Thailand Country Profile

Clean Air Initiative for Asian Cities (CAI-Asia) Center

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CONTENTS

About CAI-Asia

The Clean Air Initiative for Asian Cities (CAI-Asia) was established as a joint initiative by the Asian Development Bank, World Bank, and the United States – Asia Environmental Partnership (a project of USAID) in 2001.

CAI-Asia promotes and demonstrates innovative ways to improve the air quality of Asian cities through sharing experiences and building partnerships. Since 2007, this multi-stakeholder initiative is divided into

- The CAI-Asia Center, a regional, Philippine-based non-profit organization as the implementing arm of CAI-Asia
- The CAI-Asia Partnership, a United Nations Type II Partnership, with over 160 member organizations
- CAI-Asia Country Networks in China, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, and Viet Nam.

ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
BMA	Bangkok Metropolitan Administration
CAI-Asia	Clean Air Initiative for Asian Cities
CAIN	Campaign for Alternative Industry Network
CEMS	Continuous Emission Monitoring Systems
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DIW	Department of Industrial Work
DLGA	Decentralization to Local Government Organization Act
EARTH	Ecological Alert and Recovery – Thailand
EIA	Environmental Impact Assessment
EPPO	Energy Policy and Planning Office
GCM	Global Community Monitor
HC	Hydrocarbons
IEAT	Industrial Estate Authority of Thailand
MoNRE	Ministry of Natural Resources and Environment
MoI	Ministry of Industry
NAAQS	National Ambient Air Quality Standards
NE	Northeast
NEB	National Environmental Board
NEQA	National Environmental Quality Act
NGOs	Nongovernment Organizations
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
ONEP	Office of Natural Resources and Environmental Policy and Planning
O_3	Ozone
Pb	Lead
PCAs	Pollution Control Areas
PCD	Pollution Control Department
PM_{10}	Particulate matter with diameter not more than 10 microns
PPM	Parts per million
QA/QC	Quality Assurance / Quality Control
SO_2	Sulfur Dioxide
SW	Southwest
TAPCE	Thailand Air Pollution Center of Excellence
TSP	Total Suspended Particulate
US	United States
USAEP	US-Asia Environmental Partnership
USAID	U.S. Agency for International Development
VOCs	Volatile Organic Compounds
WHO	World Health Organization

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1. INTRODUCTION

Air pollution levels in the megacities of Asia show a stabilizing trend but still exceed World Health Organization guidelines.[1] Studies also show poor air quality, not only in the megacities of Asia, but also in smaller cities with populations of 150,000 to 1.5 million. While megacities often receive support for improving air quality; similar assistance seldom reaches smaller cities.[2]

Responding to the need to strengthen air quality management in smaller cities, the Association of Southeast Asian Nations (ASEAN) – German Technical Cooperation Project on "Clean Air for Smaller Cities in the ASEAN Region" is being implemented starting 2009. The Project aims to empower smaller cities to develop and implement "Clean Air Action Plans" with stakeholder participation. In its initial phase, up to fourteen cities with 150,000 to 1.5 million inhabitants in the ASEAN region will receive assistance. Preparation of country profiles, national workshops to sensitize stakeholders on clean air issues, set up of a sustainable regional training system, and conferences for dissemination of city experiences are among the project activities to support action plan development and implementation.

Country Profiles are being prepared for several ASEAN countries. These provide background information and findings on:

- **State of the Air (Chapter 2):** What is the air quality in smaller cities? Which of the smaller cities in the country are experiencing air pollution challenges or will soon enter into this situation?
- **Legal framework for air quality management (Chapter 3):** What is the air quality management system in place in smaller cities? What is the legal framework for air quality management in the country and in smaller cities? What power and resources are available to smaller cities to develop and implement clean air action plans?
- **Stakeholders (Chapter 4):** Do stakeholders take an active part in air quality management for smaller cities? How do smaller cities engage stakeholders in air quality management?

[1] CAI-Asia Center. Air Quality in Asian Cities. 2008
[2] CAI-Asia Center. Compendium of Air Quality Management and Sustainable Urban Transport Projects in Asia. 2007

2. STATE OF THE AIR

Understanding the air pollution problem of a country requires an examination of its geography and climate, the drivers (urbanization, industry and economy, energy, and transport), sources, status, and impacts of air pollution. This Chapter provides an overview of the air pollution challenge in Thailand.

2.1 General Information

Thailand is the third largest country in Southeast Asia, after Indonesia and Myanmar.[3] Its land area is slightly over 500,000 square kilometers, almost about the same land area as France and Spain.[4] It is mountainous in the northern and western parts bordered with Myanmar, and flat plateau in the northeastern part bordered with Cambodia in the South, and with Laos in the large part by the Mekong River. The capital city, Bangkok, and surrounding central area situates in a flat fertile land where several rivers form delta on top of the Gulf of Thailand. Land-sea breeze clearly affects air quality of all cities east and south of Bangkok, as well as all provinces situated along the peninsula down to the border with Malaysia.

The country experiences temperatures between 15 – 40 degrees Celsius, with the hottest days in April, when the season is changing from the influence of northeast (NE) to southwest (SW) monsoons. The SW wind brings rains that clean up the atmospheric boundary layer during May to October. Then the dry period starts with the return of NE monsoon influenced by the Asian continental high pressure system. This brings dry cool air and inversion potential which traps air pollution, especially in the northern region. During this period of November to February and March, the rain is absent in most parts of the country, except in the Eastern coast of the Southern peninsula where NE monsoon induces rain generated by moisture from wind blowing across the Gulf of Thailand.

Thailand has about 63.4 million people and 36% (22.9 million) live in urban areas.[5] As of October 2006, there were 1,161 municipalities in Thailand with populations of at least 7,001 to more than 50,000.[6] For purposes of this Country Profile, the term “smaller cities” refers to city municipalities with population of 50,001 to 1.5 million. Population densities in a sample of 25 municipalities range between 1,150 to 7,650 inhabitants per square kilometer; Bangkok’s population density is in the middle range with 4,028.9 inhabitants per square kilometer in year 2000 (Annex 1).[7] Air quality would be most important to attain in the densest of Thailand’s cities.

Thailand was one of East Asia’s best economic performers with an average annual GDP growth of 6.3% in 2004. Annual economic growth declined to 4.9% and 2.6% in 2007 and 2008 due to the state of the world economy and the negative impact of the country’s political crisis.[8] For these same reasons, the Thailand

[3] ASEAN Statistical Pocketbook 2006. http://www.aseansec.org/19192.pdf
[4] UN Data. http://data.un.org/Data.aspx?d=POP&f=tableCode%3a19
[5] Mahidol Population Gazette. Vol. 18 January 2009.
http://www.ipsr.mahidol.ac.th/ipsr/Contents/Documents/Gazette/Gazette2009EN.pdf
[6] Department of Local Administration of the Thailand Ministry of Interior. Thai Local Government. 2006
[7] http://en.wikipedia.org/wiki/List_of_cities_in_Thailand_by_population
[8] Bank of Thailand. http://www2.bot.or.th/statistics/BOTWEBSTAT.aspx?reportID=409&language=ENG

Ministry of Finance forecasts that in 2009 the economy will grow lower than 2.6%.[9] The manufacturing and tourism industries are important to Thailand's economy. In 2008, manufacturing contributed the most to GDP (40.1%).[10] In 2009, however, the manufacturing industry is expected to slow down because of reduced demand in the primary world markets, reduced domestic consumption, and uncertain internal political situation.[11] In 2009, tourism is expected to contribute about 14.7% to GDP and about one in every nine jobs in Thailand.[12] Promoting growth in both industries requires keeping air emissions from manufacturing within the national standards in order to maintain good air quality in the most visited cities in Thailand.

In 2008, oil accounted for 51% of total primary energy supply in Thailand, while gas, coal and others accounted for 36%, 11% and 2%, respectively. Electricity is produced mainly through thermal generation mostly using natural gas than coal. Natural gas accounts for 71% and coal for 21% of the fuel used for power generation; the balance of 8% is derived from hydro, fuel oil, diesel, and other fuel sources. Of Thailand's total final energy consumption, the transportation sector is the largest energy consuming sector accounting for 37% in 2007. The second largest energy consumer is the industry sector accounting for 36%.[13]

The vehicle population in Bangkok grew by about 4.8% per year (from 3,872,327 in 1997 to 5,715,078 in 2007). In smaller cities, the vehicle population growth is about 4.4% per year and the vehicle fleet consists mostly of motorcycles (81%), light duty vehicles (16%), and heavy duty vehicles (2%).[14]

2.2 Sources of Air Pollution

Major air pollution sources differ for each province and municipality (Table 1). In general, in urban areas in Thailand, the major sources of particulates are vehicles, re-suspended road and construction dust, and industry.[15] Power generation, transportation, and manufacturing are main sources of CO_2, SO_2, and NOx emissions in the country.[16]

Some industrial estates and power plants are important air pollution sources. Communities have sued some of them for releasing toxic air emissions. The community near the Map Ta Phut industrial estate secured a decision to declare the area a Pollution Control Zone (See the story of the "Map Ta Phut Bucket Brigade" in Chapter 4 and Annex 2 for the regions and provinces where industrial estates, parks and zones are located).

