EANET

Acid Deposition Monitoring Network in East Asia

FACT SHEETS

Countries' efforts and achievements in combating acid deposition

EANET

Acid Deposition Monitoring Network in East Asia

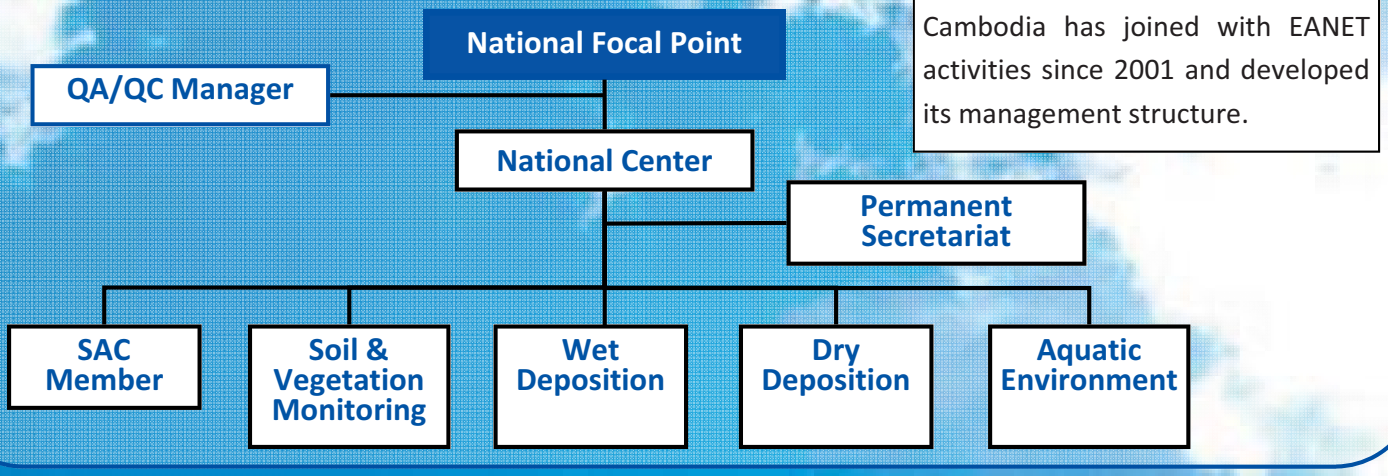
CAMBODIA

Country efforts and achievements in combating acid deposition

CAMBODIA

Policies and Practices Concerning Acid Deposition

Institutional Arrangement



Cambodia has joined with EANET activities since 2001 and developed its management structure.

State of Acid Deposition in the Country

Cambodia is not so familiar with acid deposition. Evidence of ecological, environmental impacts caused by acid deposition and information of acid deposition is still limited.

Air Pollution (including Acid Deposition) Management

Policy of acid deposition is limited comparing to others, which aimed at abating atmospheric pollution.

However, the Ministry of Environment (MoE) has developed laws and other regulations for air pollution monitoring such as Decree on Air Pollution and Noise Disturbance and disseminated throughout the country.

And inspection and control on pollution sources such as factories, handicraft is regular done to prevent and mitigate on environmental impact.

National Achievements on Air Pollution Monitoring

- Ambient air quality is measured regularly in major areas of Phnom Penh Municipality.
- Three parameters are measured including CO, NO_2 and SO_2 by using Passive Tube (24 hours) in every month.

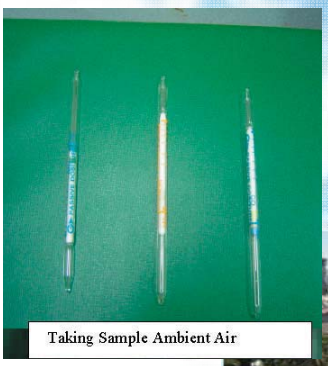
Result of Ambient Air in Phnom Penh

Parameter	2005 Average	2006 Average	2007 Average	2008 Average
NO_2 (ppm)	0.022	0.020	0.023	0.27
CO (ppm)	4.323	4.48	4.751	7.36
SO_2 (ppm)	0.062	< 0.083	ND	ND

National Achievements on Air Pollution Monitoring

Since 2003, wet sampler has been installed and samples were analyzed : pH and EC. Currently, Cambodian has analyzed wet Deposition : pH, EC, NO_3^-, NH_4^+, K^+, Ca^{2+}, Na^+, Mg_2^+, SO_4^{2-}, Cl^-.

Items	Measurement Parameters	Monitoring Interval
Wet Deposition	pH, EC, NO_3^-, NH_4^+, K^+, Ca^{2+}, nss-Ca^{2+}, Na^+, Mg_2^+,	Weekly (every precipitation)


Taking Sample Ambient Air


Wet Sampler


Waste Burning in Dumping site


Factories

Wet Sampling Analysis

Analysis operation in Lab

I C for analysis Anion and cation

Volume Weighted Mean Concentration / Precipitation

2007	SO_4^{2-}	nss-SO_4^{2-}	NO_3^-	Cl^-	NH_4^+	Na^+	K^+	Ca^{2+}	nss-Ca^{2+}	Mg^{2+}	H^+	pH	EC	Precipitation
	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L	µmol/L		ms/m	mm/year
Annual	22.5	22.0	8.3	12.6	19.7	8.2	3.6	19.2	19.1	3.3	0.2	6.69	1.37	1373.9
Max	40.6	38.1	36.6	54.1	106	40.8	37.5	55.2	54.8	9.3	0.8	7.70	25.8	
Min	9.0	8.5	1.8	<1.0	<1.0	1.5	1.4	5.8	5.8	<0.4	<1.0	6.12	0.49	
Wet Deposition (monthly)				**Unit: mmol m^{-2} $year^{-1}$**										
Annual	30.9	30.2	11.3	17.4	27.0	11.3	5.0	26.4	26.2	4.49	0.28			
2006	**Volume Weighted Mean Concentration / Precipitation**													
Annual	3.5	5.1	9.1	6.2	17.9	1.8	1.5	9.1	9.1	0.7	0.2	6.72	1.17	948.5
Max	19.6	19.2	28.0	14.2	55.2	8.1	4.7	20.9	20.8	3.0	0.9	7.680	6.47	
Min	<1.0	8.5	3.5	2.8	8.2	<1.0	<1.0	3.8	3.8	<0.4	<1.0	6.05	0.70	
Wet Deposition (monthly)				**Unit: mmol m^{-2} $year^{-1}$**										
Annual	5.04	4.82	8.59	5.88	17.0	1.75	1.41	8.64	8.61	0.63	0.18			
2005	**Volume Weighted Mean Concentration / Precipitation**													
Annual	5.7	*	*	6.2	16.3	*	*	*	*	*	0.5	6.32	0.81	1307.8
Max	14.2	<1.0	<1.0	29.1	44.8	<1.0	<1.0	<0.2	<0.2	<0.4	4.3	7.44	4.23	
Min	2.0	<1.0	<1.0	1.2	4.3	<1.0	<1.0	<0.2	<0.2	<0.4	<0.1	5.37	0.28	
Wet Deposition (monthly)				**Unit: mmol m^{-2} $year^{-1}$**										
Annual	7.43	*	*	8.12	21.13	*	*	*	*	*	0.63			

{*} for average and deposition: the constituent was not measured although precipitation was not 0 mm (%TP=0%)

Public Awareness Raising

The brochure, namely, **"We intercept and phase out acid deposition together"** has been developed in 2004 under the support of Japan Fund Global Environment, JOESC. The Public awareness raising program on acid deposition problems has been conducted and integrated in several cities and provinces by training and workshop.

