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Thailand State of Pollution Report 2013

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Preface

Thailand State of Pollution Report 2013 has been prepared under the Article 53 (9) of the Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (1992), according to which the Pollution Control Committee is responsible for annually reporting the state of pollution in Thailand to the National Environmental Board. This report is meant to provide assistance to the Board which is responsible for, among others, policy-making and planning on Thailand's pollution management. It will also be made available to the general public.

The report comprises five sections, namely: 1) state of environmental quality, which includes air quality, noise, surface water, coastal water, ground water, 2) state of waste and hazardous substances which are municipal solid waste, hazardous waste, infectious waste, and hazardous chemicals, 3) annual report of accidental pollution, 4) pollution management, and 5) Summery and suggestions. The aim is to inform the public of the current status of pollution problems, impacts and the annual pollution management in Thailand in order to raise public awareness about the significance of pollution problem solving. Furthermore, the report can be used by other relevant organizations for making plans and implementation with respect to preventing and solving the Thailand's pollution problems.

In this regard, I wish to express sincere appreciation to all concerned for their kind cooperation in providing useful information, opinions and suggestions to make the Thailand State of Pollution Report 2013 more complete.

(Mrs. Mingquan Wichayarangsaridh)
Permanent Secretary of the Ministry of Natural Resources and Environment
Chairman of the Pollution Control Committee

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Chapter 1

State of Environmental Quality

1.1 Air Quality

Air Quality in Thailand is measured from common pollutants including sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and particulate matter sized smaller than 10 microns. These pollutants were measured at 62 monitoring stations in 29 provinces. The air quality in 2013 was worse than in 2012 although it has been improving in several areas during the past six years. (Figure 1)

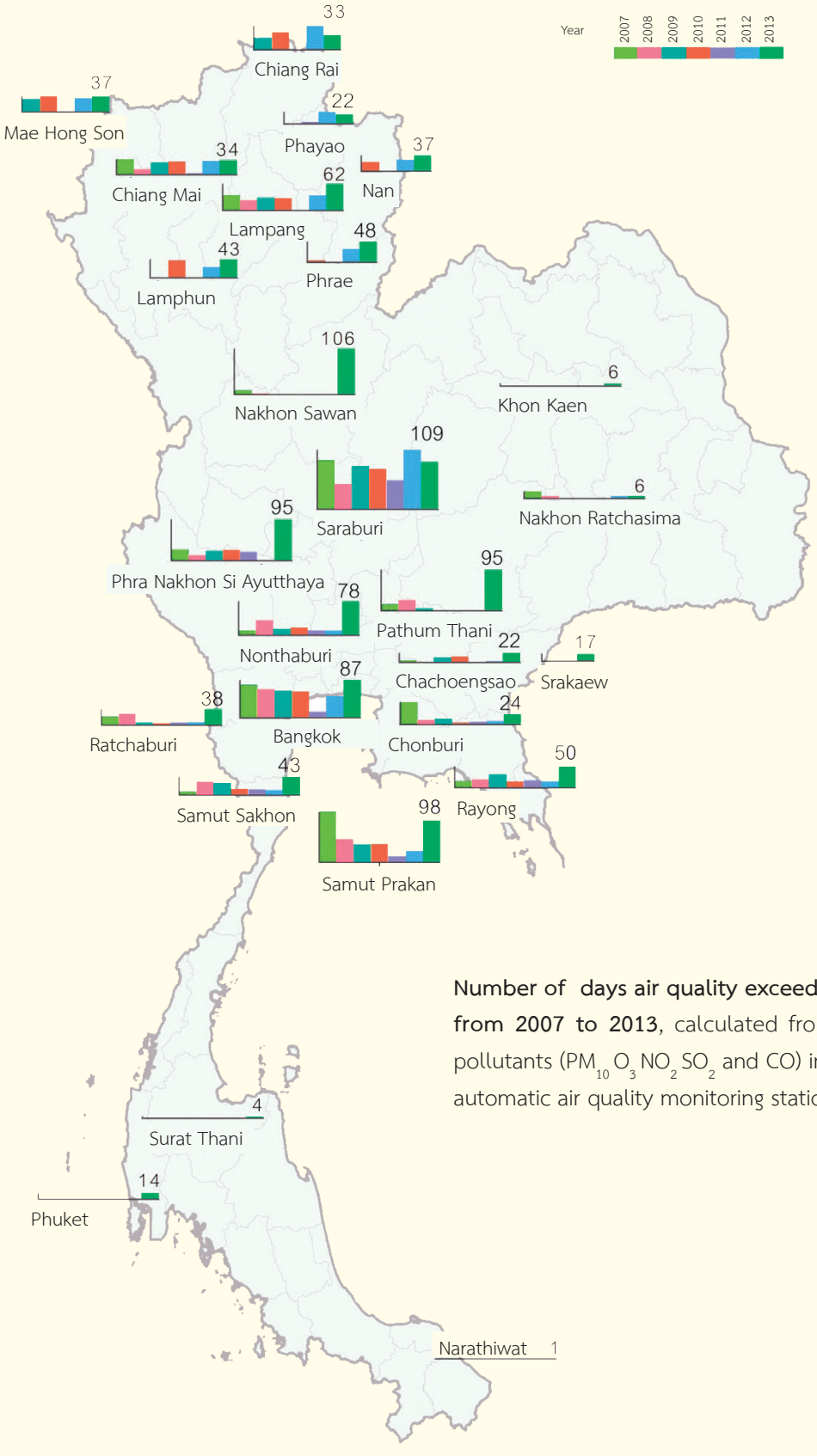
The air pollutant concentration exceeding standards found in most areas of Thailand was *ozone (O_3)*, the maximum of which was in the vicinity of Bangkok. Another major air pollutant causing some problems was *particulate matter sized smaller than 10 microns (PM_{10})* which presented the highest level in Saraburi Province, Bangkok and the upper northern provinces.

The concentration of common air pollutants lower than the standards in 2013 included sulfur dioxide, nitrogen dioxide and carbon monoxide. Compared to the past, the concentration of nitrogen dioxide was rather stable, while that of sulfur dioxide and carbon monoxide was continually decreasing.

Five Common Air Pollutants

Carbon monoxide (CO), sulfur dioxide (SO_2) and nitrogen dioxide (No_2) are categorized as the primary air pollutants, whereas **ozone (O_3)** is the secondary pollutant originating from the primary pollutants or the chemical reaction of other pollutants in the air. **Particulate matter sized smaller than 10 microns (PM_{10})** can be classified either primary or the secondary pollutant.

Exposure to these pollutants is associated with numerous effects on individual health. For instance, those who suffer from respiratory symptoms, coronary heart disease, the elderly and children may be affected by moderate concentration of air pollutants. This could trigger some acute symptoms like chest tightness, shortness of breath, stroke, and acute heart failure, etc. Healthy people, however, can also be affected by large concentration of pollutants. Moreover, air pollutants, particularly particles emitted from vehicles, industries, and open burning may contain carcinogens.



Number of days air quality exceeded the standard from 2007 to 2013, calculated from five common air pollutants (PM_{10} O_3 NO_2 SO_2 and CO) in the provinces with automatic air quality monitoring stations.

Figure 1 Number of days air quality exceeded the standard from 2007 to 2013

1.1.1 Air Quality Crisis Areas

An area of air quality crisis is a particular part of a province filled with numerous sources of air pollutants, and its air quality level continually exceeds the standard. The area, therefore, is declared a pollution-control zone so that a management plan can be set up to solve the pollution problems. The following areas in Thailand have been declared pollution-control zones.

1) Na Phra Lan Sub-district, Saraburi Province has been a pollution-control zone since 2004. Due to the fact that the District has a large number of crushing plants, stone quarries and cement plants, it has been in the highest rank of the areas with particulate matter problems. However, the situation has been improving. As seen in Figure 2, in 2013, the numbers of days for the standard exceedance of PM_{10} went down from 137 days to 95 days. Also, the annual average dropped from 107 microgram/cubic meter (µg/m^3) to 98 µg/m^3. This resulted from the cooperation of entrepreneurs who had followed the measures and regulations imposed by the government sector. Further, in the future, the relevant agencies and the private sector will push to enforce the principles of Green Supply Chain to control particulate matter as well as the supply chain starting from manufacturers to customers. Moreover, the principles will help take more control for the transport of rock and its products as well as all relevant manufacturing like brick blocks, calcium hydroxide and mineral dressing.

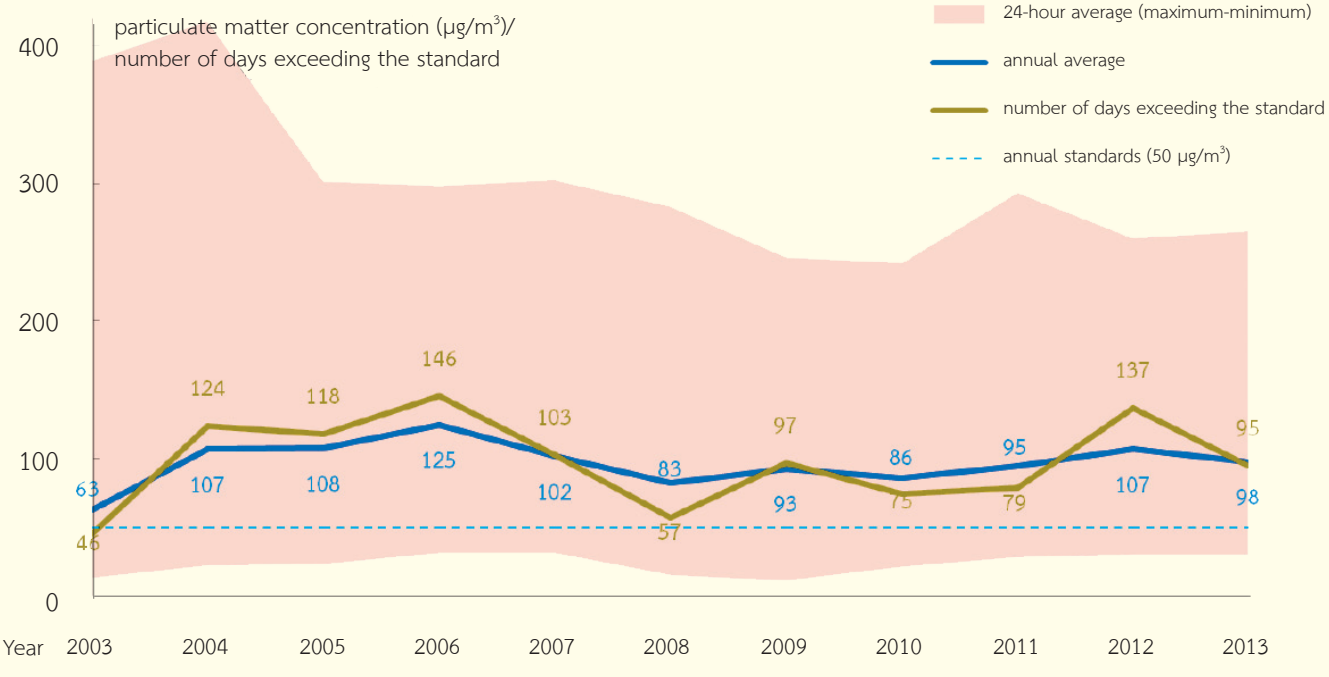


Figure 2 Concentration of particulate matter measured at Na Phra Lan Sub-district, Saraburi (2003 - 2013)

2) Map Ta Phut Sub-district, Rayong Province has been in a pollution control zone since 2009. Its major air pollutants are volatile organic compounds (VOCs) which involve easily evaporating organic chemicals in the surrounding air. According to the whole area average, exceedances in standards of benzene, 1,3-butadiene, and 1,2,-dichloroethane were found in some measuring spots. There was no change in benzene concentration from 2012 to 2013, whereas the concentration of 1,3-butadiene and 1,2-dichloroethane slightly increased (Figure 3). It was discovered that the main problem was not caused by regular production of the industrial sector, but it resulted from closures for renovation, equipment and machinery maintenance, the start-up of operational system and some activities at the ports including how to maintain, handle and transport this kind of chemicals. To cope with these problems, all relevant agencies have to set standards and strict measures to control the distribution of VOCs in all activities mentioned above.

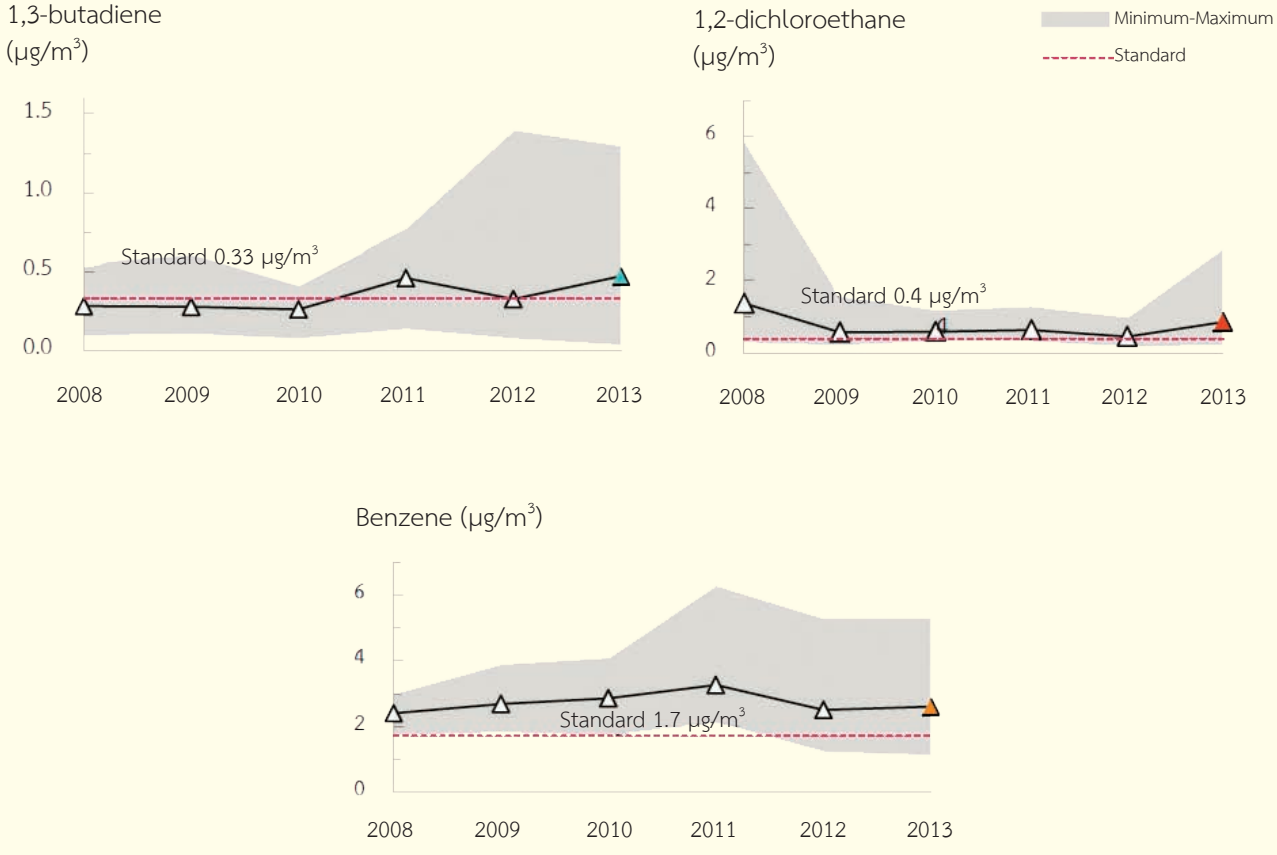


Figure 3 Trends on volatile organic compounds concentration (VOCs) - Map Ta Phut Industrial Estate, Rayong (2008 - 2013)

3) Bangkok and its vicinity - The area around Bangkok has been the pollution-control zone since 1994. It was found that air pollutants like small particles, ozone, and VOCs were still continually exceeding standards during the past 10 years (Figure 4 and 5). In 2013, the air pollutant level in Bangkok and its vicinity was relatively higher than that in any other regions of the country. This was due to the transportation sector, which was a main source of air pollutants (The accumulated rate of automobile registration increased by 9% in 2013). Moreover, the concentration of VOCs including formaldehyde and acetaldehyde which can originate from O_3 were found increasing in relation to a rise in gasohol consumption. In particular, old automobiles with inappropriate engine maintenance emitted both substances in higher parameters than new automobiles or those with good maintenance. Additionally, the vicinity area was also polluted by ozone discharged from power plants and industrial factories.

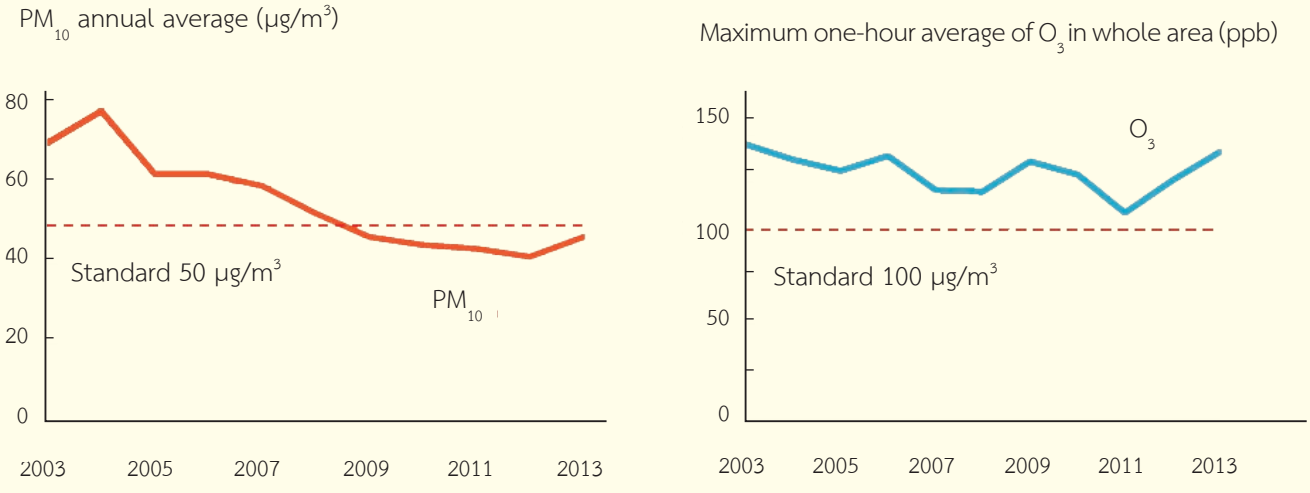


Figure 4 Annual average of particulate matter (PM_{10}) and maximum one-hour average of ozone in each measuring station in Bangkok and its vicinity (2003 - 2013)

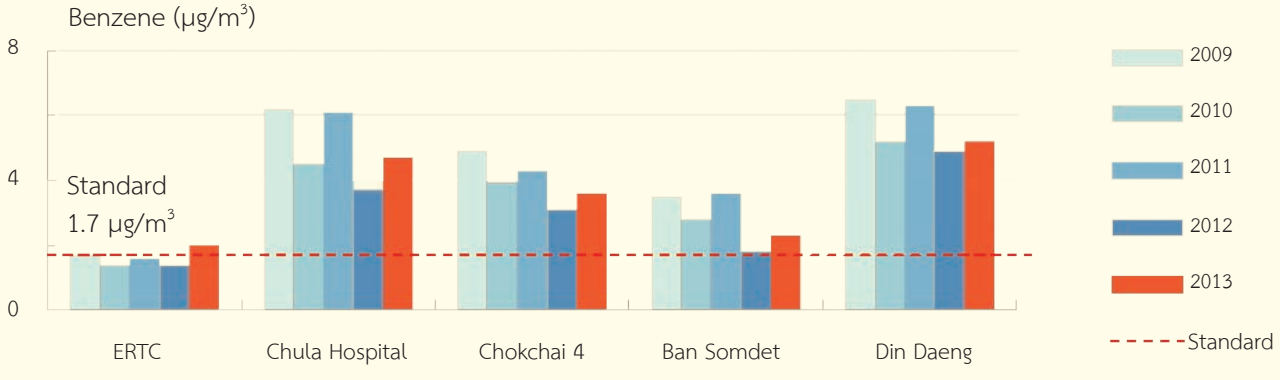


Figure 5 Benzene concentration in the air from measuring spots in Bangkok (2009 - 2013)

4) The upper northern region - Haze crisis occurs from January to April every year. Overall, the haze situation in 2013 was better than that in 2012. It appeared that 24-hour average of PM_{10} exceeded standards for 45 days, while the number of days for the same situation in 2012 reached to 64 days. One reason was provincial and relevant agencies as well as the public sector conformed to *the 2013 measures for preventing and solving haze pollution in nine provinces.* When considering the overall, however, in many provinces including Mae Hong Son, Lampang, Lamphun, Phrae, and Nan there were more days of air pollutant exceedances than that in the previous year. In Chiang Rai and Phayao, the number of standard exceedance days fell down. The maximum 24-hour average in Mae Hong Son was 432 µg/m^3, and the maximum annual average at Mae Moh, Lampang was 60 µg/m^3.

1.1.2 Major air pollutants

1) Particulate Matter Sized Smaller than 10 Microns (PM_{10})

The measuring results of PM_{10} particulate matter from automatic stations with continual measurement throughout the year 2013 showed that the annual averages started from 15 - 101 µg/m^3. The maximum average was at Na Phra Lan Sub-District, Chalerm Phrakiat District, Saraburi Province. The maximum 24-hour averages ranged from 46 - 432 µg/m^3, and the greatest maximum was at Chong Kham Sub-district, Muang District, Mae Hong Son. From 62 monitoring stations in 29 provinces, the PM_{10} concentration exceeding standards was found in 42 stations, or 68% of all stations. From 2008 - 2011, the average of countryside particulate matter was declining, but it was higher in 2013 due to the expansion of transport and energy sectors in that year (Figure 6).

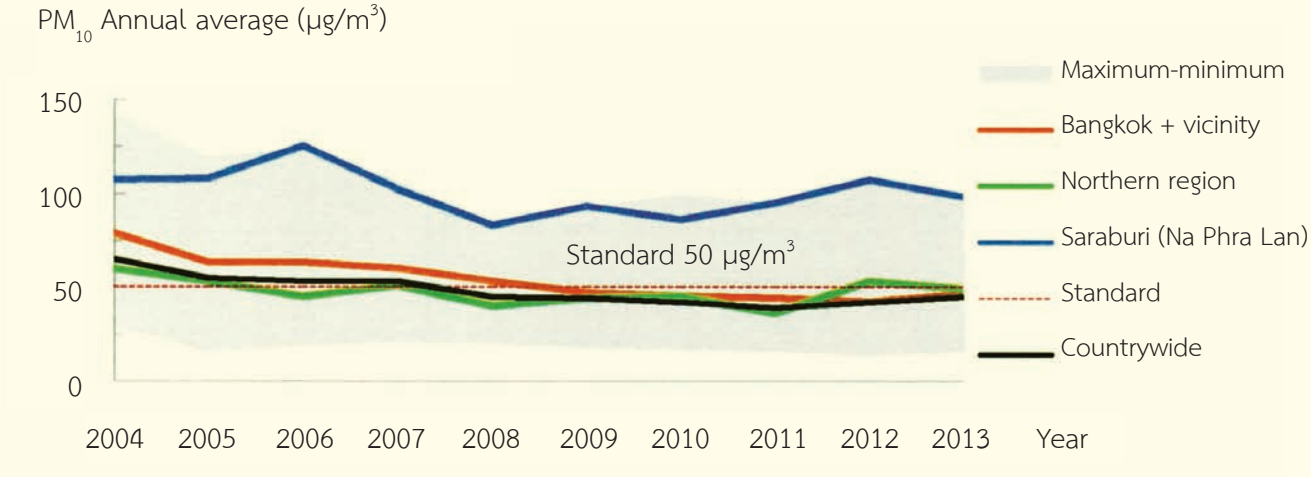


Figure 6 Annual average of particulate matter (PM_{10}) and individual area's average in 2004 - 2013

Whereas the particulate matter concentration in many regions was decreasing, that in Bangkok and the vicinity was rising. This was due to an increase in automobiles and worse traffic jam. It was revealed that the areas with high concentration of particulate matter in the country included 1) Na Phra Lan Sub-district, Chalerm Phrakiat District, Saraburi Province, 2) Phaholyothin roadside, Chatuchak distric, Bangkok, 3) Rama VI roadside, Ratchathewi Distric, Bangkok, 4) Mae Moh Sub-district, Lampang Province, and 5) Rama IV roadside, Pathumwan District (Table 1). Areas ranked by level of PM_{10} from the highest to the lowest in 2013, measured at the monitoring stations throughout the country are shown in appendix A, Table 5.

The areas polluted with particulate matter were ordered by the following criteria :

- Maximum daily averages show the maximum annual 24-hour average relating to acute health impacts
- Modes show the particle concentration most frequently found
- Annual averages are related to health impacts accumulated from exposure of polluted particles all year
- Percentages of number of days exceeding standard show health impacts likely caused by long-term and frequent exposure of pollutants

Table 1 Summary of first five areas polluted by PM_{10} ordered from maximum to minimum

Order	Provinces	Area	Maximum daily averages ($\mu g/m^3$)	Mode	Annual average ($\mu g/m^3$)	Number of days exceeding standard (%)	Total scores
1	Saraburi	Na Phra Lan Sub-district, Chalerm Phrakiat District	352	57	98	28	9
2	Bangkok	Phaholyothin roadside, Chatuchak District	303	63	82	15	12
3	Bangkok	Rama VI roadside, Ratchathewi District	178	66	74	7	36
4	Lumpang	Mae Moh Sub-district, Mae Moh District*	217	34	60	6	41
5	Bangkok	Rama IV, Pathumwan District	166	40	67	7	43

Remarks :

- Maximum daily averages, modes, annual averages and percentages of days exceeding standards were used as ordering criteria. The measuring result of each criterion in each area was ordered, and the order of each criterion was added up. The area with the minimum total score was considered the most polluted area.
- Average 24-hour standards = 120 $\mu g/m^3$, Annual standards = 50 $\mu g/m^3$
- * Existing data were less than 70% of the total measuring days

The particulate matter problem in each area was caused by different factors. For instance, automobile vehicles were the main cause of air pollutants in Bangkok and the vicinity, as well as other big cities, such as Chiang Mai and Nakhon Ratchasima. In the agricultural area of the country, air pollutants were from open burning during planting preparation. On the other hand, particulate matter in the industrial area like the area of Na Phra Lan, Saraburi resulted from a large number of crushing plants, stone quarries and cement plants. Therefore, the measures used to prevent and solve this problem should be appropriate for the main cause in each area.

2) Particulate Matter Sized Smaller than 2.5 microns ($PM_{2.5}$)

$PM_{2.5}$ has more serious impacts on human health than PM_{10} type since it canpenetrate deeper into the lungs. The first report on the measurement of $PM_{2.5}$ was done in 2010. In the year 2013, there were monitoring stations in six provincial areas including Bangkok, Saraburi, Chiang Mai, Lampang, Songkhla and Rayong. The results showed that the concentration of $PM_{2.5}$ exceeded standard in every area.

Table 2 Measuring results of 2.5 micron particulate matter or smaller ($PM_{2.5}$)

Provinces	Area	Annual average ($\mu g/m^3$)	Maximum 24-hour average ($\mu g/m^3$)	Number of standard exceedance days
Bangkok	Din Daeng Road, Din Daeng District	35	112	40
Saraburi	Na Phra Lan Sub-district, Chalerm Phrakiat District	38	140	74
Chiang Mai	Sri Phum Road, Muang District	35	188	59
Lampang *	Mae Moh Sub-district, Mae Moh District	26	71	9
Songkhla	Hat Yai Sub-district, Hat Yai District	20	51	1
Rayong	Tha Pradu Sub-district, Muang District	19	77	34

Remarks :
- Annual standard not exceeding 25 $\mu g/m^3$, average 24-hour standards = 50 $\mu g/m^3$
- *Number of measuring days less than 70% of the year

3) Ozone (O_3)

Ozone in the lower atmosphere below 10 kilometers is hazardous for life and ecological system, whereas the stratospheric ozone (20 - 30 km above the ground) helps protect living things from ultraviolet radiation. The lower ozone is caused by chemical reaction from primary air pollutants, such as volatile organic compounds (VOCs) and nitrogenoxide (NO_x) resulting from traffic, industries and open burning.

In 2013, ozone concentration was found higher than standards in almost every monitoring stations-52 out of 55 stations (95%). **The maximum one-hour average** was 73 - 190 parts-per-billion (ppb), and the highest was found at Bang Sao Thong, Samut Prakan. **The maximum eight hour average** stayed between 60 to 142 ppb with the highest at Bang Prong Sub-district, Muang District, Samut Prakan Province.

According to the order of ozone polluted areas, the first five of them included 1) Huay Pong Sub-district, Muang District, Rayong Province 2) Bang Sao Thong Sub-district, Bang Phli District, Samut Prakan Province 3) Khlong Nueng Sub-district, Khlong Luang District, Prathum Thani Province 4) Bang Prong Sub-district, Muang District, Samut Prakan Province and 5) Pratuchai Sub-district, Phranakhon Si Ayutthaya District, Pharanakhon Si Ayutthaya Province (Table 3) and areas ranked by level of ozone from the highest to lowest in 2013, measured at the monitoring stations, throught the country are shown in Appendix A, Table 6.

The ozone polluted areas were ordered according to the following criteria:

- Maximum 1 hour averages represent the maximum averages measured throughout the year related to acute health impacts.
- Modes represent the most frequently measured ozone concentration.
- Maximum 8 hour averages are related to accumulated health impacts caused by eight hours exposure of air pollutants.
- Percentages of days exceeding standard represent health impacts due-to long-term and frequent exposure of air pollutants.

Table 3 Summary of first five areas polluted by ozone in 2013 ordered from maximum to minimum

Orders	Provinces	Areas	Maximum 1 hour average (ppb)	Modes	Maximum 8 hour averages (ppb)	Percentage of days with 1-hour ozone exceedances	Total scores
1	Rayong	Huay Pong Sub-district, Muang District	150	20	117	0.68	33
2	Samut Prakan	Bang Sao Thong Sub-district, Bang Phli District	190	18	129	0.40	33
3	Pathum Thani	Khlong Nueng Sub-district, Khlong Luang District	153	11	117	2.09	34
4	Samut Prakan	Bang Prong Sub-district, Muang District	187	4	142	1.27	35
5	Phranakhon Si Ayutthaya	Pratuchai Sub-district, Phranakhon Si Ayutthaya District	143	10	117	2.10	39

Remarks :
- Maximum 1-hour averages, modes, maximum 8-hour averages, and percentages of days exceeding 1-hour ozone standard were used as ordering criteria. The measuring result of each criterion in each area was ordered before the order of each criterion was added up. The area with minimum total score was considered the most polluted area.
- Average 1-hour standards = 100 ppb; Average 8-hour standards = 70 ppb.

Maximum 1-hour average - It was found that the maximum 1-hour average of ozone exceeded standards, and its concentration has been stable since 2004. In 2013, there was a rise in ozone in many areas, particularly Bangkok and the vicinity area where its increase was greater than that in other regions (Figure 7). The major source in the urban area was automobile vehicles, while the industrial sector, petroleum, and power plants in the vicinity area, central region, and eastern region of the country were supporting factors. In Thailand, the ozone control measure is implemented along with the measure for VOCs control in its sources including chemical unloading at the ports, chemical storage in industrial factories, gas stations, and oil storage. The first control was done with the emission of VOCs in the gas stations in 23 Districts in Bangkok. With regard to automobiles, the standard quality of petrol was imposed, and certain studies on the pollution emission rates from different kinds of petrol engines were carried on. The study results were used to control and solve those pollution problems, and car users were also advised to lessen the emission of VOCs.

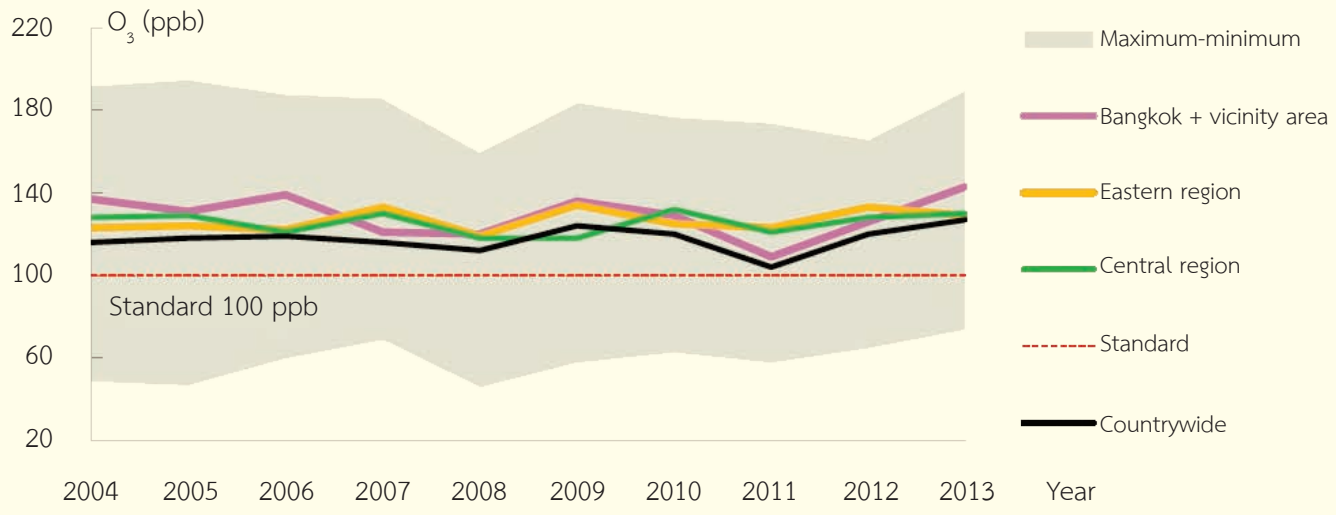


Figure 7 Maximum 1-hour average of ozone and individual area's average in 2004 - 2013

3) Volatile Organic Compounds (VOCs)

In 2013, the VOCs situation in the atmosphere was within the standards although the annual average slightly increased from the previous year. The Pollution Control Department started to measure VOCs concentration in accordance with the Notification of National Environmental Board NO. 30 (2007), setting annual average of VOCs standards and the Announcement of Pollution Control Department guideline values for 24-hour average Vocs concentration. Some examples of VOCs were collected with canisters from the atmosphere in some provinces, such as Bangkok and the vicinity, Khon Kaen, Songkhla, Rayong, and Chiang Mai.

The measuring results showed that roadside areas and industrial zones had a higher VOCs concentration than other areas. It was revealed that, in 2013, the overall image of VOCs annual average was within standards except that the annual average of benzene was exceeding standards in many areas (Figure 8). In addition, the annual averages of benzene, 1.3-butadiene and 1,2-dichloroethane were still the major problem in Rayong Province. Further, in June and July vinyl chloride was found higher than the guideline value for VOCs concentration in the atmosphere within 24 hours. This also made the annual average of vinyl chloride go exceeding standards in 2013 (Table 4). The relevant agencies investigated and controlled the emission of these chemicals, especially in processes that did not involve the regular production from industrial factories.

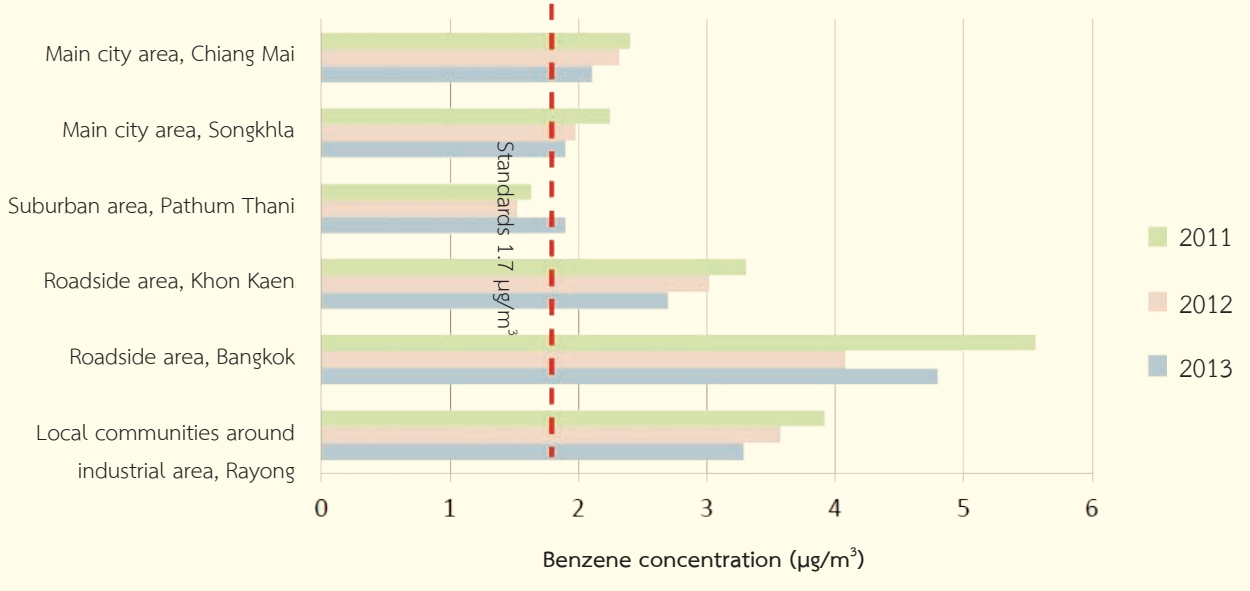


Figure 8 Annual average of benzene in 2011 - 2013

Table 4 Annual Average of Volatile Organic Compounds (VOCs) Concentration in 2013

Area	annual averages (μg/m^3)								
	Vinyl Chloride	1,3-butadiene	Dichloro Methane	Chloro Form	1,2-Dichloro ethane	Benzene	Trichloro Ethylene	1,2-dichloro propane	Tetrachloro ethylene
Standards	**10**	**0.33**	**22**	**0.43**	**0.4**	**1.7**	**23**	**4**	**200**
Bangkok									
Roadside area	0.05	0.03	2.09	0.51	0.16	4.2	0.58	0.11	0.45
Chiang Mai									
Roadside area	0.05	0.03	0.96	0.14	0.15	2.8	0.14	0.12	0.11
Commom area	0.04	0.03	0.48	0.09	0.13	1.4	0.14	0.12	0.11
Rayong	11.74	0.46	0.88	0.13	0.71	2.4	0.16	0.13	0.14
Khon Kaen	0.04	0.03	0.54	0.11	0.26	2.7	0.13	0.13	0.10
Songkhla	0.04	0.03	0.40	0.11	0.10	1.9	0.13	0.09	0.10
Pathum Thani	0.05	0.03	1.31	0.13	0.16	1.9	0.50	0.10	0.15

As mentioned above, vehicles and industrial plants were main sources of VOCs emissions. To reduce VOCs emitted from vehicles, measures on using EURO 4 standardized benzene and gasohol, has been enforced since 2012. Moreover, measures for controlling VOCs and the use of Vapor Recovery Unit (VRU) together with bottom loading systems in oil storage. Measures were also launched to regulate the emission of VOCs from major sources as well as the monitoring system in the enforcement of those measures. More importantly, to regulate the emission of VOCs in pollution-control ozone, the industries to be mentioned included 1) industries producing and/or using benzene, 2) industries producing and/or using 1,3-butadiene, 3) industries producing and/or using 1,2-dichloroethane 4) oil refinement industry, 5) fuel storage, 6) any ports where benzene, 1,3-butadiene, and 1,2-dichloroethane are kept, unloaded and transported. All relevant agencies and organization should therefore strictly conform to official safety standards in regular production. In addition, it is necessary to develop measures and standards for activities that do not involve regular production, such as business closures for renovation, equipment and machinery maintenance and start-up of machinery, etc.

1.1.3 Haze

1) Haze in Northern Region

The Pollution Control Department has continually followed and monitored the air quality in the northern region. There are 15 air quality monitoring stations in the nine northern provinces including Chiang Rai, Chaing Mai, Lamphun, Lampang, Phrae, Nan, Phayao, Mae Hong Son, and Tak. 13 stations are responsible for measuring air quality , and the other two are mobile units measuring air quality at Phu Ping Ratchaniwet Palace, Chaing Mai Province and at Mae Sod District, Tak Province.

During the 100 days strickly control burning (January 21-April 30, 2013) in the nine northern provinces, particulate matter was found exceeding standard for 45 days. As shown in Figure 9, the particulate matter levels of all provinces exceeded standards.

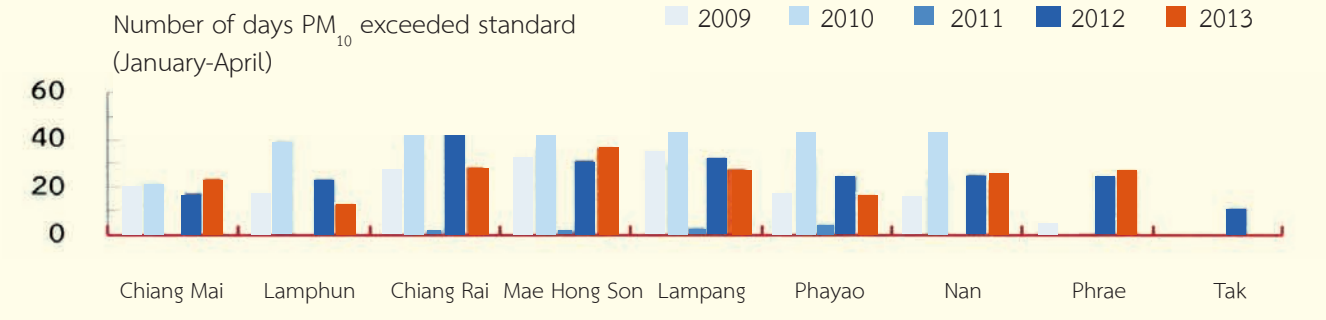


Figure 9 Number of days particulate matter concentration exceeded standards during the haze phenomenon from January to April, 2009 - 2013

Table 5 24-hour average of Particulate Matter sized smaller 10 microns (PM_{10}) in nine northern provinces from January 1 to April 30, 2014

Provinces	Maximum concentration of particulate matter (µg/m^3)	Number of days exceeding standard
Chiang Rai	308	29
Chiang Mai	229	21
Lamphun	192	12
Lampang	337	30
Phrae	225	27
Nan	264	21
Phayao	208	16
Mae Hong Son	432	35
Tak	113	-

The highest level of particulate matter concentration in 24-hour average measured at Chong Kham Sub-district, Muang District, Mae Hong Son on March 21, 2013 was 432 μg/m^3. The haze phenomenon in 2013 seemed better than that in 2012. According to Table 5, the number of days exceeding standard dropped from 64 in 2012 to 45 in 2013. Also the concentration of particulate matter went down from 479 μg/m^3 to 432 μg/m^3.

The 2013 measures for preventing and solving haze pollution in nine northern provinces were developed according to the cabinet decisions on January 8, 2013 and January 21, 2013, which are as follow:

1. Pollution Control Department was responsible for inspecting, analyzing and processing air quality data, the number of hot spots, meteorological data in order to report and give warning on the haze situation through various channels according to the four levels of particle concentration. Then, the provincial and relevant agencies and people would prepare to face the haze pollution. Daily reports and warnings were done through the use of leaflets, fax, e-mail, websites http://www.aqnis.pcd.go.th/ - www.aqnis.pcd.go.th and www.aqmthai.com, as well as Air4Thai Application.

2. Regional Environment Offices 1-4 gave support to the haze preventive operation of 70 villages in 9 northern provinces. There was an attempt to make them safe areas entitled "standardized communities and no-burn villages". A number of activities regarding the learning process and community plans to deal with haze pollution from forest fires and open burning were created. For example, villagers worked together to make fire barriers and weirs, to arrange village patrol teams, to organize workshops, brainstorming, seminars, and no-burn village contests. In addition, some equipment and forest fire extinguishers were provided for high-risk villages.

3. The northern provinces issued an announcement to prohibit burning activities during "100 days strickly control burning" (January 21 - April 20, 2013) as well as to regulate measures for intensive surveillance. These included zoning fire control, spraying water to increase humidity in residential areas, launching campaigns to enhance public participating, providing farmers with knowledge about eliminating the weed to prepare farmland by plowing rather than burning, Moreover, there were preparations for man power, vehicles, fire extinguishing equipment, and rescuers of relevant agencies in the areas in case of immediate operation.

4. Forestry Department and Department of National Parks Wildlife and Plant Conservation established a coordination center to deal with forest fires and haze in the north (available 24 hours) and set up fire-fighting networks to prevent forest fires and haze at a Sub-District or community level. Additionally, a Memorandum of Understanding (MOU) was signed between local agencies and local government organizations to prevent forest fires and also set patrol units for intensive forest fires monitoring during haze crisis.

5. Highways Department and Rural Road Department prohibited roadside weed burning and launched measures to extinguish arising fires to alleviate haze as well as to prevent car accidents and the spread of fires into forests and nearby areas.

6. Relevant agencies encouraged the private sector and its party networks to take part in the control and prevention of haze pollution, built up collaboration of all sectors including government, private, public, and volunteers for national resources and village environment in each area as well as raised funds to support the control and prevention of forest fires and haze.

7. Proactive publicity was carried out in all areas across the country–provinces, Districts, Sub-Districts and villages–, using various languages through television, radio, newspapers, billboards and mobile publicity. At the community level, all local personnel like Sub-District leaders, village chiefs, and voluntary networks were asked to continually disseminate information to villagers and inform them to stop burning during the 100 days strickly control burning. The publicity activities were done through broadcast towers, community media, and door knocks.

8. The administration center was established to prevent and mitigate haze pollutions in nine northern provinces. The single command system, led by the National Committee for Water and Flood Management, was used, and the ad hoc center was to deal with forest fires in each of the local area levels including provinces, Districts, Sub-districts and villages.

Operations to prevent and transboundary haze mitigation of pollution in the north

According to the measures for the prevention and mitigation of haze pollution at nine northern provinces, there were negotiations in the border level with The Lao People's Democratic Republic and The Union of Myanmar regarding burning control in the border areas and coordinating with ASEAN countries to enforce burning control measures to prevent transboundary haze. To enhance their abilities in transboundary haze control, training on air quality inspection and haze pollution control was organized for ASEAN countries. It was held from March 27 to March 29, 2013 with 50 participants including two representatives from each country, the representative for Office of ASEAN General Secretary, and Thai authorities from Department of National Parks, Wildlife and Plant Conservation, Forestry Department, Meteorological Department, Regional Office of Environment and Office of Provincial National Resources and Environment.

ASEAN mechanism in tackling haze pollution

1. ASEAN Agreement on Transboundary Haze Pollution aims to let the parties to the agreement take action by themselves and collaborate with other parties to prevent and control fire and haze sources by the use of environmentally friendly methods and technology. In addition, it is intended to enhance national and regional capabilities as well as to promote their collaboration in analyzing, protecting, mitigating and tackling fire and haze pollution. The Agreement has been effective since November 25, 2003. Indonesia was the only country that did not ratify the agreement.

2. The two committees dealing with transboundary haze include one with Environment Ministers from five countries in the Mekong Sub-region and the other with working groups under Environment Ministers from the same countries. (Five countries in the Mekong Sub-region comprise The Lao People's Democratic Republic, The Union of Myanmar, Vietnam, Cambodia and Thailand). The main duties of both committee involve policy making and the follow-up of fire and haze pollution control in the Mekong Sub-region.

2) Haze in the southern region

The Lower Southern Region of Thailand was affected by Transboundary haze on June 22, 2013. Many provinces in the region were covered with smoke and small particles. On June 25, 2013, the maximum concentration of particulate matter in Narathiwat was 129 ug/m^3 (Figure 10). However, due to rainfall in the fire areas of Central Sumatra and many provinces in the lower south as well as Narathiwat, the density of haze started to decrease on June 26, 2013, and the air quality finally returned to normal.

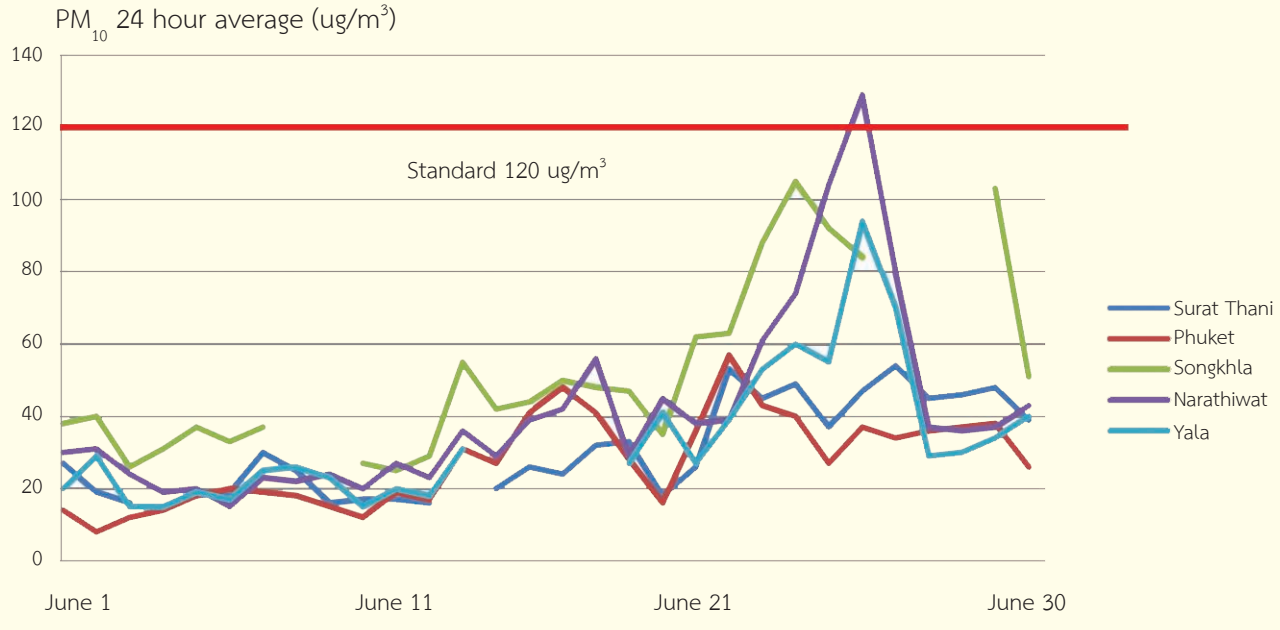


Figure 10 24-hour average of PM_{10} in Surat Thani, Phuket, Songkhla, Narathiwat and Yala (June 1 - June 30, 2013)

Transboundary haze pollution and control in the south

1. Ministry of National Resources and Environment measured air quality and reported its data through various channels like Department of Pollution Control's website (www.aqmthai.com), smart phone applications "Air 4 Thai", newspapers, radio, and television.

2. Regional Environment Office 16 (Songkhla) reported the data through The Office's website (www.reo16.mnre.go.th) everyday. The data was also reported to the Governor, relevant agencies, mass media, and networks in the area by the Office of Provincial National Resources and Environment.

3. The lower ASEAN countries including Brunei, Malaysia, Indonesia, Singapore and Thailand discussed the guidelines for preventing and dealing with transboundary haze pollution resulted from burning and forest fires in the lower ASEAN Sub-region. The discussion was done in the 15th meeting on Transboundary haze pollution by the working groups under The Environment Ministers from five countries (15th TWG & MSC), held

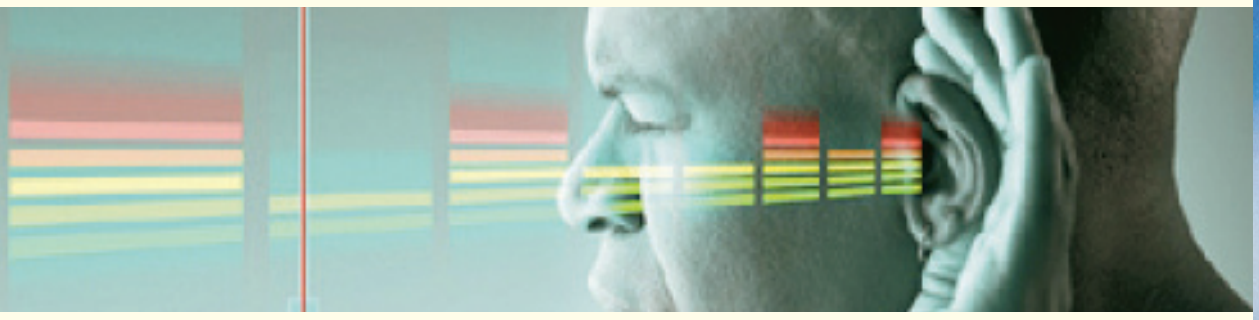
in Malaysia during July 16 - July 17, 2013. According to the resolution of the meeting, all countries must continually and strictly implement the measures to protect and control forest fires, farmland burning, and peat swamp forest burning. In addition, it was agreed that Indonesia carry on intensive operations to protect and deal with peat swamp forest and farmland burning, as well as to mobilize manpower and resources from all sectors to immediately put out a fire before it spread and push to build up community awareness and participation in preventing, reporting, and joining to put out fires. Furthermore, Indonesia has confirmed it will ratify the ASEAN agreement on transboundary haze pollution soon.

How to solve haze problems from peat swamp forest burning in Southern Thailand

1. Manage the water system in peat swamps in accordance with Pak Phanang River Basin development project; retain the water in canal branches, subcanals, and Klong Sai Kai (a kind of small canals dug around an area to drain water) make and repair weirs and dikes; make alternate water sources in peat swamp areas, and request for a support from Royal Rainmaking Project to create humidity in the areas.

2. Prevent forest fires and haze in peat swamp forests by zoning fire-control areas; ask farmers to stop burning their farmlands; promote no-burn agriculture; join to form fire patrols; use aircrafts for proactive suppression; and set up checkpoints for the use of peat swamps forests during the dry season.

3. Publicize fire prevention by sending fire patrols to give information to villagers at their homes; participate in the village monthly meetings; ask people to refrain from igniting near the areas of peat swamp forests; publicize the information to mass media and leaflets; hold exhibitions to disseminate forest fire occurrences and continually raise public awareness about them; be well-prepared for forest fire extinguishing, such as preparing firemen and all equipment; set up a rehearsal for forest fire fighting by Department of National Parks Wildlife and Plant Conservation in collaboration with Forestry Department; organize fire prevention training for the staff of rescue foundation networks, voluntary civil defense, local government organizations, and voluntary administrations.



1.2 Noise level

Thirty **automatic monitoring stations** continually measured noise levels in both roadside areas and general areas all year **in order to assess the situation and trends of noise pollution**. The result showed that roadside areas in the provinces had higher noise levels.

Noise level measuring was operated in 33 **temporary measuring locations** including in roadside areas and ground areas of Bangkok as well as roadside areas in seven provinces : Chumphon, Nakhon Si Thammarat, Surat Thani, Tak, Kamphaeng Phet, Nakhon Sawan, Uthai Thani. This operation was intended to monitor the noise situation and gather data for making environmental management plan or for solving problems arising in any relevant plans.

The overall image of noise level in Bangkok, vicinity areas, and the provinces from both automatic measuring stations and temporary measuring spots in 2013 (Figure 11)

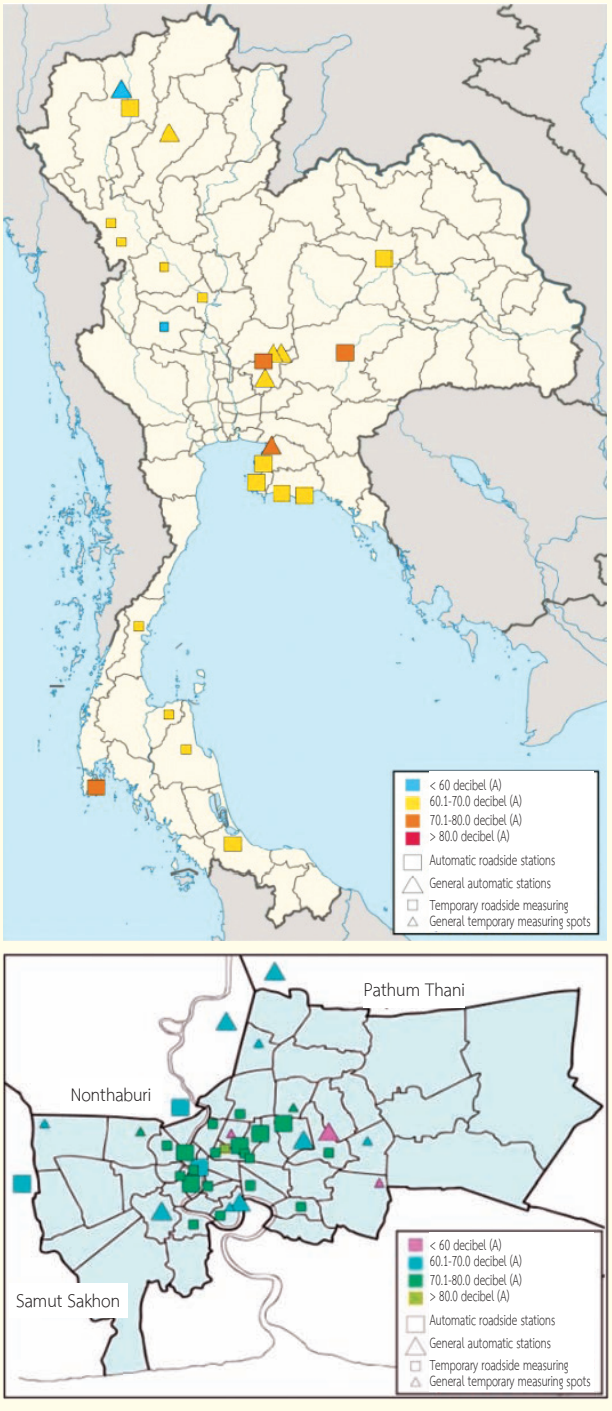


Figure 11 Noise level in Bangkok, vicinity areas, and the provinces in 2013

1.2.1 Noise level data from Automatic Monitoring Stations

In 2013, the noise level in roadside areas was higher than that in general areas, such as communities, residences, and educational institutions because of the traffic (Figure 12). During five years (2009 - 2013), the lowest 24-hour average noise level in every area was fairly higher (Figure 13). It might have been due to a larger number of vehicles and a longer period of vehicles running on the roads and in community areas. Moreover, the data on noise standard exceedances in roadside areas of Bangkok, vicinity, and the provinces tend to be higher (Figure 14).

Noise levels in Bangkok and vicinity

The noise levels in roadside areas slightly changed from last year. The average of 24-hour average noise level (L_{eq}) in 2013 was 69.1 dBA (The average in 2012 was 69.6 dBA). The areas in which the noise level exceeded standards everyday included Chokchai Police Station on Ladprao Road, Public Community Din Daeng on Din Daeng Road, and Pahurat on Tripetch Road. The noise level at Pahurat was the highest area. (The standards of 24-hour average noise level (L_{eq}) do not exceed 70 dBA).

General areas : There was no change in noise level compared to the previous year. The 24-hour average of noise level (L_{eq}) in 2013 was 58.9 dBA, while it was 58.8 dBA in 2012. The noise levels in most of the measured areas were within standards (not more than 70 dBA.

The management of noise pollution in Bangkok is operated in line with the operational plan of air and noise pollution management in Bangkok (2012 - 2016). The plan includes intensive activities, such as engine inspection for annual vehicle registration renewal, detection and inspection of loud vehicles, inspection and maintenance of Bangkok Mass Transit Authority (BMTA)'s buses and its affiliated buses to keep pollutant emissions within standards. Another important activities is the modification of road surface to lessen noise pollution.

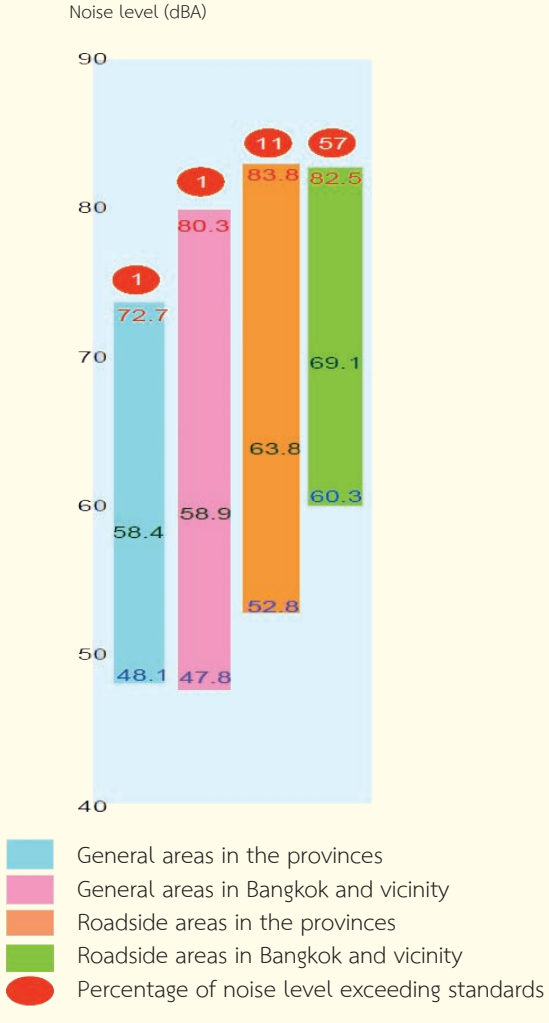


Figure 12 24-hour average noise level in 2013

Figure 13 Noise level trends during 2009 - 2013

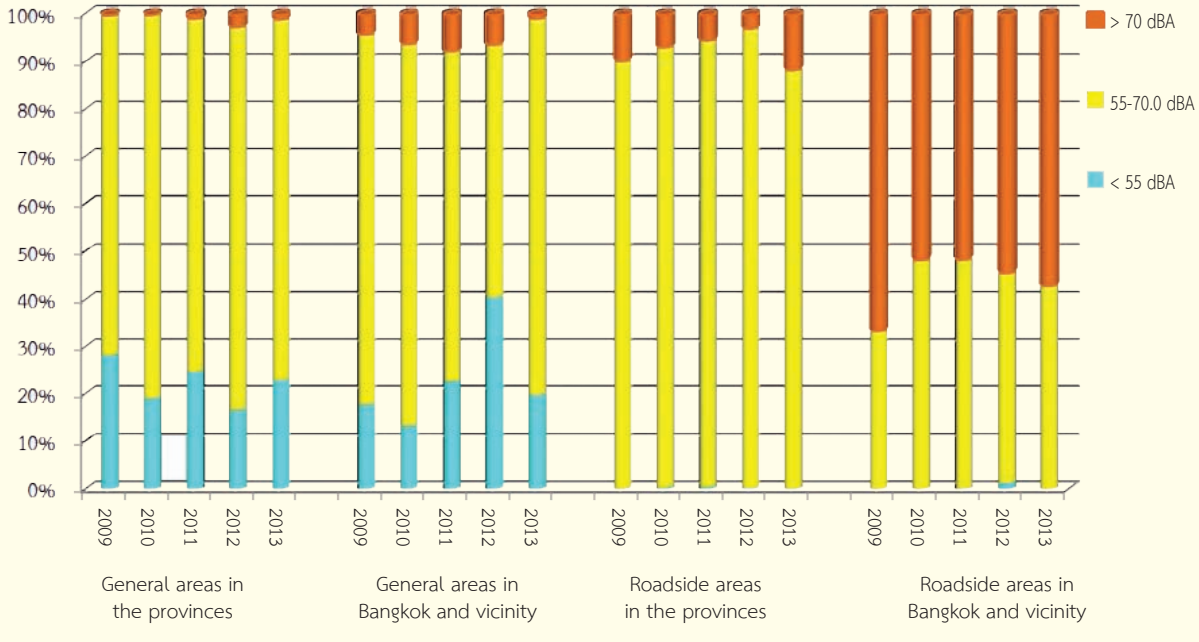


Figure 14 Percentage of 24-hour average noise level during 2009 - 2013

Noise Levels in Provincial Areas

Roadside areas : The noise level was higher than that of the previous year. Its 24-hour average (L_{eq}) was 63.8 dBA, while that in 2012 was 62.9 dBA. The area with higher noise level was Saraburi Province, which exceeded standards every day due to the traffic.

General areas : The noise level was less than in the previous year. The 24-hour average in 2013 was 58.4 dBA, while it was 59.4 dBA in 2012. The noise level in the area of Chonburi General Education Office was higher than that in other areas, which was 5% of the gathered data, due to activities within the area.

1.2.2 Noise level data from temporary monitoring stations

According to the noise measurement from 33 temporary monitoring stations in seven provinces for the monitoring and control of noise level, it was found that the level of noise from all measuring spots in roadside areas of Bangkok exceeded standard. For the general areas of Bangkok, it exceeded standard in some spots because of trading activities nearby. However, the noise level in the provinces was within standard.

Noise in Bangkok

Roadside areas : The noise in all measuring spots exceeded standard. The three roads where noise levels were found very high included Taksin Road with maximum 24-hour average (L_{eq}) of 79.7 dBA, followed by Arun Amarin-Prannok Road and Sukhumvit Road with maximum 24-hour average (L_{eq}) of 77.8 dBA.

General areas : It was found in eight measuring spots that most areas were within standard except the areas of Ladphrao District Office and Taling Chan District Office where the maximum of 24-hour averages (L_{eq}) were 75.8 and 75.0 dBA respectively. The noise in these areas was due to trading activities nearby.

Noise in the provinces

Roadside areas : The measuring results showed that the areas with higher noise levels included Dechatiwong Junction, Nakhon Sawan and Tak City Hall. The maximum 24-hour averages in these areas were 70.0 and 69.7 dBA respectively, and the noise was still within standard.

1.3 Surface Water Quality

According to the monitoring of water quality from 52 water resources in 2013, the water samples from 366 monitoring stations were collected four times/ year : the first collection was done from January to March; the second was from April to June; the third from July to September; and the fourth from October To December. The water quality was assessed by Water Quality Index (WQI)[1]. The results showed that 28% was good; 49% was fair; and 23% was poor (Figure 15 and Table 16). However, it was found that there was neither water with excellent quality and considerably degraded.

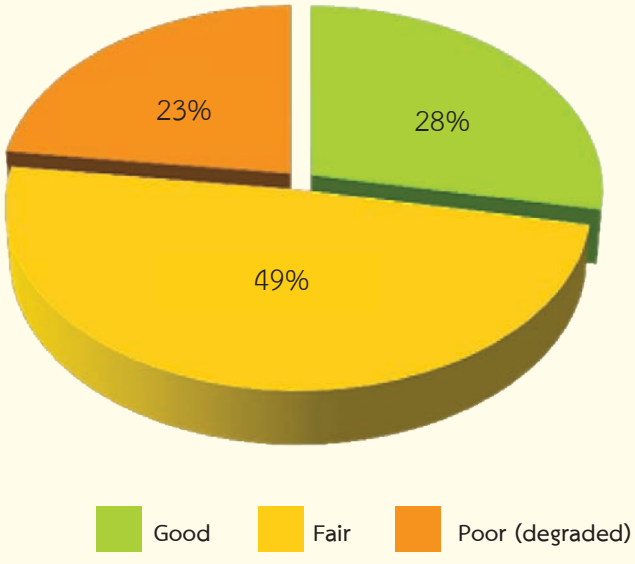


Figure 15 State of surface water quality in 2013

[1]The overall condition of water quality is indicated by Water Quality Index (WQI). It is considered from 5 water quality parameters : dissolved oxygen, Biochemical Oxygen Demand, all coliform bacteria, faecal coliform bacteria, and ammonia nitrogen with scores ranging from 0 to 100. A score from 91 to 100 is considered excellent; 71 to 90 is good, 61 to 70 is fair, 31 to 60 is poor; and 0 to 30 is very poor. For more information, go to the website http://iwis.pcd.go.th/document/WQI.pdf.

Table 6 Surface water quality measured in 2013

Water Quality	Surface water in various regions of the country					Percentage of water resources (%)
	North	Central	Northeast	East	South	
 Excellent	None	None	None	None	None	0
 Good	Wang, Ing, Kok(+) Li(+) Mae Chang	Kwae Yai, Kwae Noi	Oon, Songkhram, Nong Han, Lamchee, Upper Lamtakong	Welu, Prasae(+)	Upper Tapi, Trang, Upper Pattani, Phum Duang(+)	28
 Fair	Ping, Yom, Nan, Kuang(+) Kwan Phayao	Upper Chao Phraya, Upper Phetchaburi(-), Noi, Mae Klong, Pranburi, Kuiburi	Pong, Chi, Mun(-) Siew, Lam Pao, Loei(-)	Lower Phang Rad, Chanthaburi(-) Trat(-), Bang Pakong, Nakhon Nayok, Prachinburi	Lower Tapi, Thale Noi, Tale Luang(-), Saiburi(-), Pak Phanang, Lower Pattani, Upper Lang Suan(-), Lower Lang Suan, Songkhla Lake	49
 Poor	Bueng Boraphet	Lower Chao Phraya, Central Chao Phraya(-), Upper Tha Chin(-), Central and Lower Tha Chin, Pa Sak, Lopburi, Sakae Krang(-), Lower Phetchaburi	Lower Lamtakong	Upper Rayong, Lower Rayong, Upper Phang Rad	Chum Pon(-)	23
 Very poor	None	None	None	None	None	0

Remarks : (+) is the water resource where its water quality was 1 level higher than that of 2012

(-) is the water resource where its water quality was 1 level lower than that of 2012

In 2013, the water quality of most water resources was considered fair, but it became worse when compared with that in 2012. Evidently, eight water resources, mostly in the Northeast and the South, whose water used to be in good quality dropped to fair level. Also, four water resources, mostly in the central region, with fair quality went down to deteriorated level. These results conformed with the assessment of water quality in the past five years (2009 - 2013), which indicated that good water resources were declining, while fair and deteriorated water resources tended to rise. The water resources that have been degraded for years include the following rivers : the lower Chao Phraya, the lower Tha Chin, the central Tha Chin, the lower Lamtakong, the lower Petchaburi, the lower Rayong, and the Lopburi Rivers. The parameters indicating water contamination comprised of a high concentration of Biochemical Oxygen Demand (BOD), Fecal Coliform Bacteria (FCB), Total Comliform Bacteria (TCB), and ammonia-nitrogen (NH_3-N). The high values of these substances indicated that the water resources had received sewage discharged from community, agricultural and livestock activities.

