)	0.995	0.602	0.735

The amount of waste generated per person per day in Tessaban is 0.995 kg/person/day and in Orbortor 0.602 kg/person/day giving an average in AYP of 0.753 kg/person/day.

j.1.4. Physical Composition of Waste

A survey on the composition of waste was conducted at four disposal sites in AYP during the feasibility study for a central waste disposal system.⁶

Table 4-55: Physical Composition of the Waste in AYP

Waste Composition	Unit	Tessaban Tambon Sena	Tessaban Tambon Nakhon Luang	Tessaban Phra Nakhon Si Ayutthaya	Tessaban Tambon Tha Ruea	Analysis Result (Average)
Bulk Density	Ton/m ³ .	0.24	0.20	0.24	0.22	0.22
Food waste	%	44.21	43.89	48.27	42.53	44.73
Paper	%	17.11	15.54	11.68	12.85	14.30
Plastic	%	11.05	10.22	15.91	16.15	13.33
Rubber/leather	%	0.14	0.00	0.00	1.18	0.33
Cloth	%	1.03	2.30	5.54	1.28	2.54
Wood/leave	%	13.90	16.00	12.54	9.90	13.09
Glass	%	3.99	3.80	2.75	4.48	3.76
Metal	%	3.28	1.94	1.35	5.21	2.95
Stone/ceramic	%	3.49	3.31	0.00	4.27	2.77
Other	%	1.80	3.00	1.96	2.15	2.23
Total	%	100.00	100.00	100.00	100.00	100.00

The three kinds of waste that make up the largest portion are food waste (44.7%), paper (14.3%) and plastic (13.3%).

j.1.5. Transfer Station

There is no transfer station in AYP and all the wastes are transported directly to the final disposal site.

j.1.6. Final Disposal Site

There are 18 final disposal sites according to the opinion survey conducted by the JICA Study Team.

⁶ Central Waste Disposal and Night Soil Phra Nakhon Si Ayutthaya Province, by Suwanabhumi Engineering Consultant Co., Ltd. in September 2007.

Table 4-56: Final Disposal Site in AYP

Name of LA	Operating organization	Tipping Fee (Baht/ton)	Final disposal amount (ton/day)	Location of final disposal site	Disposal Method
1. TES.N Nakhon Sri Ayutthaya	TES.N Nakhon Sri Ayutthaya		140	Moo 8, Tambon Ban Pom, Amphur Mueang	Open Dump
2. TAO Salaloy	TES.T Tha Ruoa	0	12	Moo 13, Tambon Salaloy, Amphur Tha Ruoa	Open Dump
3. TES.T Nakhon Luang	TES.T Nakhon Luang	0	20	Moo 3, Tambon Bang Rakam, Amphur Nakhon Luang	Semi-sanitary Landfill
4. TAO Mae La	TAO Mae La	0	4	Moo 3, Tambon Bang Rakam, Amphur Nakhon Luang	Semi-sanitary Landfill
5. TES.T Bang Sai	Individual Contractor	180	11	Moo 5, Tambon Bang Plee, Amphur Bang Sai	Semi-sanitary Landfill
6. TES.T Ratchakram	TES.T Ratchakram	0	8	Moo 2, Tambon Chang Yai, Amphur Bang Sai	Semi-sanitary Landfill
7. TES.T Ban Sang	TES.T Ban Sang	0	15	Moo 5, Tambon Ban Sang, Amphur Bang Pa-in	Open Dump
8. TES.T Bang Kra San	TES.T Bang Kra San	0	20	Moo 10, Tambon Bang Krasan, Amphur Bang Pa-in	Semi-sanitary Landfill
9. TES.T Chieng Rak Noi	Individual Contractor	180-200	74	Moo 11, Tambon Chieng Rak Noi, Amphur Bang Pa-in	Semi-sanitary Landfill
10. TES.T Phachi	TES.T Phachi	0	5	Moo 1, Tambon Phachi, Amphur Phachi	Open Dump
11. TES.T Lat Bua Luang	TES.T Lat Bua Luang	0	0.5	Moo 1, Tambon Lat Bua Luang, Amphur Lat Bua Luang	Semi-sanitary Landfill
12. TES.T Sam Mueang	TES.T Sam Mueang	0	20	Moo 4, Tambon Sam Mueang, Amphur Lat Bua Luang	Open Dump
13. TES.T Lam Ta Sao	TES.T Lam Ta Sao	0	15	Moo 5, Tambon Lam Ta Sao, Amphur Wang Noi	Open Dump
14. TES.T Sam Ko	TES.M Sena	0	14.7	Moo 5, Tambon Sam Ko, Amphur Sena	Semi-sanitary Landfill
15. TES.T Chao Jet	TES.T Chao Jet	0	5	Tambon Chao Sadej, Amphur Sena	Semi-sanitary Landfill
16. TES.T Bang Nom Ko	TES.T Bang Nom Ko	0	5	Moo 1, Tambon Bang Nom Ko, Amphur Sena	Semi-sanitary Landfill
17. TES.T Uthai	TES.T Uthai	0	8	Moo 12, Tambon Uthai, Amphur Uthai	Open Dump
18. TES.T Rong Chang	TES.T Rong Chang	0	3	Moo 6, Tambon Pitta Pien, Amphur Maharat	Open Dump
Total			286.2		

Remark: TES.N – Tessaban Nakhon, TES.M – Tessaban Mueang, TES.T – Tessaban Tambon
TAO – Tambon Administrative Organization

According to the table above, the disposal site in Tessaban Nakhon Si Ayutthaya is the largest one in AYP. Around 140 tons of waste are disposed there per day. Two Tessaban (Phra Nakhon Si Ayutthaya, Bang Bal) and 10 Orbortor (Ban Pom, Pak Kran, Hantra, Sampao Lom, Koh Rian, Phukhao Thong, Phra Khao, Nam Tessaban, Ban Pan, Chao Chet) are using this disposal site⁷.

There are 18 disposal sites within AYP, which is around 2,600 km² in area. Therefore, one disposal site covers around 144 km² on average which shows that the transportation distance to the disposal site is quite short but operation efficiency of the disposal sites is quite low.

Orborjor of AYP recognizes this fact and plans to construct two central disposal sites which will cover the entire provincial area. The feasibility report has recommended two central disposal sites at the Sena Disposal Site and Nakhon Luang Disposal Site.

⁷ Central Waste Disposal and Night Soil Phra Nakhon Si Ayutthaya Province, by Suwanabhumi Engineering Consultant Co., Ltd. in September 2007.

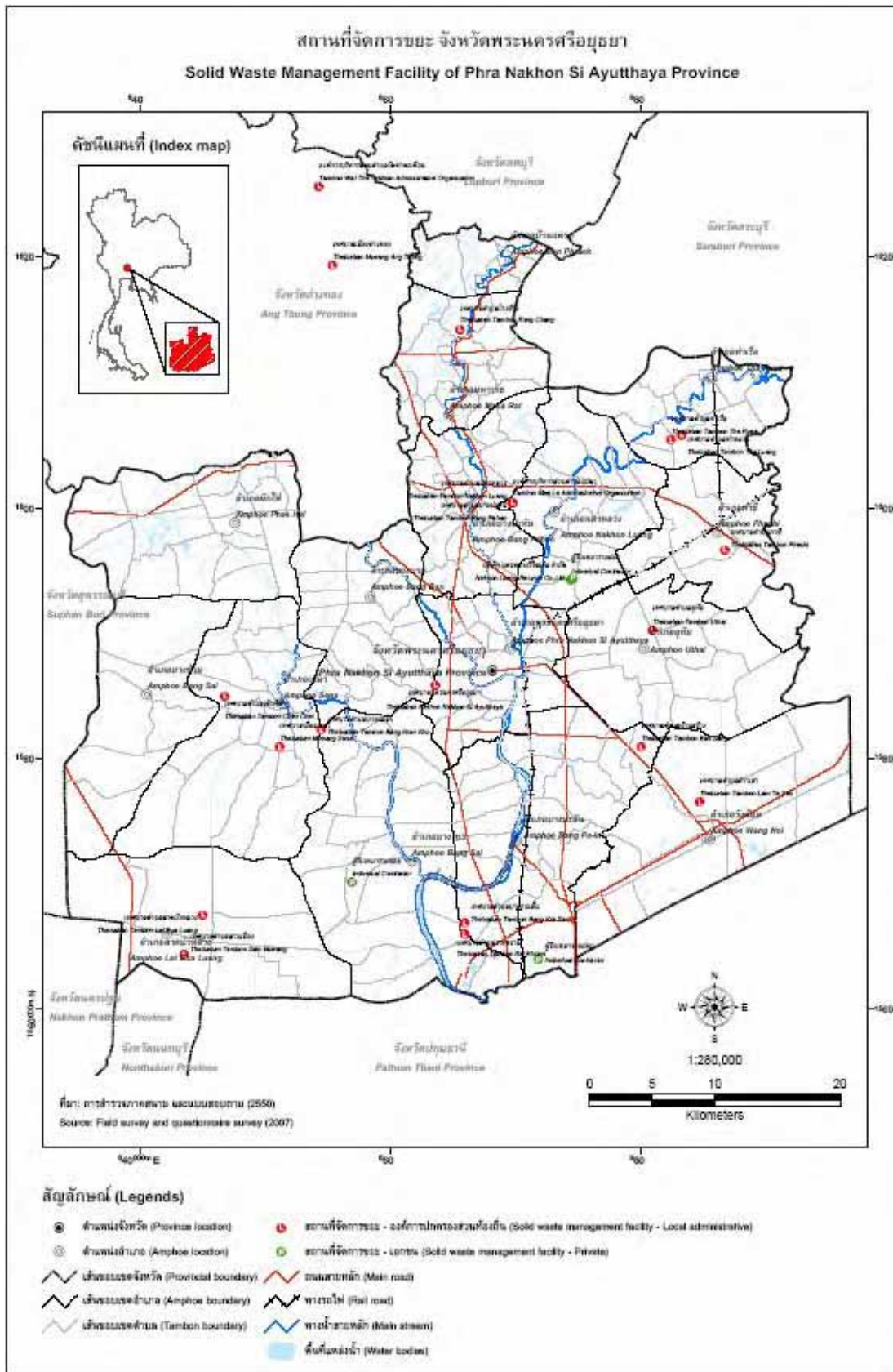


Figure 4-29: Location of Disposal Sites in AYP

j.2 Impact Analysis

j.2.1. Number of Complaints

The number of complaints regarding natural resources and environment are increasing year by year. It is unclear as to which complaints are directly related to solid waste management (SWM). Nevertheless, complaints about odor are assumed to be related to waste, and their number is on the rise.

Table 4-57: Number of Complaints regarding Natural Resources and Environment

Year	Number of Complaints					Total Number
	Water	Air	Noise	Odor	Others	
2003	2	2	0	2	1	7
2004	5	6	2	1	0	14
2005	11	8	3	5	3	30
2006	14	15	4	8	1	42

Source: PEQMP for KPI in 2007

j.2.2. Result of Opinion Survey

The result of the opinion survey on solid waste is shown below.

Table 4-58: Result of Opinion Survey on Solid Waste

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	17%	17%	24%	42%	%	0	100%
Resident	69%	10%	9%	11%	1%	0	100%
BE	68%	13%	10%	8%	0%	0%	100%

Source: Opinion survey by Study Team

According to the interviews with local residents in the JICA study, 79% replied that problems with waste management are “Not serious at all” or “Not very serious”. Those who replied that problems are very serious stated that the reasons for their opinion were collection of waste and odor emanating from the wastes.

However, according to the interview survey of the 54 local administrations, 66% of LAs replied that problems with waste management are “Somewhat serious” or “Very serious” and 43% pointed out SWM is the second most serious problem in their administrative areas.

Table 4-59: Specific Aspects and Reasons for Concern about Solid Waste

	Aspects of Concern	Reasons of Concern
LAs	Large amount of garbage is not managed properly	Causes serious environmental problems
	No area for disposal site	Causes serious environmental problems
Residents	Solid waste collection	Uncollected garbage
	Smell from garbage	Causes health problem
BEs	Solid waste collection	Uncollected garbage
	Smell from garbage	Causes health 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 0.995kg/person/day for Tessaban and 0.602kg/person/day for Orbortor are used as the rate of generation,
- Proportion of population in Tessaban and Orbortor are 33.9% and 66.1% respectively and will not change from 2005 to 2011.

