Air quality and acid deposition monitoring in Thailand

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Department of Environmental Quality Promotion,
Ministry of Natural Resources and Environment

Organization of MoNRE

Ministry of Natural Resources and Environment

- Environmental Cluster
  - DEQP
  - PCD
- Natural Resources Cluster
- Policy Cluster

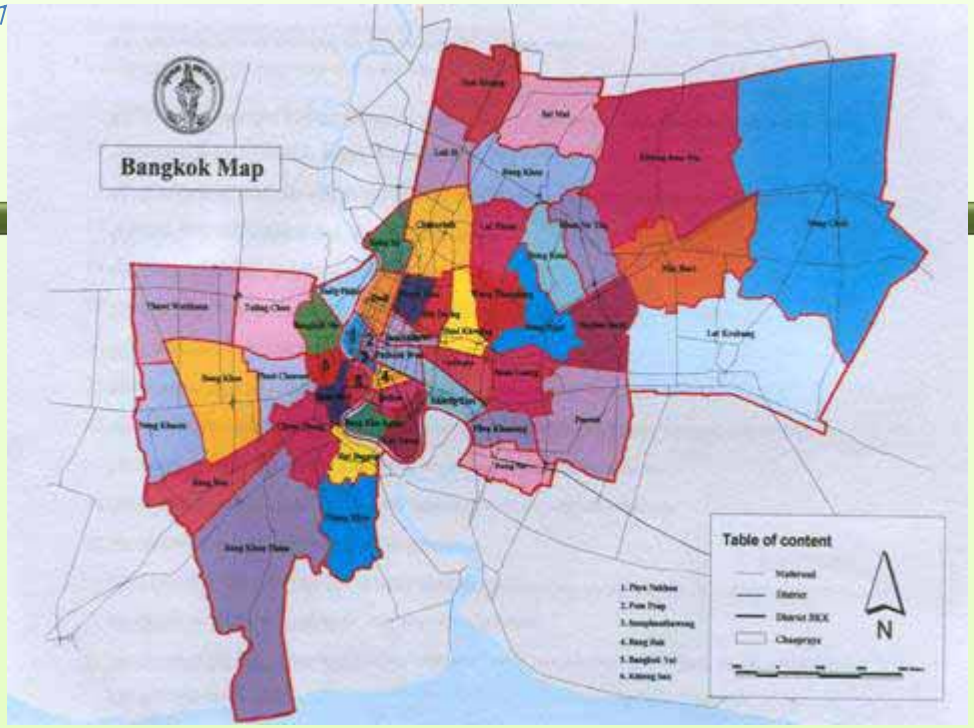
Environmental Research and Training Center

Environmental Research and Training Centre

- Administrative Division
  - General Administration Sub-division
  - Standard and Accreditation Sub-division
- Human Resource Development Division
- **Dioxins Laboratory**
- Research and Development Division
  - Water Research and Development Sub-division
  - Hazardous Substances Research and Development Sub-division
  - Environmental Network and Research cooperation Sub-division
  - Air, Noise and Vibration Research and Development Sub-division
  - Ecological economic Research and Development Sub-division

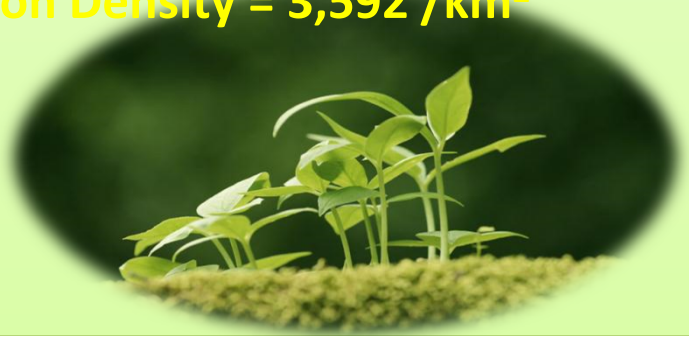
Outline of the presentation

- Background information
- Air Quality Monitoring and NAQS
- Acid deposition monitoring (under EANET regional cooperation)



THAILAND:
Total Area 544,000 km2
Population in 2006 = 65,300,000
Population Density = 121/km²

BANGKOK:
Total Area 1,568 km²
Population in 2008 = 8,000,000
Population Density = 3,592 /km²



Status of Air Quality in Thailand

Acknowledgement

Air Quality and Noise Management Bureau, Pollution Control Department


Past
Present
TAXI
9 3 2004
9 3 2004

Effect of O_3 on Bangkok Visibility

Maximum 1-hr average O_3 = 131 ppb

Maximum 1-hr average O_3 = 60 ppb

JETJARAS NA RANONG

Pollution protest

Greenpeace volunteers in patient gowns and with medical equipment stage a protest outside the Industry Ministry after the National Environment Board delayed a decision to declare the Map Ta Rhut industrial estate a pollution control zone.

Home

PRTR System

SAMPLING

A POISON COCKTAIL

With some international help, residents in areas adjoining the Map Ta Phut Industrial Estate have found a new tool to monitor their own air quality, writes

SUPARA JANCHITFAH

HOW TO SAMPL

Home

PRTR System

SAMPLING

A POISON COCKTAIL

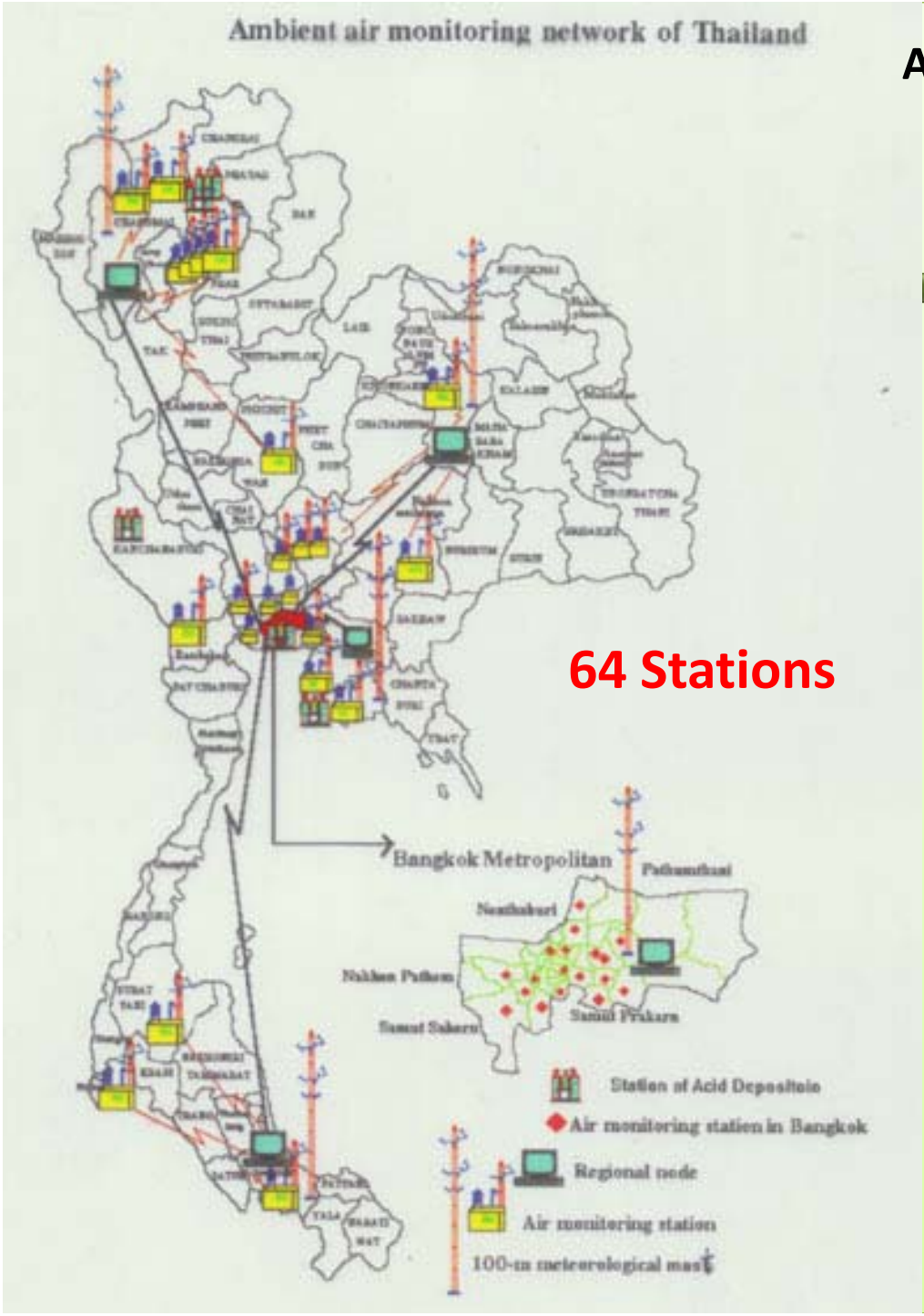
With some international help, residents in areas adjoining the Map Ta Phut Industrial Estate have found a new tool to monitor their own air quality, writes

SUPARA JANCHITFAH

HOW TO SAMPLE?

In the air around Map Ta Phut

Air quality monitoring in Thailand

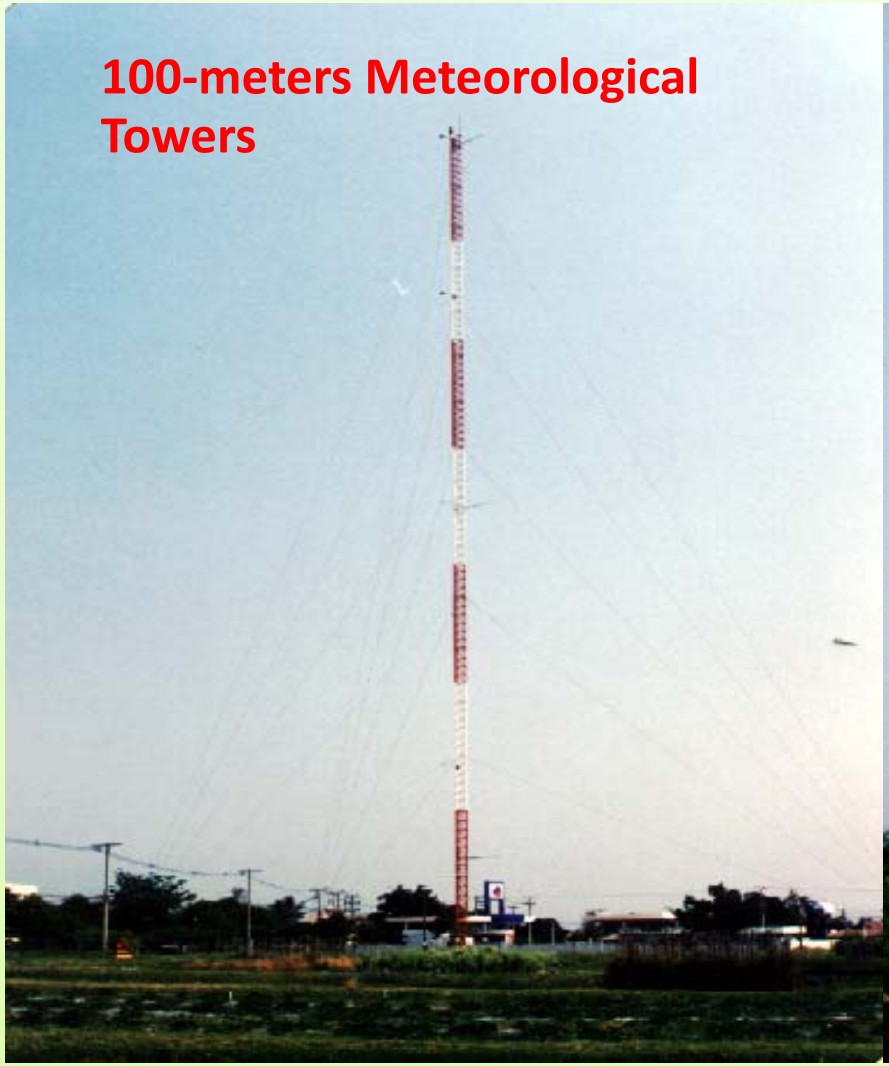


64 Stations

Ambient Air Quality Monitoring Network

Region	Air Quality Stations	100-meters Met. Towers
North	10	1
Northeast	5	1
Central	32	1
East	14	1
South	3	1