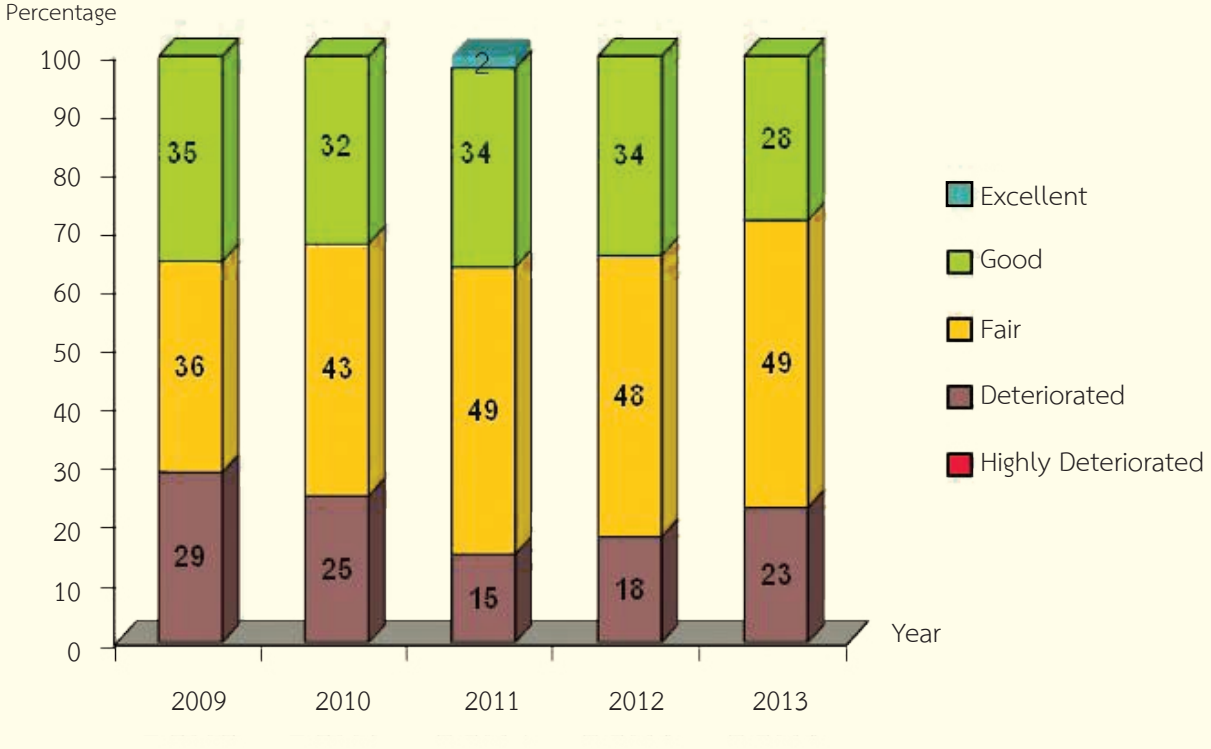


Figure 16 Surface water quality trends during 2009 - 2013

Northern Region

Generally, the water quality was in good and fair levels, and it was improving when compared with that in 2012. The parameters indicating water quality problems included FCB and heavy metals like cadmium (Cd) which were found in the areas shown in Table 7.

Table 7 Parameters indicating water quality problems found in the Northern Region

Parameters	Water Resources	Areas
FCB	Yom River	- Thani Sub-district, Muang District, Sukhothai
		- Sawankalok District, Sukhothai
		- Ban Nam Khong, Muang District, Phrae
	Nan River	- Tha Luang Sub-district, Muang District, Pichit
		- Wiang Sa District, Nan
	Kuang River	- Muang Nga Sub-district, Muang District, Lamphun
Cd	Nan River	- Bang Mun Nak District, Pichit
		- Taphan Hin District, Pichit
		- Nai Wiang Sub-district, Muang District, Nan

Central Region

The water quality of most water resources was poor, but when compared with that in 2012, it had become more degraded. The parameters indicating water quality problems were TCB, FCB, BOD, DO, and NH_3-N. The areas where these parameters were found are shown in Table 8.

Table 8 Parameters indicating water quality problems found in the Central Region

Parameters	Water Resources	Areas
TCB and FCB	Chao Phraya River	- Phra Samut Chedi District in Samut Prakan and Bang Kruai District in Nonthaburi
		- Muang District in Chainat, Phayuha Khiri District and Muang District in Nakhon Sawan
	Mae Klong River	- Ban Pong District in Ratchaburi and Tha Maka District in Kanchanaburi
	Noi River	- Pho Thong District, Ang Thong
	Phetchaburi River	- Ban Laem District and Muang District in Phetchaburi
	Pa Sak River	- Tha Ruea District in Phra Nakhon Si Ayutthaya and Lom Sak District in Phetchabun
	Tha Chin River	- Muang District, Krathum Baen District in Samut Sakhon and Sam Phran District in Nakhon Pathom
		- Muang District, Suphan Buri
BOD	Chao Phraya River	- Phra Pradaeng District in Samut Prakan, and Bang Kruai District in Nonthaburi
	Lopburi River	- Muang District in Phra Nakhon Si Ayutthaya and Muang District in Lopburi
	Pa Sak River	- Muang District in Saraburi and Wichian Buri District in Phetchabun
	Tha Chin River	- Muang District, Krathum Baen District in Samut Sakhon and Sam Phran District in Nakhon Pathom
		- Song Phi Nong District, Muang District, Sam Chuk District in Suphan Buri and Hankha District in Chainat

Table 8 Parameters indicating water quality problems found in the Central Region (Continued)

Parameters	Water Resources	Areas
DO	Chao Phraya River	- Phra Samut Chedi District in Samut Prakan and Bang Kruai District in Nonthaburi
	Tha Chin River	- Muang District in Samut Sakhon and Sam Chuk District in Suphan Buri
NH_3	Chao Phraya River	- Phra Samut Chedi District in Samut Prakan and Bang Kruai District in Nonthaburi
	Tha Chin River	- Muang District, Krathum Baen in Samut Sakhon and Sam Phran District in Nakhon Pathom

Northeastern Region

The water quality of most water resources was fair, but when compared with that in 2012, it had become more degraded. The parameter indicating water quality problems was NH_3-N caused by community sewage, drainage and soil erosion in agricultural areas which were mostly paddy fields. The areas where this parameters was found are shown in Table 9.

Table 9 Parameters indicating water quality problems found in the Northeastern Region

Parameters	Water Resources	Areas
NH_3 - N	Chi River	- Warin Chamrap District, Khueang Nai District in Ubon Ratchathani and Maha Chana Chai District, Muang District in Yasothon
		- Selaphum District in Roi Et and Ban Tha Tum, Muang District, Kosum Phisai District in Maha Sarakham
		- Muang District in Khon Kaen and Ban Kwao in Chaiyaphum
	Mun River	- Khong Chiam District, Muang District, and Warin Chamrap District in Ubon Ratchathani
NH_3 - N	Pong River	- Phra Lap Sub-district, Khok Si Sub-district, Muang District, Ban Khud Namsai Noi, Over Bueng Huay Jode about 100 metres, Nam Pong District, and Ban Bo Nok Khao Bridge
		- Ubolratana District, Khon Kaen
	Siew River	- Suwannaphum District, Kaset Wisai District in Roi Et, and Wapi Pathum District, Borabue District in Maha Sarakham

Eastern Region

The water quality of most resources was fair, and when compared with that in 2012, it had been stable. The parameters indicating water quality problems were TCB, FCB, and NH_3-N. The areas where these parameters were found are shown in Table 10.

Table 10 Parameters indicating water quality problems found in the Eastern Region

Parameters	Water Resources	Areas
TCB and FCB	Bang Pakong River	- Bang Pakong Bridge, Bang Pakong District, Cha Choeng Sao
	Chanthaburi River	- Muang District, Chantaburi
	Phang Rad River	- Na Yai Am Sub-district, Na Yai Am District, Chantaburi
	Rayong River	- Muang District and Ban Khai District, Rayong
NH_3-N	Phang Rad River	- Na Yai Am Sub-district, Na Yai Am District, Chantaburi
	Rayong River	- Muang District and Ban Khai District, Rayong

Southern Region

The water quality of most water resources was fair, but when compared with that in 2012, it had become more degraded. The parameters indicating water quality problems were FCB and TCB, and the areas where these parameters were found are shown in Table 11.

Table 11 Parameters indicating water quality found in the southern region

Parameters	Water Resources	Areas
TCB and FCB	Chumphon River	- Muang District, Chumphon
	Lang Suan River	- Bang Maphrao Sub-district and Lam Sai Sub-district, Lang Suan District, Chumphon
	Pak Phanang River	- Ban Pak Phanang Cross River Pier, Pak Phanang District and Tha Samed Sub-district, Cha-Uat District, Nakhon Si Thammarat
	Pattani River	- Ba Na Sub-district, Muang District, Pattani and Tha Sap Sub-district, Muang District, Yala
	Saiburi River	- Saiburi District, Pattani, Ra Man District, Yala, and Sri Sakhon District, Narathiwat
	Tapi River	- Muang District, Surat Thani
	Talay Noi	- Talay Noi Village, Phra Nang Tung Sub-district, Kuan Kanun District, Patthalung
	Songkhla Lake	- Pak Khlong Sam Rong, Muang District, Songkhla

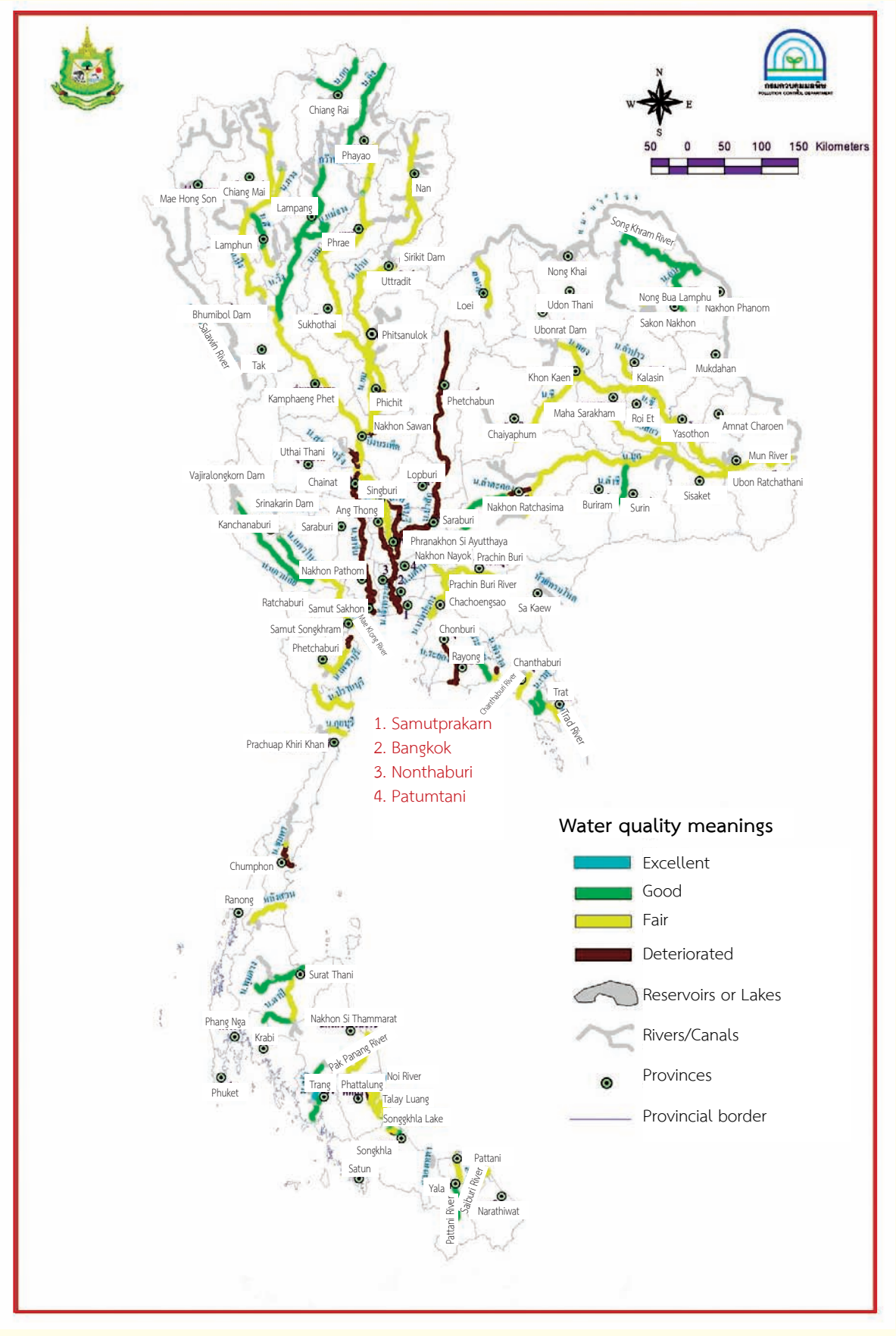


Figure 17 Surface water quality throughout Thailand in 2013

According to 2013 water quality measuring between dry season (January - June) and rainy season (July - December), there were a greater number of water resources with good quality in rainy season than that in dry season. As shown in Figure 18, a larger quantity of water slightly affected deteriorated water resources, while fair water resources were more affected. The parameters indicating water quality problems in dry season included FCB, TCB, NH_3-N and BOD, and those found in rainy season were FCB, NH_3-N, and TCB.

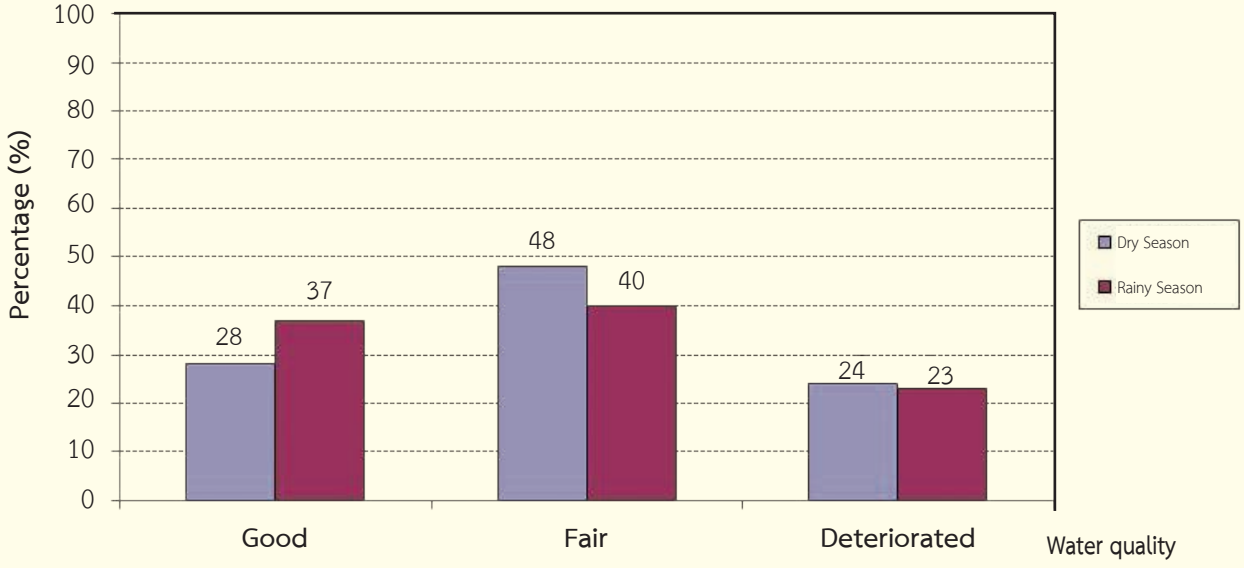


Figure 18 The comparison of water quality in Dry and Rainy season in 2013

Table 12 Summary of surface water quality during Dry and Rainy season in 2013

Water quality	Northern Region		Central Region		Northeastern Region		Eastern Region		Southern Region		Percentage of water resources (%)	
	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season
 Excellent	None	None	None	None	None	None	None	None	None	None	0	0
 Good	Li, Wang, Kok, Ing, Mae Chang	Mae Chang, Yom(+), Li, Kok, Wang, Ing, Kwan Pa Yao	Kwae Yai, Kwae Noi, Upper Phetchaburi	Kwae Noi, Kwae Yai, Kuiburi(+), Upper Chao Phraya(+)	Nong Han, Lam Chi, Songkhram	Nong Han, Mun(+), Songkhram, Oon(+), Lam Chi, Upper Lam Takhong(+)	Welu, Prasae	Welu, Prasae, Lower Phang Rad(+)	Upper Tapi, Trang, Phum Duang, Upper Pattani, Lower Pattani	Upper Tapi, Pak Phanang(+), Trang, Saiburi(+)	28	37
 Fair	Ping, Yom, Kuang, Nan, Bueng Boraphet, Kwan Pa Yao	Ping, Nan, Kuang	Upper Chao Phraya, Pranburi, Noi, Mae Klong, Kuiburi	Upper Phetchaburi(-), Noi, Mae Klong, Pranburi	Pong, Chi, Siew, Loei, Lam Pao, Oon, Mun, Upper Lam Takhong	Siew, Pong, Chi, Lam Pao, Loei	Bang Pakong, Nakhon Nayok, Prachinburi, Chanthaburi, Trat, Lower Phang Rad	Upper Phang Rad(+), Trat, Chanthaburi, Nakhon Nayok, Prachinburi, Bang Pakong	Pak Phanang, Upper Lang Suan, Lower Tapi, Saiburi, Thale Luang, Songkhla Lake	Lower Tapi, Upper Pattani(-), Phum Duang(-), Thale Luang, Lower Lang Suan, Upper Lang Suan, Lower Pattani(-), Songkhla Lake	48	40
 Poor	None	Bueng Boraphet(-)	Central Chao Phraya, Lower Chao Phraya, Upper Tahjeen, Central Tahjeen, Pasak, Sakae Krang, Lopburi, Lower Phetchaburi	Central Chao Phraya, Lower Chao Phraya, Upper Tahjeen, Central Tahjeen, Lopburi, Lower Phetchaburi, Sakae Krang, Pasak	Lower Lam Takhong	Lower Lam Takhong	Upper Rayong, Lower Rayong, Upper Phang Rad	Upper Rayong, Lower Rayong	Lower Lang Suan, Chumphon, Thale Noi	Chumphon, Thale Noi	24	23
 Very poor	None	None	None	None	None	None	None	None	None	None	0	0

Remarks : + : *The water resource where its water quality is 1 level higher than that in dry season.*

- : *The water resource where its water quality is 1 level lower than that in dry season.*

According to the 2013 water quality ranking in 64 provinces using Water Quality Index (WQI), it was found that Bangkok (The Chao Phraya River) had the poorest water quality, whereas Sisaket (The Mun and Siew Rivers) had the best quality. This data can be used for the water quality management plan in order to improve the degraded water and maintain the good one: (Table 13).

Table 13 Water quality in various provinces ranked by WQI values ranging from deteriorated (lowest WQI) value to good (highest WQI) value.

2013 Ranks	Provinces	WQI values in 2013	2012 Ranks	Water resources
1	Bangkok	36	3	Chao Phraya River
2	Samut Sakhon	37	1	Tha Chin River
3	Samut Prakan	42	2	Chao Phraya River
4	Nakhon Pathom	46	4	Tha Chin River
5	Nonthaburi	48	6	Chao Phraya River
6	Suphanburi	49	5	Tha Chin River
7	Pathum Thani	55	19	Chao Phraya River
8	Saraburi	56	7	Pasak River
9	Phetchabun	57	10	Pasak River
10	Lopburi	58	8	Pasak River, Lopburi River
11	Uthaithani	58	22	Sakae Krang River
12	Phra Nakhon Si Ayutthaya	59	11	Chao Phraya River, Pasak River, Noi River, Lopburi River
13	Roi Et	60	28	Chi River, Siew River
14	Phichit	61	12	Yom River, Nan River
15	Phetchaburi	61	18	Phetchaburi River
16	Ratchaburi	62	21	Mae Klong River
17	Yasothon	62	26	Chi River
18	Chumphon	63	39	Chumphon River, Lang Suan River
19	Nakhon Nayok	63	23	Nakhon Nayok River
20	Nakhon Sawan	63	24	Upper Chao Phraya River, Ping River, Nan River, Bueng Boraphet
21	Rayong	63	14	Rayong River, Prasae River
22	Kamphaeng Phet	63	44	Ping River
23	Maha Sarakham	64	27	Chi River, Siew River
24	Chachoengsao	64	25	Bang Pakong River
25	Ubon Ratchathani	64	29	Mun River, Chi River

Table 13 Water quality in various provinces ranked by WQI values ranging from deteriorated (lowest WQI) value to good (highest WQI) value. (continued)

2013 Ranks	Provinces	WQI values in 2013	2012 Ranks	Water resources
26	Nan	64	9	Nan River
27	Chainat	64	32	Upper Chao Phraya River, Upper Tha Chin River, Noi River, Sakae Krang River
28	Prachin Buri	65	20	Prachinburi River, Bang Pakong River, Nakhon Nayok River
29	Samut Songkhram	65	34	Mae Klong River
30	Phitsanulok	65	36	Yom River, Nan River
31	Prachuap Khiri Khan	65	43	Pranburi River, Kuiburi River
32	Nakhon Ratchasima	65	45	Lam Takhong River, Mun River, Chi River
33	Singburi	66	16	Upper Chao Phraya River, Noi River, Lopburi River
34	Lumphun	66	17	Kuang River, Li River
35	Nakhon Si Thammarat	66	41	Pak Phanang River, Tapi River
36	Surat Thani	67	38	Tapi River, Phum Duang River
37	Chantaburi	67	53	Chanthaburi River, Phang Rad River
38	Phayao	67	37	Ing River, Yom River, Kwan Pa Yao
39	Phatthalung	67	49	Thale Noi, Thale Luang
40	Tak	67	50	Ping River, Wang River
41	Ang Thong	67	13	Upper Chao Phraya River, Noi River
42	Pattani	68	42	Pattani River, Saiburi River
43	Loei	68	58	Loei River
44	Khon Kaen	68	40	Phong River, Chi River
45	Kalasin	68	46	Lam Pao River
46	Chaiyaphum	68	30	Chi River
47	Chiang Mai	68	35	Ping River, Kuang River
48	Narathiwat	69	47	Saiburi River
49	Songkhla	69	33	Thale Luang, Songkhla Lake
50	Uttaradit	69	15	Nan River
51	Yala	71	52	Pattani River, Saiburi River
52	Sukhothai	71	51	Yom River
53	Trat	72	56	Welu River, Trat River
54	Kanchanaburi	74	54	Mae Klong River, Kwae Yai River, Kwae Noi River
55	Chiang Rai	74	31	Kok River, Ing River

Table 13 Water quality in various provinces ranked by WQI values ranging from deteriorated (lowest WQI) value to good (highest WQI) value. (continued)

2013 Ranks	Provinces	WQI values in 2013	2012 Ranks	Water resources
56	Buriram	74	60	Mun River, Lam Chi River
57	Lampang	75	55	Wang River, Mae Chang River
58	Sakhon Nakhon	76	61	Songkhram River, Oon River, Nong Han
59	Phrae	77	48	Yom River
60	Nong Khai	77	63	Songkhram River
61	Nakhon Phanom	77	64	Songkhram River, Oon River
62	Trang	79	57	Trang River
63	Surin	80	62	Mun River, Lam Chi River
64	Sisaket	85	59	Mun River, Siew River

Remarks : Water Quality Index (WQI) values ranged from 0 to 100 : 91 to 100 is excellent; 71 to 90 is good; 61 to 70 is fair; 31 to 60 is deteriorated; and 0 to 30 is highly deteriorated.

Water quality of public canals in pollution control zones, Rayong Province

According to the monitoring of water quality in public canals in Map Ta Phut and nearby areas of Rayong Province by Pollution Control Department in collaboration with Regional Environmental Office 13, Chonburi Province, the 40 monitoring stations covered 16 public canals (Figure 19) including Khlong Chakmak, Khlong Namhu, Khlong Huay Yai, Khlong Ta Kuan, Khlong Lod, Khlong Bangberd, Khlong Bang Kraprun, Khlong Namtok, Khlong Konpuek, Khlong Kha, Khlong Thap Ma, Khlong Phayun, Khlong Nam Dam, Khlong Nongkhla, Kholng Nong Phak Nam, and Khlong Kra Chet. The results showed that the dirtiest canals were Khlong Lod, Khlong Nam Dam, and Khlong Ta Kuan, and the rest of were also quite dirty. The dusky black water in these canals was full of sediments, and it stank and flowed slowly, which was categorized as Type 5 of surface water quality standards (used for transport).

Additionally, the detected parameters causing chronic problems included Biochemical Oxygen Demand (BOD), Total Coliform Bacteria (TCB), Fecal Coliform Bacteria (FCB), Amonia-Nitrogen (NH_3-N) and heavy metals, such as arsenic, manganese, and lead. The overall quality of water in the areas tended to be improving in 2013, except Khlong Bangberd and Khlong Huay Yai, where the water quality had degraded (The water quality changed from deteriorated to highly deteriorated). This was because they are located in a big community near Rayong City Municipal. Both canals therefore were water bodies receiving household sewage discharged from residential areas which are extending rapidly as well as a rapid increase in population.

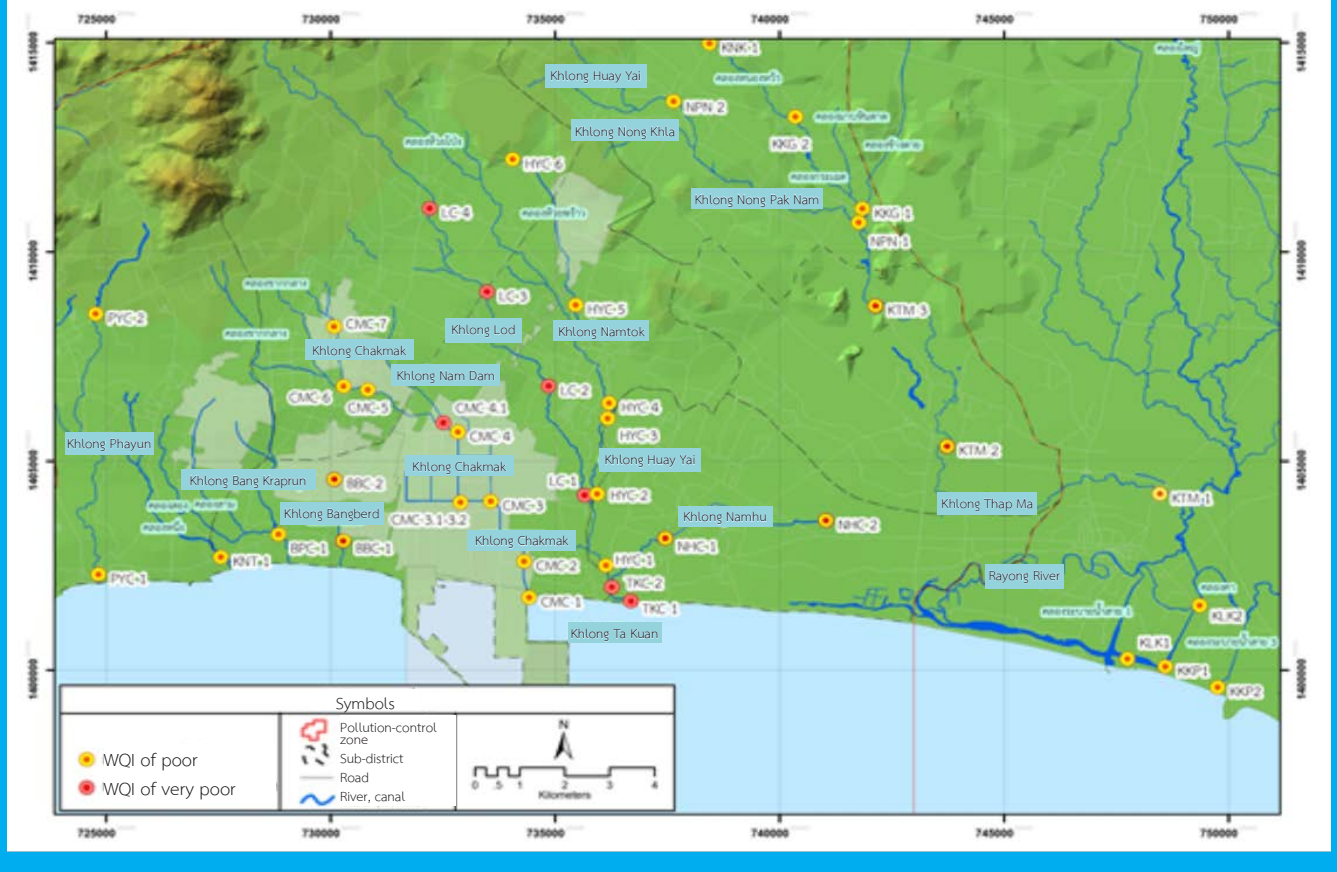


Figure 19 Water quality monitoring stations and Water Quality Index of 16 public canals

1.4 Coastal Water Quality

The coastal water quality[2] is assessed countrywide twice a year. The first monitoring was conducted during February - March and the second time during June - August with a total sampling stations of 112 and 110 respectively. The results showed that 16% of the water samples indicated good quality; 35% of the water was fair; 36% was deteriorated; 13% was highly deteriorated; and the sample water with very good quality was not found. (Figure 20)

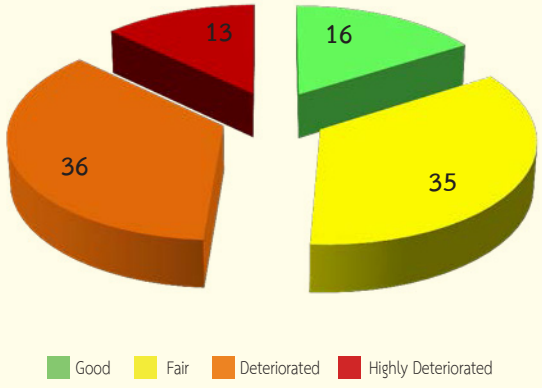


Figure 20 Proportion of coastal water quality

Good coastal water quality was found in the Western coast of the Gulf of Thailand, for instance, the beach area of Sailom Hotel at Hua Hin, and the mouth of Khlong Wan in Prachuab Khiri Khan Province; Ban Hua Thanon marine water quality in 2013 (Bang Nam Cheut Bay), Koh Samui, Saphan Pla, and Koh Phangan in Surat Thani; Samila Beach in Songkhla; and some areas on the Andaman coast, such as Ban Khao Pi Lai, Ban Thap Lamu in Phangnga; Patong Beach, Karon Beach, Kata Noi Beach, Kata Yai Beach and Chalong Bay in Phuket; Chao Mai Beach in Trang.

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[2] The Marine Water Quality Index (MWQI) is a tool developed by Pollution Control Department and used for the assessment of overall marine water quality. Its values range between 0-100, calculated from eight parameters indicating marine water quality. Those include Dissolved Oxygen (DO), Total Coliform Bacteria (TCB), Phosphate-Phosphorus (PO_4^{3-} - P), Nitrate-Nitrogen (NO_3^- - N), Temperature (Temp.), suspended solids (SS), Acidity-Alkalinity (pH), Ammonia-Nitrogen (NH_3 - N). In case of pesticides and toxic elements, such as Mercury (Hg), Cadmiun (Cd), Total Chromium (Total Cr), Chromium Hexavalent (Cr^{6+}), Lead (Pb), Copper (Cu), Cyanide (CN^-) and PCBs are found exceeding Marine Water Quality Standards, the MWQI will promptly become "0".

Highly deteriorated coastal water quality was found in the inner Gulf of Thailand including the mouth of Sibsong Thanwa Canal in front of The dyeing factory km 35; The Chao Phraya River's mouth in Samut Prakan; Bang Khun Thian, Bangkok; The Tha Chin River's mouth, Samut Sakhon; The Maeklong River's mouth, Samut Songkhram; and nearby areas, such as Ang Sila (oyster farms), Laem Chabang Port (on the end), and Sattahip Port in Chonburi; Ban Laem Canal's mouth (in the middle part), and Cha Am Beach in Petchaburi. Moreover, the areas of Andaman Coast where chronically very poor water quality was found included Chan Damri Beach, Pak Nam Ranong in Ranong Province.

The comparison of coastal water quality by each parameter and Marine Water Quality Standards[3] demonstrated that parameters indicating problems were Dissolved Oxygen, Acidity-Basicity, Phosphate-Phosphorus, Nitrate-Nitrogen, Total Coliform Bacteria, Fecal Coliform Bacteria, Enterococci Bacteria[4], heavy metals, such as Copper, Lead, Mercury, Zinc and Chromium. Besides, suspensions and oil slicks were found floating on the water surface in beach areas, estuary of canals and rivers, piers, particularly during the second sample collection from June to August.

[3] Marine Water Quality Standards were announced in The Royal Thai Government Gazette, Issue : Announcements and General Affairs, Book 124, Part 11D, February 1, 2007.

[4] Enterococci bacteria are Gram-positive bacteria with a round shape that often occur in pairs or chains, are well resistant to the changing environment. For example, they are reasonably heat-resistant, so they can grow in a temperature of 45°C. Besides, they are highly base-resistant to pH 9.6 and salt-resistant to 6.5%. These bacteria usually live in the intestines of human and warm-blooded animals. The major types include Streptococcus faecalis and S. Faecium which can cause an infection in the urinary tract and Endocarditis. They can also survive in water and sediments longer than Fecal Coliform Bacteria.

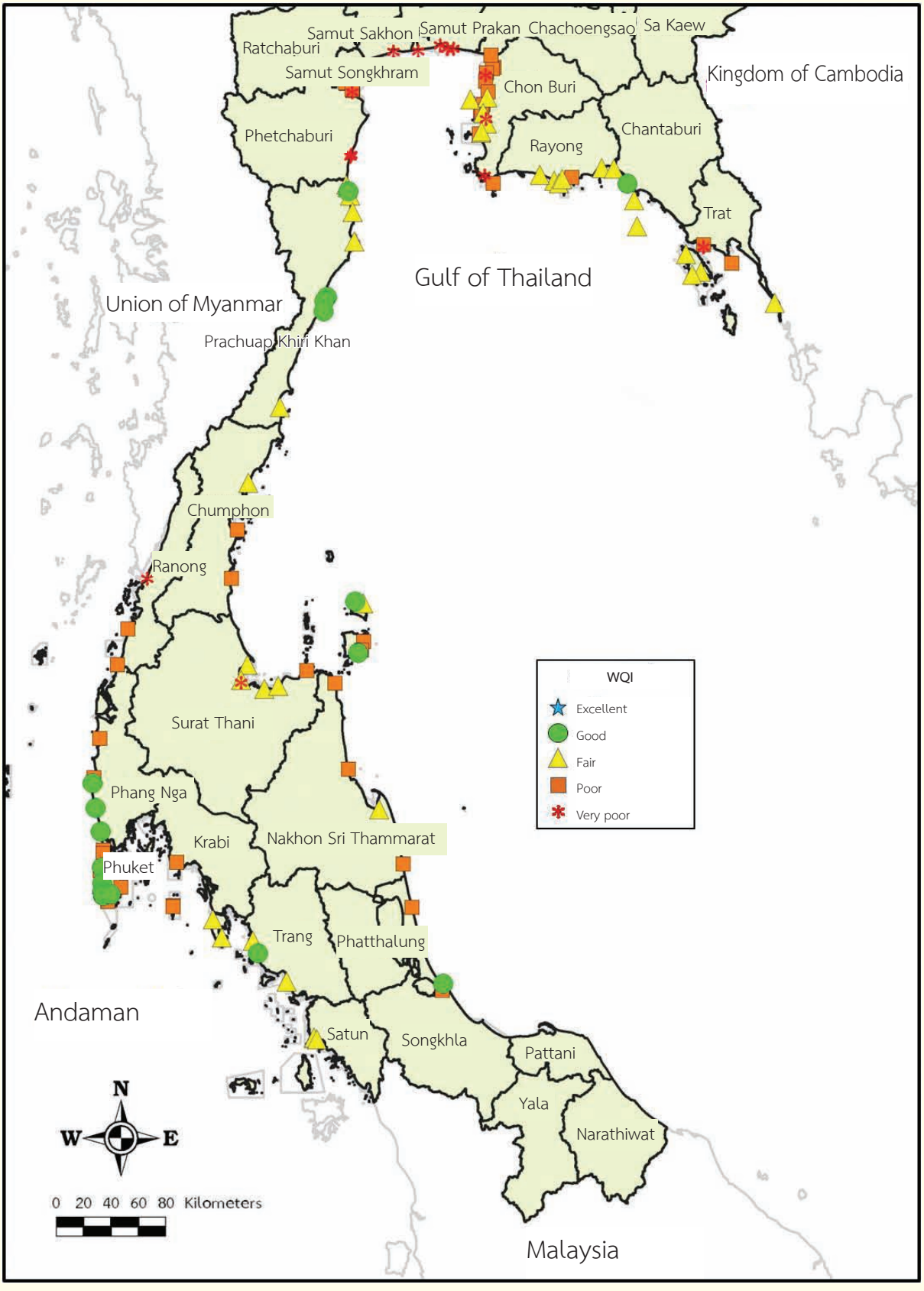
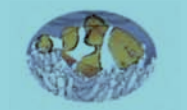


Figure 21 Assessment results of Marine Water Quality Index throughout Thailand in 2013

Table 14 State of coastal water quality in 2013 assessed by Marine Water Quality Index

State	Inner Gulf of Thailand	Eastern Coast of Gulf of Thailand	Western Coast of Gulf of Thailand	Andaman Coast
 Excellent (>90 - 100)	None	None	None	None
 Good (>80 - 90)	None	**Chantaburi** Kung Kra Ben Beach (100)	**Prachuap Khiri Khan** On the beach of Sailom Hotel, Hua Hin (100), North Prachuap Bay, In front of Khao Ta Mong Lai (100), Central Prachuap Bay (100), Pak Klong Wan (100) **Surat Thani** Ban Hua Thanon (Bang Nam Chut Bay), Koh Samui (100), Jetty in Koh Pha Ngan (100) **Songkhla** Samila Beach (100)	**Phang Nga** Thai Muang, Pak Klong Thaplamu (100), Ban Khao Pi Lai (100), Ban Thaplamu (100)+ **Phuket** Bang Tao Beach (100), Patong Beach (In front of Patong Bay Hotel) (100), Karon Beach (In front of Phuket Golden Sand Inn) (100), Kata Noi Beach (In front of Katathani Hotel) (100), South Kata Yai Beach (100), Central Chalong Bay (100)+ **Trang** Central Chaomai Beach (100)
 Fair (>50 - 80)	None	**Trat** Koh Chang, White Sand Beach (10), Salakpetch Bay (100), Bang Bao Bay (100), Estuary of Trat-Laem Sok River (Banpu) (500), Pak Klong Yai (100) **Chanthaburi** Estuary of Chantaburi River (500), Estuary of Welu River (500) **Rayong** Estuary of Prasae River (500), Estuary of Phang Rad River (500), Estuary of Rayong River (500), Mae Ramphueng Beach (100), Fish Market (Ban Phe Market) (100) **Chon Buri** Sichang (Tha Thewawong) (100), Si Racha (Ko Loi) (100), Central Laem Chabang Port (100), Na Kluea Market (100), Central Pattaya (100), North Pattaya (100)	**Prachuap Khiri Khan** Beach in the area of Klai Kangwon Palace (10), Hua Hin Jetty (100), Khao Takiab (100), Estuary of Pran Buri River (100), Sam Phraya Beach, Khao Sam Roi Yot National Park (100), Pak Klong Ban Bang Saphan (100) **Chumphon** Ban Sa Pli, Sa Pli Bay (100), Estuary of Chumphon River, Pakhat Bay (100) **Surat Thani** Pak Klong Phum Riang, Chaiya District (100), Pak Klong Tha Khoei, Tha Chang District (500), Estuary of Tapi River, Central Bandon Bay (100), Klong Kade, Kanchanadit District (100), Hat Rin Bay, Koh Pha Ngan (100)	**Phuket** Patong Beach (In front of Patong Merlin) (100) **Krabi** Koh Lanta, Ban Sala Dan (100), Beach in the Ban Sriraya community (100) **Trang** Pak Meng Beach (100), Central Chao Samran Beach (100) **Satun** Pak Bara Pier (100), Ban Thung Rin (100)

Table 14 State of coastal water quality in 2013 assessed by Marine Water Quality Index (continued)

State	Inner Gulf of Thailand	Eastern Coast of Gulf of Thailand	Western Coast of Gulf of Thailand	Andaman Coast
 Deteriorated (>25 - 50)	**Chachoengsao** Estuary of Bang Pakong River	**Trat** Laem Ngob (100), Laem Sok (100) **Rayong** Pak Klong Klaeng (500) **Chon Buri** Chon Buri Bay (100), Chon Buri Bay (Oyster Farm) (100), Ang Sila (Pier) (100), Bangsaen (Ocean World) (100), Bang Pra (100), Ao Udom (Jetty) (100), Hua Laem Chabang (100), Laem Chabang Port (500), South Pattaya (10), Chong Samae San (100)	**Phetchaburi** Pak Klong Ban Bang Tabun Tai (500), Pak Klong Ban Bang Tabun Klang (500), Pak Klong Ban Bang Tabun Noei (500), Pak Klong Ban Laem (North), Oyster Farm (500), Pak Klong Ban Laem (South) (500) **Chumphon** Ban Bo Kha (Kho Bay), Sawi District, Pak Klong Sawi (100), Estuary of Lang Suan River (100) **Surat Thani** Pak Klong Don Sak (100), Kho Samui, Central Chaweng Bay (100), Lamai Beach (100) **Nakhon Si Thammarat** Khanom Power Plant, Khanom District (100), Pak Klong Tha Sung, Tha Sala District (100), Ban Pak Klong, Hua Sai District (100) **Songkhla** Pak Rawa Floodgate, Ra Not District (100), Estuary of Songkhla Lake (100)	**Ranong** Bang Ben Beach (100), Praphat Beach (100) **Phang Nga** Klong Pak Bang (Khao Lak) (100), Ban Nam Khem (100) **Phuket** Mai Khao Beach (100), Nai Yang Beach (100), Surin Beach (100), Rawai Beach (Fishing Village) (100), Pak Klong Tha Chin at Ban Koh Sirey (100) **Krabi** Nopparat Thara Beach (Pak Klong Haeng) (100), Loh Dalum Beach (Phi Phi Cabana) in Phi Phi Islands (100), Ton Sai Beach (Tonsai Village) in Phi Phi Islands (South) (100)
 Highly Deteriorated (0 - 25)	**Samut Prakan** Klong 12 Thanwa estuary (100), In front of the dyeing factory KM.35 (100), Chao Phraya River Estuary (500) **Bangkok** Bang Khun Thian (100) **Samut Sakhon** Estuary of Tha Chin River (500) **Samut Songkhram** Estuary of Mae Klong (500)	**Trat** Laem Ngob Pier (100) **Chon Buri** Ang Sila (Oyster Farm) (500), At the end of Laem Chabang Port (100), Sattahip Port (100)	**Phetchaburi** Pak Klong Ban Laem (Central) (500), Central Cha-am Beach (Tourist Information Center) (100), North Cha-am Beach (In front of Long Beach Hotel) (100) **Surat Thani** Pak Klong Tha Khoei (Oyster Farm) (100)	**Ranong** Chan Dam Ri Beach, Estuary of Ranong River (100)

Remarks : + : The water resources with 1 level better quality than that in 2012 (compared at the same location and distance from the coast)
++ : The water resources with 2 levels better quality than that in 2012 (compared at the same location and distance from the coast)
- : The water resources with 1 level worse quality than that in 2012 (compared at the same location and distance from the coast)
-- : The water resources with 2 levels worse quality than that in 2012 (compared at the same location and distance from the coast)
Numbers in parentheses () : The distance from coasts are presented (meter)

Changes in coastal water quality over 5-year period (2009 - 2013) showed that the coastal marine water had degraded. Apparently, very good marine water quality was not found. Fair marine water quality turned worse compared to that of the previous year, whereas the water with deteriorated increase. Particularly, during the years 2012 to 2013 the percentage of deteriorated and highly deteriorated marine water quality was obviously increasing. According to the marine water detection, its quality didn't meet standards due to the contamination of heavy metals found in several areas, for instance, Laem Ngob, Trat Province; the mouth of Chao Phraya River and the Klong 12 Thanwa estuary, Samut Sakhon; the mouth of Ban Laem Canal and Cha-am Beach, Petchaburi; and Laem Chabang Port, Chon Buri Province. As a result, there should be a marine water quality monitoring system in these areas, and certain trouble-shooting measures should be launched if heavy metals are still frequently found.

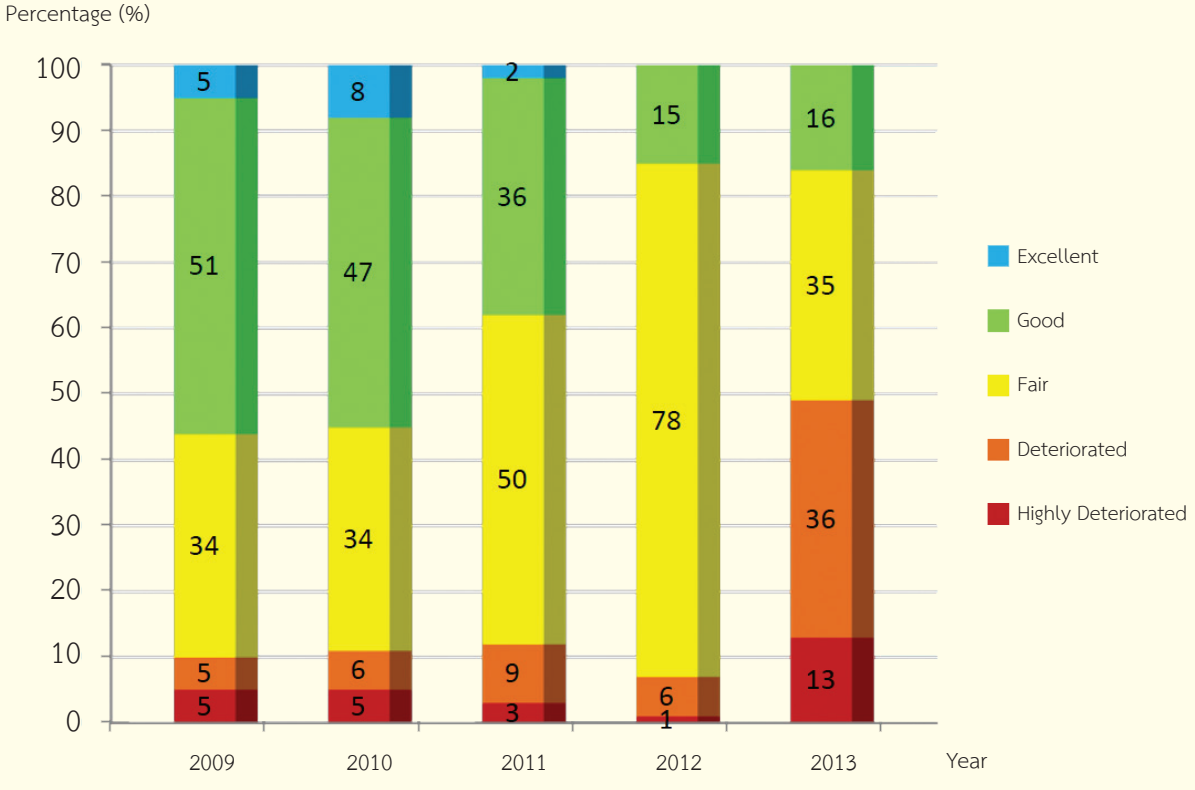


Figure 22 Coastal water quality trend during 2009 - 2013

The marine water quality in the past five years: 2009 - 2013 (Figure 22) tended to be declining due to the fact that the fair marine water quality in some areas became worse. According to the above data, most of the areas with deteriorated to highly deteriorated marine water quality were located around the estuary of rivers and canals. This was due to household wastewater or community sewage resulting in the degraded quality of marine water in the country. In addition, since degraded marine water was found on coastal aquaculture areas, it reflected the inefficiency of the aquaculture. The relevant organizations, therefore, had to accelerate problem solving and reduce the impact of effluent quality on coastal water quality by collaborating to make policies and plan for further resolution.

The Quality of Marine Water, sediments, and aquatic animals in pollution control zones, Rayong Province

(1) Marine water quality : Most of marine water was within Marine Water Quality Standards Type 5. The parameters indicating problems included Amonia-Nitrogen, Dissolved Nitrogen, and Manganese. Based on the Marine Water Quality Index (MWQI), the marine water quality in only one measuring station was deteriorated; six were fair; and ten were good.

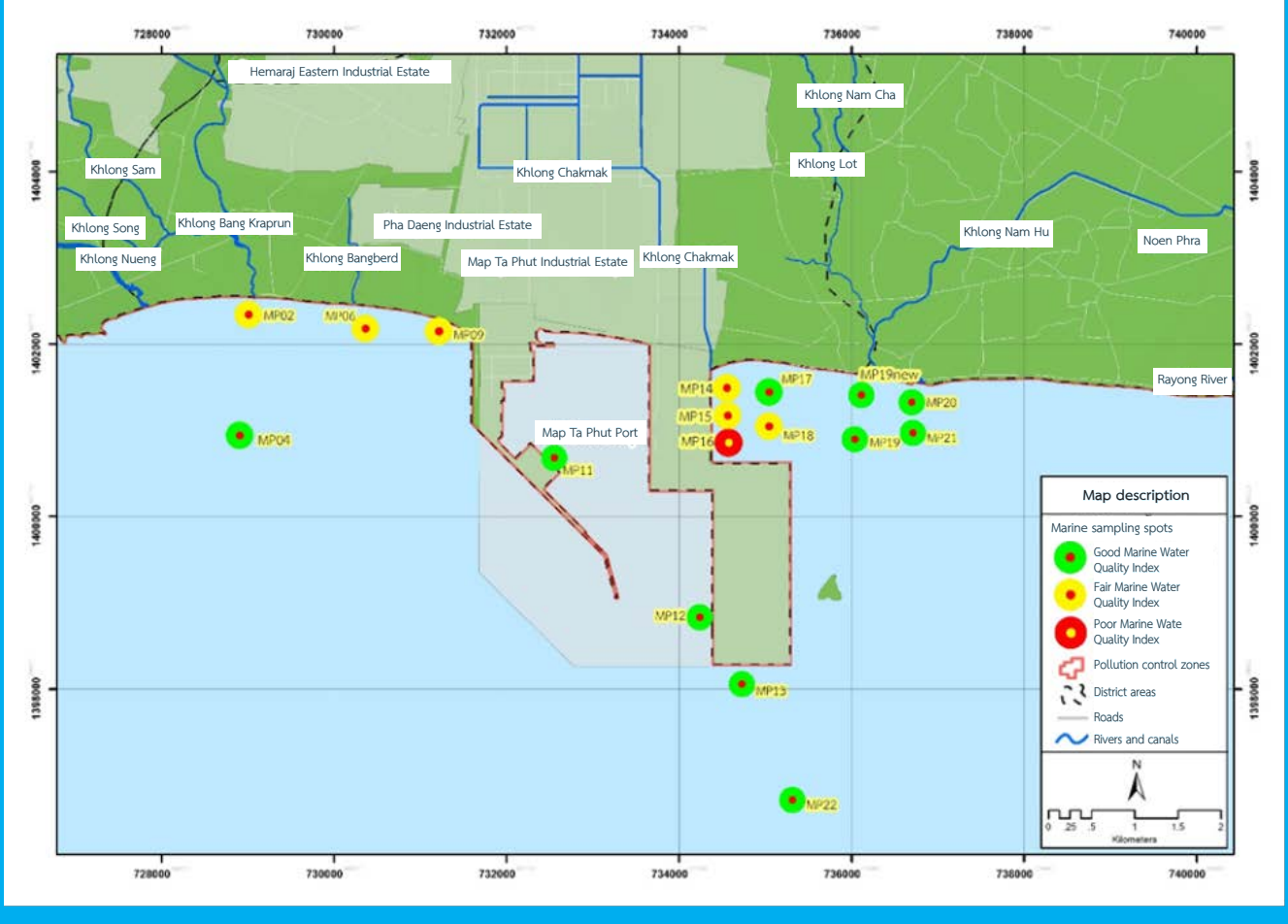


Figure 23 Marine water quality monitoring stations and marine water quality index in pollution control zones, Rayong Province

(2) Sediment quality: The concentration of heavy metals found in marine sediments conformed to the Marine and Coastal Sediment Quality Guidelines for Thailand, which were under the Land Pollution Project of UNEP GEF (Pollution Control Department, 2006). The effects of hazardous matter in sediments on benthic organisms were measured on two levels : Effects Range (ERL) and Effects Range Median (ERM), the measured results are displayed as follow.

Areas	Sediment quality 2013 (mg/kg dw)						
	Arsenic	Cadmium	Chromium	Copper	Mercury	Lead	Zinc
Pak Khlong Chakmak	20.0	1.00	35.0	26.0	2.80	28.0	863.0
Pak Khlong Ta Kuan	14.0	0.59	20.0	16.0	0.31	19.0	175.0
Effects Range Low (ERL)	≤ 8.2	≤ 1.2	≤ 81	≤ 34	≤ 0.15	≤ 46.9	≤ 150
Effects Range Median (ERM)	≤ 70	≤ 9.6	≤ 370	≤ 270	≤ 0.71	≤ 218	≤ 410

Proposed Marine and Coastal Sediment Quality Guidelines for Thailand (mg/kg dw)

exceeding Effects Range Low (ERL)

exceeding Effects Range Median (ERM)

(3) According to the random collection of aquatic animals' tissues from the mussel cages near Sai Thong Beach, no contamination was found. The samples' quality met the contaminated food standards in accordance with the Ministry of Public Health's Announcement 273 (2003).

Sample collecting spots	Types of aquatic animals	Aquatic animal tissue quality in 2013 (mg/kg ww)			Parameters indicating problems
		Mercury	Total Arsenic	Inorganic Arsenic	
Mussel rafts (Pradu Bay-Saithong Beach)	Inaequivalve ark	< 0.0005	0.0466	0.0093	-
	Mussels	< 0.0005	0.0612	0.0122	-
	Chacunda Gizzard-Shard	< 0.0005	0.0360	0.0072	-
	Short-body Mackerel	< 0.0005	0.0228	0.0046	-
Contaminated food standards based on Ministry of Public Health's announcement 273, 2003		0.5	-	2	

1.5 Groundwater

1.5.1 Groundwater quality in general areas

Overall, the groundwater quality was standardized for consumption, based on the Ministry of Natural Resources and Environment's Announcement in 2009. Naturally, groundwater is located beneath the earth's surface in soil pore spaces and in the fractures of rock formations; thus, high concentration of minerals, such as Iron and Manganese are dissolved in the water. In addition, Fluoride can be found in most of the hot spring areas of Northern Region. Likewise, salty groundwater can be found in coastal areas and the northeast due to a large number of Halite or rock salt sources. The groundwater with a high level of hardness is usually embedded in limestone areas like Saraburi and Ratchaburi Provinces. It was revealed that there were several problems concerning groundwater quality resulting from human activities, for example, non-theoretical landfills, illegal toxic waste dumping, mining and agriculture, etc, and these problems are likely to get worse. The management of groundwater resources, therefore, has to depend on the use of monitoring networks (Figure 24) to observe a change in groundwater levels and its quality. This will assist to control the groundwater situation continuously and systematically. For example, groundwater quality may be affected by contamination in the area, land subsidence due to excessive groundwater pumping, and other contamination problems caused by industrial waste and chemical dumping as well as the spread of toxins from various pollutant sources. This data can be used to efficiently manage groundwater resources in order to make clean and safe water for sustainable use.

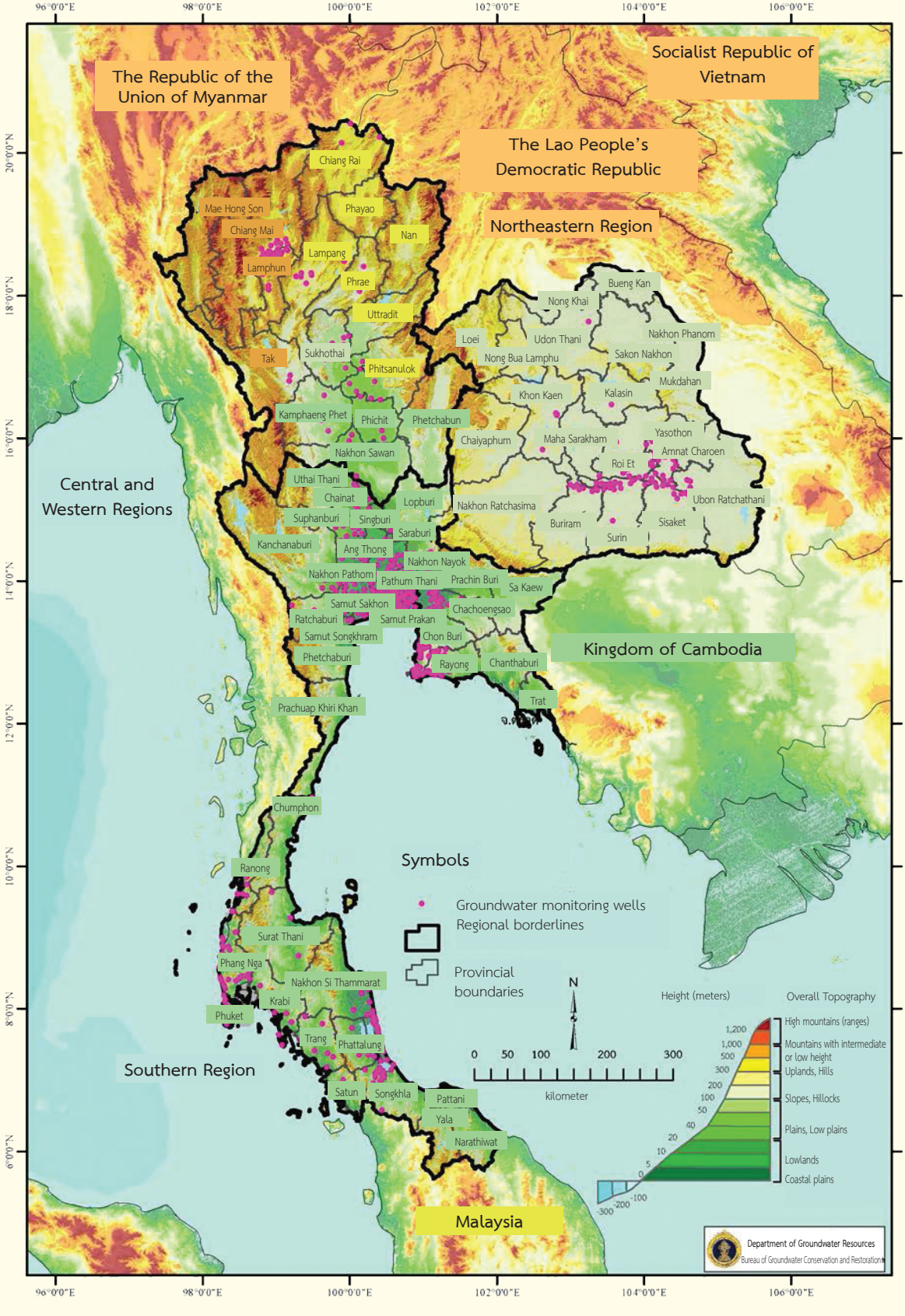


Figure 24 Locations of Groundwater monitoring station network throughout Thailand in 2013

1.5.2 The groundwater quality of individual region

1) Northern Region

The groundwater quality in this region was good enough for consumption, and there was just a slight change in its quality. In some areas, however, the groundwater was contaminated with Iron and Fluoride whose concentration was exceeding drinking water standards. The average Iron concentration was 1-20 mg/l, and 50 mg/l in some areas. The average Fluoride concentration was 1-10 mg/l. The contamination resulted from the aquifer layers that are associated with faults and hot springs in the area.

2) Central and Western Regions

The groundwater quality in these regions was satisfactory. Nonetheless, there was an intrusion of saltwater into the groundwater layers at a depth of 100, 150 and 200 metres along the Chao Phraya River and the Gulf of Thailand's coast, especially in the coastal areas of Samut Prakan, Samut Sakhon, and Bang Khun Thian District. It was found that the spread of Chloride or saltwater intruded into freshwater zones due to excessive groundwater pumping within the same area, which made the pressure of groundwater layer drop below the saltwater from higher pressure area flowed down to the lower pressure area instead. The same situation may have occurred in the areas near coastal plains owing to the intrusion of marine water.

3) Northeastern Region

Groundwater with good quality was found at a depth of 10 - 30 metres. In some areas, however, there was brackish and salty water due to the intrusion of rock salt layers, which was found in the areas of several provinces including Nongkhai, Udon Thani, Sakon Nakhon, Nakhon Phanom, Khon Kaen, Kalasin, Chaiyaphum, Maha Sarakham, Roi Et, Yasothon Amnat Charoen, Nakhon Ratchasima, Buriram, Surin, Sisaket, Ubon Ratchathani.

4) Southern Region

Most of the groundwater in this region was satisfactorily good except some areas in Songkhla Province where more brackish groundwater was found. According to the survey, the concentration of Chloride in the ground water was higher than 600 mg/l, and it was found at a depth of 50-100 metres (Hat Yai groundwater layer and Khu Tao groundwater layer) in a coastal area of 200 square kilometers near Songkhla Lake. This problem may have been caused by too much groundwater pumping to make the groundwater pressure decrease, and the marine water with higher pressure intruded into the freshwater. Besides, some Arsenic was found in the areas of Nakhon Si Thammarat Province due to the natural contamination of aquifer layers and Tin mining.

5) Eastern Region

The quality of groundwater was satisfactory. The problems frequently found included illegal toxic waste dumping, wastewater or sewage from households and industrial factories, which resulted in the contamination of groundwater layer. Also, the intrusion of saltwater into underground freshwater was found. In this region, freshwater was not sufficient to meet demand although its average annual rainfall was higher than that of the other regions.

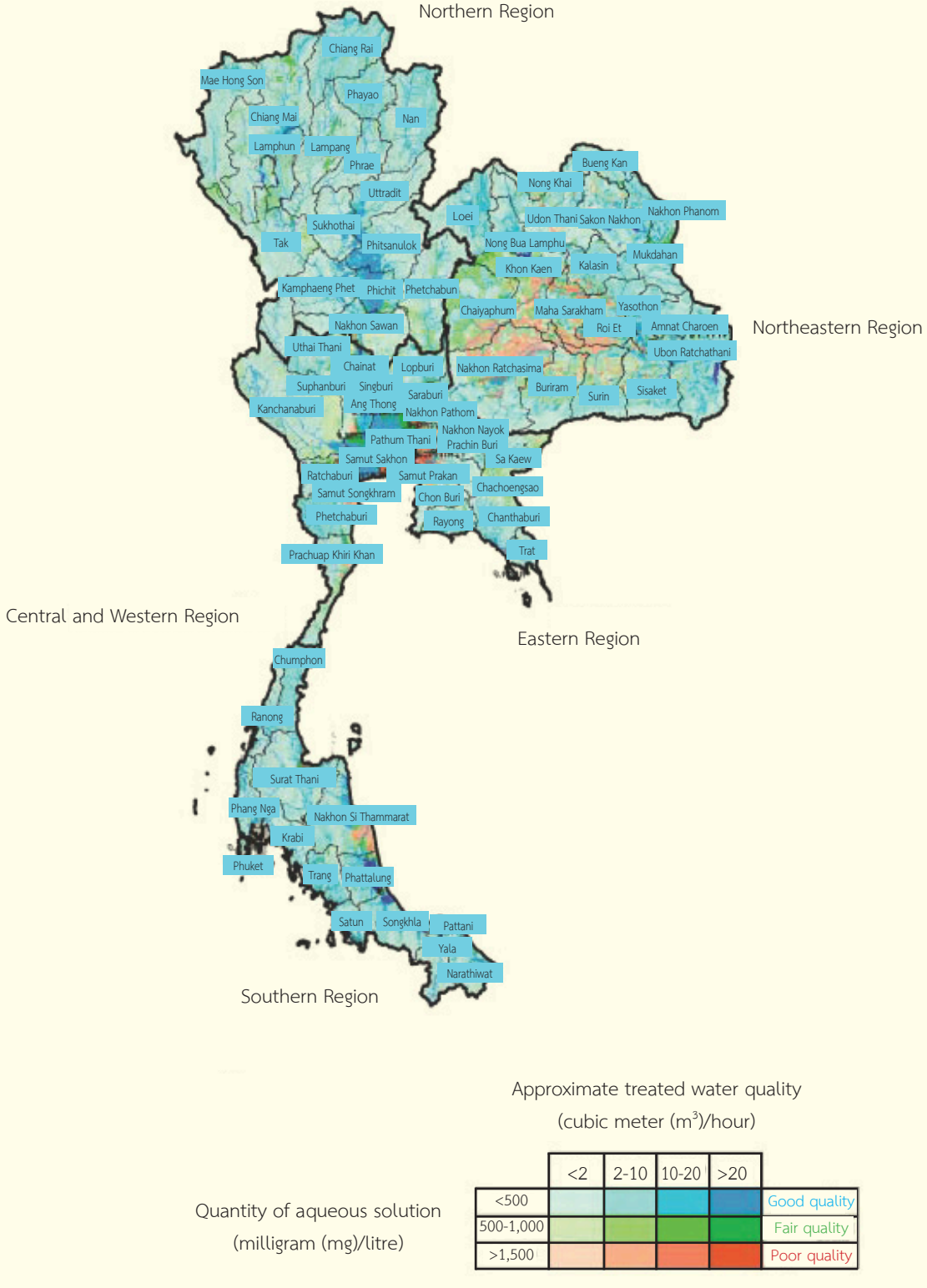


Figure 25 Quantity and quality of groundwater

1.5.3 Ground water quality in the risk areas

1) The area of Nong Nae Sub-district, Phanom Sarakham District, Chachoengsao Province : According to the problem concerning industrial toxic waste dumping, 11 spots of the dumping sites were detected. In August 2012, the sample groundwater was collected from 13 groundwater wells and 60 shallow wells (Figure 26). After that, it was physically and chemically analyzed, and toxins were detected. The analytical process was done four times in February, May, July and September 2013, and the results were compared to drinkable groundwater standards. It was revealed that the quality of the sampled groundwater met the standards except some areas where high a concentration of Iron and Manganese was found, yet it was naturally contaminated.

According to the analysis of groundwater wells during the rainy season in May and July 2013, Phenol was found exceeding standards (between 0.0018 and 0.04 mg/l) in 2 groundwater wells and 15 shallow wells (based on Industrial product standards for consumption published in the Royal Thai Government Gazette Book 95, Part 68, July 4, 1978, which does not allow Phenol concentration to exceed 0.001 mg/l). During September 2013, Phenol was found exceeding standards in the water from six groundwater and shallow wells, and its value was between 0.004 - 0.05 mg/l. These figures, however, were within the monitoring level.

From the detection of Volatile Organic Compounds (VOCs), none of them were found exceeding the groundwater quality standards. However, the physical and chemical monitoring of groundwater quality as well as the detection of toxins and VOCs will further monitoring.