[9] Thailand Ministry of Finance. Economic Report: Thailand's Economic Projection for 2009. 2009. http://www2.mof.go.th/economic_report_detail.php?id=29

[10] Bank of Thailand. http://www.bot.or.th/English/EconomicConditions/Thai/genecon/Pages/Thailand_Glance.aspx

[11] Office of Industrial Economics, Ministry of Industry. Summary of Industrial Economics in 2008 and Trends for 2009: Annual Report on Conditions of Manufacturing Industries in 2008. 2008. http://www.oie.go.th/industrystatus1_en.asp

[12] Tourism Economic Research: Thailand, World Travel and Tourism Council. 2009. http://www.wttc.org/eng/Tourism_Research/Tourism_Economic_Research/Country_Reports/Thailand/

[13] Energy Policy and Planning Office. http://www.eppo.go.th/index-E.html

[14] Thailand Department of Land Transport

[15] CAI-Asia and Thailand Pollution Control Department. Clean Air in Thailand: Summary of progress on improving air quality. 2008

[16] Power generation accounts for 41% of CO_2, 50% of SO_2 and 26% of NOx; transportation for 27% of CO_2, 3% of SO_2 and 28% of NOx; while manufacturing for 24% of CO_2, 46% of SO_2 and 25% of NOx. Source: National Statistical Office of Thailand. The 2008 core environment. 2008. http://web.nso.go.th/indicator/environ/air.pdf

In a separate legal battle, more than 400 people from Lampang sued the Electricity Generating Authority of Thailand for compensation for illnesses caused by sulfur dioxide emissions from the Mae Mo power plant.[17]

Table 1. Major sources of air pollution in selected provinces and municipalities in Thailand

Province	**Municipality**	**Major sources of air pollution**
Chiang Mai	Chiang Mai	Motor vehicles, forest fires, slash-and-burn farming, open burning (4)
Lampang	Lampang (Mae Mo)	Coal-fired power plant, mining industry, open burning (1), (2), (3)
Nakhon Ratchasima	Nakhon Ratchasima	Motor vehicles (3)
Chonburi	Laem Chabang	Port, refinery, industries in Laem Chabang Industrial Estate (3)
Rayong	Rayong	Industries in the Map Ta Phut Industrial Estate (3),(5)
Saraburi	Saraburi, Phra Kiat District	Cement, rock crushing plants, mining industry stone mines, stone and quarrying industries, local transportation (1),(2)
Ratchaburi	Ratchaburi	Rock crushing plants (1)
Ayutthaya	Ayutthaya	Motor vehicles (3),(4)

Sources: (1) Thailand Air Pollution Information (1994); (2) Thailand State of Pollution Report 2004; (3) Industrial Estate Authority of Thailand; (4) Journal papers[18],[19] (5) Thailand's Air: Poison Cocktail by Campaign for Alternative Industry Network

2.3 Status of Air Quality

PM_{10} is a significant air pollutant in Thailand. While roadside particulate matter is the most serious pollutant in Bangkok; in the provinces and smaller cities, the major pollutants include PM_{10} and ozone (O_3).[20]

Air Quality Monitoring

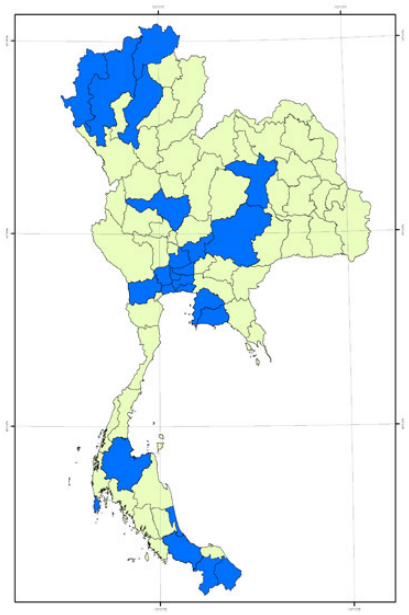
A total of 53 air quality monitoring stations operated by the Thailand Pollution Control Department (PCD) continuously measure air quality and meteorological parameters. The most common pollutants monitored are PM_{10}, CO, SO_2, NOx and O_3. The monitoring stations are set up only in selected provinces and municipalities throughout the country. The location of the stations in 21 provinces is shown in the colored areas in Figure 1.

[17] Bangkok Post. Mae Mo battle ends in win for villagers. 2009. http://www.bangkokpost.com/news/local/12739/mae-mo-battle-ends-in-win-for-villagers

[18] Sitthichok Puangthongthub, Supat Wangwongwatana, Richard M. Kamens, Marc L. Serre Modeling the space/time distribution of particulate matter in Thailand and optimizing its monitoring networking, Atmospheric Environment (41), 7788-7805,2007

[19] Somporn Chantara, Walaya Sangchan, Sensitive analytical method for particle-bound polycyclic aromatic hydrocarbons: A case study in Chiang Mai, Thailand, ScienceAsia (35), 42-48,2009

[20] CAI-Asia and Thailand Pollution Control Department. Clean Air in Thailand: Summary of progress on improving air quality. 2008. http://www.cleanairnet.org/caiasia/1412/articles-70822_Thailand.pdf

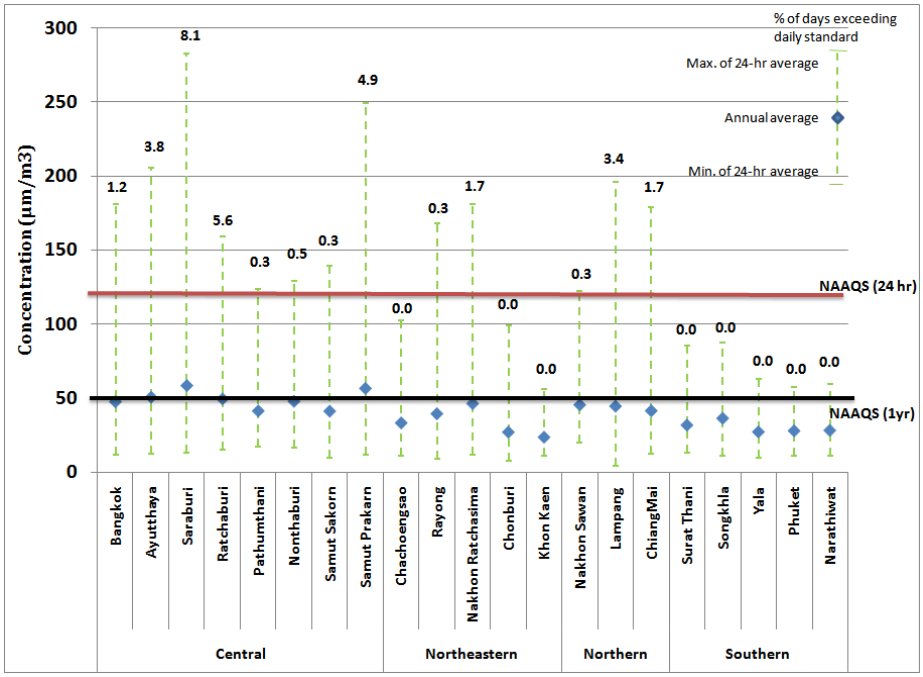


Source: PCD

Figure 1: Location of monitoring stations

Air Quality Data

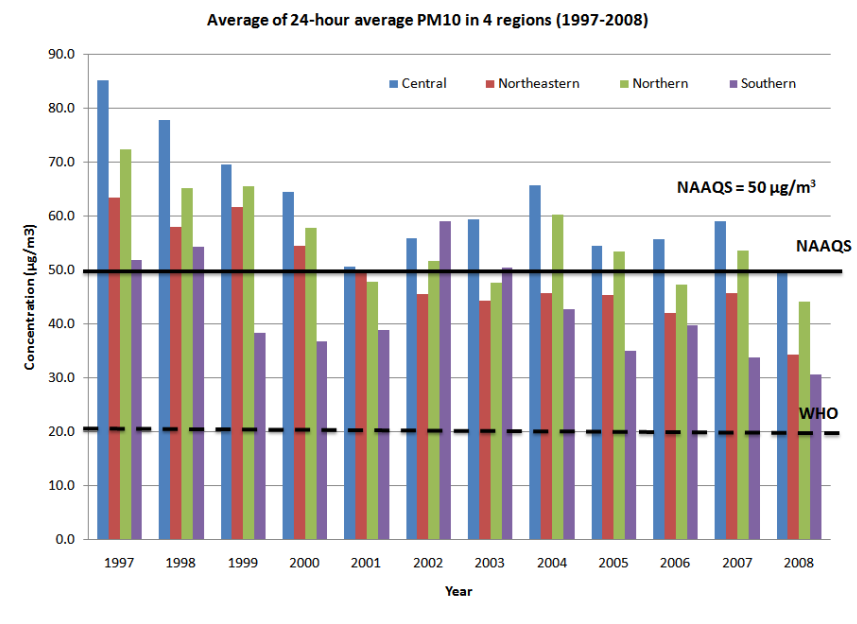
PM_{10} is a significant pollutant in Thailand. In 2008, the annual average of PM_{10} was around 41µg/m^3 from 53 stations. The maximum of the average daily PM_{10} exceeded the daily standard in the Central, Northeastern and Northern regions (Figure 2). The average annual PM_{10} levels in Saraburi and Samut Prakarn in the Central region exceeded the annual standard. The provinces of Saraburi, Ratchaburi, Samut Prakarn and Ayutthaya (Central), Nakhon Ratchasima (Northeast), Lampang and Chiang Mai (North) had high percentage of days when the PM_{10} level exceeded the daily standard.