Table 4-60: Forecast of Generation Amount of Municipal Waste (AYP)

year	Population			Generation Amount of Municipal Waste		
	Tessaban	Orbortor	Total	Tessaban	Orbortor	Total
				ton/day	ton/day	ton/day
2005	253,316	493,603	746,919	252.0	297.0	549.0
2006	253,561	494,408	747,969	252.3	297.6	549.9
2007	253,917	495,102	749,019	252.6	298.1	550.7
2008	254,273	495,796	750,069	253.0	298.5	551.5
2009	254,629	496,490	751,119	253.4	298.9	552.3
2010	254,985	497,184	752,169	253.7	299.3	553.0
2011	255,341	497,878	753,219	254.1	299.7	553.8

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.

The current municipal SWM mainly consists of collection system and final disposal system. The important issue is that there are over 18 disposal sites for a population of about 750,000 in the province as shown in Figure 4-29. Almost all of the disposal sites are open dump operations. Consequently, the adverse impacts to the surrounding environment by the disposal sites are very serious, especially at sites located in flood prone areas as shown in the figure below.

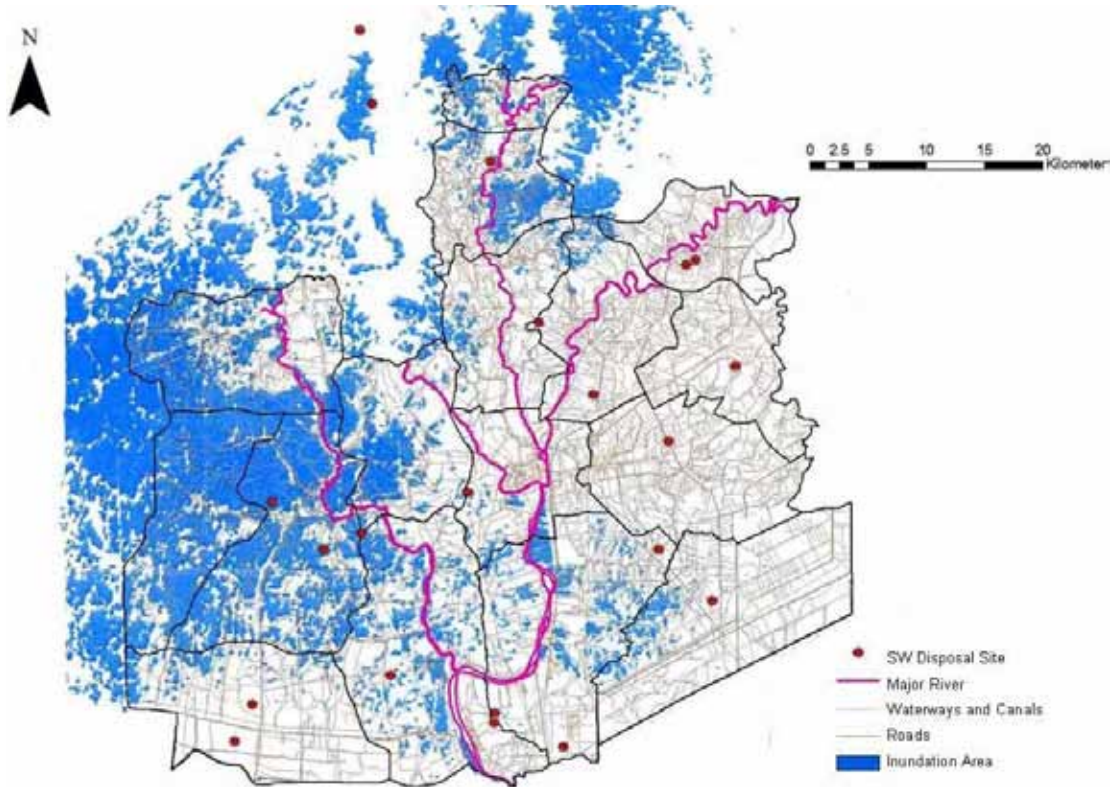


Figure 4-30: Location of Disposal Sites in Flood Prone Areas (Year of 2006)

j.3 Issues

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

Table 4-61: Targets for the Waste Management Indicators

	Unit	Tessaban Nakhon	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 waste generation rate per person per day in AYP is 0.995 kg/person/day in Tessaban and 0.602 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 30%.

According to the information given by PEO of AYP, there is a significant unregistered population in AYP believed to be working at factories. It is important to get an understanding of those population numbers in order to obtain an accurate rate of waste generation per person per day.

j.3.2. Collection Rate

The waste collection rate in Tessaban is 91%, and in Orbortor is 75% so that the average in the province is 82%. These figures should be increased, by a few percentage points in Tessaban and around 15% in Orbortor, in order to fulfill the target (90-95%).

Residents are typically settling along rivers, canals, and roads in Orbortor but not in single, densely populated areas. More than 80% of land is used for agriculture, so it is estimated that much of the garbage is disposed of in some unidentified way. A detailed survey to determine the actual waste stream is needed.

j.3.3. Final Disposal

According to the opinion survey by the Study Team, some of the disposal sites were said to be maintained under semi-sanitary landfill conditions. When the Study Team investigated the sites, however, they found that most of the disposal sites are operated under simple open dump conditions. Because the disposal sites in AYP are located at low elevations and the water table is high, disposal sites should be operated in a particularly sanitary manner to prevent leachate from seeping into the groundwater.

Five of the disposal sites have reached capacity and require either new disposal sites constructed or their capacities expanded. Especially in the disposal site at Phra Nakhon Si Ayutthaya where the majority of the wastes are disposed, its location near the World Heritage city calls for urgent action to be taken.

Because population, area and budget of each local administration, especially each Orbortor, is small, it is difficult to hire heavy machinery to operate their small scale local landfills (a few tons per day) in a sanitary fashion.

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. Furthermore, composting of food waste, which makes up about half of the waste, and thermal recycling of plastic and paper should be considered.

It is estimated that around 430,000 people living in AYP are not registered⁸. This figure would be 57% of the registered population in 2005. If this figure is accurate, the waste generation rate per person per day is around 0.5 kg/person/day which would mean that AYP has already achieved the national target.

The population of unregistered residents is the main unknown parameter without which the current situation cannot be correctly assessed for a proper solid waste management in AYP.

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.

⁸ Central Waste Disposal and Night Soil Phra Nakhon Si Ayutthaya Province, by Suwanabhumi Engineering Consultant Co., Ltd. in September 2007.

As mentioned above, the resident density is low due to settlement pattern, and it is assumed that a considerable number of residents dispose of their waste in some unidentified way. It is necessary to gain an accurate understanding of the waste stream in order to decide whether further improvements are necessary.

j.4.3. Final Disposal

As mentioned above, due to the small scale of LAs, it is difficult for them to operate local landfills in a sanitary fashion. Therefore, cooperation between several local administrations will be required.

j.4.4. Implement Master Plan

The National Solid Waste Management Plan recommended the construction of a central waste disposal system. The Orborjor of AYP has hired a private consultant to formulate a master plan for this system. Under this master plan, two central disposal centers are proposed to be constructed which will receive all the wastes from the entire province.

It is important to implement the master plan through public participation in order to obtain the public's cooperation, especially those residents living near the future central disposal sites.

k. Hazardous Waste and Toxic Substances

Situation

Hazardous waste (HW) is categorized into the following groups according to the generation source 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

The following figures indicate the location of factories and hospitals which may become generation sources of hazardous industrial waste (HIW) and medical wastes.