Meteorological stations

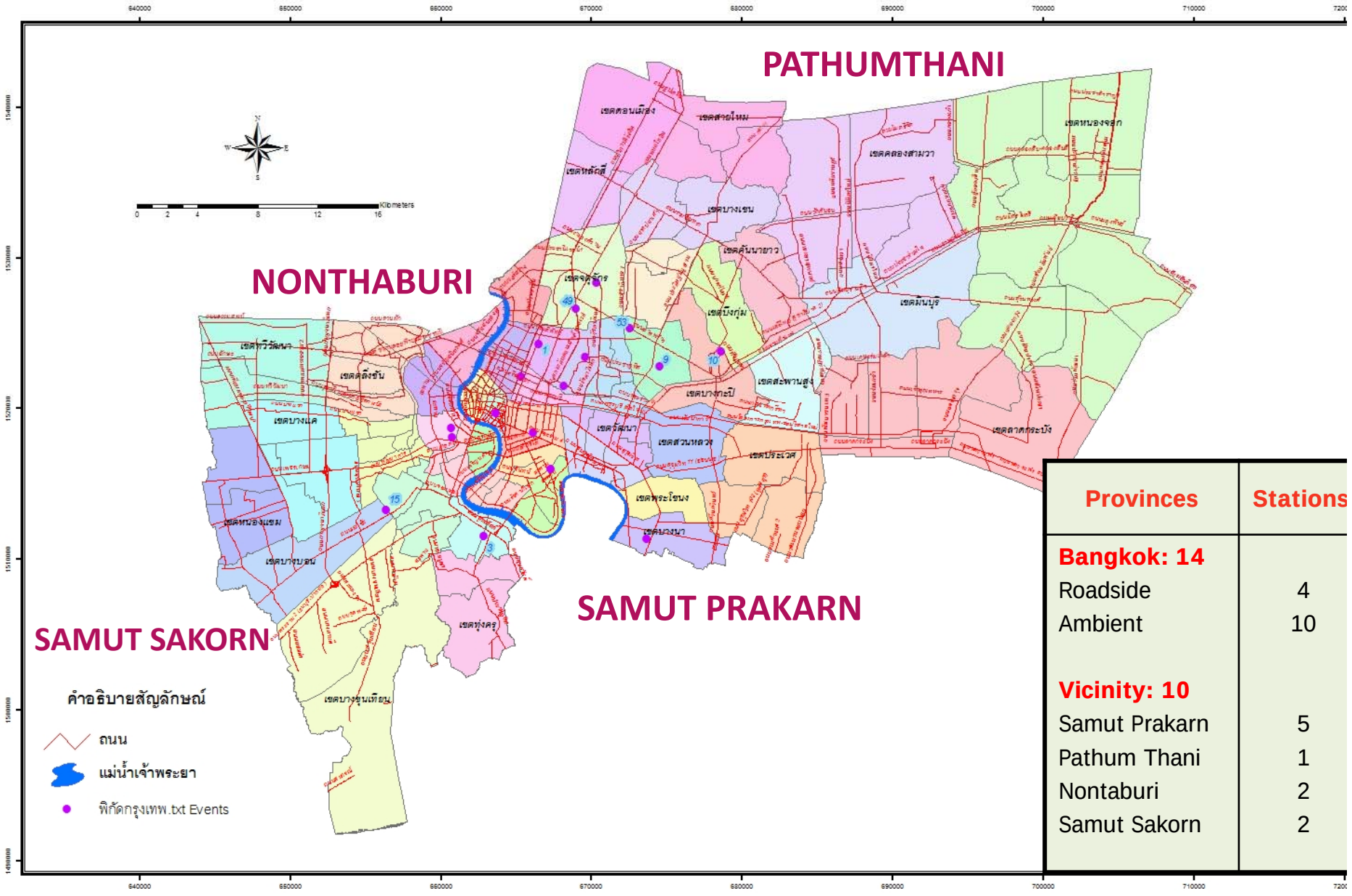


100-meters Meteorological Towers

Meteorological Towers at Monitoring Stations – 10 or 30 meters

Parameters: Wind speed, Wind direction, Relative Humidity, Temperature, Solar Radiation, Net Radiation, Barometric Pressure, Precipitation

Monitoring Stations in BKK & Vicinity



Provinces	Stations
Bangkok: 14	
Roadside	4
Ambient	10
Vicinity: 10	
Samut Prakarn	5
Pathum Thani	1
Nontaburi	2
Samut Sakorn	2

Continuous air quality monitoring stations

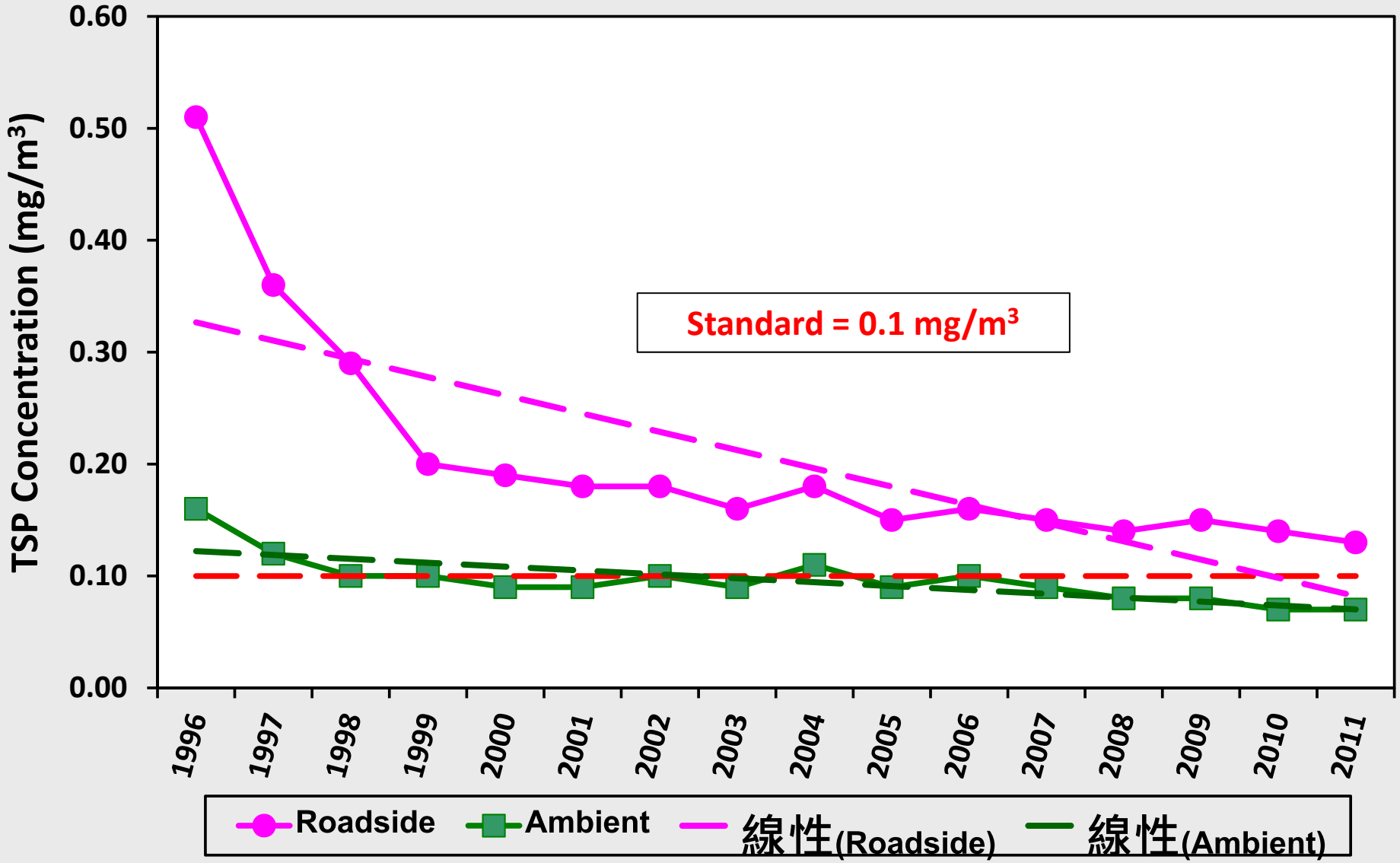
Temporary air quality monitoring stations

Pollutants: TSP, PM_{10}, CO, O_3, NO, NO_2, SO_2, THC, NMHC and Pb

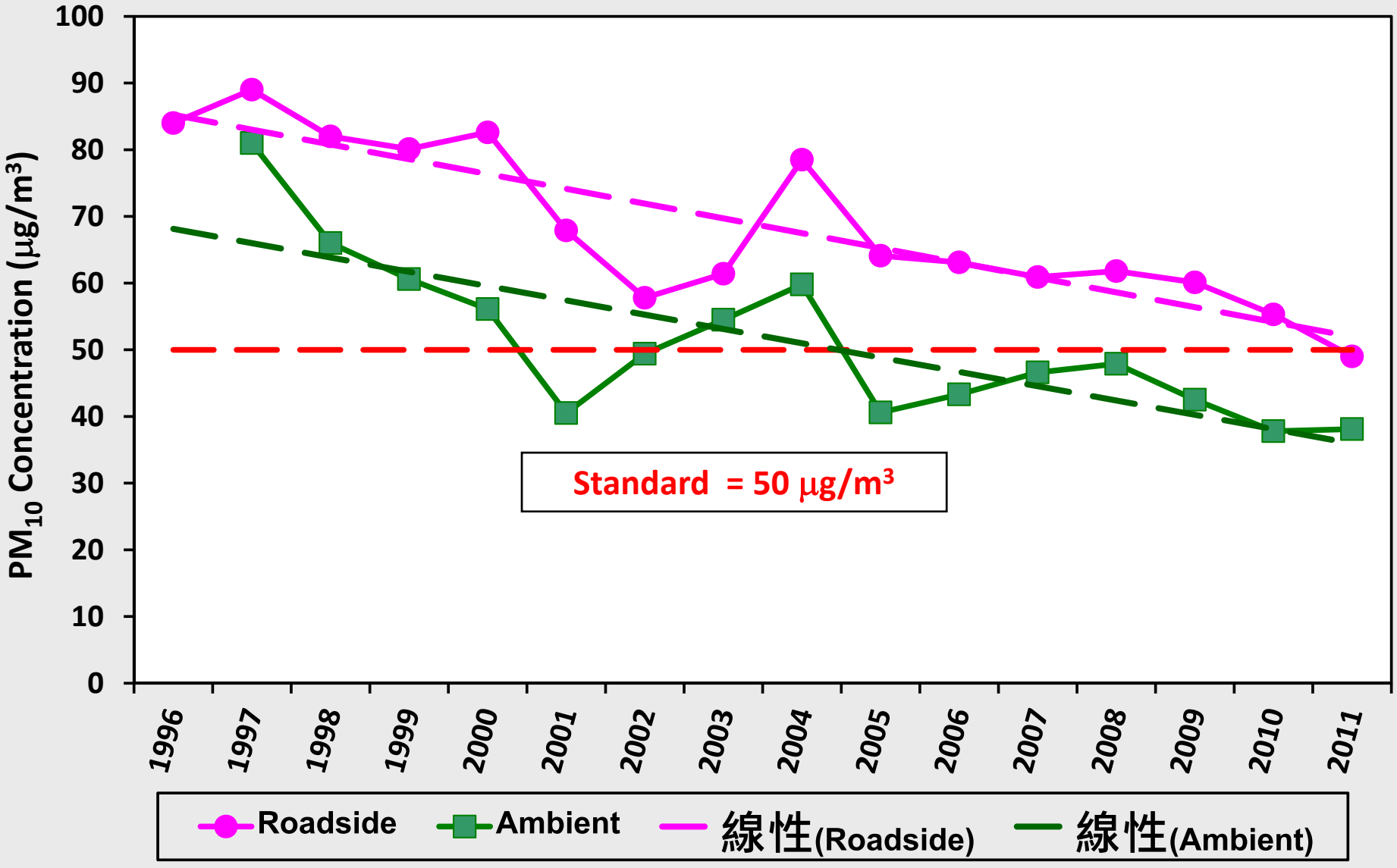
Thailand Ambient Air Quality Standards (criteria pollutants)