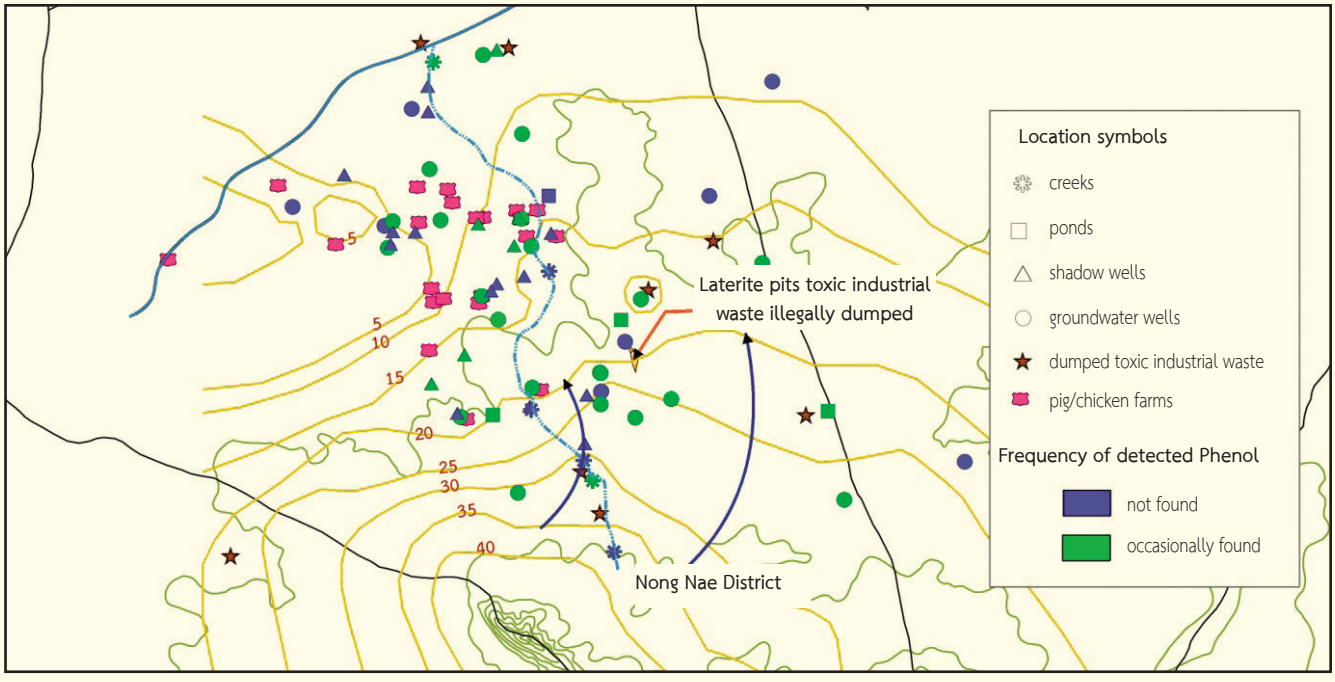


Figure 26 Direction of groundwater flow in Nong Nae Sub-district

2) Pollution control zones, Rayong Province : According to the measurement of groundwater quality in the areas of Map Ta Phut Industrial Estate, Hemaraj Eastern Industrial Estate, Asia Industrial Estate, and 33 communities around Map Ta Phut Industrial Estate by various relevant agencies, the monitored pollutants comprised of 10 kinds of heavy metals and 16 kinds of VOCs. The measured values of pollutants were compared with the groundwater quality standards in the Environment Board's Announcement, Issue 20, 2000 and Drinking Water in Hermectically Sealed Containers Standards (Maximum Acceptable Concentration) announced in the Ministry of Public Health's Notification Issue 135, 1991 (only Iron value was compared). The inspection of groundwater quality was done twice a year in 66 groundwater wells which comprised of: 1) 17 groundwater wells theoretically constructed by Department of Groundwater Resources for utilization purposes, where the water quality of 16 wells did not meet the standards; 2) 4 monitoring wells were built by entrepreneurs, and none of them did not comply with the standards; 3) 45 shallow wells were made by local residents for household consumption, and the water in 18 wells did not meet the quality standards. The results of the measurement are shown in Figure 27.

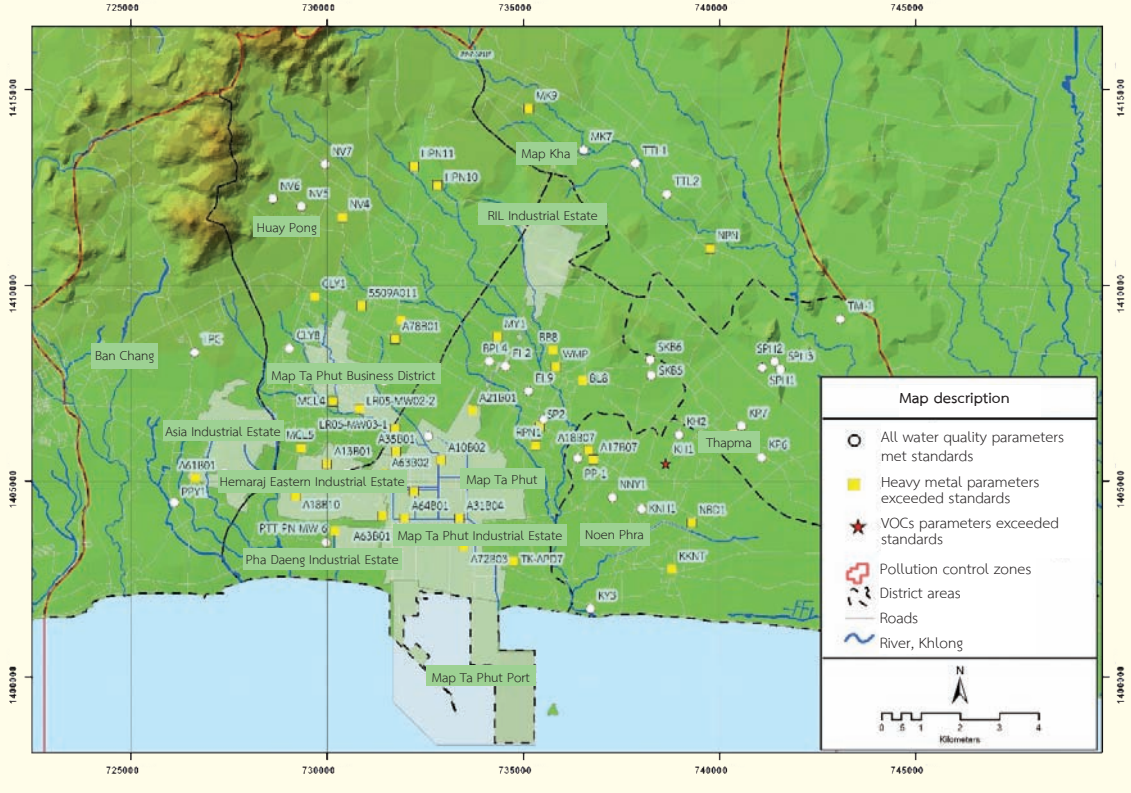


Figure 27 Monitoring stations and groundwater quality

2.1) Groundwater well : According to the monitoring, heavy metals were still the main cause of groundwater contamination. In 2013, the parameters which exceeded groundwater standards included Arsenic, Manganese and Lead, and the figures for this year were 32.26%, 29.03% and 19.35% respectively. The contamination of VOCs was not found, whereas the concentration of Arsenic was between 0.005 - 0.072 mg/l. When considering the Arsenic concentration in Map Ta Phut area's groundwater wells from 2008 - 2013, it was declining (Figure 28).

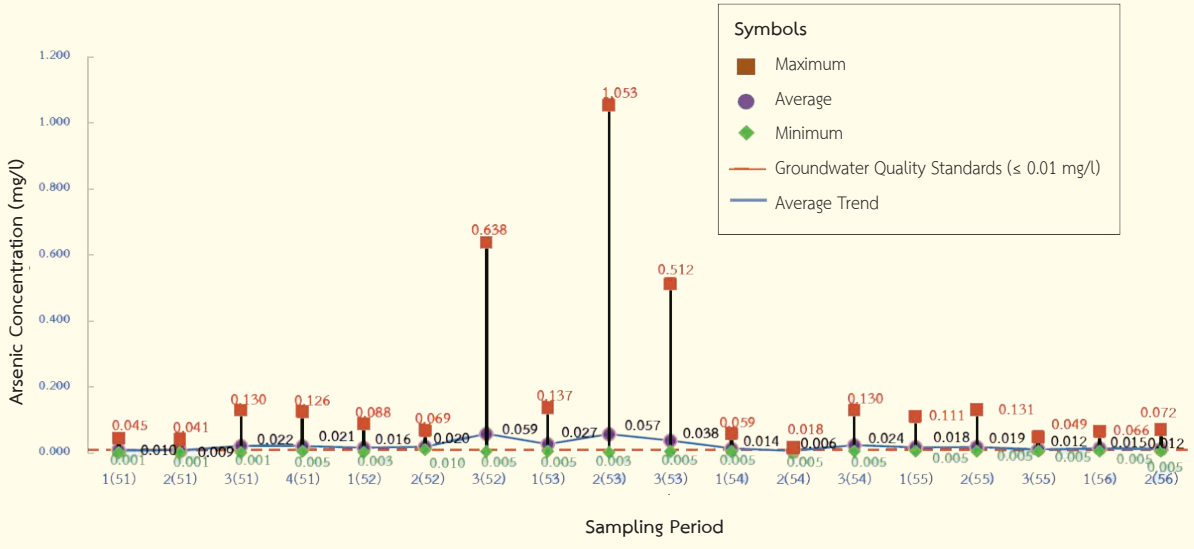


Figure 28 Trend of Arsenic concentration in Map Ta Phut's groundwater wells during 2008 - 2013

2.2) Monitoring wells : Heavy metals were also the main cause of water problems in the industrial monitoring wells of industrial factories. High concentration of parameters not complying to underground water standards were Manganese, Arsenic and Selenium, and the figures of sub-standard samples were 71.42%, 28.57% and 14.29% respectively. However, VOCs were not found in the monitoring wells at all.

2.3) Shallow wells : In the year 2013, large amounts of heavy metals found in the shallow wells included Manganese, Selenium, and Arsenic, and the sub-standard samples stood at 8.88%, 6.66% and 4.44% respectively. However, the Manganese concentration found in 2013 was between 0.050 - 2.300 mg/l, and it was not changing when considering the Manganese concentration in Map Ta Phut area's shallow wells from 2008 - 2013. (Figure 29).

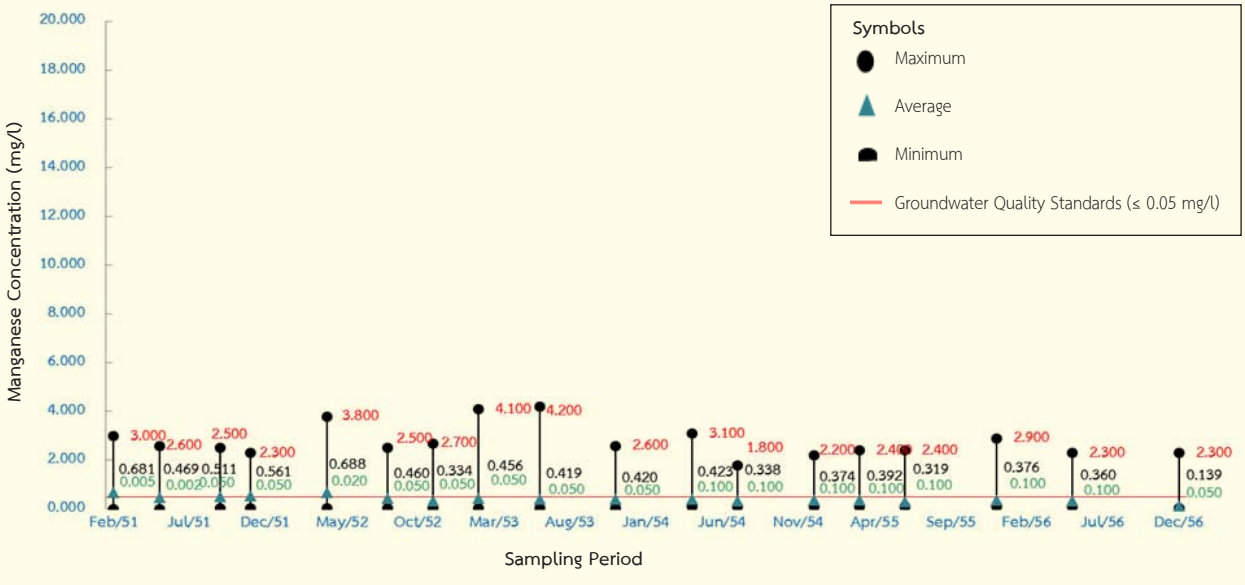


Figure 29 Trend of Manganese concentration in Map Ta Phut's groundwater wells during 2008 - 2013

In the shallow wells, VOCs not complying with the groundwater standards included 1,2-dicholoroethane and carbon tetrachloride, and 1.11% of them was found. In 2013, the concentration of 1,2-dichloroethane was between 0.08 and 48.00 µg/l, and the concentration of Carbon tetrachloride was between 0.08 and 110.00 µg/l. The trend of both parameters values from 2008 to 2013 were not changing (Figure 30 and 31)

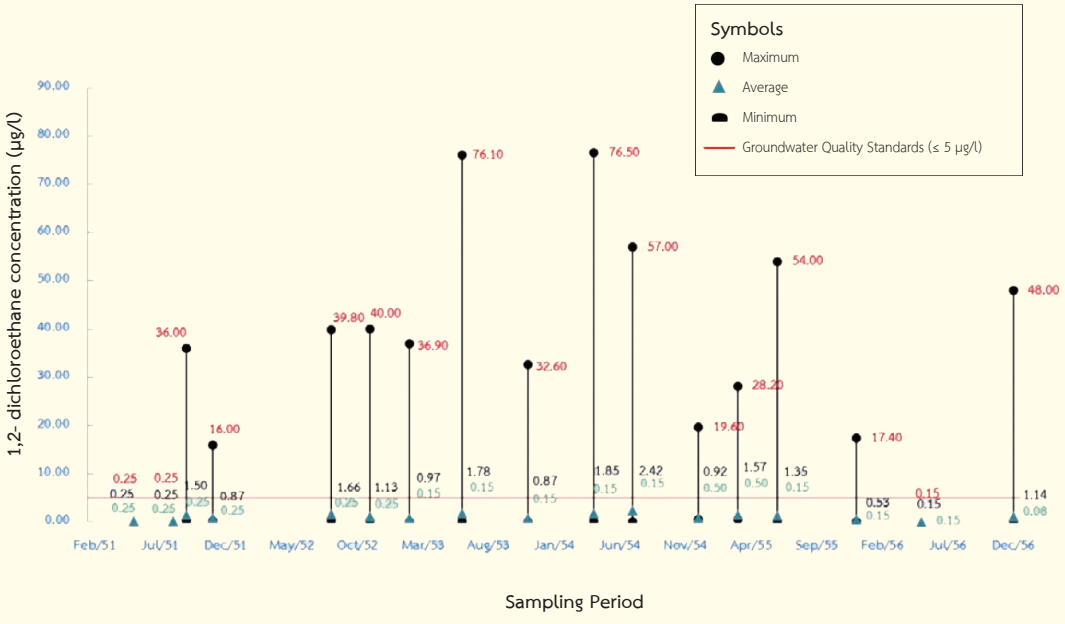


Figure 30 Trend of 1,2-dichloroethane concentration in shallow wells in Map Ta Phut's area during 2008 - 2013

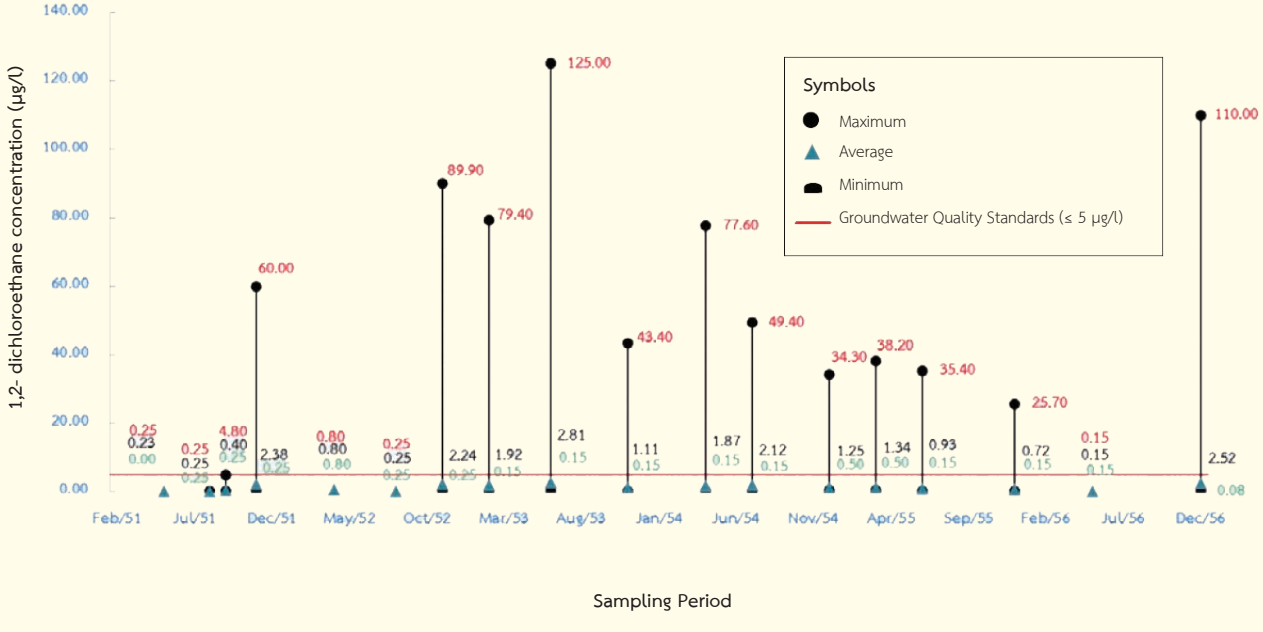


Figure 31 Trend of Carbon tetrachloride concentration in shallow wells in Map Ta Phut's area during 2008 - 2013

Chapter 2

State of Waste and Hazardous Substances

2.1 Municipal solid waste (MSW)

2.1.1 Current situation of municipal solid waste

In 2013, the Pollution Control Department conducted a survey on the volume of solid waste generated in the country using questionnaires and field surveying. The target group of the survey was 7,782 Local Administration Organizations (LAOs) throughout the country including 2,273 municipalities and Pattaya City, 5,508 Subdistrict Administrative Organizations (SAO), and Bangkok Metropolitan Administration (BMA). The result showed that the volume of MSW generated in 2013 was about 26.774 million tons, or about 73,355 tons a day. The volume can be divided into the solid waste generated in *BMA* at about 4.137 million tons (16%), the solid waste generated in *municipalities* and Pattaya City at about 10.241 million tons (38%), and the solid waste generated in *SAO* at about 12.396 million tons (46%) (Figure 32)

Local Administrative Organizations	the volume of MSW	
	million tons	percentage (%)
Bangkok Metropolitan Administration (BMA)	4.137	16%
Municipalities and Pattaya City	10.241	38%
Subdistrict Administrative Organizations (SAO)	12.396	46%
Total	**26.774**	**100%**

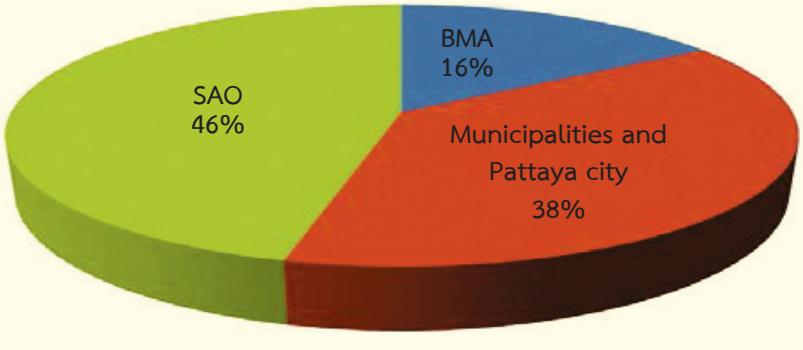


Figure 32 The volume of solid waste generated in 2013

Out of 7,782 local administration organizations, 4,179 (54%) of them provided waste transport and disposal services. About 7.421 million tons, or 20,332 tons a day, equal to 52% of the total volume of the collected waste is delivered to suitable waste management facilities. On the other hand, 6.938 million tons, or 19,008 tons a day, equal to 48% of the total volume of the collected waste, especially in small LAOs, were unsuitably disposed of by open burning or open dumping into old abandoned pits or undeveloped areas (Figure 33 and 34).

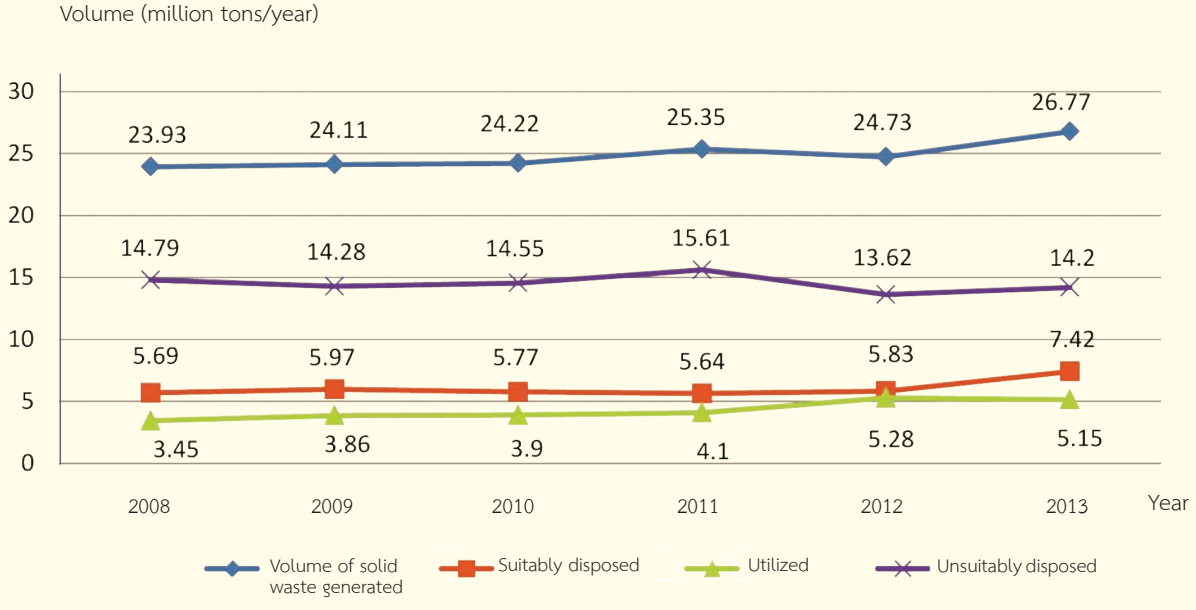


Figure 33 The volume of solid waste generated, waste Utilization, and suitable disposal during the years 2008 - 2013

Sources : 1) The information on waste transport and disposal in Bangkok is from the Department of Environment Bangkok Metropolitan Administration, 2013.

2) The information on waste transport and disposal of municipalities, Pattaya City, and Subdistrict Administrative Organizations (SAO) is from the Pollution Control Department, 2013.

3) The obvious shift on the volume of waste in 2013 is a result of the database adjustments.

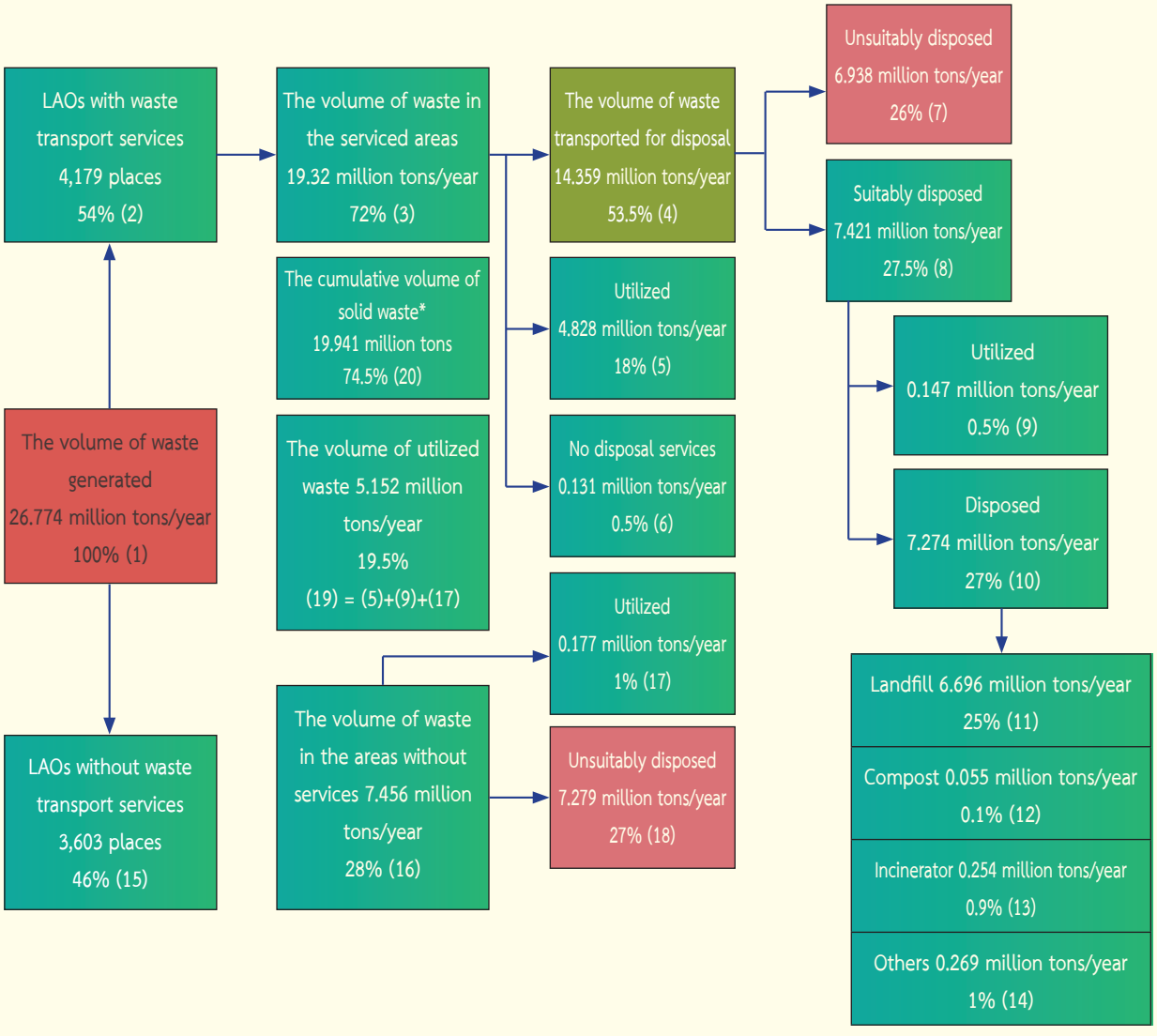


Figure 34 The flowchart of the municipal solid waste management in 2013

Remarks : The cumulative volume of solid waste refers to the volume of waste residue remained or left after unsuitable disposal including open dumping or illegal waste dumping.

*The cumulative volume of solid waste can be calculated by multiplying the capacity of the waste disposal facility (the waste dumped in the pit) by the density of municipal solid waste dumpsite.

The volume of 14.359 million tons of the collected solid waste was disposed of at one of the 2,490 waste management facilities scattered throughout the country. The waste management facilities can be divided into suitable disposal facilities and unsuitable facilities. Suitable waste disposal sites refer to 446 sanitary landfills, engineered landfills, control dumps with the capacity of less than 50 tons/day, incinerators with air pollution control systems, Waste to Energy Technology (WTE), composting, and mechanical biological treatment systems (Table 15). On the other hand, unsuitable waste disposal sites refer to 2,024 open dumps, control dumps with the capacity of at least 50 tons/day, open burning sites, and incinerators without air pollution control systems.

Table 15 Suitable waste disposal sites

Suitable waste disposal sites 466 sites in total			
Public sites		**Private sites**	
Type	**Amount**	**Type**	**Amount**
Sanitary landfills/ engineered landfills	64	Sanitary landfills/ engineered landfills	9
Control dumps with the capacity of less than 50 tons/day	341	Control dumps with the capacity of less than 50 tons/day	26
Incinrators with air pollution control system	1	Incinerators with air pollution control system	1
Incinerators with the capacity of less than 10 tons/day and have an emission control system (cyclones)	8	Waste to Energy Technology	1
Integrated system	12		
Mechanical biological treatment system	1	Mechanical biological treatment system	2
Total (public sites)	**427**	**Total (private sites)**	**39**

During recent years, the MSW situation in Thailand has shown the tendency of becoming even worse due to the volume of waste that has been growing every year paralleling with the growing number of population, national economic growth, and changes in consuming behaviours of people. Moreover, only 4,179 LAOs provide waste transport and disposal services. The number is only about 54% of the entire number of more than 7,700 LAOs throughout the country. Besides, some of the waste collected within the serviced areas of some LAOs was not suitably disposed of by openly burnt or openly dumped in an old pit or undeveloped area without proper control and management. This action might affect the environment of the surrounding areas and people in the neighbourhood of the unsuitable dumpsites. As for the local administrative organizations that did not provide any waste management services, people in the areas need to be responsible for their household waste, and some of them might illegally dump the waste in public areas or by the roadside.

According to the problem, the Pollution Control Department provides a national ranking of provinces faced with a waste management crisis considering from the volume of waste that has not been transported to disposal sites, the volume of waste that has been unsuitably disposed, and the volume of cumulative waste remained in unsuitable dump sites. The ranking of provinces faced with a waste management crisis from worst to best is provided in Table 16.

Table 16 The ranking of provinces facing with the waste management crisis from worst to best

Rank	Provinces with waste management crisis	Rank	Provinces with waste management crisis
1	Songkhla	26	Tak
2	Samut Prakan	27	Maha Sarakham
3	Kanchanaburi	28	Samut Songkhram
4	Nakhon Si Thammarat	29	Phayao
5	Surat Thani	30	Phetchabun
6	Rachaburi	31	Narathiwat
7	Petchaburi	32	Phatthalung
8	Phrae	33	Nakhon Ratchasima
9	Prachin Buri	34	Phrachuap Kiri Khan
10	Phra Nakhon Si Ayutthaya	35	Sa Kaeo
11	Ranong	36	Lampang
12	Nakhon Phanom	37	Nakhon Pathom
13	Pattani	38	Si Sa Ket
14	Chachoengsao	39	Sukhothai
15	Roi Et	40	Chaiyaphum
16	Lop Buri	41	Phichit
17	Ang Thong	42	Yala
18	Khon Kaen	43	Chainat
19	Buri Ram	44	Nong Bua Lam Phu
20	Chumpon	45	Surin
21	Krabi	46	Bueng Kan
22	Loei	47	Kalasin
23	Suphan Buri	48	Uttaradit
24	Trang	49	Nan
25	Pathum Thani	50	Trat

Table 16 The ranking of provinces facing with the waste management crisis from worst to best (continued)

Rank	Provinces with waste management crisis	Rank	Provinces with waste management crisis
51	Kamphang Phet	64	Nakhon Sawan
52	Chon Buri	65	Mokdahan
53	Sing Buri	66	Uthai Thani
54	Nakhon Nayok	67	Ubon Ratchathani
55	Satun	68	Chiang Rai
56	Amnat Charoen	69	Samut Sakhon
57	Udon Thani	70	Rayong
58	Phitsanulok	71	Saraburi
59	Sakon Nakhon	72	Lamphun
60	Phangnga	73	Nong Khai
61	Chanthaburi	74	Chiang Mai
62	Yasothon	75	Nonthaburi
63	Mae Hong Son		Phuket
			Bangkok

2.1.2 Waste Utilization

2.1.2.1 Solid waste utilization

Out of the volume of 26.774 million tons/year of municipal solid waste generated in 2013, 5.152 million tons, or 19%, of the volume was utilized. The methods of waste utilization can be divided into 3 methods as following (Figure 35) :

1) Recycling method is processed by the separation and recovery of recyclable waste including glass, paper, plastic, steel, and aluminums from junk shops, community recycling centers, waste banks, packaging buyback/return systems, and product inventions from waste. The volume of waste collected for recycling purpose was around 3.935 million tons, or 76%, of the total volume of the utilized waste.

2) Organic waste utilization is processed by sorting organic waste including food scraps, vegetables, and fruits in order to make compost and enzyme ionic plasma used as fertilizer, and to make biogas used as an alternative energy source. The volume of organic waste collected for this purpose was around 1.114 million tons, or 22%, of the total volume of the utilized waste.

3) Waste-to-Energy method is processed by putting solid waste in the processing procedure to generate energy in the form of electricity or an alternative energy source of refuse derived fuel (RDF). The volume of waste collected for this purpose was about 0.103 million tons, or 2%, of the total volume of the utilized waste.

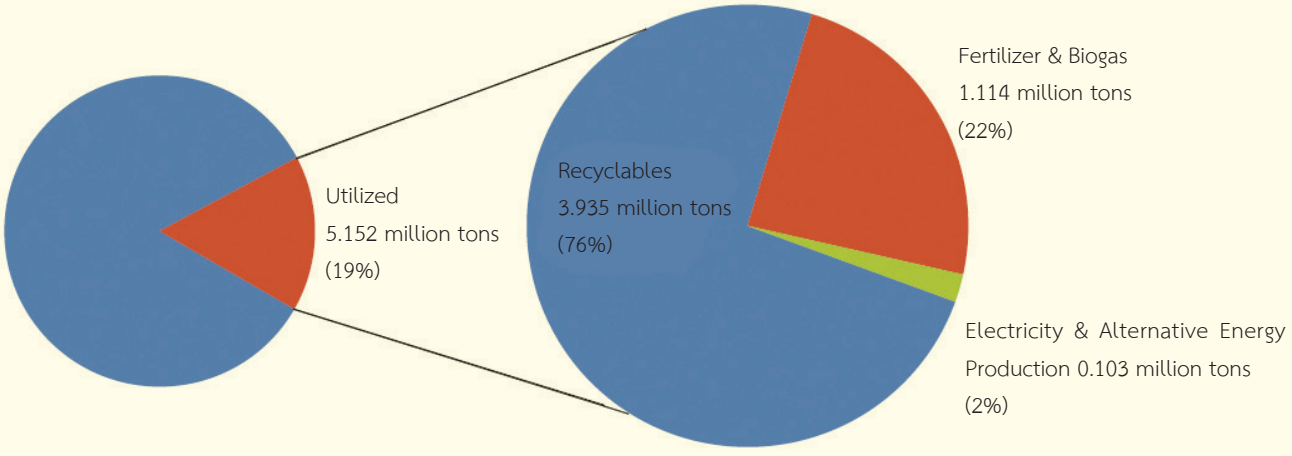


Figure 35 The proportions of the utilized MSW in 2013

2.1.2.2 Utilization of Recyclable industrial waste

In 2013, it was estimated that the industrial sector produced about 13.22 million tons of industrial recyclates including glass, paper, plastic, steel, aluminium, and rubber. About 8.44 million tons or 65.7% of the total volume of industrial recyclates have been recycled, reused or used as an alternative energy source. (Figure 36)

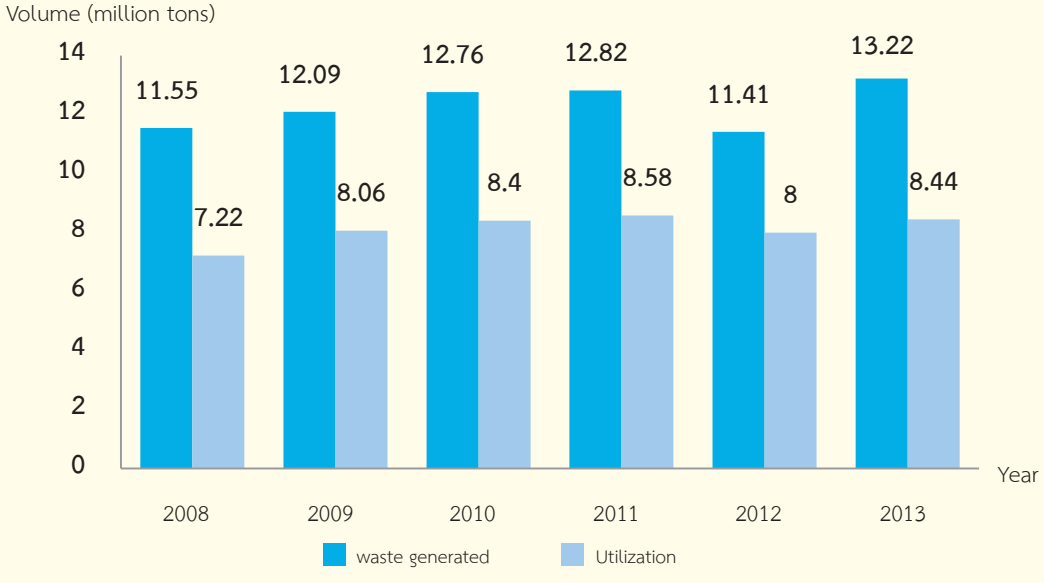


Figure 36 The volume of the utilization of recyclable industrial waste during 2008 - 2013

Sources : The information has been collected from the Office of Industrial Economics, Research and Development Centre for Thai Rubber Industry, Pulp and Paper Industry Club, the Federation of Thai Industries, the Customs Department, the Siam Cement Group, and the survey conducted by the Pollution Control Department.

The total volume of utilized industrial recyclates is about 8.440 million tons. The volume can be divided into industrial recyclates from community recycling centres at 3.935 million tons or 46.6%, while the other 4.505 million tons or 53.4% were collected from either the waste exchange system by manufactures, importers, and distributors, or from the deposit-refund system. (Figure 37)

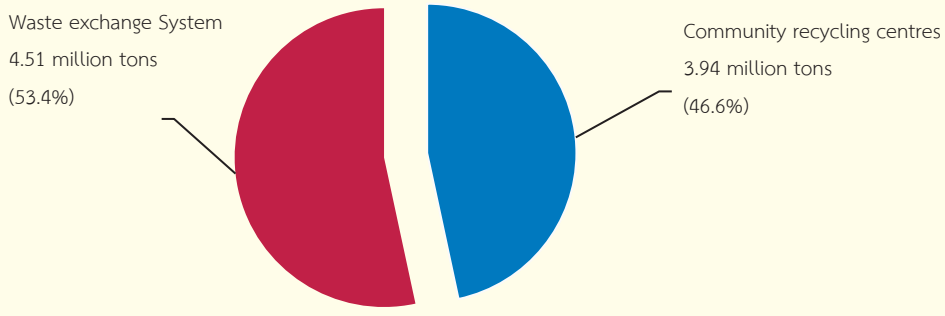


Figure 37 The utilization of industrial waste

According to the information about the utilization of industrial recyclates, the results show that the rates of the utilization of industrial waste have increased in almost every type of industries due to the growth of industrial groups of glass, paper, plastic, steel, aluminium, and rubber tyres following the growth in the manufacturing sector of food industries, electronic appliances, consumer goods, cosmetics and drugs (Table 17 and Figure 38). As a result, a consistent campaign for the utilization of industrial waste should be initiated and supported in order to reduce resource exploitation and the budget for waste management. Moreover, the campaign should integrate different approaches for better results. For example, there should be a campaign to support the reduction, reuse, and recycling of waste along with the support on research and development of waste utilization technology, recycling markets, and the quality control of products made from waste.

Table 17 The volume of the utilization of industrial waste

Type of waste	Volume of waste (tons) generated	The utilization of waste		Total		Method
		community recycling centres (tons)	waste exchange systems (tons)	Tons	Percentage (%)	
Glass	2,548,597	997,100	125,100	1,122,200	44	Recycling
			241,000	241,000	9	Reuse
Paper	4,078,477	1,106,000	1,286,000	2,392,000	59	Recycling
Plastic	2,082,296	653,700	135,000	788,700	38	Recycling
Steel/Metal	3,438,205	1,110,000	2,182,500	3,292,500	96	Recycling
Aluminium	547,878	62,500	310,000	372,500	68	Recycling
Rubber	522,768	6,100	124,470	130,570	25	Recycling
			81,000	81,000	15	Reuse
			20,000	20,000	4	Fuel
Total	**13,218,220**	**3,935,400**	**4,505,070**	**8,440,470**	**64**	

Sources : The information was collected from the Office of Industrial Economics, Research and Development Centre for Thai Rubber Industry, Pulp and Paper Industry Club, The Federation of Thai Industries, The Customs Department, The Siam Cement Group, and the survey conducted by the Pollution Control Department.

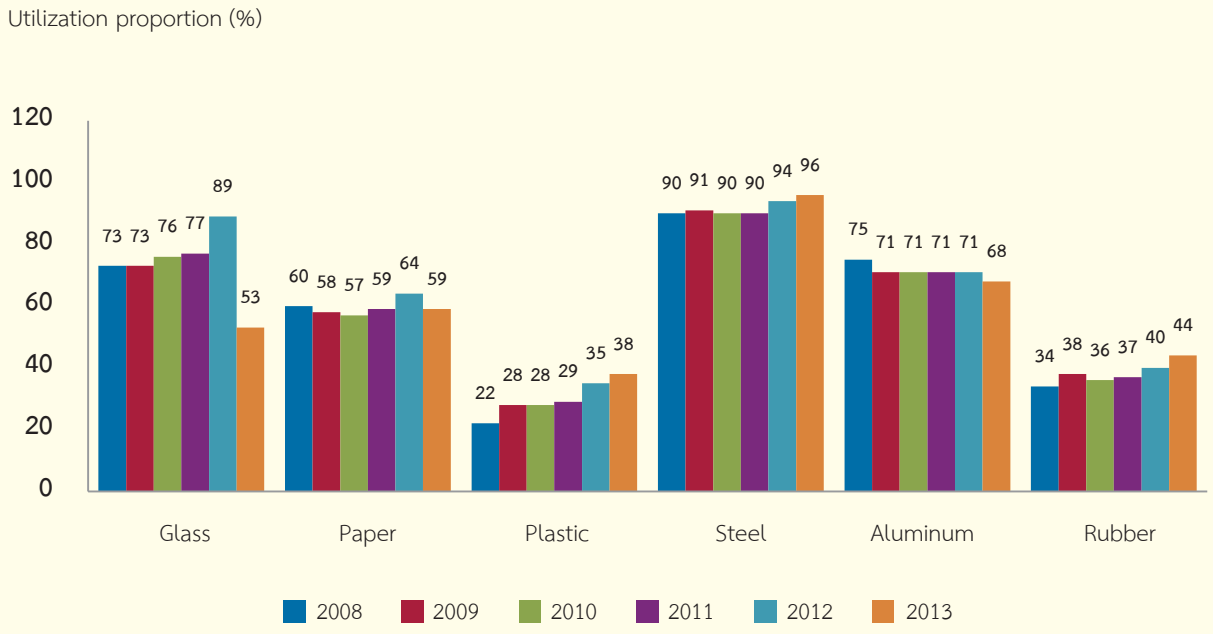


Figure 38 The proportions of the utilization of industrial waste during 2008 - 2013

2.2 Hazardous waste

In 2013, it was estimated that 3.30 million tons of hazardous waste was generated throughout the country reducing from the year 2012 by about 0.27 million tons, or 8%. The majority of hazardous waste, 2.69 million tons or 81.5%, was industrial hazardous waste. The rest, 0.61 million tons, or 18.5%, was household hazardous waste (including Waste from Electrical and Electronic Equipment (WEEE), and infectious waste) (Table 18).

Table 18 The volume of hazardous waste categorised by sources during 2012 - 2013

Hazardous waste	2012 million tons	2013 million tons	volume up - down	percentage up - down
Industries	2.81*	2.69 **	-0.12	-4
Municipalities	0.71	0.56 ***	-0.15	-21
Infectious waste	0.04	0.05 ***	0.01	25
Total	3.57	3.30	-0.27	-8

Sources: * The information on the requests for permission to remove waste or used materials from factory permises (Sor. Kor. 2), Department of Industrial Works, 2012.

** The information on the requests for permission to remove waste or used materials from factory permises (Sor. Kor. 2), Department of Industrial Works, 2013.

*** The estimation of the information on household hazardous waste and infectious waste, Pollution Control Department, 2013.

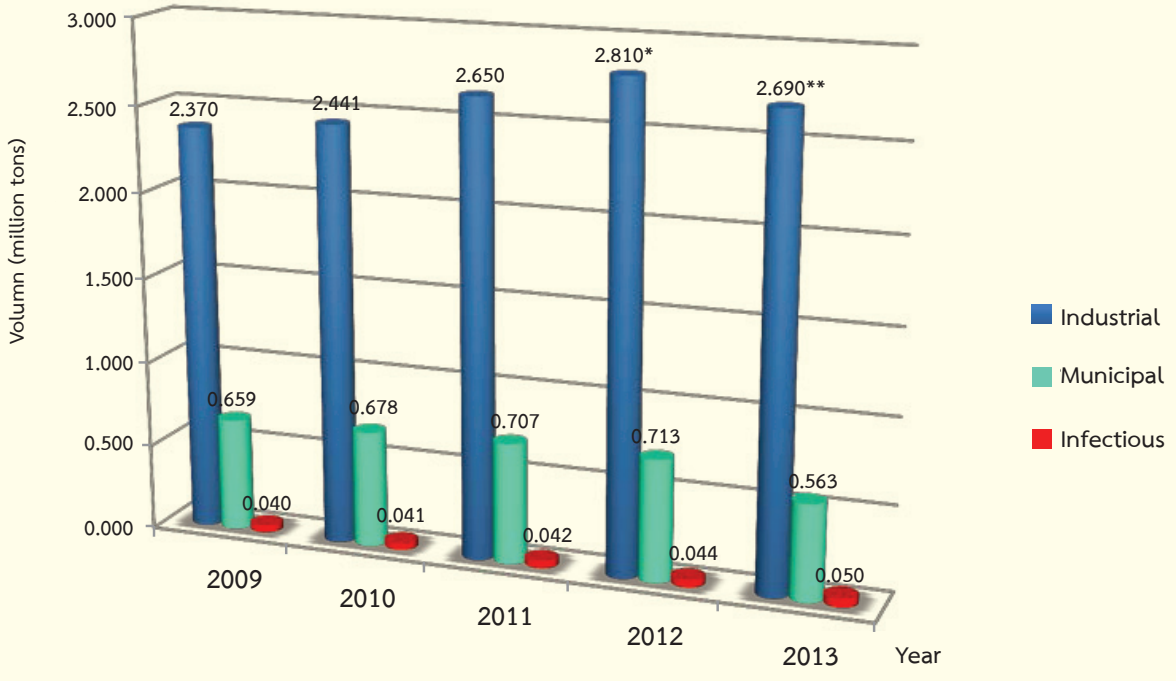


Figure 39 The volume of hazardous waste during 2009 - 2013 categorised by type

Sources : The estimation of the information on municipal hazardous waste and infectious waste, Pollution Control Department, 2013.

* The information on the requests for permission to remove waste or used materials from factory permises (Sor. Kor. 2), Department of Industrial Works, 2012.

** The information on the requests for permission to remove waste or used materials from factory permises (Sor. Kor. 2), Department of Industrial Works, 2013.

2.2.1 Household hazardous waste (HHW)

The volume of household hazardous waste (HHW) generated in 2013 was 562,834 tons, down from 2012 by 149,936 tons, or 21%. The majority of household hazardous waste, about 368,314 tons, or 65.4%, was from Waste from Electrical and Electronic Equipment (WEEE). The rest of the hazardous waste from municipalities which was about 194,520 tons, or 34.6%, consists of batteries, light bulbs, and chemical containers.

At present, the existing management of household hazardous waste is mostly ineffective. Mostly, the WEEE is handled informally by selling it to junk shops or buyers. Electrical and electronic parts of the waste are mostly unsuitably disassembled. On the other hand, other hazardous waste is mainly dumped together with non-hazardous waste. Now, there are only three private household hazardous waste disposal sites, which can suitably dispose hazardous waste at only 630 tons/year. However, since 2006, the Pollution Control Department has continuously supported and encouraged potential LAOs to separate hazardous waste from MSW, and transfer the collected waste to recycling facilities or to suitable sites for hazardous waste disposal.

A survey by the Pollution Control Department, along with the information from other sources, was conducted to study customer behaviours towards the management of packages after use and to estimate the volume of packaging waste from the behaviours in 2013. Details are shown in Table 19.

Table 19 The estimation of the volume of packaging waste in 2013

Item	Products	The volume of waste (tons/year)
1	Televisions	101,286
2	Air conditioners	71,821
3	Refrigerator	63,092
4	Washing machines	58,930
5	Computers	53,958
6	VCD/DVD players	17,458
7	Telephones	1,620
8	Digital cameras	184

Source : The estimated volume calculated by the Pollution Control Department based on "Full report of the survey of the volume and types of packaging waste from electrical and electronic equipment, Pollution Control Department, 2008" and "Full report of the survey of the volume and types of packaging waste from electrical and electronic equipment, Pollution Control Department, 2012," Pollution Control Department 2013.

In the near future, the management of WEEE will become big problem for the country. It is partly because the ever-changing technology that encourage customers to keep buying new devices and throw the old ones away. The country has not yet provided a product buyback/return system under the responsibility of shops and sellers. As a result, the WEEE has become the burden of LAOs which don't have a suitable site for the disposal of this type of waste.

2.2.2 Industrial Hazardous Waste

In 2013, the volume of industrial hazardous waste generated throughout the country was about 2.69 million tons decreasing from the previous year by 0.12 million tons, or 4.3%. This was due to the Department of Industrial Works continuously encouraging the utilization of industrial waste and the reduction of the volume of waste that must be disposed of by being dumped in a sanitary landfill, and encouraging the industrial sector to reduce the volume of waste generated from the manufacturing sector and to enhance the capacity of the utilization of industrial waste according to 3Rs principles which refer to Reduce (use less or as necessary), Reuse, and Recycle methods. Moreover, many businesses have initiated a policy to make use of all industrial waste and left none to be sent to the landfill or Zero Waste to Landfill policy.

In Thailand, almost half of the total volume of industrial hazardous waste in 2013 was generated in the eastern part of the country, while Bangkok and its vicinities and the central part of Thailand ranked the second highest. These areas are controlled by the laws and regulations of the Department of Industrial Works and the Industrial Estate Authority of Thailand. Within the regulated areas, there are 461 disposal sites granted permission for the disposal of hazardous waste from the Ministry of Industry. These 461 permitted disposal sites are divided into 3 sanitary landfills, 12 cement kiln incineration plants, and 446 hazardous waste recycling facilities. Nonetheless, illegal dumping of hazardous waste was still found in many areas. According to the information in

2013, it was found that there were reports of illegal dumping of more than 10 times. Risk areas for illegal dumping are scattered across 25 provinces because the areas are dense with industrial plants, industrial estates and industrial parks. Moreover, there is a record of illegal dumping in these areas. The provinces in crisis are Chachoengsao, Chon Buri, Rayong, Prachin Buri, and Samut Prakan. The rest of the risk provinces including Nonthaburi, Suphan Buri, Sara Buri, Samut Sakhon, Ratchaburi, Phra Nakhon Si Ayutthaya, Prachuap Khiri Khan, Pathum Thani, Nakhon Pathom, Kanchanaburi, Chumphon, Nakhon Si Thammarat, Songkhla, Surat Thani, Khon Kaen, Nakhon Ratchasima, Udon Thani, Chiang Mai, and Lampang. According to the information collected by authorities and organizations that are in charge of the management of industrial waste of industries around the country, such as the Department of Industrial Works of the Ministry of Industry, Industrial Estate Authority of Thailand, Provincial Industry Office, and industrial waste disposal businesses, it was found that in 2013, industrial waste was handled using different methods (Table 20).

Table 20 The management of industrial hazardous waste in 2013

Methods of disposal	Volume	
	million tons/year	percentage
Processed and used as materials	0.36	13
Waste-to-energy	0.81	30
Processed and reused	0.84	31
Through the treatment process	0.07	3
Disposed	0.54	20
Exported for recycling and disposal in other countries	0.07	3
Total	**2.69**	**100**

Source: The information from the requests for permission to remove waste or used materials from factory permises (Sor. Kor. 2), Department of Industrial Works, 2013.

2.3 Infectious waste

In 2013, Pollution Control Department conducted a new survey on the volume of infectious waste generated from three types of healthcare centres including 1) public and private healthcare centres (hospitals, healthcare stations, and clinics), 2) animal hospitals and clinics, and 3) dangerous pathogen laboratories. The department distributed questionnaires to 1,348 different public and private hospitals throughout the country. The collected data was analysed together with the information on the generation rate of infectious waste from health promotion centres and the Department of Health. The estimation showed that the total volume of infectious waste from different origins was about 50,481 tons/year. The estimated volume can be divided into the waste from public hospitals, 28,668 tons/year (57%), from private hospitals, 8,606 tons/year (17%), from clinics, 9,698 tons/year (19%), from health promoting centres and hospitals, 3,215 tons/year (6%), animal healthcare centres, 291 tons/year (0.6%), and from dangerous pathogen laboratories, 3 tons/year (0.006 %) (Figure 40 and Table 21).

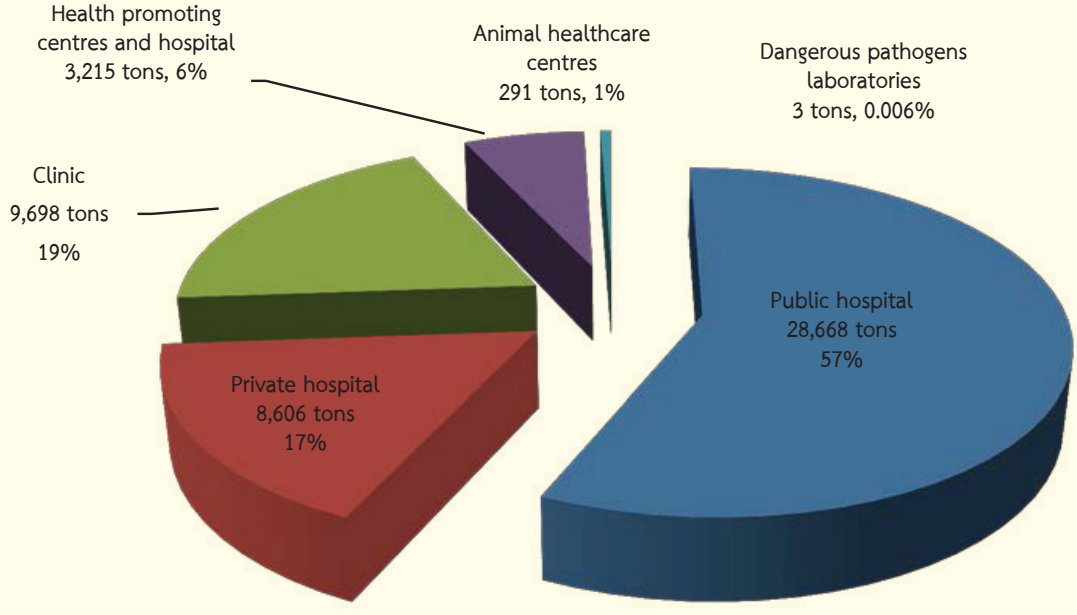


Figure 40 The estimated volume of infectious waste throughout the country in 2013

Sources : The estimation of the information on infectious waste, Pollution Control Department, 2013

Table 21 The generation rate of infectious waste from different sources in 2013

Rank	Types of healthcare centre	Generation rate (kg./bed/day)
1	Regional hospitals	0.84**
2	General hospitals	0.54**
3	Commune hospitals	0.77**
4	Other hospitals under Ministry of Public Health	0.47**
5	Hospitals under other ministries	0.71**
6	Private hospitals	0.70**
7	Private clinics/polyclinics	1.32*
8	Health promoting centres/hospitals	0.90**
9	Animal promoting centres/hospitals	0.37*
10	Dangerous pathogens laboratories	0.43*

Remarks : * refers to the generation rate of infectious waste from the report of the Pollution Control Department according to the campaign towards the holistic management of infectious waste from potential local administrative organizations in 2009.

** refers to the generation rate of infectious waste from the survey of the Pollution Control Department in 2013.

The majority of infectious waste was generated from large-scale healthcare service providers which are public and private hospitals, including dangerous pathogen laboratories which are usually located within the hospital. Mostly, the hospitals provide a budget and standard principles for the management of infectious waste in order to ensure that the management will be in accordance with any laws and regulations involved, such as the Ministerial Regulation on Infectious Waste Disposal B.E. 2545, and in standard with the quality assessment and hospital accreditation system in which the standards of the hospital waste disposal are clearly specified. The regulations state that the management of infectious waste from the hospital must be in accordance with Public Health Act, B.E. 2535 and the Amendment Act, B.E. 2550. LAOs must be responsible for the collection and disposal of infectious waste. The management can be conducted by the organizations themselves, or they may outsource to waste management providers.

The results of the 2013 survey show that 75% (37,277 tons/year) of the total volume of infectious waste from public and private hospitals, and dangerous pathogen laboratories was handled as following:

- At least 142 hospitals are responsible for the disposal of their own infectious waste using the hospital's waste incinerators. The volume of infectious waste that is disposed by this method is about 2,352 tons/year. However, most of the hospital's incinerators are not in proper condition.

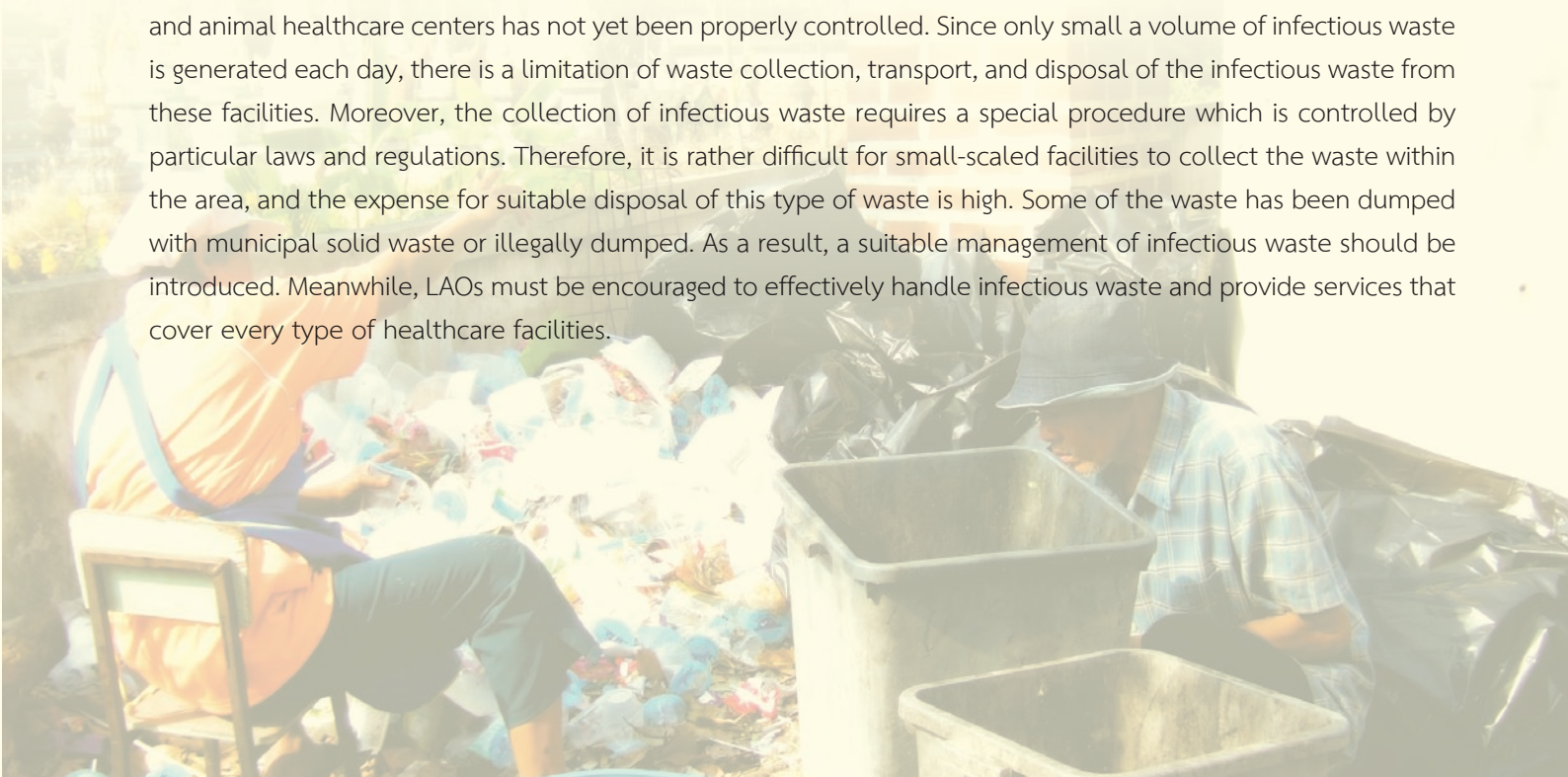
- Private agents are employed. Most of the private agents are responsible for collection and transport of infectious waste to be disposed in one of the 10 disposal facilities of LAOs, or at least 4 private disposal sites. 28,095 tons/year of infectious waste are disposed by incineration process.

- The rest of the infectious waste (6,830 tons) is transported to at least 4 new private disposal sites.

In practice, however, infectious waste from small healthcare centers including clinics and some health promoting centers/hospitals is transported and disposed at a public hospital within the network, and some might be unsuitably disposed by illegal dumping and other disposal methods.

Besides, most of the incinerators for infectious waste are not equipped with an appropriate system, equipment, or device necessary for the effective control of pollution. There is neither an air pollution measurement system that's required by the laws involved, or a suitable operation of the incineration system to control risks towards people's health and environment. People involved in the process of waste disposal as well as others might be affected by the incineration, and in the future, the process might affect the quality of the environment as well. As a result, there should be a fundamental assessment of the quality of incinerators for infectious waste around the country in order to develop a proper management for the disposal of waste.

Since 21 November 2013, the Ministry of Public Health has regulated that any healthcare facilities and dangerous pathogen laboratories under the governance of Ministry of Public Health that employ a private agent to handle the transport of infectious waste must be controlled by the infectious waste manifest system. The system helps at least 75% of the management of infectious waste from large-scale healthcare facilities and has become more systematic and ensures infectious waste has been suitably disposed. However, the infectious waste management of the other 25% of the small-scaled healthcare facilities including clinics, health promoting center/hospitals, and animal healthcare centers has not yet been properly controlled. Since only small a volume of infectious waste is generated each day, there is a limitation of waste collection, transport, and disposal of the infectious waste from these facilities. Moreover, the collection of infectious waste requires a special procedure which is controlled by particular laws and regulations. Therefore, it is rather difficult for small-scaled facilities to collect the waste within the area, and the expense for suitable disposal of this type of waste is high. Some of the waste has been dumped with municipal solid waste or illegally dumped. As a result, a suitable management of infectious waste should be introduced. Meanwhile, LAOs must be encouraged to effectively handle infectious waste and provide services that cover every type of healthcare facilities.



2.4 Hazardous substances

In 2013, 6.15 million tons of chemicals were imported into Thailand, and about 61.85 million tons were domestically produced (Figure 41) by factories type 42 (1) which engage in businesses related to chemicals, chemical products, and hazardous substances. However, comparing with the import volume of chemicals in 2012, this number reduced by 4.85 million tons (44%). The imported chemicals were divided into organic chemicals, 3.37 million tons, and inorganic chemicals, 2.78 million tons. The volume of the top 10 imported chemicals from both types is equal to 2.99 million tons (Table 22). Most of them are industrial chemicals.

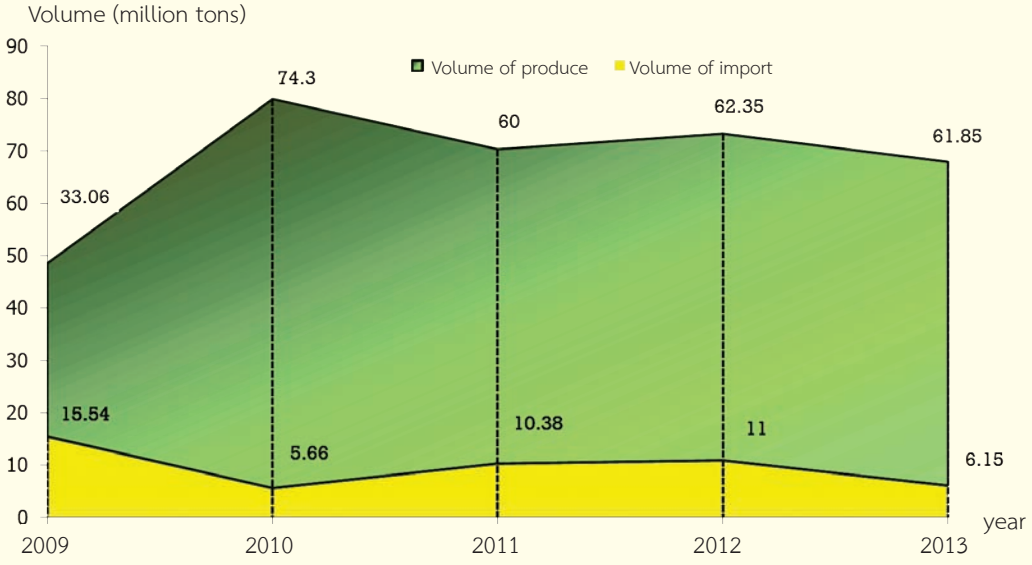


Figure 41 The import and export of chemicals in Thailand during 2009 - 2013

Source : The information about the import and export of chemicals evaluated from the import and export volume of organic chemicals (group 29) and inorganic chemicals (group 28), the Customs Facilitation: www.customs.go.th

Dangerous substances, hazardous substances, and hazardous chemicals refer to elements or substances that can be harmful to people, animals, and plants, and cause damage to any property and environment. These type of substances can be divided into 9 classes: Class 1 explosive, Class 2 gases, Class 3 flammable liquids, Class 4 flammable solids, Class 5 oxidizing agents and organic peroxides, Class 6 toxic and infectious substances, Class 7 radioactive substances, Class 8 corrosive substances, and Class 9 miscellaneous.

Hazardous substances according to Hazardous Substances Act, B.E. 2535 refer to an explosive, an flammable substance, an oxidizing agent and a peroxide substance, a toxic substance, an infectious substance, a radioactive substance, a mutagen, a corrosive substance, an irritating substance, and other substances, either chemical products or other substances, that can be harmful to people, animals, plants, property, or environment.

Table 22 Top 10 organic and innorganic chemicals imported into Thailand in 2013

Rank	Type of chemicals	Volume (tons)	Authorities
1	Methanol : Methyl alcohol	595,965.05	Department of Industrial Works Food and Drug Administration
2	Disodium carbonate	514,597.27	-
3	Ethylene dichloride	439,636.01	Department of Industrial Works Department of Agriculture Food and Drug Administration
4	Ammonia anhydrous	353,687.04	Department of Industrial Works
5	Sulphuric acid more than 50%w/w	337,672.68	Department of Industrial Works
6	Sodium hydroxide more than 20%w/w	172,180.09	Department of Industrial Works
7	Disodium sulfate	158,367.38	-
8	Ethylene glycol	156,599.99	Department of Industrial Works
9	Phenol : Hydroxy benzene	149,397.86	Department of Industrial Works
10	4,4'- isopropylidenediphenol and salts	116,545.09	-
Total		**2,994,648.45**	

Remarks : Authorities according to Hazardous Substances Act, B.E. 2535
The symbol "-" means that the chemicals are not restricted by Hazardous Substances Act, B.E. 2535.

Source : Based on the statistic of chemicals import of the Customs Facilitation, 2013.

2.4.1 Agrochemicals

In 2013, of all 210 types of imported hazardous agrochemicals was 172,674 tons in total (Table 23)., based on the Hazardous Substances Act, B.E. 2535 under the governance of the Department of Agriculture, most most of them were in the category of herbicides, insecticides and plant growth regulators (PGR). Comparing to the year 2012, the volume increased to 38,297 tons, or 29% (Figure 42). The volume of the Top 10 chemicals imported in 2013 was 127,020.31 tons (Table 24). 45% of the volume of the Top 10 chemicals imported in 2013 was isopronylammonium which is a PGR. On the other hand, the volume of Top 10 chemicals exported in 2013 was 3,736.15 tons (Table 25). 40% of the volume was difenoconazole + propiconazole.