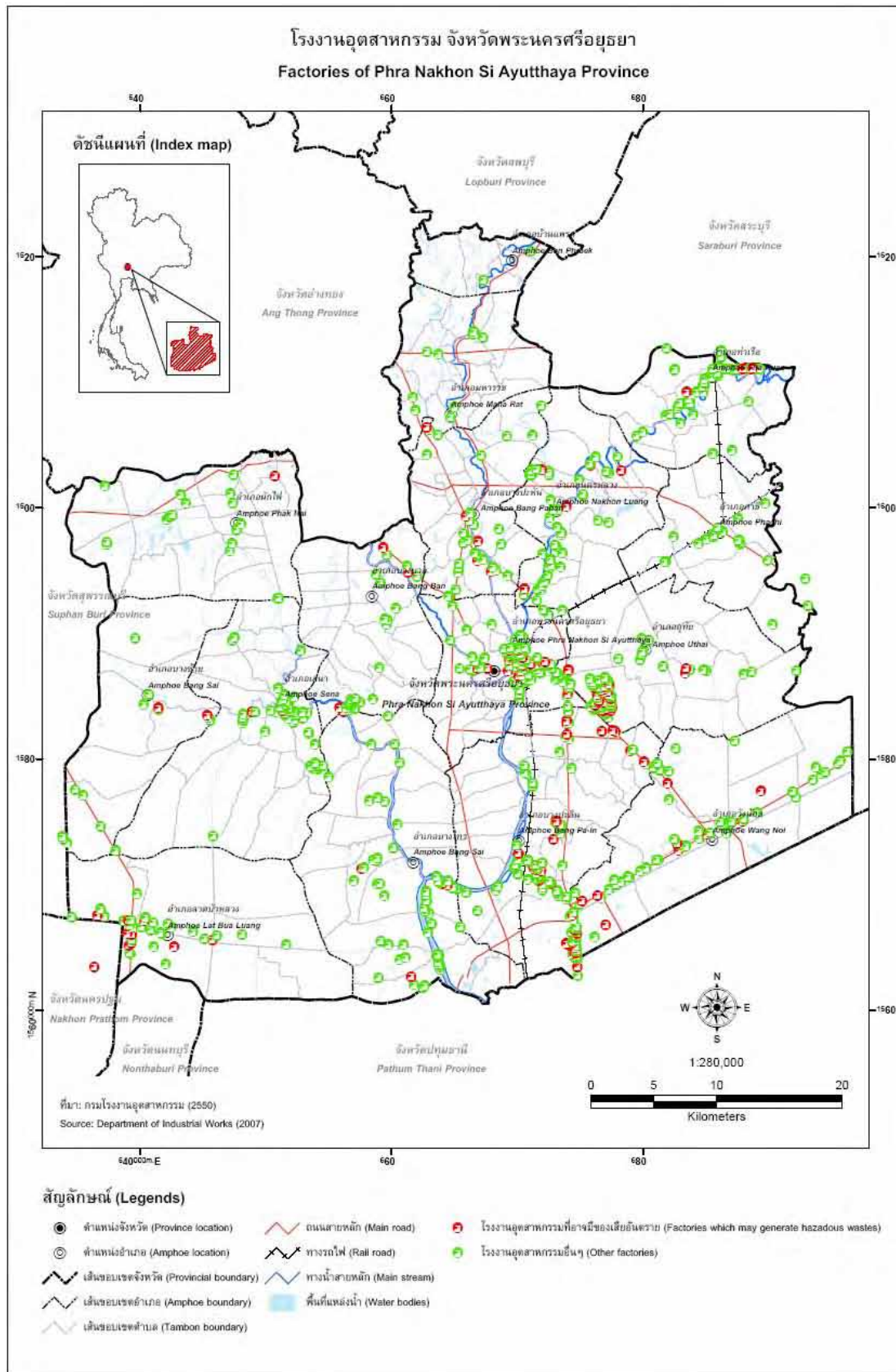


Figure 4-31: Location of Factories in AYP

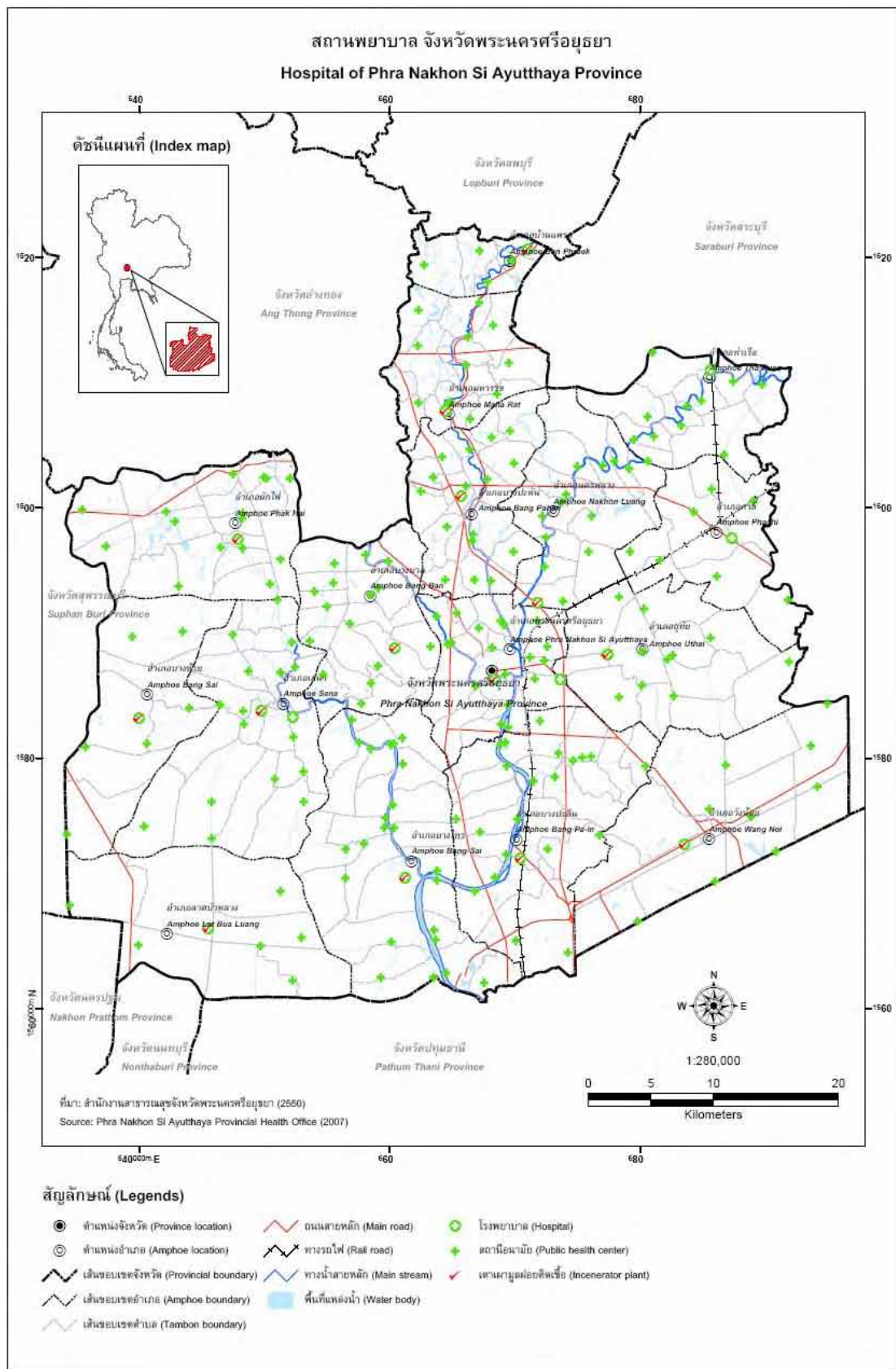


Figure 4-32: Location of Hospitals and Health Stations in AYP

k.1.1. Generation Amount of Hazardous Wastes

Domestic Hazardous Waste (HW)

No reports were available regarding the amount and quality of domestic hazardous substances contained in the municipal wastes in AYP. Therefore, the ratio of domestic HW was adopted from the REO 6 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: 549 ton/day⁹
- Ratio of Domestic HW: 0.00 – 0.07 %-municipal SW¹⁰
- Amount of Domestic HW: 0 – 0.38 ton/day

Medical Waste

There are 19 hospitals and 206 health stations in AYP, and the number of beds is 1,015 in total.¹¹

To calculate the amount of medical waste generated per bed or place, the generation rate of medical waste in Bangkok was used. The amount of medical waste is calculated as follows:

Table 4-62: Amount of Medical Waste Generated (AYP)

Generation Source	Generation Rate*	bed/place	Amount Generated
Hospital	0.46 kg/bed/day	1,015 bed	467 kg/day
Health Station	1.32 kg/place/day	206 place	272 kg/day
Total			739 /kg/day

*Note: Actual values for unit generated are for Bangkok

Industrial Waste (IW) including Hazardous Industrial Waste (HIW)

The current situation for IW is described below, in the following order:

- 1) General data on factories in AYP
- 2) Category of factories
- 3) Classification of industrial waste (non-HIW and HIW)
- 4) Industrial waste generation rate (non-HIW and HIW)
- 5) Methodology of estimating industrial waste generation
- 6) Generation amount

(1) General Data on Factories

There are 1,441 factories located in the province according to information provided by DIW. The industrial wastes generated at factories differ according to their business code.

The amount of industrial waste (IW) generated is calculated based on the data obtained by “The Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity in the Kingdom of Thailand (JICA 2002)”.

⁹ Source : REO 6 Nonthaburi, 2006

¹⁰ Source : PCD 2003, Muang District Municipality’s Waste Components

¹¹ Source: PEQMP for KPI by AYP

- Number of factories: 1,441¹²,
- Number of employees: 156,177,
- Category of factories: 33 categories,
- Category of waste: 14 categories for Non-HIW (Hazardous Industrial Waste)
12 categories for HIW,
- Rate of recycling : Non-HIW 86.5%, HIW 33.3%,
- Generation rate: Per employee of each factory category.

(2) Category of Factories

Business codes for factories have been categorized into 33 codes, simplified from 106 MOI codes¹³.

Table 4-63: Study Code and MOI Code of Factories

Study Code	MOI Code	Description of Industries
G01	001 – 002, 004 – 009	Food (agricultural product, non-aquatic animals, aquatic animals etc.)
G02	010 – 015	Food (flour, sugar, tea, ice, etc.)
G03	016 – 021	Drink, Beverage
G04	022	Textile, Thread, Fibre
G05	023 – 027	Textile product (Clothes, mats, etc.)
G06	028	Apparel
G07	029 – 033	Hide, Fur, Footwear
G08	034	Woodwork (any or many items)
G09	035 – 036	Woodwork (bamboo, rattan, straw, cork, etc.)
G10	037	Furniture
G11	038 – 040	Paper, Cardboard
G12	041	Printed matter
G13	042 – 050	Chemical matter, Petroleum
G14	051 – 052	Rubber
G15	053	Plastic product
G16	054 – 058	Glassware, Ceramics, non-Metallic Matter
G17	059 – 060	Steel basic industries, non-ferrous metal basic industries
G18	061 – 062	Metal products (tools, appliances, household furniture, building interior, etc.)
G19	063	Metal product (construction, installation)
G20	064	Metal product (others)
G21	065 – 066	Machines (Engines, Turbines, Machinery)
G22	067	Machines (for producing metal or wood products)
G23	068	Machines (for paper, chemical, food, textile etc.)
G24	069 – 070	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors, etc.)
G25	071 – 073	Electric product (Machines or Product under No.70, Radio set, Electric

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.

¹³ From the amendment of a ministerial regulation (No.15 BE 2544, 2001) pursuant to the Factory Act, enacted December 2001.

		instruments or appliances, etc.)
G26	074	Electric product (Electric Equipment)
G27	075 – 077	Transportation machines (Ships, Trains, Streetcars, Cars or Trailers)
G28	078 – 080	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles, etc.)
G29	081 – 084	Precision machinery
G30	085 – 087	Others (Musical instruments, Sport, Toys, etc.)
G31	088 – 094	Others (Electric power, Gas, Packaging, Cold storage, etc.)
G32	095	Others (Engine-driven for vehicles or motorcycles, etc.)
G33	003, 096 – 106	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt, etc.)

(3) Classification of Industrial Waste (IW)

- **Non Hazardous Industrial Waste (Non-HIW)**

The code for non-HIW is categorized, and non-HIW classified as follows, based on the Notification of Ministry of Industry No. 1, B.E. 2541 (1998).

Table 4-64: Classification of Non-HIW

Non-HIW Code	Description
C01-01	Parts of plants such as roots, bark and leaves
C01-02	Parts of animals such as bones, skins, hair and excreta
C02	Parts of wood
C03	Paper waste
C04	Plastics or synthetic rubbers
C05	Cloth, thread and fabric
C06	Animal fat and oil and vegetable oil
C07	Natural rubbers
C08	Metals and metal alloys (not in salt form)
C09-01	Ceramics
C09-02	Glasses
C10	Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete
C11	Mixed waste
C12	Others

- **Hazardous Industrial Waste (HIW)**

The code for HIW is categorized, and HIW classified as follows, based on the MOI Notification No. 6 B.E. 2540 (1997) issued pursuant to the Factory Act B.E. 2535 (1992).

Table 4-65: Classification of HIW

HIW Code	Description
W01	Acid
W02	Alkalis
W03	Heavy Metal Compounds
W04	Liquid Inorganic Compounds
W05	Solid Inorganic Compounds
W06	Organic Compounds

W07	Polymer Materials
W08	Fuel, Oil and Grease
W09	Fine Chemicals and Biocides
W10	Pickling Waste
W11	Filter Materials, Treatment Sludge
W12	Other Toxic substance (besides W01-W11)

(4) Industrial Waste (IW) Generation Rate

- **Non-HIW**

The rate of non-HIW generated per employee was calculated for each of the 33 categories of factory and for each type of waste based on the results of the factory survey, as shown in the following table.

Table 4-66: Non-HIW Generation Rate (per employee)

Unit: kg/year/person

Study Code	Descriptions	C01-01	C01-2	C02	C03	C04	C05	C07	C08	C09-01	C09-02	C10	C11	W12	Total
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	16.9	2,987.1		2.8	179.1			1.0				0.1	0.5	3,187.5
G02	Food (flour, sugar, tea, ice etc.)			1.6	13.9	18.6	5.1	50.8	12.2					285.0	387.2
G03	Drink, Beverage	1,294.3		0.9	3.4	18.9			4.1		1,212.8			171.2	2,705.6
G04	Textile, Thread, Fibre				8.3	30.6	327.4		62.0				7.0	13.5	448.8
G05	Textile product (Clothes, mats etc.)	577.3		16.4	16.4	259.1	40.8	0.0	0.0						910.0
G06	Wearing Apparel				7.8	0.4	222.3		0.2				58.0		288.7
G07	Hide, Fur, Footwear		443.7		3.4	55.0	134.9	8.9	1.8			8.9		1.1	657.7
G08	Woodwork (any or many items)			5,577.2	0.3				0.2				104.6		5,682.3
G09	Woodwork (bamboo, rattan, straw, cork etc.)			3,907.9	11.8								127.2		4,046.9
G10	Furniture			5,231.3	12.7				4.7				98.1		5,346.8
G11	Paper, Cardboard				720.7	58.2			16.2					1,031.6	1,826.7
G12	Printed matter				971.8	1.5			1.4					88.2	1,064.1
G13	Chemical matter, Petroleum				11.0	27.2			12.4					14.6	87.1
G14	Rubber			300.8	50.3	200.9	0.3	679.7	0.6			1.6			1,234.2
G15	Plastic product			116.7	36.5	789.7	2.1		4.4					2.7	952.1
G16	Glassware, Ceramics, non-Metallic Matter			0.1	5.1		0.2		61.9	836.1	947.8	702.3		20.1	2,573.6
G17	Steel basic industries, non-ferrous metal basic industries				30.5	30.5			15,128.3			7,623.9		46.4	22,859.6
G18	Metal product (tools, appliances, household furniture, building interior etc.)			3.4	9.2		1.4		4,313.1						4,327.1
G19	Metal product (construction, installation)			54.5		5.5			2,501.8						2,561.8
G20	Metal product (others)			2.3	133.2	1.8	4.6		653.2						795.1
G21	Machines (Engines, Turbines, Machinery)			60.2	121.1	5.0			1,928.8			30.1	352.5		2,497.7
G22	Machines (for producing metal or wood products)				10.6				335.1				10.6		356.3
G23	Machines (for paper, chemical, food, textile etc.)			2.8	1.7				547.2					21.8	573.5
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)					56.2			49.9				0.8		106.9
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)			2.4	22.4	55.0			229.2				128.0	170.7	607.7
G26	Electric product (Electric Equipment)				78.7	447.9			440.4		458.8	0.6	3.4		1,429.8
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)			3.8	46.5	15.0			61.3			1.1			127.7
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)				0.8	1.9	441.7	23.5	627.0		4.7	47.0		0.8	1,147.4
G29	Precision machinery				3.4	0.7			13.8			6.6			24.5

Study Code	Descriptions	C01-01	C01-2	C02	C03	C04	C05	C07	C08	C09-01	C09-02	C10	C11	W12	Total
G30	Others (Musical instruments, Sport, Toys etc.)		1.1	6.4	45.7	277.5	1.3		6.4				2.9		341.3
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)		70.4	0.2	115.7	7.3						1,270.8			1,464.4
G32	Others (Engine-driven for vehicles or motorcycles etc.)				4.7	7.8			27.2						39.7
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)					2.5			11.9				2.1		16.5
All Category of Factories		86.5	205.1	351.2	56.4	70.9	50.5	17.8	296.2	6.3	75.7	209.4	29.5	47.5	1,503.0

• **HIW**

HIW generation rate per employee was calculated in each of the 33 categories of factories and for each type of waste based on the result of the factory survey, as shown in the following table.