Source: Data from Thailand PCD

Figure 2. PM_{10} monitoring in 21 provinces in Year 2008

In general, the annual average PM_{10} in Thailand has been decreasing from 1997 to 2008 (Figure 3). In 2008, the annual average PM_{10} in four regions met the national ambient air quality standard of 50µg/m^3 (annual) but still exceeded the WHO guideline value of 20µg/m^3 (annual).



Source: Data from Thailand PCD

Figure 3. Average of Annual PM10 in 4 regions (1997-2008)

In addition to PM_{10}, O_3 is potentially becoming a problem, although most of the stations are situated in the areas which are not downwind of the O_3 precursors' transport. According to published data in the years 2006 and 2007, more than 20 hours per year were found exceeding the 1-hour O_3 standard at PCD's stations in the Bangkok suburbs as well as in the smaller cities such as Ayutthaya, Saraburi, Chonburi and Rayong.[21] More exceedances could be found if a regional modeling study is conducted. In the next fiscal year (2009-2010), PCD aims to conduct a research study on the impact of alternative fuels (Natural gases, Bio-diesel and Gasohol (gasoline with ethanol replacing MTBE), which are increasingly used in vehicles, on air pollution.

Reporting and Use of Air Quality Information

Daily air quality data of SO_2, NO_2, CO, O_3, PM_{10} are collected and air quality index are available to the PCD and the general public.[22] This daily reporting has been made possible with the AIRVIRO system (with Swedish support since 1994), and now a new locally designed network system called Ayutthaya, used by PCD to collect and report real-time ambient air quality and meteorology data from the monitoring stations. PCD uses the information for policy making, planning and research.[23] It also allows PCD to forecast the air quality in the

[21] http://web.nso.go.th/indicator/environ/air.pdf
[22] Thailand Pollution Control Department. http://www.pcd.go.th/indexEng.cfm
[23] Thailand Pollution Control Department. http://www.aqnis.pcd.go.th/en/mainpe.htm

regions.[24] This information is also made available to the public through different media including the PCD website and the media such as The Bangkok Post which reports the air quality index.

2.4 Impacts of Air Pollution

Several studies estimate the impact of air pollution in Thailand cities. A World Bank report estimates that an increase of 1µg/m^3 of PM_{10} concentration in six cities (Bangkok, Chiang Mai, Nakhon Sawan, Khon Kaen, Nakhon Ratchasima and Songkhla) would increase the mortality rate by 0.084%, chronic bronchitis cases to 3.06 per 100,000 and incidence of respiratory symptoms to 18,300 per 100,000 adults. For these six cities, the health cost from PM_{10} exposure is estimated to be US$644 million per year.[25]

A study of the US-based Health Effects Institute estimating the mortality effects of PM in Bangkok found that there are "strong associations between several different mortality outcomes and PM_{10}" and that "the excess risk for non-accidental mortality was 1.3% per 10µg/m^3 of PM_{10}."[26]

A $PM_{2.5}$ and PM_{10} exposure study carried out in the summer of 2005 found that samples in Chiang Mai and Lamphun Provinces were cytotoxic to lung cells and alveolar macrophages and the samples at Bann Klang, Lamphun Province induced apoptosis of alveolar macrophages.[27, 28]

Some tourists have expressed concern about the poor air quality in tourist spots like Chiang Mai and are avoiding trips to the province because of air pollution.[29] If air pollution in tourist destinations continues to deteriorate, this could negatively impact on Thailand's tourism industry.

[24] Thailand Pollution Control Department. http://www.aqnis.pcd.go.th/
[25] World Bank. Thailand Environment Monitor 2002
[26] Health Effects Institute. The Public Health and Air Pollution in Asia (PAPA) Project: Estimating the Mortality Effects of Particulate Matter in Bangkok, Thailand. 2008.
http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2535619
[27] Vinitketkumnuen, U., K. Kalayanamitra, T. Chewonarin, and R. Kamens. 2002. Particulate matter, PM10 and PM2.5 levels, and airborne mutagenicity in Chiang Mai, Thailand. Mutat. Res. 519(12):121-131.
[28] Usanee Vinitketkumnuen*, Khanittha Punturee Taneyhill, Teera Chewonarin, Narongpan Chunram, Akravit Vinitketkumnuen and Siwapong Tansuwanwong, Exposure to Ambient PM2.5 and PM 10 and Health Effects, CMU. J. Nat. Sci. (2007) Vol. 6(1)
[29] Web forum on Chiang Mai air pollution

3. LEGAL FRAMEWORK FOR AIR QUALITY MANAGEMENT

A country's seriousness in implementing a policy to provide better air quality for its people may be judged on whether: (1) the policy and its implementation details are reflected in laws, regulations and plans; (2) enough resources are provided to implement it; and (3) the laws, regulations and plans are actually implemented. This Chapter discusses the main laws, regulations, policies and plans that are the basis for air quality management in Thailand; an overview of the management of pollution from motor vehicles, industries, and area sources; and the power and resources of smaller cities to develop and implement clean air action plans.

3.1 Air Quality Management

The laws, regulations and plans to manage pollution from motor vehicles, industries, and area sources are discussed below and summarized in Annex 3.

Ambient Air Quality Standards

The National Ambient Air Quality Standards (NAAQS) of CO, NO_2, O_3, SO_2, Pb, PM_{10} and TSP, are specified in the Notification of the National Environmental Board No. 10 (1995), No. 24 (2004) and No. 28 (2007). Smaller cities are required to meet these standards. They should take steps to monitor air quality. Compared with WHO Guidelines, Thailand NAAQS are less stringent. A comparison of the NAAQS and WHO Guidelines is provided in Table 1.

Table 1. Thailand's National Ambient Air Quality Standard and WHO Guidelines

Pollutant	Average Time	NAAQS (µg/m^3)	WHO
TSP	24 hours	330	---
	1 year	100[a]	---
PM10	24 hours	120	50[b]
	1 year	50[a]	20[b]
Pb	1 month	1.5	---
	1 year	---	0.5[c]
SO2	10 min	---	500
	1 hour	780	---
	24 hours	300	20[b]
	1 year	100[a]	---
NO2	1 hour	320	200[b]
	1 year	---	40[b]
O3	1 hour	200	---
	8 hours	140	100[b]
CO	1 hour	34,200	30,000[c]
	8 hours	10,260	10,000[c]

TSP – Total Suspended Particulates; PM10 – Particulates, the size less than 10µm; Pb – Lead; SO2 – Sulfur dioxide; NO2 – Nitrogen Dioxide; O3 – Ozone; CO – Carbon Monoxide

[a] Arithmetic mean

[b] WHO Global Update 2005

[c] WHO 2000

Source: http://www.pcd.go.th/info_serv/en_reg_std_airsnd01.html (Thai standards)

Management of Mobile Sources

The PCD of the Ministry of Natural Resources and Environment (MNRE), and the Department of Land Transport of the Ministry of Transport are responsible for managing end-of-pipe emissions from mobile sources, together with the Police Department.

On fuel quality standards, a road map is being implemented in cooperation with the Ministry of Energy. Leaded gasoline was phased out from Thailand completely in 1995. Thailand is working towards gasoline reformulation for benzene and sulfur contents to be equivalent to Euro 4 (1% benzene and 50 parts per million (ppm) sulfur) by 2012. Diesel fuels are already Euro 3-compliant (350 ppm sulfur), but the country aims to achieve Euro 4 by 2012.

Emission standards for new vehicles are now comparable to Euro 3 for both gasoline and light duty diesel vehicles. New heavy duty vehicles were required to comply with Euro 3 since January 2007 while new motorcycles should comply with 97/24/EC which requires CO emission no more than 3.5 g/km, and HC+NOx emission of no more than 1.8 – 2 g/km.[30]

All in-use vehicles are required to renew registration annually. As a pre-requisite to renewal of registration, emissions of in-use vehicles are checked to ensure they are within the allowable emission limits. The emission limits differ depending on the type of in-use vehicle and on the original year of registration (Annex 4). For example, the emission limits for in-use gasoline vehicles registered before November 1, 1993 are CO of 4.5% and HC within 600 ppm. The emission limits are more stringent for vehicles registered after then (CO 1.5% and HC 200 ppm). While those registered since January 1, 2007 are controlled at CO 0.5% and HC 100 ppm levels. Different emission limits apply to in-use diesel vehicles and motorcycles (including Tuk-Tuks).[31]

The Department of Land Transport has local offices in all 76 provinces, where the annual renewal of vehicle registration is done across the country. Registered private garages check the vehicle emissions. Supporting national projects include PCD's Emission Clinic program which promotes QA/QC of garages and sets up a good garage network which is expanding into the smaller cities each year.