Table 23 Types of hazardous agrochemicals imported during 2009 - 2013

Rank	Type of chemical	Import volume (kg.)				
		2009	2010	2011	2012	2013
1	Herbicide	24,680,168.90	80,278,187.82	112,176,809.59	106,860,024.20	131,048,869.06
2	Insecticide	10,366,987.08	23,417,251.34	34,672,233.30	16,796,966.18	21,485,943.91
3	Fungicide	97,956,856.41	9,670,895.96	12,178,739.38	6,971,703.72	10,350,009.52
4	Plant growth regulator (PGR)	622,097.24	2,292,534.00	3,046,926.40	2,374,630.50	1,390,307.00
5	Funigants	222,490.01	850,378.00	732,929.26	945,361.00	1,249,480.50
6	Acaricide	2,107,459.63	348,700.00	602,655.00	233,389.00	1,000,260.99
7	Mollussicide	695,387.50	403,137.97	473,250.86	195,088.29	149,064.00
8	Rodenticide	942,946.50	437,395.40	499,441.00	10.00	-
9	Nematocide	-	-	30.00	4.01	6.00
10	Other	-	-	0.04	3	-
Total		**137,594,393.27**	**117,698,480.49**	**164,383,014.83**	**134,377,179.90**	**172,673,940.98**

Source : Office of Agricultural Regulation, Department of Agriculture. Retrieved 30 January 2014 from www.doa.go.th

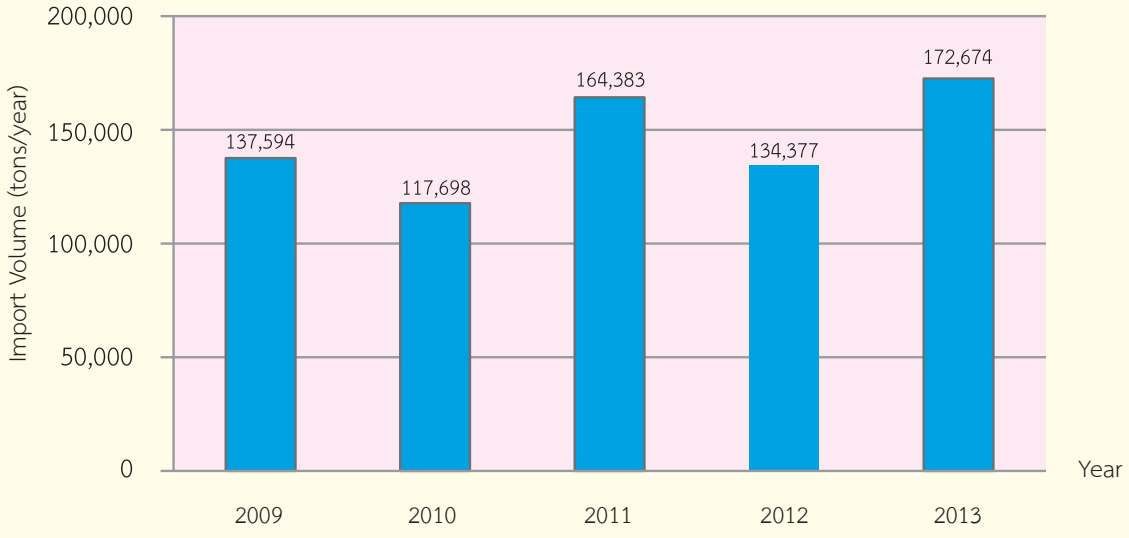


Figure 42 The import volume of agrochemicals under Hazardous Substances Act, B.E. 2535 during 2009 - 2013

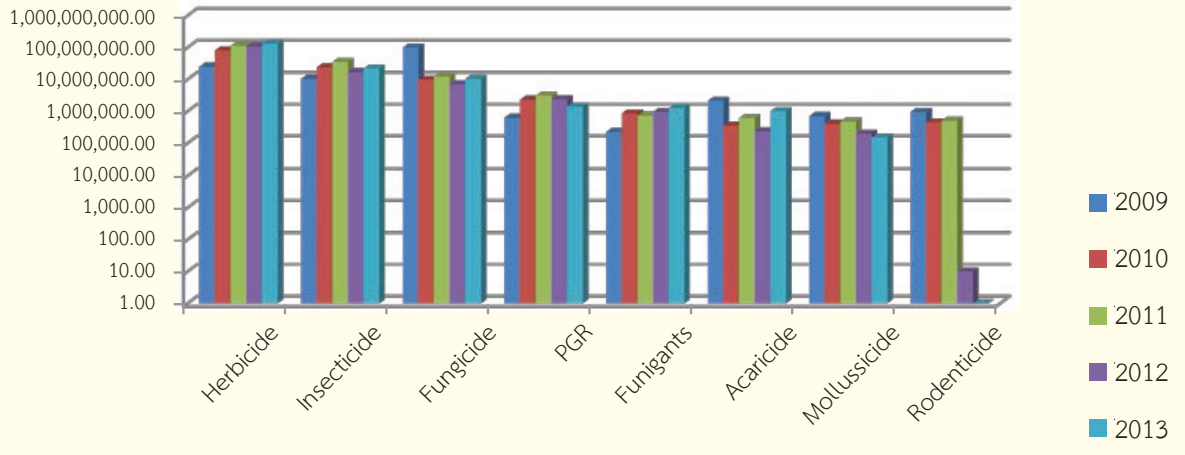


Figure 43 Hazardous agrochemicals under Hazardous Substance Act, B.E. 2535 imported during 2009 - 2013

Table 24 Top 10 hazardous agrochemicals imported in 2013

Rank	Chemical	Volume (tons)	Usage	Class
1	Isopronylammonium	56,746.84	Herbicide	3
2	Paraquat dichloride	36,048.25	Herbicide	3
3	2,4 - D dimethyl ammonium	7,287.74	Herbicide	3
4	2,4 - D sodium salt	6,696.46	Herbicide	3
5	Ametryn	5,947.61	Herbicide	3
6	Atrazine	4,984.21	Herbicide	3
7	Butachlor	3,060.33	Herbicide	3
8	Diuron	2,220.30	Herbicide	3
9	Chloripyrifos)	2,136.94	Herbicide	3
10	Mancozeb	1,891.64	Herbicide	3
Total		**127,020.31**		

Source : Office of Agricultural Regulation, Department of Agriculture. Retrieved 1 June 2013 from www.doa.go.th

Table 25 Top 10 hazardous agrochemicals exported in 2013

Rank	Chemical	Volume (tons)	Usage	Class
1	Difenoconazole + Propinazole	1,493.34	Herbicide	3
2	Paraquat dichloride	751.48	Herbicide	3
3	Ametryn	374.03	Herbicide	3
4	Pretilachlor	217.65	Herbicide	3
5	Dinotefuran	193.59	Herbicide	3
6	Carbaryl	192.45	Herbicide	3
7	Fosetyl - Aluminium	152.69	Herbicide	3
8	Glyphosate isopropylammonium	145.56	Herbicide	3
9	Difenoconazole	138.23	Herbicide	3
10	Imidacloprid	77.14	Herbicide	3
Total		3,736.15		

Source : Office of Agricultural Regulation, Department of Agriculture, 2013.

2.4.2 Hazardous industrial chemicals

In 2013, 217 out of 525 hazardous industrial chemicals under Hazardous Substances Act, B.E. 2535 under the governance of Department of Industrial Works were imported. The volume of the chemicals imported was 3,638,229.16 tons (Figure 44) which was less than the volume of the previous year, 2,576,754 tons, or 41%. On the other hand, only 99 out of 525 hazardous industrial chemicals were exported. The export volume of hazardous industrial chemical was 2,398,921.33 tons increasing from the previous year, 6,079.11 tons, or 0.26%. Top 10 hazardous industrial chemicals under Hazardous Substances Act imported and exported in 2013. (Table 26 and Table 27).

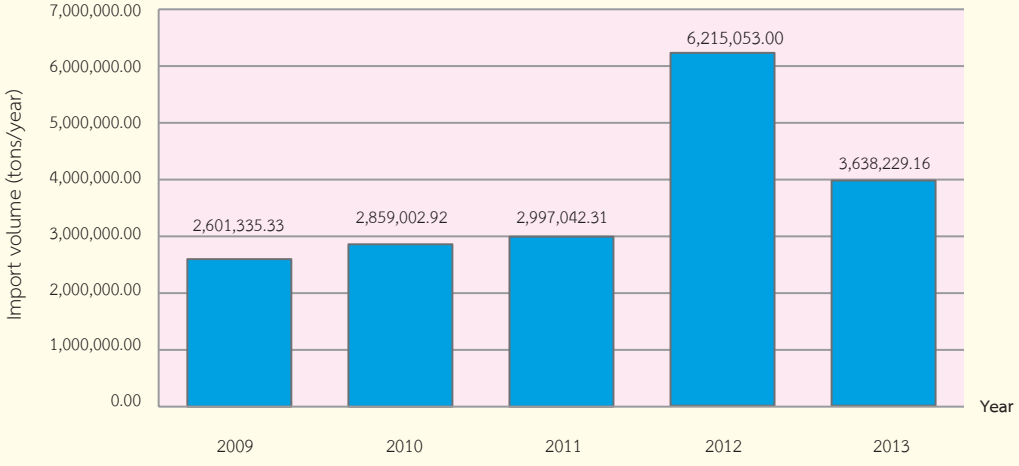


Figure 44 The import volume of industrial chemicals under Hazardous Substances Act, B.E. 2535 during 2009 - 2013

Table 26 Top 10 hazardous industrial chemicals under Hazardous Substances Act imported in 2013, and their industrial usages

Rank	Chemical	Volume (tons)	Industry	class
1	Methanol : Methyl Alcohol	740,227.490	Plastic, color	1
2	Ethylene dichloride or 1,2 - Dichloroethane	442,543.814	PVC chemical industry	3
3	Sulfuric acid	380,867.785	Fertilizer production	3
4	Ammonia anhydrous	369,449.524	Fertilizer production	3
5	Sodium hydroxide	213,659.044	Pulp and paper	1
6	Phenol : Hydroxyl benzene	152,953.747	Polymer industry Plastic resin	2
7	Styrene monomer	132,896.730	Foam industry	2
8	Acrylic acid	122,433.819	Textile industry	1
9	Benzene	120,816.968	Materials for chemicals production	3
10	Acetic acid	109,340.904	Food industry	3
Total		**2,785,189.83**		

Source : Department of Industrial Works, retrieved 29 January 2014 from www.diw.go.th

Table 27 Top 10 hazadous industrial chemicals under Hazardous Substances Act, B.E. 2535 exported in 2013

Rank	Chemical	Volume (tons)	Industry	class
1	Benzene	899,010.900	Material for producing chemicals	3
2	Propylene Oxide; 1,2 - Epoxypropylene; Methyloxirane	280,812.001	Polyester industry	3
3	Methyl methacrylate	230,902.173	Refractory, glass and mirror industry	3
4	Toluene	132,366.645	Petroleum industry	3
5	Hydrogen Peroxide	112,285.587	Food bleaching and cleaning supplies	3
6	Vinyl chloride or Chloroethene	111,583.000	Material for producing PVC resin	3
7	Phenol : Hydroxyl benzene	108,455.082	Polymer industry Plastic resin	3
8	Sodium hydroxide	104,254.077	Pulp and paper	3
9	1,3 - butadiene or buta - 1,3 - diene	90,355.000	Synthetic rubber industry	3
10	Acetone	81,826.295	Plastic, fiber, drug and chemical industry	3
Total		**2,151,850.76**		

Source : Department of Industrial Works, retrieved 29 January 2014 from www.diw.go.th

According to the information about the current situation of chemicals usage in both agricultural and industrial sectors, it signifies that Thailand has still employed a large volume of chemicals in order to enhance agricultural productivity and to use in industrial production. However, the application of chemicals can lead to unfavorable results caused by direct and indirect toxic effects of chemicals used in different activities and direct contact of chemicals of users, workers, farmers, persons involved in the production, the public, and the environment. The Contact can occur at any step involving chemicals including importing, transferring, stocking, producing, using, treatment, and disposal process. The information suggests that although chemicals provide a great deal of benefits, they can bring about serious risks if the users of those chemicals lack knowledge and experience in safety usage and toxic effects of chemicals.

Furthermore, the application of chemicals affects the country's environment in different ways; for example, the chemicals can spread through the air and into water sources. They might remain in the soil, underground water, and even in living creatures. As a result, every involving sector needs to initiate and support policies to reduce and stop the use of chemicals. For example, there should be a campaign for raising awareness of effects of chemicals, the reduction of chemical uses, and the cancelation of some chemicals with fatal toxic effects.

Chapter 3

Annual Report of Accidental Pollution

3.1 Emergency cases and complaints of pollution

When there is an emergency case or accidents caused by pollution, the crisis will be mutually tackled by various agencies such as the Disaster Prevention and Mitigation Provincial Office, Disaster Prevention and Mitigation Center, Industrial Estate Authority of Thailand, Regional Environment Office, Provincial Office of Natural Resources and Environment, Department of Industrial Works, Bangkok Fire and Rescue Department, District Administrative Office, Bureau of Health, Bangkok Metropolitant Administration (BMA) and the Pollution Control Department. In the year 2013, the Pollution Control Department had recieved a total of 26 emergency cases and accidents caused by pollution, classified as 6 emergencies in industrial factories and warehouses, 3 cases from chemical transport and 4 other cases, as well as 13 cases of illegal dumping of waste (Figure 45). Additionally, a number of accidents and emergencies from pollutants were reported by other agencies including the Disaster Prevention and Mitigation Provincial Office, Disaster Prevention and Mitigation Center, Industrial Estate Authority of Thailand, Department of Industrial Works, Bangkok Fire and Rescue Department, and Bureau of Environmental Health, BMA.

Figure 45 Statistics of pollution accidents during 2008 - 2013

Source : The information reported to the Pollution Control Department only, January 2014

3.1.1 Chemical Accidents

Chemical accidents occurring in industrial plants, warehouses and chemical transports cause a direct impact on the public. According to the statistics in 2013 there were 13 incidents with details as follows (Table 28).

Table 28 Chemical Accidents in 2013

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
1	11 January 2013	Truck hit by another truck transporting agricultural chemicals at the 392-393 kilometer marker on Petchakasem Road, under Koh Yai Chim, Ronthong Sub-district, Bangsapan District, Prachuap Khiri Khan Province causing a fire and leakage of agricultural chemicals spilling over 10 tons of chemicals.	Pollution Control Department of in cooperation with Prachuap Khiri Khan Provincial Office of Natural Resources and Environment, and Ronthongcity Subdistrict Municipality undertook the following measures : - Checking for contamination of agricultural chemicals in water resources around the scene. - Offering guidelines for waste spilled on the road. After the investigation, it was found that there were contaminations of agricultural chemicals under Organophosphate Carbamate and Pyrethroid groups. The company owner was therefore coordinated to manage and recover the waste appropriately according to the guidelines including environmental restoration. - Monitoring the environmental quality to return to normal.
2	18 January 2013	A fire around the old warehouses of Rungtuatid recycling industry Limited Partnership at Phraeksamai Sub-district, Muang District Samut Prakan Province causing a lot of smoke spreading over the area.	Phraeksamai Sub-district Administrative Organization coordinated with local administrative offices to jointly send over 20 units of fire trucks to tackle the fire which took approximately 1 hour to control.
3	29 January 2013	Fire outbreak of waste garbage inside an old pond at Moo 2, Mabphai Sub-district, Ban Bung District, Chon Buri Province causing dusky smoke and a severely bad smell Disturbing people in the area. Large quantities of various types of industrial waste were dumped in this pond such as used oil, circuit boards and crushed circuit boards.	Pollution Control Department in cooperation with the Regional Environment Office 13 (Chon Buri), Chon Buri Provincial Office of Natural Resources and Environment, Chon Buri Provincial Industry Office, Chon Buri Provincial Health Office and the Mabphai Subdistrict Administrative Organization jointly conducted an examination of the effects of fire breakout causing black smoke with a drifting pungent smell permeating the atmosphere directly affecting people living in the downwind direction, causing nausea, vomiting and headache. Initially, Mabphai Subdistrict Administrative Organization alerted residents to evacuate the area temporarily, and coordinated with firefighter units from various municipalities in Muang District, and Ban Bung District, Chon Buri District, sending over 30 firefighting vehicles to tackle the burning fire. The Pollution Control Department monitored the pollution that occurred during the fire and detected various gases at a relatively high levels, such as acetone, benzene, ethyl benzene, and chloroform. The information was shared with Mabphai Subdistrict Administrative Organization and Chon Buri Provincial Health Office as reference in the planning of prevention on the impacts to public health of the people and the environment.

Table 28 Chemical Accidents in 2013 (continued)

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
4	4 February 2013	Chlorine gas leak in the pool of St. Dominic College on Petchaburi Road, Makkasan Sub-district, Rajthevi District, Bangkok. A total of 39 students inhaled chlorine causing burning eyes and nose, dizziness, nausea, and vomiting and had to be hospitalized.	The Pollution Control Department provided information and advice to the Bangkok Fire and Rescue Department and Bureau of Health, BMA to indicate the type of chemical spilt in the area and the potential impact on students and school personnel who were exposured to chlorine gas into the body and ways to prevent problems such as the evacuation of students, temporary school closings, etc. This also included waste chemical recovery and personal protective outfits for rescue personnel.
5	9 February 2013	At 8.30 a.m. on February 9, 2013 there was a fire at Supreme Plastic Industries Co., Ltd., Bung Sub-district, Sriracha District, Chon Buri Province. The fire erupted due to flammable foam and plastic material with periodic blasts in the building. There was also a large area of black smoke floating in the air creating a bad smell spreading all over the area affecting villagers and communities surrounding the plant.	- The concerned agencies coordinated and mobilized fire fighting units in the Sriracha area and surrounding neighborhoods to send more than 10 units of fire trucks to control the fire. The fire completely destroyed the entire buildings number 4 and 5. Building number 3 was partially damaged and was sprayed with water for over 1 hour to secure the area from the fire. - The Pollution Control Department in cooperation with the Regional Environment Office 13, Chon Buri Province examined the scene after the fire was extinguished and measured the amount of vapors from the foam for substrates such as Ethylene and Styrene. The substances were detected in low concentrations with no severe immediate impacts to cause any acute harm to the recipient; it was undetected in the community in front of the plant (north wind).
6	22 February 2013	A fire erupted on a 24-wheel fuel tanker truck of Good Team Enterprise Co., Ltd., carrying around 6,000 liters of gasohol 91 and diesel fuel on Burirum-Surin Road, Samed Sub-district, Muang District Buriram Province.	Buriram City Municipality, Samed Subdistrict Administrative Organization, Sawia Chik Subdistrict Administrative Organization and Sa Kaesam Administrative Organization sent altogether 10 fire trucks to fight the fire. The road was closed for an hour until the fire was under controll. No one was injured or killed.
7	6 March 2013	Illegal oil smuggling in the middle of Plu Ta Luang National Housing Village exploded at Plu Ta Luang Sub-district, Sattahip district, Chon Buri Province. Fire spread to the surrounding public houses and damaged 3 houses. During the fire there were a few consecutive numbers of explosions.	Fire fighter unit of Plu Ta Lung Subdistrict Administrative Organization and Sattahip Town Municipatity sent 5 fire trucks together with officers of Sawang Rajanathamsatan Rescue Foundation to tackle the fire which consisted of over 1,000-liters of benzene which is very difficult to extinguish. Officials had to keep directing water into the fire for more than 1 hour to bring it under control.

Table 28 Chemical Accidents in 2013 (continued)

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
8	16 March 2013	A recycling plant warehouse, Wax Garbage Recycle Center Co., Ltd. located in Rangbua Sub-district, Chombung District, Ratchaburi Province, was on fire causing damage to more than 4 warehouses. The warehouses were used for storage of flammable materials such as paints, plastics and fuel contained in numerous tanks, causing black smoke and widespread dust in the atmosphere. A bad smell also affected the local communities.	- Ratchaburi Province requested over 30 fire trucks from various local fire departments to tackle the fire by directing water and fire extinguisher foam into the area for about 5 hours to be able to control the fire. - Pollution Control Department and Regional Environment Office 8, Ratchaburi examined the pollutant ratio from the fire scene and nearby communities by measuring the volatile substances and solvents such as acetone, methyl alcohol and toluene, etc., with recommendations to resolve the issue with concerned provincial and local units.
9	29 March 2013	Plastics plant of Master Glove Industries Limited located at Moo 1, Klongnoi Road, Maekoo Num Sub-district, Pluack Daeng District, Rayong Province was on fire with black plumes of smoke drifting from the factory fire.	Regional Environment Office 13, Chon Buri with Rayong Province examined and provided suggestions on how to fix the problem for the company and local agencies by monitoring air quality and checking for volatile organic compounds (VOCs) over a 24-hour period and alerted the people living around it.
10	26 April 2013	A truck carrying 2,000 liters of nitric acid overturned on the side of Asia Road - inbound to Bangkok leg at the 13 kilometer marker, under the district of Taling Chan Sub-district, Bang Pa-in District. 2 large plastic buckets ruptured with nitric acid leaking down the side causing a traffic jam for more than seven kilometers.	Phra Nakhon Si Ayutthaya Disaster Prevention and Mitigation Provincial Office tackled the situation by closing all traffic and using lime powder sprinkled all over the area to absorb and neutralize the nitric acid and placed into loaders to dispose of properly according to the guidelines. No-one was injured or killed.
11	6 June 2013	At approximately 16.00 hours, the oil recycling plant of Chatuporn Recycle Co., Ltd. located at Moo 9, Soi Kodang Saengfa, Teparak Road, Bangpla Sub-district, Bangplee district, Samutprakarn Province, caught on fire and explosive-like noises occurred several times. Authorities ordered a temporary evacuation from the area due to the smell of chemicals spreading in the area and the concern that the fuel tank in the factory might explode.	- Local authorities coordinated with local fire departments to tackle the incident, spending over two hours to control the fire within a limited perimeter by directing water and chemical foam to prevent reoccurring fires starting during the night. - Pollution Control Department together with the Samut Prakan Provincial Office of Natural Resources and Environment and Regional Environment Office 6, Nonthaburi sent officials to jointly examine the scene and explore the extent and amount of oil contamination in the water from the leak of fire extinguisher substances outside the factory. The guidelines for waste management from a fire and the collection of waste water contaminated with oil according to the guidelines were provided.

Table 28 Chemical Accidents in 2013 (continued)

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
12	27July 2013	Crude oil from PTT Global Chemical Public Company Limited leaked from oil pipes in the coastal area of Ao Phrao bay, Koh Samed area Ban Phe Sub-district, Muang District, Rayong Province.	Pollution Control Department together with Rayong Provincial Office of Natural Resources and Environment and Regional Environment Office 13, Chon Buri jointly examined the scene by measuring the concentrations of volatile organic compounds (VOCs) and BTEX compounds in the area of Ao Phrao beach and other beaches including seaside communities at Ban Phe Sub-district to assess the risk of acute air pollution that may cause harm to residents and visitors including staff and volunteers who participated in recovering the leaked oil at Ao Phrao bay. This also included water quality analysis from various bays around Samed island and on the mainland continuously to evaluate the contamination of oil in the sea-water. The process included taking samples of sand layers to examine contamination of oil on Ao Phrao bay to complement the environmental rehabilitation together with related agencies such as the Marine Department, Department of Marine and Coastal Resources, and the Department of Natural Parks, Wildlife and Plant Conservation, etc.
13	14 November 2013	Hydrogen gas tank exploded at Chachoengsao market, Marupong Road, Na Muang Sub-district, Muang District, Chachoengsao Province killing 4 people on the scene, 6 injured, and over 20 commercial buildings and 9 vehicles damaged.	Chachoengsao Province the Disaster Prevention and Mitigation Provincial Office coordinated the related agencies to examine the scene and salvage and recover the exploded gas tank in the area.

An important chemical accident this year was the oil spilt from pipelines in the sea of PTT Global Chemical (PLC) at 06:50 hours on July 27, 2013. There were approximately 50,000 gallons of crude oil leaking from a 16 inch soft tube belonging to PTT Global Chemical (PLC) about 20 miles away from the coast of Mabtaput towards the Southeast, and moving to Ao Phrao Beach, Samed Island, on July 29, 2013. Many staff and volunteers were engaged and attended in beach restorations.

3.1.2 Illegally dumped waste

The practice of illegal dumping of waste in abandoned areas or old ponds was still rising steadily by the year 2013, totaling 13 times. Most of the dumped waste was largely from the industrial sector. The area with most of the illegal waste dumping was Prachinburi Province, totaling 3 times. The dumping that took place in 2013 includes the following (Table 29).

Table 29 Illegal waste dumped in 2013

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
1	18 January 2013	Illegal dumping of waste in an earth pond at Moo 2, Mab Phai Sub-district, Ban Bung District, Chon Buri Province.	Regional Environment Office 13, Chon Buri in collaboration with the relevant agencies in the area such as Mabphai Subdistrict Administrative Organization and Chon Buri Provincial Industry Office investigated the deserted pond area at Moo 2, Mabphai Sub-district, Ban Bung District, Chon Buri Province and found various kinds of industrial waste dumped, such as discarded quantities of used oil, circuit boards and broken circuit boards which are considered as hazardous wastes according to Factories Act, Year 1992. The office therefore coordinated with Chon Buri Provincial Industry Office to take legal actions against landowners and ordered appropriate disposal of the waste in the pond.
2	31 January 2013	Illegal dumping of industrial waste-water in agricultural areas of Ban Nongtalai, Moo 3, Lattakhian Sub-district, Kabinburi District, Prachinburi Province in the form of dark colored liquid with a pungent smell.	Pollution Control Department conducted a joint investigation with Prachinburi Office of Natural Resources and Environment by collecting samples in the area that consist of farmers' fields to analyze the type of waste and heavy metal residue in the soil. Initially, it was found that the waste water was from the paper production process dumped in the cultivated area. The Prachinburi Office of Natural Resources and Environment therefore informed the Prachinburi Provincial Industry Office to proceed with legal actions against the landowner.
3	23 March 2013	Illegal dumping of waste in the area of Bangpoo Industrial Estate, Praeksa Sub-district, Muang District, Samut Prakarn Province. A waste disposal factory "Waste Recovery" disposed chemical contaminated wastewater into the drainage lines in the estate.	Pollution Control Department coordinated with Regional Environment Office 6, Nonthaburi and Samut Prakan Provincial Office of Natural Resources and Environment to collect wastewater samples in the water drainage lines inside Bangpoo Industrial Estate. Contamination of phenol was detected at high levels that were considered hazardous according to the Factory Act, Year 1992. Preliminarily the wastewater was blocked and quarantined within the side drainage lines of the factory to be pumped for further treatment.
4	31 March 2013	Illegal dumping of industrial wastewater in Kabinburi district, Prachinburi Province.	Pollution Control Department coordinated with Regional Environment Office 7, Saraburi and Prachinburi Office of Natural Resourcesand Environment to send officials to collect environmental samples including water, soil sediment and fresh water animals from the canal to examine for mercury contamination and found that mercury levels did not exceed the benchmark standards of surface water and soil. However, monitoring is still being currently conducted on a continuous basis.

Table 29 Illegal waste dumped in 2013 (continued)

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
5	3 May 2013	Illegal chemicals and industrial waste dumping in an earthen pond in Moo 18, Bangphra Sub-district, Muang District, Prachinburi Province. A deserted pond covering an area of about 30 rai with a pile of waste amounting more than 100 square meters, weighing over 100 tonnes in forms of lime scale powder and gray clumping with a pungent odor similar to ammonia causing irritation and burning eyes. This also included fine black powder, odorless ash and gray-green sludge from wastewater treatment systems.	The Pollution Control Department coordinated with the Prachinburi Office of Natural Resources and Environment and Regional Environment Office 7, Saraburi to investigate and resolve the problem. By examining the waste, dross from aluminum smelter was found. Therefore the Prachinburi Provincial Industry Office was coordinated to investigate and take legal action against the landlord, closed the pond and ordered proper disposal of the waste.
6	30 May 2013	Illegally dumped chemical waste in a discarded natural pond in Moo 1, Mab Yangporn Sub-district, Pluack Daeng District, Rayong Province covering an area of about 15 rai.	Pollution Control Department in cooperation with Rayong Provincial Office of Environment and Natural Resources and Mab Yang Porn Subdistrict Administrative Organization investigated and resolved the problem as it was initially found that the area was contaminated with waste in the form of black powder and white fibers of Acrylonitrile, Styrene, ABS Plastics and solvents compounds covered with earth. The Rayong Provincial Industry Office therefore coordinated an investigation and proceeded with legal actions.
7	3 June 2013	Illegally dumped toxic waste at the opposite side of Lam Kaek Mosque School, Suwinthawong Road, Lam Pakchee Sub-district, Nongjok District, Bangkok.	Pollution Control Department together with Nongjok District Administrative Office, and Bureau of Health, BMA jointly examined the type of waste initially suspected as wastewater from tank cleaning business in the area. Most of the wastewater was contaminated with organic solvents. The Nongjok District Administrative Office was instructed to resolve the stench odor affecting students and the schools had to be temporarily closed. Rice husk ashes were used to absorb the waste around the contaminated area.
8	15 July 2013	Illegal fusion of lead in Nong Pla Lai Sub-district, Nong Prue District, Kanchanaburi Province resulted in the spread of vapor and lead residues in the environment.	Pollution Control Department together with Kanchanaburi Office of Natural Resources and Environment, Nong Prue Police Station, and Nong Prue Subdistrict Municipality jointly investigated contamination of lead in the soil and found high levels of lead contamination. They provided guidelines for implementing the solutions for lead contamination and taking related legal actions such as Factories Act, Year 1992.

Table 29 Illegal waste dumped in 2013 (continued)

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
9	9 August 2013	A truck illegally drained wastewater into the waterway on the side of Kaengkoi-Banna Road, Sam Pakpaew Sub-district, Kaengkoi District, Saraburi Province. The dumped wastewater drained into the gully beside the road that connects to the rice fields. The wastewater had a pungent stink causing eye and nose irritation and having impacts on nearby residents. The waste was described as a black oily residue.	Pollution Control Department has coordinated with Saraburi Office of Environment and Natural Resources and Regional Environment Office 7, Saraburi to jointly examine and make recommendations to resolve the problem. Initially, the soil was found to have been illegally contaminated with wastewater with high acidity and a pungent stench. The Saraburi Office of Natural Resources and Environment therefore coordinated to propose to the local authorities to initially resolve the issue by using lime powder to cover the area to reduce the stench of chemicals.
10	19 August 2013	Illegal waste dumping in Thalor Sub-district, Thamuang District, Kanchanaburi Province in form of gray powder with ammonia-like odor in 20 chemical, 200 liter tanks.	Pollution Control Department together with Regional Environment Office 8, Ratchaburi and Kanchanaburi Office of Natural Resources and Environment sent officials to jointly examine and indicate the type of waste and offer waste management recommendations. Initially it was found that the dumped waste was aluminum dross from a furnace and degraded solvents. The Kanchanaburi Office of Natural Resources and Environment was informed and coordinated with concerned agencies for the inspection results. Finally, Department of Industrial Works was able to find the offenders and the waste was ordered to be relocated and disposed of properly.
11	30 August 2013	Illegal dumping of waste in earth ponds aside the Liquor Distillery Organization's factory in Moo 4, Pak Nam Sub-district, Bangkla District, Chachoengsao Province, in the form of oily stains and used engine lubricants dumped into many deserted ponds covering an area of at least 10 rai. The wastewater was dark brown to black in color. Sticky, pungent, smelly oil stains were also found on the edge of each pond.	Pollution Control Department together with Chachoengsao Office of Natural Resources and Environment and Chachoengsao Provincial Industry Office investigated the area and initially found the illegal dumping of oil-contaminated wastewater from the factory into the earth ponds. The Chachoengsao Provincial Industry Office was therefore coordinated to proceed with legal actions.
12	3 September 2013	Illegal dumping of sludge from wastewater treatment systems in a deforested area near Kao Kaew Reservoir, Klong Rue Sub-district, Viharn Daeng District, Saraburi Province.	Pollution Control Department in coordination with Saraburi Office of Environment and Natural Resources, Regional Environment Office 7, Saraburi and Klong Rue Subdistrict Administrative Organization jointly investigated the scene and initially assumed that the waste was the sludge from a wastewater treatment system from a sauce production plant. Later on, the Department of Industrial Works was able to find the offenders and the waste was ordered to be relocated and disposed of properly.

Table 29 Illegal waste dumped in 2013 (continued)

No	Date of indicent/ being reported	Event Description	Procedures and Solutions
13	14 November 2013	Illegal dumping of waste in a gravel pit covering an area of 3 rai with 2,400 cubic meters of wastewater in Ban Nongsuk-Nongsano, Moo 13, Nong Hieng Sub-district, Panasnikom District, Chon Buri Province.	The Pollution Control Department in coordination with Regional Environment Office 13, Chon Buri and Nong Hiang Subdistrict Administrative Organization investigated the area where the illegal dumping of waste occurred and found that there was illegal sewage contamination of organic solvents and oils in the pond. Chon Buri Regional Environment Office 13 was informed to coordinate with Nong Hiang Subdistrict Administrative Organization to resolve the problem especially the smell by using rice husk ashes to absorb, relocate and properly dispose of.

An important case of illegal dumping of waste which took place this year was the illegal dumping of waste in a form of gray powder having ammonia-like odor and a 200-liter chemical tank in Thalor Sub-district, Tha Muang District, Kanchanaburi Province. The Department of Industrial Works was able to find the offender and took related legal action. Afterwards, a partnership between the public and the relevant authorities in Kanchanaburi Province was created to monitor and carry out the surveillance of illegal waste dumping, so it won't occur in the area again.

3.1.3 Complaint Management on pollutions

With the rapid metropolitan growth, the economy is highly competitive, and with the growth of industry without a good plan and lack of some entrepreneurs' awareness on environmental protection, some people are operating their businesses with pollutant disposals that affect environmental quality. People have inevitably suffered from pollution problems, so making complaints of polluting to the responsible government agencies is one of the solutions that people initially think of, and the government sector must tackle such problems in order to provide relief to the people.

According to the collection of statistical data of the concerned agencies receiving complaints about pollution during 2008 - 2013, it was found that for the Department of Industrial Works and Pollution Control Department, the number of complaints had slightly increased whereas the complaints reported to Bangkok Metropolitan Administration, Share Service Center, Ministry of Natural Resources and Environment and Damrongdhama Center, Ministry of Interior as well as the People Service Center, Office of the Permanent Secretary had reduced. This is in relevance to the decrease of overall complaints of polluting by the six agencies as well (Figure 46), possibly due to the government agencies focusing on providing more channels to report the complaints of local and regional pollution problems. However, pollution problems still continue to cause harm to the public or impact the environment as continuously seen from the news and various media.

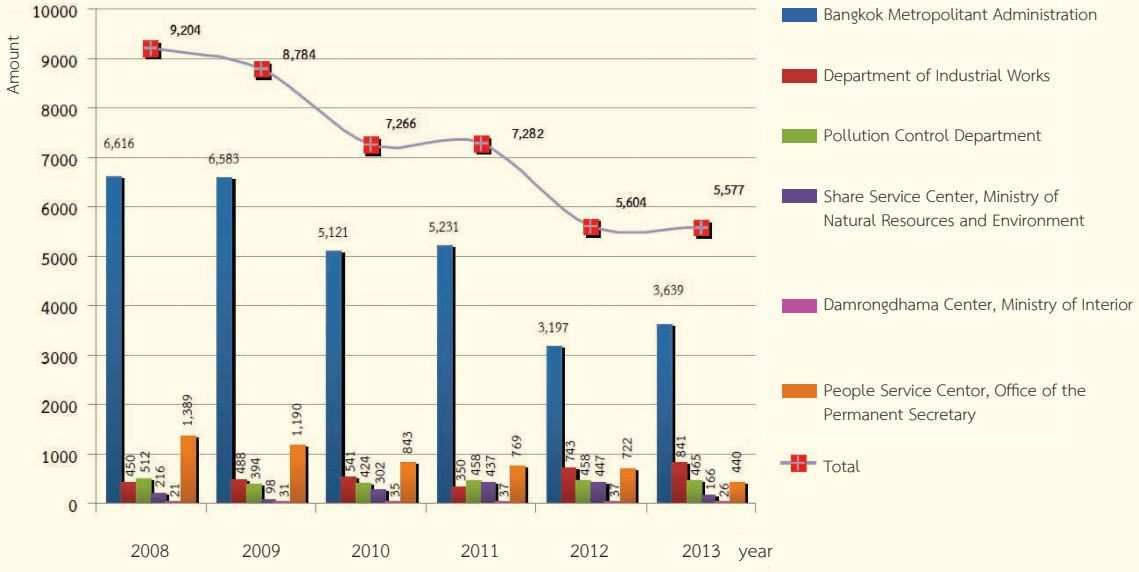


Figure 46 Statistics on pollution complaints in the year 2008 - 2013

The type of pollution which was complained about the most in 2013 as per the consistent record of Department of Industrial Works, Pollution Control Department and Damrongdhama Center, Ministry of Interior (Figure 47) was air pollution including odor problems, dust and smoke with an average percentage of 54, 64 and 64, respectively, followed by the noise pollution and vibration with an average of 25 percent, 18 and 29 respectively. Considering the sources of the problems and sufferings distinguished by the agencies receiving the complaints, it was found that Bangkok had reported 3,639 complaints, mostly coming from residents' and home equivalent at 30 percent, business with a health hazard at 29 percent, and food consumption areas and food storage at 20 percent. The Department of Industrial Works received 841 complaints, whereas the Pollution Control Department received 465 complaints. Most complaints were concerning the operation of industrial factories producing food production flavoring, furniture, accessories, chemicals and coal, automobiles, plastics, foam, and the steel industry, all accountable for 45 percent. Damrongdhama Center of Ministry of Interior received 26 complaints, mainly from the operation of factories, at 45 percent, and restaurants, at 15 percent. People Service Center, Office of the Permanent Secretary received 440 complaints, mainly about the problems of trash, garbage and hazardous waste, accountable for 63 percent.

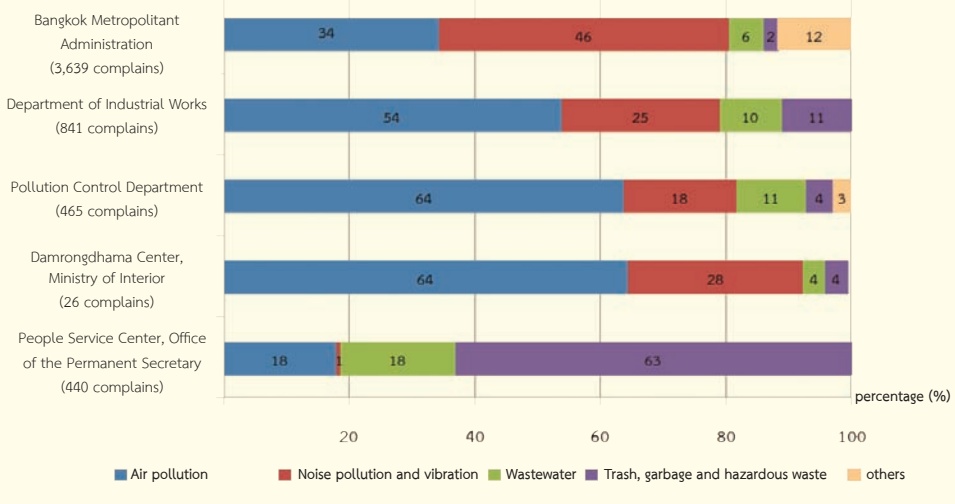


Figure 47 Proportion of pollution problem types being complained about in 2013

Bangkok and its vicinities are the areas with the highest complaints (Figure 48). The reports are consistent among the 3 agencies, including the Department of Industrial Works, Pollution Control Department and the People Service Center, Office of the Permanent Secretary, averaging at 62%, 64% and 38% respectively. This is because they are an economic hub with industrial factories, many business establishments and the expansion of urban community areas.

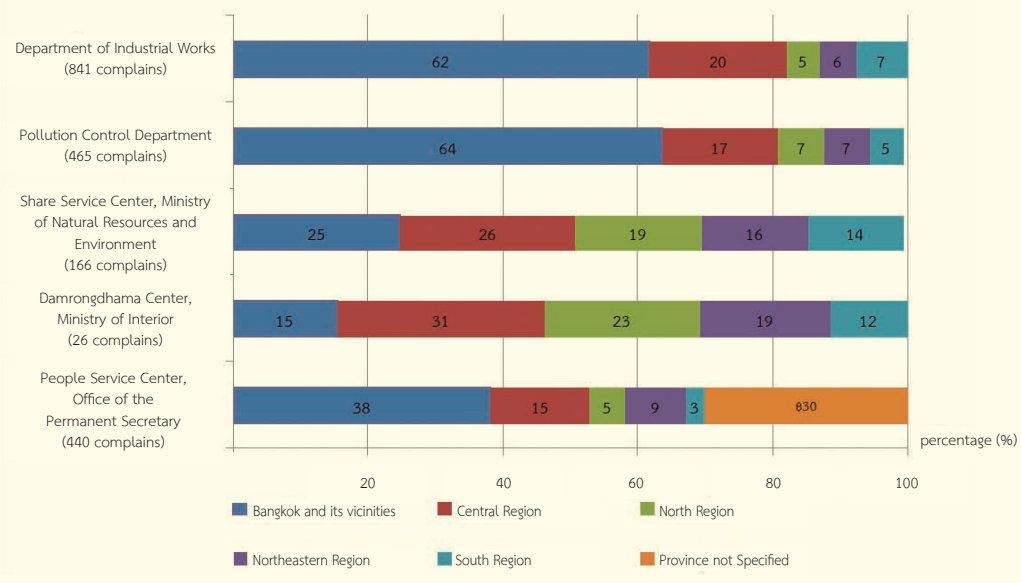


Figure 48 Proportion of complaints about pollution in each region in 2013

According to the report of complaints of pollution collected by 6 government agencies including Bangkok Metropolitant Administration, Department of Industrial Works, Pollution Control Department, Share Service Center, Ministry of Natural Resources and Environment and Damrongdhama Center, Ministry of Interior as well as the People Service Center, Office of the Permanent Secretary, there were 5,577 complaints. As for the implementation of the solutions, the related agencies proceeded with the given authority to issue orders to correct or improve, or to cease operations of the factory and conduct prosecution of legal actions, etc. 83 percent of the issues had been settled with 17 percent under on-going process. (Table 30).

Table 30 Results of actions of pollution complaints by government agencies in 2013

Agencies	Number of complaints	Result of actions on the complaints			
		Settled		Under Process	
		Amount	Percentage	Amount	Percentage
Bangkok Metropolitant Administration	3,639	3,184	87	455	13
Department of Industrial Works	841	651	77	190	23
Pollution Control Department	465	253	54	212	46
Share Service Center, Ministry of Natural Resources and Environment	166	137	83	29	17
Damrongdhama Center, Ministry of Interior	26	14	54	12	46
People Service Center, Office of the Permanent Secretary	440	416	95	24	5
Total	**5,577**	**4,655**	**83**	**922**	**17**

Remark : Information as on 20 January 2014

The satisfaction survey on the procedures to take action on complaints about pollutions

Pollution Control Department has conducted a satisfaction survey in action against complaints. It was found that, from the complaints, most were satisfied with overall services, with a satisfactory level accountable at 87 percent, tracking and responding to complainants at 89 percent, politeness and friendliness of the staff at 89 percent, attention and enthusiasm of the staff at 83 percent, effort to resolve the problem at 89 percent, providing relevant guidance and information at 81 percent, and integrity, transparency and fairness of the authorities at 95 percent.

3.2 Dominant environmental events of the year

3.2.1 Crude oil spilled into the sea in Rayong

On July 27, 2013 there was a leak in a crude oil pipeline of PTT Global Chemical Public Company Limited (PTTGC) while unloading oil from a tanker ship to refineries in the area. As a result, approximately 50,000 gallons of crude oil leaked into the sea and was swept onto the bay of Ao Phrao beach and Koh Samed. Most areas of the beach were covered with oil stains covering a distance of over 600 meters. After the incident, the agencies involved have taken steps to resolve the problems as specified in the water pollution prevention and elimination plan due to oil leak as follows :

- On July 27, 2013, PTTGC requested permission to use the oil dispersant agent, Slickgone NS Type 2/3 (Dasic slickgon NS). Pollution Control Department allowed the usage for an amount of 5,000 liters, considering that the duration of the spill allowing the oil dispersant usage effectively; water depths being greater than 10 meters and therefore other recovery methods are not effective enough, and the need to prevent oil stains on the beach of Koh Samed which would affect the marine and coastal resources of the major attraction of Rayong Province to a critical level. PTTGC together with the Navy, Marine Department, and IRPC (PCL) sprayed the oil decomposition solution using a C 130 airplane from Oil Spill Response Co., Ltd., Limited spraying the solution to decompose the oil stains. However, on the night of July 28, 2013, a massive amount of oil was washed ashore the bay of Ao Phrao, Koh Samed.

- On July 29, 2013, the Rayong Governor declared Ao Phrao bay area a maritime disaster zone. Visitors were not allowed to swim there.

- Related authorities including the Marine Department, Royal Thai Navy, Department of National Parks, Wildlife and Plant Conservation, Rayong Prevention and Mitigation Office, PTTGC, and volunteers joined hands to remove the oil stains and clean the rocks and sand of Ao Phrao bay area to return it back to normal.

The authorities under the Ministry of Natural Resources and Environment including Pollution Control Department, Department of Marine and Coastal and the Department of National Parks, Wildlife and Plant Conservation jointly monitored and evaluated natural resources and environmental quality continuously as follows :

1. The sea water quality was monitored at 12 stations around Koh Samed, 9 stations on Rayong coastal lines, and 23 offshore stations continuously during August - October 2013. It was found that overall, the water quality was as per the standard of class 4 with recreational status. Only at Ao Phrao Bay, an amount of petroleum hydrocarbons were found beyond the standard content with a respective decreasing ratio. Since the 12th measurement (23 September 2013) to the 17th (29 October 2013), all parameters measured were within the standard of water quality class 4 with recreation status at all stations. At Rayong coastal lines from the 3rd measurement (28 August 2013) till the 11th (31 October 2013), all parameters measured were within the standard of water quality class 4 with recreation status at all stations, whereas at Rayong offshore, the amount of polycyclic aromatic hydrocarbons in the sea water qualified for the standard of class 4 at all stations (Figure 49).

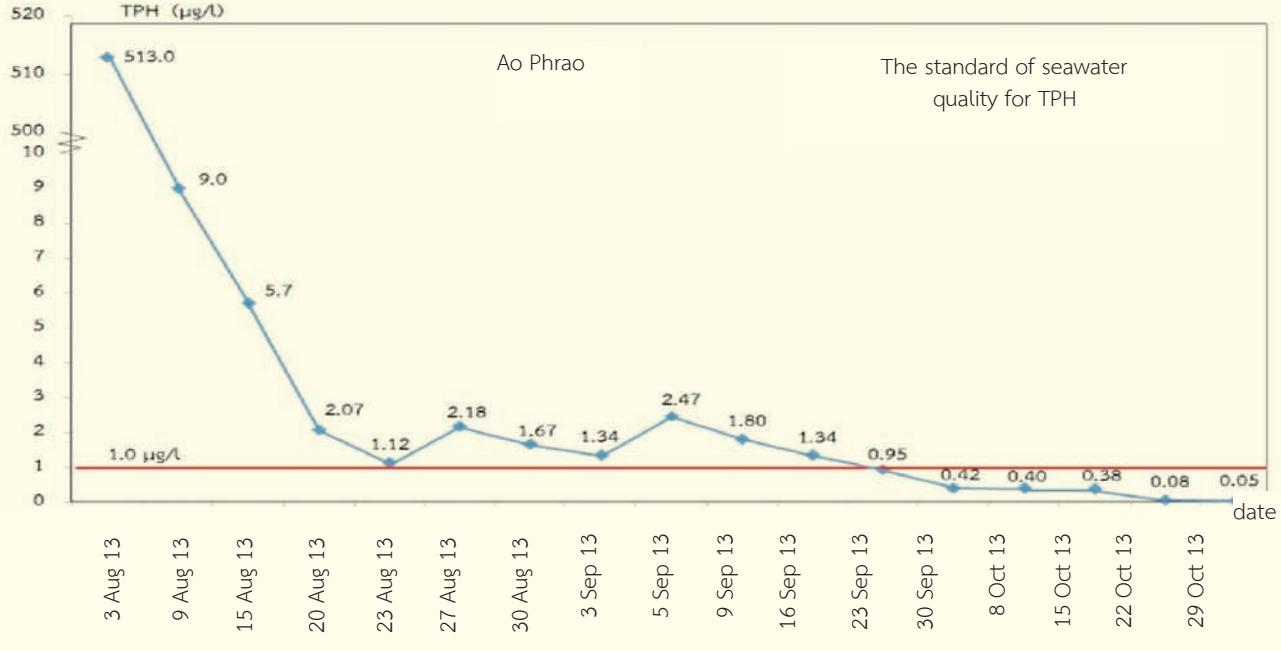


Figure 49 Amount of Petroleum Hydrocarbons in seawater at Ao Phrao Bay area, Koh Samed

2. Sea soil sediment quality samples were collected from 6 stations and indicated all parameters were within the standard of coastal sediment at all stations in Thailand.

3. The span of contamination across Ao Phrao Bay indicated volatile organic compounds (VOCs) in the sand at a depth of 0.2 meters, this was considered to be a very low level. Petroleum Hydrocarbons (TPH) were within the standard level of soil sediment quality, equivalent to the public parks of Australia (not exceeding 11,200 mg per kg) and the standard of Australian Ecological Investigation Level (not exceeding 1,000 mg per kg). The reference area did not detect such substances. For heavy metals, mercury and lead were undetected, whereas cadmium, nickel and arsenic were within the standard level of soil quality used for other purposes beyond agriculture and housing, according to the National Environmental Committee Act No. 25, 2004 (B.E. 2547).

4. BTEX (Benzene, Toluene, Ethyl benzene, Xylene) air quality parameters were measured well below the AEGL-1 standard (8 hours), whereas the VOCs in the air being collected continuously for 24 hours at the beach areas of Ban Phe, Ao Phrao, and Sai Kaew were within the acceptable level.

5. The coral reef ecosystems were explored in the area of the oil slick contamination around Samed Island and adjacent areas were measured 2 times (August and October 2013). The results of the survey in October 2013 indicated no oil slick on the water surface, the sea floor or the coral colonies. At Ao Phrao Bay bleached corals were found with color fading down by 10 - 30 percent, a decrease from the survey in August. Most of them were rock coral which are the dominant coral species in the area. The “big stars” corals were found fading at some colonies. For other locations, there was just a slight bleaching of coral.

6. The impact on rare marine mammals was explored in August 2013. It was found that in the coastal areas and around Samed Island, no rare and endangered marine animals such as sea turtles, dugongs, dolphins and various species of whale were found dead at the scene, and nearby coastal areas didn’t suffer any effect from this incident.

7. The ecosystems of sand and stone beaches in the tidal zone of rocky beach on the north of Ao Phrao Bay were explored in August and October 2013. In October 2013, the status of the rocky beach was almost normal with creatures thriving in the area, especially scallops. There was no death of organisms found in the survey area but there were some traces of oil stains and tar balls under rocks and hidden areas.

8. The impact on sea grass was explored and accessed in August 2013 and found that they were generally in normal condition. Various aquatic species such as goby, crab, cerithidea, nerite, arcidae, and shells attached to rocky surfaces like oysters, chiton, snails and gastropods were found in small basins.

Since the incident in the Ao Phrao Bay area, there has been continuous environment quality monitoring to ensure all parties that the area can be used for tourism as earlier. Samed Island was reopened to tourism on 1 November 2013. The Ministry of Natural Resources and Environment created a “Resolution and restoration of natural resources and environment plan for Ao Phrao, Samed Island and the areas affected by the oil spill at Rayong Province” under the supervision of the committee for situation assessment and restoration of natural resources and the environment affected by the oil spill (the case of crude oil pipeline spill in the middle of the sea off Rayong Province), chaired by the Permanent Secretary of the Ministry of Natural Resources and Environment with the focus

on the rehabilitation of ecosystems and the environment around Samed Island that have been affected to return to its original shape and better quality. The plan was submitted to The Committee for Prevention and Eradication of Water Pollution due to Oil and PTTGC to proceed and take related actions, with the environmental situation monitoring to continue for another 1 year. This is in order to build confidence and to make Khao Laem Ya – Samed Islands National Park to become the number one tourist destination for tourists, both foreigners and Thais again.

3.2.2 Huai Kliti Creek with the intention of fixing the problem

Since April 1998, the lead contamination at Huai Kliti Creek, Chalae Sub-district, Thong Pha Phoom District, Kanchanaburi has been investigated, due to the activities of lead flotation of a mineral processing plant allowing leakage of muddy water from a retention sediment tailing pond into the creek resulting in contamination of lead from the south of the mineral processing plant for a distance of about 20 kilometers. The problem has been solved as follows :

- The problem of the spread and movement of tailing mineral sediment along the creek has been solved by constructing 2 loose rock fill weirs at a distance of 4.5 kilometers and 8 kilometers away from the plant to slow and trap sediment contaminated with lead. The inspection in 2009 indicated that both weirs were left in a decadent status. Stones had been swept away by the tides reducing the efficiency of trapping sediment. Therefore, a plan to restore the performance of both weirs was made by the cooperation of Department of Water Resources to make a survey, design and reconstruction of the weirs to be able to trap sediment more effectively.



- In the year 2013, the company employed Better World Green Public Company Limited to manage sediment contamination of lead in 4 landfills (from a total of 8 wells) at the creek area for off-site disposal practically, as it was found that lead contamination from the landfill had spilt into the creek. The treatment included stabilization and landfills at Saraburi Industrial Waste Disposal Administrative Center with an amount of contaminated sediment not less than 570 cubic meters, and an adjustment of landfills by filling the wells with soil from the other areas having a similar nature and less than 400 milligrams per kilogram of lead contamination sediment according to soil quality standards for residential and agricultural use.

- The environment quality of Huai Kliti Creek has been monitored and investigated and has publicized the environmental monitoring results to the public continuously.

However, on January 10, 2013 the Administrative Court adjudicated and instructed the Pollution Control Department to carry out the processes as follows :

- To define, plan and implement restoration, examine samples of water, soil, vegetables and aquatic animals in the creek covering all seasons at least once every season until it was found that the lead content in water, soil, vegetables and aquatic animals in the creek is above the governed standards for a period of at least one year, and inform the prosecution by way of revelation.

- To make compensation to 22 residents of Huai Kliti Creek at 177,199.55 baht each for having to bear the cost of food and damages stemming from violations of the rights of natural resources and biodiversity which was conducted on March 29, 2013.

- To develop procedures and restoration of Huai Kliti Creek area during 2013 - 2016.

- To report on the progress of implementation to the Law Enforcement Bureau, Office of Administrative Court.

- To publicize the results of environmental investigation by court order by preparation of 4 permanent information boards to be installed at the utility area by the village headman, Chalae Sub-district Administrative Organization, Thong Pha Phoom District Administration Office, and Wat Kliti Lang Temple. In addition, the information was publicized via the website of the Pollution Control Department (www.pcd.go.th) and its newsletters.

The results of the environmental monitoring at Huai Kliti Creek in 2013 indicated that the amount of lead found in the river water was mainly within the standards of surface water quality. But a high quantity of lead content was still found in the soil sediment on the river bed in the area of the mineral processing plant affecting the aquatic animals living in the ground surface level to accumulate high lead levels. This also included vegetables, especially those grown along the banks of the creek, which were detected at a higher level than the standard of contaminated food according to Ministry of Public Health's Act Number 98 (Year 1986). As for the amount of lead found in the soil naturally, the lead was mostly found to have accumulated at a higher level than the soil quality standard for residential and agriculture use as well.

In 2014, the Pollution Control Department will follow up and monitor the environmental quality of Huai Kliti Creek constantly to inform the residents and the general public of the situation and find ways to restore the creek from lead contamination and remove all lead contaminated soil in the 4 remaining landfills.

3.2.3 Mercury Contamination at 304 Industrial Park Area

The case study from the Ecological Alert and Recovery - Thailand (EARTH) in collaboration with the International Physical Activity and the Environment Network (IPEN) of the United States - indicated the accumulation of mercury in fish samples and in the hair of people living around coal power plants and the nearby areas of the 304 Industrial Park and Chalong Waeng Canal, Tha Tum Sub-district, Sri Maha Bodhi District, Prachinburi Province. Pollution Control Department investigated the areas and called for coordinated actions to resolve the problems, with various local authorities including Regional Environment Office 7 (Saraburi) Prachinburi Provincial Office of Natural Resources and Environment, and Prachinburi Provincial Health Office to conduct an environmental quality survey in the area surrounding 304 Industrial Park in Prachinburi and the Chalong Waeng canal, Rung canal, Nong Kla canal, Nongkong canal, Tha Fuek canal, Phraprong canal, Bang Pakong River, and Prachinburi River during January - August 2013.

The results of the investigation in 2013 showed that the water environmental quality around the canals and rivers in the area of the 304 Industrial Park, Sri Maha Bodhi District, Prachinburi Province, contained no contamination of mercury as per the water quality standard for surface water. However, mercury contamination was found above the safety standards for soil sediment in the ground level in the water resource at Chalong Waeng canal and Rung canal above Krogsomboon village only in February 2013, with a tendency likely to decline in April and July 2013 (Figure 50). As for mercury accumulation in aquatic animals, the accumulated level was not over the international food standard (Codex Alimentarius Commission), with the mercury intensity for plant-eating fish at 0.5 milligrams per kilogram and carnivorous fish at 1 mg per kg (Figure 51). However, the majority still remained beyond the contaminated food standard according to the Ministry of Health's Act No. 98 (A.D. 1986, B.E. 2529) allowing the mercury in other food not exceeding 0.02 milligrams per kilogram.

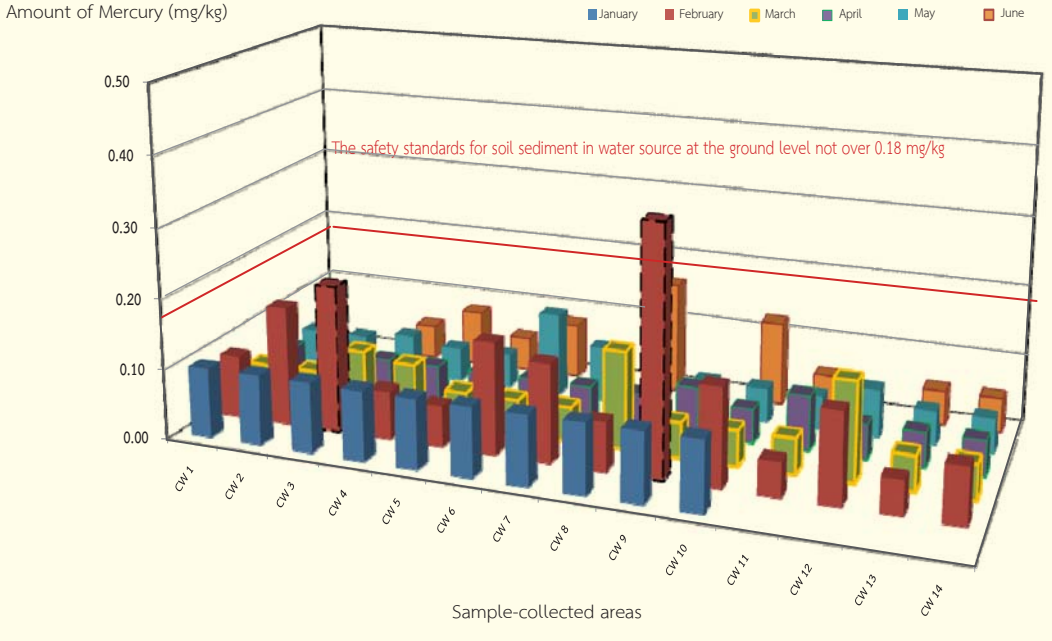


Figure 50 Amount of Mercury in soil sediment in the water

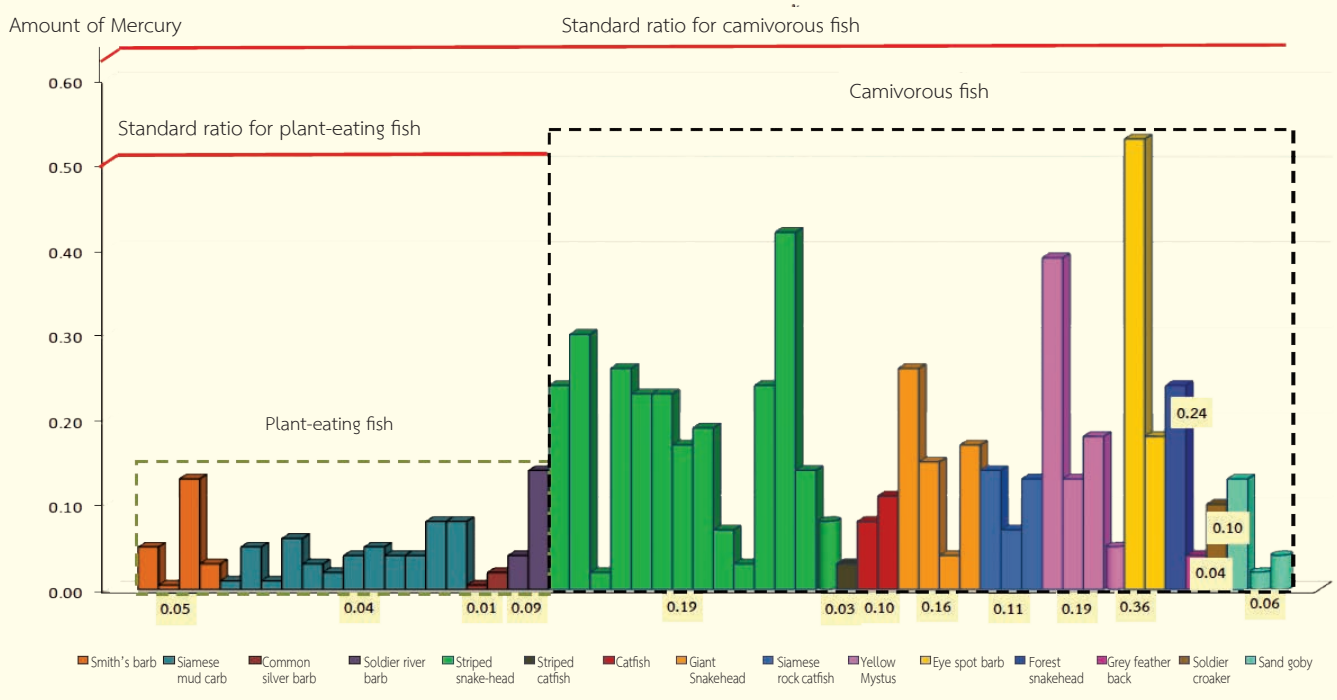


Figure 51 Amount of Mercury in fish samples in the canals and rivers during February - August 2013

Remark * International Food Standard (Codex Alimentarius Commission)

In addition, samples of dust particles smaller than 10 microns (PM_{10}) were collected from 11 - 13 March 2013. 6 Samples of dust particles were smaller than 10 microns in the range of 0.0589 to 0.0800 milligrams per cubic meter which is well under the standard of air quality in the general atmosphere (<0.12 mg per cubic meter).

The tripartite committee to resolve the pollution and mercury at 304 Industrial Park areas, Sri Maha Bodhi District, Prachinburi, including the Department of Industrial Works, Pollution Control Department, Department of Disease Control, Prachinburi Provincial Industry Office, Prachinburi Provincial Health Office, Prachinburi Provincial Fisheries Office, Regional Environment Office 7 (Prachinburi) Prachinburi Provincial Office of Natural Resources and Environment, Thatoom Sub-district Administrative Organization, representatives from the public sector and representatives from 304 Industrial Park have jointly investigated and analyzed the causes of the mercury contamination problem. The working board concluded the implementation of the project "Restoration of Chalong Waeng canal and return to its original perfection" as per the request from the public sector. The guidelines for the health surveillance and protection from mercury has been set to determine the health monitoring of those who have taken a high level of mercury into the body, the investigation of mercury exposure, the risk assessment of fish consumption, and the environmental monitoring in the areas over a period of time.

3.2.4 Continuity in Implementation of Ministerial Regulations, Section 80

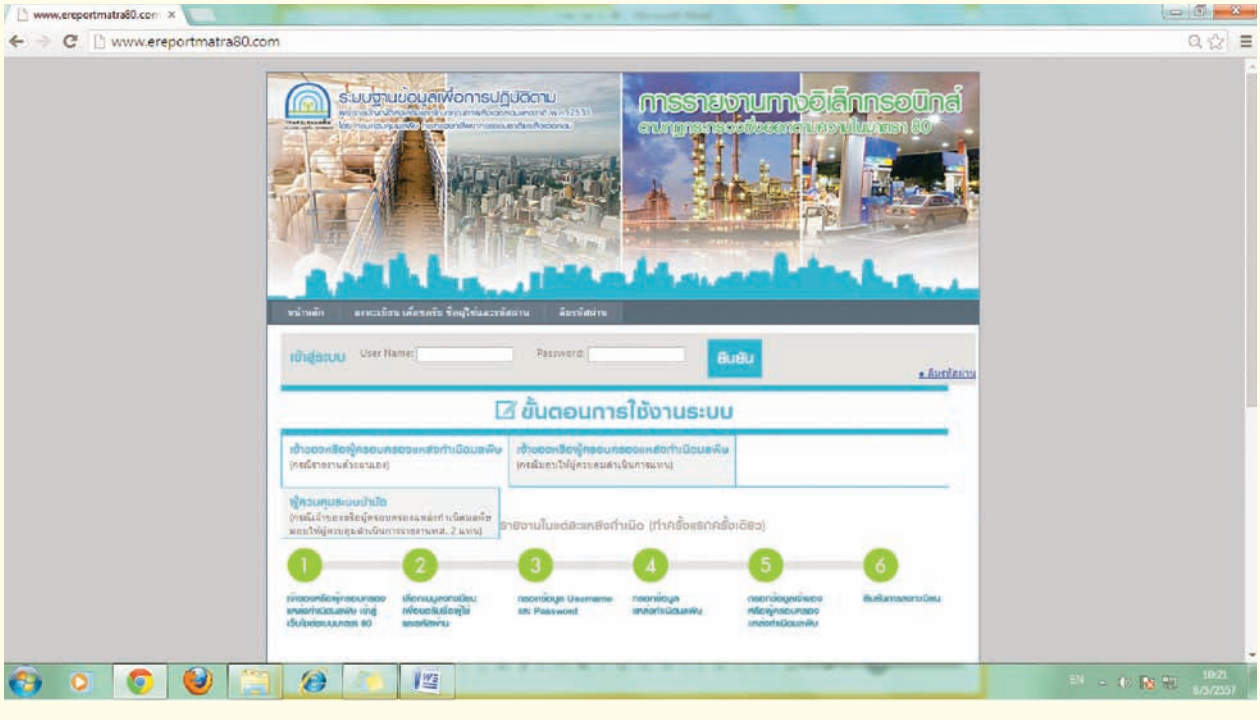
The Enhancement and Conservation of the National Environment Quality Act B.E. 2535 (1992), for a period of over 20 years, was mainly focusing on Command and Control measures in pollution problem restoration, such as determining the standard rank of the pollution from the original sources or instructing the owner or occupier of pollution sources for treatment before being released into the environment. However, using mainly the command and control measurement alone could not accomplish the principle of the law, and therefore the concept of prevention is better than cure (Precautionary Principles) has been additionally applied to enhance the supervision and control of the pollution problem. By virtue of the provisions of Section 80 of the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) as a tool to examine the pollution sources and the operation of the wastewater treatment system on a daily basis. If there is any malfunction in the wastewater treatment system detected, it can be fixed immediately prior to causing environmental impacts.

10 types of pollution sources to be processed according to Ministerial Regulations, Section 80

- Factories and Industrial Estates
- Certain types and size of Buildings
- Developed Estates
- Pig Farms
- Fisheman's Wharf, Fish Pier, and Fish Raft Business
- Petrol Station
- Coastal aquaculture ponds
- Brackish water aquaculture ponds
- Freshwater aquaculture ponds
- The community wastewater treatment system

The Ministry of Natural Resources and Environment legislated a ministerial regulation to set out the rules, procedures, statistic and data collections, preparation of detailed records and make a report to summarize the operation of a wastewater treatment system in 2012, issued under Section 80 of the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) (effective on 2 August 2012). With the implementation of such regulations, the owners or occupants of pollution sources must check the operation of wastewater treatment systems every day as a protection from any fault that might occur in the wastewater treatment system. If there is any equipment malfunctioning, it can be fixed immediately before causing an impact to the environment. Or, if unavoidable, a minimal impact is expected. As for the data from the Tor Sor 2 reports, the related authorities, central, regional and local, can use them to plan the management of water pollution appropriately.

Over the last year, it was found that there were very few Tor Sor 2- format reports on pollution originating sources when compared to the number of all sources of pollution. Therefore, it is required to improve the enforcement of the ministerial regulations by constantly promoting, coupled with the command and control measures and enforcement of the law against pollution originating sources seriously to prevent and mitigate the impacts of water pollution problems. In addition, in the following stage, electronic reporting channels would be expanded to facilitate the sources of pollution, which is currently in the system testing stage and will soon be legally effective and implemented.



3.2.5 Odor measuring systems by human scent at Or Noi Temple

"Measurement of odor intensity by analyzing the smell using sniffing method" or "smelling human" is a method of odor sampling collection and examination of the intensity of odors in the laboratory to determine the relationship of the odor levels and people's sense of smell using the registered smell tester group as smell detectors. This smell examination by human is a widely popular technique in various countries in Europe, the U.S. and Asia. Pollution Control Department uses the standard of the American Society for Testing and Materials (ASTM) or the Japanese Industrial Standard (JIS) set for odor detection.

An incident appeared in the newspaper on 21 January 2013 at Or Noi Temple (Dhamma Issara), Nakhon Pathom Province, presenting a banner in front of the temple saying, "Cheap temple for sale, awful unbearable smells from an animal food processing factory, intolerable suffering" created a buzz for the travelers in the area. This was a result from awful smells and dust having severe impacts to monks and novices as well as those practicing Dharma rituals in the temple and people in the vicinity.

From the investigation to tackle such a problem, a sample was taken to measure odor intensity by sniffing and found that the air pollution from the factory's chimney vent had exceeded the limit (according to the declaration of Ministry of Natural Resources and Environment's standard for odor intensity of the air pollution released from pollution sources. the intensity of the odor discharged from factory chimneys located outside an industrial area must not exceed 300 units). Concerned authorities including Nakhon Pathom Administrative Office, Department of Industrial Works, and Sub-district Administrative Organization have implemented actions as per the Factories Act Year 1992 and the Health Act Year 1992, respectively. Nakhon Pathom Provincial Industry Office ordered the animal food processing factory to improve its air pollution treatment system by installing a three Stage Scrubber which was completed on 18 March 2013. The results of the odor intensity were examined again after the improvement and found that the odor intensity had improved as per the legal standard. The novices, monks and residents in the surrounding area had no further trouble with stench and dust from the factory and did not have to announce the temple sale to escape from the smell problem anymore.

This odor examining and analyzing by sniffing grabbed widespread attentions due to the use of the human senses as a tool for environmental monitoring. The sensory perception of man somewhat acquires high sensitivity and can distinguish different odors in various different levels. Each person may have a different level of awareness, some have more, and some have less, depending on individual abilities and senses. So, a thorough analysis of the odor intensity by means of this method should be carried out on the basis of a valid theory to obtain results that are accurate and reliable as possible.

Monitoring smelling odor intensity (Sensory test method).

1. Collect sampled air with a fragrance by using a vacuum pumping air into a sampling bag with a capacity of at least 10 liters.

2. Take air samples to detect the odor intensity in the laboratory within 24 hours or latest not exceeding 30 hours using 6 registered odor testers by the Pollution Control Department or related agencies.

3. Test the perception of all odor testers prior to analysis of the odor intensity every time. Each one will have to sniff 5 standard fragrances consisting of flower- like odor (Beta phenyl-ethyl alcohol), burnt odor (Methyl cyclopenolon), sock-like odor (Iso-valeric acid) rotten fruit-like odor (Gamma undecalctone) and a sharp smelly odor (Scatol). If the tester does not pass any of the 5 smells, he would not be able to conduct that test.