The following industrial categories may generate hazardous industrial wastes more than the others.

- G03 Drink, Beverage
- G13 Chemical matter, Petroleum
- G17 Steel basic industries, non-ferrous metal basic industries
- G20 Metal product (others)
- G25 Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances, etc.)
- G32 Others (Engine-driven for vehicles or motorcycles, etc.)

Table 4-67: HW Generation Rate per Employee

Unit: kg/year/person

Study Code	Descriptions	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	Total
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)								0.1					0.1
G02	Food (flour, sugar, tea, ice etc.)								0.2			39.5		39.7
G03	Drink, Beverage		139.8						10.4			20.7	1,553.1	1,724.0
G04	Textile, Thread, Fibre								8.2			2.4	0.3	10.9
G05	Textile product (Clothes, mats etc.)							0.0	0.0			0.8	1.8	2.6
G06	Wearing Apparel								0.1					0.1
G07	Hide, Fur, Footwear						0.5		0.0				3.2	3.7
G08	Woodwork (any or many items)						4.9		0.1			80.1	4.4	89.5
G09	Woodwork (bamboo, rattan, straw, cork etc.)								2.4				0.7	3.1
G10	Furniture						11.0		1.8			35.7	146.9	195.4
G11	Paper, Cardboard						0.4						8.1	8.5
G12	Printed matter								80.5				188.4	268.9
G13	Chemical matter, Petroleum			29.3	62.2		21.9	27.7	36.6	0.3		286.8	309.3	774.1
G14	Rubber							0.3	37.0				0.6	37.9
G15	Plastic product						73.7	141.6	94.3				132.6	442.2
G16	Glassware, Ceramics, non-Metallic Matter								0.2				6.7	6.9
G17	Steel basic industries, non-ferrous metal basic industries								4,256.0					4,256.0
G18	Metal product (tools, appliances, household furniture, building interior etc.)								4.5			68.8		73.3
G19	Metal product (construction, installation)								85.1			14.7		99.8
G20	Metal product (others)		5.5		458.2		13.6		38.2		9.1	8.8	306.5	839.9
G21	Machines (Engines, Turbines, Machinery)			46.0	5.0				72.5			29.2	3.3	156.0
G22	Machines (for producing metal or wood products)								60.5				136.7	197.2
G23	Machines (for paper, chemical, food, textile etc.)						1.7		52.7					54.4

Study Code	Descriptions	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	Total
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)			0.2	61.7		0.7	17.6	2.6			8.8	13.0	104.6
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)			1.7	12.1				0.6			1,121.6	96.2	1,232.2
G26	Electric product (Electric Equipment)	61.6		78.5					12.7		22.6		75.5	250.9
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)					10.7	1.7		28.1			185.5	96.9	322.9
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	11.1		0.2			104.8	28.2	4.7			20.4	54.2	223.6
G29	Precision machinery						4.3	17.0	20.2			8.1	0.0	49.6
G30	Others (Musical instruments, Sport, Toys etc.)											1.1	1.3	2.4
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)								0.6					0.6
G32	Others (Engine-driven for vehicles or motorcycles etc.)						43.6		324.0			373.8	4.7	746.1
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	5.0							1.0			46.6	50.1	102.7
All Category of Factories		1.6	7.0	2.9	19.6	0.6	4.8	5.0	56.4	0.0	0.8	125.3	121.7	345.7

(5) Methodology of Estimating Industrial Waste Generation

Industrial waste generation is shown in the equation given below:

$$IWG = \sum_{i=1}^n \sum_{j=1}^m (M_i \cdot G_{ij})$$

where,

- IWG : Industrial Waste Generation (tons/year)
- i : Industrial category (Study Code)
- j : Type of waste
- M : Number of employees (person)
- G : IW generation rate (tons/year/person)
- n : Number of industrial categories (33 categories)
- m : Number of waste categories

(6) Generation Amount

The amount of non-HIW and HIW generated is summarized in the following table. The results are 495.4 ton/day for non-HIW and 224.0 tons/day for HIW.

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 wastes¹⁴.

¹⁴ The study on industrial wastes in Bangkok and its vicinity carried out by the JICA in 2002

Table 4-68: Generation Amount of Industrial Waste (IW) (AYP)

Amphoe		No of Factories	No of Employees	Non-HIW (ton/day)	HIW (ton/day)	Total (ton/day)
1	Phra Nakhon Si Ayutthaya	125	3,678	32.6	2.4	35.0
2	Tha Ruer	50	3,540	13.6	1.1	14.7
3	Nakorn Luang	132	13,141	46.1	13.6	59.7
4	Bang Tsai	55	3,513	21.9	1.6	23.5
5	Bang Sai	19	1,228	14.9	0.2	15.1
6	Bang Ban	59	1,560	12.2	3.3	15.5
7	Bang Pahan	90	1,855	12.1	2.2	14.3
8	Bang Pa-in	315	54,087	140.8	92.2	233.0
9	Bang Phreak	2	7	0.1	0.0	0.1
10	Pak Hai	34	612	4.2	0.1	4.3
11	Pa Chi	12	331	2.1	0.1	2.2
12	Maharaj	14	186	1.1	0.1	1.2
13	Lad Bua Luang	56	2,401	33.3	6.9	40.2
14	Wang Noi	166	14,386	49.9	15.5	65.4
15	Sena	95	13,232	32.2	1.9	34.1
16	Uthai	217	42,420	78.3	82.8	161.1
Total Generation Amount		1,441	156,177	495.4	224.0	719.4
Recycling Rate				86.5	33.3	-
Recycle Amount				428.5	74.6	503.1
Treated & Disposal Amount				66.9	149.4	216.3

k.2 Impact Analysis

k.2.1. Result of Opinion Survey

The result of the opinion survey on hazardous and toxic substances is shown below.

Table 4-69: Result of Opinion Survey on Hazardous Waste and Toxic Substances

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	63%	28%	2%	4%	4%	0	100%
Resident	84%	10%	3%	2%	2%	0	100%
BE	86%	9%	4%	1%	0%	0%	100%

Source: Opinion survey by Study Team

According to the opinion survey, 94% of the residents, 91% of LAs and 95 % of the business entities considered that hazardous waste and toxic substances are not serious or not very serious problems.

The LAs, residents and business entities who replied that problems were very serious, specified the following aspects of and reasons for their concern: all noted that hazardous wastes were not collected separately and that hazardous substances mixed in with other domestic wastes caused hazardous conditions to people.

Table 4-70: Specific Aspects and Reasons for Concern about Hazardous and Toxic Substances

	Aspects of Concern	Reasons for Concern
LAs	No separate collection system	Causes hazardous conditions to municipality staff
Residents	No separate collection	Causes hazardous conditions to people
	Use of pesticides in agricultural area	Causes hazardous conditions to people
BEs	No separate collection	Causes hazardous conditions to people

k.2.2. Impact

Forecast of Medical Waste Generation

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

- The rate of generation in BMA is applied; specifically, 1.32 kg/bed/day in hospitals and 0.46 kg/place/day in health stations,
- The rate of generation does not change, but the number of beds and health stations increase in proportion to the population.

Table 4-71: Forecast of Generation Amount of Medical Waste (AYP)

Year	Hospital			Health Station			Total kg/day
	Bed	Generation rate kg/bed/day	Amount kg/day	Station	Generation rate kg/station/day	Amount kg/day	
2005	1,015	0.46	467	206	1.32	272	739
2006	1,016	0.46	467	206	1.32	272	739
2007	1,018	0.46	468	207	1.32	273	741
2008	1,019	0.46	469	207	1.32	273	742
2009	1,021	0.46	470	207	1.32	273	743
2010	1,022	0.46	470	207	1.32	273	743
2011	1,023	0.46	471	208	1.32	273	744

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)”.

- Number of factories : 1,441¹⁵
- Category of factories : 33 categories
- Category of waste : 14 categories for Non-HIW (Hazardous Industrial Waste)

¹⁵ 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.

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 employee increases in proportion to economic growth, but the rate of generation will not change.

Table 4-72: Forecast of Non-HIW (AYP)

	Amphoe	Unit	2005	2006	2007	2008	2009	2010	2011
1	Prha Nakhon Si Ayutthaya	ton/day	32.6	34.8	37.5	40.2	42.9	45.6	48.4
2	Tha Ruea	ton/day	13.6	15.1	16.3	17.5	18.7	19.9	21.1
3	Nakorn Luang	ton/day	46.1	51.5	55.5	59.5	63.5	67.5	71.5
4	Bang Saai	ton/day	21.9	24.4	26.3	28.2	30.2	32.0	34.0
5	Bang Sai	ton/day	14.9	16.6	18.0	19.2	20.5	21.8	23.1
6	Bang Ban	ton/day	12.2	13.6	14.7	15.7	16.8	17.8	18.9
7	Bangpahan	ton/day	12.1	13.5	14.5	15.6	16.6	17.7	18.7
8	Bang Pa-in	ton/day	140.8	157.3	169.5	181.8	194.0	206.3	218.7
9	Bang Phraek	ton/day	0.1	0.1	0.1	0.1	0.1	0.1	0.1
10	Phak Hai	ton/day	4.2	4.7	5.1	5.4	5.8	6.2	6.6
11	Phachi	ton/day	2.1	2.3	2.5	2.7	2.8	3.0	3.2
12	Maha Rat	ton/day	1.1	1.3	1.3	1.4	1.5	1.6	1.7
13	Lad Bua Luang	ton/day	33.3	37.3	40.1	43.0	45.9	48.8	51.7
14	Wang Noi	ton/day	49.9	55.8	60.1	64.5	68.8	73.1	77.5
15	Sena	ton/day	32.2	36.0	38.7	41.6	44.4	47.2	50.0
16	Uthai	ton/day	78.3	87.4	94.3	101.1	107.9	114.7	121.6
	Generation Amount	ton/day	495.4	551.7	594.5	637.5	680.4	723.3	766.8
	Rate of Recycling	%	86.5	86.5	86.5	86.5	86.5	86.5	86.5
	Recycled Amount	ton/day	428.5	477.2	514.2	551.4	588.5	625.7	663.3
	Treated and Disposed Amount	ton/day	66.9	74.5	80.3	86.1	91.9	97.6	103.5

Table 4-73: Forecast of HIW (AYP)

	Amphoe	unit	2005	2006	2007	2008	2009	2010	2011
1	Prha Nakhon Si Ayutthaya	ton/day	2.4	2.7	2.9	3.1	3.3	3.5	3.8
2	Tha Ruea	ton/day	1.1	1.2	1.3	1.4	1.5	1.6	1.7
3	Nakorn Luang	ton/day	13.6	15.2	16.4	17.5	18.7	19.9	21.1
4	Bang Saai	ton/day	1.6	1.8	2.0	2.1	2.2	2.4	2.5
5	Bang Sai	ton/day	0.2	0.3	0.3	0.3	0.3	0.4	0.4
6	Bang Ban	ton/day	3.3	3.7	4.0	4.2	4.5	4.8	5.1
7	Bangpahan	ton/day	2.2	2.5	2.7	2.9	3.1	3.3	3.5
8	Bang Pa-in	ton/day	92.2	103.0	111.1	119.1	127.1	135.1	143.2
9	Bang Phraek	ton/day	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Phak Hai	ton/day	0.1	0.2	0.2	0.2	0.2	0.2	0.2
11	Phachi	ton/day	0.1	0.1	0.1	0.1	0.1	0.2	0.2
12	Maha Rat	ton/day	0.1	0.2	0.2	0.2	0.2	0.2	0.2

13	Lad Bua Luang	ton/day	6.9	7.7	8.3	8.9	9.5	10.1	10.7
14	Wang Noi	ton/day	15.5	17.3	18.7	20.0	21.4	22.7	24.1
15	Sena	ton/day	1.9	2.1	2.3	2.5	2.6	2.8	3.0
16	Uthai	ton/day	82.8	92.5	99.7	106.9	114.1	121.3	128.6
Generation Amount		ton/day	224.0	250.5	270.2	289.4	308.8	328.5	348.3
Rate of Recycling		%	33.3	33.3	33.3	33.3	33.3	33.3	33.3
Recycled Amount		ton/day	74.6	83.4	90.0	96.4	102.8	109.4	116.0
Treated and Disposed Amount		ton/day	149.4	167.1	180.2	193	206	219.1	232.3

Summary

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

Table 4-74: Current and Future Generation of Hazardous Waste (HW)

HW	2005	2011
Domestic HW	less than 0.38 tons/day	Not available
Medical waste	about 0.739 tons/day	0.744 tons/day
Total Hazardous Industrial Waste (HIW)	about 224 tons/days	about 348 tons/days
Treated and Disposed HIW	about 149 tons/day	about 232 tons/days

Although there were many assumptions made for estimating HW generation, and the estimate thus may not be accurate, the table above indicates that the impact of improper HIW management on the environment of AYP will be significant.

k.3 Issues

- The amount of hazardous wastes generated from factories is estimated as 224 tons/day, but information on their disposal has not been identified. The impact by improper HIW management on the environment of AYP is significant,
- Although generation amount of medical waste is limited, information on 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.