Management of Stationary Sources

PCD of MNRE and the Department of Industrial Work (DIW) of the Ministry of Industry (MoI) are responsible for managing emissions from stationary sources. Currently, all industries must report their emissions annually to DIW, and in the case of large emission sources, they must report to the Office of Natural Resources and Environmental Policy and Planning (ONEP), as a part of their Environmental Impact Assessment (EIA) reports. The industry must comply with the National Emission Standards notifications issued by Ministry of Natural Resource and Environment (MONRE) and MoI. DIW and ONEP run annual inspection programs to check the status reports of the industry.

[30] Thailand Pollution Control Department. http://www.pcd.go.th/info_serv/reg_std_airsnd02.html#s3
[31] Thailand Pollution Control Department. http://www.pcd.go.th/info_serv/en_reg_std_airsnd02.html#s3

Industrial emission data is partly collected through Continuous Emission Monitoring systems (CEMs). DIW of MoI receives emission data from CEMs of large emission sources and PCD receives emission data from some power plants. MoI and PCD are taking steps to improve sharing of the emissions database with each other.

Securing industrial emission data may pose a challenge for the municipality. While owners of industries are required to submit emission reports to heads of municipalities (Section 80 of the National Environmental Quality Act of 1992), in reality the municipality usually gets hold of emission data from various offices such as the Provincial Office of the MoI, the Industrial Estate Authority of Thailand (IEAT) which is a state enterprise attached to the MoI, and the Pollution Control Department. The Provincial Office of the MoI has authority over industries within the province but located outside the industrial estates while the IEAT has authority over those located within the industrial estates. While MoI and PCD are taking steps to share the data they collect with each other; the different agencies still need to actively make industrial emission data easily accessible to the municipalities.

Although Command-and- Control has been the key practice to manage stationary sources of pollution, there are several award programs which provide incentives for good performance such as the Star Awards for Mill and Quarry industry run by PCD and ONEP's EIA Awards to promote Corporate Social Responsibility. A study on the market mechanism of air pollution emission trading for Thailand was conducted by Mrs. Chailaiwan Mueller, a Thai expert working at the South Coast Air Quality Management, California, however, emission trading has yet to be piloted in Thailand.

Energy efficiency in industries is promoted by ONEP ("Divided by Two" program) and the Energy Policy and Planning Office (EPPO) of the Ministry of Energy.

With regard to environment-related complaints filed by affected individuals or communities, these are either dealt with directly at the municipality level or transferred to the central authorities like DIW or PCD. If the complaint is transferred to the central authorities, the central authorities usually form a special investigation team to handle the complaint and they work jointly to resolve the case.

Management of Area Sources

The management of pollution from open burning in Thailand is guided by the National Master Plan for Open Burning Control which was approved by the Cabinet in 2003. The plan designates PCD as the national focal point for its implementation. It also identified these three key sources of open burning: burning of agricultural residue, burning of community solid waste, and forest fire.

Following the National Master Plan, the National Action Plan was drawn for 4-year implementation; this is called the Open-Burning and Forest Fire Prevention and Remediation 2008–2011. The plan specifies the development of Changwat Action Plan for Open Burning and Forest Fire which must be integrated to the Changwat Action Plan for Environmental Quality Management; the public/ local authorities must be involved in the drafting of the plan. The Changwat listed are in the upper Northern Region which have been affected by the annual open burning in the dry season, i.e. Chiang Mai, Mae Hong Son, Chiang Rai, Nan, Lamphun, Lampang, Payao and Phrae. Among the recommended strategies to prevent open burning at the municipality level are: set up of a proper solid waste management system, promotion of burning-free organic farming (i.e.

the smoke-free or agricultural residue management technology), and management of traditional or festival events which involve open burning.

Apart from open burning, PCD and the Ministry of Energy focus on the control of Volatile Organic Compounds (VOCs) and the other carcinogenic/mutagenic fugitive pollutants from oil and gas tank farms and petrol stations. The incentives for the entrepreneurs involved in this program are the co-benefits of preventing product loss through leakage and mitigating pollution.

Air Quality Institutional Mandate

Agencies and offices at the municipality, province, region, and national levels play different roles in managing air quality in smaller cities.

In Thailand, municipalities are classified into 3 levels: Nakorn Municipality (City), Muang Municipality (Town) and Tambon Municipality (District). The population range for each level is as follows: Nakorn Municipality is a municipality with population over 50,000; Muang Municipality is a municipality over 10,000; and Tambon Municipality is a municipality with 10,000 population and smaller. There are 7,853 local governments (as of August 2008) of which 23 are City Municipalities, 140 are Muang Municipalities, and the rest of local governments are Tambon Municipalities (except the Mega City Bangkok and the special City of Pattaya). The municipality which could be classified as a "smaller city" in the context of this report would be the Nakorn Municipality.

The inputs from municipalities within the same province are valuable in action planning by the Province. Any Action Plan should actually involve the whole province (Changwat), since by law, the mandate to manage the natural resources and environment resides within the Governor, who needs to incorporate all action plans of the local governments within his/her province into the Changwat Action Plan as specified in the National Environment Quality Act (NEQA) of 1992.

The agencies involved in air quality management are literally almost all agencies in the province, as well as the city. The provincial representatives of the Ministry of Health, Ministry of Education, Ministry of Industry, Ministry of Transport, Ministry of Agriculture and Ministry of Natural Resource and Environment are all important partners to the development and implementation of the plan.

Each Ministry has also appointed Regional representative offices, which are responsible on Regional issues, and make links between adjacent provinces. These offices play roles in the Regional Air Quality Management.

At the national level, the same ministries mentioned above, but more specifically the departments within each ministry, manage specific sources of pollution which are within their mandate.

Co-benefits of Air Pollution Control and Climate Change Mitigation

The 5th Better Air Quality (BAQ) workshop which took place in Bangkok in November 2008 created a momentum towards the co-benefit of air quality management and climate change mitigation.[32] Air pollution control, which was previously seen mostly for its health and environmental benefits, could gain more ground if applied in concert with the Kyoto protocol joint implementation being carried out during 2008-2012. Thailand is a Non-Annex I country, and priorities have been given to climate change adaptation, but climate change mitigation has gained a lot of public interest. The BAQ workshop has helped in raising the awareness of air pollution control agencies that their strategies to cut down air pollution can earn more public and industrial interest if the air quality could be improved while reducing GHG emissions.

Integrated air quality and climate change inventories, such as the Atmospheric Brown Cloud (ABC) Emission Inventory which used Thailand as an example (as presented at an Asian Institute of Technology workshop in December 2008), is helping to identify these co-benefits. Since particulate matter and O_3 are identified as the most serious threats to air quality in Thailand, there can be discussions on the specific technological options that cut down local O_3 precursor and particulate emissions, and also reduce CO_2 emissions. Improving public transport is the one of the most immediate co-benefits measure for cities. Fuel switching from diesel and gasoline to Bio-diesel and Gasohol has been implemented in Thailand, although controversy remains on the impact to food security, and actual benefit to lower CO_2 emission is being tested. Black carbon (BC) contributes to global warming by absorbing atmospheric radiation, and the high-efficiency biomass household stoves can be a good strategy to reduce black carbon emissions. The control of the open biomass burning in Thailand is also the strategy to reduce black carbon if viewed from a climate change mitigation perspective.

The Bangkok Metropolitan Administration (BMA) has taken the lead in acting upon climate change in Thailand and has initiated its own Action Plan to reduce GHG emissions from the city. Thirty-six private and public sector organizations jointly signed BMA's Declaration of Cooperation on Alleviating Global Warming Problems last May 2007. The Declaration has led to the establishment of the BMA Action Plan on Global Warming Mitigation, which was developed through a consultative process with different sectors such as the academe and private sectors, as well as the public. The final BMA Action Plan on Global Warming Mitigation contains 5 initiatives:

1. Expand mass transit and improve traffic systems
2. Promote the use of renewable energy
3. Improve electricity consumption efficiency
4. Improve solid waste management and waste water treatment efficiency
5. Expand park areas

The Action Plan is aimed at bringing about a 15% reduction in Bangkok's GHG emissions below the baseline scenario by 2012.[33]

[32] www.baq2008.org

[33] http://www.baq2008.org/climate-change

3.2 Clean Air Action Plans in Smaller Cities

Cities in Thailand have the power to develop and implement clean air action plans. The bases of this power include: (1) the Constitution of the Kingdom of Thailand 2007, (2) Determining Plans and Process of Decentralization to Local Government Organization Act B.E.2542 (DLGA 1999), and (3) The Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (NEQA 1992). The Decentralization Plan to Local Government Organization following Section 30 of DLGA 1999 determines ONEP's transfer of responsibility and budget relating to the Provincial (Changwat) Action Plan for Environmental Quality Management to the local government organizations.