Training

TV's Program

Workshop

Brochure

MoE's Magazine

A book for senior high school (grade 8)

In other words, Cambodia has many programs produced in collaboration with TVK and the MoE to promote environmental public awareness including impact of air pollution and how to prevent air pollution, etc.

Newsletter has been issued in tri-monthly basis by Environmental pollution Control Department and MoE and also included awareness raising on Air Pollution and Acid Deposition Problems. Acid Deposition Lesson is integrated into curriculum of school children.

Future Activities

Cambodia:

- Will set up dry deposition monitoring in 2009.
- Will continue to issue newsletter or magazine for raising public awareness.
- Will continue public awareness on acid deposition activities for Department of Environmental cities and provinces.
- Will provide relevant documents of acid deposition or air pollution to integrate into the TV programs.

National Center

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Secretariat

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Acid Deposition Monitoring Network in East Asia

CHINA

Country efforts and achievements in combating acid deposition

CHINA

Policies and Practices Concerning Acid Deposition

Upon the approval of the State Council in November 1998, the former State Environmental Protection Administration (SEPA) joined the Acid Deposition Monitoring Network of East Asia (EANET) during the period 1999-2000 for trial operation. In December 1998, headed by SEPA, the China National Environmental Monitoring Center organized four cities of Chongqing, Xi'an, Xiamen and Zhuhai for the establishment of a China Network of EANET. China then began the preparatory monitoring plan of EANET from April 1999.

In October 2000, the State Council approved China's official involvement in EANET. Starting from 2001, the work of EANET entered into the stage of formal operation.

Altogether 9 monitoring stations of four Chinese cities have joined in EANET including Xi'an, Chongqing, Zhuhai and Xiamen.

The monitoring projects cover the monitoring work for the following four items: wet deposition, dry deposition, soil, and vegetation and inland water environment. They fulfill each monitoring task according to the technical requirements of EANET on annual basis.

Distribution of Monitoring Sites of China

The four cities hold meeting for technical exchange annually to discuss technologies for the monitoring of acid deposition as well as the work progress.

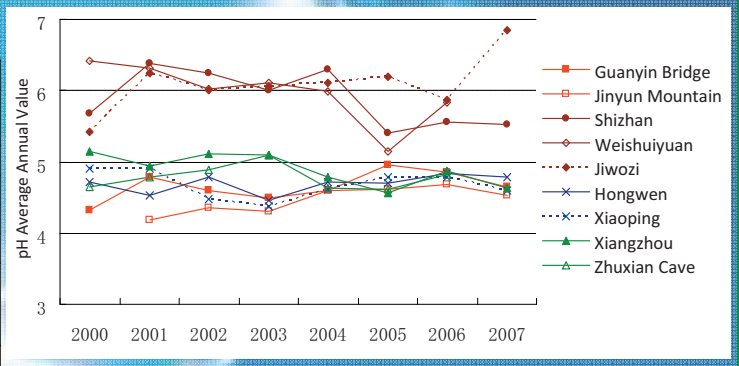
Annual Meeting for Technical Exchange of China Network for EANET

Monitoring Items, Parameters and Frequency

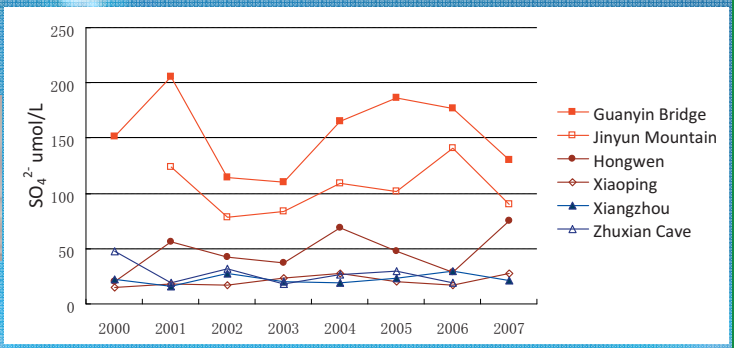
Item	Monitoring Parameter	Monitoring Frequency
Wet Deposition	pH, EC, precipitation, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}	24h. 09:00 to 09:00 in the next day
Dry Deposition	SO_2, NO_2, PM_{10}	1h
	Gaseous SO_2, NO, NO_2, O_3, HNO_3 and NH_3	1-2 week
	Aerosol chemical component	
	SO_4^{2-}, NO_3^-, NH_4^+, Ca^{2+}, Cl^-, Na^+, K^+ and Mg^{2+}	
Soil	pH (H_2O), pH (KCl), exchangeable Na^+, K^+, Ca^{2+}, Mg^{2+}, effective cation exchange capacity (ECEC), exchangeable acidity, T-N and T-C	Once in every 3 years
Vegetation	Investigation and decay of the property of trees and the investigation of understory	Once in every 3 years and once a year from 2008 for the investigation of decay
Inland Water	pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+} and basicity	4 times/year
	Chromaticity, transparency, COD, NO_2^- and PO_4^{3-}	1 time/year

Acid Deposition Monitoring Facilities Used in China Network for EANET

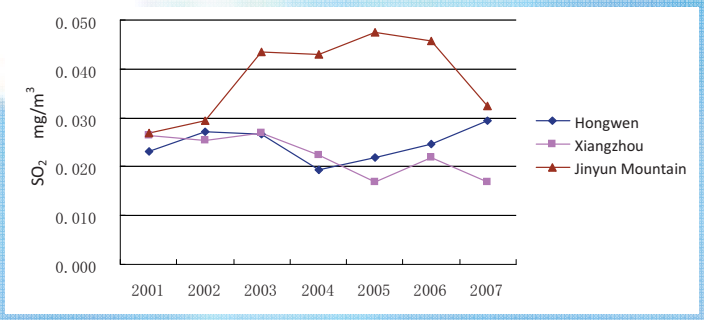
The 8 monitoring sites of precipitation of China Network for EANET includes 5 urban sites, 1 rural site and 2 remote sites.



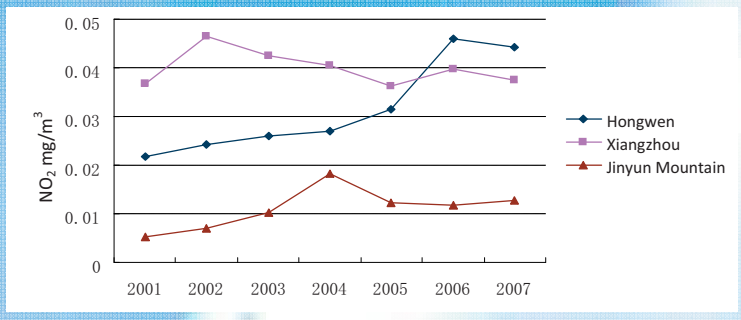
Average Annual Change of Precipitation pH Value of Each Site of China Network for EANET



Average Annual Change of Precipitation SO_4^{2-} Concentration of Each Site of China Network for EANET



Average Annual Change of Air SO_2 Concentration of Each Site of China Network for EANET

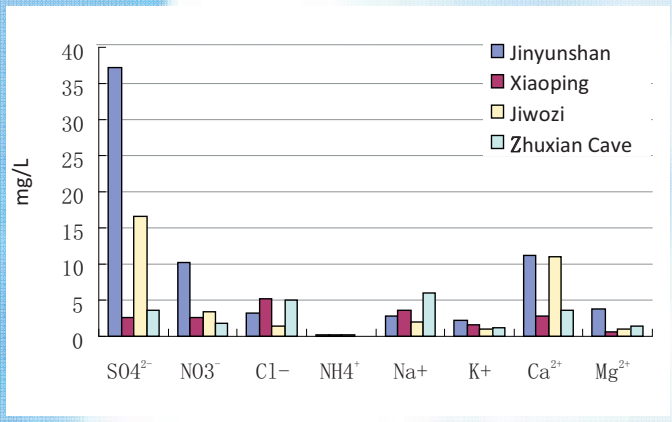


Average Annual Change of Air NO_2 Concentration of Each Site of China Network for EANET