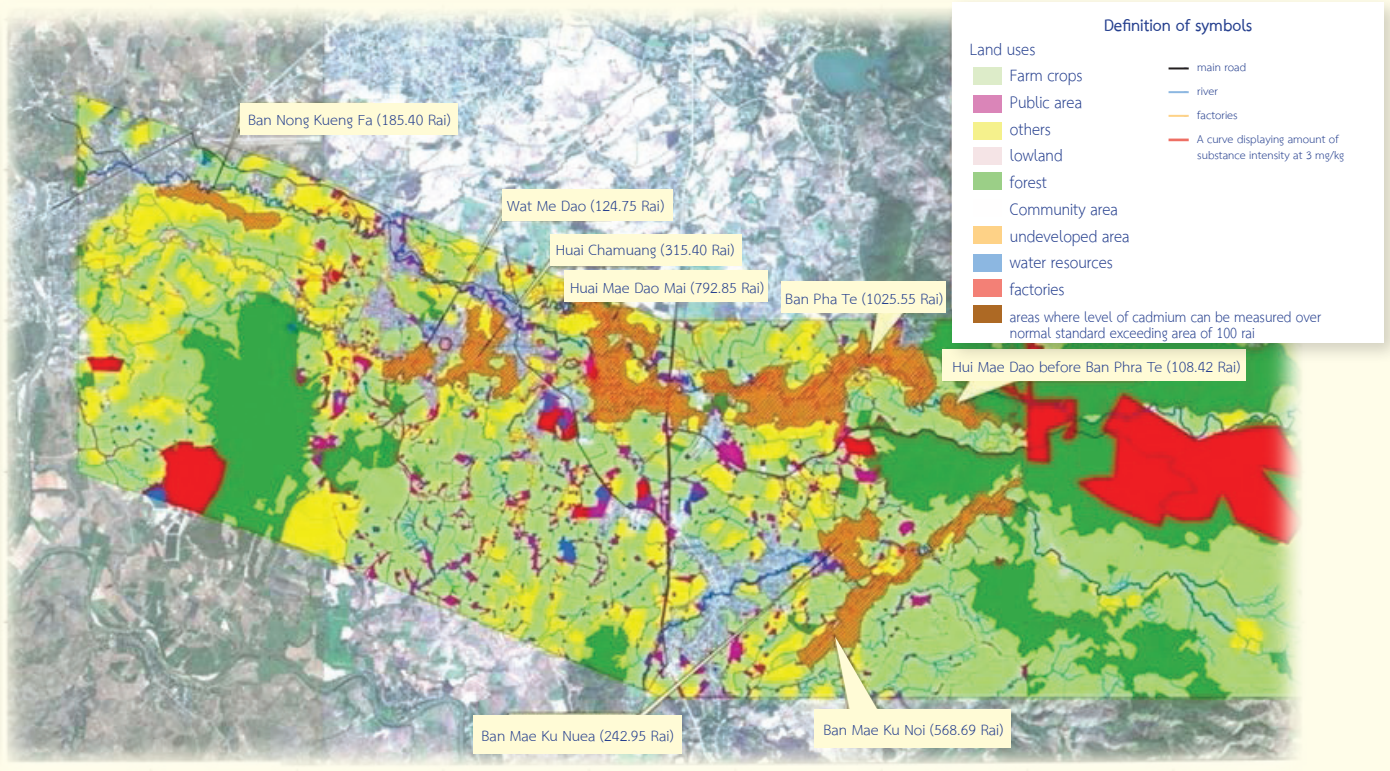
4. Dilute the air samples collected prior to the smell test every time. Begin by dilution of 10 times and diluted until no odor.

5. Smell tester must sniff 3 bags with a capacity of 3 liters each (Bag No. 1, 2 and 3), there is only one bag with bad air contaminants (other 2 bags are odor free). The smell will cease once the smell tester is not able to recognize it correctly.

6. The smell tester group requires a minimum of 6 people and upon completion of smell, the level of odor perception (Threshold) of all would be calculated. The value of person with highest perception and the person with the least perception would be removed. The results of the other 4 persons would be calculated for the odor intensity at that time to be compared to the set standard value.

3.2.6 Preparation for Announcement of Mae Tao Environmental Protection Zone

On 14 August 2013, the Phitsanulok Administrative Court issued a verdict for an administrative litigation black case No. 398/2552 and red case No. 245/2556 by the International Association against Global Warming as prosecutor (No. 1) and 32 associates (villagers in Mae Gu Sub-district, Phratat Pha Daeng Sub-district, and Mae Tao Sub-district living in the area of Mae Tao river), who filed a lawsuit against the National Environmental Committee (No.1) and 6 associates as defendants, including Pollution Control Board (No. 2), Land Development Committee (No. 3), Minister of Agriculture and Corporative (No. 4), Minister of Industry (No. 5), and Director of Department of Primary Industries and Mines. The Phitsanulok Administrative Court issued a verdict and ordered the National Environmental Committee under the power of section 43 of the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992), to recommend the Minister of Natural Resources and Environment to issue ministerial regulations to promote Mae Tao river basin area as an environmental protection zone and set the protection measures in the regulations under section 44 of the Act, to be implemented within ninety days from the date the case is final.



"One or more protection measure's under Section 44" is as follows: (1) Establish measures to restrict the right to use the land, (2) no action or some types of activities that may harm or cause impact in the changing of the ecology in the area allowed, (3) Instruct the reporting of the environmental impact assessment of the project or activity of certain areas (4) Establish measures to handle specific areas, including the scope of duties and responsibilities of the relevant government agencies to work together to preserve the natural ecosystem in the area, and (5) Establish other protection measures as appropriate and suitable to the site conditions.

Currently, the Office of Natural Resources and Environmental Policy and Planning is in progress to establish the Mae Tao basin area, Maesod District, Tak Province, to be the environmental protection zone and it has already set measures to protect the natural resources and environment there.

The problem of high levels of cadmium contamination in paddy soil and rice products using water from Huai Mae Tao, including the soil sediment from the river beds of Huai Mae Tao and Huai Mae Ku at Ban Pha Te, Phratat Pha Daeng Sub-district, Maesod District, Tak started in 2004. Related agencies, both from public and private sectors have collaborated to resolve the problem and reduce the impact on the environment and public health, such as the project to promote the cultivation of sugar cane to produce ethanol instead of rice growing, buying the grains contaminated with cadmium to be destroyed, relief and rehabilitation of the people, monitoring of mining operations to seriously comply with environmental mitigation measures, etc. Spending the budget of over 280 million baht.

In 2007, the National Environment Committee has established a resolution ordering the Pollution Control Department to conduct a study to explore the causes and extent of contaminations in the Mae Tao river basin. The results indicated cadmium contamination in soil sediment in an area of 3,800 rai caused by natural decays and mining activities. The National Environment Committee in its 6/2556 meeting dated 29 August 2013 approved the management measures for cadmium-contaminated areas at Mae Tao river basin, Maesod district, Tak Province and assigned the relevant authorities to proceed as follows.

1) Dredging soil surface and place clean soil over the soil highly contaminated with cadmium (more than 30 milligrams per kilogram) covering the area of approximately 250 rai.

2 Cultivate alternative crops, especially sugarcane to produce ethanol over the soil medium contaminated with cadmium (more than 3 - 30 milligrams per kilogram) covering the area approximately 3,500 rai.

3) Manage the soil sediment in Huai Mae Tao and Mae Ku creeks by dredging the areas with high cadmium contamination.

However, the monitoring of cadmium contamination in the Mae Tao river basin has been conducted continuously 2 times a year.

Chapter 4

Pollution Management

4.1 The Budget for Pollution and Environmental Management

4.1.1 The Overview of the Budget

In 2007 - 2013, the national budget in general has increased from 1,566,200 million baht to 2,400,000 million baht. (An increase of more than 50%.) However, the budget for processing the pollution and environmental management has a proportion between 0.28 - 0.40% or an average of 0.36%. When compared to the annual government statement of expenditure, this proportion was very low, and it was a factor that has caused the delay in solving the pollution situation that happens each year. (Figure 52).

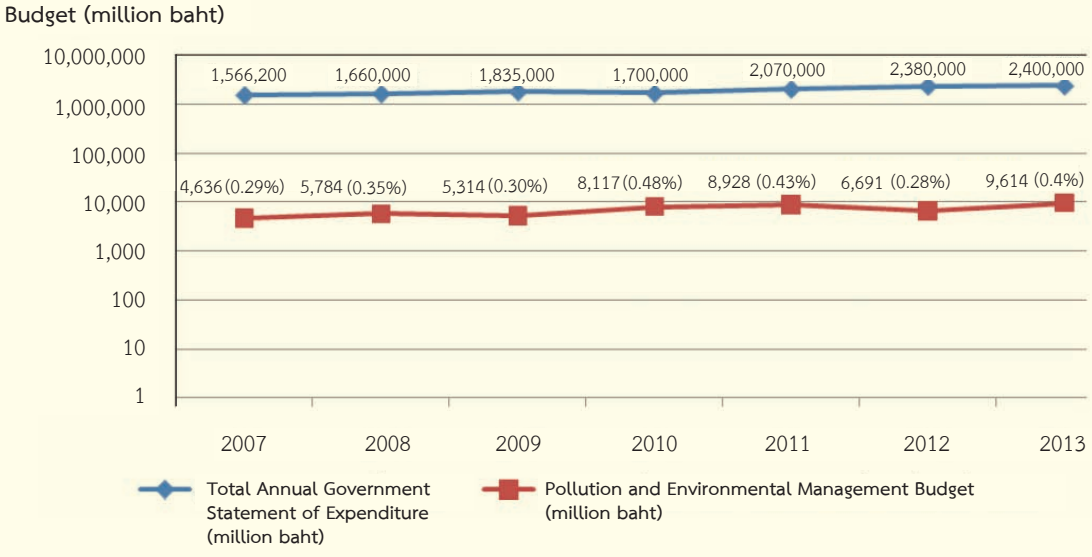


Figure 52 Comparison of the Budget for Pollution and Environmental Management and Total Annual Government Statement of Expenditure of Thailand during the fiscal years of 2007 - 2013

In 2013, the budget for the pollution and environmental management of the nation was allocated in the amount of 9,614 million baht, which was 0.4% of the total of the annual government statement of expenditure of Thailand (2,400,000 million baht). This has increased from the year 2012 by 0.12% (the year 2012 by 0.28%). This budget was divided into the budget under the strategies for managing the natural resources and environment in the amount of 3,513 million baht; the strategies on managing governmental administration efficiently and fair in the amount of 3,922 million baht; the strategies on education, integrity, morality, quality of life, and equality in the society in the amount of 1,868 million baht; the strategies on building stable and sustainable economical growth in the amount of 196 million baht; and the strategies on science, technology, research, and innovation development in the amount of 115 million baht (Figure 53). The stated budget was used for the management, the prevention, the control, and the resolution of the pollution problem under the implementation of organization including the central sectors, the regional sectors, the Local Administration Organizations, and the participation of the private sectors and communities.

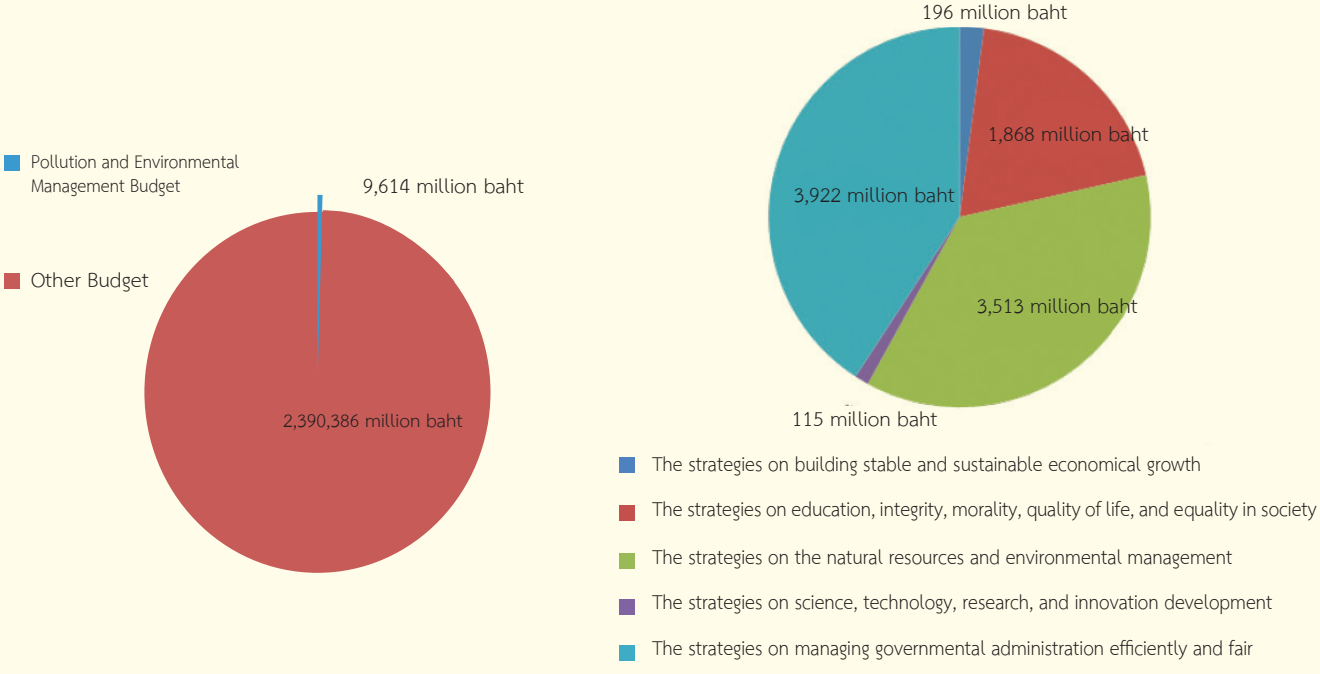


Figure 53 The Proportion of National Environmental Budget Allocation under the Fiscal year 2013 Strategies

Source : Gathering from: The Annual Government Statement of Expenditure of Thailand in the fiscal year 2013, Bureau of the Budget, Office of the Prime Minister.

4.1.2 The Budget under the Action Plan for Environmental Quality Management at the Provincial Level in the Year of 2013

A mechanism used as an important tool for natural resources and environment management was the action plan for Environmental Quality Management at the provincial level, according to Section 37 of the Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (1992) to support and push forward the natural resources and environment management in the areas systematically and with a clear format of procedures. The budget sources under this action plan consisted of 1) the annual government statement of expenditure (specific grants); 2) the environmental fund; 3) the budget for developing provinces/ groups of provinces; 4) the budget of the Local Administration Organization; 5) the investment of the private sectors; and others.

Since the fiscal year 2012, specific grants for the projects under the provincial Environmental Quality Management Action Plan have been allocated for the Office of Natural Resources and Environmental Policy and Planning (ONEP) under the Ministry of Natural Resources and Environment. Previously, these grants were allocated for the Department of the Local Administration, under the Ministry of the Interior, according to the resolution of the Decentralization of the Local Administration Board. Besides, the National Environment Board agreed upon the action plan at the provincial level in the meeting No.1/ 2011 on January 14, 2011 to cover the procedures of the protection and resolution of the environmental problem in all aspects. This included common effluent treatment projects and common sewage disposal systems. The Board also agreed upon ways to encourage the Local Administration Organizations to submit the action plan at provincial level for projects or activities which could truly and continually solve the problems in the areas, with the signified responsible persons who could manage the projects or activities effectively.

In 2013, the budget allocated specific grants to the Local Administration Organization for solving the environmental problems in the local areas. These were projects on sewage and effluent management, according to the action plan for Environmental Quality Management at the provincial level. The specific grants were in the sum of 567 million baht and were divided across 25 projects for sewage management in the amount of 420 million baht and 6 projects for effluent management in the amount of 147 million baht. (Figure 54).

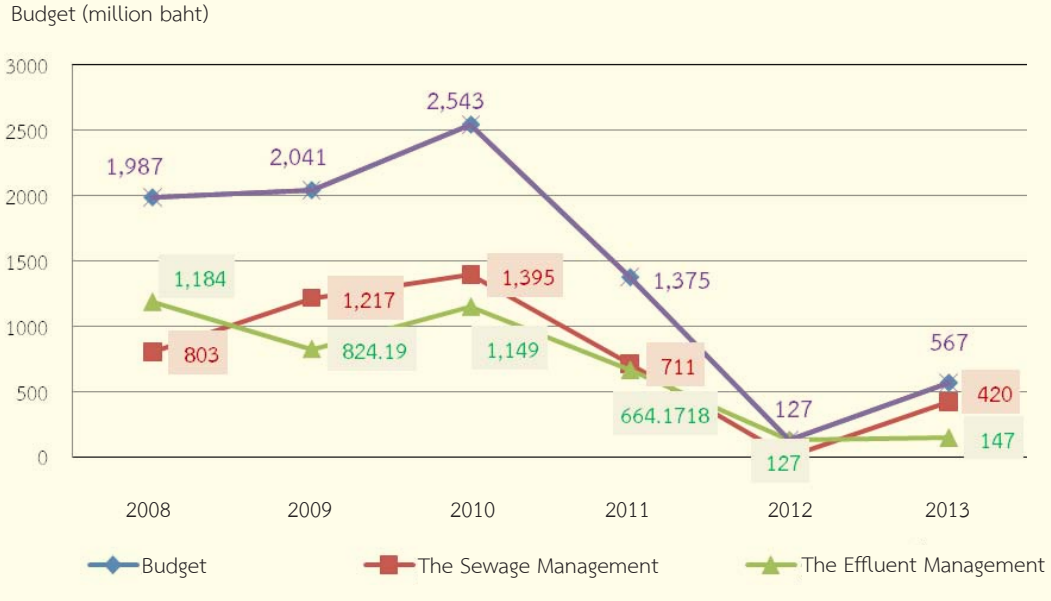


Figure 54 The Budget for the Sewage Management and Effluent Management under the Provincial Environmental Quality Management Action Plan in 2008 - 2013.

Source : Gathering from The Annual Government Statement of Expenditure of Thailand in the Fiscal Years of 2008 - 2013, the Bureau of the Budget, Office of the Prime Minister.

The Environmental Fund which has been an important budget source was established according to the Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 to function as a financial mechanism for supporting Local Administration Organization, governmental sectors, state enterprises, private organizations, and private sectors. This was to solve the environmental problems under collaborative procedures of all sectors and to set up the treatment systems for air pollution and effluent, together with sewage disposal system for controlling, treating, and disposing pollution. This included the processing of the activities for supporting and conserving the environmental quality in the forms of loans and grants. From the start of the Environment Fund (B.C. 2535) up till now, the Environment Fund has supported 272 projects in the amount of 13,556.41 million baht. This amount was divided into the following projects.

1) 104 projects for supporting the set up of effluent treatment and sewage disposal systems for the local governmental sectors in the amount of 9,381.04 million baht;

2) 27 projects for giving loans to private sectors to set up effluent treatment and sewage disposal systems resulting from the activities of legal private businesses in the amount of 1,077.53 million baht;

3) 61 projects for supporting the enhancement and conservation of the quality of the environment of both governmental sectors and local governmental sectors in the amount of 2,759.28 million baht; and

4) 80 projects for supporting and conserving environmental quality of private organizations which are registered at the Ministry of Natural Resources and Environment in the amount of 338.56 million baht.

4.2 Important Tools and Mechanisms for Pollution Management in 2013

4.2.1 The National Master Plan and Measures

The Industrial Pollution Management Plan B.E. 2555 - 2559 has been processed, according to the resolution of the cabinet on March 20, 2012. The Ministry of Industry was assigned to set up the Industrial Pollution Management Plan B.E. 2555 - 2559 . According to the plan, the Department of Industrial Works set up the plan, which was approved by the internal sections of the Ministry of Industry and by the external sections of both governmental and private sectors. The plan had the integration in conformity with Pollution Management Plan B.E. 2555 - 2559, of the Pollution Control Department, the Ministry of Natural Resources and Environment. The amount of 5,800 million baht of the plan consisted of 124 projects and was divided into 5 Pollution management guidelines: 1) environmentally friendly industrial production; 2) the increase in efficiency of inspecting and controlling point sources; 3) the controlling of chemicals and hazardous waste management in the industrial sectors; 4) the development of the personnel's capacities in the industrial sectors and communities; and 5) environmental procedures for preparation to enter the ASEAN communities or related to the international agreement and obligations.

Prevention and Resolution Measures for Haze Pollution Problems in the 9 Provinces in the North of Thailand in 2013 The cabinet agreed upon the measures for Prevention and Resolution Measures for Haze Pollution Problems in the 9 Provinces in the North of Thailand in 2013 on January 8, 2013. This was processed by the related governmental sectors such as the Ministry of the Natural Resources and Environment, Ministry of Interior, Ministry of Agriculture and Cooperatives, Ministry of Transportation and Communications, Ministry of Defense, Ministry of Public Health, Ministry of Foreign Affairs, Ministry of Education, Office of Prime Minister, and Ministry of Information and Communication Technology, including private sectors and citizens. The 2P2R principles were applied

in the measures such as Prevention, Preparation, Response, and Recovery. There were 8 measures: Measure No.1. Controlling the burning/ fire during "the dangerous 80-day period"; Measure No. 2. An intensive resolution to the forest fire problem; Measure No.3. Supporting "the standard communities to be free from burning"; Measure No.4. Promoting the private sector's collaborations to participate in the prevention and resolution of haze pollution; Measure No.5. A proactive public relation to the target groups; Measure No.6. Warning of haze situations; Measure No.7. Extending the collaborations with neighboring countries to decrease the transbaundary haze pollution problems; and Measure No.8. Establishing the headquarters for preventing and solving the haze problems in the 9 provinces in the North of Thailand.

Also, the cabinet agreed upon ***the action plan for prevention and resolution of forest fire, open-burning, and haze pollution problems B.E. 2556 - 2562,*** under the Master Plan of National Fire Safety Development on November 1, 2013. This was a collaborative integration of 44 sectors, consisting of 153 plans/projects with the budget in the amount of 10,380 million baht. The goals for the plan included the forest fire management, and the decrease of the forest fire areas to not exceed 300,000 rais per year, the management of residuals materials from the agricultural sectors in lieu of burning in the areas for at least 200,000 rais per year, the decrease of open-burning of waste/ garbage by setting-up the correct and safe waste/ garbage disposal for more than 50% of all provinces, and the utilization of the waste/ garbage for more than 30% of the total waste/ garbage quantity of each area.

The results from following the measures intensively yielded a better view, in general, of the dangerous 100-day period (January 21 - April 30, 2013) and the smog situation in the North, when compared to the ones in the same period in the year 2012. Moreover, it was found that PM_{10} was beyond the standard limit for 45 days (This was lower than the ones in 2012 with the value beyond the standard limit for 64 days).

The Measures for the Prevention and Resolution of Illegal Dumping of Hazardous Industrial Waste

The cabinet agreed upon the measures for the Prevention and Resolution of Illegal Dumping of Hazardous Industrial Waste on June 3, 2009. However, the procedures following the stated measures of many activities have not yet been completed and have not followed the timeline as planned. This resulted in ineffective prevention and resolution. Furthermore, it was found that previously, there were some illegal waste dumping in many areas, and this has caused the residents who resided around the areas to get worried about the effects of the waste on their health and environment, especially the illegal industrial waste dumping in the areas of the Chachoengsao province. This situation concerned the nearby residents, and has shown that many measures needed to be speeded up, reviewed, and added to solve the problems in a concrete fashion. On March 7, 2013, the National Environment Board acknowledged the results of the procedures following The Measures for the Prevention and Resolution of Illegal Dumping of Hazardous Industrial Waste during 2009 - 2012 of the responsible sectors and agreed upon the setting of the measures to be in 3 phases, according to the urgency, as follows.

- The short-term phase : This phase included the resolution of illegally transporting and dumping of hazardous and infected industrial waste from the source to the transportation to the disposal sites. The solution was to strictly control the transportation or moving of the hazardous waste and to make a list of the industries that caused the hazardous waste, for both types, and quantity.
- The intermediate-term phase: This phase is to develop the quality of the industries and the industrial hazardous and infected waste disposal warehouse by setting the industrial standard to control and direct the industries that offered to treat or dispose the industrial hazardous and infected waste.
- The long-term phase: This phase is to promote and develop the business in disposing industrial hazardous and infected waste to be proportionate to the actual quantity at a reasonable price, with a quick

process of getting the permit and the incentive of the investment such as the support from the environmental fund, including legal measures for effectively controlling and directing the management of industrial hazardous and infected waste internally and internationally.

The Promotion Plans for Environmentally Friendly Products and Services B.E. 2556 - 2559 The cabinet agreed upon *The Promotion Plans for Environmentally Friendly Products and Services B.E. 2556 - 2559* on August 29, 2013. This was to push the promotion plans for procuring products and services that were friendly to the environment of the governmental Sectors to be active and continuous, following the plan of the cabinet on January 22, 2008. *The Promotion Plans for Environmentally Friendly Products and Services B.E. 2551 - 2554* have been extended to the target groups such as the Local Administration Organization, state enterprises, universities, sectors under governmental control, and public organizations. The governmental sectors have already participated in this project and have set up additional standards of products and services that were friendly to the environment such as gas stations. Furthermore, they also pushed this through the Comptroller General's Department (CGD) to adjust the Regulations of the Office of the Prime Minister on Procurement B.E. 2535 (1992) for the central and local governmental sectors to be able to procure the products and services that were friendly to the environment.

The essence of the plans B.E. 2556 - 2559 showed its vision that Thailand will have sustainable development and would be friendly to the environment, with the sustainable mechanism of the production and consumption for maximizing the ability of the resources and for reducing pollution. This consisted of 4 strategies: 1) the propulsion of the quantity of the procurement in the governmental sectors; 2) stimulating the production of the products and services which were friendly to the environment; 3) building a sustainable consumption of public and organizational sectors; and 4) the management and control of the promotion plan.

4.2.2 The Notifications and/or the Regulations under the Law Related to Pollution and Environment

In 2013, the law related to pollution and environment was noticed. The law was divided into 4 categories: 1) the control of the pollution at source; 2) the determination and control of the hazardous substances; 3) measures related to the process of setting criterias, methods, regulations, and guidelines for developing Environmental Import Assessment (EIA) reports; and 4) the determination of areas and measures for environmental protection, 18 issues in total, as stated below.

1) The Control of the Pollution at Source

- Notification of the Pollution Control Board titled "The Polluted-Air Sampling, the Measurement, and the Quantification of the Total Sum of the Toxins 1,2-dychloroethane and vinyl chloride that the Factories Release."
- Notification of Ministry of Natural Resources and Environment titled "The Standardization of the Odor Intensity of the Polluted Air Caused by Animal Farms."
- Notification of the Pollution Control Board titled "The Order Sampling Released from Animal Farms, the Sensory Test, and the Listing of the Testers of the Pollution Control Department, Ministry of Natural Resources and Environment."
- Notification of the Pollution Control Department titled "The Methods of Measuring the Levels of the Aviation Noise in Community Areas."
- Notification of Department of Industrial Works titled "The Notification and the Report of the Full-Time Personnel in the Environment of the Factories B.E. 2556."

● Notification of Department of Industrial Works titled "The Registration of the Controllers of the Water Pollution Treatment System, the Controllers of the Air Pollution Treatment System, or the Controllers of Industrial Waste Management System."

● Notification of Department of Land Transport titled "The Standardization of the Size, Quantity, and Quality of the Fire Extinguishers of the Trucks Used for the Cargo for transporting animals or goods, the 4th type (the Cargo for hazardous materials)."

● Notification of Department of Land Transport titled "The Specification of the Types, Sizes, Standards, and Quality of the Exhaust Tester, the Gas Analyzer, the Measuring Tools for the Gas Leakage, Measuring Tools for the Noise Levels, Measuring Tools for the Engine Speed, and Measuring Tools for the Intensity of the Tinted Film for the Motor Vehicle Inspection of the Motor Vehicle Inspection Centers."

● Notification of Department of Land Transport titled "The Specification of the Types, Sizes, Standards, and Quality of the Exhaust Tester, the Gas Analyzer, the Measuring Tools for the Gas Leakage, Measuring Tools for Noise Levels, Measuring Tools for the Engine Speed, and Measuring Tools for the Intensity of the Tinted Film for the Motor Vehicle Inspection of the Motor Vehicle Inspection Centers." (The 2nd Edition).

2) The Specifications and the Control of the Hazardous Materials

● Notification of Ministry of Industry titled "The List of Hazardous Materials B.E. 2556."

● Notification of Ministry of Public Health titled "The Identification of Names and Types of the Materials which are not permitted to import B.E. 2556."

● Notification of Department of Agriculture titled "The Specification of the Intensity Rate in each Formula of the Registered Hazardous Materials (No.3) B.E. 2556."

● Notification of Food and Drug Administration titled "The Notification, Issuing the Notification, and Filing the Renewal and the Renewal of the Notification to Process the Type 2 Hazardous Materials to the Food and Drug Administration B.E. 2556."

3) Measures of Issuing the Principles, Methods, Practices, and Procedures for Writing the Report of the Environmental Effect Analysis

● Notification of Ministry of Natural Resources and Environment titled "The Specification of the Types and Sizes of the Projects or Businesses which must be Written in the Form of the Report of the Environmental Effect Analysis, and the Principles, Methods, Practices, and Procedures for Writing the Report of the Environmental Effect Analysis No. 2 (the Revised Version of the Project No. 14 the Iron or Steel Industries)."

● Notification of Ministry of Natural Resources and Environment titled "The Specification of the Types and Sizes of the Projects or Businesses must be written in the form of the Report of the Environmental Effect Analysis, and the Principles, Methods, Practices, and Procedures for Writing the Report of the Environmental Effect Analysis No. 3 (the Revised Version of the Project No. 25 the Construction or the Extended Construction in the Sea or the Sea Areas)."

● Notification of Energy Regulatory Commission titled "The Measurements in Preventing, Resolving, and Monitoring the Environmental Effects for those who Do Not Need to Make the Report of the Environmental Effect Analysis, under the Law of the Enhancement and Conservation of the National Environmental Quality for Producing the Electrical Power from Biofuel (The Solid Fuel Type)."

● Notification of Ministry of Energy titled "The Principles, Methods, Practices, and Procedures for Writing the Report of the Results from following the Measures of the Preventing, Resolving, Reducing, Monitoring,

and Inspecting of the Environmental Effects Resulted from the Natural Gas Transportation via Pipelines B.E. 2556."

- Notification of Ministry of Energy titled "The Specification of the Types and Sizes of the Natural Gas Transportation System via Pipelines, and the Principles, Practices, and Procedures for Writing the Report of the Environment B.E. 2556."

4) The Specification of the Areas and the Measures of Environment Protection

In 2013, the National Environment Board agreed together with the Office of Natural Resources and Environmental Policy and Planning to proceed with the specification of the Environmental Protection Areas and Measures, as follows.

- The areas of the districts namely Oao Luek, Muang Krabi, Nuea Khlong Sub-district, Khlongthom District, and Koh Lanta, Krabi Province.
- The areas of the districts namely Khuraburi, Takuapaa, Thaaj Muang, Takuathung, Muang Phang nga, Thapput, and Koh Yao, Phang nga Province.
- Some areas of the districts namely Pluak Daeng, Baan Khaaj, and Nikhom Pattana, Rayong Province.
- The areas of the Subdistricts namely Wat Kat, Nong Hoi, Nong Phueng, Yang Nueng Saraphi, Saraphi District, Chiang Mai Province, Muang Chiang Mai District, as well as some area of Umong Subdistrict, Muang Lamphun District, Lamphun Province.
- The areas surrounding the Mae Tao River, Tak Province (resulted from the judgement of the Phitsanulok Administrative Court on August 14, 2013).

4.2.3 The Local Legislation on Pollution

The Local Administration Organization has the power and duties in managing the public service system for the benefit of the local people, according to the Plan and Procedure of the Decentralization of the Local Administration Act B.E. 2542 and the Public Policy Act B.E. 2535 such as the installment of effluent treatment grease traps in buildings; the pollution control caused from fume and dust; the sewage and waste collection, transportation, and disposal; the control of the businesses which are dangerous to health; the hygiene and order; the control of animal domestication and liberation; the market control; and the control of husk rice. In 2013, the Local Administration Organization legislated 131 local laws in many areas.

4.2.4 The Guideline for Important Pollution and Environmental and Agreements

The Guidelines were settled for the return and repatriation of illegally transboundary moved hazardous waste under the Hazard Substances Act B.E. 2535, the Custom Act B.E. 2469, the Goods Exported out of, or Imported into the Kingdom Act B.E. 2522, the Implementation of the Thai Water Act B.E. 2535, and the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 under the Sections of the illegally transboundary moved hazardous and non-hazardous waste, which was under distrainment, and which became a burden of the government to dispose of. The National Environmental Board, in the meeting no. 3/B.E. 2556 on March 7, 2013, agreed upon The Guideline were settled for the return and repatriation of illegally transboundary moved hazardous waste, according to the Basel Convention Sub-committee. The stated guidelines have the following steps in brief: 1) the operation upon the notification. The related sectors were the Pollution Control Department, Department of Industrial Works, the Customs Department, and other sectors such as the Port Authority of Thailand, and Department of Special Investigation; 2) the investigation; 3) the prosecution and the practice which followed the measures of the related sectors; 4) the return and repatriation to the culprit or an agent to consider

for the expenses, the environmentally friendly technological management of the hazardous waste, and the internal law or policies related to the disposal of hazardous waste; 5) the continuation of prosecution; 6) the report of the information to the Secretariat of the Basel convention for acknowledgement. This would be processed by the Pollution Control Department as the national focal point for implementation acting according to the Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Dispasal. The Guideline were settled for the return and repatriation of illegally transboundary moved hazardous waste would be publicized to the stakeholders including the government sectors, private sectors, businesses of goods transportation, and individuals to know and follow these guidelines effectively.

The Prevention and Decrease of Health Effects on Caused by Biomass Power Plants

On October 1, 2013, the cabinet agreed upon the settlement of the criteria and development of biomass power plants to be sustainable and to prevent legal gap use of enterpreneur in setting up a biomass power plant with the lower 10-mega watt size for avoiding the preparation of environment and health assessment reports, and to set up the monitoring techniques, including the proper rehabilitation of the affected persons caused by the biomass power plants. The National Health Commission Office of Thailand proposed the related sectors to consider the potentials which can support the development of the biomass power plants to the provincial overview. Moreover, this would reform the standards and criteria of land use in the city plan; improve the industrial accounts for the types of running the business on the power plants; including the advancement of the notification of the principles, methods, and conditions of issuing and withdrawing the permit. This includes the preparation of the regulations to control and prevent the effects on health caused by the operation of biodiesel power plants, and of stating that the business in running a biodiesel power plant can be hazardous to health. Besides, the measurements of the surveillance and support of the equipment are to be used in inspecting the environmental quality around the areas of the biodiesel power plants. Furthermore, the surveillance and inspection plan for environmental quality should be supported.

4.3 The implementation of international obligation and cooperation on pollution management of Thailand

In 2013, the operation management of pollution under the international conventions, agreements and co-operations that Thailand got involved in are as follows :

4.3.1 The Basel Convention on the Control of Transboundary Movements of Hazardous Waste and Disposal

This convention was set up to reduce the number of transboundary movements of hazardous waste and to control the disposal in a safe way, which would not affect people's health and environment. Thailand joined this convention on 24th November 1997 which has been effective since 22nd February 1998 by having Hazard Substances Act B.E. 2535 (1992) for implementing legislation.

According to the statistics from Department of Industrial Works regarding the export and import of hazardous waste based on the Basel Convention of Thailand from 1998 to 2012, it was found that 1) the average rate of the export of hazardous waste, which was mainly used electronic waste, electronics, sewage sludge, slag, and oxidation catalyst, was approximately between 200 - 22,000 tons. Due to the fact that Thailand has limited space to accommodate some kinds of waste, the country had to export this waste for final elimination. 2) The average rate of imported hazardous waste, which were mainly used photocopiers and other used office devices, was approximately between 500 - 5,000 tons. Thailand has imported hazardous waste since 2002 because of the establishment of waste recycling plants in Thailand. Department of Industrial Works only allows the import of this waste as raw materials for the production in industrial factories.

In general, the rate of the import-export of hazardous waste of Thailand accounted for 14 percent of all ASEAN countries. Three countries, namely Singapore, the Philippines and Malaysia had the highest rates of import-export of hazardous waste from/to Thailand. It is expected that after the ASEAN integration in 2015, the rate of hazardous waste import-export should increase among the countries in the region.

In addition, Thailand has carried out activities to support the disposal of hazardous waste in an environmental friendly way e.g. Environmentally Sound Management of Electrical and Electronic Waste (ESM of e-wastes), the development of hazardous disposal manuals, organizing seminars and training on how to dispose of used electric appliances and electronics and on transboundary of hazardous waste.

4.3.2 Stockholm Convention on Persistent Organic Pollutants (POPs)

This convention aims to protect human health and the environment, Thailand reduced and stopped producing, using and releasing persistent organic pollutants (POPs) or organic substances that are difficult to decay, are toxic, residual or moveable over long distances. Thailand signed the Stockholm Convention on POPs on 22nd May 2002 and had a ratification on 31st January 2005. The Convention has been effective since 1st May 2005.

In 2013, there were some activities, namely, the development of management plans based on the Stockholm Convention 2, the use of the best techniques and practices of environmental management to deal with the emission of dioxins/ furans from the production of iron, metal, electricity, industrial boilers and incinerators, translating and publishing the text of the revised version of the Stockholm Convention B.E. 2554 (2011), and attending the sixth Conference of the Parties to the Stockholm Convention. After the conference, there was an agreement to revise Appendix A of the Convention by adding the name of the 'exabromocyclododecane' substance to the list with an exception for the production and the use of this substance for expanded polystyrene and extruded polystyrene inside buildings. The revision will be effective on 26th November 2014. Therefore, the members have to stop producing and using and also get rid of all the substances in Appendix A (The list of chemical substances that can no longer be used according to the Stockholm Convention).

4.3.3 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

This convention aims to enhance the cooperation and accept responsibility towards hazardous chemical trade, government authorities have to be informed regarding properties of some hazardous chemicals when these substances are imported/exported. In addition, there are also some restrictions on the use of pesticides and insecticides that are extremely dangerous. Thailand had a renewal of the Rotterdam Convention on 19th February 2002. The Rotterdam Convention has been effective since 24th February 2004. By following the Rotterdam Convention, the activities done in 2006 are as follows:

1) There was a report on the import-export of chemical substances during 2009 - 2012. It was found that out of the first five chemical substances exported to Thailand the most were (1) 1,2-dichloroethane (190,050 tons), (2) nonylphenolethoxylates (4,757 tons), (3) chlorate (3,000 tons), (4) nonylphenol (821 tons), and (5) ethylene oxide (563 tons). Most of them are classified under the controlling standard of hazardous substances in category 3 or category 4 according to the Hazard Substances Act B.E. 2535.

2) Considering and reviewing the list of hazardous chemicals that are banned as Stated in the mechanism of the Rotterdam Convention Currently, there are 47 kinds of hazardous chemicals that need to be informed in advance according to the Rotterdam Convention. In Thailand, 44 kinds of those hazardous chemicals are already controlled under the Hazard Substances Act B.E. 2535 except 3 kinds, namely, (1) commercial pentabromodiphenyl ether, (2) commercial octabromodiphenyl, and (3) perfluorooctane sulfonic acid, perfluorooctanesulfonates, perfluorooctane sulfonamides and perfluorooctanesulfonyls, which are in the process of being controlled.

3) Thailand attended the sixth Rotterdam Conference and the second Conference of the Parties to the Basel, Rotterdam and Stockholm Convention between 28th April – 10th May 2013 in Geneva, Switzerland. Some of the main outcomes of the decision include the review of the list of chemicals that need to be prior informed, the endorsement of some regulations, and the adoption of new joint activities with the World Trade Organization (WTO).

4) Thailand has developed the potential of officers to a higher capacity so that they can support the operation for considering and checking the import and export of hazardous chemicals under the Rotterdam Convention correctly. In addition, the officers are also supported to enhance their ability to report incidents from the components of hazardous pesticides and insecticides.

4.3.4 Adopting Minamata Convention on Mercury

The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. The text of the 'Minamata Convention on Mercury' was presented for adoption and opened for signature at the Conference of Plenipotentiaries on the Minamata Convention on Mercury in October 2013 in Japan. Currently, 97 countries have signed the Minamata Convention and agreed to be members. However, the Convention is not immediately effective. It, on the other hand, is effective after 90 days of signing and having a ratification from 50 countries. Thailand has already adopted the text but not yet signed the convention due to the agreement of the Cabinet meeting on 8th October 2013.

A key factor of this Convention is to control the anthropogenic releases of mercury throughout its lifecycle, which involves different organizations. Therefore, the Pollution Control Department, as a coordinating center of the Minamata Convention, will determine the suitability for being a member of the Convention and provide suggestions for related organizations that involve the ratification of this Convention so that these organizations can use the information to support their opinion towards the ratification of the Minamata Convention.

4.3.5 ASEAN - German Project on Energy Efficiency and Climate Change Mitigation in the Land Transport Sector

The Thai Cabinet approved the contract from the ASEAN side and also the draft of the agreement of the ASEAN – German Project on Energy Efficiency and Climate Change in the Land Transport Sector on 24th September 2013 in order to develop the land transport strategies and formulate strategies and action plans towards the improvement of energy efficiency and the reduction of greenhouse gas emissions. The plans will be implemented and monitored through Measurement, Reporting and Verification (MRV). Moreover, local scholars and international scholars are encouraged to have more cooperation for developing land transport policies that are suitable for Thailand by having the Office of Natural Resources and Environmental Policy and Planning as the main organization responsible for this project.

4.3.6 ASEAN Sub-Regional Haze Monitoring System (HMS)

ASEAN Sub-Regional Haze Monitoring System is a joint haze monitoring system among Sub-Regional Ministerial Steering Committees in trans-boundary haze pollution countries. It intends to combat yearly pollution caused by illegal fires that plague large parts of the region and can be used to find out who should be claimed responsible when a fire happens. The Cabinet approved the principals of HMS as proposed by the Office of Natural Resources and Environmental Policy and Planning on 8th October 2013. The Cabinet also agreed that Thailand would share the information regarding maps of the use of land and the land with concession to HMS at the ASEAN summit. However, before sharing any piece of information, each of them has to be approved by a related organization and must not be against the laws/ regulations of Thailand.

4.3.7 Other agreements/cooperative projects

- **The Project of ASEAN Agreement on Transboundary Haze Pollution** focuses on the cooperation to solve the problems of forest fires and haze in tropical countries in the Mekong sub-region.

- **The Project of Clean Air for Smaller Cities in the ASEAN Region** assists cities and national governments in developing the capacity to improve air quality. There are two pilot provinces of Thailand, namely, Chiang Mai and Nakhon Ratchasima joining the project.

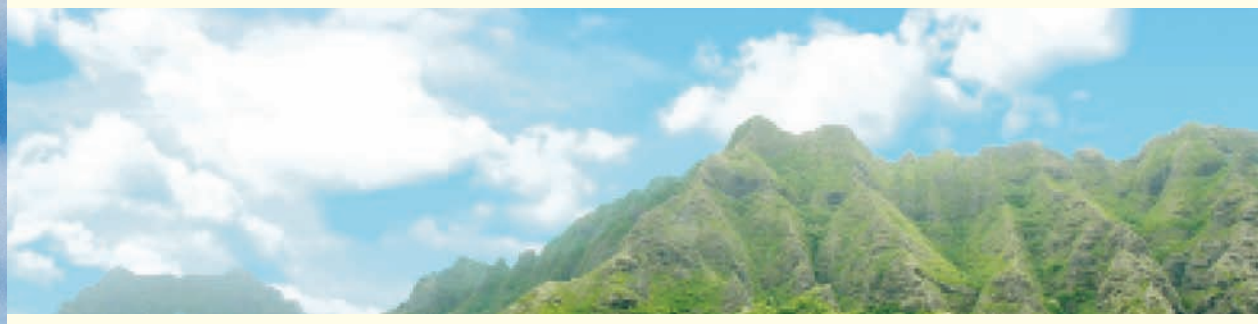
- **The Project of Agreement between Thailand and Lao PDR on measurement of environment quality and pollution management under the bilateral agreement on water management and environment between Thailand and Lao PDR** helps to establish a semi-permanent station for measuring air quality in Lao PDR. There will also be an establishment of a station for measuring the water quality of the Mekong River in the fiscal year 2015.

- **The Project of Waste Landfill Planning Assistance for Thailand under the cooperation with JICA** is to transfer the Semi-Aerobic Landfill technology for improving waste disposal space in an appropriate and effective way. The improved space can also be used as a model for small-medium local governments so that it can applied in their areas. The pilot project has been tested in Sikhiu city with the cooperation of the Office of Natural Resources and Environment 11.

- **The Project of Thai - German Cooperation Project on Improved Water Management of Extreme Events through Ecosystem-based Adaption in Watersheds** will support Thailand in improving water related disaster prevention including flood and drought in the watershed areas of Thailand through the implementation of eco-system based or "green" measures. The two pilot areas of the project are the Chi river basin in the northeast and the Thadi river basin in Nakhon Si Thammarat.

Chapter 5

Summary and Suggestions



5.1 Summary

The state of solid waste is a serious and troubling issue due to the lack of a proper waste management system. In 2013, Thailand approximately generated 26.774 million tons of solid waste. Of the total waste, 53.5% or 14.359 million tons were disposed. Only 7.421 million tons (27.5%) were properly disposed and 6.938 million tons (26%) were improperly disposed. This indicates that of the total waste generated, only 25% was properly disposed of. Meanwhile, there were 7,782 Local Administrative Organizations in Thailand and 4,179 that used waste disposal services. However, there were 2,490 waste management sites and out of those, only 466 were proper waste treatment sites, representing 6% of the total number of Local Administrative Organizations. The remaining 2,024 were improper disposal sites, for example, open dumping and open burning. As a result, the amount of residual waste in waste treatment areas did not decrease while the rate of solid waste generation has increased from 1.03 kg in 2008 to 1.15 kg per person/day.

Hazardous waste --Approximately 3.3 million tons of hazardous waste was produced in the country consisting of 2.69 million tons (81.5%) of industrial waste and 0.61 million tons (18.5%) of household waste. Waste from electrical and electronic equipment made up 65.4% of hazardous household waste and the other 34.6% were other types of hazardous waste including batteries, light bulbs and chemical containers; none of which were properly managed. The former was sold to recycling shops which might improperly decompose them while the latter was disposed along with general waste. Since 2006, Local Administrative Organizations have been encouraged to continuously separate hazardous wastes from the community and collect them for recycling or for disposal at proper hazardous waste treatment sites. However, there is still no explicit hazardous waste management system.

Infectious waste --There was approximately 50,481 tons of infectious waste produced in the country per year. Of the total waste, 28,668 tons (57%) came from public hospitals, 8,606 tons (17%) from private hospitals and 9,698 tons (19%) from clinics. Most of which (75%) were properly managed by large medical facilities. However, small medical facilities such as clinics, health-promoting hospitals, community health centers or veterinary clinics (25%) were limited in waste collection, transportation and disposal management. At present, there are at least 142 infectious waste incinerators in the country. Most of which were not properly equipped to treat air pollution in accordance with regulations or treat infectious waste in order to reduce health and environmental risks. This could expose incinerator workers to potential health risks and affect the environment as well. Therefore, it is necessary to assess the capacity of every hazardous waste incinerator in the country in order to gather useful information and plan a management system.

Air quality monitoring was conducted on 5 dominant pollutants representing air quality, namely sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter sized smaller than 10 microns and ozone at 62 monitoring stations in 29 Provinces. It was found that air quality in 2013 has deteriorated from 2012.

There were 4 areas with critical air quality problems: 1) *Na Phra Lan Sub-district, Saraburi Province* which had been designated as a pollution control area since 2004 and had the most severe particulate matter problem in the country. The main sources of particulate matter in this area were grinding mills, quarries and cement plants. However, in 2013 the situation improved with the days PM exceeding the standard level had decreased from 137 days to 95 days, and the average annual value decreased from 107 µg/m^3 to 98 µg/m^3 / 2) *Map Ta Phut Sub-district, Rayong Province* has been designated as a pollution control area since 2009. The main source of air pollution in this area is VOCs (Volatile Organic Compounds) exceeding the standard were benzene, 1,3-butadiene and 1,2-dichloroethane. This was caused by activities that were not related to regular production of factories namely machine renovations, maintenance and operation as well as port activities where the chemicals were stored, transported and loaded/unloaded. 3) In *Bangkok and its vicinity*, the value of particulate matter, ozone and VOCs had consistently exceeded the standard for the past 10 years. In 2012, air pollution in this area increased in a higher proportion than the rest of the country due to transportation, which was a major source of pollution. 4) Upper northern Provinces had faced haze crisis during January - April every year. The overall situation improved from 2012. The value of PM exceeding standards decreased from the previous year from 64 days to 45 days. However, many Provinces were found to have more days where air pollution exceeded the standard value, namely Mae Hong Son, Lampang, Lamphun, Phrae and Nan. The highest 24-hour average value was 432 µg/m^3 in Muang District, Mae Hong Son. The highest average annual value was 60 µg/m^3 in Mae Mo District, Lampang.

Air pollutants that were the country's significant problems were 1) *particulate matter* sized smaller than 10 microns. The average value of the country had previously decreased in 2008 - 2011, but it escalated in 2012. In many regions, PM value also decreased but in Bangkok and its vicinity, the value increased due to transportation and worsened traffic congestion. 2) *Ozone* was found to have increased in average value from 2012 as a result of transportation in Bangkok and its vicinity, which is a major source of pollution in urban areas. The Industrial and petroleum sector were also contributing factors especially in those vicinities, central region and eastern region. On the surface, the value had increased during the past 10 years. 3) *VOCs* slightly increased in average annual value from 2012, but it is still within the standard with the exception of benzene, which exceeded the standard in many monitored areas. The chemicals 1, 3-butadiene and 1,2-dichloroethane also exceeded the standard in Map Ta Phut Industrial Estate

Noise levels in 2012 were similar to the previous year. In Bangkok and its vicinities, the 24-hour average noise levels (L_{eq}) were 69.1 dBA at roadsides (69.6dBA in 2012) and 58.9 dBA in general areas (58.8 dBA in 2012). Meanwhile, in provincial areas, the noise level at roadsides slightly increased from the previous year with 63.8 dBA (62.9 dBA in 2012). There was a slight decrease in general areas which was 58.4 dBA (59.4 dBA in 2012). Most monitoring results were within the standard.

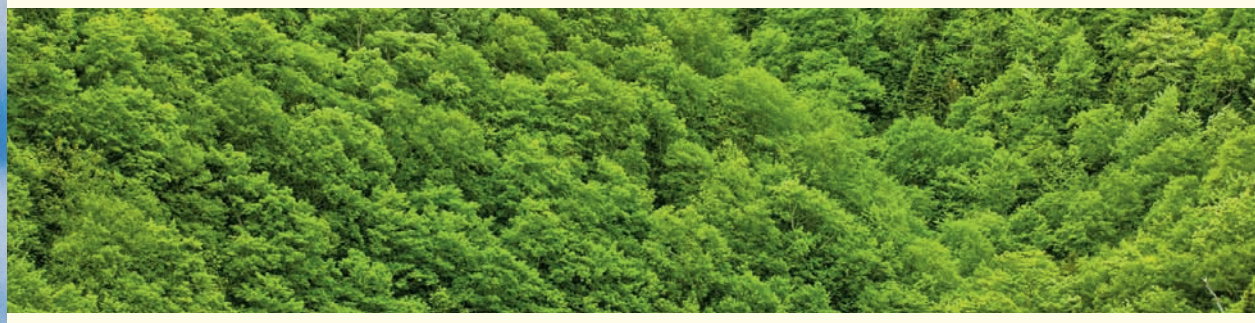
River and significant water resources in Thailand were found to be in good, fair and deteriorated conditions, representing 28%, 49% and 23% respectively. In comparison to 2012, the water quality had deteriorated with 8 good quality water resources degraded to fair condition. Most of those were in the north east region and south region. There were 4 fair quality water resources that degraded to deteriorated conditions. Most of these were in the central region. This was in line with the water quality assessment over the 5-year period (2009 - 2013), which found that water resources with good conditions tended to decline while those with fair and deteriorated conditions were on the rise. The water resources that were consistently in deteriorated conditions were Lower Chao Phraya, Lower Tha Chin, Central Tha Chin, Lower Lamtakong, Lower Phetchaburi, Lower Rayong and Lopburi River.

The quality of coastal water was in good, fair, deteriorated conditions and highly deteriorated conditions representing 16%, 35%, 36% and 13% respectively. When comparing data from the last 5 years, it was found that the quality of coastal water tended to deteriorate. None were in excellent condition and there was a decline in fair quality water resources compared to the previous year. However, deteriorated and highly deteriorated condition water resources were on the rise due to heavy metal substances found in many areas, such as Lam Ngob in Trad; the estuaries of major rivers including of Chao Phraya, 12 Thanwa Canal in Samut Prakan, Ban Lam Canal in Petchburi and Lam Chabang Port in Chonburi.

The quality of groundwater was generally within standard for consumption. Groundwater in risk areas were 1) Nong Han Sub-district, Chachoengsao where water samples were collected. The quality was mostly within the standards for consumption except for Phenol, which exceeded the standard and was in monitoring level. 2) In the pollution controlled area in Rayong samples were collected from groundwater wells, groundwater monitoring wells in industrial plants, and public shallow wells for domestic consumption. Contaminations from heavy metals, such as arsenic, manganese, selenium, and lead, were found exceeding the standard. The results tended to decline when comparing to 2008-2013. However, VOCs, namely 1,2-dichloroethane and carbon tetrachloride, slightly exceeded groundwater quality standard especially in the samples collected from shallow wells.

Regarding *Emergencies, pollution accidents and complaint management* in 2012, the Pollution Control Department received 26 notifications of pollution emergencies and incidents which was on a decline from 2008 (the number of complaints during 2008 - 2012 was 44 48 29 37 and 51 respectively); however, the severity of the damage was similar. Of these cases, 6 cases were incidents in industrial factories and warehouses, 3 involved chemicals shipping and 4 other cases, and 13 were illegal dumping of waste. The area with the most illegal dumping was Prachinburi with 3 incidents. The most significant chemical incident of this year was oil leak from PPT undersea pipeline, which resulted in an oil slick that stretched for 600 meters along the coastline of Ko Samed's Ao Phrao. Related agencies contained the damage by suspending oil transfer and removing the oil slick from the beach of Ao Phrao, closely monitoring the environmental impact and restoring the Bay. After the Bay was consistently monitored to ensure safety for tourism, it was reopened on November 1, 2012. A committee had also been formed to "monitor, rectify and rehabilitate affected areas of the Rayong oil leak" with the permanent secretary of the Ministry of Natural Resources and Environment as the Chairman.

Pollution Management in 2012 allocated a budget of 9,614 million baht which was a very small proportion compared to the total government budget (representing 0.4% of the total government budget of 2,400,000 million baht). This indicated that pollution and environmental management was not considered a priority, which was one of the factors why the plan was not updated or effective. Therefore, other measures were used to manage pollution and environment. *Examples of significant measures taken to manage pollution in 2012* include: Industrial Pollution Management Plan 2012 - 2016, Prevention and Resolution Measures for Haze Pollution Problems in 9 Northern Provinces 2012, Measures in Preventing and Solving the Problem of Illegal Dumping and Industrial Hazardous Waste Management, Promotion Plan for Environmental Friendly Products and Services 2012 - 2016, Guidelines for Recovery and Delivery of Illegally Transported Toxic Waste across Borders, Measures in Preventing and Minimizing Health Impact from Biomass Power Plants, etc. Laws related to pollution and environment were noticed for implementation which consisted of 9 issues of the control of pollution at source, 4 issues of the determination and control of hazardous substances 5 issues of measures in setting criterias, methods, regulations and guidelines for developing Environmental Impact Assessment (EIA) reports, 18 issues in total.



5.2 Policy Proposal

Regarding the pollution situation and future trends in Thailand, the implementation of pollution management in various aspects, analysis had been conducted on problems, difficulties, impacts on environment quality and people's health, pollution complaints and conditions affecting the development of the country. The analysis led to the proposal of a policy for pollution management that should proceed as follows :

5.2.1 Propelling "Solid Waste Management as a National Agenda"

- Implementing recycle communities by reducing unnecessary consumption to reduce solid waste and hazardous waste generation; promoting use of environmentaly friendly products; encouraging waste separation and reuse of solid waste and hazardous waste to maximize practicality and efficiency.

- Organizing packaging or product take-back programs in accordance with Extended Producer Responsibility (EPR) principle by encouraging producers to be responsible for their products once they expire. This included collection, transportation and disposal of the products to ensure environmental safety.

- Clustering of Local Administrative Organizations in order to implement the entire and centralized municipal solid waste, hazardous waste and infectious waste management system.

- Processing Solid Waste into Energy by propelling the plan for concrete results.

- Promoting a research and development plan of using efficient technology to manage solid waste and hazardous waste that suited the area, quantity and components of each type of waste. This included operation, maintenance, energy processing cost efficiency and the management of Local Administrative Organizations.

- Participating with the private sectors in Public Private Partnerships (PPPs) to enhance efficiency of the proper management of solid waste, hazardous waste and infectious waste from collection, transportation, recycling and disposal.

5.2.2 Expediting the Green Supply Chain in accordance with Green Economy and Green Growth. This included deliverers, designers, manufacturers, distributors, transporters and retailers. In particular, industrial sectors were encouraged to create a market for environmentaly friendly products namely ***Green Manufacturing, Green Consumption*** and ***Green Recycling. Green Manufacturing*** or clean technology production controls pollution along the Supply Chain from producing, shipping, packaging and distributing to consumers. Its focus was to maximize efficiency and capacity of the production factors for profit, and reduce environmental impact in line with the rules of 3Rs, namely Reduce, Reuse and Recycle. This was aimed to reduce waste at the source and not after consumption***. Green Consumption*** created awareness and motivation for consumers to use green products with efficient consumption and the least impact on resources. Producers should communicate with consumers on proper and environmentally friendly usage of their products. ***Green Recycling*** is the utilization of packaging. Packaging with pollutants could create complications in disposal and recycling. Therefore, packaging designers should be trained on proper ways to disassemble packaging, and a tax on products that generate pollution or levying fees for pollutant discharge to use as additional guidelines in designing a package.

5.2.3 Spatial Pollution Management

● Clearly establishing proper areas for industrial development (Zoning). Ranking the rehabilitation of pollution in the areas that affect people's quality of life by preparing information regarding basic environmental quality to determine the types and number of industries that were the development targets to be in line with the conditions, utilization and pollution carrying capacity of the areas. The information also served as a regulation criteria for the planning of industry development and suitable environmental management in order to evaluate the permission of business operation and efficient determination of the development direction of the area.

● Determining regulations to control pollution emission in specific areas and evaluating pollution emission permits to establish necessary spatial management. Setting up a pollution database at area level, such as the type and amount of pollutants that were permitted in business operation, amount of pollutants occurred as well as methods for treatment/disposal. Disclosing and linking the database among the agencies including the monitoring results of pollution sources, environmental quality, environmental impacts, and pollution impacts on health. Implementing strict measures to supervise environmental quality in industrial areas, such as establishing specific areas to control the number of vehicles and industry, chemicals transportation and storage, machine maintenance and supervising of industrial waste transportation.

● Managing pollution situations in critical areas and risk areas namely pollution control areas, haze pollution areas, mines, industrial areas, illegal dumping sites and Inner Gulf of Thailand to revise environmental quality situation; evaluating results of pollution source management, preparing for pollution emergencies and public complaint management.

● Allocating budgets to support Local Administrative Organizations in implementing wastewater treatment in the communities that are consistent with the problems and management capacity of Local Administrative Organizations. Developing or enhancing wastewater treatment facilities to accommodate the volume of wastewater in the areas by utilizing the existing wastewater collection and treatment system. Connecting the sewage system to collect wastewater from households into wastewater treatment service areas.

5.2.4 Prevention measures to alleviate pollution emission emergencies

● Monitoring and evaluating risks of chemical emergencies and incidents in risk areas such as industrial estates, industrial factories or areas with frequent chemical incidents. This was to create a map of risk areas and expedite operations in accordance with the Action Plan for Industrial Pollution Emergencies and Incidents, which included factory activities, shipping of materials or products, as well as the treatment, disposal and remediation of polluted areas.

● Reviewing the Disaster Prevention and Mitigation Plan. Revising the Action Plan to Respond to Actual Situations of Chemical and Hazardous Material Emergencies on various levels, namely an Emergency Plan for Provinces, Industrial Estates, Factories and Communities. Preparing related officials in upgrading the warning system notification level, alleviating incidents and strictly following procedures.

● Enhancing efficiency in monitoring, supervising and enforcing the laws on pollution sources in accordance with the measures to prevent and solve environmental impacts and measures to monitor environmental quality as stated in the environmental impact analysis report.

● Establishing guidelines to indicate levels of safety and toxic chemicals to protect the public in case of chemical leakage. The guidelines were also for emergency warnings at area level and community level to determine evacuation or safety levels.

● Compiling the name list of high-risk chemicals in a database. Industrial plants located in and around industrial estates, and every business operations with such chemicals in possession must report their inventory (types and quantities) for the database. This information was for effective preparations in case of a chemical emergency. To prevent accidents, industrial plants installed chemical leakage monitoring devices, which could be connected to the Warning Center at the Industrial Estate Authority of Thailand to facilitate an emergency warning.

5.2.5 Driving budget mechanism for pollution treatment and disposal

● Using budget mechanism as a tool to raise priority of pollution and environmental problems. Clearly establishing a budget plan that does not overlap at central or local levels. Defining a pollution and environmental strategy to set a budget plan for the country and various agencies.

● Creating a mechanism to allocate a budget in the treatment and disposal of pollution in order to alleviate people's suffering and solve preliminary problems. Claiming expenses from pollution sources in accordance with civil law Section 96 of the Enhancement of Conservation of the Natural Environment Quality Act B.E. 2535 (1992). Requiring that industrial plants/business operations with chemicals and/or hazardous toxic waste must place collateral and compensation in case of pollution emission when applying for business permission or business expansion.