Pollutants	Standards					
	1-hr	8-hr	24-hr	1-month	annual	Measurement Methods
CO (ppm)	30	9	-	-	-	Non-Dispersive Infrared
NO_2 (ppm)	0.17	-	-	-	0.03	Chemiluminescence
SO_2 (ppm)	0.3	-	0.12	-	0.04	Pararosaniline/ Ultraviolet fluorescence
O_3 (ppm)	0.1 (1995)	0.07 (2007)	-	-	-	Chemiluminescence/ Ultraviolet absorption photometry
TSP (mg/m^3)	-	-	0.33	-	0.1	Gravimetric High Volume
PM_{10} (mg/m^3)	-	-	0.12	-	0.05	Gravimetric High Volume/ Beta Gauge/ TEOM /Dichotomous
Pb (mg/m^3)	-	-	-	0.0015	-	Atomic Absorption Spectrophotometer
$PM_{2.5}$ (mg/m^3)	-	-	0.05	-	0.025	
CS_2 (mg/m^3)	-	-	0.18	-	-	US EPA Compendium Method TO-15

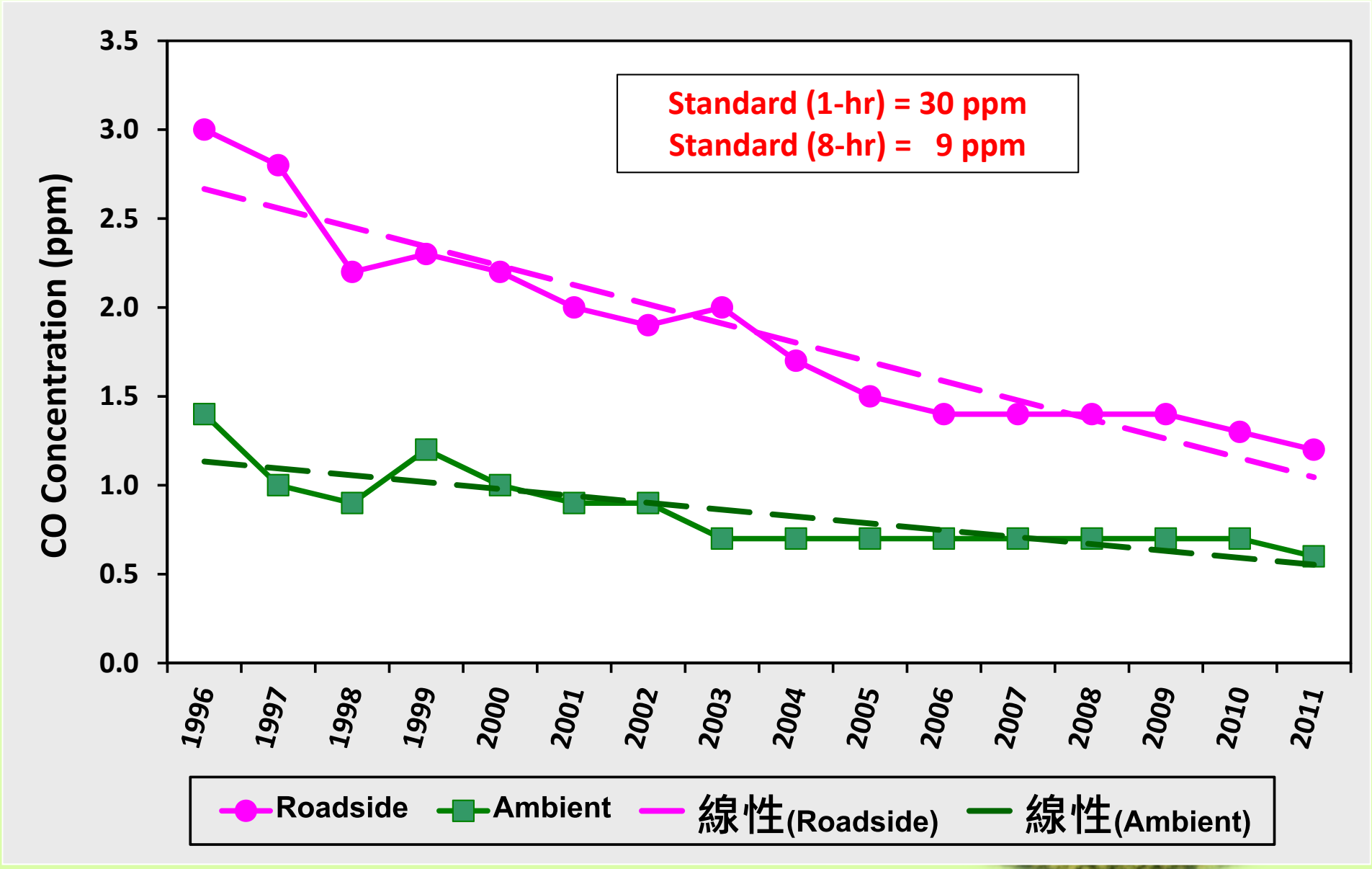
Annual Average Concentration of TSP in Bangkok 1996 - 2011



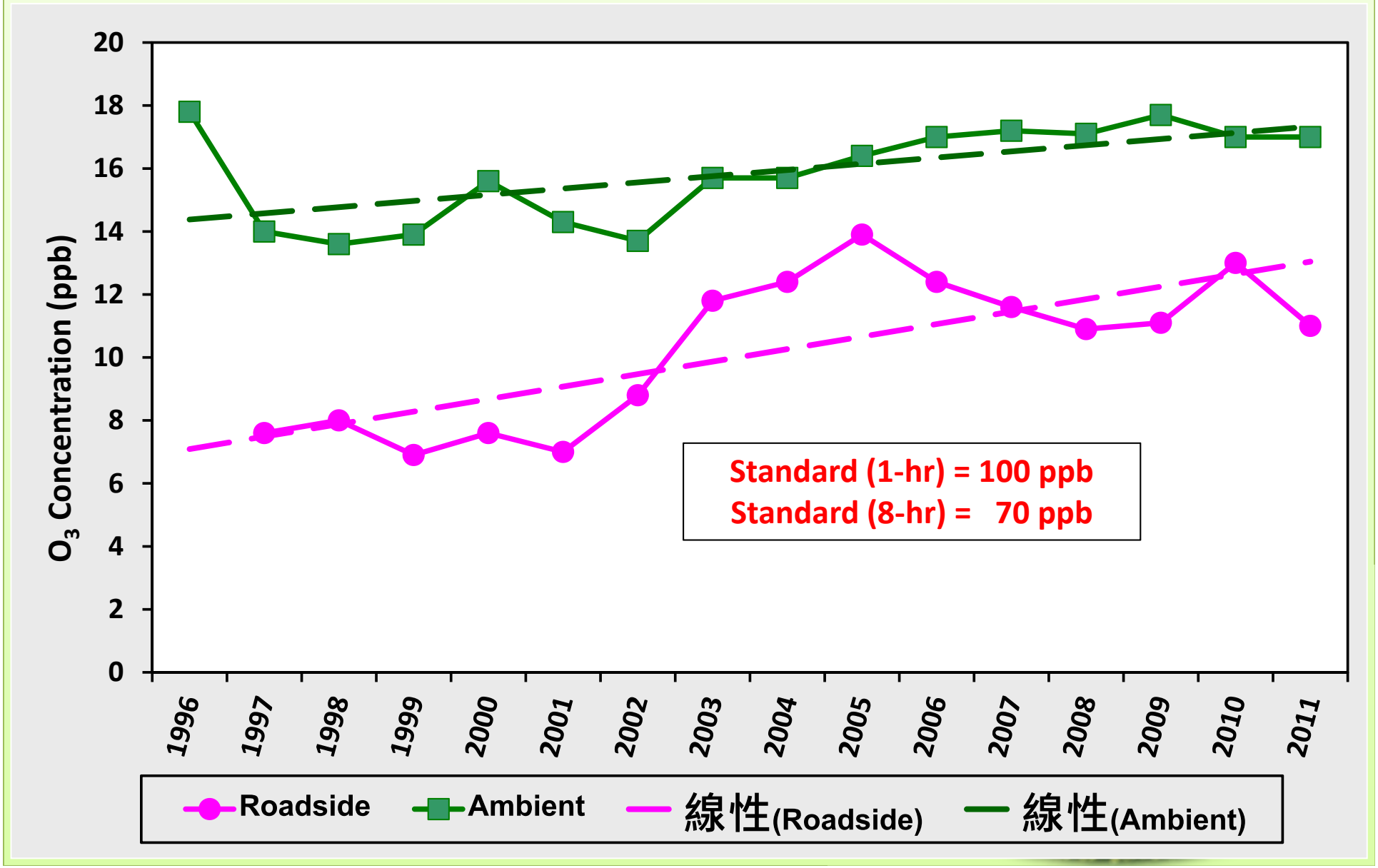
Annual Average Concentration of PM_{10} in Bangkok 1996 - 2011



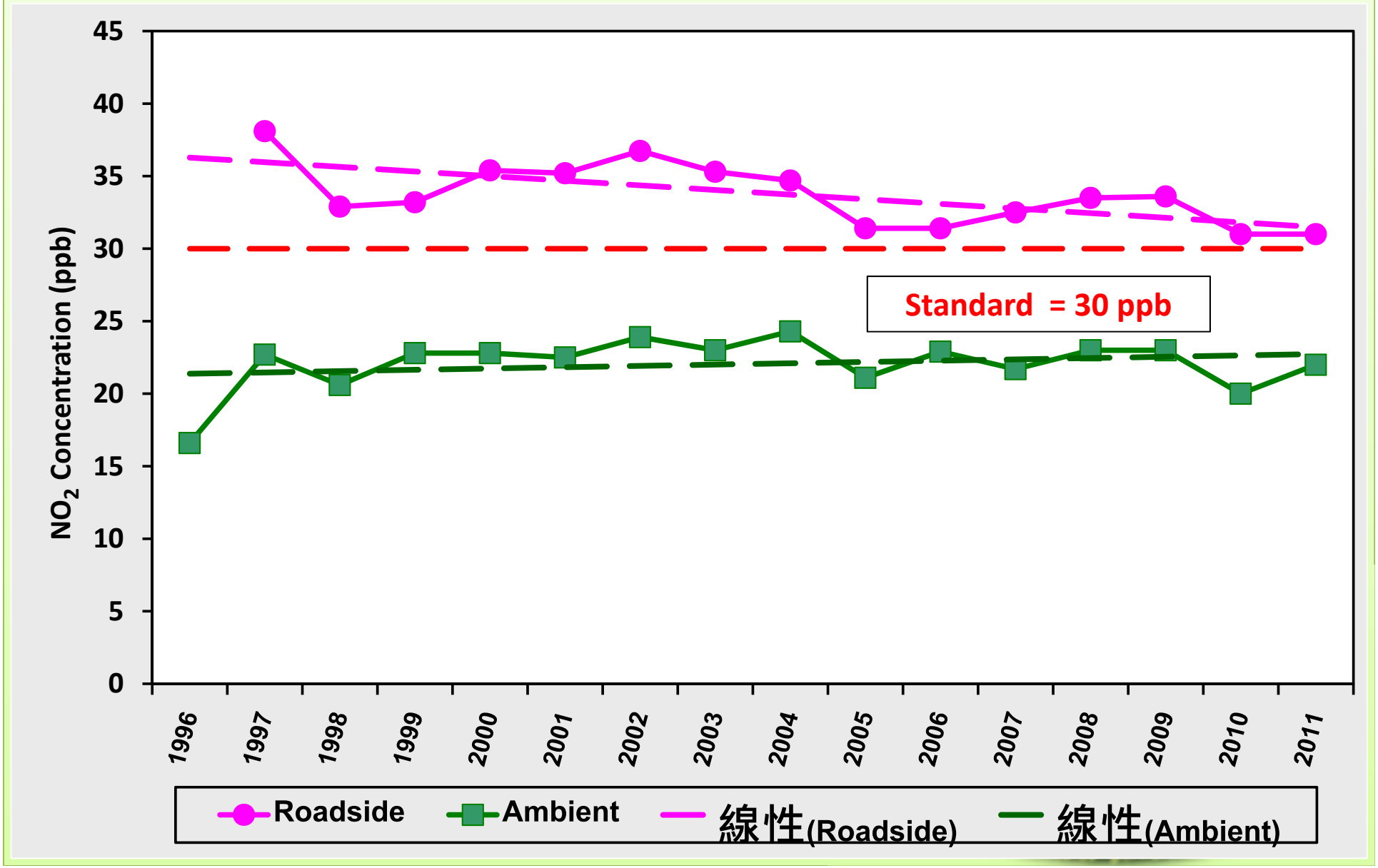
Annual Average Concentration of CO in Bangkok 1996 - 2011