I. Urban Environment

I.1 Situation

An attractive and pleasant urban space, rows of lovable houses along streets well-harmonized with surrounding green nature; those are the things which make an urban environment attractive and comfortable. At the same time animated streets, along which people take a walk, stimulates people's minds pleasantly. Even if an office is in a busy commercial district, once people step out of the business quarter, they are wrapped in a space which makes them relaxed and refreshed. Nowadays this sort of urban environment is hardly ever encountered in most large cities. However, there is a good chance that Ayutthaya could be like that, as it has substantial nature and scenery.

AYP is topographically very flat. Rice paddies and crop fields are everywhere. Fortunately, nature still dominates the living environment, leaving much opportunity to have a pleasant urban life in harmony with surrounding nature.

Ayutthaya was the capital of Ayutthaya Kingdom from 1350 to 1767. Therefore, it has substantial historical heritage which makes it a popular destination among tourists. The rivers of Chaophraya, Pasak, and Lopburi surround the city of Ayutthaya. This feature has made the city embody a lifestyle which is closely related with water, and such a lifestyle has become a tradition of Ayutthaya. The central part of Ayutthaya was registered as a World Heritage site by UNESCO in 1991. Judging from the opinion survey conducted by the Study Team, residents are proud of Ayutthaya's beautiful scenery.

Since AYP is on flat low land with no mountains, land in the province is mostly used for agriculture. Residential areas are mixed with urban/commercial areas in the city, following the rivers, canals, main roads, alleys, and housing development areas. Industrial areas are along the Pasak River, Chao Phraya River, Asia Road to the north, and Rojana Industrial Estate on Highway No.309. The cultural areas, which include archaeological sites and registered World Heritage sites, are strictly managed by the Fine Arts Department. Construction and some other activities are restricted in the cultural area. However, Phra Nakhon Si Ayutthaya is now facing a major problem in managing cultural and archeological sites due to the severe damage caused by natural weathering and by people. AYP is having a difficult time in protecting and maintaining its precious heritage.

Land use area maps help to understand the environmental situation of AYP and Phra Nakhon Si Ayutthaya Amphoe.

The urban areas (Tessaban) of AYP together with its districts (Amphoe) were shown in Figure 4-10: Tessaban (Municipality) in AYP.

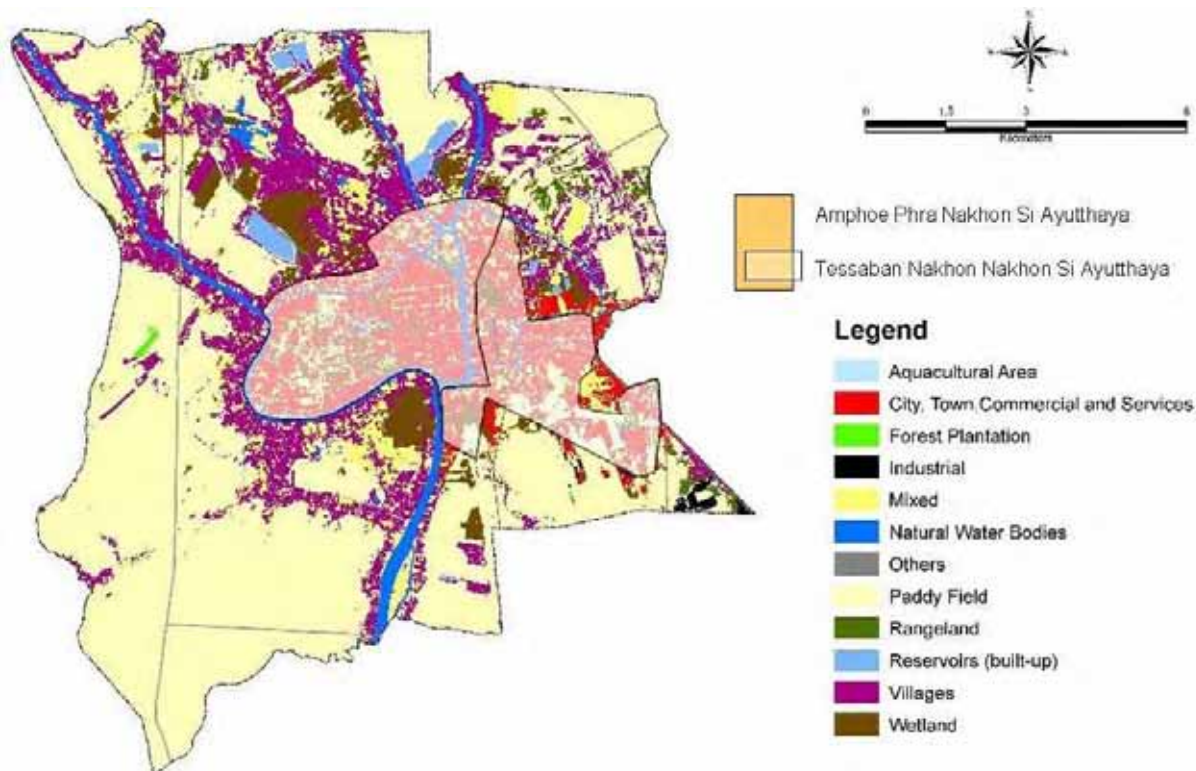
AYP has changed its economic backbone from agriculture to industry. As a result, people from several other provinces have moved into urban areas (Tessaban) of the province. Urban areas have expanded rapidly without provisions for a proper infrastructure, causing various problems related to quality of life for residents such as a lack of recreational areas and sport grounds, slums near industrial estates, insufficient power supplies, insufficient maintenance of canals, and so forth.

Table 4-75: Land Use of Phra Nakhon Si Ayutthaya Amphoe and AYP

Land Use	AYP ^{*1}		Phra Nakhon Si Ayutthaya Amphoe	
	Area (Km ²)	%	Area (Km ²)	%
City, Town, Commercial, and Services	44.81	1.78	12.35	10.63
Villages	142.88	5.66	18.13	15.61
Forest Plantation	4.36	0.17	0.08	0.07
Industrial	41.37	1.64	0.38	0.33
Natural Water Bodies	39.11	1.55	4.43	3.81
Orchards-Perennial	61.38	2.43	9.82	8.45
Paddy Field	2,076.33	82.27	61.99	53.36
Rangeland	47.50	1.88	1.11	0.96
Reservoirs(Built-up)	19.71	0.78	1.37	1.18
Extractive	14.51	0.57	0.41	0.35
Wetland	31.99	1.27	6.10	5.25
Total Area	113.71	100	116.17	100

Source: Satellite (SPOT) image, 2005, Data Analysis

Note: *1: See Figure 4-11: Land Use Map based on SPOT Satellite Image from 2005



Source: Satellite image (Spot) 2005

Figure 4-33: Land Use of Phra Nakhon Si Ayutthaya Amphoe

1.2 Impact Analysis

1.2.1. Result of opinion survey

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

Table 4-76: Result of Opinion Survey on Urban Environment

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	67%	25%	9%	0%	0	0	100%
Resident	82%	8%	4%	4%	2%	0	100%
BE	85%	9%	2%	4%	0%	0%	100%

According to the opinion survey, 90% of the residents and 92% of LAs considered that the urban environment does not have serious or very serious problems.

Residents and business entities, who replied that problems are very serious, specified that there are not enough public parks. The number of amenity facilities in urban areas need to be increased in near future according to the public request.

Table 4-77: Specific Aspects and Reasons for Concern about Urban Environment

	Aspects of Concern	Reasons for Concern
Residents	Too few public parks	No recreation facilities
BEs	Too few public parks	No recreation facilities

1.2.2. Impact

According to Table 4-14: Changes in Land Use in AYP from 1988 to 2007, there was no increase in urban and built-up land from 1988 to 1998, but a significant increase was observed from 1998 to 2007; around 50 km² changed to urban and built-up area in the last 10 years. According to the land use study, development of industrial estates was the main factor of this increase.

1.3 Issues

- Urban areas are expanding without appropriate direction, which tends to cause physical and visual congestion. Especially the expansion of residential areas near industrial estates have adverse impacts on the surroundings due to a lack of proper infrastructure,
- The development of communities is not in accordance with the master plan for urban development,
- The fact that a good urban environment is crucial for economic and cultural prosperity needs to be recognized and publicized, and a proper policy needs to be prepared,
- A provincial land and water transportation network needs to be developed,
- Roads should be lined with trees which improve not only the urban environment but also help fight global warming,
- A sufficient power supply system should be developed along with campaigns to save energy.

1.4 Measures to be Taken

- Clarify the vision of the urban environment which AYP is aiming for,
- Develop community areas according to a comprehensive urban plan,

- Ensure the administration recognizes and publicizes the fact that a good urban environment is crucial to economic and cultural prosperity, and aligns its policy accordingly,
- Support people in their effort to develop public spaces to conserve the community environment,
- Allocate funds for planning and development of a provincial transportation network in AYP,
- Work for both government and resident cooperation to develop green boulevards, urban neighborhood parks, recreational facilities and etc.,
- Increase the awareness of all stakeholders so that they work for conservation of the community environment,
- Take legal measures to protect beautiful urban scenery,
- Allocate funds for maintenance of canals.

m. Natural and Cultural Heritage

m.1 Situation

There are no mountains in AYP, which is situated in the Chao Phraya River Basin. AYP is topographically very flat (average elevation 3.5m, minimum elevation 2.0 m - 2.5 m, maximum elevation 4.0 m~5.0 m). There are four rivers, (Chao Phraya, Pasak, Lopburi, and Noi) meandering and winding through the province, which provides natural irrigation throughout the province. Numerous canals, large and small, extend in all directions. Water levels rise up high in the rainy season, which makes the land ideal for paddy fields. In fact, 80% of the area is used as agricultural land, and of that, 96% is used as paddy fields.

Phra Nakhon Si Ayutthaya, the capital of AYP, is located in the middle of the province. The city has a rich historical and cultural heritage. The central part of the city is designated as a World Cultural Heritage by UNESCO (1991). It used to be the capital of the mighty Ayutthaya Kingdom for more than four centuries beginning in the middle of the 14th century. Ayutthaya was especially prosperous during the governing period of King Narai (1656 – 1688), when Louis XIV, King of France, sent an envoy to Ayutthaya, and Ayutthaya sent an envoy to France. There were many foreign residents, e.g. Chinese, Japanese, and Europeans living in Ayutthaya at that time. It was a cosmopolitan city: remains of a Japanese town and Portuguese town remind us of those days. Unfortunately the palace, temples, stupas, and Buddha images were destroyed when the kingdom fell in the 18th century. However, even now, there are many remains, and currently, repairs of those remains are in progress.