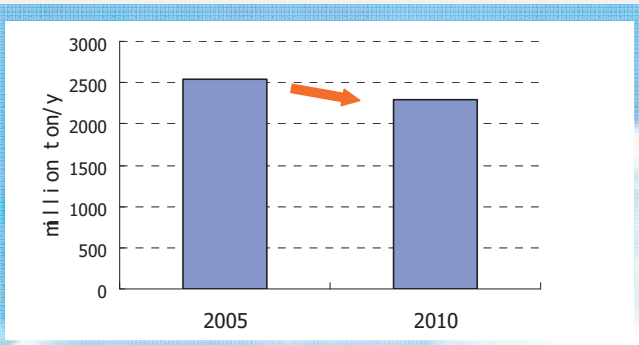
The Guidelines of the 11th Five-Year Plan for National Environmental Protection of China identifies the target for the control of total amount of major pollutants and stipulates that we should give top priority to pollution control, expedite structural reform, strive to build environment-friendly society and ensure the annual SO_2 emission be cut by 10% by 2010 than that of 2005.

In 2006, the central budget appropriated 680 million Yuan from national debts to supporting 111 major energy conservation projects. Through the implementation of energy conservation and emission reduction projects, a great deal of energy conservation and SO_2 reduction capacity were built up.

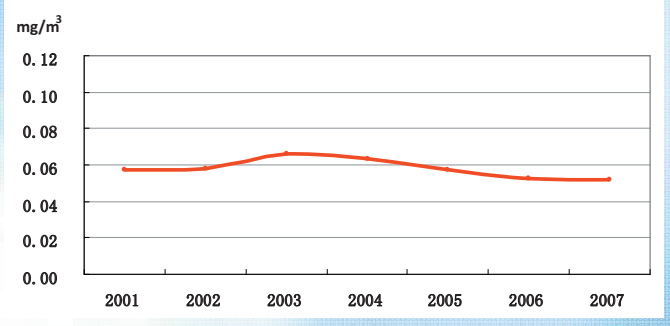
In 2007, the energy consumption per capita GDP of China dropped by 3.27%, 89.8 million tons of coal equivalent were saved, and the total SO_2 emission was down by 4.66%.



Ion Components of Inland Water of China Network for EANET in 2007



SO_2 Emission Reduction Target during the 11th "Five-Year" Plan Period



Annual Average Change of SO_2 Concentration in Chinese Cities

Public Awareness Raising

Report on environmental quality is being published every year covering the information about acid deposition; special websites on environmental protection publicity were set up; the specialty of environmental protection has been offered in numerous universities and colleges, fostering a lot of excellent talents engaging in environmental protection work over the past years; more and more people including children are paying greater attention to environmental protection; and the awareness of harmonious and green living style is deeply rooted among the people.

Environmental Protection Campaign Spreading in Communities and Schools

Future Activities

The policies to be adopted in the future are the followings:

China will take more efforts in environmental monitoring during the 11th "Five-Year" Plan period, which mainly covers the following areas:

We will establish and improve the National Monitoring Network of Acid Rain, provide facilities like automatic sampler, pH meter, conductivity meter and ion-exchange chromatography, etc. to cities involving the Network and improve the monitoring capacity over acid rain. We will set up 1 suburban site and 1 urban site respectively in 80 cities to monitoring regional and urban acid deposition and 1 suburban site in 275 cities respectively to monitoring regional acid deposition.

We will establish 14 national sub-stations for background air quality, 31 representative monitoring stations of GHGs sources, 3 regional representative monitoring stations of GHGs and 31 rural automatic monitoring sub-stations for air quality and carry out pilot monitoring of ozone in 18 cities of 7 pilot cities and regions.

National Center

China National Environmental Monitoring Center (CNEMC)

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Secretariat

United Nations Environment Programme Regional Resource Center for Asia and the Pacific (UNEP RRC.AP)

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EANET

Acid Deposition Monitoring Network in East Asia

INDONESIA

Country efforts and achievements in combating acid deposition

INDONESIA

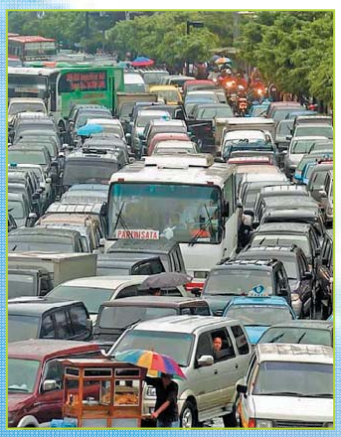
Policies and Practices Concerning Acid Deposition

Acid Deposition in Indonesia

Indonesia has participated at the Acid Deposition Monitoring Network in East Asia (EANET) since 1998 when the First Intergovernmental Meeting (IG1) approved the establishment of EANET.

Acid deposition is a transboundary environmental problem, which affects distant areas from the pollution sources. Indonesia has various problems relating to air pollution originated from human activities such as manufacturing, vehicles using fossil fuel, and land clearing by traditional farmers who perform open burning as a part of land preparation.

Approximately 70% - 80% of air pollution problem in Jakarta, Indonesia's capital, was contributed by the transportation sector which consumes 81% of the total energy. Considering the energy sources, 99.4% of the vehicles use fossil fuel while 0.06% of the total vehicles have used gas for fuel.



State of Acid Deposition

Related government institutions have involved in the acid deposition monitoring with their respective capability and authority namely:

1. Environmental Management Center
2. LAPAN
3. BMG
4. Puslit Air
5. Puslitanak

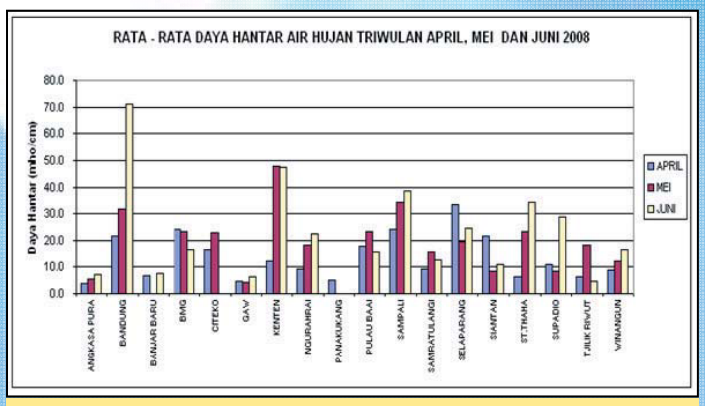
The monitoring of acid deposition in Indonesia covers: wet deposition, dry deposition, soil and vegetation and inland aquatic.