Appendix A

Air Quality Monitoring Results

Table 1 : Air Quality from Air Monitoring Stations in Bangkok in 2013

Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)				Carbon Monoxide (CO)			
	1-hour average (ppb)			1- Year	1-hour average (ppb)			1- Year	1-hour average (ppb)			1- Year	8-hour average (ppb)			1- Year
	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
Bansomdejchaopraya Rajabhat University, Thon Buri District	17	0	0/7,604	2	89	3	0/7,640	20	4.20	0.00	0/7,632	0.64	3.03	0.00	0/7,935	0.64
Rat Burana Post Office, Rat Burana District	19	0	0/7,911	1	101	0	0/8,160	23	3.70	0.00	0/8,050	0.32	2.80	0.00	0/8,370	0.32
Bang Na Meteorological Department, Bang Na District	19	0	0/7,538	3	95	0	0/7,881	15	3.60	0.00	0/7,918	0.72	3.03	0.03	0/8,229	0.72
Chandrakasem Rajabhat University, Chatuchak District	11	0	0/6,316	3	126	2	0/6,368	26	2.90	0.00	0/6,353	0.49	2.18	0.00	0/6,602	0.49
Klongchan National Housing Authority, Bang Kapi District	17	0	0/1,655	5	95	0	0/3,166	25	4.70	0.00	0/2,902	0.88	3.10	0.04	0/3,030	0.88
Huai Khwang National Housing Authority Stadium, Huai Khwang District	14	0	0/8,306	3	112	4	0/8,295	28	3.80	0.20	0/8,308	0.96	2.81	0.35	0/8,628	0.96
Nonsi Witthaya School, Yannawa District	18	0	0/7,845	2	107	5	0/7,843	28	3.40	0.00	0/7,740	0.65	2.38	0.00	0/8,088	0.65
Mathayom Watsing school (Singharat Pittayakom), Bang Khun Thian District	20	0	0/8,062	3	91	0	0/5,802	13	4.30	0.00	0/7,573	0.67	3.57	0.00	0/7,886	0.67
Government Public Relations Department , Phaya Thai District	12	0	0/3,895	2	115	5	0/8,027	25	2.50	0.00	0/8,009	0.16	1.92	0.00	0/8,450	0.16
Bodindecha (Sing Singhaseni) School, Wang Thonglang District	20	0	0/7,830	3	110	0	0/7,510	18	5.60	0.00	0/7,922	0.67	2.94	0.00	0/8,242	0.67
Standard		300		40		170		30		30		-		9		-

Remarks : * Number of times pollution exceeding standards/ Number of times pollution measured

Table 2 : Air Quality from Air Monitoring Stations on Roadsides in Bangkok Categorized by Stations in 2013

Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)				Carbon Monoxide (CO)				Ozone (O_3)			
	1 - hour average (ppb)			1- Year	1 - hour average (ppb)			1- Year	1 - hour average (ppb)			1- Year	8 - hour average (ppb)			1- Year	1 - hour average (ppb)			1- Year
	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
Ministry of Science and Technology, Rama VI Rd.	#	#	#	#	#	#	#	#	6.30	0.00	0/6,520	1.56	4.24	0.00	0/6,474	1.56	#	#	#	#
Department of Land Transport, Phahon Yothin Rd.	20	0	0/7,584	3	168	0	0/5,741	22	4.50	0.00	0/8,187	0.94	2.96	0.01	0/8,553	0.94	94	0	0/4,315	19
King Chulalongkorn Memorial Hospital, Rama IV Rd.	#	#	#	#	#	#	#	#	5.70	0.00	0/8,349	2.05	4.80	0.00	0/8,356	2.05	#	#	#	#
22nd July Traffic Circle, Santiparb Rd.**																				
Thonburi Power Sub-Station, Intharaphithak Rd.	23	0	0/6,860	3	180	0	1/7,671	27	4.80	0.00	0/8,286	0.90	2.90	0.00	0/8,635	0.90	141	0	31/6,728	29
Chok Chai Police Station, Ladprao Rd.	26	0	0/6,798	2	109	0	0/8,163	20	3.80	0.00	0/8,267	0.60	2.93	0.00	0/8,552	0.60	103	0	2/7,693	15
Din Daeng National Housing Authority, Din Daeng Rd.	19	0	0/8,213	3	140	6	0/7,834	37	5.30	0.00	0/8,197	0.98	3.42	0.00	0/8,513	0.98	109	0	1/7,976	9
Standard		300		40		170		30		30		-		9		-		100		-

Remarks : * : Number of times pollution exceeding standards/ Number of times pollution measured
** : The station is under readjustment so there is no report in 2013.
# : No monitoring

Ozone (O_3)				Ozone (O_3)				Particulate matters smaller than 10 microns (PM_{10})				Total Suspended Particulate (TSP)				Lead (Pb)			
1-hour average (ppb)			1- Year	8-hour average (ppb)			1- Year	24-hour average (µg/m³)			1- Year	24-hour average (µg/m³)			1- Year	1- month average (µg/m³)			1- Year
Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
127	0	8/7,644	17	99	1	64/7,963	17	158	6	12/310	53	0.13	0.04	0/14	0.09	0.04	0.02	0/4	0.03
120	0	6/7,846	20	94	0	31/8,082	20	129	10	2/347	42	0.19	0.03	0/48	0.08	0.09	0.01	0/19	0.03
145	0	28/7,985	20	109	1	93/8,298	20	173	13	12/289	44	0.18	0.03	0/54	0.08	0.15	<0.005	0/20	0.06
137	0	38/5,652	23	115	0	145/5,848	23	154	12	6/339	51	0.19	0.04	0/54	0.09	0.04	0.01	0/20	0.02
142	0	20/4,224	25	104	1	87/4,401	25	121	13	1/181	42	0.15	0.04	0/19	0.08	0.05	0.01	0/8	0.02
137	0	20/8,283	17	94	0	59/8,585	17	141	13	2/344	42	0.19	0.04	0/53	0.09	0.05	0.01	0/22	0.02
126	0	15/7,816	16	100	0	61/8,159	16	189	9	9/333	50	0.12	0.04	0/19	0.07	0.06	0.02	0/7	0.03
143	0	26/8,118	17	115	0	63/8,464	17	57	8	0/361	20	0.19	0.03	0/41	0.08	0.14	<0.005	0/16	0.04
138	0	48/7,821	21	117	0	145/8,221	21	146	12	5/359	41	0.16	0.03	0/46	0.07	0.05	0.01	0/17	0.02
165	0	72/7,419	25	120	1	208/7,691	25	103	5	0/315	25	0.17	0.03	0/55	0.08	0.06	<0.005	0/22	0.02
	100		-		70		-		120		50		0.33		0.1		1.5		-

Ozone (O_3)				Particulate matters smaller than 10 microns (PM_{10})				Particulate matters smaller than 10 microns (PM_{10})				Total Suspended Particulate (TSP)				Lead (Pb)			
8 - hour average (ppb)			1- Year	24 - hour average (µg/m³)			1- Year	24 - hour average (µg/m³)			1- Year	24 - hour average (µg/m³)			1- Year	1- month average (µg/m³)			1- Year
Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
#	#	#	#	178	25	16/210	74	#	#	#	#	0.20	0.04	0/51	0.09	0.07	0.01	0/19	0.03
71	0	2/4,461	19	303	13	39/252	82	#	#	#	#	0.25	0.05	0/49	0.13	0.07	0.01	0/19	0.03
#	#	#	#	166	25	26/339	67	#	#	#	#	0.22	0.04	0/48	0.10	0.04	0.01	0/17	0.02
												0.20	0.06	0/50	0.13	0.08	0.01	0/17	0.03
104	1	132/6,947	29	109	7	0/257	22	#	#	#	#	0.20	0.04	0/49	0.09	0.07	0.01	0/20	0.03
74	0	3/8,016	15	54	9	0/358	23	#	#	#	#	0.19	0.04	0/53	0.09	0.06	0.01	0/20	0.02
60	0	0/8,260	9	156	21	12/359	58	112	9	40/266	35	0.20	0.04	0/56	0.11	0.04	0.01	0/20	0.02
	70		-		120		50		50		25		0.33		0.1		1.5		-

Table 3 : Air Quality from Air Monitoring Stations in Vicinities Areas in 2013

Station	Province	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)				Carbon Monoxide (CO)			
		1-hour average (ppb)			1-Year	1-hour average (ppb)			1-Year	1-hour average (ppb)			1-Year	8-hour average (ppb)			1-Year
		Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Min	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
Rehabilitation Center for Persons with Disabilities, Phra Pradaeng District	Samut Prakarn	22	0	0/6,994	3	88	0	0/7,516	23	3.60	0.00	0/7,614	0.54	3.04	0.00	0/7,949	0.54
South Bangkok power plant, Muang District		20	0	0/8,178	3	77	0	0/7,787	12	2.90	0.00	0/8,286	0.61	1.98	0.00	0/8,538	0.60
Department of Primary Industries and Mines Residences, Phra Pradaeng District		34	0	0/3,203	4	95	1	0/7,784	17	3.00	0.00	0/7,190	0.42	2.26	0.00	0/7,507	0.42
Sumut Prakan City Hall, Muang District		55	0	0/7,652	4	119	0	0/6,579	25	4.79		0/8,092	1.01	2.57	0.11	0/8,421	1.01
Bang Phli National Housing Authority, Bang Phli District		17	0	0/7,763	2	87	0	097,949	13	2.60	0.00	0/4,449	0.49	1.86	0.00	0/4,642	0.49
Bangkok University, Rangsit Campus, Khlong Luang District	Pathum Thani	28	0	0/8,080	3	73	1	0/7,481	16	2.10	0.00	0/8,085	0.73	1.91	0.00	0/8,385	0.73
Highway District Samut Sakhon, Krathum Baen District	Samut Sakhon	159	0	0/7,384	7	91	0	0/7,471	16	2.90	0.00	0/7,546	0.69	1.95	0.26	0/7,854	0.69
Samut Sakhon Provincial Administrative Organization, Muang District		58	0	0/2,554	4	99	0	0/3,259	16	3.00	0.00	0/2,903	0.32	1.95	0.00	0/2,964	0.32
Samutsakhonwittayalai School, Muang District		105	0	0/1,979	8	149	0	0/1,996	26	#	#	#	#	#	#	#	#
Electricity Generating Authority of Thailand, Bang Kruai District	Non-thaburi	17	0	0/3,759	1	97	0	0/7,065	22	4.20	0.00	0/6,696	0.72	2.50	0.00	0/6,995	154
Sukhothai Thammathirat Open University, Pak Kret District		38	0	0/7,828	2	107	0	0/7,642	12	3.20	0.00	0/7,889	0.49	1.99	0.00	0/8,232	150
Standard			300		40		170		30		30		-		9		-

Remarks : * Number of times pollution exceeding standards/ Number of times pollution mearured

No monitoring

Ozone (O_3)				Ozone (O_3)				Particulate matters smaller than 10 microns (PM_{10})				Particulate matters smaller than 2.5 microns ($PM_{2.5}$)				Total Suspended Particulate (TSP)				Lead (Pb)			
1-hour average (ppb)			1-Year	8-hour average (ppb)			1-Year	24-hour average (µg/m³)			1-Year	24-hour average (µg/m³)			1-Year	24-hour average (µg/m³)			1-Year	1-month average (µg/m³)			1-Year
Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
175	0	33/6,901	18	132	0	90/6,877	18	166	6	5/277	21	#	#	#	#	0.21	0.04	0/45	0.09	0.09	0.02	0/17	0.04
187	0	102/8,061	26	142	1	353/8,355	26	166	13	19/331	48	#	#	#	#	0.14	0.02	0/52	0.05	0.04	<0.005	0/19	0.02
165	0	44/7,611	20	131	0	126/7,917	20	147	11	2/359	40	#	#	#	#	#	#	#	#	#	#	#	#
118	0	6/7,484	22	82	1	98/7,718	23	189	20	20/342	64	#	#	#	#	0.19	0.06	0/51	0.10	0.05	0.01	0/18	0.03
190	0	32/7,951	25	129	1	116/8,310	25	143	12	7/352	43	#	#	#	#	#	#	#	#	#	#	#	#
153	4	168/8,035	27	117	5	480/8,325	28	148	9	8/341	52	#	#	#	#	0.17	0.02	0/48	0.09	0.19	0.01	0/17	0.06
139	0	32/7,499	18	108	0	133/7,787	18	200	11	15/319	54	#	#	#	#	0.22	0.06	0/41	0.12	0.16	0.01	0/15	0.07
139	0	25/3,567	23	110	0	60/3,625	23	62	9	0/167	22	#	#	#	#	#	#	#	#	#	#	#	#
130	0	11/1,982	17	95	0	27/2,059	17	176	10	18/92	89	130	16	49/84	62	#	#	#	#	#	#	#	#
154	0	99/4,098	30	118	0	293/4,285	30	139	15	6/337	47	#	#	#	#	0.16	0.04	0/48	0.08	0.07	0.01	0/19	0.03
150	0	73/7,897	22	121	0	229/8,245	22	165	6	6/334	41	#	#	#	#	0.18	0.04	0/45	0.08	0.05	0.01	0/17	0.02
	100		-		70		-		120		50		50		25		0.33		0.1		1.5		-

Table 4 : Air Quality from Air Monitoring Stations in Provincial Areas in 2013

Station	Regian	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)			
		1-hour average (ppb)			1-Year	1-hour average (ppb)			1-Year	1-hour average (ppb)			1-Year
		Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
Chiang Mai City Hall, Muang Dist. Chiang Mai	North	8	0	0/8,118	1	71	2	0/8,211	12	2.40	0.00	0/8,320	0.49
Yupparaj Wittayalai School, Muang Dist. Chiang Mai		26	0	0/7,478	1	111	0	0/8,158	16	4.90	0.00	0/6,697	0.66
Lampang Meteorological Station, Muang Dist. Lampang		10	0	0/7,747	2	66	0	0/7,739	7	2.70	0.30	0/7,748	0.84
Ban Sop Pad Health Promotion Hospital, Mae Moh Dist. Lampang		43	0	0/7,777	2	61	0	0/7,784	4	2.90	0.10	0/7,789	0.72
Ban Tha Si Health Promotion Hospital, Mae Moh Dist. Lampang		27	0	0/7,678	2	26	0	0/5,500	3	2.97	0.00	0/7,774	0.36
Mae Moh Provincial Waterworks Authority, Mae Moh Dist. Lampang		37	0	0/2,671	2	40	0	0/4,102	3	2.03	0.00	0/1,534	0.33
Nakhon Sawan Irrigation Project, Muang Dist. Nakhon Sawan		14	0	0/7,905	2	59	0	0/7,880	12	2.80	0.00	0/7,908	0.89
Natural Resources and Environment Office, Chiang Rai, Muang Dist. Chiang Rai		#	#	#	#	#	#	#	#	2.50	0.10	0/7,790	0.68
Natural Resources and Environment Office, Mae Hong Son, Muang Dist. Mae Hong Son		#	#	#	#	#	#	#	#	5.30	0.00	0/7,221	0.51
Municipality Offie, Nan, Muang Dist. Nan		19	0	0/6,158	1	93	0	0/7,054	3	3.50	0.00	0/6,833	0.58
Sport Stadium, Lamphun Administrative Organization, Muang Dist, Lamphun		8	0	0/7,957	1	98	0	0/7,508	8	1.90	0.00	0/8,349	0.47
Phrae Meteorological Station, Muang Dist. Phrae		15	0	0/6,826	1	58	0	0/7,932	8	3.50	0.00	0/8,032	0.65
Phayao Knowledge Park, Muang Dist. Phayao		11	0	0/8,191	1	59	0	0/7,536	6	2.50	0.00	0/8,201	0.50
Mae Sai Health Office, Mae Sai Dist. Chiang Rai		#	#	#	#	#	#	#	#	#	#	#	#
City Mayor Residence, Muang Dist. Khon Kaen	North East	7	0	0/4,927	1	98	1	0/4,147	22	3.50	0.00	0/3,771	0.71
Hydrological Department, Water Resources Office Region 4, Muang Dist. Khon Kaen		4	0	0/2,085	1	62	0	0/2,086	8	1.70	0.00	0/2,090	0.25
Municipal Waste Water Pumping Station, Nakhon Ratchasima, Muang Dist. Nakhon Ratchasima		10	0	0/4,791	1	95	0	0/5,061	19	4.20	0.00	0/4,405	0.67
Provincial Health Office, Loei, Muang Dist. Loei		#	#	#	#	#	#	#	#	#	#	#	#
Ayutthaya Witthayalai School, Phra Nakhon Si Ayutthaya Dist. Phra Nakhon Si Ayutthaya	Central	19	0	0/7,781	2	74	0	0/7,802	14	3.80	0.00	0/7,800	0.79
Na Phra Lan Police Station, Chaloem Phra Kiat Dist. Saraburi		17	0	0/8,317	1	100	0	0/8,334	23	2.20	0.00	0/8,220	0.49
Khao Noi Fire Station, Muang Dist. Saraburi		89	0	0/8,184	3	82	0	0/8,164	16	2.60	0.00	0/8,200	0.47
Medical Engineering Center 1, Muang Dist. Ratchaburi		32	0	0/8,251	3	60	0	0/8,073	8	2.10	0.00	0/6,577	0.55
Ta Sit Sub-district Administrative Organization, Pluak Daeng Dist. Rayong	East	20	0	0/4,929	4	33	0	0/6,837	4	2.20	0.00	0/6,846	0.38
Map Ta Phut Health Promotion Hospital, Muang Dist. Rayong		83	0	0/6,882	6	70	0	0/7,612	14	2.80	0.00	0/7,773	0.51
Rayong Agricultural Office, Muang Dist. Rayong		22	0	0/8,359	2	72	1	0/8,322	11	3.20	0.10	0/8,359	0.86
Rayong Field Crops Research Center, Muang District, Rayong		39	0	0/7,027	3	59	0	0/7,907	9	1.35	0.00	0/8,009	0.41
Rayong Government Complex, Muang Dist. Rayong		59	0	0/8,303	3	69	0	0/8,289	13	1.90	0.00	0/8,314	0.65
Laem Chabang Municipality Sport Stadium, Si Racha Dist. Chon Buri		58	0	0/6,714	4	114	0	0/7,324	12	3.70	0.00	0/2,689	0.84
Si Racha Municipal Youth Center, Si Racha Dist. Chon Buri		23	0	0/2,318	3	82	0	0/4,123	16	2.50	0.00	0/5,463	0.78
Ban Khao Hin Health Promotion Hospital, Si Racha Dist. Chon Buri		#	#	#	#	63	2	0/2,118	12	#	#	#	#
Chon Buri General Education Office, Muang Dist. Chon Buri		42	0	0/7,370	2	109	0	0/4,951	15	4.10	0.00	0/7,267	0.63
Wang Yen Sub-district Administrative Organization, Plaeng Yao Dist. Chachoengsao		48	0	0/7,109	2	91	0	0/5,046	4	3.60	0.00	0/6,525	0.40
Sriaranyothai Kindergarten, Aranyaprathet Dist. Sa Kaew		#	#	#	#	#	#	#	#	#	#	#	#
Regional Environmental Office 14, Muang Dist. Surat Thani	South	7	0	0/7,784	1	19	0	0/7,882	3	2.50	0.00	0/7,918	0.20
Municipal Health Center, Phuket, Muang Dist. Phuket		17	0	0/7,793	1	64	0	0/7,984	10	1.90	0.00	0/8,250	0.48
Had Yai Municipality, Had Yai Dist. Songkhla		18	0	0/7,624	2	34	0	0/6,677	7	3.26	0.00	0/7,921	0.51
Narathiwat City Hall, Muang Dist. Narathiwat		#	#	#	#	#	#	#	#	1.60	0.00	0/8,128	0.50
White Elephant Park, Muang Dist. Yala		#	#	#	#	#	#	#	#	1.80	0.00	0/8,024	0.39
Standard			300		40		170		30		30		-

Remarks : * : Number of times pollution exceeding standards/ Number of times pollution measured

: No monitoring

Carbon Monoxide (CO)				Ozone (O_3)				Ozone (O_3)				Particulate matters smaller than 10 microns (PM_{10})				Particulate matters smaller than 2.5 microns ($PM_{2.5}$)			
8-hour average (ppb)			1-Year	1-hour average (ppb)			1-Year	8-hour average (ppb)			1-Year	24-hour average (μg/m³)			1-Year	24-hour average (μg/m³)			1-Year
Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average	Max	Min	Time > std.*	Average
1.96	0.00	0/8,677	0.49	111	0	5/8,026	21	80	1	64/8,364	21	208	5	11/362	41	#	#	#	#
2.73	0.00	0/6,947	0.66	120	0	9/8,310	22	86	0	82/8,648	22	229	6	21/357	47	188	11	59/347	35
2.47	0.39	0/8,088	0.84	131	3	38/7,749	31	106	3	357/8,090	31	226	11	17/332	51	#	#	#	#
2.63	0.13	0/8,047	0.72	134	7	27/7,705	28	101	8	319/7,955	28	204	14	12/287	54	#	#	#	#
2.35	0.00	0/8,039	0.36	106	0	3/8,014	17	81	0	26/8,306	17	337	7	25/303	45	#	#	#	#
1.98	0.00	0/1,582	0.33	97	0	0/4,090	31	79	3	28/4,245	31	217	9	13/196	60	71	6	9/49	26
2.06	0.40	0/8,275	0.89	127	5	96/7,900	45	113	7	676/8,263	45	177	15	20/329	56	#	#	#	#
2.20	0.30	0/8,173	0.68	104	0	4/7,912	20	88	1	68/8,279	20	244	10	26/338	52	#	#	#	#
3.84	0.00	0/7,395	0.51	110	0	5/7,333	19	92	1	92/7,486	19	432	7	35/308	49	#	#	#	#
2.48	0.00	0/7,068	0.57	117	0	16/7,657	24	93	1	156/7,938	24	264	7	22/324	45	#	#	#	#
1.66	0.00	0/8,677	0.47	115	0	13/7,654	26	94	1	169/7,937	26	192	8	12/360	44	#	#	#	#
2.59	0.00	0/8,372	0.65	125	0	26/8,005	24	99	1	194/8,330	24	225	15	28/358	57	#	#	#	#
2.10	0.00	0/8,549	0.50	103	0	2/8,071	26	93	0	63/8,411	26	208	6	19/325	44	#	#	#	#
#	#	#	#	#	#	#	#	#	#	#	#	308	12	20/308	36	#	#	#	#
2.61	0.00	0/3,761	0.71	90	0	0/5,269	20	73	0	1/5,472	20	80	11	0/209	34	#	#	#	#
1.04	0.00	0/2,175	0.26	73	0	0/2,089	27	70	1	0/2,172	27	156	14	5/79	63	#	#	#	#
2.60	0.09	0/4,567	0.67	88	0	0/4,217	22	73	1	2/4,384	22	137	15	6/220	60	#	#	#	#
#	#	#	#	#	#	#	#	#	#	#	#	108	7	0/235	32	#	#	#	#
2.36	0.01	0/8,140	0.79	143	0	163/7,756	33	117	0	494/8,073	32	206	9	20/336	56	#	#	#	#
1.58	0.00	0/8,573	0.49	132	0	27/8,090	14	97	0	72/8,409	14	352	17	95/343	98	140	8	74/283	38
1.47	0.00	0/8,537	0.47	115	0	10/7,796	21	93	0	44/8,093	21	53	7	0/350	21	#	#	#	#
1.47	0.00	0/6,843	0.55	132	0	26/7,768	30	107	3	191/8,037	30	76	6	0/289	25	#	#	#	#
1.50	0.00	0/7,180	0.38	87	0	0/4,800	17	72	0	14/4,914	17	152	11	2/310	38	#	#	#	#
2.10	0.17	0/7,978	0.51	133	0	20/7,622	23	112	1	88/7,916	23	209	14	22/260	54	#	#	#	#
1.99	0.16	0/8,711	0.86	121	1	9/7,550	24	99	2	74/7,863	24	107	9	0/346	33	77	5	24/355	19
1.04	0.00	0/8,207	0.41	150	0	54/7,890	27	117	0	235/8,081	27	112	11	0/306	40	#	#	#	#
1.30	0.30	0/8,657	0.65	131	0	11/8,311	22	104	2	65/8,656	22	107	11	0/362	36	#	#	#	#
2.93	0.00	0/2,704	0.85	128	0	5/7,134	18	90	0	17/7,484	18	103	12	0/251	37	#	#	#	#
1.80	0.01	0/5,609	0.78	170	0	26/5,438	19	126	0	94/5,697	19	46	5	0/225	16	#	#	#	#
#	#	#	#	110	0	4/2,123	31	86	7	10/2,220	31	102	8	0/91	49	#	#	#	#
2.93	0.00	0/7,486	0.62	163	0	16/7,595	21	106	0	33/7,821	20	49	4	0/276	15	#	#	#	#
2.90	0.00	0/6,731	0.40	98	0	0/6,453	31	95	1	228/6,641	31	51	7	0/282	23	#	#	#	#
#	#	#	#	#	#	#	#	#	#	#	#	180	8	17/310	53	#	#	#	#
0.66	0.00	0/8,277	0.20	98	0	0/7,921	18	72	1	12/8,284	18	73	7	0/319	35	#	#	#	#
1.23	0.00	0/8,591	0.48	96	0	0/7,433	26	86	0	231/7,679	26	61	8	0/347	24	#	#	#	#
2.70	0.00	0/8,245	0.51	80	0	0/7,899	18	61	0	0/8,233	18	101	11	0/313	38	51	7	1/347	20
1.31	0.04	0/8,485	0.50	#	#	#	#	#	#	#	#	135	11	1/332	36	#	#	#	#
1.40	0.08	0/8,359	0.39	#	#	#	#	#	#	#	#	97	9	0/327	29	#	#	#	#
	9		-		100		-		70		-		120		50		50		25

Table 5 : Summary of areas with particulate matter problems (PM_{10}) in 2013 ranging from the highest to the lowest

Rank	Province	Area	Maximum daily mean (mcg/m^3)	Mode of Daily mean	Annual mean (mcg/m^3)	Percentage of Days exceeding standards	Total score
1	Saraburi	Na Phra Lan Sub-district, Chaloem Phra Kiat District	352	57	98	28	9
2	Bangkok	Phaholyothin Road Roadside, Chatuchak District	303	63	82	15	12
3	Bangkok	Rama VI Road Roadside, Ratchathewi District	178	66	74	7	36
4	Lampang	Mae Mo Sub-district, Mae Mo District *	217	34	60	6	41
5	Bangkok	Rama IV Road Roadside, Pathum Wan District	166	40	67	7	43
6	Samut Prakan	Pak Nam Sub-district, Muang Samut Prakan District	189	62	64	6	44
7	Phrae	Nai Wiang Sub-district, Muang Phrae District	225	28	57	8	47
8	Rayong	Map Ta Phut Sub-district, Muang Rayong District	209	28	54	8	49
9	Phra Nakhon Si Ayutthaya	Pratu Chai Sub-district, Phra Nakhon Si Ayutthaya District	206	34	56	6	52
10	Nakhon Sawan	Pak Nam Pho Sub-district, Muang Nakhon Sawan District	177	36	56	6	56
11	Samut Sakhon	Omnoi Sub-district, Krathum Baen District	200	37	54	5	60
12	Chiang Rai	Wiang Phang Kham Sub-district, Mae Sai District	308	25	52	6	63
13	Lampang	Sop Pat Sub-district, Mae Mo District	204	29	54	4	70
13	Chiang Rai	Wiang Sub-district, Muang Chiang Rai District	244	20	52	8	70
15	Nakhon Ratchasima	Nai Muang Sub-district, Muang Nakhon Ratchasima District*	137	83	60	3	75
16	Bangkok	Hiran Ruchi Sub-district, Thon Buri District	158	39	53	4	76
17	Bangkok	Din Daeng Road Roadside, Din Daeng District	156	32	58	3	78
18	Chiang Mai	Si Phum Sub-district, Muang Chiang Mai District	229	24	47	6	82
19	Lampang	Tha Si Sub-district, Mae Mo District	337	17	45	8	86
19	Mae Hong Son	Chong Kham Sub-district, Muang Mae Hong Son District	432	11	49	11	86
21	Bangkok	Chong Nonsi Sub-district,Yan Nawa District	189	31	50	3	87
22	Sa Kaeo	Aranyaprathet Sub-district, Aranyaprathet District	180	23	53	5	91
22	Bangkok	Bang Na Sub-district, Bang Na District	173	32	44	4	91
24	Pathum Thani	Khlong Nueng Sub-district, Khlong Luang District	148	36	52	2	92
25	Lampang	Hua Wiang Sub-district, Muang District	226	19	51	5	94
26	Nan	Nai Wiang Sub-district, Muang Nan District	264	16	45	6	95
27	Bangkok	Chan Kasem Sub-district, Chatuchak District	154	33	51	2	99
27	Samut Prakan	Bang Prong Sub-district, Muang Samut Prakan District	166	24	48	6	99
29	Phayao	Wiang Sub-district, Muang Phayao District	208	18	44	6	108
30	Chiang Mai	Chang Puek Sub-district, Muang Chiang Mai District	208	23	41	3	114
30	Nonthaburi	Bang Kruai Sub-district, Bang Kruai District	139	30	47	2	114
32	Lamphun	Nai Muang Sub-district, Muang Lamphun District	192	16	44	3	126
33	Rayong	Tasit Sub-district, Pluak Daeng District	152	29	38	0.65	130

Table 5 : Summary of areas with particulate matter problems (PM_{10}) in 2013 ranging from the highest to the lowest (continued)

Rank	Province	Area	Maximum daily mean (mcg/m^3)	Mode of Daily mean	Annual mean (mcg/m^3)	Percentage of Days exceeding standards	Total score
33	Samut Prakan	Bang Sao Thong Sub-district, Bang Phli	143	27	43	2	130
35	Bangkok	Rat Burana Sub-district, Rat Burana District	129	28	42	0.58	133
35	Samut Prakan	Talad Sub-district, Phra Pra Daeng District	147	28	40	0.56	133
37	Bangkok	Din Daeng Sub-district, Din Daeng District	141	28	42	0.29	135
38	Bangkok	Samsen Nai Sub-district Phaya Thai District	146	25	41	1	139
39	Songkhla	Hat Yai Sub-district, Hat Yai District	101	37	38	0.00	142
40	Bangkok	Khlong Chan, Bang Kapi District*	121	27	42	1	143
40	Nonthaburi	Bang Phut Sub-district, Pak Kret District	165	18	41	2	143
42	Narathiwat	Bang Nak Sub-district, Muang Narathiwat District	135	27	36	0.30	152
43	Rayong	Noen Phra Sub-district, Muang Rayong District	107	28	36	0.00	155
44	Rayong	Huai Pong Sub-district, Muang Rayong District	112	20	40	0.00	166
45	Chon Buri	Thung Sukhla Sub-district, Si Racha District*	103	24	37	0.00	167
46	Surat Thani	Makham Tia Sub-district, Muang Surat Thani District	73	26	35	0.00	173
47	Samut Prakan	Songkanong Sub-district, Phra Pradaeng District	166	8	21	2	174
48	Loei	Naaan Sub-district, Muang Loei District*	108	19	32	0.00	181
49	Khon Kaen	Nai Muang Sub-district, Muang Khon Kaen District (old)*	80	20	34	0.00	182
50	Rayong	Tha Pradu Sub-district, Muang District	107	18	33	0.00	184
50	Yala	Sateng Sub-district, Muang Yala District	97	20	29	0.00	184
52	Phuket	Talad Yai Sub-district, Muang Phuket District	61	21	24	0.00	191
53	Chachoengsao	Wang Yen Sub-district, Plaeng Yao District	51	23	23	0.00	193
54	Bangkok	Wang Thonglang Sub-district, Wang Thongland District	103	14	25	0.00	196
55	Bangkok	Bang Yee Rue Sub-district ,Thon Buri District	109	12	22	0.00	199
55	Samut Sakhon	Mahachai Sub-district, Muang Samut Sakhon District (old)*	62	19	22	0.00	199
57	Bangkok	Lad Phrao Road Roadside, Wang Thonglang District	54	16	23	0.00	207
58	Ratchaburi	Na Muang Sub-district, Muang Ratchaburi District	76	8	25	0.00	208
59	Saraburi	Pak Preaw Sub-district, Muang Saraburi District	53	14	21	0.00	215
60	Bangkok	Bang Khun Thian Sub-district, Chom Thong District	57	12	20	0.00	216
61	Chon Buri	Si Racha Sub-district, Si Racha District (old)*	46	12	16	0.00	222
62	Chon Buri	Bang Pla Soi Sub-district, Muang Chon Buri District	49	8	15	0.00	226

Remarks :

- * Data less than 70 percent of dates measured
- The ranking employs the criteria of the highest 1- hour mean and mode, maximum 8- hour mean, and the percentage of the number of days the Ozone exceeds standards by measuring the particulate matter obtained from each criterion and arranging the results from measurements of all areas from the highest to the lowest.

Table 6 : Ranking of areas with ozone problems in 2013 from the highest to the lowest

Rank	Province	Area	Highest 1-hour mean (ppb)	Mode	Highest 8-hour mean (ppb)	Percentage of days exceeding 1-hour Ozone standards	Total Score
1	Rayong	Huai Pong Sub-district, Muang Rayong District	150	20	117	0.68	33
1	Samut Prakan	Bang Sao Thong Sub-district, Bang Phli District	190	18	129	0.40	33
3	Pathum Thani	Khlong Nueng Sub-district, Khlong Luang District	153	11	117	2.09	34
4	Samut Prakan	Bang Prong Sub-district, Muang Samut Prakan District	187	4	142	1.27	35
5	Phra Nakhon Si Ayutthaya	Pratu Chai Sub-district, Phra Nakhon Si Ayutthaya District	143	10	117	2.10	39
6	Bangkok	Wang Thonglang Sub-district, Wang Thonglang District	165	6	120	0.97	43
7	Nakhon Sawan	Pak Nam Pho Sub-district, Muang Nakhon Sawan District	127	30	113	1.22	51
8	Nonthaburi	Bang Phut Sub-district, Pak Kret District	150	2	121	0.92	60
9	Chon Buri	Si Racha Sub-district, Si Racha District (old) *	170	2	126	0.48	61
10	Nonthaburi	Bang Kruai Sub-district, Bang Kruai District *	154	0	118	2.42	62
11	Lampang	Hua Wiang Sub-district, Muang Lampang District	131	21	106	0.49	64
11	Samut Prakan	Songkanong Sub-district, Phra Pradaeng District	175	0	132	0.48	64
13	Samut Prakan	Talad Sub-district, Phra Pradaeng District	165	0	131	0.58	65
14	Bangkok	Chan Kasem Sub-district, Chatuchak District *	137	4	115	0.67	71
14	Bangkok	Inthara Phithak Road Roadside, Thon Buri District	141	10	104	0.46	71
14	Ratchaburi	Na Muang Sub-district, Muang Ratchaburi District	132	20	107	0.33	71
17	Rayong	Map Ta Phut Sub-district, Muang Rayong District	133	13	112	0.26	77
18	Chon Buri	Bang Pla Soi Sub-district, Muang Chon Buri District	163	7	106	0.21	79
19	Bangkok	Bang Na Sub-district, Bang Na District	145	3	109	0.35	80
20	Bangkok	Khlong Chan Sub-district, Bang Kapi District *	142	3	104	0.47	84
20	Bangkok	Samsen Nai Sub-district, Phaya Thai District	138	0	117	0.61	84
22	Samut Sakhon	Mahachai Sub-district, Muang Samut Sakhon District (old)*	139	0	110	0.70	87
23	Lampang	Sop Pat Sub-district, Mae Mo District	134	9	101	0.35	88
24	Rayong	Noen Phra Sub-district, Muang Rayong District	131	11	104	0.13	94
24	Bangkok	Bang Khun Thian Sub-district, Chom Thong District	143	1	115	0.32	94
26	Samut Sakhon	Omnoi Sub-district, Krathum Baen District	139	1	108	0.43	97
27	Rayong	Tha Pradu Sub-district, Muang Rayong District	121	17	99	0.12	105
28	Phrae	Nai Wiang Sub-district, Muang Phrae District	125	3	99	0.32	114
29	Bangkok	Din Daeng Sub-district, Din Daeng District	137	2	94	0.24	116
30	Chon Buri	Thung Sukhla Sub-district, Si Racha District	128	10	90	0.07	122
30	Samut Prakan	Pak Nam Sub-district, Muang Samut Prakan District	118	20	82	0.08	122

Table 6 : Ranking of areas with ozone problems in 2013 from the highest to the lowest (continued)

Rank	Province	Area	Highest 1-hour mean (ppb)	Mode	Highest 8-hour mean (ppb)	Percentage of days exceeding 1-hour Ozone standards	Total Score
32	Bangkok	Hiran Ruchi Sub-district, Thon Buri District	127	3	99	0.10	123
33	Saraburi	Na Phra Lan Sub-district, Chaloem Phra Kiat District	132	0	94	0.33	124
33	Lamphun	Nai Muang Sub-district, Muang Lamphun District	115	7	94	0.17	124
35	Bangkok	Rat Burana Sub-district, Rat Burana District	120	8	94	0.08	125
36	Chachoengsao	Wang Yen Sub-district, Plaeng Yao District	98	23	95	0.00	128
37	Nan	Nai Wiang Sub-district, Muang District	117	3	93	0.21	132
38	Bangkok	Chong Nonsi Sub-district, Yan Nawa District	126	0	100	0.19	133
39	Phayao	Wiang Sub-district, Muang Phayao District	103	15	93	0.02	137
40	Chiang Mai	Si Phum Sub-district, Muang Chiang Mai District	120	3	86	0.11	141
41	Lampang	Mae Mo Sub-district, Mae Mo District*	97	37	79	0.00	144
41	Phuket	Talad Yai Sub-district, Muang Phuket District	96	20	86	0.00	144
43	Saraburi	Pak Preaw Sub-district, Muang Saraburi District	115	0	93	0.13	152
44	Chiang Mai	Chang Puek Sub-district, Muang Chiang Mai District	111	5	80	0.06	153
44	Chiang Rai	Wiang Sub-district, Muang Chiang Rai District	104	5	88	0.05	153
46	Bangkok	Lad Phrao Road Roadside, Wang Thonglang District	103	9	74	0.03	156
47	Mae Hong Son	Chong Kham Sub-district, Muang Mae Hong Son District	110	2	92	0.07	157
48	Khon Kaen	Nai Muang Sub-district, Muang Khon Kaen District (old) *	90	10	73	0.00	163
49	Surat Thani	Makham Tia Sub-district, Muang Surat Thani District	98	8	72	0.00	166
50	Lampang	Tha Si Sub-district, Mae Mo District	106	2	81	0.04	168
51	Nakhon Ratchasima	Nai Muang Sub-district, District *	88	2	73	0.00	186
51	Songkhla	Hat Yai Sub-district, Hat Yai District	80	3	61	0.00	186
53	Bangkok	Din Daeng Road Roadside, Din Daeng District	109	0	60	0.01	188
54	Bangkok	Phaholyothin Road Roadside, Chatuchak District *	94	0	71	0.00	196
55	Rayong	Tasit Sub-district, Pluak Daeng District*	87	0	72	0.00	197

Remarks :

- *Data less than 70 percent of dates measured
- The ranking employs the criteria of the highest 1- hour mean and mode, maximum 8- hour mean, and the percentage of the number of days the Ozone exceeds standards by measuring the particulate matter obtained from each criterion and arranging the results from measurements of all areas from the highest to the lowest.

Table 7 : Comparison of Yearly 24-hr average and Yearly average standards of 9 Volatile Organic Compounds in 2013

Station	Vinyl Chloride	1,3 Butadiene	Dichloromethane	Chloroform	1,2-Dichloroethane	Benzene	Trichloroethylene	1,2-Dichloropropane	Tetrachloroethylene
Bangkok and Vicinity area									
Roadside areas									
- Din Daeng National Housing Authority, Din Daeng Rd.*	0.05	0.03	2.02	0.17	0.16	4.8	0.41	0.10	0.29
- Chok Chai 4 Police Station, Lat Phrao Rd.*	0.05	0.03	2.28	0.23	0.16	3.4	0.90	0.12	0.35
- King Chulalongkorn Memorial Hospital, Rama IV Rd.	0.04	0.03	1.95	1.12	0.17	4.5	0.42	0.12	0.71
General area									
- Environmental Research and Training Centre, Pathum Thani*	0.05	0.03	1.31	0.13	0.16	1.9	0.50	0.10	0.15
Chiang Mai									
Roadside area : Yupparaj Wittayalai School*	0.05	0.03	0.96	0.14	0.15	2.8	0.14	0.12	0.11
General area : City Hall, Chiang Mai*	0.04	0.03	0.48	0.09	0.13	1.4	0.14	0.12	0.11
Khon Kaen									
City Mayor Residence, Khon Kaen	0.04	0.03	0.54	0.11	0.26	2.7	0.13	0.13	0.10
Songkhla									
Hat Yai City Municipality, Songkhla	0.04	0.03	0.40	0.11	0.10	1.9	0.13	0.09	0.10
Rayong									
- Nong Faeb Temple	0.05	0.03	0.44	0.24	0.21	1.6	0.14	0.18	0.11
- Map Chalud Temple	0.42	0.03	0.73	0.17	0.27	1.0	0.14	0.12	0.14
- Banplong Community	99.79	0.23	1.00	0.11	0.46	5.3	0.16	0.14	0.18
- Muang Mai Station, Map Ta Phut	2.12	1.26	1.00	0.20	2.91	2.5	0.24	0.14	0.17
- Map Ta Phut Public Health Station Health Promoting Hospital	2.31	0.67	0.78	0.13	1.72	2.3	0.14	0.14	0.15
- Takhuan Public Health Center	0.36	0.70	1.01	0.09	0.26	2.1	0.14	0.14	0.14
- Noppaked Village	0.43	0.12	2.17	0.09	0.25	3.0	0.22	0.12	0.17
- Nong Chok Public Health Station	0.06	0.03	0.37	0.09	0.18	1.4	0.13	0.11	0.11
- Pluak Ket Temple	0.05	0.99	0.53	0.09	0.16	2.3	0.14	0.13	0.11
Yearly Standard (µg/m³)	**10**	**0.33**	**22**	**0.43**	**0.4**	**1.7**	**23**	**4**	**200**

Remarks : * This information does not cover 12 months

Appendix B

Noise Quality Monitoring Results

Table 1 : 24-hour average noise levels (L_{eq}) measured at roadside monitoring stations in Bangkok and its vicinity areas in 2013

Monitoring station	Noise Level (dBA)		Number of days noise exceeding standard/Number of monitoring days (Percentage)
	Min-Max	Average*	
Phahurat, Tree Petch Road	73.4 - 76.0	74.4	363/363 (100)
Choke Chai Police Station, Lad Phrao Road	71.2 - 74.2	72.6	308/308 (100)
Din Daeng National Housing Authority, Din Daeng Road	70.9 - 82.5	72.1	309/309 (100)
Thonburi Power Sub-Station, Inthara Phithak Road	69.5 - 73.9	71.0	342/361 (95)
22nd July Traffic Circle, Santipap Road	66.1 - 71.3	68.5	12/365 (3)
Huai Khwang, National Housing Stadium, Pracha Songkhro Road	61.7 - 78.6	66.9	35/221 (16)
Electricity Generating Authority of Thailand, Bang Kruai - Sai Noi Road, Nonthaburi	60.3 - 68.8	63.8	0/262 (0)
Road and Transit Division of Samut Sakhon, Petchkasem Road, Samut Sakhon	62.1 - 67.7	63.6	0/218 (0)
Standard	70		

Remark : * refers to average values of 24-hour average noise levels (L_{eq}) measured in 1 year

Table 2 : 24-hour average noise levels (L_{eq}) measured at monitoring stations in Bangkok and its vicinity areas in 2013

Monitoring station	Noise Level (dBA)		Number of days noise exceeding standard/Number of monitoring days (Percentage)
	Min-Max	Average*	
Nonsi Witthaya School, Nang Linchee Road	51.9 - 71.7	62.2	9/262 (3)
Singharat Pittayakom School, Ekachai Road	59.5 - 69.7	62.0	0/267 (0)
Bodindecha School, Soi Ladphrao 122	52.6 - 80.3	60.3	2/266 (1)
Sukhothai Thammathirat Open University Nonthaburi	55.0 - 66.8	59.4	0/225 (0)
Bangkok University, Rangsit Campus, Pathum Thani	47.8 - 68.0	53.0	0/267 (0)
Klongchan National Housing Authority, Sukha Phiban 1 Road	46.7 - 64.6	55.9	0/126 (0)
Standard	70		

Remark : * refers to average values of 24-hour average noise levels (L_{eq}) measured in 1 year

Table 3 : 24-hour average noise levels (L_{eq}) measured at roadside monitoring stations in other provinces in 2013

Province	Monitoring station	Noise Level (dBA)		Number of days noise exceeding standard/Number of monitoring days (Percentage)
		Min-Max	Average*	
Saraburi	Na Phra Lan Police Station, Chalermprakiat District	70.5 - 79.4	72.2	282/282 (100)
Nakhon Ratchasima	Wastewater Pump Station, Nakhon Ratchasima City Municipality	62.6 - 83.8	66.5	23/263 (9)
Rayong	Rayong Provincial Agricultural Extension Office, Muang Rayong District	64.4 - 70.1	65.7	1/272 (0)
Khon Kaen	Official Residence of Deputy District Chief, Muang Khon Kaen District	61.7 - 68.4	65.2	0/297 (0)
Chiang Mai	Yupparaj Wittayalai School, Muang Rayong District	59.9 - 70.8	64.7	2/357 (1)
Rayong	Map Ta Phut Health Promoting Hospital, Muang Rayong District	58.6 - 71.8	62.3	3/284 (1)
Phuket	Phuket Health Centre, Muang Phuket District	52.8 - 79.9	61.1	22/364 (6)
Chon Buri	Laemchabang City Municipality Office, Si Racha District	54.5 - 75.0	60.5	2/255 (1)
Songkhla	Hat Yai Municipality, Hat Yai District	53.0 - 76.6	59.8	5/361 (1)
Chon Buri	Si Racha Municipality Youth Centre, Si Racha District	56.0 - 67.5	59.9	0/268 (0)
Standard		70		

Remark : * refers to average values of 24-hour average noise levels (L_{eq}) measured in 1 year

Table 4 : 24- hour average noise levels (L_{eq}) measured at monitoring stations in general areas in other provinces in 2013

Province	Monitoring station	Noise Level (dBA)		Number of days noise exceeding standard/Number of monitoring
		Min-Max	Average*	
Chon Buri	Chon Buri General Education Office, Muang Chon Buri District	50.5 - 71.2	63.9	10/220 (5)
Saraburi	Fire Station (Khao Noi), Muang Saraburi District	53.3 - 69.3	58.6	0/365 (0)
Lampang	Shrine of the City Pillar Muang Lampang District	51.4 - 70.9	58.9	2/214 (1)
Saraburi	Wat Tham Si Wilai, Chalermprakiat District	49.0 - 72.6	58.5	4/336 (1)
Saraburi	Na Phra Lan Sub-district Administrative Organization, Chalermprakiat District	48.1 - 72.7	55.8	1/350 (0)
Chiang Mai	Chiang Mai City Hall, Muang Chiang Mai District	50.7 - 65.3	54.5	0/342 (0)
Standard		70		

Remark : * refers to average values of 24-hour average noise levels (L_{eq}) measured in 1 year

Table 5 : 24- hour average noise levels (L_{eq}) measured at temporary roadside monitoring stations in Bangkok in 2013

No.	Monitoring station	Date	Noise Level (dBA)	Average*	Number of days Noise exceeding standard/Number of monitoring days (Percentage)
1	Mahai Sawan Intersection Police Booth, Tak Sin Rd.	9 - 15 August	76.6 - 79.7	78.4	7/7 (100)
2	Arun Amarin-Phran Nok Intersection Police Booth	30 August - 5 September	77.5 - 78.2	77.8	7/7 (100)
3	Suk Sawat-Pracha Uthit Intersection Police Booth	4 - 10 September	77.0 - 77.7	77.4	7/7 (100)
4	Phra Khanong Police Station, Sukhumvit Rd., Soi 77	2 - 8 August	75.9 - 78.2	77.3	7/7 (100)
5	Maeng Si Police Booth, Bamrung Muang Rd.,	5 - 11 September	76.3 - 77.5	77.0	7/7 (100)
6	Victory Monument Police Booth, Dokya Bookstore	19 - 25 September	74.6 - 86.5	76.6	7/7 (100)
7	M.C.O.T. Intersection Police, Rama IX Rd.	4 - 10 July	76.2 - 76.6	76.3	7/7 (100)
8	Bansomdejchaopraya Rajabhat Institute Police Booth, Isaraphab Rd.	1 - 7 August	75.5 - 76.3	75.8	7/7 (100)
9	Yaowarat Police Booth, Yaowarat Rd.	26 September - 2 October	74.5 - 76.0	75.6	7/7 (100)
10	Office of Atoms for Peace, Vibhavadi-Rangsit Rd.	21 - 27 August	74.5 - 76.0	75.6	7/7 (100)
11	Ministry of Science, Rama VI, Phaya Thai Dstrict	2 - 8 February	74.7 - 76.1	75.4	7/7 (100)
12	Khlong Toei Intersection Police Booth, At Narong Rd.	25 - 31 August	71.5 - 74.6	73.8	7/7 (100)
13	Sathupradit Intersection Police Booth, Rama III Rd.	3 - 9 August	68.9 - 73.4	72.1	7/7 (100)
14	Kiak Kai Intersection Police Booth, Sam Sen Rd.	24 - 30 April	70.4 - 71.1	70.7	7/7 (100)
15	Department of Land Transport, Phahonyothin Rd. Phaya Thai District	4 - 10 April	69.9 - 70.7	70.3	7/7 (100)
16	Lam Salee Intersection Police Booth, Ramkhamhaeng Rd.	16 - 22 July	68.6 - 71.1	70.1	7/7 (100)
17	Rama IX Intersection Police Booth, Rama IX Rd.	26 June - 2 July	67.6 - 74.9	69.3	6/7 (86)
Standand		70			

Remark : * refers to average values of 24-hour average noise levels (L_{eq}) during the monitoring day.

Operated by : Pollution Control Department

Table 6 : 24- hour average noise levels (L_{eq}) measured at temporary monitoring stations in general areas of Bangkok in 2013

No.	Monitoring station	Date	Noise Level (dBA)	Number of days Noise exceeding standard/Number of monitoring days (Percentage)
1	Lad Phrao District Office, Nak Niwat Road	27 - 31 May	71.4 - 75.8	73/73 (100)
2	Taling Chan District Office, Chak Phra Road	4 - 8 February, 14 - 17 May	62.5 - 75.0	47/124 (38)
3	Yannawa District Office, Narathiwat-Ratchanakarin Road	22 - 26 April	59.7 - 60.7	0/73 (0)
4	Lak Si District Office, Chaengwattana Road	29 April - 3 May	58.9 - 60.1	0/73 (0)
5	Saphan Sung District Office, Ramkhamhaeng 118 Road	27 - 31 May	58.7 - 63.1	0/76 (0)
6	Prawech District Office, Chalermprakiat Rama 9 Road, Soi 81	14 - 8 January, 3 - 7 June	56.3 - 59.9	0/146 (0)
7	Phaya Thai District Office, Phaholyothin Road, Soi Aree 2	29 April - 3 May	55.8 - 58.4	0/74 (0)
8	Taweewattana District Office, Utthayan Road, Soi 5	4 - 8 February, 14 - 17 July	51.0 - 60.3	0/125 (0)
Standard		70		

Remark : * moving Leq

Operated by : Bangkok Metropolitan Administration

Table 7 : 4- hour average noise levels (L_{eq}) measured at roadside temporary monitoring stations in other provinces in 2013

Province	Monitoring stations	Date	Noise Level (dBA)	Average*
Chumphon	Chumphon Forest Cooperation Center, The 11th Royal Forest Department (Surat Thani) Poramin Makka Road, Muang Surat Thani District	27 - 28 February	63.5	-
Nakhon Si Thammarat	Prem Tinnasulanon Archive Rachadamnoen Road, Muang Nakhon Si Thammarat District	5 - 6 February	63.0	-
Surat Thani	The 14th Regional Environment Affairs Office (Surat Thani) Wat Pho Road, Muang Surat Thani District	20 - 21 February	60.7	-
Tak	City Hall, Muang District	3 - 5 March	68.9 - 69.7	69.2
	Shrine of King Naresuan Maharat, Mae Sot District	6 - 8 March	62.4 - 64.8	63.8
Kamphaeng Phet	Kampaeng Phet Traffic Operations Center (Bang Temple)	3 - 5 March	64.3 - 68.8	66.1
Nakhon Sawan	Chon Tawan Traffic Operations Center (Dechatiwong Bridge intersection), Muang District	18 - 20 March	69.7 - 70.0	69.9
Uthai Thani	Uthai Thani Natural Resources, and Environment Office, Muang District	18 - 20 March	53.8 - 55.3	54.6
Standard		70		

Remark : * refers to average values of 24-hour average noise levels (L_{eq}) during the monitoring day.

Operated by : Regional Environment Office 4 and Regional Environment Office 14

Appendix C

Result of Water Quality Analysis

Table 1 : The significant water quality index and the problem areas concerning water quality in the Northern Region

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Ping	3	4.0 - 8.1 6.4 100% (56/56)	0.2 - 8.5 1.7 64% (36/56)	500 - ≥160,000 5,000 89% (50/56)	80 - 50,000 1,300 80% (45/56)	ND - 0.69 0.14 98% (54/55)	BOD Banphot Phisai District, Nakhon Sawan (Jun[2]) Pa Tan Sub-district, Muang Chiang Mai District (May), Mae Taeng District (May), Chiang Mai TCB Khanu Woralaksaburi District, Kamphaeng Phet (Aug) Chom Thong District (Nov), Pa Tan Sub-district, Muang Chiang Mai District (May[3] Aug) Mae Taeng District (May[3] Aug), Chiang Mai FCB Muang Nakhon Sawan District, Nakhon Sawan (Aug) Khanu Woralaksaburi District, Kamphaeng Phet (May Aug) Nong Bua Tai Sub-district, Muang Tak District, Tak (Aug, Nov) Chom Thong District (Nov) Pa Tan Sub-district, Muang Chiang Mai District (May Aug Nov) Mae Taeng District (May[4] Aug), Chiang Mai NH_3-N Mae Taeng District, Chiang Mai (May[5])
Wang	3	4.4 - 9.2 6.4 100% (24/24)	0.5 - 2.4 1.4 92% (22/24)	110 - 90,000 2,700 92% (22/24)	<20 - 8,000 750 83% (20/24)	ND - 0.34 0.01 100% (24/24)	TCB Rubber dam at Lampang City Municipality (Feb Sep[3]) FCB Rubber dam at Lampang City Municipality (Feb Sep[4] Dec) Chae Hom District, Lampang (Sep)
Yom	3	2.4 - 9.5 6.1 92% (48/52)	0.5 - 6.3 1.5 75% (39/52)	40 - 90,000 2,400 92% (48/52)	<20 - 24,000 500 84% (43/51)	ND - 0.40 0.04 100% (52/52)	BOD Pho Thale District (May) Pho Prathap Chang District (May[2]) Sam Ngam District (Feb Aug), Phichit, Bang Rakam District, Phitsanulok (Feb) Chiang Muan District, Phayao (May) TCB Thani Sub-district, Muang Sukhothai District, Sukhothai (Feb May[3] Dec[3]) Bannamkhong, Muang Phrae District, Phrae (Feb) FCB Thani Sub-district, Muang Sukhothai District (May[4] Dec) Sawankhalok District (May Dec) Si Satchanalai District (Feb), Sukhothai, Bannamkhong, Muang Phrae District, Phrae (Feb May Sep)
Nan	3	3.6 - 9.8 5.8 98% (55/56)	0.8 - 3.8 1.8 61% (34/56)	400 - ≥16,000 3,000 100% (56/56)	14 - ≥16,000 900 86% (48/56)	ND - 0.69 0.14 98% (55/56)	FCB Tha Luang Sub-district (Feb[4] May) Nai Muang Sub-district (Feb) Muang Phichit District, Phichit, Tha Thong, Muang Phitsanulok District, Phitsanulok (May) Ngiwngam Sub-district Muang Uttaradit District, Uttaradit (Nov) Wiang Sa District (Feb[4] Aug[4]) Tha Wang Pha District (Aug), Nan NH_3-N Nai Muang Sub-district, Phichai District, Uttaradit (Aug[5])
Kok	2	5.1 - 7.8 6.8 81% (13/16)	0.5 - 1.7 1.2 75% (12/16)	2,200 - 16,000 5,000 69% (11/16)	270 - 16,000 1,300 31% (5/16)	ND - 0.29 0.15 100% (16/16)	FCB Mae Fa Luang Bridge, Muang Chiang Rai District, Chiang Rai (Feb[4] Aug)
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows: DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 1 : The significant water quality index and the problem areas concerning water quality in the Northern Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Kuang	3	1.2 - 8.2 5.3 79% (22/28)	0.5 - 4.3 1.7 71% (20/28)	1,100 - 90,000 13,500 86% (24/28)	110 - ≥16,000 1,700 75% (21/28)	ND - 1.12 0.11 79% (22/28)	DO San Sai District, Chiang Mai (May[1]) BOD In front of Wang Thong Dam at Muang Nga Sub-district, Muang Lamphun District, Lamphun (Feb[2]) TCB Sop Tha Dam at Pa Sang Bridge (Aug) Ban Yu Dam (Feb[3] Aug) In front of Wang Thong Dam, Muang Nga Sub-district (Feb) Muang Lamphun District, Lamphun FCB Sop Tha Dam at Pa Sang Bridge (May[4] Aug) Ban Yu Dam (Aug) Tha Nang Bridge, the North of Lamphun Town Municipality (Feb) In front of Wang Thong Dam, Muang Nga Sub-district (Feb Aug Nov[4]) Muang Lamphun District, Lamphun NH_3-N Sop Tha Dam at Pa Sang Bridge (Feb[5] Aug) Ban Yu Dam (Aug) Tha Nang Bridge, the North of Lamphun Town Municipality (Aug) The sewerage of the industrial estate (Aug) In front of Wang Thong Dam, Muang Nga Sub-district (Feb) Muang Lamphun District, Lamphun
Li	2	5.1 - 7.7 6.9 75% (12/16)	0.9 - 1.9 1.2 69% (11/16)	300 - 50,000 2,650 63% (10/16)	80 - 14,000 400 56% (9/16)	ND - 0.42 0.09 100% (16/16)	TCB Ban Mai Siwilai, Li District, Lamphun (May, Aug[3]) FCB Wiang Nong Long District, Lamphun (Aug) Ban Mai Siwilai, Li District, Lamphun (May[4])
Oing	2	1.4 - 7.8 6.2 56% (9/16)	0.4 - 4.4 1.3 56% (9/16)	40 - ≥16,000 1,100 81% (13/16)	<2 - 1,700 95 88% (14/16)	ND - 0.50 0.07 100% (16/16)	DO Ban Rong Ha, Muang Phayao District, Phayao (Dec[1]) BOD Ban Rong Ha, Muang Phayao District, Phayao (May[2])
Mae Chang	2	2.3 - 9.7 6.7 56% (9/16)	0.8 - 4.8 1.6 44% (7/16)	20 - >16,000 600 94% (15/16)	<20 - 800 60 100% (16/16)	ND - 0.45 0.01 100% (16/16)	BOD Sop Pa Sub-district, Mae Mo District, Lampang (Sep[2])
Kwan Phayao	-	0.5 - 9.2 4.9 61% (11/18)	1.4 - 4.2 2.4 39% (7/18)	<20 - >16,000 220 100% (18/18)	<20 - 9,000 20 94% (17/18)	ND - 0.84 0.01 94% (17/18)	DO Mae Sai canal estuary (Feb[1]) BOD In the middle of Kwan Phayao (May[2]) FCB In front of King Ngam Muang Monument (Dec[4]) NH_3-N In front of Phayao Provincial Waterworks Authority (May[5])
Bueng Boraphet	-	1.4 - 7.8 5.4 58% (7/12)	1.5 - 9.4 3.5 8% (1/12)	23 - 30,000 140 92% (11/12)	4 - 13,000 40 92% (11/12)	ND - 0.34 0.11 100% (12/12)	DO Ban Puak Sung (Nov[1]) Ban Noen Rakang (Nov) BOD Ban Noen Rakang (Feb) Ban Tha Dindaeng (Feb) Ban Nong Duk (Feb, Aug[2]) TCB Ban Nong Duk (Aug[3]) FCB Ban Nong Duk (Aug[4])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows: DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 2 : Heavy metal monitoring results and problem areas in the Northern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	The Over-Standard / Problem Areas
Cd 7.3% (12/165)*	ND - 0.026	≤ 0.005 , ≤ 0.05	Yom River Pho Thale District, Phichit (Nov_0.014) Nan River Bang Mun Nak District (Feb_0.021 Aug_0.0079), Taphan Hin District (Feb_0.0099 May_0.008 Aug_0,0068), Tha Luang Sub-district, Muang Phichit District (Feb_0.026**), Phichit, Tha Thong Sub-district, Muang Phitsanulok District, Phitsanulok (Feb_0.0138) Phatthana Phak Nuea 13 Bridge, Muang Uttaradit District, Uttaradit (May_0.0051) Nai Wiang Sub-district, Muang Nan District (Feb_0.0117 Nov_0.006), Wiang Sa District (Aug_0.0107) Nan
Total Cr	ND - 0.0418	≤ 0.05***	Not found
Mn 0.6% (1/166)*	ND - 1.420	≤ 1.0	Ping River Mae Tang District, Chiang Mai (May_1.42**)
Ni	ND - 0.035	≤ 0.1	Not found
Pb 4.8% (8/166)*	ND - 0.400	≤ 0.05	Nan River Bang Mun Nak District (Feb_0.115), Taphan Hin District (Feb_0.074), Tha Luang Sub-district, Muang Phichit District (Feb_0.194) Phichit, Tha Thong Sub-district, Muang Phitsanulok District, Phitsanulok (Feb_0.057), Nai Wiang Sub-district, Muang Nan District (Feb_0.131 Nov_0.058), Wiang Sa District (Aug_0.084), Tha Wang Pha District (May_0.400**) Nan
Zn 1.2% (2/166)*	ND - 4.00	≤ 1.0	Kok River Chiang Saen District, Chiang Rai (Aug_1.60) Mae Chang River Hua Suea Sub-district, Mae Tha District, Lampang (Feb_4.00)
Cu	ND - <0.08	≤ 0.1	Not Found
Hg 5.3% (8/150)*	ND - 0.006	≤ 0.002	Yom River Bang Rakam District, Phitsanulok (May_0.0046) Ping River Banphot Phisai District, Nakhon Sawan (Jun_0.006**) Pradang Sub-district, Muang Tak District, Tak (May_0.0021) Nan River Bang Mun Nak District (May_0.0032), Taphan Hin District (May_0.0029), Nai Muang Sub-district, Muang Phichit (May_0.0021), Phichit, Nai Wiang Sub-district, Muang Nan District (May_0.0034) Tawangpa District (May_0.0043) Nan
As 1.3% (2/155)*	ND - 0.013	≤ 0.01	Ping River Khanu Woralaksaburi District (Aug_0.011) Nakhon Chum Sub-district, Muang Kamphaeng Phet District (Aug_0.013**) Kamphaeng Phet

Remarks :

- The standard value of Cd below 0.005 mg/l where water hardness does not exceed 100 mg/l
- The standard value of Cd below 0.05 mg/l where water hardness exceeds 100 mg/l
- * Percentage of monitoring sessions that exceed standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)
- ** Maximum value
- *** Is the standard value of hexavalent Cr, but the analysis result was Total Cr
- ND = non-detected

Cd	=	0.00006	mg/l	Zn	=	0.004	mg/l
Total Cr	=	0.00013	mg/l	Cu	=	0.002	mg/l
Mn	=	0.1	mg/l	Hg	=	0.0005	mg/l
Ni	=	0.004	mg/l	As	=	0.0003	mg/l
Pb	=	0.00013	mg/l				

Table 3 : The significant water quality index and the problem areas concerning water quality in the Central Region

Water Resource	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Upper Chao Praya	2	3.2 - 8.2 5.4 18% (5/28)	0.7 - 2.8 1.4 57% (16/28)	450 - >160,000 6,000 50% (14/28)	<180 - 54,000 1,350 43% (12/28)	ND - 0.45 0.12 100% (28/28)	TCB Muang Ang Thong District, Ang Thong (May) Muang Sing Buri District, Sing Buri (Feb) Muang Chai Nat District, Chai Nat (Feb[3]) Phayuha Khiri District, Nakhon Sawan (Nov) Muang Nakhon Sawan District, Nakhon Sawan (Aug[3]) FCB Muang Chai Nat District, Chai Nat (Feb[4] Aug) Phayuha Khiri District, Nakhon Sawan (Feb Aug Nov) Muang Nakhon Sawan District, Nakhon Sawan (Aug Nov)
Central Chao Praya	3	1.1 - 7.6 3.1 20% (4/20)	0.9 - 4.4 2.0 55% (11/20)	3,300 - 35,000 7,900 85% (17/20)	200 - 17,000 1,300 90% (18/20)	<0.02 - 0.51 0.19 95% (19/20)	DO Muang Nonthaburi District, Nonthaburi (Dec[1]) Muang Pathum Thani District, Pathum Thani (Dec) Sam Khok District, Pathum Thani (May Dec) BOD Bang Pa-in District, Phra Nakhon Si Ayutthaya (May[2]) TCB Pathum Thani District, Pathum Thani (Feb) Sam Khok District, Pathum Thani (Aug) Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya (Feb[3]) FCB Muang Nonthaburi District, Nonthaburi (Aug) Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya (Feb[4]) NH_3-N Muang Nonthaburi District, Nonthaburi (Feb[5])
Lower Chao Praya	4	0.1 - 5.5 1.2 38% (9/24)	1.8 - 7.7 4.1 50% (12/24)	1,100 - >160,000 24,000 46% (11/24)	400 - >160,000 7,900 29% (7/24)	0.20 - 2.30 0.85 29% (7/24)	DO Muang Samut Prakan District, Samut Prakan (May Aug) Phra Pradaeng District, Samut Prakan (Jun Aug Dec) Klong Toei District, Bangkok (Jun Aug Dec[1]) Krung Thep Bridge, Bangkok (Feb Dec) Phra Phuttha Yodfa Bridge, Bangkok (Feb Dec) Bang Kruai District, Nonthaburi (Feb Jun Dec) BOD Phra Pradaeng District (Feb Jun Aug Dec) Klong Toei District (Feb[2] Jun Dec) Krung Thep Bridge (Feb Jun) Phra Phuttha Yodfa Bridge (Jun) Bang Kruai District (Jun[2] Dec) TCB Muang Samut Prakan District, Samut Prakan (May Aug) Phra Pradaeng District (Jun[3] Aug) Klong Toei District (Feb Jun Dec[3]) Krung Thep Bridge (Jun Aug) Phra Phuttha Yodfa Bridge (Aug) Bang Kruai District (Feb Jun Aug) FCB Muang Samut Prakan District, Samut Prakan (May Aug) Phra Pradaeng District (Jun Aug) Klong Toei District (Feb Jun Dec[4]) Krung Thep Bridge (Jun Aug) Phra Phuttha Yodfa Bridge (Feb Jun Aug Dec) Bang Kruai District (Feb Jun Aug Dec) NH_3-N Muang Samut Prakan District, Samut Prakan (Feb May Aug Dec) Phra Pradaeng District (Feb Jun Aug) Klong Toei District (Feb[5] Jun Dec) Krung Thep Bridge (Feb Jun Dec) Phra Phuttha Yodfa Bridge (Feb Jun Dec) Bang Kruai District (Feb)
Upper Tha Chin	2	1.8 - 7.5 3.1 19% (3/16)	1.1 - 8.2 3.8 6% (1/16)	200 - 54,000 4,900 63% (10/16)	120 - 4,900 780 53% (8/15)	<0.10 - 0.18 0.10 100% (16/16)	DO Sam Chuk District, Suphan Buri (May Aug[1]) BOD Pho Phraya Watergate, Muang Suphan Buri District, Suphan Buri (May Aug) Sam Chuk District (May Aug) Hankha District, Chai Nat (Feb May[2]) Wat Sing District, Chai Nat (May) TCB Pho Phraya Watergate (May[3]) Sam Chuk (Nov) FCB Sam Chuk (Nov[4])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	The criteria of the water quality that are considered as problems are as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 3 : The significant water quality index and the problem areas concerning water quality in the Central Region (Continued)

Water Resource	Type of Water Resource	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Central Tha Chin	3	1.0 - 7.0 2.4 25% (3/12)	1.2 - 8.2 4.2 17% (2/12)	2,700 - 160,000 11,000 67% (8/12)	450 - 92,000 1,200 75% (9/12)	<0.10 - 0.49 0.10 100% (12/12)	DO Bang Len District, Nakhon Pathom (May[1] Aug) Song Phi Nong District, Suphan Buri (May Aug) At the end of Suphan Buri, Suphan Buri (May Aug) BOD Bang Len District (Feb) Song Phi Nong District (Feb Aug) At the end of Suphan Buri (Feb May[2] Aug Nov) TCB Bang Len District (Aug) At the end of Suphan Buri (Feb May[3] Aug) FCB At the end of Suphan Buri (Feb May[4] Aug)
Lower Tha Chin	4	0.7 - 5.6 2.2 50% (14/28)	1.4 - 9.6 4.5 43% (12/28)	3,300 - 540,000 28,500 39% (11/28)	200 - 240,000 4,900 32% (9/28)	<0.10 - 2.09 0.61 39% (11/28)	DO Tha Chin Estuary, Muang Samut Sakhon District, Samut Sakhon (May Aug) Wat Siri Mongkhon, Muang Samut Sakhon District, Samut Sakhon (May[1] Aug) Krathum Baen District, Samut Sakhon (May Aug) In front of Wat Thian Dat, Sam Phran District, Nakhon Pathom (May Aug) Wat Bang Chang Nuea, Sam Phran District, Nakhon Pathom (May Aug) Ban Tha Kham, Sam Phran District, Nakhon Pathom (May Aug) Nakhon Chai Si District, Nakhon Pathom (May Aug) BOD Tha Chin Estuary (Feb[2] May) Wat Siri Mongkhon (Feb May Aug) Krathum Baen (Feb May Aug) In front of Wat Thian Dat (Feb May Aug) Wat Bang Chang Nuea (Feb Aug) Ban Tha Kham (Feb Aug) Nakhon Chai Si (Feb) TCB Tha Chin Estuary (Feb May Aug Nov) Wat Siri Mongkhon (May Aug Nov) Krathum Baen (Feb May Aug Nov) In front of Wat Thian Dat (Feb May Aug[3] Nov) Wat Bang Chang Nuea (Feb May) FCB Tha Chin Estuary (Feb May Aug Nov) Wat Siri Mongkhon (May Aug Nov) Krathum Baen (Feb May Aug Nov) In front of Wat Thian Dat (Feb May[4] Aug Nov) Wat Bang Chang Nuea (Feb May Aug) Nakhon Chai Si (Feb) NH_3-N Tha Chin Estuary (Feb May[5] Aug Nov) Wat Siri Mongkhon (May Aug Nov) Krathum Baen (May Aug Nov) In front of Wat Thian Dat (May Aug Nov) Wat Bang Chang Nuea (May Aug) Ban Tha Kham (May Aug)
Mae Klong	3	3.2 - 7.3 4.6 70% (28/40)	0.6 - 2.7 1.4 85% (34/40)	330 - 330,000 7,900 73% (29/40)	130 - 49,000 1,020 83% (33/40)	ND - 0.28 0.07 100% (40/40)	TCB Mae Klong Estuary, Muang Samut Songkhram District, Samut Songkhram (Aug) Muang Ratchaburi District, Ratchaburi (Nov[3]) Photharam District, Ratchaburi (Aug) Ban Pong District, Ratchaburi (Feb May Nov) Tha Maka District, Kanchanaburi (Feb May Aug Nov) Muang Kanchanaburi District, Kanchanaburi (Nov) FCB Mae Klong Estuary (Feb) Muang Ratchaburi District, Ratchaburi (Nov) Photharam District, Ratchaburi (Aug) Ban Pong District (May Nov) Tha Maka District (Feb May[4])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 3 : The significant water quality index and the problem areas concerning water quality in the Central Region (Continued)

Water Resources	Type of Water Resource	Min - Max, Median, and Percentage*					Aeas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Upper Phetchaburi	2	1.3 - 8.9 4.6 38% (3/8)	0.6 - 1.8 1.0 88% (7/8)	140 - 13,000 1,250 88% (7/8)	20 - 1,300 130 88% (7/8)	ND - 0.13 0.06 100% (8/8)	DO Kaeng Krachan District, Phetchaburi (Sep[1] Dec)
Low Petchaburi	3	1.9 - 6.5 4.5 63% (10/16)	1.0 - 3.5 1.9 63% (10/16)	4,600 - 310,000 33,000 31% (5/16)	310 - 49,000 3,300 56% (9/16)	ND - 0.78 0.19 88% (14/16)	DO The bridge to Ban Laem District, Phetchaburi (Sep[1]) TCB Ban Laem Estuary, Ban Laem District, Phetchaburi (Mar Jun) The bridge to Ban Laem District, Phetchaburi (Jun Sep Dec) Khlong Krasae SubDistrict, Muang Phetchaburi District, Phetchaburi (Mar Jun Sep[3] Dec) Ton Muang Sub-District, Muang Phetchaburi District, Phetchaburi (Jun Sep) FCB Ban Laem Estuary (Mar Jun) The bridge to Ban Laem District, Phetchaburi (Sep Dec) Khlong Krasae Sub-District (Jun Sep[4]) Ton Muang Sub-District, Muang Phetchaburi District (Sep) NH_3-N Ban Laem Estuary, Ban Laem District (Mar Jun[5])
Kwae Yai	2	2.3 - 5.3 3.7 0% (0/20)	0.5 - 1.5 1.0 100% (20/20)	45 - 23,000 2,550 80% (16/20)	<18 - 2,300 86 95% (19/20)	ND - 0.35 0.10 100% (20/20)	TCB Ban Nuea sub-District, Muang Kanchanaburi District, Kanchanaburi (Feb[3] Nov[3])
Kwae Noi	2	2.2 - 6.9 5.0 15% (3/20)	0.3 - 1.8 0.9 90% (18/20)	170 - 13,000 2,300 80% (16/20)	<18 - 3,300 445 75% (15/20)	ND - 0.40 0.03 100% (20/20)	Not found
Pasak	3	2.0 - 8.0 5.4 82% (36/44)	1.0 - 6.2 2.6 23% (10/44)	130 - >160,000 5,400 82% (36/44)	45 - 92,000 1,700 77% (34/44)	0.06 - 1.00 0.19 95% (42/44)	BOD Tha Ruea District, Phra Nakhon Si Ayutthaya (May) Muang Saraburi District, Saraburi (May Aug) Chai Badan District, Lop Buri (May Dec) Wichian Buri District, Phetchabun (May Dec) Muang Phetchabun District, Phetchabun (May) Lom Sak District, Phetchabun (Mar[2]) TCB Nakhon Luang District, Phra Nakhon Si Ayutthaya (Feb Aug) Tha Ruea District (Feb[3] May) Kaeng Khoi District, Saraburi (Aug[3]) Phatthana Nikhom District, Lop Buri (Aug) Wichian Buri District, Phetchabun (May) Lom Sak District, Phetchabun (Aug) FCB Nakhon Luang District (Aug) Tha Ruea District (Feb Dec) Muang Saraburi District, Saraburi (Aug) Kaeng Khoi District (Aug[4]) Phatthana Nikhom District (Aug) Chai Badan District (May) Lom Sak District (Mar Aug) NH_3-N Nakhon Luang District (Feb) Tha Ruea District (May[5])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 3 : The significant water quality index and the problem areas concerning water quality in the Central Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Aeas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Lop Buri	3	1.5 - 7.5 3.8 45% (9/20)	1.3 - 6.5 2.8 35% (7/20)	1,300 - 54,000 7,450 90% (18/20)	200 - 7,900 1,700 90% (18/20)	<0.02 - 0.65 0.19 85% (17/20)	DO Muang Sing Buri District, Sing Buri (Aug[1]) BOD Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya (Feb May) Muang Lop Buri District, Lop Buri (Mar[2] May)* TCB Tha Wung District, Lop Buri (May[3]) Muang Sing Buri District, Sing Buri (May) FCB Ban Phraek District, Phra Nakhon Si Ayutthaya (Aug[4]) Muang Sing Buri District, Sing Buri (May) NH_3-N Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya (Feb[5]) Ban Phraek District, Phra Nakhon Si Ayutthaya (Feb) Muang Sing Buri District, Sing Buri (Feb[5])
Noi	3	1.9 - 6.9 3.7 45% (9/20)	0.4 - 3.5 1.2 80% (16/20)	400 - >160,000 4,750 80% (16/20)	<180 - 35,000 850 85% (17/20)	<0.02 - 0.87 0.17 90% (18/20)	DO Bang Sai District, Phra Nakhon Si Ayutthaya (Dec[1]) TCB Phak Hai District, Phra Nakhon Si Ayutthaya (May) Pho Thong District, Ang Thong (Aug[3] Dec) Bang Rachan District, Sing Buri (May[3]) FCB Pho Thong District, Ang Thong (Aug[4] Dec[4]) Bang Rachan District, Sing Buri (May) NH_3-N Bang Sai District, Phra Nakhon Si Ayutthaya (May[5]) Phak Hai District, Phra Nakhon Si Ayutthaya (Feb)
Sakaekrang	3	2.2 - 7.2 4.7 67% (8/12)	2.0 - 4.3 2.8 8% (1/12)	170 - 13,000 1,450 100% (12/12)	130 - 7,000 400 92% (11/12)	0.08 - 0.56 0.21 92% (11/12)	BOD Ban E-toeng School, Muang Uthai Thani District, Uthai Thani (Aug[2]) FCB The Bridge at the end of the city, Muang Uthai Thani District, Uthai Thani (Mar[4]) NH_3-N Manorom District, Chai Nat (Jun[5])
Pranburi	2	0.7 - 6.9 4.7 20% (4/20)	0.7 - 4.1 1.4 55% (11/20)	230 - 79,000 4,900 60% (12/20)	20 - 4,900 700 70% (14/20)	ND - 0.65 0.11 95% (19/20)	DO Waterworks at Khao Noi Sub-district, Pran Buri District, Prachuap Khiri Khan (Mar[1] Jun Sep) BOD Wang Phong Sub-District, Pran Buri District, Prachuap Khiri Khan (Dec[2]) TCB Waterworks at Khao Noi Sub-district (Jun[3] Sep) Ban Plai Nam, Khao Noi Sub-District, Pran Buri District, Prachuap Khiri Khan (Sep) FCB Waterworks at Khao Noi Sub-District (Jun[4]) NH_3-N Ban Pak Nam Pran Estuary, Pak Nam Pran Sub-district, Pran Buri District, Prachuap Khiri Khan (Jun[5])
Kui Buri	3	3.5 - 6.7 4.9 88% (7/8)	0.9 - 4.0 1.5 75% (6/8)	330 - 13,000 2,300 100% (8/8)	45 – 490 220 100% (8/8)	ND - 0.38 0.16 100% (8/8)	Not found
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 4 : Heavy Metal Monitoring Results and Problem Areas in the Central Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	The Over-Standard / Problem Areas
Cd	ND - 0.0045	≤ 0.005 , ≤ 0.05	Not found
Total Cr 0.5% (1/199)*	ND - 0.0850	≤ 0.05***	Pa Sak River Muang Phetchabun District, Phetchabun (Aug_0.085)**
Mn 2% (4/199)*	ND - 3.450	≤ 1.0	Kui Buri River Muang Prachuap Khiri Khan District, Prachuap Khiri Khan (Jun_3.45)** Phetchaburi River Estuary Ban Laem District, Phetchaburi (Mar_1.79 Jun_1.04) Pa Sak River Muang Phetchabun District, Phetchabun (Mar_1.08)
Ni	ND - 0.057	≤ 0.1	Not found
Pb	ND - 0.032	≤ 0.05	Not found
Zn	ND - 0.507	≤ 1.0	Not found
Cu	ND - 0.016	≤ 0.1	Not found
Hg 1.5% (3/196)*	< 0.0005 - 0.003	≤ 0.002	Chao Praya River Krung Thep Bridge, Bangkok (Jun_0.003)** Kui Buri River Muang Prachuap Khiri Khan District, Prachuap Khiri Khan (Mar_0.0022) Pran Buri River Estuary Pran Buri District, Prachuap Khiri Khan (Mar_0.002)
As 7.3% (14/192)*	< 0.0003 - 0.021	≤ 0.01	Chao Praya River Muang Samut Prakan District, Samut Prakan (Dec_0.012) Muang Ang Thong District, Ang Thong (Aug_0.012) Muang Sing Buri District, Sing Buri (Aug_0.018) Phayuha Khiri District, Nakhon Sawan (Aug_0.021)** Mae Klong River Muang Ratchaburi District, Ratchaburi (Feb_0.012) Pran Buri River Pak Nam Pran Sub-district, Prachuap Khiri Khan (Sep_0.013) Pa Sak River Muang Saraburi District, Saraburi (Aug_0.017) Tha Chin River Estuary Muang Samut Sakhon District, Samut Sakhon (Feb_0.011 Aug_0.012) Wat Siri Mongkhon, Muang Samut Sakhon District, Samut Sakhon (Aug_0.014) In front of Wat Thian Dat, Sam Phran District, Nakhon Pathom (Aug_0.014) Nakhon Chai Si District, Nakhon Pathom (Aug_0.013) At the end of Suphan Buri (Aug 0.016) Wat Sing District, Chai Nat (Aug_0.013)