In general, the framework of the Changwat Action Plan consists of sections on (1) water quality, (2) air quality, (3) solid waste, and (4) hazardous waste. The Changwat Action Plan should be in harmony with the conservation of the natural resources. It is, however, based on the actual circumstances, conditions and priorities of each area or Changwat. The Changwat Action Plan consists of 4 programs: (1) public awareness raising program, (2) surveillance and protection program, (3) remedy and rehabilitation program, and (4) applied research program.

There are ten Pollution Control Areas (PCAs) declared according to Section 59 of the NEQA 1992: (1) The City of Pattaya, Chonburi, (2) Phuket, (3) Hat Yai, Songkhla, (4) Muang, Songkhla, (5) PP Island, Krabi, (6) Samut Prakarn, (7) Bangkok suburbs: Pathum Thani, Nonthaburi, Samut Sakorn and Nakorn Pathom, (8) Petchaburi and Prachubchirikhan, and (9) Saraburi (Nah Pralaan District), and (10) Rayong (only Map Ta Phut and surrounding districts). The NEQA 1992 defines a PCA as any locality affected by pollution problems with a tendency that such problems may be aggravated, to cause health hazards to the public or adverse impact on the environmental quality. The National Environment Board (NEB) has the authority to designate localities as a PCA in order to control, reduce, and eliminate pollution (Section 59, NEQA 1992).

Heads of localities which are designated as PCAs must prepare and submit an Action Plan for Reduction and Eradication of Pollution to the Changwat Governor and the Governor incorporates such plan into the Changwat Action Plan for Environmental Quality Management (Section 60, NEQA 1992). The Changwat Action Plan is to be submitted to the NEB for approval. It must be noted that not all provinces are required to come up with the Action Plan for Environmental Quality Management; only those considered PCAs. However, the NEQA 1992 encourages those provinces without localities designated as PCAs to prepare a Changwat Action Plan (Section 37, NEQA 1992).

The clean air action plan in smaller cities has been seen as being incorporated in the "Action Plan for Reduction and Eradication of Pollution" of some PCAs (i.e. Saraburi and upcoming action plan of Rayong), and Changwat Action Plans of the northern Thai provinces following the "National Action Plan for Open-Burning and Forest Fire Prevention and Remediation 2008–2011." These clean air action plans, which are part of the Changwat Action Plan, are considered official and mandatory because they undergo an official process briefly described below.[34]

[34] Interview with Thailand Department of Local Administration Officials

Step 1: Local Action Plans were drawn by the Local Governments with specific clean air project as desired. The plan should include clear aims, description and budget.

Step 2: The Governor, being guided closely by the recommendations of the Regional office of MNRE, and the Provincial representative of MNRE, incorporates the local plans to the Changwat (Provincial) Action Plan, set priorities, identifies primary and secondary responsible agencies, then proposes the Changwat plan to ONEP.

Step 3: ONEP checks the Changwat Action Plan whether it is in accordance with the National Environmental Quality Plan then submits the plan to be considered by a task force which comprises of central government departments' representatives. This task force set up by ONEP clarifies the plan, and approves its proposal to a Sub-committee of Guiding Changwat Action Plans which will finally consider if the plan is ready for official approval by the NEB.

Step 4: The NEB approves the Action Plan. Then ONEP forwards the plan to the Committee of Decentralization to Local Government Organization (which was set up as specified by the DLGA 1999), who will consider and make a proposal to the Bureau of Budget for annual budgets of the Department of Local Administration, Ministry of Interior, to be earmarked specifically for this purpose.

In the process of developing and implementing the clean air action plans of smaller cities, national government agencies play an important role. For example, they form the task force which considers every Changwat Action Plan for Environmental Quality Management (of which the clean air action plan should be a part of), before it would be submitted by ONEP to the NEB which is chaired by the Prime Minister. Another role of national government agencies in implementation of the clean air action plan is that their local representatives may be identified as primary or secondary responsible agencies in the implementation of each project.

There are several possible sources for funding of clean air action plans. Taking the example of the Changwat Action Plan of Saraburi, a PCA, the budget was secured from the Decentralization Fund (following the above-mentioned steps). The other possible of funding sources are the Environment Fund and the local authority income. Under the NEQA 1992, an Environmental Fund was established by the NEB with money from the Fuel Oil Fund, service fees and penalties collected by virtue of the NEQA 1992, grants from the Thai Government, moneys or properties donated by donors. The fund can be used for several purposes such as **loans** to local administration or state enterprise for air pollution control system to be used specifically in the activities of the local administration or state enterprise, or as **grants** to support any activity concerning the promotion and conservation of environmental quality as the Fund Committee sees fit and with the approval of the NEB (Section 23, NEQA 1992).

While smaller cities are given the power to address air pollution issues within their jurisdiction, the reality is that very few cities consider air pollution as a priority. Thailand is faced with the huge challenge of translating national air pollution laws at the city level. Overcoming this challenge requires awareness raising on air pollution issues and capacity building in air quality management at the local level.[35]

[35] Interview with Grassroots Development Institute

4. STAKEHOLDERS

No less than the Constitution of the Kingdom of Thailand 2007 recognizes the right of communities and individuals to participate in environmental protection, conservation and management to ensure that they live in communities that are environmentally sustainable and not hazardous to health, welfare and quality of life. Local development planning rules also provide community representation in local planning bodies. This Chapter takes a look at whether stakeholders actively participate in air quality management especially in municipalities.

Nongovernment Organizations (NGOs)

NGOs play the important role of providing technical support to communities that want to protect themselves from the harmful effects of air pollution. The story of the Map Ta Phut Bucket Brigade exemplifies how NGO support can empower citizens to participate more effectively in air quality management. The Map Ta Phut Industrial Estate in the Rayong Province houses over 90 industries such as oil refineries, petrochemical and chemical facilities with over 200 stacks. Twenty-five communities surround the industrial estate. The Campaign for Alternative Industry Network (CAIN) and Greenpeace with support from the Global Community Monitor (GCM) initiated the "Thailand Bucket Brigade" project to engage the communities in monitoring what was in air that they were breathing. Using a "bucket," a sturdy, easy-to-use plastic container with a sampling bag to capture gases, five air samples were taken over a five-month monitoring period. These samples were sent to a laboratory in the United States for analysis. A total of 20 different toxic chemicals were found in the samples at levels exceeding health protective standards in the US. Based on the findings (which were published in a report called the "Thailand's Air: Poison Cocktail"), the community filed a suit to have the Map Ta Phut area declared a PCA and be required to convene a Pollution Control Committee with representatives from the communities to develop an Action Plan for the Reduction and Eradication of Pollution. The communities claimed victory when the court decided in its favor early this year.

It is worthy to note that before the publication of the report "Thailand's Air: Poison Cocktail," the PCD only monitored VOC samples from Bangkok. The publication of the report and the increased awareness and media coverage about the seriousness of the VOC problem in areas outside of Bangkok contributed to the expansion of PCD's Air Toxic Program. The PCD has responded by issuing nine VOC standards in the ambient air.[36] The PCD is developing emission standards for the VOCs as well.

Media

Judging from the numerous air pollution-related articles posted online by newspapers in Thailand, there is quite a good coverage of stories of communities asking government agencies to take action to prevent and control air pollution. The media coverage helps bring these air pollution problems to the attention of national and local agencies responsible for managing air quality.

[36] Thailand Pollution Control Department. http://www.pcd.go.th/info_serv/en_reg_std_airsnd01.html#s3

Universities and academe

Several universities (Annex 5) are active in conducting research on air pollution topics such as analyzing ambient air quality and its impacts on health and examining emissions from specific sources of pollution. Many studies have been conducted especially in the provinces of Bangkok and Chiang Mai. Some of these studies have called attention to the gravity of the health impacts of air pollution. One such study is on $PM_{2.5}$ and PM_{10} exposure held in 2005 which found that samples in Chiang Mai and Lamphun Provinces were cytotoxic to lung cells and alveolar macrophages.[37, 38]

The Thailand Air Pollution Center of Excellence (TAPCE) is a partnership of the PCD and local universities. Its purposes are to educate and improve the human resources in air pollution, create a technical network of air pollution control and prevention, support the research and development on air pollution control technology and improve the local and regional administration competence and expertise in air pollution management. TAPCE is well-placed to play an important role in increasing the capacity of smaller cities to manage air pollution.