HV Sampler

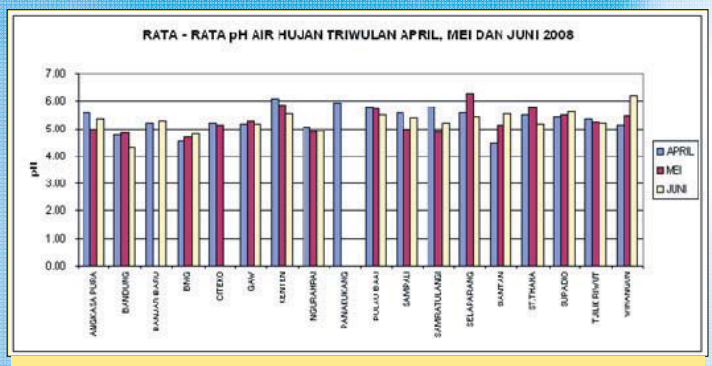
Wet and Dry Rain Gauge

pH meter

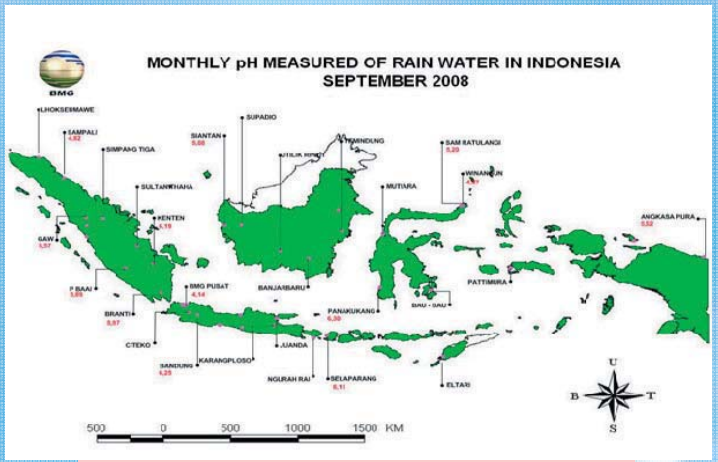
Location	Parameters	Interval
Serpong (EMC)	WD: pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+} DD : SO_2, HNO_3,HCl, NH3, PMC	WD : event DD : Biweekly
Bandung (LAPAN)	WD: pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}	event
Jakarta (BMG)	WD: pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}	weekly
Kototabang (BMG)	WD: pH, EC, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}	weekly
Patenggang Lake (Puslit SDA)	IA : T, pH, EC, Alk, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}	4 times/yr
Bogor Forest Research (Puslitanak)	SV : Decline, K etc. in leaves, ions in soil	Once/3-5 yr



Indication of rain water contaminated by residue of fossil fuel burning appears to have high concentration of SO_4^{2-} and NO_3^-.



The monthly pH measurement shows most cities in Indonesia have pH below 5.6 and some of the cities have pH over the standard. It states that acid deposition has been occurring in most cities.



We have also measured other parameters such as anions of SO_4^{2-}, nss SO_4^{2-}, NO_3^-, Cl^- and cations of H^+, NH_4^+, Na^+, Mg^{2+}, Ca^{2+}, nss Ca^{2+} and K^+. The highest concentration of acid chemicals were found in Jakarta followed by Serpong, Bandung and Kototabang.

Corrosion caused by acid rain containing $SO4^{2-}$ and form CuSO4 with green color

Acid deposition has affected the Bandung city which pH measurement is 5.0 – 5.2. Acid rain potential is influenced by dominant acid factors such as SO_4^{2-}, NO_3^-, and Cl^-. Impact of acid deposition to the building and heritage structures could be observed at copper statues in Bandung.

Policy on Acid Deposition Relating to Air Pollution Control

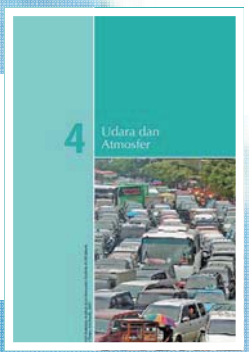
Indonesia has promulgated policies to regulate air pollution from various sources including stationary sources as well as mobile sources. Indonesia has set the target to achieve the energy primer composition by 2025 through Presidential Decree.

Regularly, Ministry of Environment has checked vehicles emission and emission certificate during the extension of vehicle permit by the owner.

Public Awareness

To introduce acid deposition issue to public community, we have carried out seminars and published campaign materials. This issue also has been included in the environmental curriculum based and children tool for environment education.

Annually, report of air quality and acid deposition should be published to the public through the State of Environment Report of Indonesia.



Hans Seidel Foundation has developed air pollution module. To introduce it to school teacher, they conducted one day seminar in Jakarta.

Science camp for secondary school with a topic on climate change, ozone layer protection and acid deposition.

The **National Workshop on Acid Deposition Issues and Programs and its Impact Management** was held in Jakarta, Indonesia on 27-28 May 2009. The workshop was attended by approximately 65 participants.