Remarks :

- The standard value of Cd below 0.005 mg/l where water hardness does not exceed 100 mg/l
- The standard value of Cd below 0.05 mg/l where water hardness exceeds 100 mg/l
- * Percentage of monitoring sessions that exceed standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)
- ** Maximum value
- *** Is the standard value of hexavalent Cr, but the analysis result was Total Cr
- ND = non - detected

Cd	=	0.00006	mg/l	Zn	=	0.004	mg/l
Total Cr	=	0.00013	mg/l	Cu	=	0.002	mg/l
Mn	=	0.1	mg/l	Hg	=	0.0005	mg/l
Ni	=	0.004	mg/l	As	=	0.0003	mg/l
Pb	=	0.00013	mg/l				

Table 5 : The significant water quality index and the problem areas concerning water quality in the Northeastern Region

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Phong	3	0.5 - 7.9 4.5 60% (31/52)	0.4 - 3.0 1. 96% (50/52)	80 - ≥ 24,000 490 98% (51/52)	< 20 - ≥ 24,000 170 96% (50/52)	0.03 - 1.52 0.41 65% (34/52)	DO Nong Wai Dam, Nam Phong District, Khon Kaen (Aug) Nam Phong Pump, Nam Phong District, Khon Kaen (May) 100-metre Southward Huai Chod Lake estuary, Nam Phong District, Khon Kaen (May[1]) TCB Khok Si Sub-district, Muang Khon Kaen District (May[3]) FCB Khok Si Sub-district, Muang Khon Kaen District (May[4]) Ban Nong Hin Pump, Muang Khon Kaen District, Khon Kaen (May) NH_0-N Phra Lap Sub-district, Muang Khon Kaen District, Khon Kaen (Feb Nov) Khok Si Sub-district, Muang Khon Kaen District (Feb May Jul) Ban Nong Hin Pump (Jul) Ban Tha Maduea, Nam Phong District (May) Tha Mao – Wang Chai Bridge, Nam Phong District (Jul) Ban Kut Nam Sai Noi, Nam Phong District (Feb Jul) Chao Pu Thung Thiaw Shrine, Nam Phong District (Jul) Nam Phong Pump, Nam Phong District (Mar) 100-metre Southward Huai Chod Lake estuary (Nov) 100-metre Northward Huai Chod Lake estuary (Aug Nov[2]) Khok Sung Sub-district, Ubolratana District, Khon Kaen (Nov) Ban Bo Nokkhao, Ubolratana District (May Nov)
Chi	3	1.9 - 14.1 5.5 90% (43/48)	0.5 - 4.8 1.3 71% (34/48)	130 - ≥ 24,000 490 98% (47/48)	<2 - 16,000 75 96% (46/48)	0.10 - 1.90 0.53 48% (23/48)	DO Ban Tha Tum Sub-district, Muang Maha Sarakham District, Maha Sarakham (Feb[1]) BOD Muang Yasothon District, Yasothon (May[2]) Selaphum District, Roi Et (May) Ban Kaeng Kham Bridge, which links Chaiyaphum with Nakhon Ratchasima (May[2]) TCB Ban Din Dam, Muang Maha Sarakham District, Maha Sarakham (May[3]) FCB Kosum Phisai District, Maha Sarakham (May[4]) Ban Khwao District, Chaiyaphum (May[4]) NH_3-N Warin Chamrap District, Ubon Ratchathani (May Nov) Khueang Nai District, Ubon Ratchathani (Feb May Nov) Maha Chana Chai District, Yasothon (May[5] Aug Nov) Muang Yasothon District, Yasothon (Feb May Nov) Selaphum District (Feb May Nov) Ban Tha Tum Sub-district (Aug Nov) Ban Din Dam (Nov) Kosum Phisai District (May Nov) Muang Khon Kaen District, Khon Kaen (Jun Nov) Mancha Khiri District - Chonnabot District Cross Bridge Khon Kaen (Jun) Ban Kaeng Kham Bridge (May) Ban Non Noi, Ban Khwao District, Chaiyaphum (Feb May)
Mun	3	0.0 - 7.9 5.2 88% (63/72)	0.2 - 5.1 1.5 72% (52/72)	20 - 91,800 335 97% (70/72)	< 2 - 49,000 20 99% (70/71)	ND - 1.79 0.10 74% (53/72)	DO Tha Tum District, Surin (Feb[1]) Phimai District, Nakhon Ratchasima (Feb May) BOD Phimai District (May) Chok Chai District, Nakhon Ratchasima (Feb[2]) TCB Phibun Mangsahan District, Ubon Ratchathani (May[3]) Hat Wat Tai, Nai Muang Sub-district, Muang Ubon Ratchathani District, Ubon Ratchathani (May) FCB Phibun Mangsahan District (May[4]) NH_3-N Khong Chiam Sub-district, Khong Chiam District, Ubon Ratchathani (May Nov) Under Pak Mun Dam, Ban Hua Heo, Khong Chiam District (May Nov[5]) Over Pak Mun Dam, Ban Hua Heo (May Nov) Phibun Mangsahan District (May) Hat Wat Tai, Nai Muang Sub-district (Feb May Nov) Seri Prachathipatai Bridge, Nai Muang District (May Aug Nov) Hat Khu Duea, Muang Ubon Ratchathani District, Ubon Ratchathani (Feb May Nov) Warin Chamrap District, Ubon Ratchathani (May Nov) Chok Chai District, Nakhon Ratchasima (May)
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 5 : The significant water quality index and the problem areas concerning water quality in the Northeastern Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Songkhram	3	4.6 - 10.5 6.1 100% (20/20)	0.6 - 2.6 1.1 90% (18/20)	43 - 4,600 460 100% (20/20)	9 - 2,400 93 100% (20/20)	ND - 0.96 0.01 80% (16/20)	NH_3-N Tha Uthen District, Nakhon Phanom (Nov) Akat Amnuai District, Sakon Nakhon (Nov[5]) Seka District, Bueng Kan (Nov) So Phisai District, Nong Khai (Nov)
Upper Lam Takhong	3	3.1 - 8.0 6.0 95% (19/20)	0.1 - 5.0 1.9 60% (12/20)	<20 - 30,000 2,700 90% (18/20)	<20 - 170 20 100% (20/20)	<0.10 - 1.46 0.10 85% (17/20)	BOD Nong Sarai Sub-district, Pak Chong District, Nakhon Ratchasima (May[2]) TCB Army's Ordnance Department Bridge, Pak Chong District, Nakhon Ratchasima (Nov[3]) Nong Sarai Sub-district (Nov) NH_3-N Army's Ordnance Department Bridge (May[5]) Nong Sarai Sub-district (May) Khanong Pra Sub-district, Pak Chong District (May)
Lower Lam Takhong	4	0.0 - 5.1 3.1 63% (5/8)	2.3 - 7.6 6.3 13% (1/8)	170 - 160,000 9,400 75% (6/8)	<20 - 4,000 20 100% (8/8)	<0.10 - 0.36 0.10 100% (8/8)	DO Pa Nao Sub-district, Muang Nakhon Ratchasima District, Nakhon Ratchasima (Feb[1]) Nai Muang Sub-district, Muang Nakhon Ratchasima District, Nakhon Ratchasima (Feb[1] Aug) BOD Pa Nao Sub-district, Muang Nakhon Ratchasima District (Feb May Aug Nov) Nai Muang Sub-district, Muang Nakhon Ratchasima District (Feb[2] May Nov) TCB Pa Nao Sub-district, Muang Nakhon Ratchasima District (Nov[3]) Nai Muang Sub-district, Muang Nakhon Ratchasima District (Nov[3])
Lam Paw	2	2.2 - 8.2 5.4 35% (7/20)	0.7 - 3.8 1.8 40% (8/20)	140 - >24,000 490 85% (17/20)	20 - 460 140 100% (20/20)	0.05 - 1.27 0.33 80% (16/20)	TCB Ban Don Sanuan Bridge, Muang Kalasin District, Kalasin (Nov[3]) NH_3-N Rong Kham District, Kalasin (Nov) Kamalasai District, Kalasin (Jun) Ban Don Sanuan Bridge, Muang Kalasin District (Aug Nov[5])
Siao	3	2.9 - 9.5 5.2 90% (18/20)	0.5 - 3.8 1.3 70% (14/20)	<2 - >24,000 405 90% (18/20)	<2 - 4,900 50 95% (19/20)	<0.10 - 1.19 0.52 45% (9/20)	TCB Suwannaphum District, Roi Et (Sep[3]) Borabue District, Maha Sarakham (Aug[3]) FCB Suwannaphum District (Sep[4]) NH_3-N Suwannaphum District (Feb May Nov) Kaset Wisai District, Roi Et (Feb May Nov) Wapi Pathum District, Maha Sarakham (Feb May Nov[5]) Borabue District, Maha Sarakham (May Nov)
Loei	3	4.5 - 11.5 7.7 100% (20/20)	1.0 - 3.4 1.9 80% (16/20)	23 - >240,000 1,750 80% (16/20)	23 - >240,000 930 85% (17/20)	ND - 1.29 0.01 80% (16/20)	TCB Ban Mai Bridge, Muang Loei District, Loei (Mar[3] Jun) Wang Saphung Sub-district, Wang Saphung District, Loei (Jun Nov[3]) FCB Ban Mai Bridge (Mar[4] Jun) Wang Saphung Sub-district, Wang Saphung District (Jun) NH_3-N Ban Mai Bridge, Muang Loei District (Nov) Ban Na An, Muang Loei District, Loei (Nov) Wang Saphung Sub-district, Wang Saphung District (Nov)
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 5 : The significant water quality index and the problem areas concerning water quality in the Northeastern Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Un	3	4.5 - 9.2 6.7 100% (16/16)	1.2 - 3.9 1.8 75% (12/16)	93 - 4,600 460 100% (16/16)	<3 - 2,400 102 100% (16/16)	ND - 1.14 0.01 88% (14/16)	NH_3-N Si Songkhram District, Nakhon Phanom (Nov) Phang Khon District, Sakon Nakhon (Nov[5])
Lam Chi	3	3.9 - 7.9 5.7 90% (18/20)	0.2 - 7.5 1.2 85% (17/20)	<20 - 5,000 225 100% (20/20)	<20 - 20 20 100% (20/20)	ND - 0.10 0.10 100% (20/20)	BOD Nong Teng Sub-district, Krasang District, Buri Ram (May[2])
Nong Han	-	3.5 - 10.0 7.4 96% (27/28)	0.5 - 7.2 1.2 82% (23/28)	<3 - >240,000 43 93% (26/28)	<3 - 110,000 13 89% (25/28)	ND - 1.87 0.01 82% (23/28)	BOD In front of Khu Mak Suea Waste water Treatment System, Sakon Nakhon (Mar[2]) TCB In front of Khu Mak Suea Waste water Treatment System (May Jul[3]) FCB Water Supply Pumping Point, Sakon Nakhon (Jul) In front of Khu Mak Suea Waste water Treatment System (May Jul[4]) NH_3-N Lam Nam Kam Estuary, Sakon Nakhon (Nov) Don Plan, Sakon Nakhon (Nov[5]) Don Sawan Yai, Sakon Nakhon (Nov) In front of Khu Mak Suea Waste water Treatment System (Jul Nov)
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 6 : Heavy Metal Monitoring Results and Problem Areas in the Northeastern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	The Over-Standard / Problematic Areas
Cd	ND - 0.0003	≤ 0.005 , ≤ 0.05	Not found
Total Cr 0.6% (1/160)*	ND - 0.084	≤ 0.05***	Mun River Seri Prachathipatai Bridge, Nai Muang Sub-district, Muang Ubon Ratchathani (Nov_0.084)**
Mn 1.3% (2/160)*	ND - 1.610	≤ 1.0	Lam Paw River Ban Don Sanuan Bridge, Muang Kalasin District, Kalasin (Feb_1.610)** Siao River Suwannaphum District, Roi Et (Feb_1.200)
Ni	ND - 0.025	≤ 0.1	Not found
Pb 0.6% (1/160)*	ND - 0.140	≤ 0.05	Siao River Kaset Wisai District, Roi Et (Feb_0.140)**
Zn	ND - 0.369	≤ 1.0	Not found
Cu	ND - 0.021	≤ 0.1	Not found
Hg 2.0% (3/149)*	ND - 0.006	≤ 0.002	Loei River Ban Mai Bridge, Muang Loei District, Loei (Jun_0.0064)** Un River Na Wa District, Nakhon Phanom (Jun_0.0027) Songkhram Tha Uthen District, Nakhon Phanom (Jun_0.0023)
As 1.3% (2/158)*	ND - 0.016	≤ 0.01	Chi River Kosum Phisai District, Maha Sarakham (Feb_0.016)** Lam Takhlong River Water Supply Pumping Point, Sikhio District, Nakhon Ratchasima (Aug_0.012)

Remarks :

- The standard value of Cd below 0.005 mg/l where water hardness does not exceed 100 mg/l
- The standard value of Cd below 0.05 mg/l where water hardness exceeds 100 mg/l
- * Percentage of monitoring sessions that exceed standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)
- ** Maximum value
- *** Is the standard value of hexavalent Cr, but the analysis result was Total Cr
- ND = non - detected

Cd	=	0.00006 mg/l	Zn	=	0.004 mg/l
Total Cr	=	0.00013 mg/l	Cu	=	0.002 mg/l
Mn	=	0.1 mg/l	Hg	=	0.0005 mg/l
Ni	=	0.004 mg/l	As	=	0.0003 mg/l
Pb	=	0.00013 mg/l			

Table 7 : The significant water quality index and the problem areas concerning water quality in the Eastern Region

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Bang Prakong	3	1.5 - 10.9 4.9 67% (34/51)	1.0 - 3.8 1.8 62% (32/52)	45 - 54,000 1,700 96% (50/52)	40 - 54,000 595 90% (47/52)	0.03 - 0.50 0.25 100% (52/52)	DO Wat Sai Chon Na Rangsi, Muang Chachoengsao District, Chachoengsao (Nov) Bang Nam Priao District, Chachoengsao (Nov[1]) TCB Bang Pakong Bridge, Bang Pakong District, Chachoengsao (Feb) Bang Khla District's Port, Chachoengsao (May[3]) FCB Bang Pakong Bridge, Bang Pakong District (Feb May) Chachoengsao Bridge, Muang Chachoengsao District, Chachoengsao (Feb) Wat Sai Chon Na Rangsi (Feb) Bang Khla District's Port (May[4])
Prachin Buri	2	2.8 - 7.5 5.3 35% (7/20)	1.4 - 3.9 2.4 10% (2/20)	170 - 24,000 2,350 60% (12/20)	78 - 5,400 700 75% (15/20)	0.08 - 0.30 0.17 100% (20/20)	TCB Muang Prachin Buri District, Prachin Buri (May[3]) FCB Muang Prachin Buri District, Prachin Buri (May) Si Maha Phot District, Prachin Buri (Aug[4])
Nakhon Nayok	3	2.2 - 7.2 4.4 65% (13/20)	0.6 - 7.8 2.0 45% (9/20)	230 - 160,000 1,700 90% (18/20)	78 - 160,000 595 90% (18/20)	0.09 - 1.18 0.19 90% (18/20)	BOD Nakhon Nayok Bridge, Muang Nakhon Nayok District, Nakhon Nayok (May[2]) TCB Ban Na District, Nakhon Nayok (May) Nakhon Nayok Bridge, Muang Nakhon Nayok District (May[3]) FCB Ban Na District, Nakhon Nayok (May) Nakhon Nayok Bridge, Muang Nakhon Nayok District (May[4]) NH_3-N Ongkharak District, Nakhon Nayok (Dec) Ban Na District (Dec[5])
trat	3	4.9 - 7.9 6.5 100% (16/16)	0.5 - 6.1 1.2 94% (15/16)	68 - 16,000 2,400 100% (16/16)	20 - 5,400 945 88% (14/16)	0.03 - 0.36 0.25 100% (16/16)	BOD Ban Dan Kao Estuary, Muang Trat District, Trat (Feb[2]) FCB Ban Dan Kao Estuary (Aug[4]) Wat Tha Pradu, Khao Saming District, Trat (Aug[4])
Chanthaburi	3	5.5 - 9.1 7.0 100% (32/32)	0.3 - 5.6 1.3 88% (28/32)	< 18 - 160,000 12,600 63% (20/32)	< 18 - 160,000 1,700 59% (19/32)	0.03 - 0.73 0.14 97% (31/32)	BOD The bridge in front of Wat Ang Hin, Ko Khwang Sub-district, Muang Chanthaburi District, Chanthaburi (Feb) The bridge behind KP Grand Hotel, Muang Chanthaburi District, Chanthaburi (Feb[2]) TCB Ban Tha Chalap's Immigation Bureau, Muang Chanthaburi District, Chanthaburi (Jun Aug Nov[3]) The bridge in front of Wat Ang Hin (Jun Aug Nov) The bridge behind KP Grand Hotel (Feb[3] Jun Aug Nov) Tha Luang Bridge, Muang Chanthaburi District, Chanthaburi (Jun[3]) In front of Wat Tha Luang Lang, Makham District, Chanthaburi (Nov) FCB Immigation Bureau (Jun Aug Nov) The bridge in front of Wat Ang Hin (Feb Jun Nov) The bridge behind KP Grand Hotel (Feb[4] Jun Aug Nov) Tha Luang Bridge, Muang Chanthaburi District (Jun Nov) In front of Wat Tha Luang Lang (Aug) NH_3-N The bridge behind KP Grand Hotel (Feb[5])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

Table 7 : The significant water quality index and the problem areas concerning water quality in the Eastern Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Upper Rayong	3	4.1 - 6.0 5.2 100% (8/8)	1.6 - 3.9 2.0 63% (5/8)	2,800 - 54,000 15,600 50% (4/8)	1,100 - 54,000 8,200 38% (3/8)	0.28 - 0.92 0.52 50% (4/8)	TCB The bridge at Ban Khai District, Rayong (Feb Jun[3] Aug) Nong Lalok Sub-district, Ban Khai District, Rayong (Jun[3]) FCB The bridge at Ban Khai District, Rayong (Feb Jun[4] Aug Nov) Nong Lalok Sub-district, Ban Khai District (Jun[4]) NH_3-N The bridge at Ban Khai District, Rayong (Feb[5] Nov) Nong Lalok Sub-district, Ban Khai District (Jun Nov)
Lower Rayong	4	1.4 - 6.1 3.8 94% (15/16)	0.5 - 2.7 1.6 100% (16/16)	3,500 - >160,000 35,000 31% (5/16)	930 - >160,000 12,000 31% (5/16)	0.08 - 1.41 0.59 44% (7/16)	DO Piam Phong San Bridge, Muang Rayong District, Rayon (Feb[1]) TCB Municipality 8 Bridge, Ban Pak Khlong, Muang Rayong District, Rayong (Feb Jun[3] Aug) Chaloem Chai Bridge, Muang Rayong District, Rayong (Feb Jun[3] Aug) Piam Phong San Bridge (Feb Jun Aug Nov) Highway 3 Bridge, Muang Rayong District, Rayong (Jun[3]) FCB Municipality 8 Bridge, Ban Pak Khlong (Feb Jun Aug) Chaloem Chai Bridge (Jun[4] Aug) Piam Phong San Bridge (Feb Jun Aug Nov) Highway 3 Bridge (Jun[4] Aug) NH_3-N Municipality 8 Bridge, Ban Pak Khlong (Feb Jun Nov) Chaloem Chai Bridge (Feb Jun Aug[5]) Piam Phong San Bridge (Feb) Highway 3 Bridge (Aug Nov)
Pra Sae	3	5.2 - 7.4 6.3 100% (20/20)	0.6 - 2.6 1.4 90% (18/20)	450 - 7,000 2,400 100% (20/20)	45 - 5,400 490 95% (19/20)	0.03 - 0.31 0.20 100% (20/20)	FCB Ban Hua Khot Estuary, Pak Nam Prasae Municipal District, Klaeng District, Rayong (Aug[4])
Upper Phang Rat	3	5.8 - 10.8 7.5 100% (8/8)	1.9 - 5.6 3.2 13% (1/8)	410 - 160,000 5,700 63% (5/8)	220 - 160,000 1,950 63% (5/8)	0.03 - 1.12 0.31 63% (5/8)	BOD Ban Yan Sue, Na Yai Am Sub-district, Na Yai Am District, Chanthaburi (Feb[2]) Ban Na Yai Am Bridge Moo 1 Sukhumvit Rd. Na Yai Am Sub-district, Na Yai Am District, Chanthaburi (Feb[2] Jun) TCB Ban Na Yai Am Bridge Moo 1 Sukhumvit Rd. (Feb[3] Jun Nov[3]) FCB Ban Na Yai Am Bridge Moo 1 Sukhumvit Rd. (Feb Jun Nov[4]) NH_3-N Ban Yan Sue, Na Yai Am Municipal District (Jun) Ban Na Yai Am Bridge Moo 1 Sukhumvit Rd. (Jun[5] Aug)
Lower Phang Rat	2	5.1 - 8.9 6.9 63% (5/8)	0.8 - 3.3 1.5 38% (3/8)	<18 - 11,000 1,045 88% (7/8)	<18 - 11,000 640 63% (5/8)	0.06 - 0.50 0.25 100% (8/8)	FCB Sala Klang Ban Moo 1 Ban Tao Pun Chang Kham Sub-district, Na Yai Am District, Chanthaburi (Aug[4])
Welu	2	5.7 - 8.1 6.7 93% (26/28)	0.1 - 4.5 0.8 79% (22/28)	18 - 14,000 78 93% (26/28)	<18 - 5,400 43 89% (25/28)	0.03 - 0.70 0.27 82% (23/28)	BOD Bo Sub-district, Khlung District, Chanthaburi (Nov[2]) FCB Phanom Phrik Estuary, Saen Tung Sub-district, Khao Saming District, Trat (Aug[4]) NH_3-N Tha Som Sub-district Estuary, Khao Saming District, Trat (Nov) Bang Chan Sub-district, Khlung District, Chanthaburi (Nov[5]) Phanom Phrik Estuary, Saen Tung Sub-district (Nov) Bo Sub-district, Khlung District, Chanthaburi (Nov[5]) Wan Yaw Sub-district, Khlung District, Chanthaburi (Nov[5])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

Table 8 : Heavy Metal Monitoring Results and Problem Areas in the Eastern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	The Over-Standard / Problematic Areas
Cd	ND - 0.0014	≤ 0.005 , ≤ 0.05	Not found
Total Cr	< 0.0050 - 0.0148	≤ 0.05***	Not found
Mn 1.1(1/89)*	ND - 1.49	≤ 1.0	Rayong The bridge at Ban Khai District, Rayong (Nov 1.49**)
Ni	<0.004 - <0.012	≤ 0.1	Not found
Pb	ND - 0.01490	≤ 0.05	Not found
Zn	ND - 0.540	≤ 1.0	Not found
Cu	ND - <0.100	≤ 0.1	Not found
Hg 3.4(3/89)*	< 0.0005 - 0.01380	≤ 0.002	Nakhon Nayok Estuary at Ban Sang District, Prachin Buri (May 0.0138**) Phang Rat Ban Na Yai Am Bridge, Na Yai Am District, Chanthaburi (Jun 0.0049) Chanthaburi Tha Luang Bridge, Muang Chanthaburi District, Chanthaburi (Jun_56 0.0027)
As 1.2(1/86)*	< 0.0003 - 0.02	≤ 0.01	Bang Pakong Bang Pakong's river source, Ban Sang District, Prachin Buri (Aug_0.02**)

Remarks :

- The standard value of Cd below 0.005 mg/l where water hardness does not exceed 100 mg/l
- The standard value of Cd below 0.05 mg/l where water hardness exceeds 100 mg/l
- * Percentage of monitoring sessions that exceed standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)
- ** Maximum value
- *** Is the standard value of hexavalent Cr, but the analysis result was Total Cr
- ND = non - detected

Cd	=	0.00006 mg/l	Zn	=	0.004 mg/l
Total Cr	=	0.00013 mg/l	Cu	=	0.002 mg/l
Mn	=	0.1 mg/l	Hg	=	0.0005 mg/l
Ni	=	0.004 mg/l	As	=	0.0003 mg/l
Pb	=	0.00013 mg/l			

Table 9 : The significant water quality index and the problem areas concerning water quality in the Southern Region

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3-N (mg/l)	
Upper Tapi	2	8.2 - 8.8 8.4 100% (3/3)	0.1 - 1.3 0.5 100% (3/3)	790 - 54,000 2,400 67% (2/3)	330 - 54,000 490 67% (2/3)	<0.05 - 0.37 0.05 100% (3/3)	TCB Phipun District, Nakhon Si Thammarat (Mar[3]) FCB Phipun District, Nakhon Si Thammarat (Mar[4])
Low Tapi	3	3.5 - 7.8 5.5 89% (16/18)	0.2 - 3.8 1.4 72% (13/18)	1,100 - 54,000 3,500 89% (16/18)	330 - 24,000 790 83% (15/18)	<0.05 - 5.50 0.05 72% (13/18)	TCB Ban Pak Nam, Talat Sub-district, Muang Surat Thani District, Surat Thani (Jun[3]) Ban Don Port, Muang Surat Thani District, Surat Thani (Sep) FCB Ban Pak Nam, Talat Sub-district, Muang Surat Thani District (Jun) Ban Don Port, Muang Surat Thani District (Mar Sep[4]) NH_3-N Ban Pak Nam, Talat Sub-district, Muang Surat Thani District (Jun Sep[5]) Ban Don Port, Muang Surat Thani District (Sep) Chulachomklao Bridge, Phunphin District, Surat Thani (Sep) Chawang District, Nakhon Si Thammarat (Sep)
Phum Duang	3	3.0 - 7.3 6.8 92% (11/12)	0.2 - 2.8 1.2 92% (11/12)	<18 - 35,000 2,850 92% (11/12)	<1.8 - 7,900 640 92% (11/12)	<0.05 - 1.10 0.05 83% (10/12)	TCB Ban Ta Khun, Ban Ta Khun District, Surat Thani (Sep[3]) FCB Ban Ta Khun, Ban Ta Khun District (Sep[4]) NH_3-N In front of liquor factory Phunphin District, Surat Thani (Sep[5]) Khao Phang Sanitation, Ban Ta Khun District, Surat Thani (Sep[5])
Pak Phanang	3	1.4 - 6.4 3.7 38% (8/21)	0.1 - 5.0 1.9 57% (12/21)	130 - 35,000 2,400 90% (19/21)	20 - 24,000 330 81% (17/21)	0.05 100% (21/21)	DO Estuary at Pak Phanang District, Nakhon Si Thammarat (Mar[1]) Ban Pak Phanang's Ferry, Pak Phanang District, Nakhon Si Thammarat (Mar) BOD Estuary at Pak Phanang District (May Aug[2]) Ban Pak Phanang's Ferry, Pak Phanang District (Aug) Under Cha-uat Sanitation, Tha Samed Sub-district, Cha-uat District, Nakhon Si Thammarat (Mar[2]) TCB Ban Pak Phanang's Ferry (May) Under Cha-uat Sanitation, Tha Samed Sub-district, Cha-uat District (Mar[3]) FCB Ban Pak Phanang's Ferry (Mar May) Under Cha-uat Sanitation, Tha Samed Sub-district, Cha-uat District (Mar[4] Aug)
Chumphon	3	1.6 - 8.0 4.8 58% (7/12)	1.1 - 4.3 1.8 58% (7/12)	1,300 - 43,000 10,600 75% (9/12)	330 - 16,000 4,450 50% (6/12)	<0.05 - 1.90 0.20 67% (8/12)	DO Estuary at Pak Nam Chumphon Sub-district, Muang Chumphon District, Chumphon (May[1]) BOD Estuary at Pak Nam Chumphon Sub-district, Muang Chumphon District (Mar[2]) Tha Yang Sub-district, Muang Chumphon District, Chumphon (Dec) TCB Estuary at Pak Nam Chumphon Sub-district, Muang Chumphon District (May Aug[3]) Tha Yang Sub-district, Muang Chumphon District, Chumphon (Dec) FCB Estuary at Pak Nam Chumphon Sub-district, Muang Chumphon District (Mar May[4] Aug) Tha Yang Sub-district, Muang Chumphon District, Chumphon (Aug Dec) Tha Sae District, Chumphon (Mar) NH_3-N Estuary at Pak Nam Chumphon Sub-district, Muang Chumphon District (Mar Dec[5]) Tha Yang Sub-district, Muang Chumphon District (Dec) Tha Sae District (Dec)
Upper Lang Suan	2	4.5 - 9.3 7.5 90% (9/10)	0.4 - 2.2 1.0 90% (9/10)	170 - 16,000 3,150 60% (6/10)	40 - 6,300 945 50% (5/10)	<0.01 - 4.20 0.05 63% (5/8)	FCB Khan Ngoen Sub-district, Lang Suan District, Chumphon (Mar[4]) Pang Wan Sub-district, Phato District, Chumphon (Jan) NH_3-N Khan Ngoen Sub-district, Lang Suan District (Dec[5]) Pang Wan Sub-district, Phato District (Sep Dec)
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

Table 9 : The significant water quality index and the problem areas concerning water quality in the Southern Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Low Lang Suan	3	4.1 - 8.2 4.8 100% (10/10)	0.4 - 3.0 1.5 80% (8/10)	2,100 - 16,000 7,300 100% (10/10)	1,100 - 5,400 4,050 50% (5/10)	<0.05 – 1.10 0.05 75% (6/8)	FCB Estuary at Bang Maphrao Sub-district, Lang Suan District, Chumphon (Jan May[4] Sep) Laem Sai Sub-district, Lang Suan District, Chumphon (Mar[4] May) NH_3-N Laem Sai Sub-district, Lang Suan District (Sep Dec[5])
Trang	3	4.1 - 7.5 5.4 100% (16/16)	0.4 - 1.6 0.8 100% (16/16)	230 - 92,000 1,850 75% (12/16)	20 - 7,900 280 88% (14/16)	ND 100% (16/16)	TCB Estuary at Katang Tai Sub-district, Kantang District, Trang (Nov) Tha Phae Khanan Yon, Kantang Sub-district, Kantang District, Trang (Nov) Kantang Lower Pumping Station, Thap Thiang Sub-district, Muang Trang District, Trang (Nov[3]) Huai Yot Lower Pumping Station, Khao Kop Sub-district, Huai Yot District, Trang (Nov) FCB Estuary at Katang Tai Sub-district, Kantang District (Nov[4]) Huai Yot Lower Pumping Station (Nov[4])
Upper Pattani	2	5.0 - 8.9 6.2 67% (8/12)	0.8 - 2.0 1.4 83% (10/12)	330 - 54,000 3,550 50% (6/12)	330 - 54,000 1,550 33% (4/12)	ND 100% (12/12)	TCB Yala Municipality Lower Pumping Station, Tha Sap Sub-district, Muang Yala District, Yala (Feb) Ban Ba Cho, Ba Cho Sub-district, Bannang Sata District, Yala (Feb) At the end of Bang Lang Dam, Bannang Sata Sub-district, Bannang Sata District, Yala (Feb[3]) FCB Yala Municipality Lower Pumping Station (Feb May Dec) Ban Ba Cho, Ba Cho Sub-district, Bannang Sata District (Feb) At the end of Bang Lang Dam, Bannang Sata Sub-district, Bannang Sata District (Feb[4])
Lower Pattani	3	5.0 - 6.5 6.0 100% (8/8)	0.9 - 2.5 1.4 88% (7/8)	330 - 35,000 10,700 88% (7/8)	130 - 35,000 10,700 38% (3/8)	ND 100% (8/8)	TCB Estuary at Bana Sub-district, Muang Pattani District, Pattani (Feb[4]) FCB Estuary at Bana Sub-district, Muang Pattani District (Feb[3] May Aug Dec) Ban Anopulo, Yapi Sub-district, Yarang District, Pattani (Feb)
Sai Buri	3	3.4 - 9.1 6.2 94% (15/16)	0.7 - 1.8 1.1 100% (16/16)	490 - 35,000 7,300 94% (15/16)	490 - 35,000 4,450 50% (8/16)	ND 100% (16/16)	TCB Rueso Lower Pumping Station, Rueso District, Narathiwat (Feb[3]) FCB Estuary at Taluban Sub-district, Sai Buri District, Pattani (Feb May Aug) Kayuboko Sub-district, Raman District, Yala (Feb May) Rueso Lower Pumping Station (Feb[4]) Si Sakhon District, Narathiwat (Feb Aug)
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 9 : The significant water quality index and the problem areas concerning water quality in the Southern Region (Continued)

Water Resources	Type of Water Resources	Min - Max, Median, and Percentage*					Areas with water quality problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH_3 - N (mg/l)	
Thale Noi	-	1.1 - 6.2 4.2 58% (7/12)	0.8 - 8.1 3.2 25% (3/12)	20 - 92,000 410 92% (11/12)	20 - 92,000 230 83% (10/12)	ND - 0.30 0.01 100% (12/12)	DO Thale Noi Village, Pra Nang Tung Sub-district, Khuan Khanun District, Phatthalung (Feb May[1] Nov) BOD Thale Noi Village, Pra Nang Tung Sub-district (Feb May[2] Nov) Nang Riam canal, Khuan Khanun District, Phatthalung (May) TCB Thale Noi Village (May[3]) FCB Thale Noi Village (May[4] Nov)
Thale Luang	-	0.6 - 7.0 5.8 80% (16/20)	0.4 - 9.5 2.3 45% (9/20)	20 - 24,000 790 95% (19/20)	13 - 24,000 330 90% (18/20)	ND - 0.26 0.01 100% (20/20)	DO Ban Rong Canal's estuary, Ranot District, Songkhla (Apr Nov[1]) BOD Ban Rong Canal's estuary (Apr[2] Aug Nov) TCB Ban Rong Canal's estuary (Nov[3]) FCB Ban Rong Canal's estuary (Nov[4]) Lam Pam Canal's estuary, Muang Phatthalung District, Phatthalung (Aug)
Songkhla Lake	-	0.0 - 7.0 5.4 89% (25/28)	0.9 - 29.4 2.0 57% (16/28)	20 - 280,000 365 89% (25/28)	20 - 280,000 175 86% (24/28)	ND - 1.51 0.01 93% (26/28)	DO Samrong Canal's estuary, Muang Songkhla District, Songkhla (May[1]) BOD Pawong Canal's estuary, Hat Yai District, Songkhla (Nov) Samrong Canal's estuary (Feb May[2]) TCB Samrong Canal's estuary (Feb May[3] Nov) FCB Samrong Canal's estuary (Feb May[4] Aug Nov) NH_3-N U-Tapao Canal's estuary, Rattaphum District, Songkhla (Aug) Samrong Canal's estuary (Aug[5])
The Standard of Class 2 Water Resource		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	Problematic water quality is considered as follows : DO lower than 2.0 mg/l BOD more than 4.0 mg/l TCB more than 20,000 MPN/100 ml FCB more than 4,000 MPN/100 ml NH_3-N more than 0.5 mg/l
The Standard of Class 3 Water Resource		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
The Standard of Class 4 Water Resource		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks : *Percentage of the measurement that meets the standard of surface water quality (A total of the standardized measurement / A total of all measurements)

[1] The areas that have the lowest level of DO, [2] The areas that have the highest level of BOD, [3] The areas that have the highest level of TCB, [4] The areas that have the highest level of FCB, [5] The areas that have the highest level of NH_3-N

NH_3-N The quantity of ND (non-detected) = 0.01 mg/l

Table 10 : Heavy Metal Monitoring Results and Problem Areas in the Southern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	The Over-Standard / Problematic Areas
Cd 2.9% (2/68)*	< 0.0005 - 0.125	≤ 0.005 , ≤ 0.05	Songkhla Lake Samrong Canal's estuary, Muang Songkhla District, Songkhla (Aug_0.089) Songkhla Lake's estuary, Muang Songkhla District, Songkhla (Aug_0.125**)
Total Cr 13.9% (10/72)*	< 0.001 - 0.103	≤ 0.05***	Pattani Muang Yala District, Yala (Aug_0.053) Sai Buri Rueso District, Narathiwat (Aug_0.06) Thale Noi Thale Noi Village, Khuan Khanun District, Phatthalung (Nov_0.08) Thale Luang Lam Pam Canal's estuary, Muang Phatthalung District, Phatthalung (Nov_0.081) Songkhla Lake U-Tapao Canal's estuary, Rattaphum District, Songkhla (Nov_0.081) Samrong Canal's estuary (Feb_0.054 Aug_0.064) Songkhla Lake's estuary (Feb_0.062 May_0.082 Aug_0.103**)
Mn	< 0.001 - 0.889	≤ 1.0	Not found
Ni	< 0.001 - 0.041	≤ 0.1	Not found
Pb	< 0.001 - 0.013	≤ 0.05	Not found
Zn	< 0.001 - 0.34	≤ 1.0	Not found
Cu 4.3% (3/70)*	< 0.001 - 0.16	≤ 0.1	Lang Suan Estuary at Bang Maphrao Sub-district, Lang Suan District, Chumphon (Jan_0.16**) Khan Ngoen Sub-district, Lang Suan District, Chumphon (Jan_0.15) Songkhla Lake Songkhla Lake's estuary (Aug_0.125)
Hg 1.6% (1/61)*	< 0.0005 - 0.003	≤ 0.002	Pak Phanang Estuary at Pak Phanang District, Nakhon Si Thammarat (May_0.003**)
As 6.6% (4/61)*	< 0.0003 - 0.020	≤ 0.01	Trang Muang Trang District, Trang (May_0.011) Huai Yot District, Trang (May_0.02**) Pattani Muang Yala District, Yala (Dec_0.02**) Songkhla Lake Samrong Canal's estuary (Nov_0.013)

Remarks :

- The standard value of Cd below 0.005 mg/l where water hardness does not exceed 100 mg/l
- The standard value of Cd below 0.05 mg/l where water hardness exceeds 100 mg/l
- * Percentage of monitoring sessions that exceed standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)
- ** Maximum value
- *** Is the standard value of hexavalent Cr, but the analysis result was Total Cr
- ND = non - detected

Cd	=	0.00006	mg/l
Total Cr	=	0.00013	mg/l
Mn	=	0.1	mg/l
Ni	=	0.004	mg/l
Pb	=	0.00013	mg/l
Zn	=	0.004	mg/l
Cu	=	0.002	mg/l
Hg	=	0.0005	mg/l
As	=	0.0003	mg/l

Table 11 : Results of coastal water quality monitoring in the inner Gulf of Thailand

Parameter	Min-Mas (Average)	Costal Water Quality Standards	Areas not Conforming to Standards / Surveillance areas
Odor 0% (0/14)*	-	Not objectionable	Not found
pH 0% (0/7)*	7.24 - 7.68 (7.48)	Class 1-6 7.0 - 8.5	Not found
DO 79% (11/14)*	0.69 - 4.58 (5.68) mg/l	Class 1,3 - 6 ≥ 4 Class 2 ≥ 6	Chachoengsao Bang Pakong River Estuary Samutprakarn Klong 12 Thanwa estuary, in front of dyeing factory Km. 35, Chao Phraya River estuary Bangkok Bang Khun Thian District**(1st time) Samut Sakhon Tha Chin River Estuary Samut Songkhram Mae Klong River Estuary
Phosphat - Phosphorus 100% (14/14)*	46.6 - 517.0 (210.31) µg - Phosphorus/l	Class 1, 2, 4 ≤ 15 Class 3, 5, 6 ≤ 45	Chachoengsao Bang Pakong River Estuary Samut Prakan Klong 12 Thanwa estuary, in front of dyeing factory Km. 35, Chao Phraya River estuary Bangkok Bang Khun Thian District Samut Sakhon Tha Chin River Estuary**(2nd time) Samut Songkhram Mae Klong River Estuary
Ammonia - Non-ionic Nitrogen 0% (0/14)*	1.03 - 65.89 (25.7) µg - Nitrogen/l	Class 1, 2, 4 - 6 ≤ 70 Class 3 ≤ 100	Not found
Nitrate - Nitrogen 93% (13/14)*	28.60 - 1,225.00 (300.74) µg - Nitrogen/l	Class 1 - 2 ≤ 20 Class 3 - 6 ≤ 60	Chachoengsao Bang Pakong River Estuary**(2nd time) Samut Prakan Klong 12 Thanwa estuary, in front of dyeing factory Km. 35, Chao Phraya River estuary Bangkok Bang Khun Thian District Samut Sakhon Tha Chin River Estuary Samut Songkhram Mae Klong River Estuary
Total Coliform 67% (8/12)*	40.0 - 17,000.0 (3364.17) MPN/100 ml	Class 1 - 6 ≤ 1,000	Chachoengsao Bang Pakong River Estuary Samut Prakan Klong 12 Thanwa estuary, in front of dyeing factory Km. 35, Chao Phraya River estuary Samut Sakhon Tha Chin River Estuary**(2nd time) Samut Songkhram Mae Klong River Estuary
Fecal Coliform 79% (11/14)*	< 1.0 - 6,300.0 (1,584.07) CFU/100 ml	Class 1 - 3 ≤ 70 Class 4 - 6 ≤ 100	Chachoengsao Bang Pakong River Estuary Samut Prakan Klong 12 Thanwa estuary, in front of dyeing factory Km. 35, Chao Phraya River estuary Bangkok Bang Khun Thian District Samut Sakhon Tha Chin River Estuary**(1st time) Samut Songkhram Mae Klong River Estuary

Table 11 : Results of coastal water quality monitoring in the inner Gulf of Thailand (Continued)

Parameter	Min-Mas (Average)	Costal Water Quality Standards	Areas not Conforming to Standards / Surveillance areas
Enterococci Bacteria 0% (0/14)*	1.0 - 14,400.0 (1,562.71) CFU/100 ml	Class 1, 3, 5, 6 Not defined Class 2, 4 ≤ 35	Not found
Arsenic 0% (0/14)*	< 0.30 - 6.23 (1.58) µg/l	Class 1 - 6 ≤ 10	Not found
Cadmium 0% (0/14)*	< 0.10 µg/l All measurement points	Class 1 - 6 ≤ 5	Not found
Chromium 7% (1/14)*	< 0.10 - 65.10 (8.00) µg/l	Class 1 - 6 ≤ 300	Samut Prakan Klong 12 Thanwa estuary**(2nd time)
Chromium Hexavalent 0% (0/14)*	< 0.10 µg/l All measurement points	Class 1 - 6 ≤ 50	Not found
Copper 29% (4/14)*	< 0.10 - 11.20 (5.02) µg/l	Class 1 - 6 ≤ 8	Samut Prakan Klong 12 Thanwa estuary**(2nd time) in front of Dyeing factory Km. 35, Chao Phraya River Estuary Bangkok Bang Khun Thian district
Lead 7% (1/14)*	< 0.10 - 8.58 (2.34) µg/l	Class 1 - 6 ≤ 8.5	Samut Prakan Klong 12 Thanwa estuary**(2nd time)
Zinc 0% (0/14)*	1.87 - 19.20 (8.76) µg/l	Class 1 - 6 ≤ 50	Not found
Mercury 7% (1/14)*	0.01 - 0.14 (0.04) µg/l	Class 1 - 6 ≤ 0.1	Samut Songkhram Mae Klong River Estuary**(2nd time)

Remarks : * Percentage of monitoring stations which didn't meet coastal water quality standards (number of stations that didn't meet the standard/ number of total areas that coastal water samples were collected in the first and the second times.)

** Highest value area of each parameter

Table 12 : Report of coastal water quality monitoring in the eastern Gulf of Thailand

Parameter	Min-Mas (Average)	Costal Water Quality Standards	Areas not Conforming to Standards / Surveillance areas
Odor 1% (1/72)*	Fishy smell	Not offensive	Trat Laem Ngob**(2nd time)
pH 8% (4/52)*	5.9 - 8.4 (7.85)	Class 1 - 6 7.0 - 8.5	Trat Trat estuary - Laem Sok (Ban Pu)**(2nd time) Chanthaburi Chanthaburi Estuary Rayong Prasae estuary, Phangrat estuary
DO 21% (15/71)*	2.58 - 7.02 (4.73) µg/l	Class 1, 3 - 6 ≥ 4 Class 2 ≥ 6	Trat Chang Island (Slak Phet Bay), Pak Klong Yai Rayong Prasae estuary Chon Buri Chon Buri Bay (Oyster farm)**(2nd time), Angsila (Pier), Angsila (Oyster farm), Bang Saen (Ocean World), Sriracha (Loi Island), Udom Bay (Fish market), Laem chabang Port (At the end), Laem chabang Port, Na Kluea Market South Pattaya, Sattahip Port
Phosphate - Phosphorus 15% (11/71)*	< 1.0 - 319.0 (26.75) µg - Phosphorus/l	Class 1, 2, 4 ≤ 15 Class 3, 5, 6 ≤ 45	Rayong Prasae estuary Chon Buri Chon Buri Bay (Oyster farm)**(2nd time), Angsila (Oyster farm), Laem Chabang Port (At the end), Na Kluea Market**(1st time) Sattahip Port
Ammonia - Non-ionic Nitrogen 0% (0/71)*	< 0.15 - 59.94 (11.10) µg - Nitrogen/l	Class 1, 2, 4 - 6 ≤ 70 Class 3 ≤ 10 0	Not found
Nitrate - Nitrogen 46% (33/71)*	2.0 - 601.0 (90.48) µg - Nitrogen/l	Class 1 - 2 ≤ 20 Class 3 - 6 ≤ 60	Trat Chang Island (Saikhao Beach, Bangbao Beach), Laem Ngob (Port), Laem Ngob**(2nd time) Trat Estuary - Laem Sok (Ban Pu), Laem Sok Chanthaburi, Chanthaburi estuary, Welu Estuary Rayong Prasae estuary Phangrat estuary, Rayong estuary, Fishing pier (Ban Phe Market), Klaeng estuary Chon Buri Chon Buri Bay, Chon buri Bay (Oyster farm) Angsila (Pier) Angsila, Angsila (Oyster farm), Bang Phra, Sriracha (Loi Island), Udom Bay (Fishing Market), Laem Chabang, Laem Chabang Port (At the end), Na Kluea Market, North Pattaya, South Pattaya, Sattahip Port, Samae San Channel
Total Coliform 20% (13/66)*	< 1.8 - 54,000 (2,315.74) MPN/100 ml	Class 1 - 6 ≤ 1,000	Trat Chang Island (Bang Bao Bay), Laem Ngob Pier Rayong Prasae estuary, Phangrat Estuary, Rayong estuary, Fishing Pier (Ban Phe Market), Klaeng estuary Chon Buri Chon Buri Bay, Chon Buri Bay (Oyster farm) Bang Phra Sichang (Tha Tewawong), Udom Bay (Fishing Market)**(2nd time), Laem Chabang, Laem Chabang Port (At the end), Sattahip Port

Table 12 : Report of coastal water quality monitoring in the eastern Gulf of Thailand (Continued)

Parameter	Min-Mas (Average)	Costal Water Quality Standards	Areas not Conforming to Standards / Surveillance areas
Fecal Coliform 37% (26/71)*	< 1.0 - 3,800 (529.24) CFU/100 ml	Class 1-3 ≤ 70 Class 4-6 ≤ 100	Trat Chang Island (Bang Bao Bay), Laem Ngob, Trat Estuary - Laem Sok (Ban Pu), Pak Klong Yai, Rayong Prasae estuary, Phangrat estuary Chon Buri Chon Buri Bay, Chon Buri Bay (Oyster farm), Angsila (Pier), Angsila (Oyster farm), Bang Phra, Sichang (Tha Tewawong), Udom Bay (Fishing Market), Laem Chabang , Laem Chabang Port (In the middle), Laem Chabang Port (At the end) **(1st time), Na Kluea Market, South Pattaya, Sattahip Port
Enterococci Bacteria 4% (3/71)*	< 1.0 - 10,400 (491.52) CFU/100 ml	Class 1, 3, 5, 6 Not defined Class 2, 4 ≤ 35	Trat Chang Island (Saikhao Beach), Chang Island (Bang Bao Bay)**(2nd time) Chon Buri Central Pattaya
Arsenic 0% (0/71)*	< 0.3 - 6.73 (1.19) µg/l	Class 1 - 6 ≤ 10	Not found
Cadmium 0% (0/71)*	< 0.1 - 0.1 (0.1) µg/l	Class 1 - 6 ≤ 5	Not found
Chromium 0% (0/71)*	< 0.10 - 3.52 (0.91) µg/l	Class 1 - 6 ≤ 300	Not found
Chromium Hexavalent 0% (0/71)*	< 0.1 - 0.1 (0.1) µg/l	Class 1 - 6 ≤ 50	Not found
Copper 4% (3/71)*	< 0.10 - 9.78 (1.77) µg/l	Class 1 - 6 ≤ 8	Trat Laem Ngob, Laem Ngob Pier**(1st time), Laem Sok
Lead 0% (0/71)*	< 0.1 - 5.7 (0.43) µg/l	Class 1 - 6 ≤ 8.5	Not found
Zinc 1% (1/71)*	< 0.1 - 119.0 (7.65) µg/l	Class 1 - 6 ≤ 50	Trat Trat estuary - Laem Sok (Ban Pu)**(2nd time)
Mercury 14% (10/71)*	< 0.01 - 0.25 (0.05) µg/l	Class 1 - 6 ≤ 0.1	Rayong Klaeng estuary Chon Buri Angsila (Pier), Angsila (Oyster farm), Bangsaen (Ocean World), Laem Chabang, Laem Chabang Port (At the end), Laem Chabang Port, South Pattaya, Sattahip port, Samae San Channel

Remarks : * Percentage of monitoring stations which didn't meet coastal water quality standards (number of stations that didn't meet the standard/ number of total areas that coastal water samples were collected in the first and the second times.)

** Highest value area of each parameter

Table 13 : Results of coastal water quality monitoring in the western Gulf of Thailand

Parameter	Min-Mas (Average)	Standard of coastal water quality	Areas not Conforming to Standards / Surveillance areas
Odor 0% (0/77)*	-	Not offensive	Not found
pH 0% (0/69)*	7.31 - 8.30 (7.95)	Class 1 - 6 7.0 - 8.5	Not found
DO 21% (16/77)*	0.13 - 6.86 (4.73) mg/l	Class 1, 3 - 6 ≥ 4 Class 2 ≥ 6	Phetchaburi Bangtaboon estuary (North, Central, South), Ban Laem estuary (North, Central, South), Cha am Beach (North**(1st time), Central), Chao samran Beach Prachuap Khiri Khan Beach at Klai kangwon palace Chumphon Ban Sa Phlee, Sa Phlee Bay
Phosphate - Phosphorus 32% (25/78)*	2.51 - 118.0 (28.19) µg - Phosphorus/l	Class 1, 2, 4 ≤ 15 Class 3, 5, 6 ≤ 45	Phetchaburi Bangtaboon Estuary (North**(2nd time), Central, South), Ban Laem estuary (North, Central, South), Cha am Beach (North, Central) Prachuap Khiri Khan Beach at Klai Kangwon palace, Pranburi estuary (Khao Ka Lok) Sam Phraya Beach, Sam Roi Yot National Park, Khao Ka Lok, Ban Bang Saphan estuary Surat Thani Kra Dae Canal, Kanchanadit Nakhon Si Thammarat Tha Sung estuary, Tha Sala District, Pak phanang estuary Songkhla Samila Beach
Nitrate - Nitrogen 22% (17/78)*	1.27 - 634.0 (40.12) µg - Nitrogen/l	Class 1, 2, 4 - 6 ≤ 70 Class 3 ≤ 100	Phetchaburi Bangtaboon estuary (North, Central**(1st time), South), Ban Laem estuary (North, Central, South), Cha am Beach (Central) Prachuap Khiri Khan Sam Phraya Beach, Sam Roi Yot National Park Chumphon Ban Sa Phlee, Sa Phlee Bay Surat Thani Tha Koei estuary Tha Chang District Tapi estuary, Bandon Bay (Central)**(2nd time)
Ammonia - Non-ionic Nitrogen 0% (0/78)*	1.56 - 28.3 (8.07) µg - Nitrogen/l	Class 1 - 2 ≤ 20 Class 3 - 6 ≤ 60	Not found
Total Coliform 14% (10/73)*	< 1.8 - 13,000.0 (724.15) MPN/100 ml	Class 1 - 6 ≤ 1,000	Phetchaburi Ban Laem estuary (North, Central, South), Cha am Beach (Central) Prachuap Khiri Khan Fishing Market, Hua Hin, Ban Bang Saphan estuary Surat Thani Tapi estuary, Bandon Bay (Central), Donsak estuary Nakhon Si Thammarat Tha Sung estuary, Tha Sala District**(2nd time), Pak Phanang estuary
Fecal Coliform 35% (27/78)*	< 1.0 - 5,480.0 (389.28) CFU/100 ml	Class 1 - 3 ≤ 70 Class 4 - 6 ≤ 100	Phetchaburi Bangtaboon estuary (North, Central**(1st time), South), Ban Laem estuary (North, Central, South), Cha am Beach (Central) Prachuap Khiri Khan Fishing Market, Hua Hin, Pranburi estuary (Khao Ka Lok), Wan estuary, Ban Bang Saphan estuary Chumphon Lang Suan estuary Surat Thani Tapi estuary, Bandon Bay (Central) Kra Dae Canal, Kanchanadit, Donsak estuary Nakhon Si Thammarat Khanom Power plant, Khanom District, Tha Sung estuary, Tha Sala District**(2nd time), Pak Phanang Estuary Songkhla Pak Rawa Floodgate, Ranod District, estuary of Songkhla Lake, Samila Beach

Table 13 : Results of coastal water quality monitoring in the western Gulf of Thailand (Continued)

Parameter	Min-Mas (Average)	Standard of coastal water quality	Areas not Conforming to Standards / Surveillance areas
Enterococci Bacteria 5% (4/78)*	< 1.0 - 3,640.0 (285.11) CFU/100 ml	Class 1, 3, 5, 6 Not defined Class 2, 4 ≤ 35	Phetchaburi Cha am Beach (North) Prachuap Khiri Khan Beach at Klai Kangwon Palace, Beach at Sailom Hotel, Hua Hin**(2nd time) Surat Thani Hat Rin Bay, Phangan Island
Arsenic 0% (0/78)*	< 0.3 - 8.31 (1.54) µg/l	Class 1 - 6 ≤ 10	Not found
Cadmium 0% (0/78)*	< 0.1 µg/l All measurement points	Class 1 - 6 ≤ 5	Not found
Chromium 0% (0/78)*	< 0.1 - 4.19 (0.62) µg/l	Class 1 - 6 ≤ 300	Not found
Chromium Hexavalent 0% (0/78)*	< 0.1 µg/l All measurement points	Class 1 - 6 ≤ 50	Not found
Copper 12% (9/78)*	< 0.1 - 12.3 (2.0) µg/l	Class 1 - 6 ≤ 8	Phetchaburi Ban Laem estuary (Central), Cha am Beach (North, Central) Surat Thani Chaweng Bay, Central, Samui Island**(1st time) Nakhon Si Thammarat Khanom Power plant, Khanom District, Tha Sung estuary, Tha Sala District, Ban Pak Khlong, Hua Sai District Songkhla Pak Rawa Floodgate, Ranod District, estuary of Songkhla Lake
Lead 0% (0/78)*	< 0.10 - 5.05 (0.26) µg/l	Class 1 - 6 ≤ 8.5	Not found
Zinc 0% (0/78)*	< 0.1 - 69.1 (4.7) µg/l	Class 1 - 6 ≤ 50	Not found
Mercury 8% (6/78)*	< 0.01 - 0.36 (0.04) µg/l	Class 1 - 6 ≤ 0.1	Phetchaburi Cha am Beach (North, Central) Chumphon Ban Bo Kha (Ao Kho), Sawee District, Sawee estuary**(2nd time), Lang Suan estuary Surat Thani Donsak estuary Lamai Beach, Samui Island

Remarks : * Percentage of monitoring stations which didn't meet coastal water quality standards (number of stations that didn't meet the standard/ number of total stations monitoring in the summer and rainy seasons.)

** Highest value area of each parameter

Table 14 : Results of coastal water quality monitoring in the Andaman

Parameter	Min-Max (Average)	Standard of coastal water quality	Areas not conforming to standards/surveillance areas
Odor 1% (1/100)*	Smell of oil	Class 1 - 6 7.0 - 8.5	Ranong Chan Dum Ri Beach, Ranong estuary**(1st time)
pH 4% (2/56)*	6.84 - 8.14 (7.82)	Class 1 - 6 7.0 - 8.5	Phangnga Thai Muang, Tab Lamu estuary, Tab Lamu**(1st time)
DO 0% (0/58)*	4.20 - 8.28 (6.03) mg/l	Class 1, 3 - 6 ≥ 4 Class 2 ≥ 6	Not found
Phosphate - Phosphorus 2% (1/56)*	0.28 - 41.10 (5.86) µg - Phosphorus/l	Class 1, 2, 4 ≤ 15 Class 3, 5, 6 ≤ 45	Phuket Mai Khao Beach**(2nd time)
Ammonia - Non-ionic Nitrogen 0% (0/56)*	0.51 - 16.80 (3.76) µg - Nitrogen/l	Class 1, 2, 4 - 6 ≤ 70 Class 3 ≤ 100	Not found
Nitrate - Nitrogen 27% (15/56)*	3.55 - 232.0 (41.68) µg - Nitrogen/l	Class 1 - 2 ≤ 20 Class 3 - 6 ≤ 60	Ranong Chan Dum Ri Beach, Ranong estuary**(2nd time), Bang Ben Beach, Prapas Beach Phangnga Tab Lamu, Ban Nam Khem Phuket Mai Khao Beach, Bangtao Beach, Tha Chin estuary, Ban Koh Si-Re, Chalong Bay (Central) Krabi Loh Dalum Beach (Phi Phi Island Cabana), Phi Phi Island, Beach at Sriraya village Satun Ban Tung Rin
Total Coliform 7% (4/56)*	< 1.8 - 14,000.0 (552.06) MPN/100 ml	Class 1 - 6 ≤ 1,000	Ranong Chan Dum Ri Beach, Ranong estuary Phuket Patong Beach (in front of Patong Merlin)**(2nd time) Satun Pak Bara Pier, Ban Tung Rin
Fecal Coliform 10% (6/58)*	< 1.0 - 2,960.0 (89.95) CFU/100 ml	Class 1 - 3 ≤ 70 Class 4 - 6 ≤ 100	Ranong Chan Dum Ri Beach, Ranong estuary**(2nd time), Prapas Beach Phangnga Ban Nam Khem Phuket Patong Beach (in front of Patong Merlin) Satun Pak Bara Pier
Enterococci Bacteria 3% (2/58)*	< 1.0 - 3,680.0 (96.59) CFU/100 ml	Class 1, 3, 5, 6 No defined Class 2, 4 ≤ 35	Phuket Patong Beach (in front of Patong Merlin)**(2nd time) Krabi Ton Sai Beach (Ton Sai Village) Phi Phi Island (South)
Arsenic 0% (0/58)*	< 0.3 - 6.84 (1.28) µg/l	Class 1 - 6 ≤ 10	Not found

Table 14 : Results of coastal water quality monitoring in the Andaman (Continued)

Parameter	Min-Max (Average)	Standard of coastal water quality	Areas not conforming to standards/surveillance areas
Cadmium 0% (0/58)*	< 0.1 µg/l All measurement points	Class 1 - 6 ≤ 5	Not found
Chromium 0% (0/58)*	< 0.1 - 3.36 (0.76) µg/l	Class 1 - 6 ≤ 300	Not found
Chromium Hexavalent 0% (0/56)*	< 0.1 µg/l All measurement points	Class 1 - 6 ≤ 50	Not found
Copper 19% (11/58)*	< 0.1 - 11.2 (2.78) µg/l	Class 1 - 6 ≤ 8	Ranong Chan Dum Ri Beach, Ranong estuary, Bang Ben Beach, Prapas Beach Phangnga Pak Bang Canal (Khao Lak), Ban Nam Khem Phuket Mai Khao Beach, Nai Yang Beach**(1st time), Rawai Beach (Fishing Village) Krabi Nopparattara Beach (Klong Hang estuary), Loh Dalum Beach (Phi Phi Island Cabana), Phi Phi Island, Ton Sai Beach (Ton Sai Village) Phi Phi Island (South)
Lead 0% (0/58)*	< 0.1 - 4.2 (0.23) µg/l	Class 1 - 6 ≤ 8.5	Not found
Zinc 0% (0/58)*	< 0.1 - 14.9 (3.99) µg/l	Class 1 - 6 ≤ 50	Not found
Mercury 4% (2/56)*	< 0.01 - 0.31 (0.03) µg/l	Class 1 - 6 ≤ 0.1	Phuket Surin Beach, Tha Chin estuary, Ban Koh Si-Re **(2nd time)

Remarks : * Percentage of monitoring stations which didn't meet coastal water quality standards (number of stations that didn't meet the standard/ number of total stations monitoring in the summer and rainy seasons.)