The natural and cultural assets of Ayutthaya can be said to include the beautiful views of the countryside with numerous villages surrounded by peaceful rice fields. Among them, the ruins of the ancient city of Ayutthaya rest quietly as a World Cultural Heritage site. People of Ayutthaya are proud of their rural scenery. It is important, and can be thought of as a kind of obligation, for the people and administration of Ayutthaya to protect this extraordinary natural environment and cultural heritage and to carry them over to future generations.

Natural and cultural assets which people of Ayutthaya mentioned in the opinion survey conducted by the Study Team include:

Natural assets

- Canals,
- Rivers,
- Swamps,
- Rural scenery.

Cultural assets

- Ayutthaya World Heritage,
- Numerous temples and related facilities,
- Ancient palace,
- Holy pond,
- Museum,
- University with tradition.

The natural and cultural heritage in Ayutthaya is listed in detail in Table 4-78: their location are shown in Figure 4-34: and Figure 4-35.

Table 4-78: List of Natural and Cultural Heritage in Ayutthaya

Name of Site	Number on Map	Details	Direction	Source of Information
The Ancient Palace	40	Old palace of Ayutthaya period, only foundation of the building remains.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road to another traffic roundabout, keep going for 1km., the palace is on the left	TAT (Tourism Authority of Thailand) ONEP
Ayutthaya Historical Study Center	N/A	The center aims at collecting knowledge and history of the Ayutthaya period. It is now serving the public as a research center and museum.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, keep going for 1.5 km., the Study Center is on the left	TAT
Ban Aranjik	N/A	The famous quality knife-making village.	Take Pachi- Nakhon Luang Road to Bang Pa Han- Nakhon Luang Road, turn right to Road 3467, turn right again to Ban Na San-Ban Pin Kaew Road, keep going for 2 km., the village is on the right	TAT
Bang Pa-in Palace	N/A	Commissioned to build by King Prasat Thong on Pang Pa-in Island where HM was born. It was renovated during the reign of King Rama IV.	Take Road 308, turn right to Pang Pa-in Train Station gateway, the palace is on the right	TAT
Bang Sai Royal Folk Arts and Crafts Center	N/A	HM King Bhumipol and HM Queen Sirikit advised to construct an arts and crafts center in order to provide information about occupations in agriculture, arts, and crafts.	Take Asia Road to Western Ring Road, turn right to Sam Kok- Sena Road, turn right at Ban Tha Sung intersection, turn left to Tha Sung- See Kuk Road, keep going for 1.8 km., the center is on the right	TAT
Bung Phra Ram (Phra Ram Pond)	49	Large pond serving as recreation space for the public, and for holding city festivals.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Chi Kun Road to another traffic roundabout, keep going for 250 m, the pond is on the left	TAT ONEP
Chantharakasem National Museum	31	Old palace of King Naresuan the Great while HM was the crown prince of Pisanulok Kingdom. It was damaged and burned when Burma defeated Ayutthaya in 1767. It was rebuilt by King Rama IV for artifacts collections.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 2 km, the museum is on the left	TAT ONEP
Chao Sam Phraya National Museum	N/A	The money for museum construction came from the sales of the Buddha Amulets from Wat Rat Burana's underground hiding place.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, keep going for 1.9 km., the museum is on the right	TAT

Name of Site	Number on Map	Details	Direction	Source of Information
Chedi Sisuriyothai	45	A major heritage site of Ayutthaya, located on the west side of the city island. The chedi is the memorial of the first Thai heroine recorded (Suriyothai).	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn left to Sri Sanpetch road, turn right to U Thong Road, keep going for 2.9 km., the Chedi is on the right	TAT ONEP
City Pillar Shrine	N/A	Believed to be built when King Ramathibodi I established the kingdom. It was destroyed in about 1757. In 1982, Phra Nakhon Si Ayutthay province decided to rebuild the City Pillar Shrine for the auspiciousness of the city.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road, keep going for 230 m., the City Pillar Shrine is on the left	TAT
Elephant Kraal, the (The Phaniat or Elephant Kraal Pavilion)	32	The pavilion was built for the king to rest while observing elephant kraal.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to Uthong Road, keep going for 2.7 km, then turn right to Kudi Thong Road, the pavilion is on the right	TAT ONEP
Japanese Settlement (Japanese Village)	48	Residential area of Japanese traders in the Ayutthaya period.	Take Road 309 to traffic roundabout, turn left to Road 3059, keep going for 3 km., the village is on the right	TAT ONEP
Khun Phaen' Residence (Khum Khun Phaen)	35	Fine example of a traditional central Thai house, built in 1894, and renovated in 1945. The location was the city prison back in the Ayutthaya Period and is believed that Khun Phaen (Ayutthaya's great poet) was imprisoned here.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, take Sri Sanphet Road to another roundabout and keep on going for 130m, Khum Khun Phaen is on the left	TAT ONEP
King Naresuan Monument	N/A	3 times larger than actual size, the monument was built to honor and memorialize King Naresuan the Great. It is located on Phu Kao Thong field.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 4.4 km, turn right to Road 309, keep going for 2 km., then turn left to Lieb Mae Nam Chao Phraya Road (Road 2055), keep going for 1 km, the monument is on the right	TAT
King U Thong Monument	N/A	The half-sized statue is a standing bronze cast, smoked by green solution, located between Bung Phratram (Phratram Pond) and Wat Phra Si Sanpetch.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road to another traffic roundabout, keep going for 430 m, the Monument is on the right	TAT
Phet Fortress (Pom Phet)	23	Part of the city wall, located at the point where Chao Phraya River meets Pasak River, built during the reign of King Maha Chakrapat.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn left to Makham Rieng Road, turn left again to U Thong Road, keep going	TAT ONEP

Name of Site	Number on Map	Details	Direction	Source of Information
Phra Si Nakarin Park	N/A	Located on the south-west side of city island. This beautiful park consists of gardens, trees often described in literature, historical places, and traditional Thai gazebos.	for 200 m, Phet Fortress is on the right Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn left to Sri Sanpetch road, turn right to U Thong Road, keep going for 1.1 km, the park is on the right	TAT
Portuguese Settlement (Portugal Village)	25	Residential area of Portuguese traders in Ayutthaya period, esp. during King Ramathibodi II. The remains such as San Pedro Church, antiques, coins, pipes, and skeletons were found.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 5.2 km., turn left, cross the bridge, then turn left to Road 3469, keep going for 5.5 km, the village is on the left	TAT
Prasat Nakhon Luang	N/A	Located on the east bank of Pasak River, Nakhon Luang district for royal resting while travelling to Phra Buddha Bat (Buddha's footprint) Saraburi Province. It was built during the reign of King Song Tham, and rebuilt as permanent place during the reign of King Prasat Thong.	Take Asia Road, turn right to Pachi- Nakhon Luang Road, keep going for 14 km, Prasat Nakhon Luang is on the left	TAT
Pridi Bhanomyong Memorial	N/A	It was built to commemorate his excellency Prime Minister Pridi Bhanomyong.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 4.5 km, turn right to Pridi Bhanomyong gateway	TAT
Queen Suriyothai Monument	N/A	Half-actual-size monument of Queen Suriyothai on a royal elephant. It is located on Makhom Yong field, Ban Mai Subdistrict, which was the battle field during the war between Thailand and Burma.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 4.4 km, turn right to Road 309, keep going for 400 meters, then turn left to Road 349, keep going for 1.8 km, the monument is on the right	TAT
Siriyalai Palace	N/A	Old palace which dates back to Ayutthaya period.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn left to Phra Si Sanpetch Road, then turn right to U Thong Road, keep going for 1.4 km, the palace is on the left	TAT
St. Joseph Church	N/A	The church was built in early Ayutthaya period when France began to trade with Thailand. Its French style is thought to be the most beautiful in the South East Asian region.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 5.2 km, then turn left, cross the bridge, and follow Road 3469 for 2.4 km, the church is on the left	TAT
Thai Boat Museum	N/A	Museum of various boat models from ocean liners,	Take Road 309 to traffic roundabout, Crom Somdej Phra	TAT

Name of Site	Number on Map	Details	Direction	Source of Information
Tourism Information Center	N/A	small ferries, to traditional Thai boats. The place served as City Hall when Field Marshal P. Piboonsongkram was the Prime Minister. It was renovated by TAT and now serves as tourism information center.	Naresuan Bridge to Rochana Road, turn right to Chi Kun Road to another traffic roundabout, turn right to Bang Ian Road, keep going for 250 m, the museum is on the left Take Road 309 to traffic roundabout, Crom Somdej Phra Naresuan Bridge to Rochana Road, keep going for 2 km, the Tourism Information Center is at Phra Si Sanpetch Road intersection	TAT
Wat Ayothaya	29	Royal temple built on the area of Ayutthaya Kingdom's palace.	Take Road 309 to traffic roundabout, turn right to Road 3058, keep going for 1.8 km, the temple is on the left	TAT ONEP
Wat Borom Buddharam	N/A	King Pet Raja commissioned this temple which is now in the area of Rajabat University Phra Nakhon Si Ayutthaya. It was named Wat Krabueng Krueb then (Glazed Tile Temple) due to the yellowish green roof tiles.	Take Road 309 to traffic roundabout, Crom Somdej Phra Naresuan Bridge to Rochana Road, turn left to Phra Si Sanpetch Road, keep going for 200 m, the temple is on the left	TAT
Wat Boromawong Esarawaram Worawihan (Wat Boromawong)	33	Originally Wat Talei Ya, believed to be built in Ayutthaya period. The location is near the Elephant Kraal Pavillion. King Rama IV commissioned the renovation.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 2.7 km., turn right to Kudi Thong Road, turn right again to the Phaniat or Elephant Kraal Pavillian, keep going for 1.2 km, the temple is on the left	TAT ONEP
Wat Chaiphum	11	1 chedi, 1 historical mound.	Take Asia Road to Chai Na Subdistrict, Sena District	ONEP
Wat Chaiwattaram	43	Commissioned by King Prasat Thong. It was once deserted but now is renovated and designated a national historical place.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 5.2 km., turn left, cross the bridge to Road 3469, keep going for 700 meters, the temple is on the left	TAT ONEP
Wat Chan Prathet	4	4 chedi.	Take Asia Road to Ban Mai Subdistrict, Phra Nakhon Si Ayutthaya District	ONEP
Wat Changyai	3	1 boad.	Take Asia Road to Wat Toom Subdistrict, Phra Nakhon Si Ayutthaya District	ONEP
Wat Chermg-tha	47	Believed to be built in 1357 at the pier opposite to Wat Phutthaisawan. It was renovated by Phraya Kosa Dhibodi Pan during the reign on King Narai the Great, and again during the reign of King	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 3.8 km, turn right to the alley in front of Na Phra Maen Temple, then turn left to Wat Chermg Tah	TAT ONEP

Name of Site	Number on Map	Details	Direction	Source of Information
		Borommakod.		
Wat Chumphon Nikayaram	17	Commissioned by King Prasat Thong in 1632, and was renovated during the reign of King Rama IV	Near bridgehead and railroad	TAT ONEP
Wat Du Si Da Ram	15	1 boat, 1 wiham, 9 chedi.	Take Asia Road to Han Tra Subdistrict, Phra Nakhon Si Ayutthaya District	ONEP
Wat Kasattrathirat	44	Old temple with large pagoda, dated back to Ayutthaya period.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 5.2 km, turn left, cross the bridge, keep going for 300 meters, the temple is on the right	TAT ONEP
Wat Ket	6	3 chedi, 1 wiham, 1 historical pond.	Take Asia Road to Ban Mai Subdistrict, Phra Nakhon Si Ayutthaya District	ONEP
Wat Khian Lai	1	2 chedi.	Take Asia Road to Ban Phraek Subdistrict, Ban Phraek District	ONEP
Wat Khit (Wat Kwid)	16	1 historical mound, low wall surrounding pagoda.	Take Asia Road to Phra Kao Subdistrict, Bang Ban District	ONEP
Wat Khok	10	1 historical mound.	Take Asia Road to Klong Ta Kien Subdistrict, Phra Nakhon Si Ayutthaya District	ONEP
Wat Khun Muang Jai	21	Old temple of Ayutthaya period, believed to share the same period as Wat Thammikarat.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, the temple is on the right near Chi Kun intersection	TAT ONEP
Wat Khunsan	30	Believed to be built in 16th or 17 th century. In the royal annals, it is said that Phraya Kiet, Phraya Ram, and Mon people, who followed King Naresuan the Great after the declaration of independence, decided to settle down here, at Ban Karmin Subdistrict, near Wat Khun San in 1584.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 2.3 km., the temple is on the left	TAT ONEP
Wat Kkok Muang	14	1 mandala, 1 belfry, 1 historical mound.	Take Asia Road to Kok Muang Subdistrict, Pachi District	ONEP
Wat Kiang	8	1 boat, 1 Wiham, 4 chedi, 1 belfry, 1 historical well.	Take Asia Road to Klong Sa Bua Subdistrict, Phra Nakhon Si Ayutthaya District	ONEP
Wat Kudidao	27	Old beautiful temple, now deserted and damaged.	Take Road 309 to traffic roundabout, turn right to Road 3058, keep going for 1 km., the temple is on the left	TAT ONEP