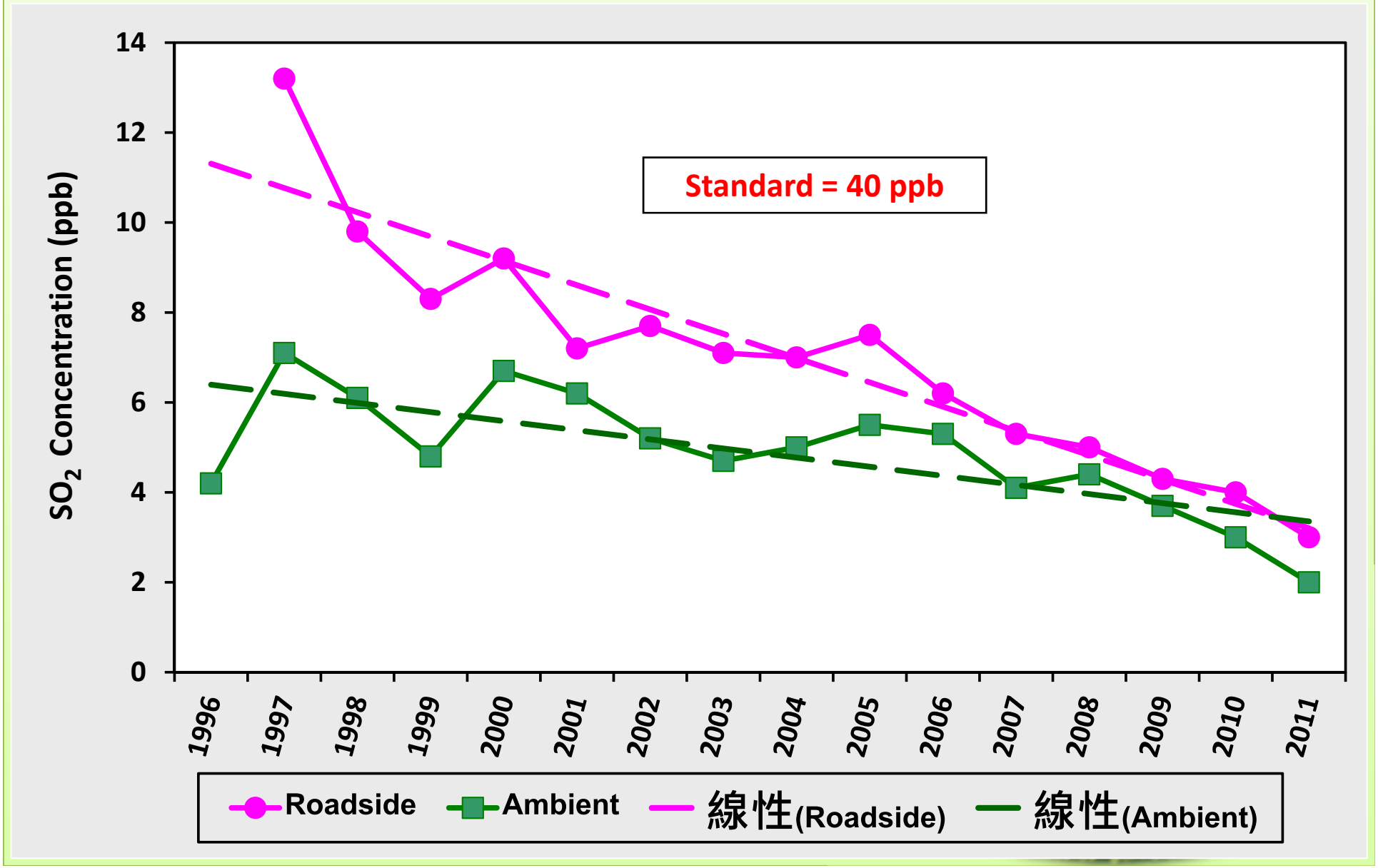
Annual Average Concentration of O_3 in Bangkok 1996 - 2011



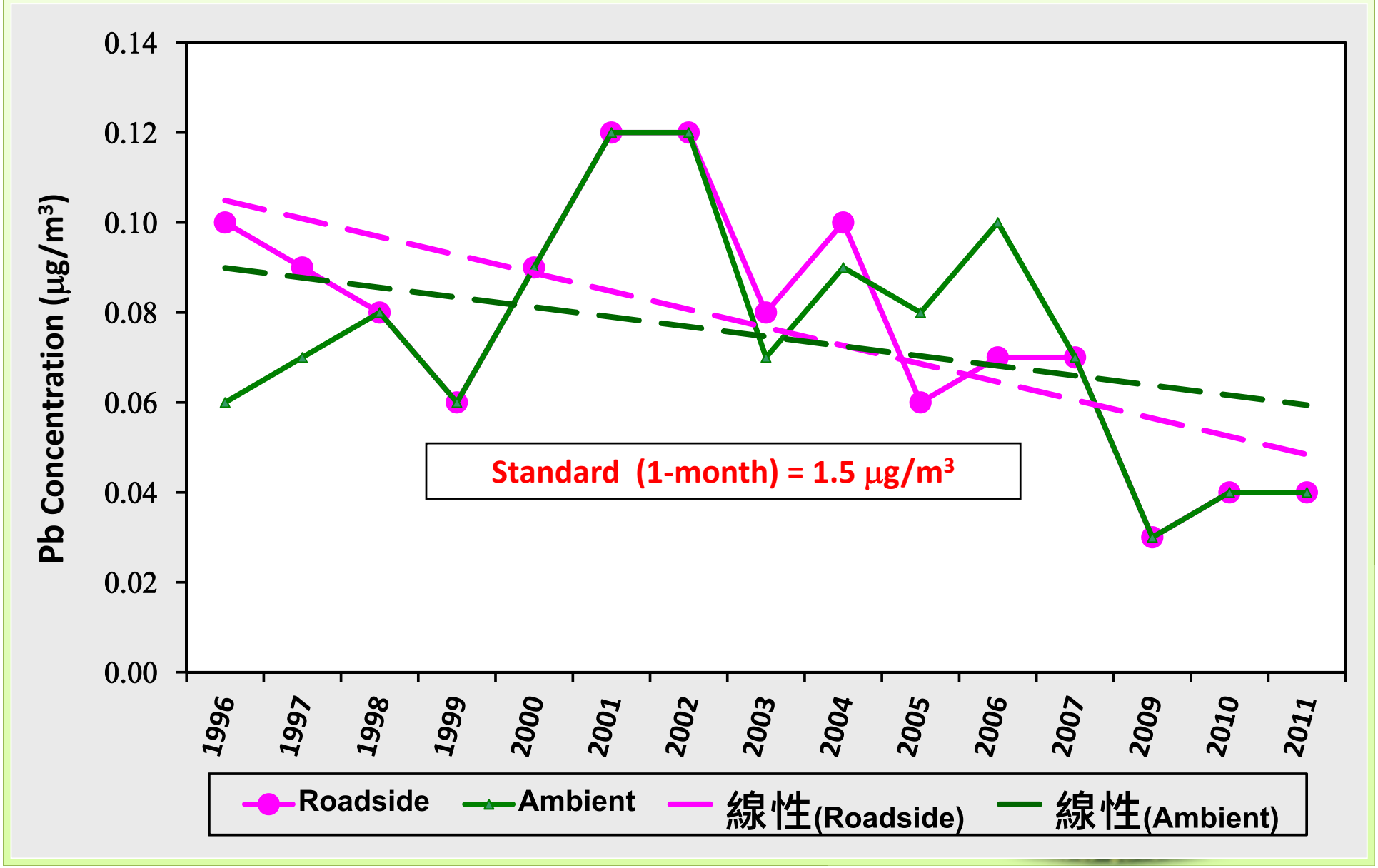
Annual Average Concentration of NO_2 in Bangkok 1996 - 2011



Annual Average Concentration of SO_2 in Bangkok 1996 - 2011



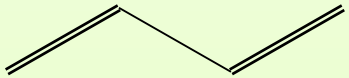
Annual Average Concentration of Pb in Bangkok 1996 - 2011



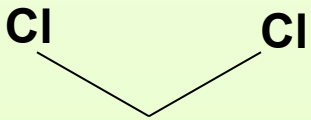
Ambient air quality standard of Volatile Organic Compounds (VOCs) since 2008

VOC is defined as any chemical compound based on carbon chains or rings with a vapor pressure greater than 2 mm Hg (0.27 kPa) at 25 degrees Celsius, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.

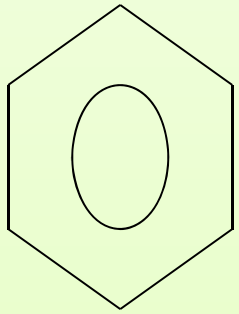
Example of VOCs molecular structure



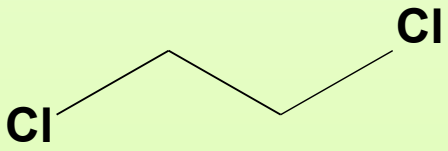
1,3-Butadiene



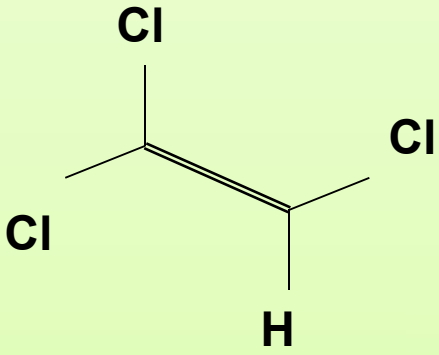
Dichloromethane



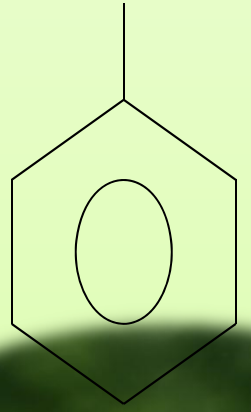
Benzene



1,2-Dichloroethane

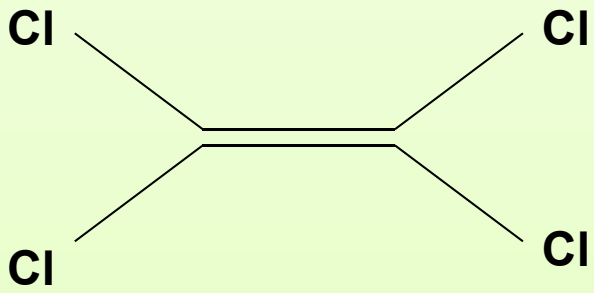


Trichloroethylene

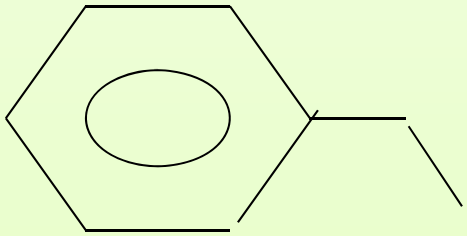


Toluene

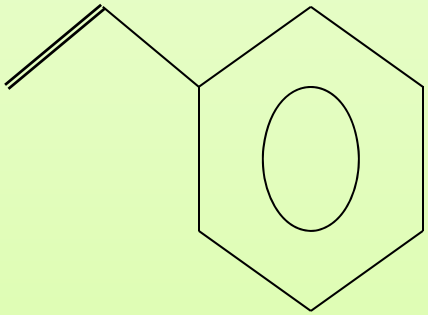
Example of VOCs molecular structure



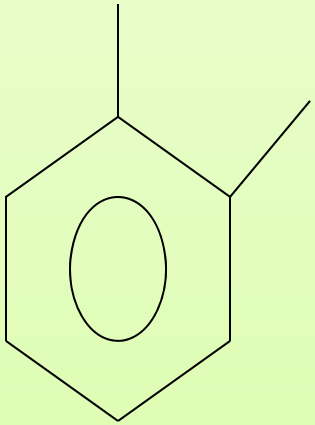
Tetrachloroethylene



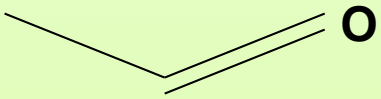
Ethylbenzene



Styrene



O-Xylene



VOCs have a variety of direct and indirect impacts on human being and the environment. Many of VOCs are directly harmful to human health on neurological effects, carcinogenicity, tetratogenicity and mutagenicity.