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National Center

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Secretariat

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EANET

Acid Deposition Monitoring Network in East Asia

JAPAN

Country efforts and achievements in combating acid deposition

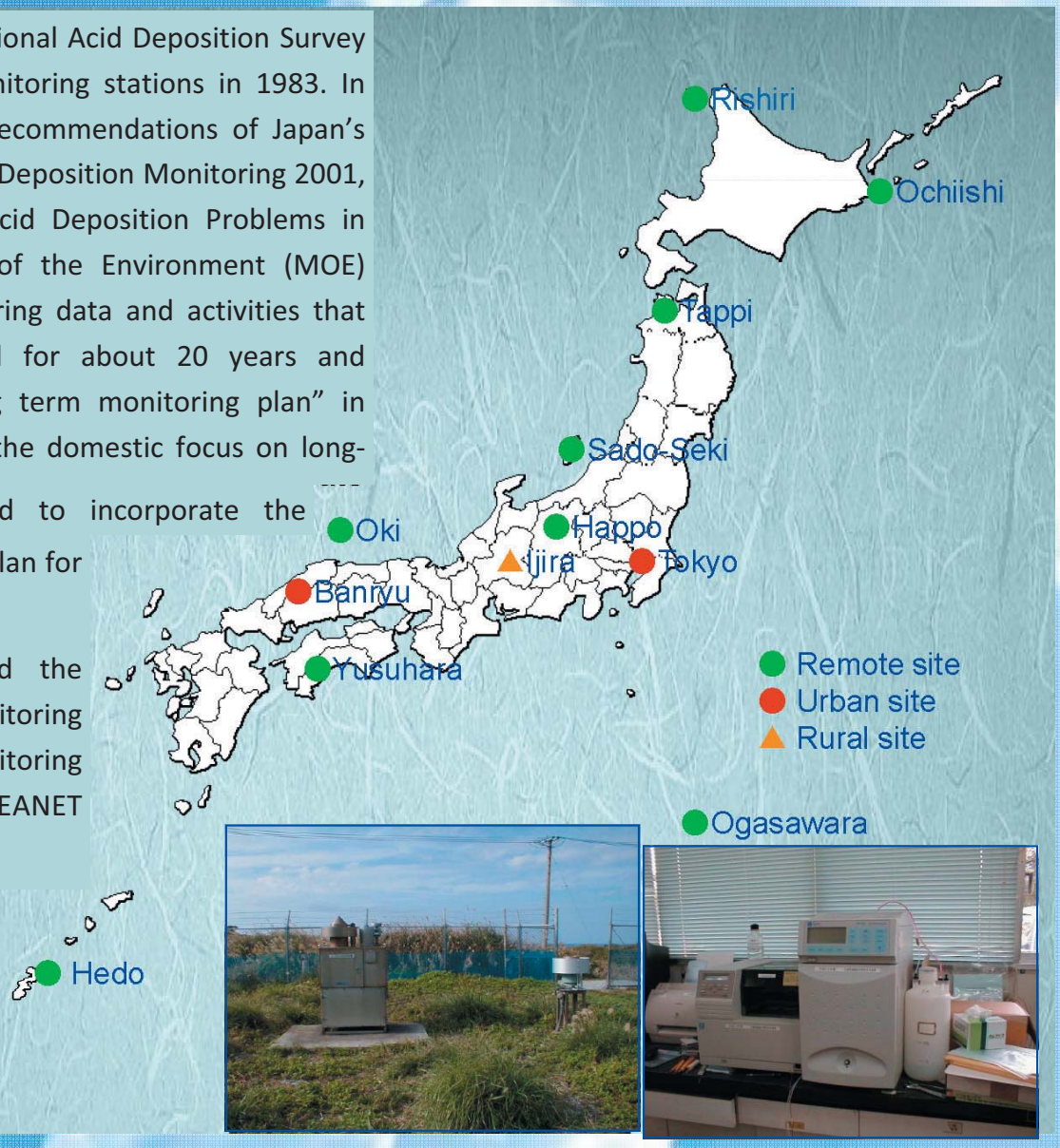
JAPAN

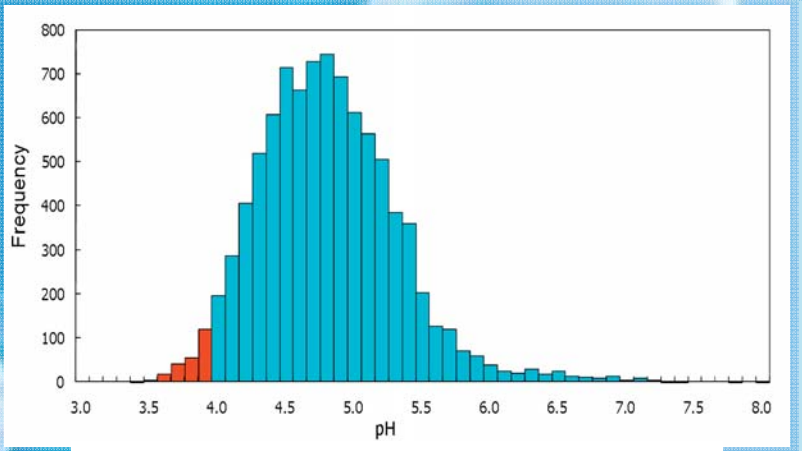
Policies and Practices Concerning Acid Deposition

Japan's Achievements in Acid Deposition Monitoring

Japan started the National Acid Deposition Survey with 14 national monitoring stations in 1983. In 2001 based on the recommendations of Japan's Achievements in Acid Deposition Monitoring 2001, the Committee on Acid Deposition Problems in Japan, the Ministry of the Environment (MOE) reviewed the monitoring data and activities that had been conducted for about 20 years and formulated the "long term monitoring plan" in March 2002 to shift the domestic focus on long-term monitoring and to incorporate the National Monitoring Plan for EANET.

Japan has continued the acid deposition monitoring at 26 national monitoring sites including EANET monitoring sites.





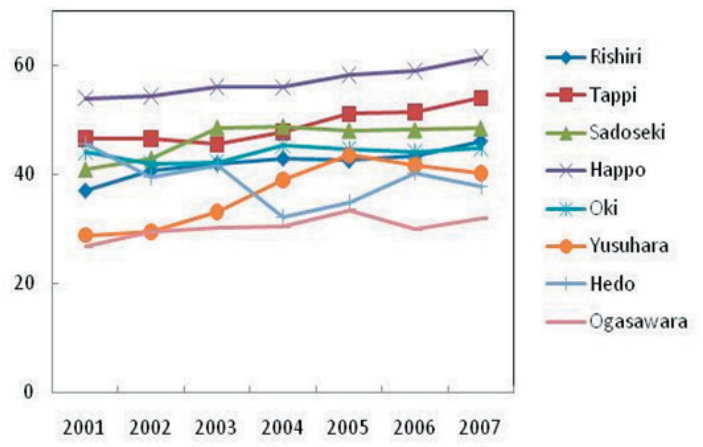
pH distribution of daily precipitation (2003-2007)

Wet and dry deposition monitoring, including ozone and PM, have been conducted at all the EANET sites, and soil & vegetation and inland aquatic environment monitoring have been carried out. Each laboratory carried out the procedures for QA/QC programs and ADORC inspects all the monitoring sites. The inter-laboratory comparison projects are undertaken by the Network Center for EANET in Niigata, Japan.

Based on the revised Monitoring Plan, Japan harmonize all the domestic monitoring activities with the Guidelines and Technical Manuals for EANET, so that the data obtained in Japan could be evaluated by comparing with those countries in East Asian region. The Monitoring Plan is subject for review in accordance with the assessment of monitoring result every five years.

MOE has introduced an automatic data transmission system for the EANET monitoring stations, so that the relevant local governments ADORC and MOE are able to govern and access the monitoring data on an hourly basis to the monitoring data.

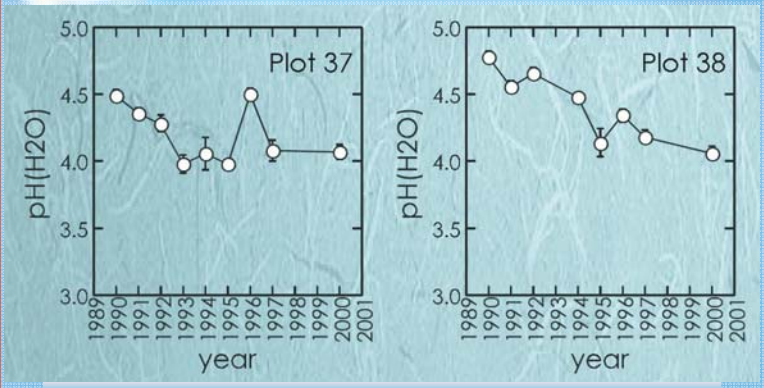
A real-time monitoring data of ozone is used for the reference of local governments to issue warning of photochemical oxidants when ozone concentration is judged to be continuously above the standards.



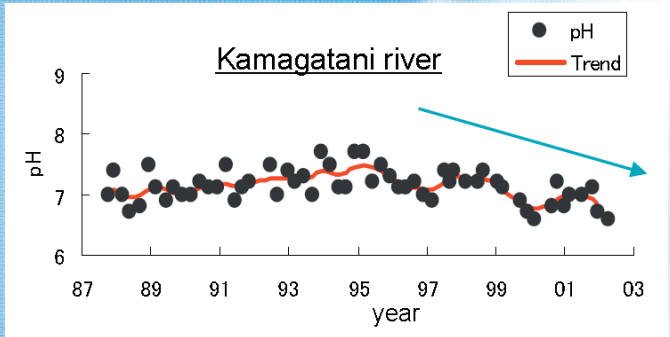
Annual mean of ozone concentration

Chemical changes, which are suspected to be caused by acid deposition, were observed in rivers flowing into Ijira Lake and its surrounding soil in central Japan.

MOE carried out the intensive surveys on atmospheric deposition and stream water in the Ijira Lake catchment from JFY 2005 to 2007. Based on elemental budgets in the catchment scale, it was suggested that atmospheric deposition had certain contributions to acidification of the stream water in this catchment. The catchment-scale analysis may be effective for quantitative discussion of ecological impacts.