Development Agencies

Development agencies provide technical and financial support through projects aimed to improve air quality management. An example of how development projects can enhance public participation in air quality management is the Chiang Mai Air Quality Initiative Program supported by the USAID/US-Asia Environmental Partnership's (USAEP) where technical experts worked with national and local officials to develop a strategic plan and an emissions inventory, and public awareness campaigns on the need for improved air quality.[39]

Other stakeholders

The Municipality League of Thailand, the national association of municipalities, could play an important role in increasing municipal officials' awareness of air pollution issues and preventing the deterioration of air quality in smaller municipalities. The League could help disseminate the results of clean air pilot projects and facilitate their replication in other municipalities. It could also help bridge the gap between the national government agencies and smaller cities and facilitate the translation of national policies to address on air pollution at the local level.

The private sector, through their industry associations, could encourage their members to exercise corporate social responsibility by ensuring that their operations comply with air pollution laws.

[37] Vinitketkumnuen, U., K. Kalayanamitra, T. Chewonarin, and R. Kamens. 2002. Particulate matter, PM10 and PM2.5 levels, and airborne mutagenicity in Chiang Mai, Thailand. Mutat. Res. 519(12):121-131.
[38] Usanee Vinitketkumnuen*, Khanittha Punturee Taneyhill, Teera Chewonarin, Narongpan Chunram, Akravit Vinitketkumnuen and Siwapong Tansuwanwong, Exposure to Ambient PM2.5 and PM 10 and Health Effects, CMU. J. Nat. Sci. (2007) Vol. 6(1)
[39] http://www.usaid.gov/pubs/cbj2003/ane/th/493-002.html

5. FINDINGS

The findings of the report focus on the three main areas discussed in the previous chapters: (1) state of the air, (2) legal framework for air quality management, and (3) stakeholder participation in air quality management.

- **State of the air:** PM_{10} is a significant pollutant in Thailand. In 2008, the maximum of the average daily PM_{10} exceeded the daily standard in the Central, Northeastern and Northern regions. Among the provinces in Saraburi and Samut Prakarn in the Central region exceeded the annual standard. The provinces with PM_{10} pollution problems are Saraburi, Ratchaburi, Samut Prakarn and Ayutthaya (Central), Nakhon Ratchasima (Northeast), Lampang and Chiang Mai (North) because they had high percentage of days when the PM_{10} level exceeded the daily standard. In addition to PM_{10}, O_3 is potentially becoming a problem. In 2006 and 2007, more than 20 hours per year were found exceeding the 1-hour O_3 standard at PCD's stations in Bangkok suburb as well as in the smaller cities such as Ayutthaya, Saraburi, Chonburi and Rayong.

- **Legal framework for air quality management:** While the policies for effective air quality management are articulated in laws, regulations, and plans, the challenge is implementing them at the local level. This could be achieved if these conditions are present: a concrete program or long-term plan to help municipalities prevent air pollution; enough knowledge in the municipalities to address this problem effectively; municipal policies are better integrated with national air quality policies; municipalities are aware of environmental standards and requirements demanded of them by the laws; and municipalities have enough personnel, policy and finance to prevent or reduce air pollution effectively.

- **Stakeholders:** Some communities are increasingly becoming aware of the health impacts of air pollution and with the support of NGOs, they are taking an interest in the quality of the air they breathe. Their active engagement in air pollution issues should be encouraged. The important role of university research and media coverage in informing policy and increasing the decision makers' and the general public's understanding of air pollution issues cannot be underestimated. The support of development agencies for projects to improve air quality management in smaller cities in Thailand is greatly needed. Other stakeholders with important roles in improving air quality in smaller cities are: Municipality League of Thailand, Thailand Air Pollution Center of Excellence, and private sector.

ANNEXES

Annex 1

Population and Population Density of Selected 25 Thailand Cities

City	Province	Region[1]	Population (Oct 2008)[2]	Area (km2)[2]	City Density (inh./km2)[2]
Phra Nakhon Si Ayutthaya	Phra Nakhon Si Ayutthaya	C	54,804	14.84	3,693
Samut Sakhon	Samut Sakhon	C	55,473	10.3	5,386
Samut Prakan	Samut Prakan	C	55,994	7.33	7,639
Rayong	Rayong	NE	57,477	16.95	3,391
Lampang	Lampang	N	59,172	22.17	2,669
Trang	Trang	S	61,320	14.77	4,152
Yala	Yala	S	63,357	19	3,335
Chiang Rai	Chiang Rai	N	69,726	60.85	1,146
Songkhla	Songkhla	S	73,170	9.27	7,893
Phuket	Phuket	S	76,208	12	6,351
Phitsanulok	Phitsanulok	N	77,444	18.26	4,241
Nakhon Pathom	Nakhon Pathom	NE	83,388	19.85	4,201
Ubon Ratchathani	Ubon Ratchathani	NE	84,866	29.04	2,922
Nakhon Sawan	Nakhon Sawan	N	92,177	27.87	3,307
Pattaya	Chon Buri	NE	104,236	22.2	4,695
Nakhon Si Thammarat	Nakhon Si Thammarat	S	108317	22.56	4,801
Khon Kaen	Khon Kaen	NE	118,667	46	2,580
Surat Thani	Surat Thani	S	127,237	68.97	1,845
Udon Thani	Udon Thani	NE	141,751	47.7	2,972
Nakhon Ratchasima	Nakhon Ratchasima	NE	146,244	37.5	3,900
Chiang Mai	Chiang Mai	N	147504	40	3,688
Hat Yai	Songkhla	S	157,596	21	7,505
Pak Kret	Nonthaburi	C	173,622	36.04	4,817
Nonthaburi	Nonthaburi	C	264,651	38.9	6,803
Bangkok		C	6,320,174[3]	1,568.73	4,029[3]

1: C – Central; N – North; NE- Northeastern; S-Southern

2: http://en.wikipedia.org/wiki/List_of_cities_in_Thailand_by_population

3: Thailand National Statistics Office. Census 2000.

Annex 2

Location of industrial estates, parks and zones

Zone	Region	Province or area where industrial estates, parks and zones are located
Zone 1	Central	Bangkok, Samut Prakarn, Pathum Thani, Samut Sakhon
Zone 2	Central and West	Ayutthaya, Saraburi, Ratchaburi
	East	Chachoengsao, Chonburi, Rayong
Zone 3	Central and West	Singburi
	East	Prachin Buri
	Northeast	Nakhon Ratchasima
	North	Lamphun, Pichit
	South	Pattani, Songkhla

Source: Industrial Estate Authority of Thailand (http://www.boi.go.th/english/how/industrial_estates.asp)

Annex 3

Summary of Laws, Regulations and Plans on Air Quality, Transport and Energy

These main supportive laws and regulations and plans laid down by the national government on the environment, air quality, transport, energy, and climate change are summarized below:

Laws and Regulations

1. The Constitution of the Kingdom of Thailand 2007
2. The Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (NEQA 1992)
3. Ambient Air Quality Standards of CO, NO_2, O_3, SO_2, Pb, PM_{10} and TSP, as specified in the Notification of National Environmental Board No. 10 (1995), No. 24 (2004) and No. 28 (2007)
4. Emission Standards as specified in the Notification of Ministry of Natural Resource and Environment (formerly Ministry of Science, Technology and Environment up to 2002) published in the Royal Government Gazette dated in the years 1996, 1997, 1999, 2001, 2002, 2003, 2004, 2005 and 2006
5. Public Health Act B.E. 2535 (PHA 1992)
6. Factory Act B.E. 2535 (FA 1992)
7. Land Transport Act B.E.2522 (LTA 1979) latest updated 2008
8. Land Traffic Act B.E.2522 (1979)
9. Industrial Product Standards Act B.E. 2511 (1968) latest updated 1992
10. Motor Act B.E.2522 (CA 1979) latest updated 2007
11. National Energy Policy Council Act B.E. 2535 (1992)
12. The Energy Conservation Promotion Act B.E.2535 (ECPA 1992)
13. Determining Plans and Process of Decentralization to Local Government Organization Act B.E.2542 (1999)
14. Decentralization Law

Plans

1. Pollution Prevention and Mitigation Policy in accordance with the Policy and Perspective Plan for Enhancement and Conservation of the National Environmental Quality 1997-2016
2. Environmental Quality Management Plan
3. Provincial (Changwat – in Thai) Action Plan for Environmental Quality Management
4. Local Action Plans

Laws and regulations

1. The Constitution of the Kingdom of Thailand 2007 states in Section 66 the right of community to participate in the management, maintenance, preservation and exploitation of natural resources, environment, and biological diversity in a balanced fashion, and in Section 67, the right of individual to join in the protection, promotion and preservation of the quality of the environment for a consistent survival in the environment which is not hazardous to his or her health, welfare or quality of life.

Moreover, the constitution particularly states that any project or activity which may seriously affect the community, the quality of the environment, natural resources, and health shall not be permitted, unless its impacts on the quality of the environment and health condition of people in the community have been studied and evaluated; and procedure on public hearing from the people and those affected, including from an independent organization, consisting of representatives from private environmental and health organizations and from higher education institutions providing studies in the environmental, natural resources, and health field, have been obtained prior to the operation of such project or activity.

The constitution also protects the rights of a community to sue a government agency, State agency, State enterprise, local government organization, or other State agencies, to perform their duties.