Hazardous Air Pollutants (HAPs)	Toxicity	(unit: μg/m^3)		
		EPA10^{-5}	WHO,EU	EQS
Acrylonitrile	2B	0.1	0.5	2
Vinyl chloride monomer	1	2.3	10	10
Chloroform	2B	0.4	-	-
Ethylene oxide	1	-	-	-
1,2-dichloroethane	2B	0.4	700	-
Dichloromethane	2B	20	3000	150
Tetrachloroethylene	2A	-	250	200
Trichloroethylene	2A	-	23	200
1,3-butadiene	2A	0.3	-	-
Benzene	1	1.3～4.5	1.7	3

IARC carcinogenicity criteria

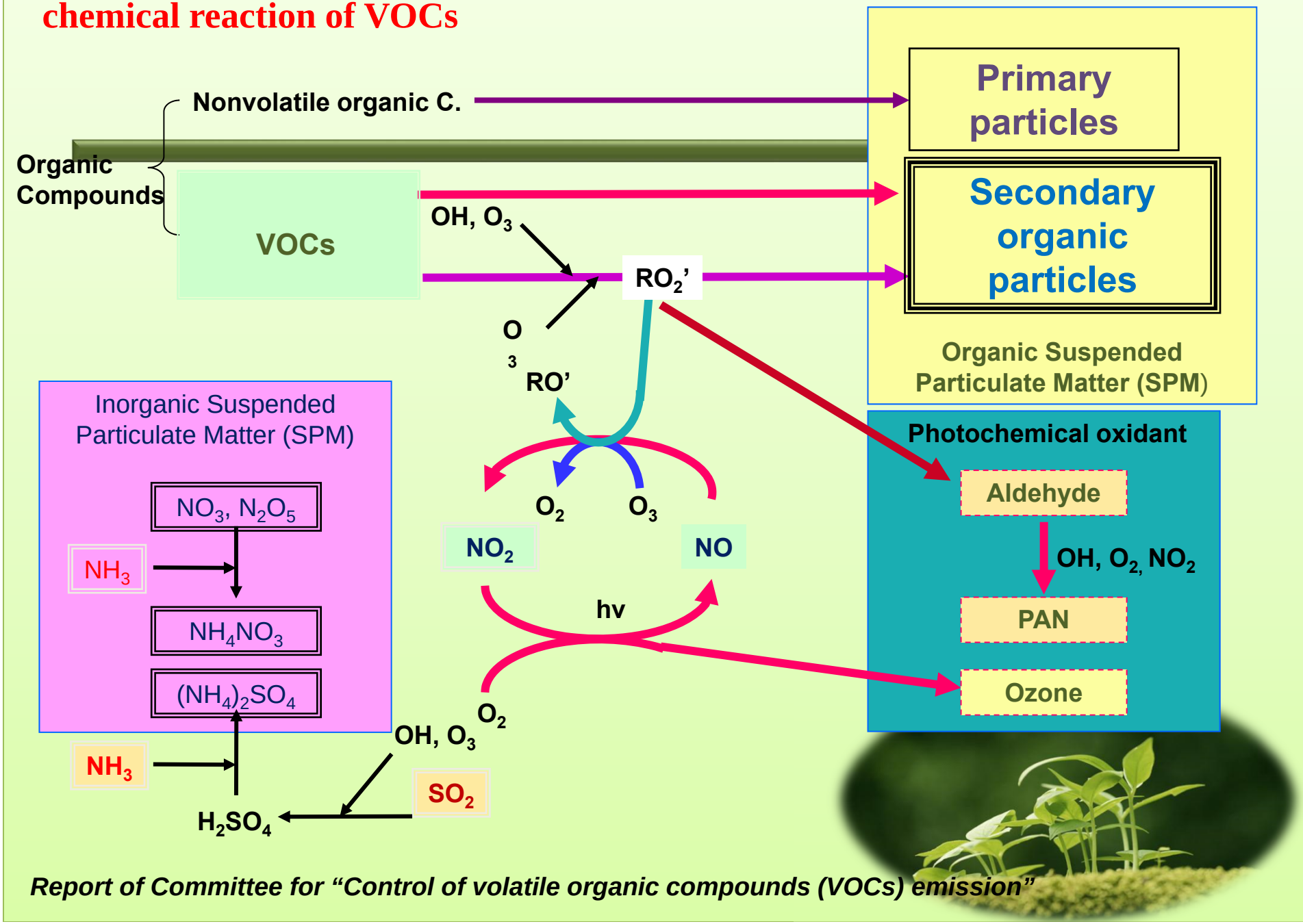
4	No evidence of carcinogenicity in human and experimental animals
3	Not classifiable as to carcinogenicity to human; Inadequate evidence in human and experimental animals
2B	Possibly carcinogenic in humans; Inadequate evidence in humans; Sufficient evidence in animals
2A	Limited evidence of carcinogenicity in humans; Sufficient evidence of carcinogenicity in experimental animals
1	Sufficient evidence of carcinogenicity in humans

National Ambient Air Quality Standard for Annual average of VOCs

& Guideline Value of VOCs for 24 hrs

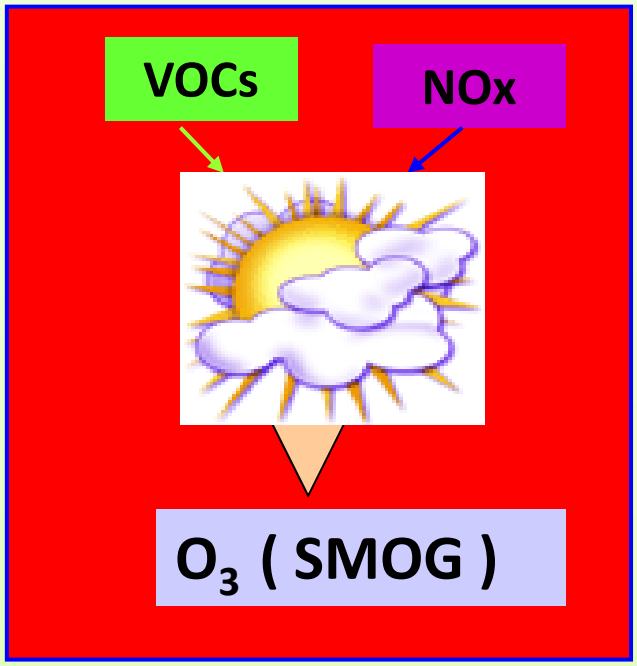
No.	Compounds	Standard Annual Average (μg/m³)	Guideline Value (μg/m³)
1	Acetaldehyde		860
2	Acrylonitrile		10
3	Benzene	1.7	7.6
4	Benzyl Chloride		12
5	1,3-Butadiene	0.33	5.3
6	Bromomethane		190
7	Carbon Tetrachloride		150
8	Chloroform	0.43	57
9	1,2-Dibromoethane		370
10	1,4-Dichlorobenzene		1100
11	1,2-Dichloroethane	0.4	48
12	Dichloromethane	22	210
13	1,2-Dichloropropane	4	82
14	1,4-Dioxane		860
15	2-Propenal/acrolein		0.55
16	Tetrachloroethylene	200	400
17	1,1,2,2-Tetrachloroethane		83
18	Trichloroethylene	23	130
19	Vinyl Chloride	10	20

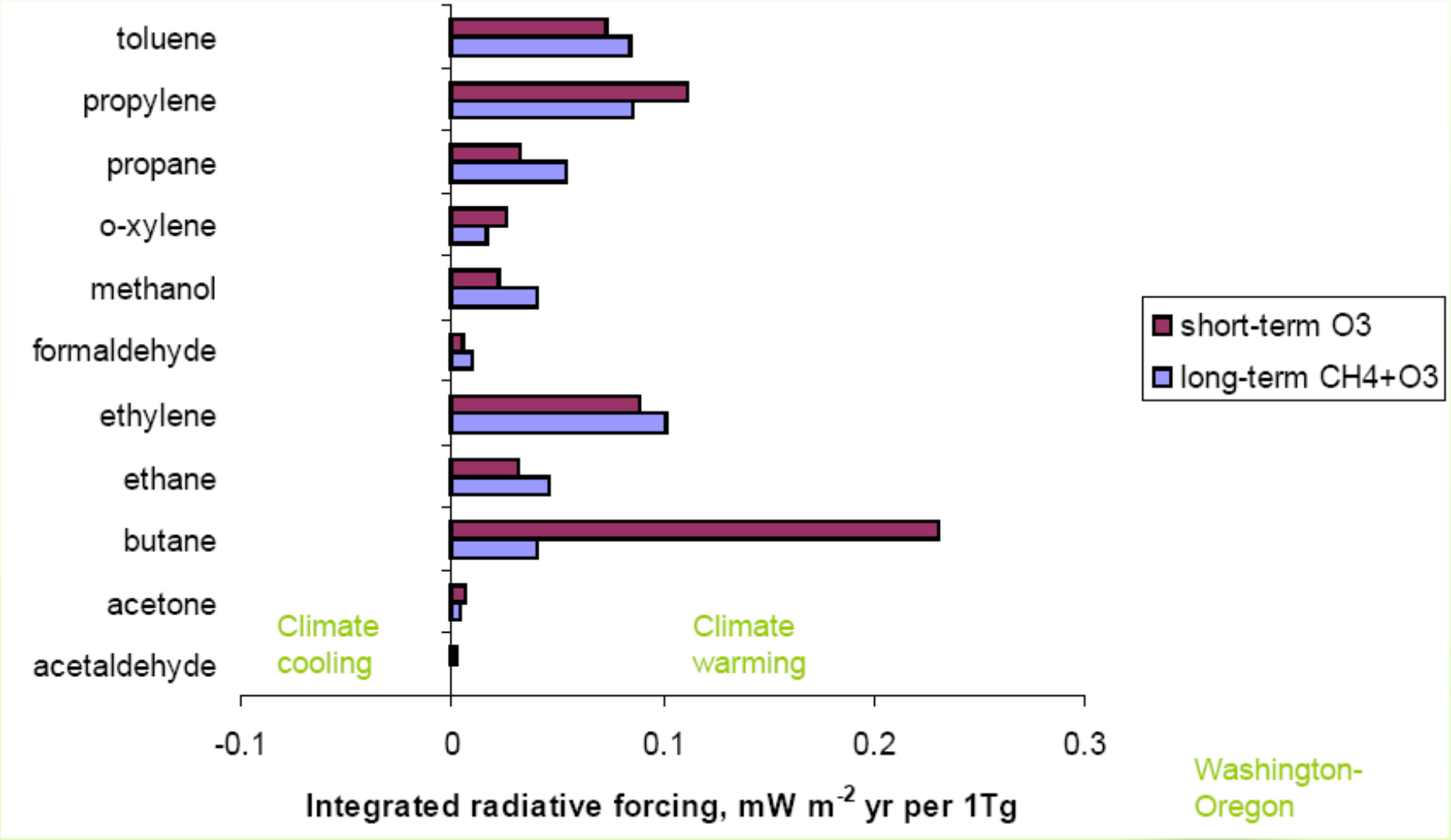
Formation of photochemical oxidants and secondary particulate by chemical reaction of VOCs



Report of Committee for "Control of volatile organic compounds (VOCs) emission"

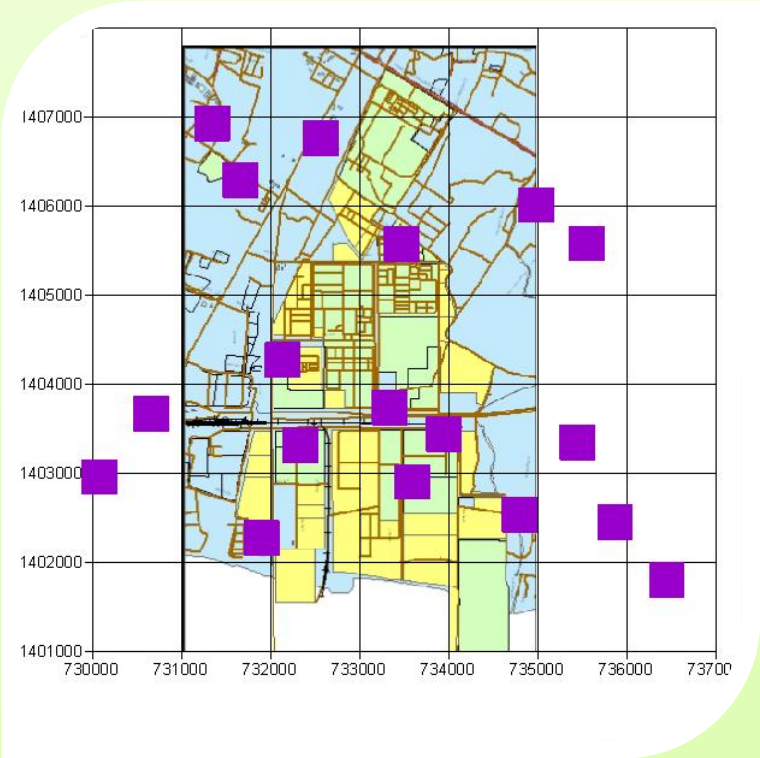
Visibility impact from photochemical oxidants in Bangkok