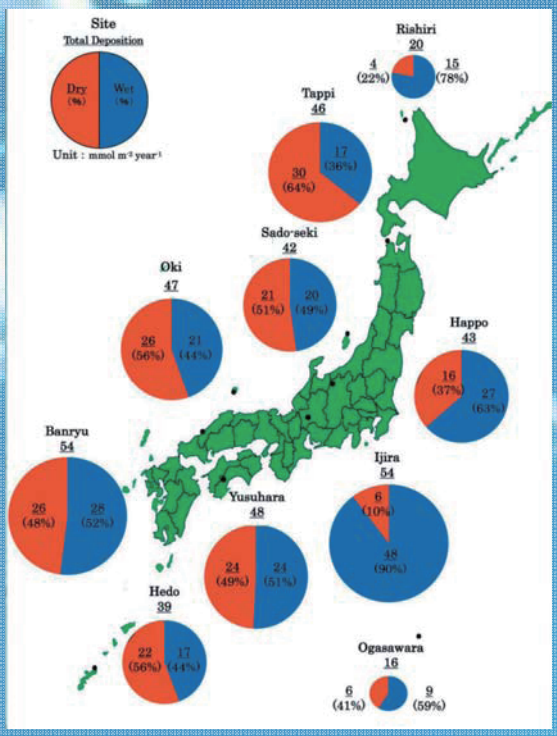
Declining trends of soil pH at the Ijira Lake catchment



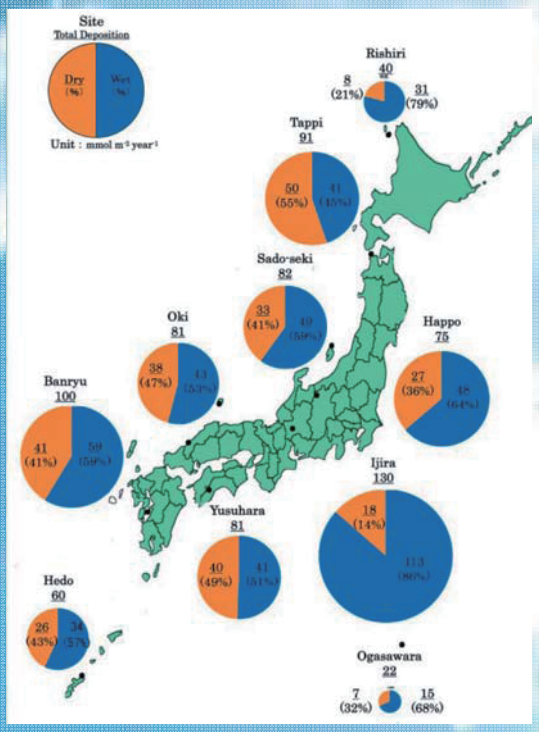
Declining trends of river water pH since the mid 1990s at the Ijira Lake catchment

A throughfall/stemflow collectors (left) and stream water sampling point (right) at the Ijira Lake catchment

Results of Monitoring and Related Activities



Average of Annual Total Sulfur Deposition derived from non sea salt (2003-2007)



Average of Annual Total Nitrogen deposition (2003-2007)

These maps show the total deposition (wet and dry depositions) of nss-sulfur and nitrogen at each site in Japan averaged over 2003-2007. The annual means of total deposition of nss-sulfur at each site ranged from 16 mmol $m^{-2}y^{-1}$ to 54 mmol $m^{-2}y^{-1}$. Those of nitrogen at each site ranged from 22 mmol $m^{-2}y^{-1}$ to 130 mmol $m^{-2}y^{-1}$.

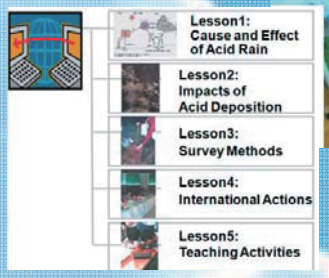
Training and Public Awareness

Capacity building

JICA HIC Training

Training Course for Municipal Staff

Understanding



E-learning Course Lessons

Environmental Study

National Center

Asia Center for Air Pollution Research (ACAP)

1182 Sowa, Nishi-ku, Niigata-shi, 950-2144 Japan

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Secretariat

United Nations Environment Programme Regional Resource Center for Asia and the Pacific (UNEP RRC.AP)

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Network Center (NC)

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EANET

Acid Deposition Monitoring Network in East Asia

LAO PDR

Country efforts and achievements in combating acid deposition

LAO PDR

Policies and Practices Concerning Acid Deposition

Institutional Arrangement

Implementing Agency

- **National Agency:**

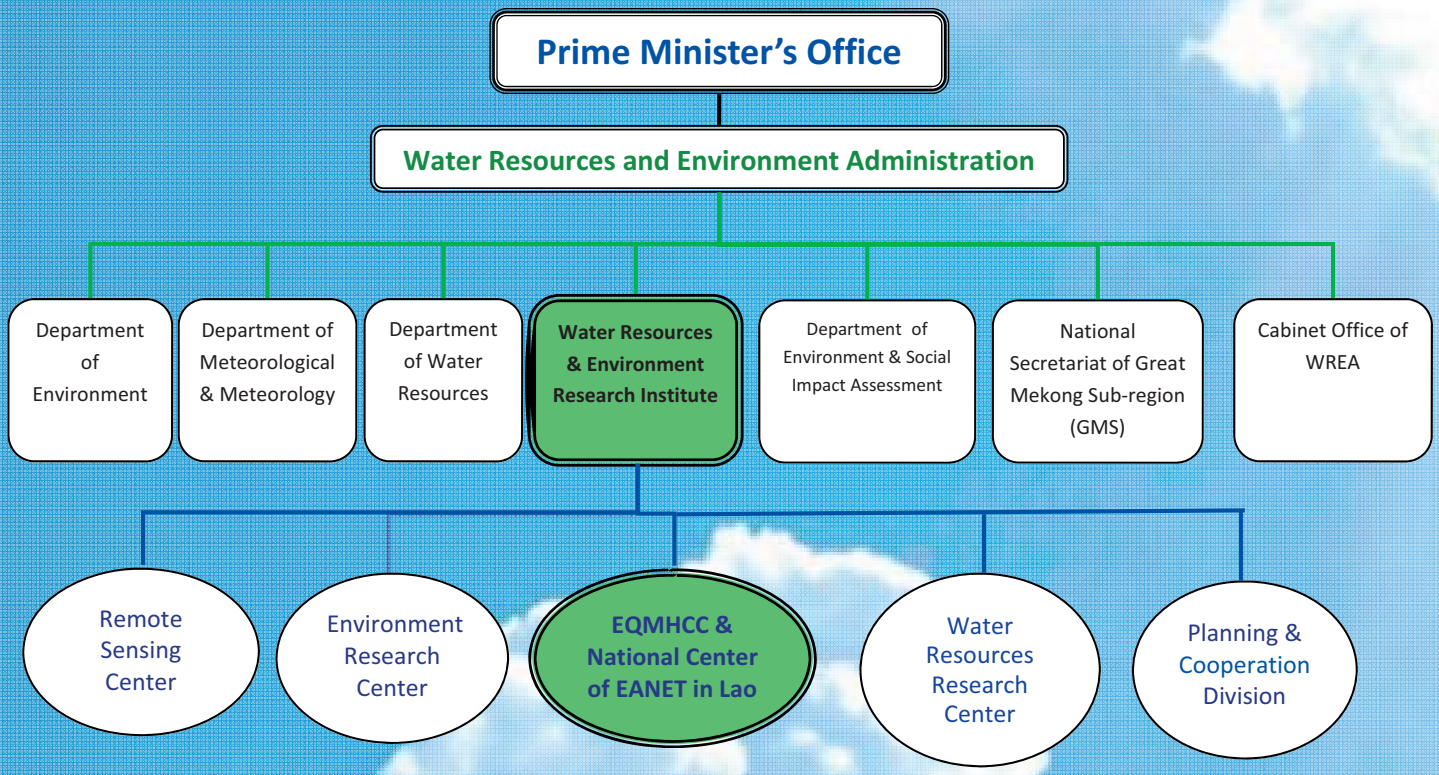
Water Resources and Environment Administration (WREA)

- **National Focal Point:**

Water Resources and Environment Research Institute (WERI)

- **National Center:**

Environment Quality Monitoring and Hazardous Chemical Center (EQMHCC)



Organizational Chart

Situation of Acid Deposition Monitoring

- Lao PDR has participated in EANET since November 2002
- Nominated the National Focal Point and Quality Assurance/Quality Control (QA/QC Manager)
- Established National Center for Acid Deposition
- Established wet deposition monitoring site
- Develop the National Plan for implementation of acid deposition monitoring