The constitution also contains the State Policy Directives in Section 85 on Land, Natural Resource, and Environment, and on Energy in Section 86. These emphasize the State's role to develop and implement the town and country planning effectively and efficiently for the interests of sustainable natural resource preservation. The importance of promoting and supporting research and development of alternative energy from natural sources is also stated.

Finally, Section 290 of the Constitution specifies the powers and duties of the local government to promote the quality of the environment by management, preservation and exploitation of the natural resources and environment in the area of the locality, or outside the area in the case where the livelihood of its inhabitants may be affected.

Air quality

2. The Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (NEQA 1992) provides the general framework for environmental protection.

Public participation is enhanced by stating the rights of individuals to be informed of the data from the government service in matters concerning environmental quality; to lodge complaint, and to be compensated by the State in case of damage as a consequence of contamination by pollution from project undertaken by government agency, state enterprise, or any activity committed in violation of the laws relating to pollution control or conservation of natural resources. Individuals should also cooperate and assist government officials in the performance of duty relating to this law.

The Act institutes the National Environmental Board (NEB), which is chaired by the Prime Minister. It also establishes the "Environmental Fund" with money from the Fuel Oil Fund, service fees and penalties collected by virtue of the Act, grants from the Government, moneys or properties donated by donors. The fund can be used; (1) as grants to government agency or local administration for investment in and operation of the central wastewater treatment plant or central waste disposal facility, including the acquisition and procurement of land, materials, equipment, instrument, tools and appliances necessary for the operation and maintenance of such facility, (2) as loans to local administration or state enterprise for making available of air pollution control system, wastewater treatment or waste disposal facilities to be used specifically in the activities of such local administration or state enterprise, (3) as loans to private person in case such person has the legal duty to make available and install an on-site facility of his own for the treatment of polluted air, wastewater or waste disposal or any other equipment for the control, treatment or eliminate pollutants that are generated by his activity or business undertaking, or such person is licensed to undertake business as a Service Contractor to render services under this Act, (4) as aids to support any activity concerning the promotion and conservation of environmental quality as the Fund Committee sees fit and with the approval of the NEB.

In addition, the **Section 32** in this act gives the authority to NEB to issue NAAQS, which is a key tool for monitoring the state of air quality. The **Section 55** also gives authority to the Minister of Environment to issue emission standards, to which all emission sources must comply, and the sources' owners must install the emission control equipment, otherwise they shall be liable to pay as a daily penalty four times as much the amount of daily expenses for the normal operation of the facilities. It also provides power to authorized officials to prohibit the use of any vehicle in violation emission standards permanently, or until it is improved to meet the emission standards requirement.

3. The National Ambient Air Quality Standards (NAAQS) of CO, NO_2, O_3, SO2, Pb, PM_{10} and TSP, as specified in the Notification of National Environmental Board No. 10 (1995), No. 24 (2004) and No. 28 (2007)

4. The National Emission Standards are issued by the Minister of Natural Resources and Environment by the recommendation of the Pollution Control Board, and agreed by the NEB. The Municipality and Provincial Governors may issue a more stringent emission standard than the national emission standard, if they find that is more suitable in their territory. The mobile sources are controlled directly with parameters, so far, ranging from opacity of fumes from diesel vehicles, white smoke from motorcycles, CO and HC from gasoline vehicles and motorcycles. The stationary sources covered SO_2, NOx as NO_2 and TSP from specific power plants, municipal waste incinerators, steel industry and Portland cement plants, and also covered TSP and opacity from mining and quarry plants, plus VOCs from bulk gasoline terminals. Other specific controls include NOx from gold smelting plants, and opacity from all boilers and crematory. In 2006, the Ministry of Environment also issued a longer list of air emission control for both combustion and non-combustion processes of industry. The parameters include not only TSP, SO_2 and NOx, but also CO, Hydrogen Sulfide, Hydrogen Chloride, Sulfuric acid, Xylene, Cresol, Antimony, Arsenic, Copper, Lead, Chlorine and Mercury.

5. Public Health Act B.E. 2535 (PHA 1992) specifies in several sections the beneficial statements to the control of air pollution. **Section 25** empowers the local authorities to mitigate or prevent the causes of public nuisances or public health violation within their territories. There are sections describing how to deal with hazardous/health threatening activities that could be adapted to air quality.

6. Factory Act B.E. 2535 (FA 1992) prescribes the rules with which all factories must comply such as the criteria relating to the location of factory, environment of the factory, nature of the buildings of factory, kind of machines, process of production and provision of equipment or tools in order to prevent or stop or mitigate the dangers that may be caused to persons or property in and surrounding the factory business. The factory must also adopt the standards and methods of controlling the discharge of waste, pollutants or

anything that affects the environment as a result of the engagement in a factory business. There have been several notifications published in the Royal Gazette specifying the same industrial emission standards with those of MNRE as above. In addition to these, industrial hazardous waste incinerators are also controlled with limits to air emission of Dioxin, Furan, Semi Volatile Metals i.e. Cadmium, Lead; Low Volatile Organic Metals i.e. Arsenic, Beryllium and Chromium. This act also enables the Ministry of Industry to prohibit the use of CFCs, to protect the stratospheric ozone layer, as Thailand has ratified the Montreal Protocol.

Transport

7. Land Transport Act B.E.2522 (LTA 1979) latest updated 2008. This act has nationwide coverage but only applies to land freight and buses. Under this law, the Ministry of Transport issues notifications which control new registration of the motor vehicles and annual renewal the registrations. **Section 83** specifies the role of inspectors who are eligible to check whether the vehicle meets the standards (emission and other features), otherwise, they could prohibit the use of the vehicle.

8. Land Traffic Act B.E.2522 (LTA 1979). **Section 6** of this Act allows the Minister of Interior to note the kind of vehicles to be prevented from commuting in land traffic (the law refers to the above notifications of MNRE). **Section 10** authorizes the Commissioner General of the Royal Thai Police to declare specific air emission criteria for the land traffic sector.

9. Industrial Product Standards Act B.E. 2511 (1968) latest updated 1992. The Minister of Industry, authorized by this act, has issued several notifications which are crucial to control air pollution from motor vehicles, both light duty diesel and gasoline vehicles (1995), as well as motorcycles (1996) and heavy duty vehicles (1997).

10. Motor Act B.E.2522 (CA 1979) latest updated 2007. This act covers cars, motorcycles, trailers, tractors and others. Under this law, the Ministry of Transport issues notifications which give power to the Department of Land Transport (DLT) to regulate the issuance of new registration of the private vehicles, and collection of fees from the annual renewal the registrations. DLT is in charge of setting the rules for the annual inspection of the vehicles including exhaust control, thus plays big roles in air pollution.

Energy

11. National Energy Policy Council Act B.E. 2535 (1992) sets up the National Energy Policy Council which has duties to submit the National Energy Policy and the National Energy Management and Development Plan to the Council of Ministers; as well as to lay down rules and conditions for prescribing the price of energy in accordance with the proposed plan. The council is also responsible in monitoring, supervising, coordinating and expediting the operations of Government agencies, State enterprises and the private sector related to energy, in order that their operations shall be in accordance with the National Plan; and finally, to evaluate the results of the plan implementation.

12. The Energy Conservation Promotion Act B.E.2535 (ECPA 1992) updated 2007 aims to conserve energy in designated factories, buildings and machinery. It empowers the Energy Minister, by the advice of the National Energy Policy Council, to issue Ministerial Regulations on the establishment of the standards, criteria and energy management procedures to be complied by the owners of designated factories, buildings and machinery; the regulations also stipulate technical specifications and academic details in accordance with the rapidly changing economic and social conditions. The act also institutes the “Energy Conservation Promotion Fund,” to be used as working capital and as grants or subsidies for the implementation of energy conservation-related work. The Fund consists of the money transferred from the Oil Fund under the law on

remedy and prevention of shortage of fuel oil, the contributions, surcharges, as well as assets received from private donors.

Others

13. Determining Plans and Process of Decentralization to Local Government Organization Act B.E.2542 (1999). According to this Act, the Decentralization to Localities Plan has been formulated.

14. Decentralization Law. In **Section 16** of DLGA1999, it is specified that the municipality shall have the power to systematize the public services for the benefit of local communities as follows:

(1) Establish local self-development plan.
…
(3) Provide and control of market, wharf, pier and parking.
(4) Public utility and other constructions.
(5) Public assistance.
(6) Promote, train and carry on occupations.
(7) Commerce and investment support.
(8) Promote tourism.
…
(10) Social welfare and develop the life quality of children, women, old people and disadvantaged people.
…
(13) Provide and maintain the recreational areas.
(14) Enhance athletic sports.
…
(16) Enhance the participation of people in development of local organizations.
(17) Keep clean and keep the city in perfect order.
(18) Waste management system including waste water.
(19) Public health, family sanitation and health care.
(20) Provide and control the cemetery and cremation.
…
(24) Provide, maintain and benefit taking from forestry, land, natural resources and Environment.
(25) City planning.
(26) Transportation and traffic engineering.
(27) Preserve public places.
(28) Control of structures.
(29) Prevent and alleviate of public dangers.
(30) The public order, promote and support the prevention and security measures of life and properties.