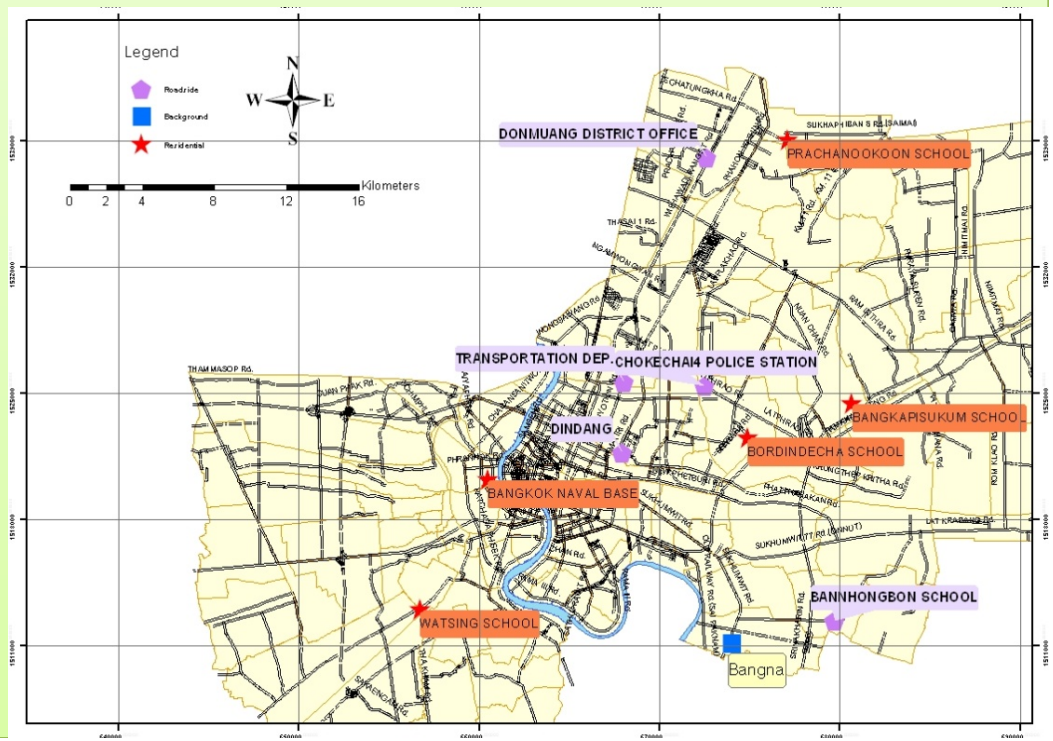
Dick Derwent, 2009, study on linkage of VOCs to climate change, found that toluene, propylene, o-xylene and others VOCs had integrated radiative forcing in the range of climate warming and possible produced short term ozone and long term CH_4+O_3 that can be affected to human health

Ambient VOC monitoring in Thailand

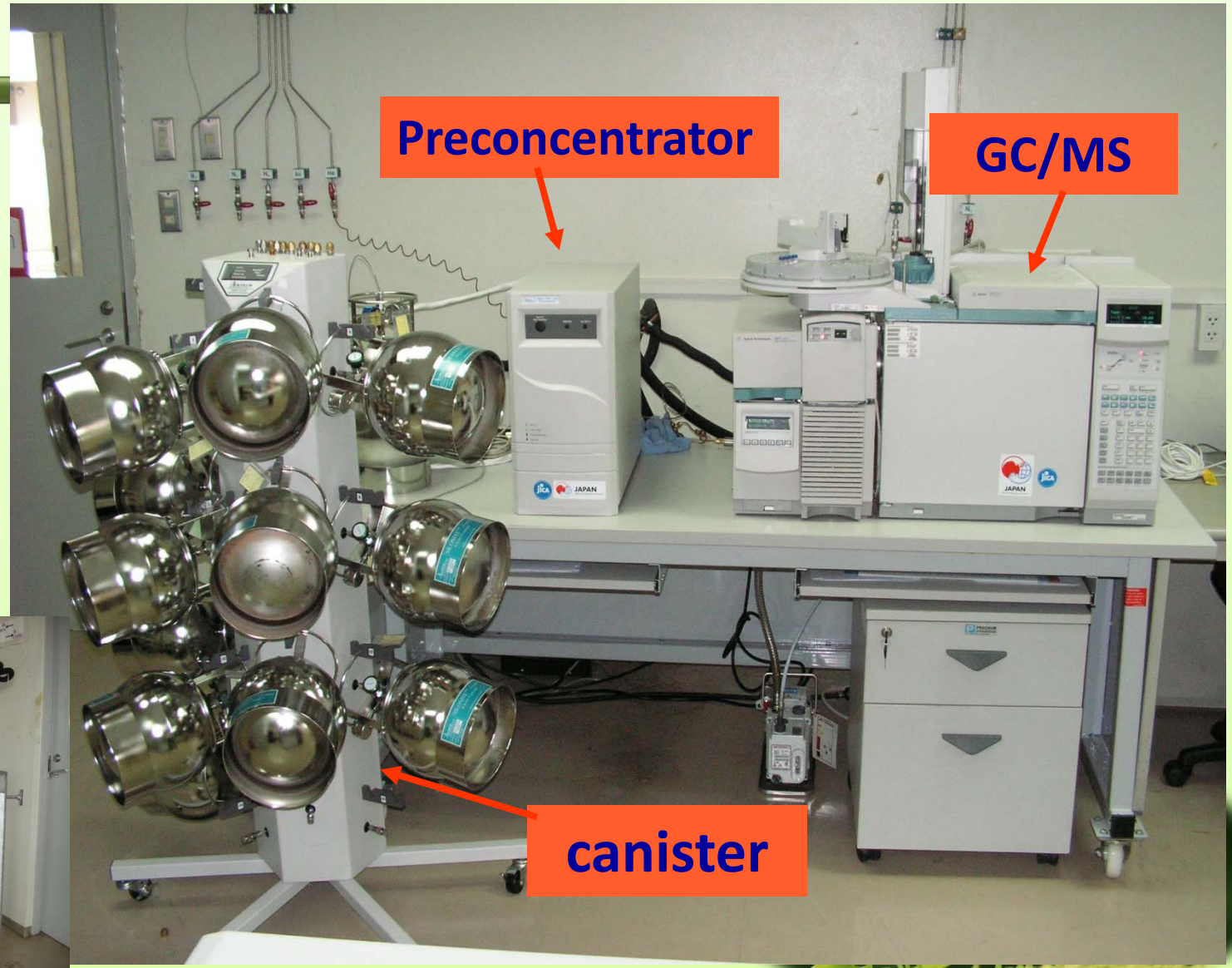


Maptaput
(Industrial area)