Activities on Acid Deposition Monitoring

- Started collecting samples since October 2003
- Parameters analyzed : precipitation amount, pH, EC and
  - Anions (SO_4^{2-}, NO_3^-, Cl^-)
  - Cations (NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+})
- Participated in the Inter-laboratory comparison with the Network Center

- Inland aquatic environment : start to collect samples for observing monitoring station in rural sites (Namhum).
- Measurement:
  - Analysis: pH, EC, Alkalinity;
  - Anions: SO_4^{2-}, NO_3^-, Cl^- ,NO_2^-, PO_4^{3-}; and
  - Cations: Na^+, NH_4^+, K^+, Ca^{2+}, Mg^{2+} by using Ion Chromatography.
- Preparing to start the dry deposition monitoring

Public Awareness

The First National Workshop on Public Awareness on Acid deposition was held on November 10, 2006 in Vientiane Capital City. The participants included:

- relevant governmental agencies;
- provincial science technology and environment offices (PSTEOs);
- private sectors;
- Academe;
- worker unions; and
- non governmental organization.

Public Awareness

The Second National Workshop on Public Awareness on Acid Deposition was held on February 2, 2007 in Vientiane Capital City. There were 50 participants who attended this workshop including relevant government agencies, high school teachers from Vientiane and other provinces, mass media, etc.

- Raise awareness on acid deposition through the newspaper.
- Distribute the brochure to the school children, university and general public.

Future Activities

- Continue monitoring of acid deposition in Lao PDR and submit the data to the Network Center.
- Capacity building and institutional strengthening on public awareness on acid Deposition.
- Disseminate knowledge and information on acid deposition.
- Incorporate acid deposition concern into education curriculum at all levels as appropriate.
- Continue to train Lao relevant staffs in accordance with Japan International Cooperation Agency (JICA), Acid Deposition and Oxidant Research Center (ADORC) and other relevant training programs.
- Join the EANET awareness activities.

National Center

Environment Quality Monitoring and Hazardous Chemical Center (EQMHCC)

Water Resources and Environment Research Institute (WERI)
Water Resources and Environment Administration (WREA)
P.O. Box 2279, Vientiane, Lao PDR

Secretariat

United Nations Environment Programme Regional Resource Center for Asia and the Pacific (UNEP RRC.AP)

c/o Asian Institute of Technology, 3rd Floor, Outreach Building, P.O. Box 4, Klongluang, Pathumthani 12120, Thailand

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Network Center (NC)

Asia Center for Air Pollution Research (ACAP)

1182 Sowa, Nishi-ku, Niigaata-shi 950-2144, Japan

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EANET

Acid Deposition Monitoring Network in East Asia

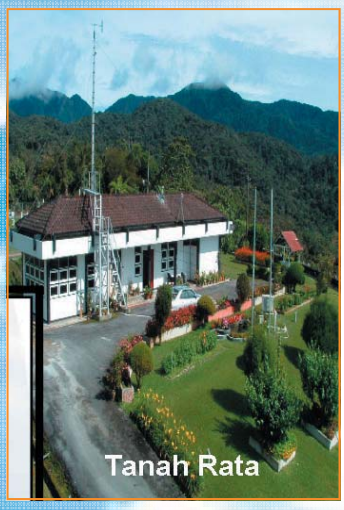
MALAYSIA

Country efforts and achievements in combating acid deposition

MALAYSIA

Policies and Practices Concerning Acid Deposition

Malaysia's acid deposition monitoring activities began in 1976 which comprises of 23 stations throughout the country. All these stations are equipped with automatic wet-only samplers to collect rainwater samples which analyzed for major cations, anions, conductivity and pH. For EANET monitoring sites, concentrations of acidic gases (SO_2, NO_2, NH_3, etc.) are measured using passive and active samplers and aerosol samples are collected with a low volume particulate sampler for determination of chemical composition.

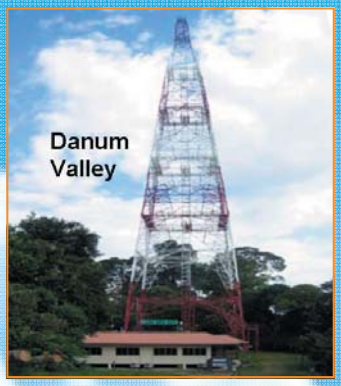


National EANET Monitoring Sites

Three sites for monitoring of wet and dry deposition operated by Malaysian Meteorological Department (MMD) and Chemistry Department include: (i) Petaling Jaya (urban); (ii) Tanah Rata, Cameron Highlands (rural); and (iii) Danum Valley (remote).

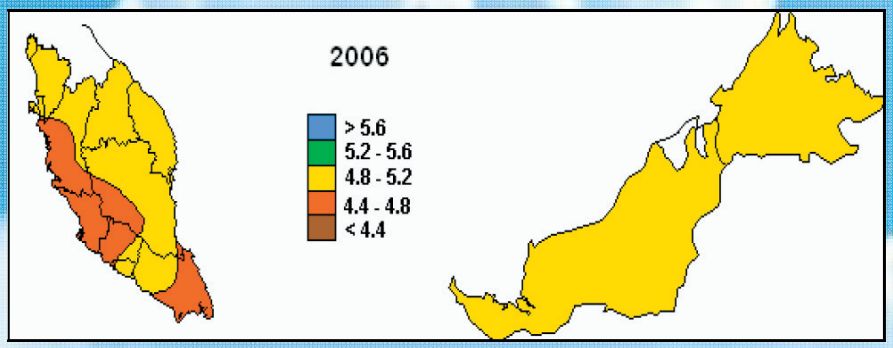
Two sites for monitoring of soil and vegetation operated by University Putra Malaysia include ; (i) Pasoh Forest Reserve; and (ii) Sungai Lalang Forest Reserve.

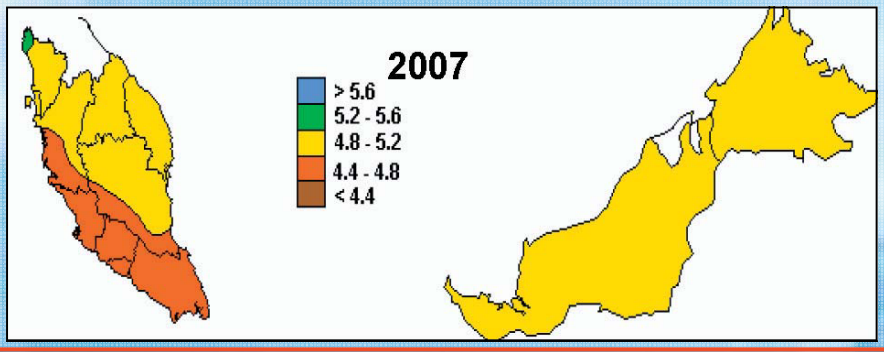
Two sites for monitoring of inland aquatic ecosystem operated by MARA University of Technology (UiTM) namely: (i) Kuala Tembeling; and (ii) Semenyih Dam.