Name of Site	Number on Map	Details	Direction	Source of Information
Wat Lokayasutha	42	The large reclining Buddha built of brick and cement 29 meters in length. The present remains of the temple are hexagonal in shape, believed to be the foundation of a viharn.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road to another traffic roundabout, turn right to Pa Tone Road, turn right to Klong Toh Road, keep going for 600 m., turn left to Wat Worachettharam gateway, keep going for another 620m, Wat Lokayasutha is on the right	TAT ONEP
Wat Mahathat	20	Built during the reign of King Ramesuan in front of the palace to the east near Pah Than Bridge in 1384.	Take Road 309 to traffic roundabout, Crom Somdej Phra Naresuan Bridge to Rochana Road, turn right to Chi Kun Road to another traffic roundabout, keep going for 400 m, the temple is on the left	TAT ONEP
Wat Maheyong	28	Built during the reign of King Borommarachathirat II (Chao Sam Phraya) in 1338. According to the annals, Burma used Wat Maheyong as the command center while blockading Ayutthaya (city) for 9 months. It was renovated in 1609 during the reign of King Tai-Sa.	Take Road 309 to traffic roundabout, turn right to Road 3058, keep going for 860 m, the temple is on the right	TAT ONEP
Wat Na Phra Men	37	Originally named Wat Meru Rachakaram. With a large and beautiful bronze Buddha image, dated back to late Ayutthaya period.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 3.8 km, and turn right to Wat Na Phra Maen gateway	TAT ONEP
Wat Niwet Thammaprawat	N/A	Commissioned to build by King Rama V in 1878 in gothic style with stained glass decoration. It is located on the island on Chao Phraya River, south to Pang Pa-in Palace.	Take cable car from Pang Pa-in Palace	TAT
Wat Phai Lom	7	3 historical mounds.	Take Asia Road to Saphan Tahri Subdistrict, Bang Ban District	ONEP
Wat Phananchong	24	Believed to be built before the Ayutthaya period. The principle Buddha image was in Maravichai post, it was recorded to be constructed in 1324 and with several renovations.	Take Road 309 to traffic roundabout, turn left to Road 3059, keep going for 2.5 km, the temple is on the right	TAT ONEP
Wat Phra Non	2	2 chedi, 1 historical mound.	Take Asia Road to Mae La Subdistrict, Nakhon Luang District	ONEP

Name of Site	Number on Map	Details	Direction	Source of Information
Wat Phra Si Sanphet	39	The royal temple of Ayutthaya period, built on the grounds of the royal palace for major ceremonies.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road, keep going for 470 m, the temple is on the left	TAT ONEP
Wat Phraram	34	Commissioned to be built by King Ramesuan on the spot where the royal cremation ceremony of King Uthong (his father) was held. The temple was located outside royal palace compound to the east, opposite to Nong Sanoh (Sanoh Pond) which is now Phraram Park.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road to another traffic roundabout, turn right to Pa Tone Road, turn left to Bung Phraram, keep going for 200 m, the temple is on the left	TAT ONEP
Wat Phu Khao Thong	46	Commissioned in 1387 by King Ramesuan. After Ayutthaya was defeated by Burma in 1569, Burmese built Chedi Phu Khao Thong on the spot. It was then renovated and adapted to Thai style by King Borommakod.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 4.4 km., turn right to Road 309, keep going for 2 km., turn left to Lieb Mae Nam Road (Road 2055), keep going for 1 km, the temple is on the right	TAT ONEP
Wat Phuthaisawan	36	Built on the site of Wiang Lek or Wiang Lhek which was the palace of King U Thong, the principle Buddha image was of early Ayutthaya period.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 5.2 km., turn left, cross the bridge, turn left again to Road 3469, keep going for 3.3 km, the temple is on the left	TAT ONEP
Wat Rat Burana	19	Commissioned by King Rachathirat II (Chao Sam Phraya) on the cremation site of Chao Ai Phraya and Chao Yee Phraya (who fought each other to death). There were also 2 chedis in front of the temple, believed to be built on the battle field.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Chi Kun Road to another traffic roundabout, keep going for 600 m, the temple is on the left	TAT ONEP
Wat Sanam Chai	12	1 boat, 7 chedi.	Take Asia Road to Sanam Chai Subdistrict, Bang Sai (บางไทร) District	ONEP
Wat Si Ka Samut	9	1 chedi, 1 historical mound.	Take Asia Road to Thanu Subdistrict, Uthai District	ONEP
Wat Suwandararam	22	Commissioned by King Phuthayodfah's father in late Ayutthaya period, showing beautiful wall paintings.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn left to Makham Rieng Road, turn left again to U Thong Road, keep going for 600 m, the temple is on the left	TAT ONEP

Name of Site	Number on Map	Details	Direction	Source of Information
Wat Tha	13	1 boad, 1 pagoda, 7 chedi, 1 small chedi, 1 belfry, 1 historical mound.	Take Asia Road to Ban Na Subdistrict, Maha Rat District	ONEP
Wat Thamma Chak	5	Historical chedi and the Wheel of Law	Take Asia Road to Wat Yom Subdistrict, Bang Ban District	ONEP
Wat Thamnikarat	18	Believed to be from the same period as Wat Phananchoenng. It was originally Wat Mukarat before changing to Thammigarat, now only ruins of stupas, and chedis.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 3.6 km, the temple is on the left	TAT ONEP
Wat Toom	N/A	Believed to be built before Ayutthaya period, and deserted after defeat to Burma in 1767. Renovated during the reign of King Rama I.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 4.4 km., turn right to Road 309, keep going for 4.7 km, the temple is on the right	TAT
Wat Worachet Thep Bamrung	N/A	Old temple dated back to Ayutthaya period.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge then U-turn to U Thong Road, keep going for 5.2 km, turn left, cross the bridge, keep going for 400 m, the temple is on the left	TAT
Wat Worachetharam	41	After King Ekka Tossarat's accession to throne in 1875, he held the royal funeral pyre for his brother (King Naresuan the Great) and commissioned the building of Wat Worachetharam to keep his brother's remaining ashes.	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road to another traffic roundabout, turn right to Pa Tone Road, turn right to Klong Toh Road, keep going for 600 m., turn left to Wat Worachetharam gateway, keep going for 300 m, the temple is on the right	TAT ONEP
Wat Yai Chaiyamongkhon	26	Commissioned by King U Thong in 1546. Later in 1592, after King Naresuan the Great defeated Burma, he ordered refurbishing and enlargement of the temple and changed the name from Wat Chai Mongkhon to Wat Yai Chai Mongkhon.	Take Road 309 to traffic roundabout, turn left to Road 3059, keep going for 1 km, the temple is on the left	TAT ONEP
Wiharn Phra Mongkhon Bophit	38	Located to the south of Wat Phra Si Sanpetch. Served as wiharn for Pra Mongkhon Bophit (name of the Buddha image).	Take Road 309 to traffic roundabout, cross Somdej Phra Naresuan Bridge to Rochana Road, turn right to Phra Si Sanpetch Road, keep going for 300 m, the temple is on the left	TAT ONEP

Sources : NREM GIS Database of AYP; Document on central Thailand tourist attractions, TAT 2000; Brochure on Phra Nakhon Si Ayutthaya tourist attractions, TAT; Document on natural heritages conservation, ONEP; Document on natural heritages conservation, ONEP; GPS, 2002; Map by RTSD, 1973-2001 (ratio 1: 50,000)