Bangkok urban area

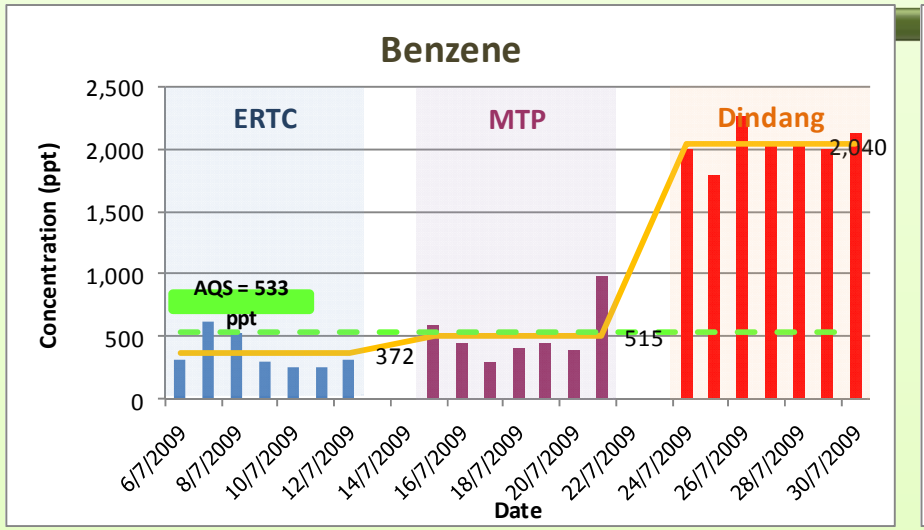


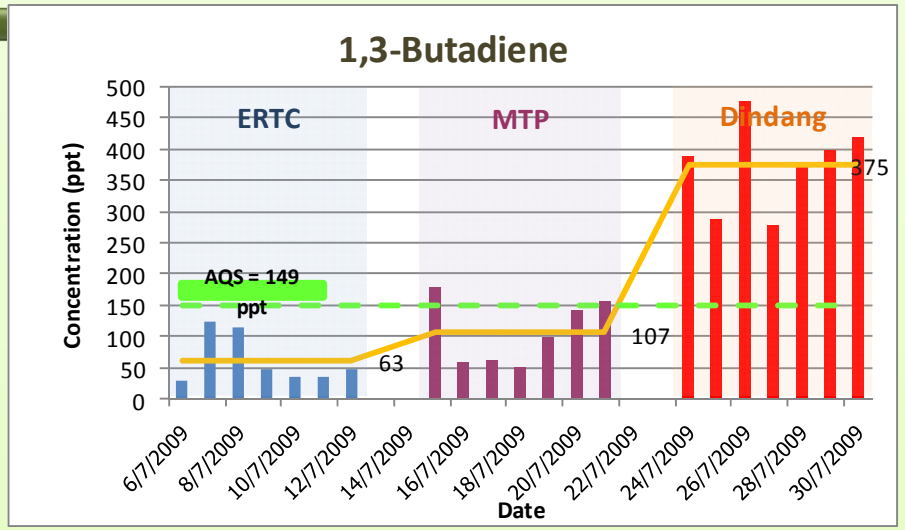
METHOD US.EPA. TO-15

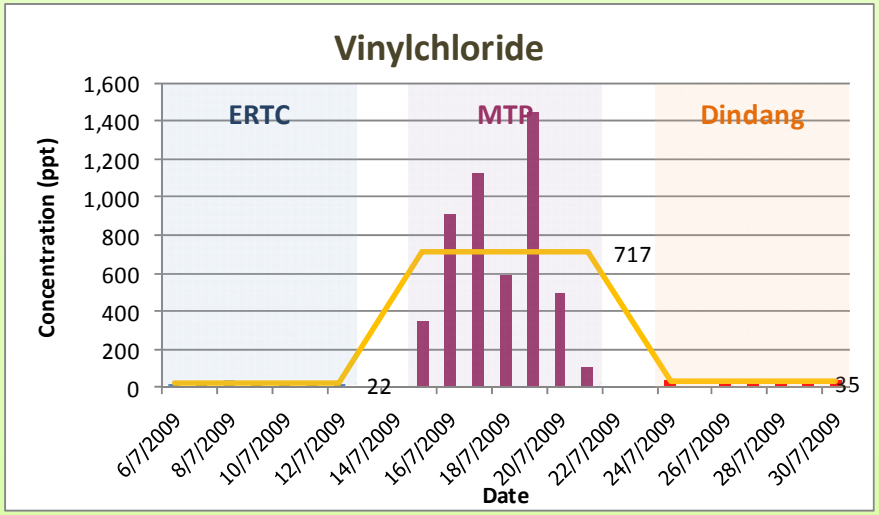


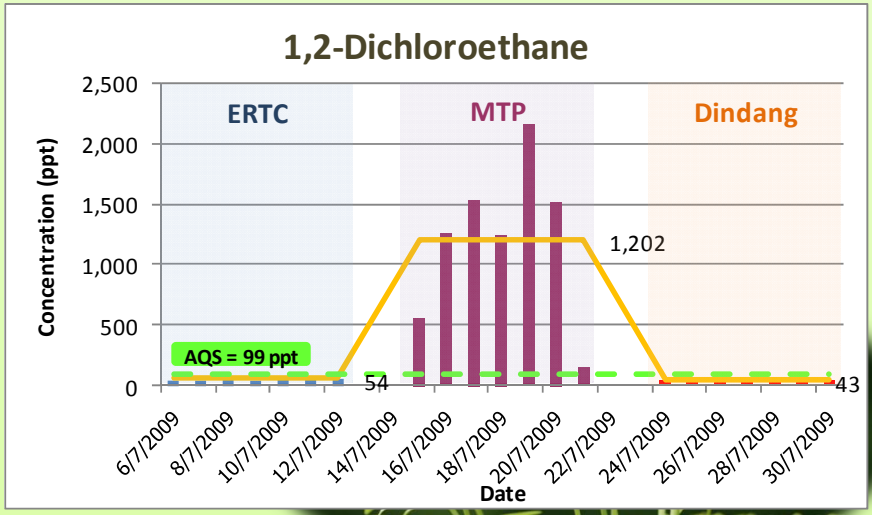
Liquid
N_2

Ambient VOCs concentration in different areas



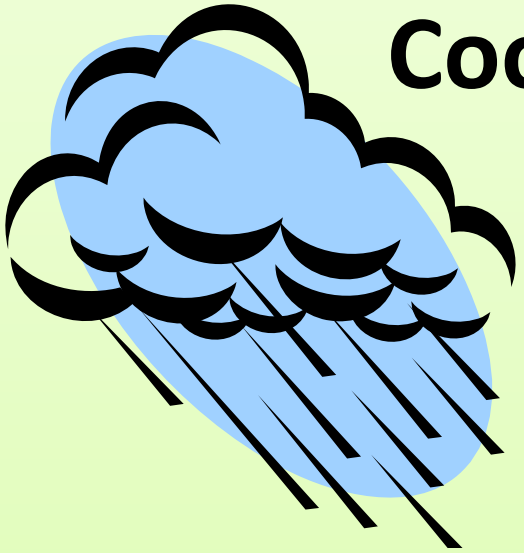




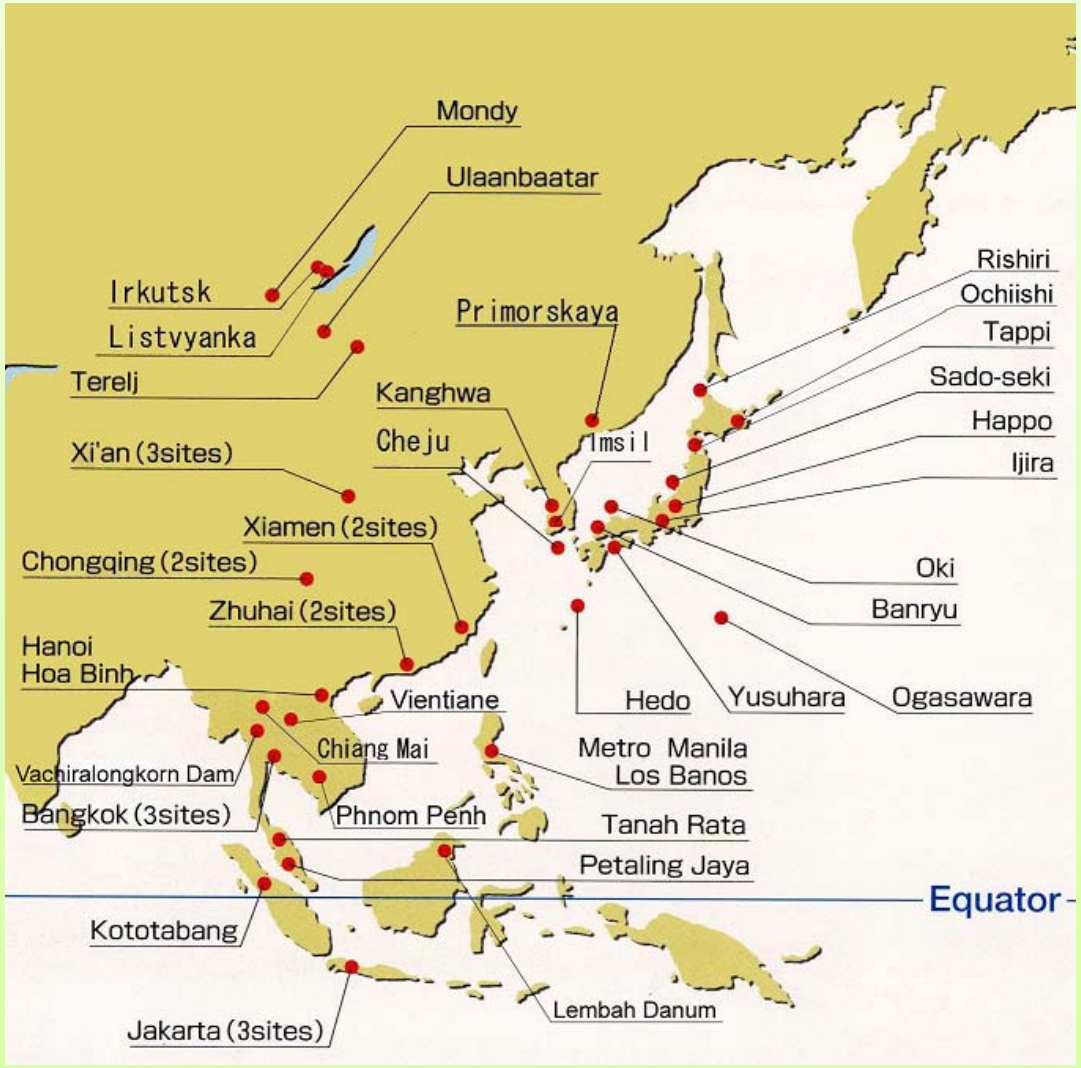


Acid deposition monitoring in Thailand

Cooperation with EANET



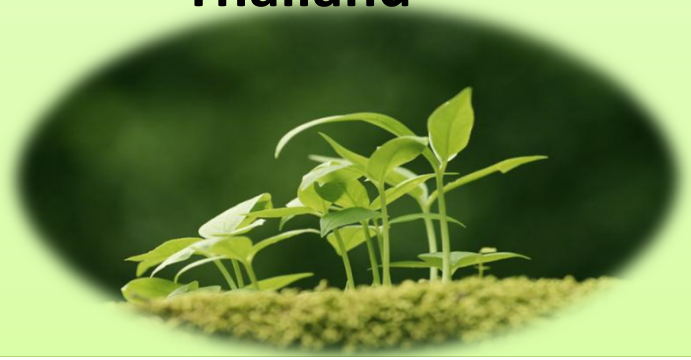
East Asian Network on Acid Deposition Monitoring (EANET)



13 Participating Countries

Cambodia	China
Indonesia	Japan
Lao PDR	Malaysia
Mongolia	Myanmar
Philippines	Korea
Russia	Vietnam

Thailand



The objectives of the EANET are

- to create common understanding of the state of the acid deposition problem in East Asia

- to provide useful inputs for preventing or reducing adverse impacts on the environment caused by acid deposition

- to contribute to cooperation on the issues related to acid deposition among the participating countries

Technical Manuals to use as guidelines for acid deposition in each participating country

Data Report on the Acid Deposition in the East Asian Region

Inter-laboratory comparison activities to assure the data quality.

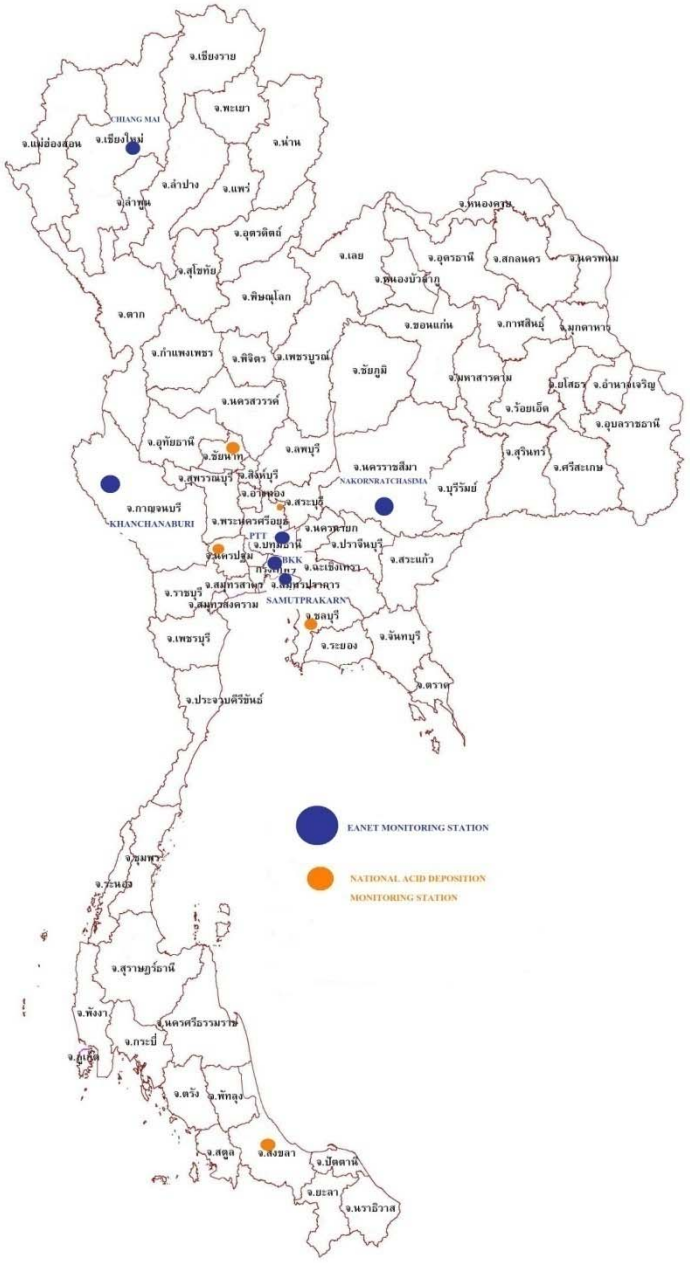
EANET monitoring activities

- ❑ Wet Deposition Monitoring
- ❑ Dry Deposition Monitoring
- ❑ Soil and Vegetation Monitoring
- ❑ Inland Aquatic Monitoring

- ❑ Catchment Monitoring

Acid deposition monitoring sites in Thailand

- 6 EANET sites
- + 5 National Acid Deposition Monitoring sites



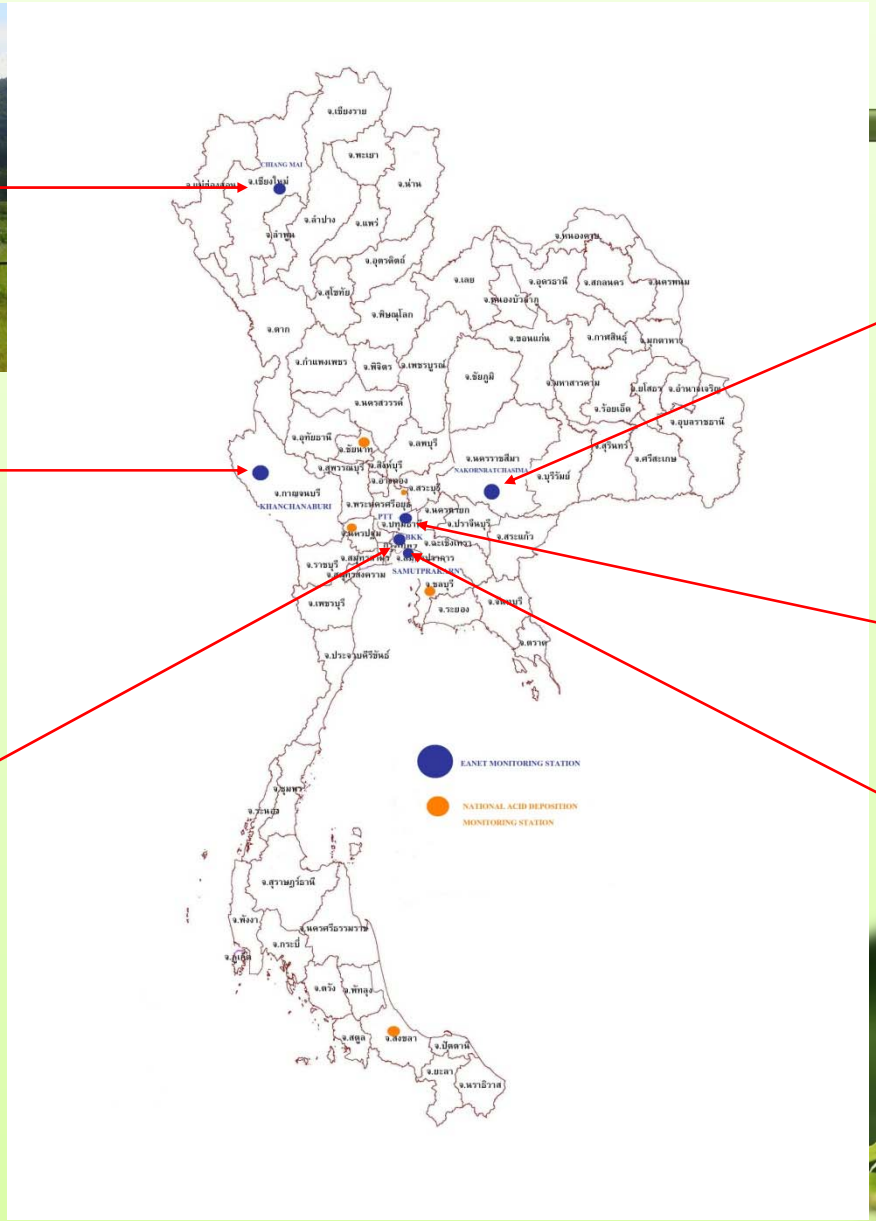
6 EANET's Wet and Dry Deposition Monitoring Sites in Thailand