Income of the municipalities is specified in **Section 23** such that they may receive income from taxes, duties, fee and revenue as follows:
(1) Land and house tax under the law on land and house.
(2) Local development land tax under the law on local development land tax.
(3) Sign tax under the law on signboard.
(4) Value added tax under the Revenue Code allocated in the rate which amalgamating with the allocation in Section 24 (3) and section 25 (6) shall not exceed 30% of value added tax collected deduct by the return payment. This collection shall be the duty of the Revenue Department.
(5) Specific business tax under the Revenue Code by issuance of provision to increase the tariff which amalgamating with the tariff in Section 24 (4) shall not exceed 30% of the tariff collected under the Revenue Code. This Collection shall be the duty of the Revenue Department.

(6) Excise tax under the law on excise, liquor law under the law on liquor and tobacco stamp under the law on tobacco collected from trade in municipal area by issuance of provision to increase the collection tariff which shall not exceed 30% of the tariff collected by The Excise Department and it is considered as taxes and stamps under the law of that matter. The collection shall be the duty of The Excise Department.
(7) Automobile tax and fee of including the increased money under law on automobile, automobile tax under the law on domestic land and fee for vehicle under the law on vehicle.
(8) Gambling tax under law on gambling.
(9) Education tax under law on national education.
(10) Animal killing duty and for other benefits from animal killing under law on control of animal killing and selling of meat.
(11) Swallow nest duty under law on duty of swallow nest.
(12) Mineral royalty fee under law on mineral after deduction for the State income at the rate of 40% as follows:
(a) Tambon Administrative Organizations or municipalities with the area covering according to the concession shall be allocated for 20% of the mineral royalty fee collected in that area.
(b) Tambon Administrative Organizations and other municipalities in the provincial area covering concession area shall be allocated for 10% of the mineral royalty fee collected in that area.
(c) Tambon Administrative Organizations and municipalities in other provinces shall be allocated for 10% of the mineral royalty fee collected in that area.
(13) Petroleum royalty fee under law on petroleum after deduction for the State income at the rare of 40% as follows:
(a) Tambon Administrative Organizations or municipalities with area covering according to the concession shall be allocated for 20% of the mineral royalty fee collected in that area.
(b) Tambon Administrative Organizations or municipalities in the provincial area covering concession area shall be allocated for 10% of the petroleum royalty fee collected in that area.
(c) Tambon Administrative Organizations and municipalities in other provinces shall be allocated for 10% of the petroleum royalty fee collected in that area.
(14) Registration of title license fee and juristic act relevant to immovable property with capital within that area. Thus, this shall be in conformity with the Land Code and Condominium Act.
(15) Airport fee under the law on Air Navigation. Thus, this shall be in conformity with the rate and procedure determined by the Committee.
(16) The following fees prescribed by provisions to increase the rate of collection shall not exceed 10% of the fees collected by law on that matter.
(a) Liquor selling license fee under the law on liquor.
(b) Gambling license fee under the law on gambling.
(17) Fee, license fee and fine in businesses authorized by law for the municipality and Tambon Administrative Organization to proceed in that local area and the income shall belong to the mentioned local government organizations. In case that the law prescribed that the municipalities shall collect fee, license fee and fine, the income shall be allocated with Tambon Administrative Organizations in the provincial area determined by the Committee.
(18) Fee from using of water from artesian well under the law on water form artesian well. Thus, this shall be in conformity with the ratio determined by the Committee.
(19) Any fees collected from users or receiving the benefits provided by public services.
(20) Other incomes, which are prescribed by law, belonging to the municipality and Tambon Administrative Organization.

Plans

1. Policy and Perspective Plan for Enhancement and Conservation of the National Environmental Quality 1997-2016. This was proposed for the cabinet approval by the NEB following the Section 13(1) in the NEQA1992.

2. Environmental Quality Management Plan proposed by the Minister of Natural Resources and Environment to be implemented every 5-year period, according to section 35 of NEQA1992. It must be approved by the NEB, and follows the 20-year plan described in the Policy and Perspective Plan for Enhancement and Conservation of the National Environmental Quality 1997-2016.

3. Provincial (Changwat – in Thai) Action Plan for Environmental Quality Management must be proposed by the Governor of the Changwat, in which there is a locality designated as Environmentally Protected Area (according to section 43 of NEQA1992), or as Pollution Control Area (according to section 59 of NEQA1992) for the NEB approval within 120 days from the date on which the Governor is directed to prepare the Changwat Action Plan. In case of Changwat, in which no locality is designated as an Environmentally Protected Area, or as Pollution Control Area, but there is a desire to enhance the environmental quality within the limits of its territory, the Governor of that Changwat may prepare a Changwat Action Plan, within the framework of the Environmental Quality Management Plan, and submit for the NEB approval.

4. Local Action plans must be prepared by the local authorities, and must be incorporated into the Changwat Action Plan as an integral part for mitigation and elimination of pollution.

Annex 4

In-Use Vehicle Emission Standards

Type	Pollutants	Standards	Equipment*	Methods**
Motorcycle				
-Register before Jul 1, 2006	CO	4.5%	NDIR	Idle Test
	HC	10,000 ppm	NDIR	Idle Test
-Register since Jul 1 ,2006	CO	3.5%	NDIR	Idle Test
	HC	2,000 ppm	NDIR	Idle Test
-Register since Jan 1, 2009	CO	2.5%	NDIR	Idle Test
	HC	1,000 ppm	NDIR	Idle Test
All Type				
-All Motorcycle	White Smoke	30%	Opacity	¾ of Max. HP RPM
	Noise	95dB(A)	Sound level meter	¾ or ½ of Max. HP RPM
-Tuk Tuk	CO	4.5%	NDIR	Idle Test
	HC	10,000 ppm	NDIR	Idle Test
	Noise	100dB(A)	Sound level meter	¾ or ½ of Max. HP RPM
Gasoline Vehicle				Measure while parking
-Register before Nov 1, 1993	CO	4.5%	NDIR	the car at idle and no
	HC	600 ppm		load

-Register since Nov 1, 1993 -Register since Jan 1, 2007	CO HC CO HC	1.5% 200 ppm 0.5% 100 ppm		
Diesel Vehicle	Black Smoke	50% 45% 40% 35%	Filter System Opacity System Filter System Opacity System	Measure while parking the car at load by quick acceleration the engine to maximum rpm Measure while the car running steady on the roller at 60% of maximum power rpm

* Non-Dispersive Infrared Detection, **Max RPM > 5,000 :Max RPM < 5,000 respectively

For motorcycle

1) Notification of the Ministry of Natural Resources and Environment, Designated Carbon monoxide and Hydrocarbon Emission Standard dated October 13, B.E. 2548 (2005) published in the Royal Government Gazette, Vol. 122 Special Part 141D, dated December 9, B.E. 2548 (2005) were revoked by 2)
2) Notification of the Ministry of Natural Resources and Environment, Designated Carbon monoxide and Hydrocarbon Emission Standard dated February 8, B.E. 2550 (2007) published in the Royal Government Gazette, Vol. 124 Special Part 29D, dated March 14, B.E. 2550 (2007)

For Gasoline Vehicle

1) Notification of the Ministry of Science, Technology and Environment No.3, B.E.2540 (1997) dated June 23, B.E.2540 (1997) published in the Royal Government Gazette, Vol. 114 Part 76, dated September 23, B.E. 2540 (1997) were revoked by 2)
2) Notification of the Ministry of Natural Resources and Environment, Designated Carbon monoxide and Hydrocarbon Emission Standard dated February 8, B.E. 2550 (2007) published in the Royal Government Gazette, Vol. 124 Special Part 29D, dated March 14, B.E. 2550 (2007)

For Diesel Vehicle

1.) Notification of the Ministry of Science, Technology and Environment No.2, B.E.2540 (1997) dated June 17, B.E.2540, published in the Royal Government Gazette, Vol. 114 Part 76, dated September 23, B.E. 2540 (1997)
2) Notification of the Ministry of Science, Technology and Environment No. 4 B.E.2541(1998) dated September 9, B.E.2541 (1998), published in the Royal Government Gazette, Vol. 115 Special part 100, dated October 27, B.E.2541 (1998)

Source: Pollution Control Department (http://www.pcd.go.th/info_serv/en_reg_std_airsnd02.html#s1)

Annex 5

List of Universities and Institutes

These universities and institutes have conducted research and air pollution studies in Thailand

1) King Mongkut's University of Technology
2) Asian Institute of Technology
3) Chiang Mai University
4) Thammasat University
5) Chulalongkorn University
6) Kasetsart University
7) Silpakorn University
8) Khon Kaen University

9) Mahanakorn University of Technology
10) Prince of Songkla University
11) PTT Research and Technology Institute
12) Rangsit University
13) Suranaree University of Technology
14) University of the Thai Chamber of Commerce