** Highest value area of each parameter

Appendix D

Survey results of waste in Thailand

Table 1 : Survey results of solid waste in 77 provinces (4 February 2014)

					1	2	3	4	5	6	7	8
						Service areas						
IDP	Province	Municipality no.	SAO no.	Total LAB no.	Vol. of waste (ton/year)	LAB service no.	Vol. of waste in LAB service area	Vol. of disposal waste (ton/year)	Vol. of recycled waste (ton/year)	Vol. of non-service disposal waste (ton/year)	Vol. of improper disposal waste (ton/year)	Vol. of proper disposal waste (ton/year)
1	Chiang Mai	105	105	210	627,404.57	129.00	457,437.15	266,341.91	191,095.24	-	12,021.59	254,320.32
	Chiang Rai	65	78	143	435,147.96	62.00	222,012.14	166,326.01	55,686.12	-	38,464.78	127,861.23
	Mae Hong Son	6	43	49	80,100.10	26.00	46,446.17	24,155.70	22,290.47	-	8,062.56	16,093.14
	Lamphun	36	21	57	144,968.13	29.00	80,554.57	57,433.44	23,121.13	-	10,800.75	46,632.69
Total	**4**	**212**	**247**	**459**	**1,287,620.76**	**246.00**	**806,450.03**	**514,257.07**	**292,192.96**	**-**	**69,349.68**	**444,907.39**
2	Lampang	40	63	103	297,605.09	53.00	199,463.15	143,939.90	55,523.25	-	91,927.40	52,012.50
	Phayao	35	36	71	191,104.28	40.00	131,769.37	82,414.81	49,354.56	-	69,639.81	12,775.00
	Phrae	25	60	85	180,278.35	47.00	117,889.62	67,473.90	50,415.72	-	67,473.90	-
	Sukhothai	20	70	90	212,721.70	55.00	143,999.14	106,628.59	37,370.55	-	76,058.62	30,569.97
Total	**4**	**120**	**229**	**349**	**881,709.41**	**195.00**	**593,121.28**	**400,457.20**	**192,664.08**	**-**	**305,099.74**	**95,357.47**
3	Phitsanulok	24	78	102	316,592.88	37.00	178,845.55	107,659.31	61,667.05	9,519.20	45,145.76	62,513.55
	Nan	17	82	99	162,267.29	36.00	75,274.22	37,007.35	31,791.77	6,475.10	18,220.80	18,786.55
	Phichit	28	73	101	198,011.99	39.00	93,318.09	55,954.50	34,100.60	3,262.99	36,135.00	19,819.50
	Uttaradit	26	53	79	169,668.74	45.00	108,076.10	69,886.55	35,721.39	2,468.16	40,193.80	29,692.75
Total	**4**	**95**	**286**	**381**	**846,540.90**	**157.00**	**455,513.96**	**270,507.71**	**163,280.81**	**21,725.45**	**139,695.36**	**130,812.35**
4	Nakhon Sawan	21	121	142	395,793.62	69.00	257,832.13	157,981.58	99,850.55	-	53,868.98	104,112.60
	Tak	19	49	68	226,209.69	59.00	205,471.24	135,475.59	69,995.65	-	135,475.59	-
	Kamphaeng Phet	24	65	89	244,459.84	43.00	133,015.30	69,733.25	63,282.05	-	35,737.15	33,996.10
	Uthai Thani	14	49	63	114,672.31	23.00	47,322.72	23,677.55	23,645.17	-	4,515.05	19,162.50
Total	**4**	**78**	**284**	**362**	**981,135.46**	**194.00**	**643,641.39**	**386,867.97**	**256,773.42**	**-**	**229,596.77**	**157,271.20**
5	Nakhon Pathom	23	94	117	353,105.24	86.00	298,957.82	226,829.46	72,128.36	-	168,794.46	58,035.00
	Suphan Buri	43	83	126	309,608.39	53.00	147,355.76	99,670.09	47,685.67	-	78,470.89	21,199.20
	Chai Nat	38	21	59	120,439.07	36.00	82,381.17	49,402.75	32,978.42	-	30,816.95	18,585.80
	Samut Sakhon	12	25	37	242,865.88	29.00	221,143.94	181,501.86	37,041.11	2,600.97	66,534.16	114,967.70
Total	**4**	**116**	**223**	**339**	**1,026,018.59**	**204.00**	**749,838.69**	**557,404.15**	**189,833.57**	**2,600.97**	**344,616.45**	**212,787.70**

9	10	11	12	13	14	15	16	17	18	19	20
Service areas						Non-Service areas					
Recycling (ton/year)	Disposal (ton/year)	Landfill (ton/year)	Compost (ton/year)	Incinerator (ton/year)	Other (ton/year)	LAB non-service no. (ton/year)	Vol. of waste in LAB non-service areas (ton/year)	Vol. of recycled waste	Vol. of improper disposal waste (ton/year)	Vol. of recycled waste (ton/year) (5)+(9)+(17)	Vol. of collected waste (ton/year)
456.25	253,864.07	249,042.03	-	-	4,822.04	81.00	169,967.40	37,393.22	132,574.20	228,944.71	1,429.32
784.75	127,076.48	117,462.36	-	-	9,614.10	81.00	213,135.82	30,193.87	182,941.95	86,664.74	3,046.50
-	16,093.14	14,458.96	-	-	1,634.18	23.00	33,653.93	7,890.75	25,763.17	30,181.23	153.60
-	46,632.69	45,902.69	-	730.00	-	28.00	64,413.56	9,769.00	54,890.12	32,890.12	731.76
1,241.00	**443,666.39**	**426,866.07**	**-**	**730.00**	**16,070.32**	**213.00**	**481,170.73**	**85,246.54**	**395,923.89**	**378,680.80**	**5,361.16**
-	52,012.50	52,007.76	-	4.75	-	50.00	96,141.94	1,697.25	96,444.69	57,220.50	395,577.60
-	12,775.00	12,775.00	-	-	-	31.00	59,334.91	6,991.51	52,343.40	56,346.07	102,030.30
-	-	-	-	-	-	38.00	62,388.73	2,065.90	60,322.83	52,481.62	365,232.33
-	30,569.97	30,569.97	-	-	-	35.00	68,722.55	-	68,722.55	37,370.55	184,257.00
-	**95,357.47**	**95,352.72**	**-**	**4.75**	**-**	**154.00**	**288,588.13**	**10,754.66**	**277,833.47**	**203,418.74**	**1,047,097.23**
6,924.05	55,589.50	-	547.50	-	55,042.00	65.00	137,747.32	7,274.45	130,472.87	75,865.55	24,376.00
3,212.00	15,574.55	14,114.55	-	-	1,460.00	63.00	86,993.07	20,669.95	66,323.12	55,673.72	28,389.89
5,412.95	14,406.55	14,406.55	-	-	-	62.00	104,693.90	11,142.96	93,550.94	50,656.51	36,957.00
3,248.32	26,444.43	25,812.98	-	631.45	-	34.00	61,592.64	7,650.40	53,942.24	46,620.11	73,163.00
18,797.32	**112,015.03**	**54,334.08**	**547.50**	**631.45**	**56,502.00**	**224.00**	**391,026.93**	**46,737.76**	**344,289.17**	**228,815.89**	**162,865.89**
-	104,112.60	104,112.60	-	-	-	73.00	137,961.49	-	137,961.49	99,850.55	17,190.00
-	-	-	-	-	-	9.00	20,738.45	-	20,738.45	69,995.65	93,560.70
-	33,996.10	33,996.10	-	-	-	46.00	111,444.54	-	111,444.54	63,282.05	14,095.44
-	19,162.50	19,162.50	-	-	-	40.00	67,349.59	-	67,349.59	23,645.17	4,252.80
-	**157,271.20**	**157,271.20**	**-**	**-**	**-**	**168.00**	**337,494.07**	**-**	**337,494.07**	**256,773.42**	**129,096.94**
-	58,035.00	58,035.00	-	-	-	31.00	54,147.43	474.50	53,672.93	72,602.86	340,585.00
-	21,199.20	21,199.20	-	-	-	73.00	162,252.63	-	162,252.63	47,885.67	144,922.50
-	18,585.80	18,585.80	-	-	-	23.00	38,057.90	-	38,057.90	32,978.42	346,092.00
1,981.95	112,985.75	112,985.75	-	-	-	8.00	21,721.95	-	21,721.95	39,023.06	52,950.00
1,981.95	**210,805.75**	**210,805.75**	**-**	**-**	**-**	**135.00**	**278,179.90**	**474.50**	**275,705.40**	**192,290.02**	**884,549.50**

Note of abbreviations : no. = number IDP = Investigation Division on Police Region SAO = Sub-district Administrative Organization
LAB = Local Administrative Bureau Vol. = volume

Table 1 : Survey results of solid waste in 77 provinces (4 February 2014) (continued)

					1	2	3	4	5	6	7	8
						Service areas						
IDP	Province	Municipality no.	SAO no.	Total LAB no.	Vol. of waste (ton/year)	LAB service no.	Vol. of waste in LAB service area	Vol. of disposal waste (ton/year)	Vol. of recycled waste (ton/year)	Vol. of non-service disposal waste (ton/year)	Vol. of improper disposal waste (ton/year)	Vol. of proper disposal waste (ton/year)
6	Nonthaburi	14	31	45	562,729.79	45.00	562,729.79	449,439.65	113,290.14	-	-	449,439.65
	Samut Prakan	18	30	48	706,547.76	48.00	706,547.76	639,222.50	67,325.26	-	639,222.50	-
	Pathum Thani	27	37	64	537,064.81	47.00	493,948.75	443,298.24	50,650.52	-	443,298.24	-
	Phra Nakhon Si Ayutthaya	36	121	157	290,607.90	123.00	250,901.36	205,735.90	45,165.46	-	205,735.90	-
	Ang Thong	21	43	64	110,103.65	43.00	82,673.56	52,768.21	29,905.35	-	52,768.21	-
	Sing Buri	8	33	41	87,910.98	16.00	52,764.53	35,854.39	16,910.14	-	17,768.64	18,085.75
Total	**6**	**124**	**295**	**419**	**2,294,964.66**	**322.00**	**2,149,565.75**	**1,826,318.89**	**323,246.86**	**-**	**1,356,793.49**	**467,525.40**
7	Saraburi	34	74	108	250,074.55	78.00	213,209.14	174,725.50	33,062.61	5,421.03	43,781.75	130,943.75
	Phetchabun	24	103	127	329,608.64	69.00	203,269.27	117,858.50	54,597.15	30,813.61	80,263.50	37,595.00
	Lop Buri	23	102	125	282,767.69	58.00	188,865.00	134,119.25	54,745.75	-	119,263.75	14,855.50
	Nakhon Nayok	6	39	45	94,531.83	27.00	64,608.77	43,909.50	20,699.27	-	21,535.00	22,374.50
	Prachin Buri	13	56	69	196,623.66	47.00	155,884.80	125,627.10	30,257.70	-	123,802.10	1,825.00
Total	**5**	**100**	**374**	**474**	**1,153,606.37**	**279.00**	**825,836.97**	**596,239.85**	**193,362.47**	**36,234.65**	**388,646.10**	**207,593.75**
8	Ratchaburi	34	77	111	315,831.72	61.00	213,239.67	154,917.62	58,322.05	-	153,297.02	1,620.60
	Kanchanaburi	47	74	121	306,427.23	69.00	183,015.67	141,270.32	41,745.35	-	135,247.82	6,022.50
	Samut Songkhram	9	26	35	91,523.64	30.00	84,488.04	69,787.66	14,700.39	-	68,108.66	1,679.00
	Phetchaburi	15	69	84	190,330.38	47.00	147,843.57	115,557.24	32,286.33	-	103,877.24	11,680.00
	Prachuap Khiri Khan	16	44	60	217,363.66	38.00	172,006.59	132,074.69	39,931.90	-	88,864.34	43,210.35
Total	**5**	**121**	**290**	**411**	**1,121,476.64**	**245.00**	**800,593.55**	**613,607.53**	**186,986.02**	**-**	**549,395.08**	**64,212.45**
9	Udon Thani	65	115	180	592,761.50	113.00	437,403.59	260,224.95	177,178.65	-	138,516.91	121,708.03
	Nong Khai	19	48	67	180,436.11	47.00	137,969.41	81,920.60	56,048.81	-	19,965.50	61,955.10
	Loei	29	71	100	237,938.11	66.00	180,547.59	98,636.38	81,911.21	-	97,358.88	1,277.50
	Nakhon Phanom	18	85	103	217,548.08	45.00	103,162.45	63,035.50	40,126.95	-	60,663.00	2,372.50
	Sakon Nakhon	50	91	141	379,540.36	53.00	157,375.94	90,541.90	66,834.04	-	31,952.10	58,589.80
	Bung Karn	18	41	59	129,256.71	50.00	110,512.16	69,346.35	41,165.81	-	55,261.00	14,085.35
Total	**6**	**199**	**451**	**650**	**1,737,480.89**	**374.00**	**1,126,971.14**	**663,705.68**	**463,265.46**	**-**	**403,717.40**	**259,988.28**

9	10	11	12	13	14	15	16	17	18	19	20
Service areas						Non-Service areas					
Recycling (ton/year)	Disposal (ton/year)	Landfill (ton/year)	Compost (ton/year)	Incinerator (ton/year)	Other (ton/year)	LAB non-service no. (ton/year)	Vol. of waste in LAB non-service areas (ton/year)	Vol. of recycled waste	Vol. of improper disposal waste (ton/year)	Vol. of recycled waste (ton/year) (5)+(9)+(17)	Vol. of collected waste (ton/year)
3,650.00	445,789.65	445,789.65	-	-	-	-	-	-	-	116,940.14	-
-	-	-	-	-	-	-	-	-	-	67,325.26	2,063,448.00
-	-	-	-	-	-	17.00	43,116.05	-	43,116.05	50,650.52	121,893.00
-	-	-	-	-	-	34.00	39,706.54	-	39,706.54	45,165.46	565,717.90
-	-	-	-	-	-	21.00	27,430.09	-	27,430.09	29,905.35	151,581.00
21.54	18,064.22	18,064.22	-	-	-	25.00	35,146.45	-	35,146.45	16,931.67	10,327.50
3,671.54	**463,853.86**	**463,853.86**	**-**	**-**	**-**	**97.00**	**145,399.13**	**-**	**145,399.13**	**326,918.40**	**2,932,967.40**
5,110.00	125,833.75	21,527.70	-	-	104,306.05	30.00	36,865.41	-	36,865.41	38,172.61	201,720.00
6,095.50	31,499.50	30,404.50	-	-	1,095.00	58.00	126,339.37	-	126,339.37	60,692.85	297,240.00
-	14,855.50	14,855.50	-	-	-	67.00	93,902.70	-	93,902.70	54,745.75	352,288.00
-	22,374.50	-	-	-	22,374.50	18.00	29,923.06	-	29,923.06	20,699.27	120,520.00
-	1,825.00	1,825.00	-	-	-	22.00	40,738.86	-	40,738.86	30,257.70	556,680.00
11,205.50	**196,388.25**	**68,612.70**	**-**	**-**	**127,775.55**	**195.00**	**327,769.40**	**-**	**327,769.40**	**204,567.87**	**1,528,448.00**
-	1,620.60	1,620.60	-	-	-	50.00	102,592.04	-	102,592.04	58,322.05	1,000,122.79
491.93	5,530.57	-	-	5,530.57	-	52.00	123,411.56	-	123,411.56	42,237.28	1,658,387.35
-	1,679.00	-	-	1,679.00	-	5.00	7,035.60	-	7,035.60	14,700.39	68,130.90
468.85	11,211.15	6,197.34	-	5,013.82	-	37.00	42,466.81	-	42,466.81	32,755.18	1,173,416.21
914.69	42,295.66	33,511.38	182.50	8,601.78	-	22.00	45,357.08	-	45,357.08	40,846.59	546,356.48
1,875.47	**62,336.98**	**41,329.32**	**182.50**	**20,825.17**	**-**	**166.00**	**320,883.09**	**-**	**320,883.09**	**188,861.49**	**4,446,413.73**
10,950.00	110,758.03	110,758.03	-	-	-	67.00	155,357.91	-	155,357.91	188,128.65	7,249.10
6,263.40	55,691.70	55,691.70	-	-	-	20.00	42,466.71	-	42,466.71	62,312.21	17,237.10
-	1,277.50	1,277.50	-	-	-	34.00	57,390.52	-	57,390.52	81,911.21	10,500.28
-	2,372.50	2,372.50	-	-	-	58.00	114,385.64	-	114,385.64	40,126.95	47,703.21
-	58,589.80	58,589.80	-	-	-	88.00	222,164.42	547.50	221,616.92	67,381.54	21,869.82
-	14,085.35	8,610.35	5,475.00	-	-	9.00	18,744.55	-	18,744.55	41,165.81	18,000.17
17,213.40	**242,774.88**	**237,299.88**	**5,475.00**	**-**	**-**	**276.00**	**610,509.75**	**547.50**	**609,962.25**	**481,026.56**	**122,559.88**

Note of abbreviations : no. = number IDP = Investigation Division on Police Region SAO = Sub-district Administrative Organization
LAB = Local Administrative Bureau Vol. = volume

Table 1 : Survey results of solid waste in 77 provinces (4 February 2014) (continued)

					1	2	3	4	5	6	7	8
						Service areas						
IDP	Province	Municipality no.	SAO no.	Total LAB no.	Vol. of waste (ton/year)	LAB service no.	Vol. of waste in LAB service area	Vol. of disposal waste (ton/year)	Vol. of recycled waste (ton/year)	Vol. of non-service disposal waste (ton/year)	Vol. of improper disposal waste (ton/year)	Vol. of proper disposal waste (ton/year)
10	Khon Kaen	75	149	224	697,955.50	170.00	576,368.42	355,021.45	221,346.97	-	285,199.13	69,822.32
	Maha Sarakham	18	124	142	350,389.36	59.00	185,237.88	120,584.30	64,653.58	-	97,917.80	22,666.50
	Kalasin	71	79	150	357,343.57	91.00	244,866.00	146,458.55	98,407.44	-	94,819.70	51,638.85
	Chaiyaphum	35	107	142	400,091.32	89.00	256,371.03	152,081.60	104,289.43	-	115,209.59	36,872.01
	Nong Bua Lam Phu	24	43	67	180,928.73	41.00	117,891.49	56,648.00	61,243.49	-	40,788.75	15,859.25
Total	**5**	**223**	**502**	**725**	**1,986,708.48**	**450.00**	**1,380,734.80**	**830,793.90**	**549,940.91**	**-**	**633,934.97**	**196,858.93**
11	Nakhon Ratchasima	82	251	333	982,760.19	136.00	528,738.78	406,395.93	102,192.77	20,150.08	238,898.05	167,497.88
	Surin	26	146	172	475,290.40	22.00	79,343.79	53,167.06	10,262.74	15,914.00	22,273.98	30,893.08
	Buri Ram	60	148	208	574,907.10	57.00	201,939.17	155,371.66	34,565.00	12,002.52	123,429.63	31,942.03
	Si Sa Ket	29	187	216	493,905.99	33.00	101,530.13	77,188.58	19,999.62	4,341.93	39,392.60	37,795.98
Total	**4**	**197**	**732**	**929**	**2,526,863.67**	**248.00**	**911,551.88**	**692,123.23**	**167,020.12**	**52,408.53**	**423,994.25**	**268,128.98**
12	Ubon Ratchathani	45	193	238	626,495.37	98.00	321,761.45	229,033.45	92,727.99	-	54,749.32	174,284.13
	Amnat Charoen	22	41	63	127,085.80	27.00	61,403.17	39,581.33	21,821.84	-	16,370.25	23,211.08
	Yasothon	23	64	87	178,346.62	56.00	120,139.54	85,358.90	34,780.64	-	34,269.85	51,089.05
	Mukdahan	24	30	54	116,877.53	25.00	62,477.15	46,501.00	15,976.15	-	12,424.60	34,076.40
	Roi Et	65	137	202	457,560.06	54.00	151,020.90	92,494.65	58,526.25	-	77,653.75	14,840.90
Total	**5**	**179**	**465**	**644**	**1,506,365.39**	**260.00**	**716,802.21**	**492,969.33**	**223,832.88**	**-**	**195,467.77**	**297,501.56**
13	Chon Buri and Pattaya	48	50	98	857,708.16	84.00	831,403.87	712,104.05	116,332.61	2,967.21	349,294.05	362,810.00
	Rayong	30	38	68	351,093.57	66.00	346,101.60	272,169.55	70,099.68	3,832.37	108,240.75	163,928.80
	Trat	14	29	43	93,309.72	30.00	74,742.60	54,632.78	20,109.82	-	36,609.50	18,023.28
	Chanthaburi	45	36	81	212,675.28	55.00	165,608.99	111,160.75	52,138.58	2,309.66	47,183.55	63,977.20
	Chachoengsao	34	74	108	287,733.52	63.00	195,352.23	146,996.45	39,964.99	8,390.78	141,667.45	5,329.00
	Sra Kaew	16	49	65	196,320.36	31.00	119,554.56	74,288.45	45,266.11	-	57,315.95	16,972.50
Total	**6**	**187**	**276**	**463**	**1,998,840.60**	**329.00**	**1,732,763.85**	**1,371,352.03**	**343,911.79**	**17,500.03**	**740,311.25**	**631,040.78**

9	10	11	12	13	14	15	16	17	18	19	20
Service areas						Non-Service areas					
Recycling (ton/year)	Disposal (ton/year)	Landfill (ton/year)	Compost (ton/year)	Incinerator (ton/year)	Other (ton/year)	LAB non-service no. (ton/year)	Vol. of waste in LAB non-service areas (ton/year)	Vol. of recycled waste	Vol. of improper disposal waste (ton/year)	Vol. of recycled waste (ton/year) (5)+(9)+(17)	Vol. of collected waste (ton/year)
585.31	69,237.00	69,237.00	-	-	-	54.00	121,587.08	71.18	121,515.91	222,003.46	723,691.68
894.25	21,772.25	21,772.25	-	-	-	83.00	165,151.49	-	165,151.49	65,547.83	66,562.64
201.76	51,437.09	51,437.09	-	-	-	59.00	112,477.58	-	112,477.58	98,609.21	45,369.65
945.35	35,926.66	35,926.66	-	-	-	53.00	143,720.29	-	143,720.29	105,234.78	30,101.10
350.77	15,508.49	15,508.49	-	-	-	26.00	63,037.24	-	63,037.24	61,594.25	29,662.20
2,977.44	**193,881.48**	**193,881.48**	**-**	**-**	**-**	**275.00**	**605,973.68**	**71.18**	**605,902.50**	**552,989.53**	**895,387.27**
-	167,497.88	122,534.74	24,833.32	7,222.48	12,907.34	197.00	454,021.40	-	454,021.40	102,192.77	460,002.38
-	30,893.08	25,277.71	4,003.53	-	1,611.84	150.00	395,946.60	-	395,946.60	10,202.74	72,451.83
-	31,942.03	31,942.03	-	-	-	151.00	372,967.93	-	372,967.93	34,565.00	124,736.48
717.26	37,078.72	29,670.53	7,408.18	-	-	183.00	392,375.86	-	392,375.86	20,716.88	111,469.20
717.26	**267,411.72**	**209,425.02**	**36,245.04**	**7,222.48**	**14,519.18**	**681.00**	**1,615,311.79**	**-**	**1,615,311.79**	**167,737.38**	**768,659.88**
30,214.70	144,069.43	144,069.43	-	-	-	140.00	304,733.93	10,603.25	294,130.68	133,545.94	314.49
3,073.30	20,137.78	19,152.28	-	985.50	-	36.00	65,682.63	5,748.75	59,933.88	30,643.89	16,304.11
5,223.15	45,865.90	39,639.00	215.35	6,011.55	-	31.00	58,207.08	2,438.20	55,768.88	42,441.99	20,252.52
5,314.40	28,762.00	28,762.00	-	-	-	29.00	54,400.38	229.95	54,170.43	21,520.50	61.29
1,107.41	13,733.49	10,295.19	-	3,438.30	-	148.00	306,539.16	12,596.15	293,943.01	72,229.81	91,979.37
44,932.96	**252,568.60**	**241,917.90**	**215.35**	**10,435.35**	**-**	**384.00**	**789,565.18**	**31,616.30**	**757,946.88**	**300,299.81**	**128,911.78**
-	362,810.00	362,810.00	-	-	-	14.00	26,304.29	-	26,304.29	116,332.61	501,635.00
40,763.93	123,164.87	110,294.97	11,774.90	1,095.00	-	2.00	4,991.97	1,222.75	3,769.22	112,066.36	45,150.00
365.00	17,658.28	17,658.28	-	-	-	13.00	18,567.12	-	18,567.12	20,474.82	20,895.00
-	63,977.20	9,537.45	-	-	54,439.75	26.00	47,066.29	-	47,066.29	52,138.58	80,115.00
1,460.00	3,869.00	3,869.00	-	-	-	45.00	92,381.29	-	92,381.29	41,424.99	202,753.20
-	16,972.50	16,972.50	-	-	-	34.00	76,765.80	-	76,765.80	45,266.11	35,175.00
42,588.93	**588,451.85**	**521,142.20**	**11,774.90**	**1,095.00**	**54,439.75**	**134.00**	**266,076.76**	**1,222.75**	**264,654.01**	**387,723.47**	**885,723.20**

Note of abbreviations : no. = number IDP = Investigation Division on Police Region SAO = Sub-district Administrative Organization
LAB = Local Administrative Bureau Vol. = volume

Table 1 : Survey results of solid waste in 77 provinces (4 February 2014) (continued)

					1	2	3	4	5	6	7	8
						Service areas						
IDP	Province	Municipality no.	SAO no.	Total LAB no.	Vol. of waste (ton/year)	LAB service no.	Vol. of waste in LAB service area	Vol. of disposal waste (ton/year)	Vol. of recycled waste (ton/year)	Vol. of non-service disposal waste (ton/year)	Vol. of improper disposal waste (ton/year)	Vol. of proper disposal waste (ton/year)
14	Surat Thani	36	101	137	357,039.35	73.00	231,738.50	226,217.15	5,521.36	-	226,217.15	-
	Chumphon	26	52	78	134,663.10	44.00	68,612.70	65,778.48	2,834.23	-	51,105.48	14,673.00
	Nakhon Si Thammarat	47	137	184	380,333.65	105.00	194,267.60	188,507.90	5,759.70	-	180,222.40	8,285.50
	Ranong	12	18	30	72,697.05	18.00	52,633.00	48,749.40	3,883.60	-	48,749.40	-
Total	**4**	**121**	**308**	**429**	**944,733.15**	**240.00**	**547,251.80**	**529,252.92**	**17,998.88**	**-**	**506,294.42**	**22,958.50**
15	Phuket	12	6	18	250,672.16	18.00	250,672.16	211,678.10	38,994.06	-	-	211,678.10
	Trang	16	83	99	240,621.88	52.00	156,117.77	74,507.45	81,610.32	-	66,784.05	7,723.40
	Phangnga	14	37	51	109,386.01	46.00	103,360.81	65,086.80	38,274.01	-	37,970.95	27,115.85
	Satun	7	34	41	106,350.82	37.00	98,299.50	60,352.75	37,946.75	-	36,861.35	23,491.40
	Krabi	13	48	61	189,148.94	46.00	152,744.77	113,635.45	39,109.32	-	112,270.35	1,365.10
Total	**5**	**62**	**208**	**270**	**896,179.82**	**199.00**	**761,195.01**	**525,260.55**	**235,934.46**	**-**	**253,886.70**	**271,373.85**
16	Songkhla	45	95	140	582,967.01	67.00	450,386.44	233,289.75	217,096.69	-	206,020.60	27,269.15
	Narathiwat	15	73	88	259,539.85	33.00	134,763.71	52,625.70	82,138.01	-	40,190.15	12,435.55
	Yala	15	48	63	194,847.15	41.00	152,503.39	68,773.30	83,730.09	-	50,242.25	18,531.05
	Pattani	16	97	113	226,139.63	54.00	135,544.61	57,903.60	77,641.01	-	57,903.60	-
	Phatthalung	48	25	73	183,536.21	41.00	106,089.60	53,067.35	53,022.25	-	41,022.35	12,045.00
Total	**5**	**139**	**338**	**477**	**1,447,029.85**	**236.00**	**979,287.75**	**465,659.70**	**513,628.05**	**-**	**395,378.95**	**70,280.75**
Total 76 Provinces	**76**	**2,273**	**5,508**	**7,781**	**22,637,274.85**	**4,178.00**	**15,181,120.07**	**10,736,777.71**	**4,313,872.73**	**130,469.63**	**6,938,178.37**	**3,796,699.34**
Bangkok	1	-	-	1	4,137,275.00	1.00	4,137,275.00	3,622,625.00	514,650.00	-	-	3,622,625.00
Total 77 Provinces	**77**	**2,273**	**5,508**	**7,782**	**26,774,549.85**	**4,179.00**	**19,318,395.07**	**14,359,402.71**	**4,828,522.75**	**130,469.63**	**6,936,178.37**	**7,421,224.34**

9	10	11	12	13	14	15	16	17	18	19	20
Service areas						Non-Service areas					
Recycling (ton/year)	Disposal (ton/year)	Landfill (ton/year)	Compost (ton/year)	Incinerator (ton/year)	Other (ton/year)	LAB non-service no. (ton/year)	Vol. of waste in LAB non-service areas (ton/year)	Vol. of recycled waste	Vol. of improper disposal waste (ton/year)	Vol. of recycled waste (ton/year) (5)+(9)+(17)	Vol. of collected waste (ton/year)
-	-	-	-	-	-	64.00	125,300.85	-	125,300.85	5,521.36	1,003,332.60
-	14,673.00	13,030.50	-	1,642.50	-	34.00	66,050.40	-	66,050.40	2,834.23	235,008.75
-	8,285.50	8,285.50	-	-	-	79.00	186,066.05	-	186,066.05	5,759.70	1,265,358.00
-	-	-	-	-	-	12.00	20,064.05	-	20,064.05	3,883.60	296,992.20
-	**22,958.50**	**21,316.00**	**-**	**1,642.50**	**-**	**189.00**	**397,481.35**	**-**	**397,481.35**	**17,998.88**	**2,800,691.55**
-	211,678.10	-	-	211,678.10	-	-	-	-	-	38,994.06	-
-	7,723.40	7,723.40	-	-	-	47.00	84,504.11	-	84,504.11	81,610.32	77,919.39
-	27,115.85	27,115.85	-	-	-	5.00	6,025.20	-	6,025.20	38,274.01	15,826.20
-	23,491.40	23,491.40	-	-	-	4.00	8,051.32	-	8,051.32	37,946.75	95,148.00
-	1,365.10	1,365.10	-	-	-	15.00	36,404.18	-	36,404.18	39,109.32	79,753.00
-	**271,373.85**	**59,695.75**	**-**	**211,678.10**	**-**	**71.00**	**134,984.80**	**-**	**134,984.80**	**235,934.46**	**268,646.59**
-	27,269.15	27,269.15	-	-	-	73.00	132,580.57	-	132,580.57	217,096.69	2,471,840.40
-	12,435.55	12,435.55	-	-	-	55.00	124,776.13	-	124,776.13	82,138.01	79,096.00
-	18,531.05	18,531.05	-	-	-	22.00	42,343.76	-	42,343.76	63,730.09	231,029.40
-	-	-	-	-	-	59.00	90,595.02	-	90,595.02	77,641.01	67,157.75
-	12,045.00	12,045.00	-	-	-	32.00	77,446.61	-	77,446.61	53,022.25	84,577.50
-	**70,280.75**	**70,280.75**	**-**	**-**	**-**	**241.00**	**467,742.09**	**-**	**467,742.09**	**513,628.05**	**2,933,701.05**
147,202.77	**3,651,396.57**	**3,073,384.69**	**54,440.29**	**254,264.79**	**269,306.79**	**3,603.00**	**7,456,154.79**	**176,671.49**	**7,279,463.30**	**4,637,746.99**	**19,941,102.87**
-	3,622,625.00	3,622,625.00	-	-	-	-	-	-	-	514,650.00	-
147,202.77	**7,274,021.57**	**6,696,009.69**	**54,440.29**	**254,267.79**	**269,306.79**	**3,603.00**	**7,456,154.79**	**176,671.49**	**7,279,883.30**	**5,152,396.99**	**19,941,102.87**

Note of abbreviations : no. = number IDP = Investigation Division on Police Region SAO = Sub-district Administrative Organization
LAB = Local Administrative Bureau Vol. = volume

Appendix E

Ranking of provinces with waste management crisis

Table 1 : Ranking of provinces facing a waste management crisis

			1	2	3	4	5	6	7	8	9	10	11	12
No.	Province	Muni-cipality	Vol. of waste (ton/year)	Vol. of disposal waste (ton/year)	Vol. of improper disposal waste	Vol. of non-service disposal waste (ton/year)	Vol. of collected waste (ton/year)	Factor A [(3)/(2)]*100	Factor B [(40) / (1)]*100	Factor C [(5)/(Max 5)] *100	Score A (6) * 0.4	Score B (7) * 0.2	Score C (8) * 0.4	Total Score (9) + (10) + (11)
1	Songkhla	16	582,967.01	233,289.75	206,020.60	132,580.57	2,471,840.40	88.31	22.74	100.00	35.32	4.55	40.00	79.87
2	Samut Prakan	6	706,547.76	639,222.50	639,222.50	0.00	2,063,448.80	100.00	0.00	83.48	40.00	0.00	33.39	73.39
3	Kanchanaburi	8	306,427.23	141,270.32	135,247.82	123,411.56	1,658,387.35	95.74	40.27	67.09	38.29	8.05	26.84	73.19
4	Nakhon Si Thammarat	14	380,333.65	188,507.90	180,222.40	186,066.05	1,265,358.00	95.60	48.92	51.19	38.24	9.78	20.48	68.50
5	Surat Thani	14	357,039.35	226,217.15	226,217.15	125,300.85	1,003,332.60	100.00	35.09	40.59	40.00	7.02	16.24	63.26
6	Ratchaburi	8	315,831.72	154,917.62	153,297.02	102,592.04	1,000,122.79	98.95	32.48	40.46	39.58	6.50	16.18	62.26
7	Phetchaburi	8	190,330.38	115,557.24	103,877.24	42,486.81	1,173,416.21	89.89	22.32	47.47	35.96	4.46	18.99	59.41
8	Phrae	2	180,278.35	67,473.90	67,473.90	62,388.73	365,232.33	100.00	34.61	14.78	40.00	6.92	5.91	52.83
9	Prachin Buri	7	196,623.66	125,627.10	123,802.10	40,738.86	556,680.00	98.55	20.72	22.52	39.42	4.14	9.01	52.57
10	Phra Nakhon Si Ayutthaya	6	290,607.90	205,735.90	205,735.90	39,706.54	585,717.90	100.00	13.66	23.70	40.00	2.73	9.48	52.21
11	Ranong	14	72,697.05	48,749.40	48,749.40	20,064.05	296,992.20	100.00	27.60	12.02	40.00	5.52	4.81	50.33
12	Nakhon Phanom	9	217,548.08	63,035.50	60,663.00	114,385.64	47,703.21	96.24	52.58	1.93	38.49	10.52	0.77	49.78
13	Pattani	16	226,139.63	57,903.60	57,903.60	90,595.02	67,157.75	100.00	40.06	2.72	40.00	8.01	1.09	49.10
14	Chachoengsao	13	287,733.52	146,996.45	141,667.45	100,772.07	202,753.20	96.37	35.02	8.20	38.55	7.00	3.28	48.84
15	Roi Et	12	457,560.06	92,494.65	77,653.75	306,539.16	91,979.37	83.95	66.99	3.72	33.58	13.40	1.49	48.47
16	Lop Buri	7	282,767.69	134,119.25	119,263.75	93,902.70	352,288.00	88.92	33.21	14.25	35.57	6.64	5.70	47.91
17	Ang Thong	6	110,103.65	52,768.21	52,768.21	27,430.09	151,581.00	100.00	24.91	6.13	40.00	4.98	2.45	47.44
18	Khon Kaen	10	697,955.50	355,021.45	285,199.13	121,587.08	723,691.68	80.33	17.42	29.28	32.13	3.48	11.71	47.33

Table 1 : Ranking of provinces facing a waste management crisis (continued)

			1	2	3	4	5	6	7	8	9	10	11	12
No.	Province	Muni-cipality	Vol. of waste (ton/year)	Vol. of disposal waste (ton/year)	Vol. of improper disposal waste	Vol. of non-service disposal waste (ton/year)	Vol. of collected waste (ton/year)	Factor A [(3)/(2)]*100	Factor B [(40) / (1)]*100	Factor C [(5)/(Max 5)] *100	Score A (6) * 0.4	Score B (7) * 0.2	Score C (8) * 0.4	Total Score (9) + (10) + (11)
19	Buri Ram	11	574,907.10	155,371.66	123,429.63	384,970.45	124,736.48	79.44	66.96	5.05	31.78	13.39	2.02	47.19
20	Chumphon	14	134,663.10	65,778.48	51,105.48	66,050.40	235,008.75	77.69	49.05	9.51	31.08	9.81	3.80	44.69
21	Krabi	15	189,148.94	113,635.45	112,270.35	36,404.18	79,753.00	98.80	19.25	3.23	39.52	3.85	1.29	44.66
22	Loei	9	237,938.11	98,636.38	97,358.88	57,390.52	10,500.28	98.70	24.12	0.42	39.48	4.82	0.17	44.48
23	Suphan Buri	5	309,608.39	99,670.09	78,470.89	162,252.63	144,922.50	78.73	52.41	5.86	31.49	10.48	2.35	44.32
24	Trang	15	240,621.88	74,507.45	66,784.05	84,504.11	77,919.39	89.63	35.12	3.15	35.85	7.02	1.26	44.14
25	Pathum Thani	6	537,064.81	443,298.24	443,298.24	43,116.05	121,893.00	100.00	8.03	4.93	40.00	1.61	1.97	43.58
26	Tak	4	226,209.69	135,475.59	135,475.59	20,738.45	93,560.70	100.00	9.17	3.79	40.00	1.83	1.51	43.35
27	Maha Sarakham	10	350,389.36	120,584.30	97,917.80	165,151.49	66,562.64	81.20	47.13	2.69	32.48	9.43	1.08	42.98
28	Samut Songkhram	8	91,523.64	69,787.66	68,108.66	7,035.60	68,130.90	97.59	7.69	2.76	39.04	1.54	1.10	41.68
29	Phayao	2	191,104.28	82,414.81	69,639.81	59,334.91	102,030.30	84.50	31.05	4.13	33.80	6.21	1.65	41.66
30	Phetchabun	7	329,608.64	117,858.50	80,263.50	157,152.98	297,240.00	68.10	47.68	12.03	27.24	9.54	4.81	41.59
31	Narathiwat	16	259,539.85	52,625.70	40,190.15	124,776.13	79,096.00	76.37	48.08	3.20	30.55	9.62	1.28	41.44
32	Phatthalung	16	183,536.21	53,067.35	41,022.35	77,446.61	84,577.50	77.30	42.20	3.42	30.92	8.44	1.37	40.73
33	Nakhon Ratchasima	11	982,760.19	406,395.93	238,898.05	474,171.49	460,002.38	58.78	48.25	18.61	23.51	9.65	7.44	40.61
34	Prachuap Khiri Khan	8	217,363.66	132,074.69	88,864.34	45,357.08	546,356.48	67.28	20.87	22.10	26.91	4.17	8.84	39.93
35	Sra Kaew	13	196,320.36	74,288.45	57,315.95	76,765.80	35,175.00	77.15	39.10	1.42	30.86	7.82	0.57	39.25
36	Lampang	2	297,605.09	143,939.90	91,927.40	98,141.9	395,577.60	63.87	32.98	16.00	25.55	6.60	6.40	38.54

Table 1 : Ranking of provinces facing a waste management crisis (continued)

			1	2	3	4	5	6	7	8	9	10	11	12
No.	Province	Muni-cipality	Vol. of waste (ton/year)	Vol. of disposal waste (ton/year)	Vol. of improper disposal waste	Vol. of non-service disposal waste (ton/year)	Vol. of collected waste (ton/year)	Factor A [(3)/(2)]*100	Factor B [(40) / (1)]*100	Factor C [(5)/(Max 5)] *100	Score A (6) * 0.4	Score B (7) * 0.2	Score C (8) * 0.4	Total Score (9) + (10) + (11)
37	Nakhon Pathom	5	353,105.24	226,829.46	168,794.46	54,147.43	340,585.00	74.41	15.33	13.78	29.77	3.07	5.51	38.34
38	Si Sa Ket	11	493,905.99	77,188.58	39,392.60	396,717.79	111,469.20	51.03	80.32	4.51	20.41	16.06	1.80	38.28
39	Sukhothai	2	212,721.70	106,628.59	76,058.62	68,722.55	184,257.00	71.33	32.31	7.45	28.53	6.46	2.98	37.98
40	Chaiyaphum	10	400,091.32	152,081.60	115,209.59	143,720.29	30,101.10	75.76	35.92	1.22	30.30	7.18	0.49	37.97
41	Phichit	3	198,011.99	55,954.50	36,135.00	107,956.89	36,957.00	64.58	54.52	1.50	25.83	10.90	0.60	37.33
42	Yala	16	194,847.15	68,773.30	50,242.25	42,343.76	231,029.40	73.05	21.73	9.35	29.22	4.35	3.74	37.31
43	Chai Nat	5	120,439.07	49,402.75	30,816.95	38,057.90	346,092.00	62.38	31.60	14.00	24.95	6.32	5.60	36.87
44	Nong Bua Lam Phu	10	180,928.73	56,648.00	40,788.75	63,037.24	29,662.20	72.00	34.84	1.20	28.80	6.97	0.48	36.25
45	Surin	11	475,290.40	53,167.06	22,273.98	411,860.60	72,451.83	41.89	86.65	2.93	16.76	17.33	1.17	35.26
46	Bung Karn	9	129,256.71	69,346.35	55,261.00	18,744.55	18,000.17	79.69	14.50	0.73	31.88	2.90	0.29	35.07
47	Kalasin	10	357,343.57	146,458.55	94,819.70	112,477.58	45,369.65	64.74	31.48	1.84	25.90	6.30	0.73	32.93
48	Uttaradit	3	169,668.74	69,886.55	40,193.80	64,060.80	73,163.00	57.51	37.76	2.96	23.01	7.55	1.18	31.74
49	Nan	3	162,267.29	37,007.35	18,220.80	93,468.17	28,389.89	49.24	57.60	1.15	19.69	11.52	0.46	31.67
50	Trat	13	93,309.72	54,632.78	36,609.50	18,567.12	20,895.00	67.01	19.90	0.85	26.80	3.98	0.34	31.12
51	Kamphaeng Phet	4	244,459.84	69,733.25	35,737.15	111,444.54	14,095.44	51.25	45.59	0.57	20.50	9.12	0.23	29.85
52	Chon Buri and Pattaya	13	857,708.16	712,104.05	349,294.05	29,271.50	501,635.00	49.05	3.41	20.29	19.62	0.68	8.12	28.42
53	Sing Buri	6	87,910.98	35,854.39	17,768.64	35,146.45	10,327.50	49.56	39.98	0.42	19.82	8.00	0.17	27.99
54	Nakhon Nayok	7	94,531.83	43,909.50	21,535.00	29,923.06	120,520.00	49.04	31.65	4.88	19.62	6.33	1.95	27.90

Table 1 : Ranking of provinces facing a waste management crisis (continued)

			1	2	3	4	5	6	7	8	9	10	11	12
No.	Province	Muni-cipality	Vol. of waste (ton/year)	Vol. of disposal waste (ton/year)	Vol. of improper disposal waste	Vol. of non-service disposal waste (ton/year)	Vol. of collected waste (ton/year)	Factor A [(3)/(2)]*100	Factor B [(40) / (1)]*100	Factor C [(5)/(Max 5)] *100	Score A (6) * 0.4	Score B (7) * 0.2	Score C (8) * 0.4	Total Score (9) + (10) + (11)
55	Satun	15	106,350.82	60,352.75	36,861.35	8,051.32	95,148.00	61.08	7.57	3.85	24.43	1.51	1.54	27.48
56	Amnat Charoen	12	127,085.80	39,581.33	16,370.25	65,682.63	16,304.11	41.36	51.68	0.66	16.54	10.34	0.26	27.14
57	Udon Thani	9	592,761.50	260,224.95	138,516.91	155,357.91	7,249.10	53.23	26.21	0.29	21.29	5.24	0.12	26.65
58	Phisanulok	3	316,592.88	107,659.31	45,145.76	147,266.52	24,376.00	41.93	46.52	0.99	16.77	9.30	0.39	26.47
59	Sakon Nakhon	9	379,540.36	90,541.90	31,952.10	222,164.42	21,869.82	35.29	58.54	0.88	14.12	11.71	0.35	26.18
60	Phangnga	15	109,386.01	65,086.80	37,970.95	6,025.20	15,826.20	58.34	5.51	0.64	23.34	1.10	0.26	24.69
61	Chanthaburi	13	212,675.28	111,160.75	47,183.55	49,375.95	80,115.00	42.45	23.22	3.24	16.98	4.64	1.30	22.92
62	Yasothon	12	178,346.62	85,358.90	34,269.85	58,207.08	20,252.52	40.15	32.64	0.82	16.06	6.53	0.33	22.91
63	Mae Hong Son	1	80,100.10	24,155.70	8,062.56	33,653.93	153.60	33.38	42.01	0.01	13.35	8.40	0.00	21.76
64	Nakhon Sawan	4	395,793.62	157,981.58	53,868.98	137,961.49	17,190.00	34.10	34.86	0.70	13.64	6.97	0.28	20.89
65	Mukdahan	12	116,877.53	46,501.00	12,424.60	54,400.38	61.29	26.72	46.54	0.00	10.69	9.31	0.00	20.00
66	Uthai Thani	4	114,672.31	23,677.55	4,515.05	67,349.59	4,252.80	19.07	58.73	0.17	7.63	11.75	0.07	19.44
67	Ubon Ratchathani	12	626,495.37	229,033.45	54,749.32	304,733.93	314.49	23.90	48.64	0.01	9.56	9.73	0.01	19.30
68	Chiang Rai	1	435,147.96	166,326.01	38,464.78	213,135.82	3,046.50	23.13	48.98	0.12	9.25	9.80	0.05	19.10
69	Samut Sakhon	5	242,865.88	181,501.86	66,534.16	24,322.91	52,950.00	36.66	10.01	2.14	14.66	2.00	0.86	17.52
70	Rayong	13	351,093.57	272,169.55	108,240.75	8,824.34	45,150.00	39.77	2.51	1.83	15.91	0.50	0.73	17.14
71	Saraburi	7	250,074.55	174,725.50	43,781.75	42,286.44	201,720.00	25.06	16.91	8.16	10.02	3.38	3.26	16.67
72	Lamphun	1	144,968.13	57,433.44	10,800.75	64,413.56	731.76	18.81	44.43	0.03	7.52	8.89	0.01	16.42

Table 1 : Ranking of provinces facing a waste management crisis (continued)

			1	2	3	4	5	6	7	8	9	10	11	12
No.	Province	Muni-cipality	Vol. of waste (ton/year)	Vol. of disposal waste (ton/year)	Vol. of improper disposal waste	Vol. of non-service disposal waste (ton/year)	Vol. of collected waste (ton/year)	Factor A [(3)/(2)]*100	Factor B [(40) / (1)]*100	Factor C [(5)/(Max 5)] *100	Score A (6) * 0.4	Score B (7) * 0.2	Score C (8) * 0.4	Total Score (9) + (10) + (11)
73	Nong Khai	9	180,436.11	81,920.60	19,965.50	42,466.71	17,237.10	24.37	23.54	0.70	9.75	4.71	0.28	14.73
74	Chiang Mai	1	627,404.57	266,341.91	12,021.59	169,967.43	1,429.32	4.51	27.09	0.06	1.81	5.42	0.02	7.25
75	Nonthaburi	6	562,729.79	449,439.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	Phuket	15	250,672.16	211,678.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	Bangkok		4,137,275.00	3,622,625.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Max	79.87
Min	0.00
Mean	36.60

Appendix F

Related laws

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
1	Notification of the Energy Regulatory board on Protection, Correction and Evaluation measures of environmental impacts for those who are exempt from submitting Environmental Impact Assessment Reports based on the National Environmental Promotion and Protection Act for electricity production from biomass (solid type)	In the electricity production business, those who are exempt from submitting Environmental Impact Assessment Reports based on the National Environmental Promotion and Protection Act, must follow the code of conduct on the Protection, Correction and Evaluation measures of environmental impacts. Businesses are exempt from submitting Environmental Impact Assessment Reports if they are producing less than 10 megawatts of electricity from biomass (solid type) that the regulatory board specified in the appendix, in order to set the standard and procedure of electricity production that does not affect the environment and the safety of the community in the nearby area of the electricity production site.	Volume 230 Special Part 11 D 25 January B.E. 2556 (2013)	-
2	Notification of the Department of Land Transport concerning the design, size, standard and features of smoke meters, gas analyzers, gas leak detectors, sound level meters, engine tachometers and tint meters for inspection of vehicles at the Vehicle Condition Inspection Office B.E. 2556	- specifying the design, size, standard and features of smoke meters, gas analyzers, gas leak detectors, sound level meters, engine tachometers and tint meters. - The smoke meters, gas analyzers, gas Leak detectors, sound level meters and tint meters that are to be used at the Vehicle Condition Inspection Office, must be approved by the Land Transportation Department to use for inspection of vehicles at the Vehicle Condition Inspection Office. - The gas analyzers and the sound level meters that were approved by the Land Transportation Department and used at the Vehicle Condition Inspection office before the effective date of this Notice, can continue to be used but must provide a device that can send the inspection results to the record system and can report the inspection results according to the Land Transportation Department's specifications before 25 June B.E. 2556.	Volume 130 Special Part 15 D 1 February B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (2 February 2013)

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
3	Notification of the Ministry of Natural Resources and Environment on the category and size of a project or enterprise that is required to submit the EIA report and criteria, method, procedure and approach for preparing the EIA Report No. 2 B.E. 2556 (Modified by added project number 14 Iron or Steel Industry)	- Adding the definition after the definition of "Water Gate in Main Rivers" in No.2 of the Notice from the Ministry of Natural Resources and Environment on specification of category and size of a project or enterprise that has to submit the EIA Report and criteria, method, procedure and approach for preparing the EIA Report dated 24 April B.E. 2555. - Cancelling the clause relating to the Size, box no. 14 in Appendix 3 of the Notice from the Ministry of Natural Resources and Environment on the specification of the category and size of project, or an enterprise that has to submit the EIA Report and criteria, method, procedure and approach for preparing the EIA Report dated 24 April B.E. 2555.	Volume 130 Special Part 37 D 22 March B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (23 March 2013)
4	Notification of the Food and Drug Administration, Ministry of Public Health on notifying, issuing the receipt of notification, renewing and applying for renewal of receipt of notification for processing hazardous substance type 2 that are under the FDA's responsibility B.E. 2556	- Cancelling the Notice of the Food and Drug Administration on notifying, receipt of notification, renewing and applying for renewal of receipt of notification for processing hazardous substance type 2 that are under the FDA's responsibility, dated Oct 17th, B.E. 2554. - Anyone who wants to produce, import, export or possess hazardous substances must report the process following the wo-or/sor-tor 3 form with documents and evidence. - Anyone who wants to change the content in the receipt of processing notification must submit the wo-or/sor-tor 11 form with documents and evidence, but change of trading name and the name and quantity of hazardous substances (essential message) cannot be changed. Permission to change the content in the receipt of processing notification must be shown in the record of changes at the end of the receipt of processing notification. - Anyone who wants to renew the receipt of processing notification must submit the wo-or/sor-tor 12 with documents and evidence within 90 days before the receipt of processing notification's permission to renew expires. Officials must show in the record of renewal at the end of the receipt of processing notification or an official may issue a new receipt of processing notification.	Volume 130 Special Part 38 D 25 March B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (26 March 2013)

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
		- Notification of processing, changing content of the receipt of processing notification and renewing the receipt of processing notification according to this Notice, must be submitted to the Office of Food and Drug Administration or to the Public Health Office in the province, or the Food and Drug Administration's electronic network online.		
5	Notification of the Ministry of Public Health on identification and category of Prohibiting transport of psychotropic substance B.E. 2556 (1) Pseudoephedrine	The Minister of Public Health with consent of the committee of the Administration of Psychotropic Substances announced the identification and category of psychotropic substance that is prohibited for transport as followed. Psychotropic Substance type 2 (1) Pseudoephedrine	Volume 130 Special Part 48 D 17 April B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (18 April 2013)
6	Notification of the Department of Industrial Work on notification and receipt of notification on hiring full-time Environmental Supervisor for the factory B.E. 2556	Procedures of notification and receipt of notification on hiring full-time Environmental Supervisor in the factory based on the clause no.7 of the Notice from the Ministry of Industry on the category of type and size of factories, method of controlling toxic waste, pollution, and others that can affect the environment, qualification of the supervisors, full-time workers and procedure of registration of supervisors for environmental pollution control system (no.2) B.E. 2554.	Volume 130 Special Part 74 D 21 June B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (22 June 2013)
7	Notification of the Department of Industrial Work on the registration of a water-pollution control system supervisor or an air-pollution control system supervisor or an industrial toxic waste management system supervisor B.E. 2556	Procedure of registration for supervisors of water-pollution control systems or supervisors of air-pollution control systems or supervisors of industrial toxic waste management systems, in order to optimize the work of the supervisor of water-pollution control systems or supervisor of air-pollution control systems or supervisor of industrial toxic waste management systems for the maximum benefit to both the enterprise and the environment inside and outside of the factory.	Volume 130 Special Part 74 D 21 June B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (22 June 2013)

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
8	Notification of the Ministry of Natural Resources and Environment on the limitation of Odor intensity releasing from animal farms.	- Setting the limitation of odor intensity being released from animal farms not to exceed 30 Odor Unit : OU - Odor intensity must be inspected by sensory test and sample collection. Registration of the names of the sensory test operators must follow the Notice of the Pollution Control Administration that was the Announcement of Government Gazette.	Volume 130 Special Part 85 D 15 July B.E. 2556 (2013)	One year after the Announcing in the Royal Gazette
9	Notification of the Department of Land transport on the specification of design, size, standard and quality of smoke meters, Gas analysis, Gas Leak meters and Tint meters used for the inspection of vehicles at the Vehicles Inspection Office (No.2) B.E. 2556	- Cancelling clause in (chor) of (1) of no. 2 of the Notice of the Department of Land Transport on the specification of design, size, standard and quality of smoke meters, Gas analysis, Gas Leak meters, Sound meters, tachometers and tint meters used for the inspection of vehicles at the Vehicles Inspection Office B.E. 2556 - Adding this following clause to (6) of no. 4 of the Notice from the Department of Land transport on the specification of design, size, standard and quality of smoke meters, Gas analysis, Gas Leak meters, Sound meters, tachometer and tint meters for inspection of vehicles at the Vehicles Inspection Office B.E. 2556 - Cancelling of clauses in (2) and (5) of no. 5 of the Notice of the Department of Land transport on the specification of design, size, standard and quality of smoke meters, gas analysis, gas Leak meters, sound meters, tachometers and tint meters for inspection of vehicles at the Vehicles Inspection Office B.E. 2556 - Cancelling clause no. 9 of the Notice of the Department of Land Transport on the specifications of design, size, standard and quality of the smoke meters, gas analysis, gas leak meters, sound meters, tachometers and tint meters used for inspection of vehicles at the Vehicles Inspection Office B.E. 2556.	Volume 130 Special Part 88 D 25 July B.E. 2556 (2013)	-

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
10	Notification of the Pollution Control Administration on collecting odor samples released from animal farms, inspection of odor intensity by sensory test and registering the names of odor test operators for the Pollution Control Department, Ministry of Natural Resource and Environment.	Inspecting odor intensity by sensory test and registration of the names of the odor test operators for the Pollution Control Department, Ministry of Natural Resource and Environment following the Notice of the Pollution Control Administration on the method of Odor Intensity Inspection by sensory test and registration of the name of the odor test operator for the Pollution Control Department, Ministry of Natural Resource and Environment dated 16 June B.E. 2554.	Volume 130 Special Part 116 D 12 September B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (13 September 2013)
11	Notification of the Ministry of Industry on the list of hazardous substances B.E. 2556	Identifying the hazardous substance or its components that have the same chemical composition and substance, and the substance has qualities specified in the list of hazardous substances in the appendix of this Notice, and are known to be a hazardous substance regardless of its concentration or utilization, except if the concentration or condition is specified for a specific purpose.	Volume 130 Special Part 125 D 27 September B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (28 September 2013)
12	Notification of the Department of Agriculture on the Limit of concentration in each formula of hazardous substance that is accepted for registration. (No. 3) B.E. 2556	Specifying the level of concentration in each formula of hazardous substance that can be registered to be more appropriately based on the power of clause no.2 of the Notice from the Department of Agriculture on detailed criteria and procedure to register, issuing of registration paper and renewing of the registration paper of hazardous substances under the jurisdiction of the Department of Agriculture (No. 2) B.E. 2553 - Cancelling of clause no.76, 170, 273 and 462, of the level of concentration in each formula of hazardous substance that can be registered. - Cancelling of clause no.582 of the level of concentration in each formula of hazardous substance that can be registered in the appendix of the Notice of the Department of Agriculture. - Cancelling of clause no. 8 and no. 25 of the level of concentration in each formula of hazardous substance that can be registered in the appendix of the Notice of the Department of Agriculture on Limit of concentration in each formula of hazardous substance that can be registered (No.2) B.E. 2556	Volume 130 Special Part 130 D 4 October B.E. 2556 (2013)	-

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
13	Notification of the Department of Land transport on the specification of size, quantity and quality of fire extinguishers for use in transport vehicles for animals or products of type 4 (Hazardous products transport vehicles) B.E. 2556	- Cancelling the Notice of the Department of Land transport on the specification of size, quantity and quality of fire extinguishers used in transport vehicles for animals or products of type4 (Hazardous products transport vehicles) dated 17 December B.E. 2541 - Specify the quality of fire extinguisher for transport vehicles for animals or products of type 4 (Hazardous product transport vehicles) - All transport vehicles for animals or products type 4 must install the fire extinguisher on board. - The fire extinguisher on the transport vehicles (in no. 3) must be installed with in easy access and must be installed with protection from environmental effects such as heat, cold or moisture that can cause malfunction to the device. - The transport vehicles for animals and products of type 4 that were registered before this Notice was effective must install the fire extinguisher following the guidelines of this notice within 180 days after this Notice is effective.	Volume 130 Special Part 136 D 16 October B.E. 2556 (2013)	After the 60 day period after the Announcement of Government Gazette.
14	Notification of the Ministry of Energy on criteria, method, protocol and approach in preparing a report of action following the measures to protect, correct, decrease, follow-up and evaluate the environmental impact of a Gas pipeline transport system B.E. 2556	- Guidelines of preparing a report of action following the measures - The authors of the report of action must have certification from the Director General of the Department of Energy Business or his appointed Official. Qualities, suspension and revocation of the certificates of the report of action writer must follow the regulations of the Notice of the Department of Energy Business - The report of action following the measures must be submitted to the Department of Energy Business with at least 5 sets of diskettes	Volume 130 Special Part 159 D 18 November B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (19 November 2013)

Ministerial Regulations related to pollution control announced in the Government Gazette in B.E. 2556 (2013 A.D.)

No.	Title	Abstract	Date announced	Effective Date
15	Notification of the Ministry of Energy on category and size of natural gas transport pipeline and criteria, method, procedure and approach in preparing environmental report B.E. 2556	- The projects with the following detailed structure and area must submit the environmental report to the Department of Energy Business: (1) Projects with the highest working pressure less than or equal to 20 bar and the diameter of the pipe less than or equal to 16 inches in all areas, except the areas where there are cabinet resolutions or laws stating otherwise (2). Projects with highest working pressure of more than 20 bar and the diameter of the pipe more than 16 inches in an Industrial Estate Area, must follow the Laws on Industrial Estate Area.	Volume 130 Special Part 159 D 18 November B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (19 November 2013)
16	Notification of the Pollution Control Administration on the collection of samples, inspection and calculation of the total waste of substances 1,2- Dichloroethane and vinyl chloride from chemical factories.	Specifying the method of air-pollution sample collection, inspection and calculation of the total waste of the substances 1,2- Dichloro-ethane and vinyl chloride from chemical factories.	Volume 130 Special Part 162 D 22 November B.E. 2556 (2013)	-
17	Notification of the Ministry of Natural Resources and Environment on the category and size of project or enterprise that must submit the Environmental Impact Assessment (EIA) Report and criteria, method, procedure and approach for preparing the EIA report No. 3 B.E. 2556 (Modified project no. 25 construction or expanding construction in the vicinity of or in the sea.)	Cancelling Clause no. 25 in Appendix 3 of the Notice of the Ministry of Industry on the category and size of a project or enterprise that must submit the Environmental Impact Assessment (EIA) Report and criteria, method, procedure and approach for preparing the EIA report dated 24 April B.E. 2555.	Volume 130 Special Part 185 D 20 December B.E. 2556 (2013)	Next to the day Announcing in Royal Gazette (21 December 2013)
18	Notification of the Department of Pollution Control on the method to monitor aircraft sound in a populated area.	1. The method to monitor aircraft sound in populated areas must follow the approach of ISO 20906:2009, Acoustics-Unattended monitoring of aircraft sound in the vicinity of airports. 2. The method to monitor aircraft sound at temporary monitoring point in populated areas must follow the details specified in the appendix of this Notice.	4 September B.E. 2556 (2013)	-

Local Pollution Ordinances Enacted in Royal Gazette B.E. 2556 (2013)

No.	Title	Promulgation Date
1.	Sap Samo Thot Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2555 (2012)	3 January 2013
2.	Bang Rak Yai Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2555 (2012)	3 January 2013
3.	Mae Lat Subdistrict Administrative Organization Legislation on Conducting a land animal, wing animal, aquatic animal, reptile or insect farm activities B.E. 2555 (2012)	3 January 2013
4.	Bang Kaeo Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2555 (2012)	10 January 2013
5.	Phan Dung Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2555 (2012)	11 January 2013
6.	Dan Chang Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2555 (2012)	28 January 2013
7.	Dan Chang Subdistrict Administrative Organization Legislation on Health hazardous business B.E. 2555 (2012)	28 January 2013
8.	Sala Daeng Subdistrict Administrative Organization Legislation on Sewage or waste collection, transport and disposal B.E. 2555 (2012)	28 January 2013
9.	Nong Chang Laen Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2555 (2012)	28 January 2013
10.	Huai Ma Subdistrict Administrative Organization Legislation on Market B.E. 2555 (2012)	28 January 2013
11.	Phue Yai Subdistrict Administrative Organization Legislation on Control of Health hazardous activities B.E. 2555 (2012)	31 January 2013
12.	Tha Khuen Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2555 (2012)	31 January 2013
13.	Tha Khuen Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2555 (2012)	31 January 2013
14.	Tha Khuen Subdistrict Administrative Organization Legislation on Cleanliness and tidiness maintenance B.E. 2555 (2012)	31 January 2013
15.	Phimon Rat Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2555 (2012)	8 February 2013
16.	Phimon Rat Subdistrict Administrative Organization Legislation on Installation of Grease trap tank for waste water treatment in buildings B.E. 2555 (2012)	8 February 2013
17.	Phimon Rat Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2555 (2012)	8 February 2013
18.	Phimon Rat Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2555 (2012)	8 February 2013
19.	Phimon Rat Subdistrict Administrative Organization Legislation on Market B.E. 2555 (2012)	8 February 2013
20.	Phimon Rat Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2555 (2012)	8 February 2013
21.	Phimon Rat Subdistrict Administrative Organization Legislation on Control of farming or releasing animal B.E. 2555 (2012)	8 February 2013
22.	Bo Win Subdistrict Administrative Organization Legislation on Market (Issue 2) B.E. 2555 (2012)	8 February 2013
23.	Bang Tanot Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2555 (2012)	14 February 2013
24.	Khok Sak Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	14 February 2013
25.	Khao Noi Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2555 (2012)	22 February 2013
26.	Khlong Khwang Subdistrict Administrative Organization Legislation on Health hazardous activities (Issue 2) B.E. 2555 (2012)	7 March 2013

Local Pollution Ordinances Enacted in Royal Gazette B.E. 2556 (2013)

No.	Title	Promulgation Date
27.	Thai Nam Subdistrict Administrative Organization Legislation on Control of rice milling by machine activities (Issue 2) B.E. 2555 (2012)	11 March 2013
28.	Ban Ko Subdistrict Administrative Organization Legislation on Control of health hazardous business, type: health service group B.E. 2555 (2012)	11 March 2013
29.	Na Ngam Subdistrict Administrative Organization Legislation on Sewage management B.E. 2555 (2012)	11 March 2013
30.	Khao Kop Subdistrict Administrative Organization Legislation on Waste management B.E. 2555 (2012)	11 March 2013
31.	Khueang Nai Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2554 (2011)	14 March 2013
32.	Pluak Daeng Subdistrict Administrative Organization Legislation on Sewage management B.E. 2555 (2012)	14 March 2013
33.	Pluak Daeng Subdistrict Administrative Organization Legislation on Waste management B.E. 2555 (2012)	14 March 2013
34.	Pluak Daeng Subdistrict Administrative Organization Legislation on Infectious waste management B.E. 2555 (2012)	14 March 2013
35.	Pluak Daeng Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2555 (2012)	14 March 2556
36.	Pluak Daeng Subdistrict Administrative Organization Legislation on Market B.E. 2555 (2012)	14 March 2013
37.	Pluak Daeng Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2555 (2012)	14 March 2013
38.	Pluak Daeng Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2555 (2012)	14 March 2013
39.	Sanean Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	20 March 2013
40.	Sanean Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	20 March 2013
41.	Mai Phatthana Subdistrict Administrative Organization Legislation on Market B.E. 2555 (2012)	21 March 2013
42.	Tha Hat Yao Subdistrict Administrative Organization Legislation on Control of health hazardous activities (Issue 2) B.E. 2556 (2013)	22 March 2013
43.	Ban Lam Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2555 (2012)	5 April 2013
44.	Lat Takhian Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	5 April 2013
45.	Tha Takro Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	11 April 2013
46.	Phraek Sa Subdistrict Administrative Organization Legislation on Control of farming or releasing animals B.E. 2556 (2013)	2 May 2013
47.	Phanom Rok Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	7 May 2013
48.	Mae Kha Subdistrict Administrative Organization Legislation on Control of wild fire and dust from burning B.E. 2556 (2013)	23 May 2013
49.	Sa Phang Lan Subdistrict Administrative Organization Legislation on Sewage and waste disposal (Issue 2) B.E. 2556 (2013)	30 May 2013
50.	Sa Phang Lan Subdistrict Administrative Organization Legislation on Health hazardous activities (Issue 3) B.E. 2556 (2013)	30 May 2013
51.	Sa Phang Lan Subdistrict Administrative Organization Legislation on Market (Issue. 2) B.E. 2556 (2013)	30 May 2013
52.	Sa Phang Lan Subdistrict Administrative Organization Legislation on Food sale site and food storage site (Issue. 2) B.E. 2556 (2013)	30 May 2013

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No.	Title	Promulgation Date
53.	Lor Yung Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	3 June 2013
54.	Bang Chalong Subdistrict Administrative Organization Legislation on Control of health hazardous activities (Issue. 2) B.E. 2556 (2013)	13 June 2013
55.	Ra-ngaeng Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	20 June 2013
56.	Ra-ngaeng Subdistrict Administrative Organization Legislation on Sewage management B.E. 2556 (2013)	20 June 2013
57.	Ra-ngaeng Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	20 June 2013
58.	Ra-ngaeng Subdistrict Administrative Organization Legislation on Control of farming or releasing animals B.E. 2556 (2013)	20 June 2013
59.	Yang Talat Subdistrict Administrative Organization Legislation on Sale of goods in public area or public roadway B.E. 2556 (2013)	4 July 2013
60.	Yang Talat Subdistrict Administrative Organization Legislation on Establishment of Market B.E. 2556 (2013)	4 July 2013
61.	Yang Talat Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	4 July 2013
62.	Yang Talat Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	4 July 2013
63.	Yang Talat Subdistrict Administrative Organization Legislation on Control of pig farming B.E. 2556	4 July 2013
64.	Phon Ngam Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	8 July 2013
65.	Phon Ngam Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	8 July 2013
66.	Lan Krabue Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	11 July 2013
67.	Nikhom Songkhro Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2556 (2013)	25 July 2013
68.	Hua Muang Subdistrict Administrative Organization Legislation on Control of farming or releasing animals B.E. 2556 (2013)	1 August 2013
69.	Ban Fang Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2553 (2010)	7 August 2013
70.	Ban Fang Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2553 (2010)	7 August 2013
71.	Thung Nonsi Subdistrict Administrative Organization Legislation on Control of health hazardous activities (Issue. 3) B.E. 2556 (2013)	8 August 2013
72.	Rat Niyom Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	15 August 2013
73.	Suan Phueng Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2556 (2013)	21 August 2013
74.	Ong Phra Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	21 August 2013
75.	Nong Hang Subdistrict Administrative Organization Legislation on Control of pig farming activities B.E. 2556 (2013)	21 August 2013
76.	Nong Hang Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	21 August 2013
77.	Nong Hang Subdistrict Administrative Organization Legislation on Sewage management B.E. 2556 (2013)	21 August 2013

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No.	Title	Promulgation Date
78.	Nong Pho Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	26 August 2013
79.	Nong Pho Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	26 August 2013
80.	Ngio Rai Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	26 August 2013
81.	Mae La Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	26 August 2013
82.	Samet Nuea Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	26 August 2013
83.	Mae La Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	26 August 2013
84.	Nong Pho Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	26 August 2013
85.	Bang Tho Rat Subdistrict Administrative Organization Legislation on Sewage and waste Management B.E. 2556 (2013)	29 August 2013
86.	Nong Trut Subdistrict Administrative Organization Legislation on Waste management B.E. 2556 (2013)	29 August 2013
87.	Sanam Chan Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	30 August 2013
88.	Krasae Bon Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	23 September 2013
89.	Nong Rawiang Subdistrict Administrative Organization Legislation on Sewage and waste collection, transport or disposal B.E. 2556 (2013)	25 September 2013
90.	Bo Rang Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	25 September 2013
91.	Mae Pao Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	25 September 2013
92.	Muang Kong Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2556 (2013)	25 September 2013
93.	Phihan Daeng Subdistrict Administrative Organization Legislation on control of Health hazardous activities B.E. 2556 (2013)	3 October 2013
94.	Nong Wang Subdistrict Administrative Organization Legislation on sewage and waste disposal B.E. 2556 (2013)	3 October 2013
95.	Phihan Daeng Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	3 October 2013
96.	Sothon Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	10 October 2013
97.	Ra-ngaeng Subdistrict Administrative Organization Legislation on Market B.E. 2556 (2013)	10 October 2013
98.	Sothon Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	10 October 2013
99.	Dong Kheng Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	14 October 2013
100.	Tham Chalong Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	14 October 2013
101.	Dong Kheng Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	14 October 2013
102.	Dong Kheng Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	14 October 2013
103.	Tham Chalong Subdistrict Administrative Organization Legislation on control of health hazardous activities B.E. 2556 (2013)	14 October 2013
104.	Pa Makhab Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	24 October 2013
105.	Phu Toei Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	24 October 2013

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No.	Title	Promulgation Date
106.	Nong Chang Laen Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	24 October 2013
107.	Nong Chang Laen Subdistrict Administrative Organization Legislation on Market B.E. 2556 (2013)	24 October 2013
108.	Nong Chang Laen Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	24 October 2013
109.	Kham Pom Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	24 October 2013
110.	Phra Phloeng Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	24 October 2013
111.	Ban Prok Subdistrict Administrative Organization Legislation on Control of farming or releasing animals B.E. 2556 (2013)	31 October 2013
112.	Bang Bai Mai Subdistrict Administrative Organization Legislation on Installation of Grease trap tank for waste water treatment in buildings B.E. 2556 (2013)	12 November 2013
113.	Taphaen Subdistrict Administrative Organization Legislation on Installation of Grease trap tank for waste water treatment in buildings B.E. 2556 (2013)	12 November 2013
114.	Bang Bai Mai Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	14 November 2013
115.	Na Bon Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2555 (2012)	14 November 2013
116.	Ban Rat Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	28 November 2013
117.	San Pa Tong Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	28 November 2013
118.	San Pa Tong Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	28 November 2013
119.	Na Mo Bun Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	28 November 2013
120.	San Pa Tong Subdistrict Administrative Organization Legislation on Food sale site and food storage site B.E. 2556 (2013)	28 November 2013
121.	San Pa Tong Subdistrict Administrative Organization Legislation on Market B.E. 2556 (2013)	28 November 2013
122.	San Pa Tong Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2556 (2013)	28 November 2013
123.	Don Pho Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	12 December 2013
124.	Phon Phaeng Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	12 December 2013
125.	Samnak Thong Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	12 December 2013
126.	Samnak Thong Subdistrict Administrative Organization Legislation on control of Health hazardous activities B.E. 2556 (2013)	12 December 2013
127.	Nong Krathum Subdistrict Administrative Organization Legislation on Sewage and waste management B.E. 2556 (2013)	12 December 2013
128.	Huai Thap Mon Subdistrict Administrative Organization Legislation on Control of health hazardous activities B.E. 2556 (2013)	26 December 2013
129.	Huai Thap Mon Subdistrict Administrative Organization Legislation on Sale of goods in a public area or public roadway B.E. 2556 (2013)	26 December 2013
130.	Huai Thap Mon Subdistrict Administrative Organization Legislation on Sewage and waste disposal B.E. 2556 (2013)	26 December 2013
131.	Tha Yiam Subdistrict Administrative Organization Legislation on Health hazardous activities B.E. 2556 (2013)	26 December 2013

Appendix G

List of glossary

Glossary / Abbreviation

Abbreviation	English
As	Arsenic
BOD	Biochemical Oxygen Demand
Cd	Cadmium
Cl	Chloride
CN^-	Cyanide
CO	Carbon Monoxide
Cr	Chromium
Cr^{6+}	Hexavalent Chromium
Cu	Copper
dBA	Decibel A
DO	Dissolved Oxygen
FCB	Fecal Coliform Bacteria
Fe	Iron
Hg	Mercury
InS	Incinerator System
IS	Integrated System
L_{eq}	Equivalent Continuous Sound Pressure Level
LF	Landfill System
mg/l	Milligrams per Liter
ml	Milliliter
Mn	Manganese
MPN	Most Probable Number
MWQI	Marine Water Quality Index
ND	Non-detected
NH_3	Ammonia
NH_3 - N	Ammonia - Nitrogen
Ni	Nickel
Non - TH	Non-carbonate Hardness as $CaCO_3$
NO_x	Nitrogen Oxide

Abbreviation	English
NO_2	Nitrogen Dioxide
NO_3 - N	Nitrate - Nitrogen
O_3	Ozone
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCBs	Polychlorinated Biphenyls
pH	Potential of Hydrogen Ion
PM_{10}	Particulate Matter 10 Micron
$PM_{2.5}$	Particulate Matter 2.5 Micron
PO_4 - P	Phosphate - Phosphorus
ppb	Part per Billion
ppm	Part per Million
ppt	Part per Thousand
RDF	Refuse Derived Fule
SO_2	Sulphur Dioxide
SS	Suspended Solid
Std.	Standard
TCB	Total Coliform Bacteria
TDS	Total Dissolve Solid
Temp.	Temperature
Total Cr	Total Chromium
TSP	Total Suspended Particulate Matter
VOCs	Volatile Organic Compounds
WQI	Water Quality Index
Zn	Zinc
% w/w	% Weight by Weight
$\mu g/m^3$	Microgram per Cubic Metre

Appendix H

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