กรมควบคุมมลพิษ
POLLUTION CONTROL DEPARTMENT

Chiang Mai

Khanchanaburi

Bangkok



Nakhon Ratchasima

Pathumtani

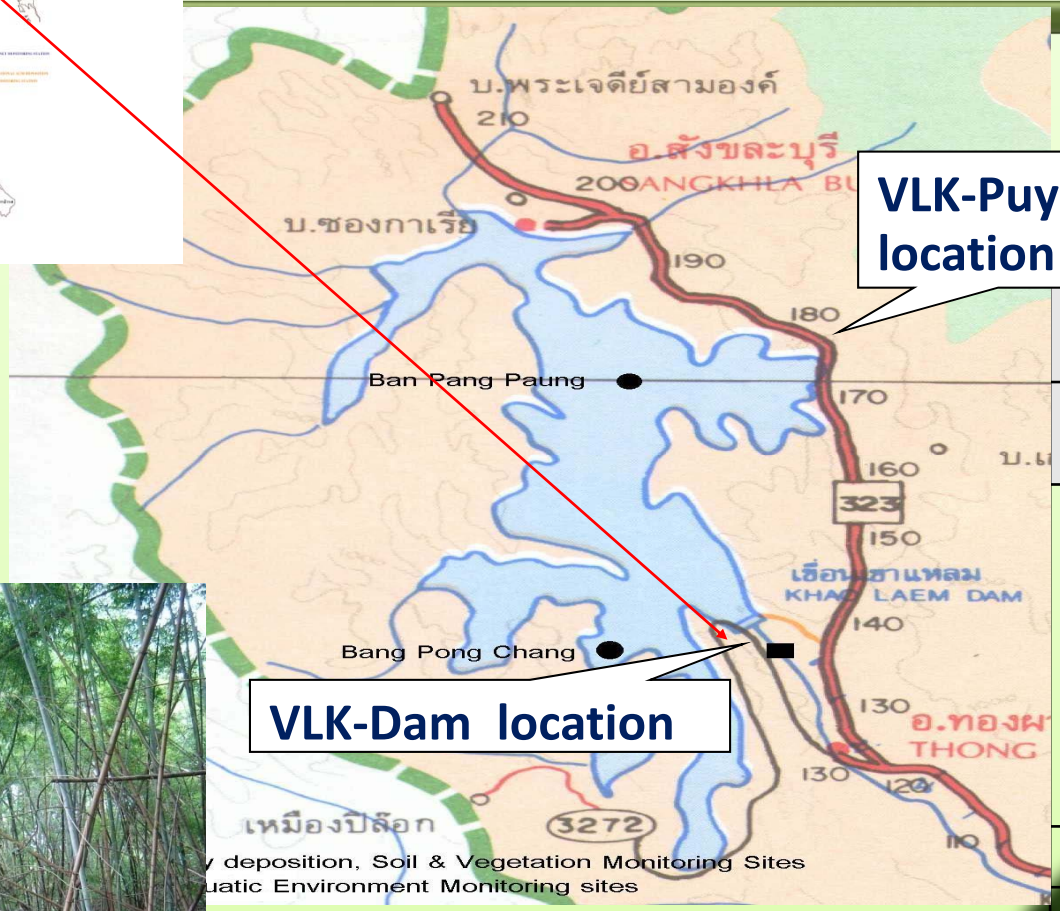
Samutprakarn

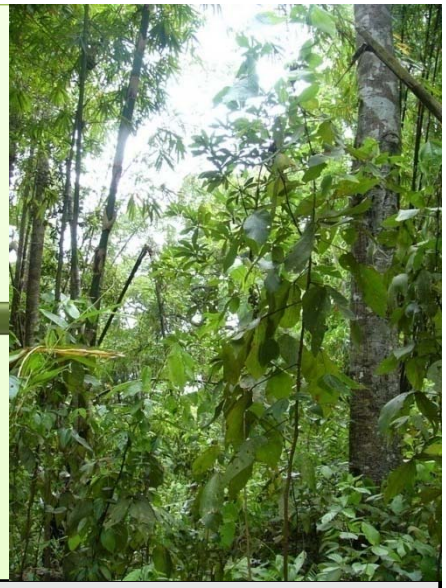
Wet and Dry Deposition Monitoring

Name of sites	Characteristics of Sites	Wet Dep.	Dry Dep.					
			Automatic				Filter Pack	Passive sampler
			SO_2	NOx	O_3	PM		
Bangkok	Urban	✓	✓	✓	✓	✓	✓	None
Samutprakarn	Urban	✓	✓	✓	✓	✓	None	None
Pathumthani	Rural	✓	None	None	None	None	✓	None
Khanchanaburi	Remote	✓	✓	✓	✓	✓	✓	None
Chiang Mai	Rural	✓	✓	✓	✓	✓	✓	None
Nakhon Ratchasima	Rural	✓	None	None	None	None	✓	None

Wet Deposition: pH, EC, Anion (Cl^-, NO_3^-, SO_4^{2-},$HCOO^-$,CH_3COO^-,PO_4^{3-} and some additional parameters), Cation (Na^+, K^+, NH_4^+, Ca^{2+}, Mg^{2+})

Vegetation Monitoring at Vachiralongkorn Dam

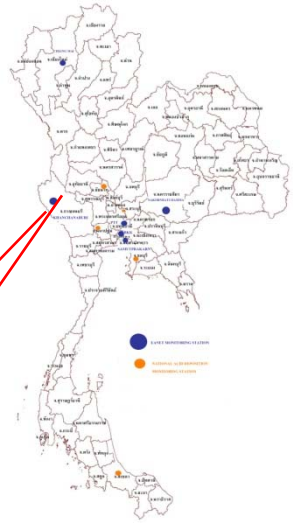




Methods Used in Thailand (Vegetation)	
Area	**Trees to be measured**
(200 m^2) radius 7.98 m. (400 m^2) radius 11.28 m. (1000 m^2) radius 17.85 m.	Tree height above 1.3 m. DBH more than 4 cm. DBH more than 18 cm.
Description of trees	
- Name of species - Diameter at Breast Height - Height of tree	
Understory vegetation survey	

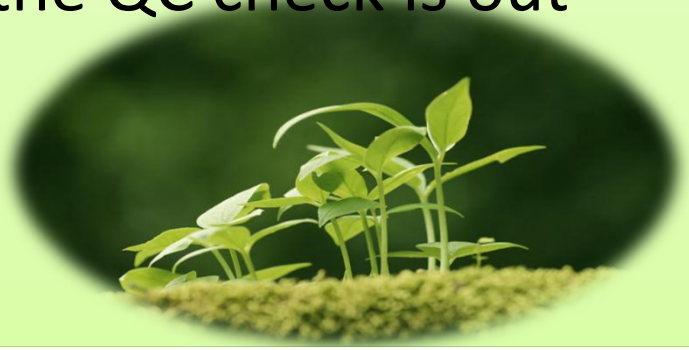
Inland Aquatic Monitoring at Vachiralongkorn Dam

Parameters
Water Quality
1. pH
2. Electric Conductivity
3. Water Temperature
4. Alkalinity
5. NO_3^-, NO_2^-, PO_4^{3-}
6. NH_4^+
7. Ca^{2+}, Mg^{2+}, Na^+, K^+
8. SO_4^{2-}
9. Cl^-

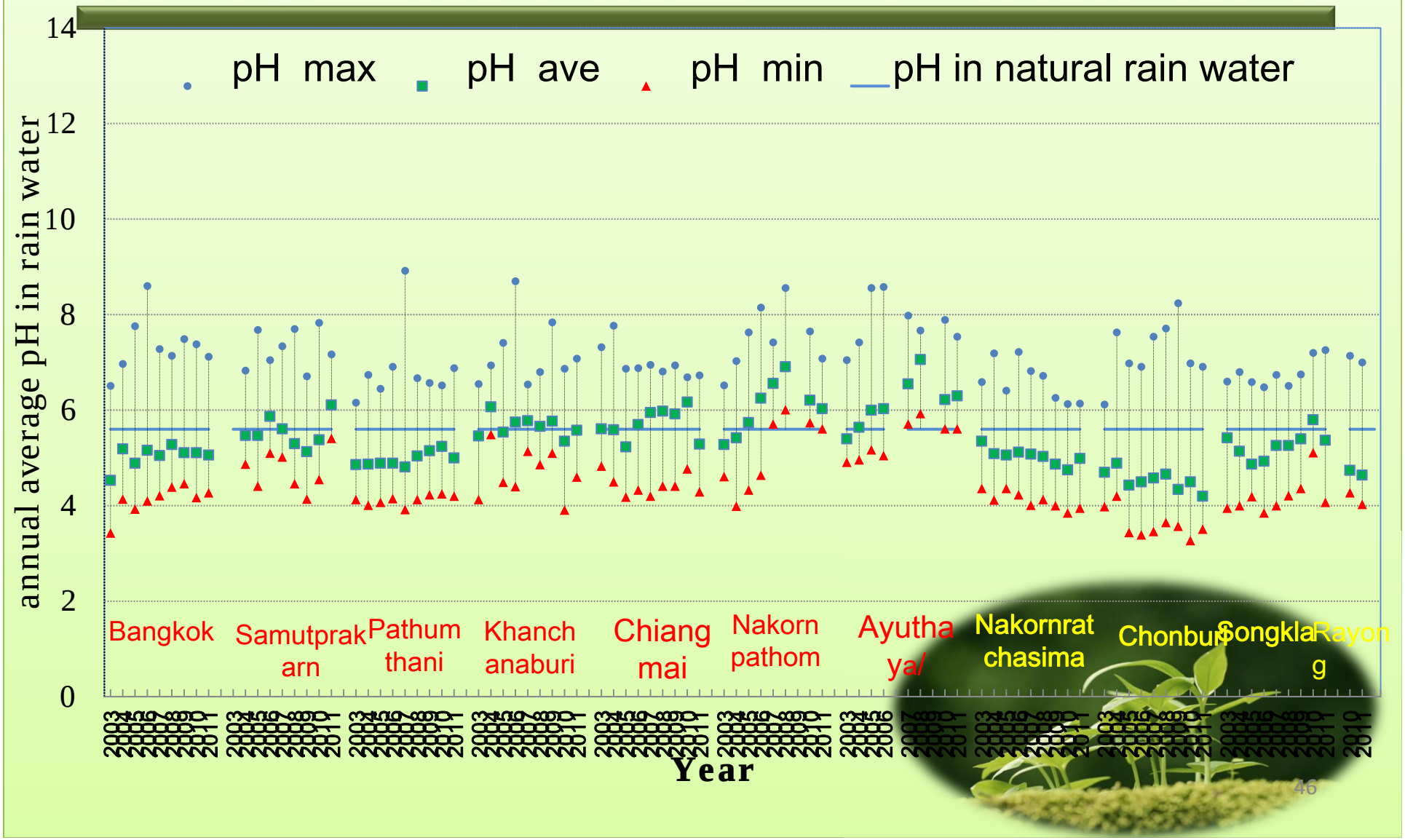


QA/QC Activities in Thailand

- Sampling
  - Do the blank check for rain sampler, filter pack
  - Compare the data of rain amount with the nearest meteorological station
  - Check the sampler and maintenance
- Analysis
  - analyze QC standard in the analytical operating procedure
  - re-analyze the sample batch if the QC check is out of design value



pH of Rain in Thailand 2003-2011



outcome

- Thailand build up capacity in acid deposition monitoring and gained knowledge in regional scale air pollution problems.
- Good laboratory practice for acid deposition monitoring, especially wet and dry deposition
- Build up the network of local people on air pollution monitoring including measurement of rain water acidity

Thank you very much

For

Your kind attention