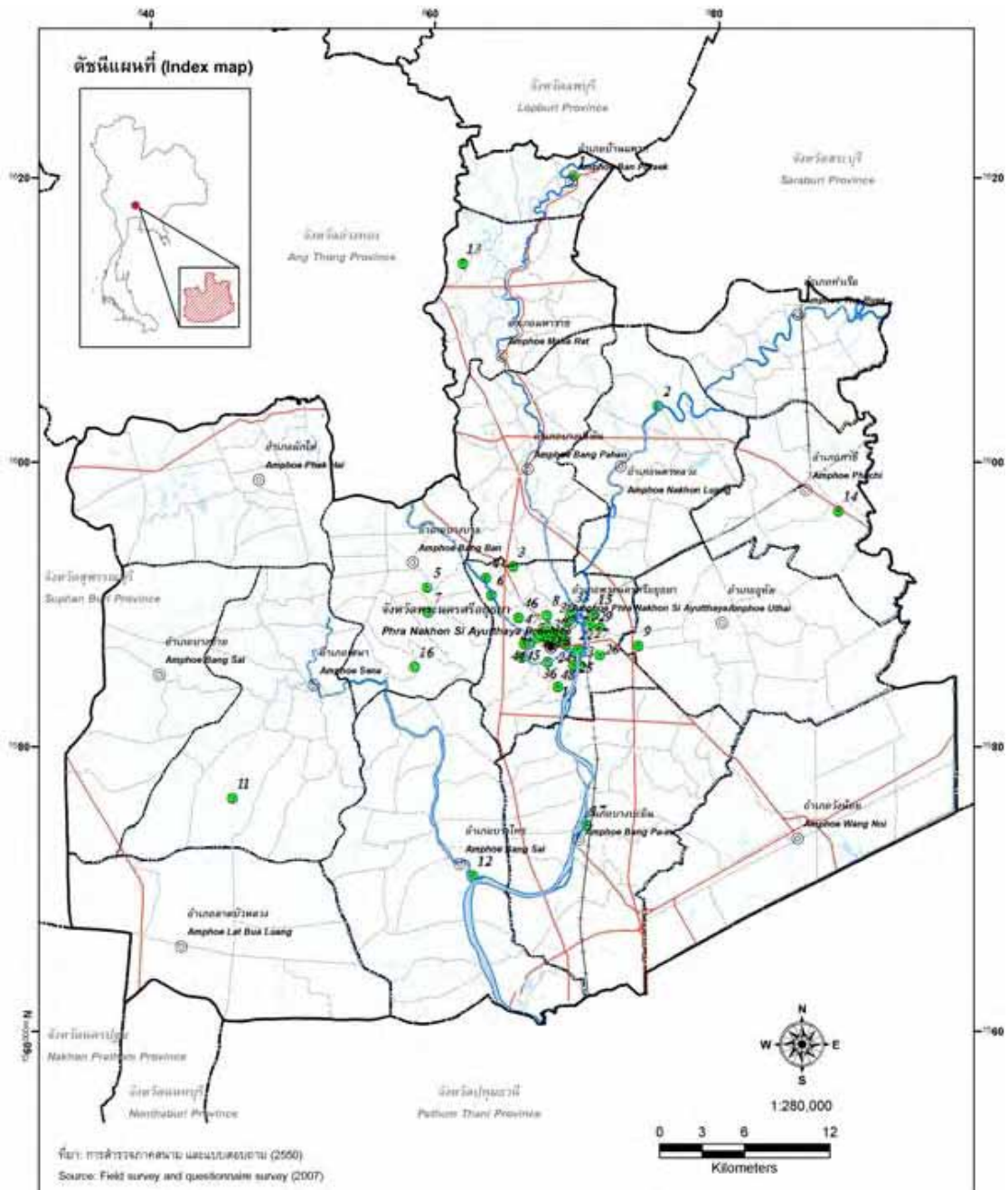


Figure 4-34: Locations of Natural and Cultural Heritage in AYP

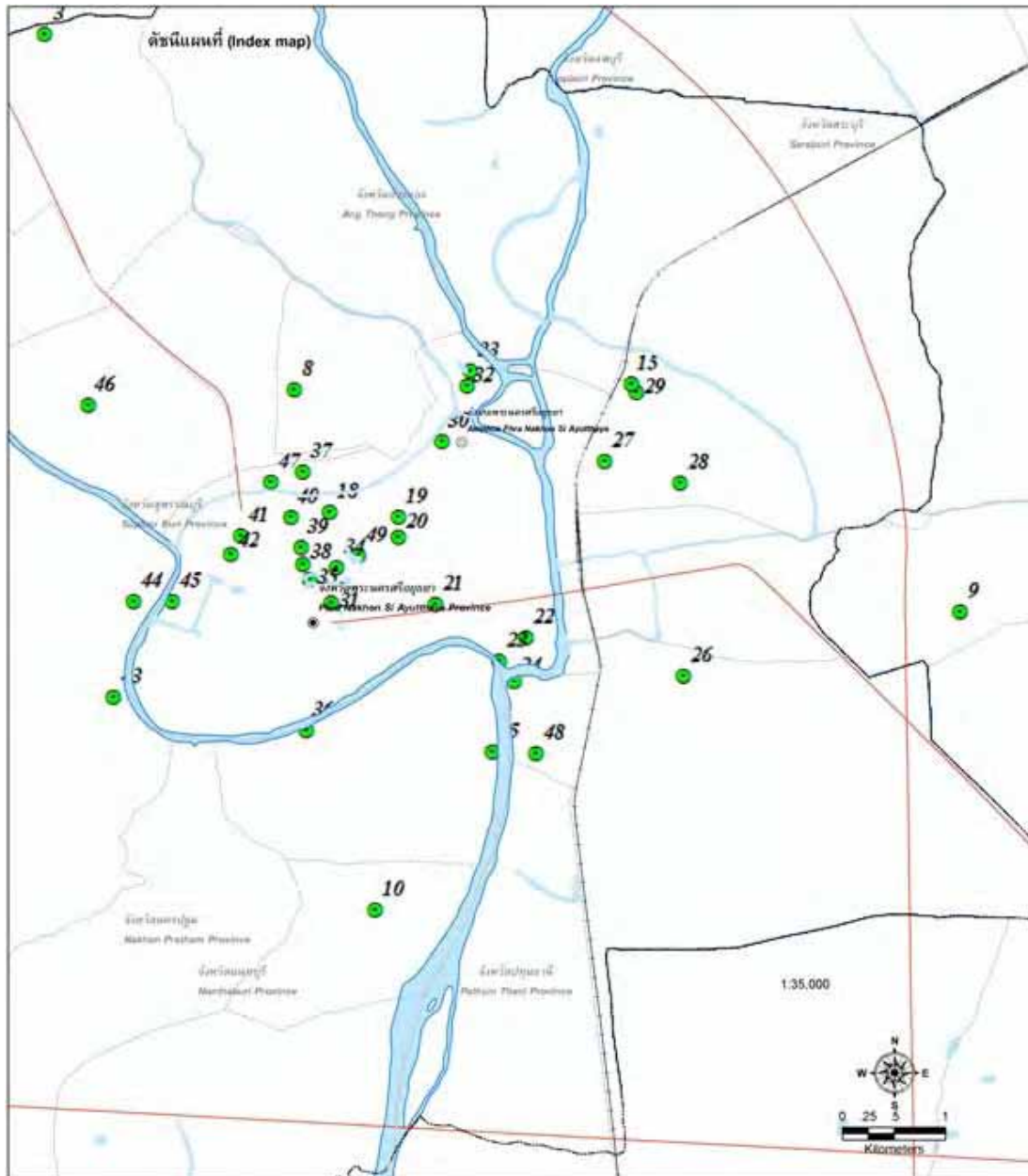


Figure 4-35: Locations of Natural and Cultural Heritage in the Ancient City of Ayutthaya

The natural and cultural heritage of AYP attracts a large number of tourists. The ancient palace, Wat Phra Sri San Phet, a ruin of the largest temple, and Wat Mahathat are quite popular among tourists. The increase in tourism requires preparation of appropriate facilities to receive tourists, and requires taking measures to protect the related environment. The following shows the number of tourists that came to AYP.

Table 4-79: Number of Visitors and Tourists in AYP

	2001	2002	2003	2004	2005
Number of Visitors	2,801,828	2,833,860	2,711,607	3,023,933	3,260,589
Thai	1,654,587	1,679,305	1,726,132	1,915,975	2,158,228
Foreigners	1,147,241	1,154,555	985,475	1,107,958	1,102,361
Number of Tourists	611,334	588,906	447,412	582,661	625,674
Thai	402,669	375,008	326,383	413,926	455,300

Foreigners	208,665	213,898	121,029	168,735	170,374
Number of Excursionists	2,190,494	2,244,954	2,264,195	2,441,272	2,634,915
Thai	1,251,918	1,304,297	1,399,749	1,502,049	1,702,928
Foreigners	938,576	940,657	864,446	939,223	931,987

Source: Ayutthaya, Provincial Statistical Report, 2006

Note: Tourists are visitors who visit the province for private reasons except work, education and who are not living or studying in the province and stay at least one night.
Excursionists means visitors who do not stay overnight in the province.
Visitors include tourists and excursionists.

m.2 Impact Analysis

m.2.1. Result of Opinion Survey

The result of the opinion survey on natural and cultural heritage is shown below.

Table 4-80: Result of Opinion Survey on Natural and Cultural Heritage

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	76%	15%	2%	7%	0	0	100%
Resident	90%	6%	2%	0%	2%	0	100%
BE	92%	5%	2	1%	0%	0%	100%

According to the opinion survey, 96% of the residents, 91% of LAs and 97 % of the business entities considered that the natural and cultural heritage does not have serious or very serious problems.

The LAs and business entities, who replied that problems were very serious, specified the following aspects of and reasons for their concern. LAs are concerned about the preservation of natural and cultural assets but are facing a shortage of funds.

Table 4-81: Specific Aspects and Reasons for Concern about Natural and Cultural Heritage

	Aspects of Concern	Reasons for Concern
LAs	No enough funds for LAs to take care of sites	LAs do not have enough funds
Residents	Some constructions damage the scenery of cultural assets	Scenery deteriorates
BE	Renovation of cultural assets	Government should pay more attention

m.2.2. Impact

Although, according to the opinion survey, people in AYP replied that the natural and cultural heritage does not face serious or very serious problems, the conditions surrounding natural and cultural assets are considered to deteriorate year by year.

m.3 Issues

- Restoration, maintenance, management, exploitation and conservation of art, cultural and historical assets,
- Sufficient and proper conservation of nature as a living environment,

- Recognizing the significance of community participation and information disclosure,
- Observation of environmental protection regulation,
- Preservation of scenery of natural and cultural assets,
- Conservation of traditional culture and performing arts.

m.4 Measures to be Taken

In order to conserve the very fortunate living environment in AYP, the following can be mentioned as environmental concerns:

- It is important to publicize the current situation of the living environment in AYP, and it is important for the administration to recognize the significance of community participation in its maintenance.
- Residents and administrations should observe the regulations for environmental protection.
- Residents and administrations should make efforts to restore, maintain, manage and conserve natural and cultural assets as well as exploiting them. For this purpose, it is necessary to develop the capacity of local administrators.
- Advocate to tourists in keeping tourism sites clean.
- Ensure functional coordination of local administration and related agencies.

AYP has drafted a master plan for the conservation and development of historical assets, "Implementation of Master Plan, Project for Conservation and Development of Phra Nakhon Si Ayutthaya Historical City". In this master plan, many projects are listed with required budgets for their implementation. The formulation of a second version of this master plan is suggested in the PEQMP-KPI of AYP.

The following problems regarding natural and cultural assets and tourism can be mentioned based on information given in the Provincial APEQM of AYP;

The art, cultural and historical assets in AYP have degraded to critical condition. Some of the important national cultural assets have been destroyed, or some are left without the proper care needed to maintain their value. The measures for conservation taken so far are ad hoc measures and not ultimate ones. Loss of important cultural assets can be attributed to the following two factors: 1) different localized environmental conditions, and 2) destruction caused by human activities, due to the changes in value resulting from newly introduced cultures, which in turn encourages improper land use. Specifically, the lack of public morals, as well as vibration and exhaust gas from construction works and vehicles has hazardous effect on cultural and historical assets. A third major factor is weathering caused by exposure to sun, wind and rain, and growth of tree roots, etc. In order to cope with these problems, the following measures are proposed in order to maintain, manage, conserve, and exploit the natural and cultural heritage and to carry them over to the next generation:

1. *Information disclosure, publication and education*
 - *Educate residents, students and children of the importance of natural and cultural assets, and to arouse their eagerness to conserve them,*
 - *Appropriate publicity as tourism resources,*
2. *Collaboration between government and private sector*

- *Collaborate with community leaders, strengthen ties with mass media,*
 - *Protect the natural and cultural assets by economic development,*
3. *Legal measures*
 - *Enact appropriate regulations to protect natural and cultural assets,*
 - *Take legal measures to make joint efforts between the private sector and government easier,*
 4. *Academic measures*
 - *Develop studies on history, archeology, ancient and traditional architecture, and arts of Ayutthaya,*
 - *Appoint academicians for restoration and rehabilitation work,*
 5. *Budgetary measures*
 - *Allocate budgets for these activities,*
 6. *Realize the “Master Plan, Project for Conservation and Development of Phra Nakhon Si Ayutthaya Historical City”,*
 7. *Draft the second version of the above Master Plan.*

n. Global Warming

n.1 Situation

According to the results of the opinion survey conducted by the Study Team, residents and Business Enterprises replied that “Global Warming/Climate Change” is the second most serious problem concerning natural resources and environment (NRE) following floods. The reasons given were that global warming/climate change are “cause of health problems” and “cause of increase of electricity cost” due to the rise of temperature. On the other hand, LAs and NGOs replied it is less serious than the other aspects.

According to the land use study conducted by the Study Team, the proportion of green areas in AYP is only 0.2%. Even when including orchards, the total comes to only 2.9%.

“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.

n.2 Impact Analysis

n.2.1. Result of Opinion Survey

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

Table 4-82: Result of Opinion Survey on Global Warming

	Not Serious	Not Very Serious	Somewhat Serious	Very Serious	Can't Choose	No Response	Total
LAs	30%	41%	22%	6%	2%	0%	100%

Resident	12%	22%	46%	19%	1%	0%	100%
BE	12%	14%	55%	14%	1%	0%	100%

71% of LAs replied that the problems from global warming are “not serious” or “not very serious”. In contrast, 65% of the residents and 69% of the business entities replied that global warming is a “very serious” or “somewhat serious” problem.

Those who replied “very serious” suggested following aspects and reasons.

Table 4-83: Specific Aspects and Reasons for Concern about Global Warming

	Aspects of Concern	Reasons for Concern
LAs	Rising a temperature	Climate change causes serious flood.
Residents	Rising a temperature	Causes health and mental problems Increase of electricity cost
BEs	Rising a temperature	Causes health problems

n.2.2. Impact

According to the land use study conducted by the Study Team, the proportion of green areas in AYP is only 0.2%. Even when orchards are included, the total comes to only 2.9%. At the same time, there are nearly 20 solid waste disposal sites in AYP and most of them are open dump operations emitting large amounts of greenhouse gas (GHG), i.e. methane gas. Thus the current situation of AYP is contributing to global warming.

n.3 Issues

- The countermeasures set up in the NSOCC are not carried out well. Especially, in spite of the extremely scarce green areas, little afforestation is carried out.
- According to the study in land use change conducted by the Study Team, the percentage of forested areas has not changed in the past 20 years. The area of “Rangeland/Wetland”, however, decreased significantly from 3.8% in 1988 to 1.5% in 2007. The decrease of the latter has been absorbed by an increase of “Urban and Built-up Land”.
- While GHG emissions from waste are significant, because final disposal sites are operated through open dumping methods 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:

- Increase forest area by afforestation;
- Enforcement of land use regulations to preserve “Rangeland/Wetland”, which has flood control functions as well as being green, from development.
- Conduct sanitary landfill operation and utilize the landfill gas. Promote 3R through public relations and education in cooperation with REO 6.