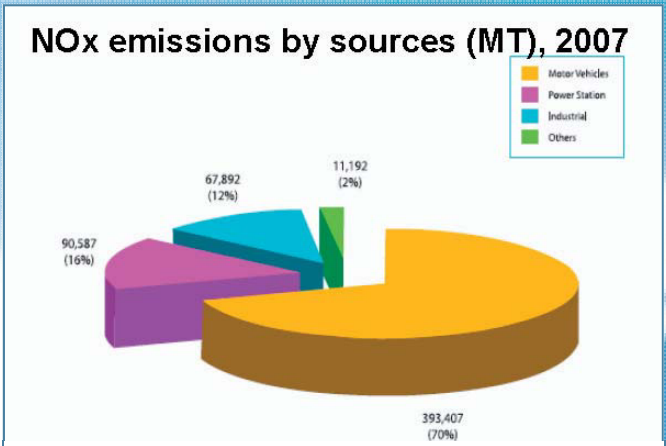


Acidity Trend for Year 2004 – 2007

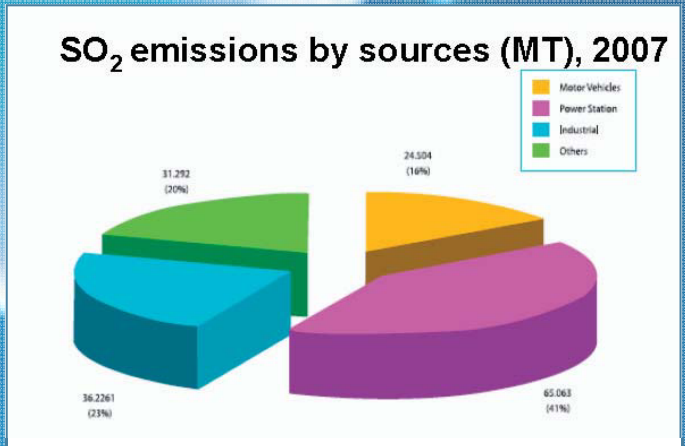
Generally, the northern and east coast states of Peninsular Malaysia and East Malaysia received rainfall with pH between 4.8 and 5.2, while the other parts of the peninsula received rainfall with pH between 4.4 and 4.8.







Motor vehicles (70%), power station (16%), industry (12%) and others (2%)



Motor vehicles (16%), power station (41%), industry (23%) and others (20%)

Air Pollution (Including Acid Deposition) Management

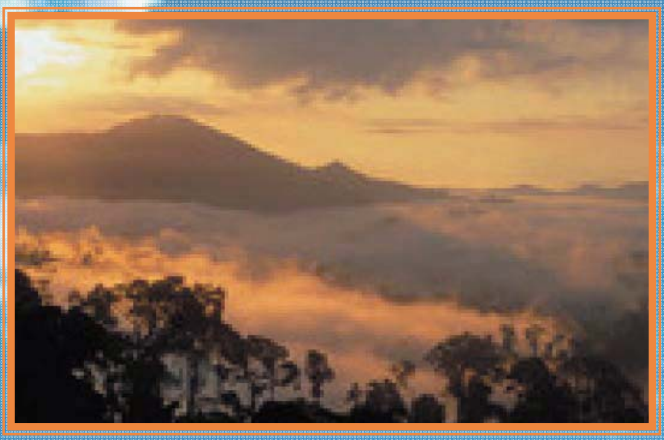
Malaysia adopts both the prevention and pollution control approach in order to protect the environment, as well as to ensure the environment is clean, safe, healthy and productive. The Environmental Quality Act (EQA), the basic framework for environmental management in Malaysia, was enacted in 1974. Under the EQA, there are several regulations to control air pollution such as:

- ✓ Environmental Quality (Clean Air) Regulations 1978, for controlling emissions from stationary sources. These Regulations are currently being revised;
- ✓ Environmental Quality (Control of Emissions from Diesel Engines) Regulations 1996;
- ✓ Environmental Quality (Control of Emissions from Petrol Engines) Regulations 1996;
- ✓ Environmental Quality (Declared Activities) (Open Burning) Order 2003, for controlling air pollution from forest fires and waste burning; and
- ✓ Environmental Quality (Control of Petrol and Diesel Properties) Regulations 2007, applies to fuel used in any combustion engine (mobile and stationary) and in industrial plants.

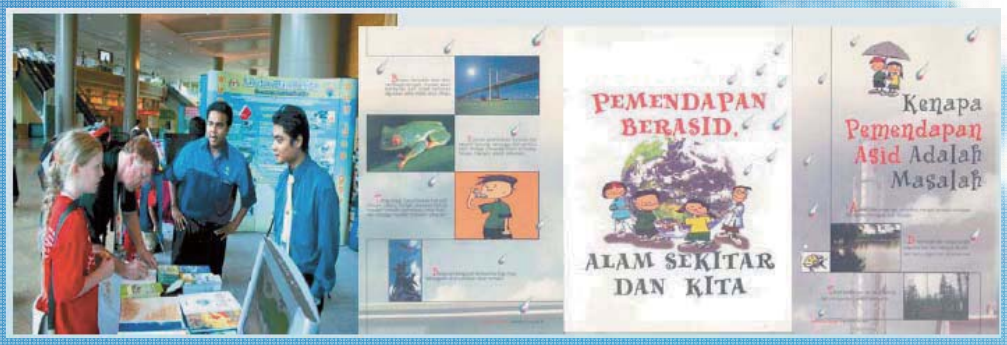
National Achievements

- ✓ Establishment of real-time air quality monitoring network for air pollutants namely SO_2, NO_2, CO, O_3 and Particulate Matter (PM).
- ✓ Commencement of soil and vegetation and inland aquatic environment monitoring for dry deposition
- ✓ Widely used of air quality (including acid deposition) data obtained by researchers and students to better understand the atmospheric acidification issue
- ✓ Pursued stricter vehicle emission standards
- ✓ Adoption of higher–quality fuels / low sulphur content
- ✓ Formulation of new sets of air quality regulations toward stricter standards for industrial emissions
- ✓ Successful enforcement programmes to control emission of pollutants from stationary and mobile sources
- ✓ Continuous public awareness and education programmes on air pollution and acid deposition issues

Future Activities



For improving air quality, Malaysia has currently developed its National Clean Air Action Plan which spells out strategies and action plans toward reducing emissions from mobile, stationary and area sources, as well as enhancement of air quality management capacity and strengthening public awareness and participation.



PROMOTION OF ENVIRONMENTAL EDUCATION AND AWARENESS PROGRAMMES

National Center

Malaysian Meteorological Department (MMD)

Jalan Sultan, 46667 Petaling Jaya
Selangor, Malaysia

Secretariat

United Nations Environment Programme Regional Resource Center for Asia and the Pacific (UNEP RRC.AP)

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EANET

Acid Deposition Monitoring Network in East Asia

MONGOLIA

Country efforts and achievements in combating acid deposition

MONGOLIA

Policies and Practices in Addressing Acid Deposition Problems

The capital city of Mongolia, Ulaanbaatar is an important center for economy, population and its density. Ulaanbaatar is the biggest city of Mongolia, which is a home to nearly half of the country's population and center of industrialization, market, service as well as a main hub of the transportation.

Air pollution of Ulaanbaatar city increases mostly during the period of October to March, due to release of smoke from heating of the ger area. Air quality control network has 31 stations which currently under operation for air quality monitoring and assesses concentrations of nitrogen oxide (NO_2) and sulphur oxide (SO_2), on a regular basis.

Acid Deposition

Monitoring of acid deposition in Mongolia started in August 1998 at two sites of wet and dry deposition. There are 2 sites of wet and dry deposition monitoring and one site of inland aquatic environment monitoring being operated for the EANET. The Central Laboratory of Environment and Metrology (CLEM) was designated and has been operating as the National Center of Mongolia for the EANET. The pH of rain water was in the range from 4.3 to 7.8 in the remote site Terelj, 4.8 to 8.3 in the urban site.

Air Pollution Sources in Ulaanbaatar City

Stationary sources:

- Coal fired Power & Heat
- Combined Plant
- Industrial boilers


Terminal Power Plant-3

Low Sources:

- Coal fired household stove
- Transportation (automobile)
- Small sized heat only boilers

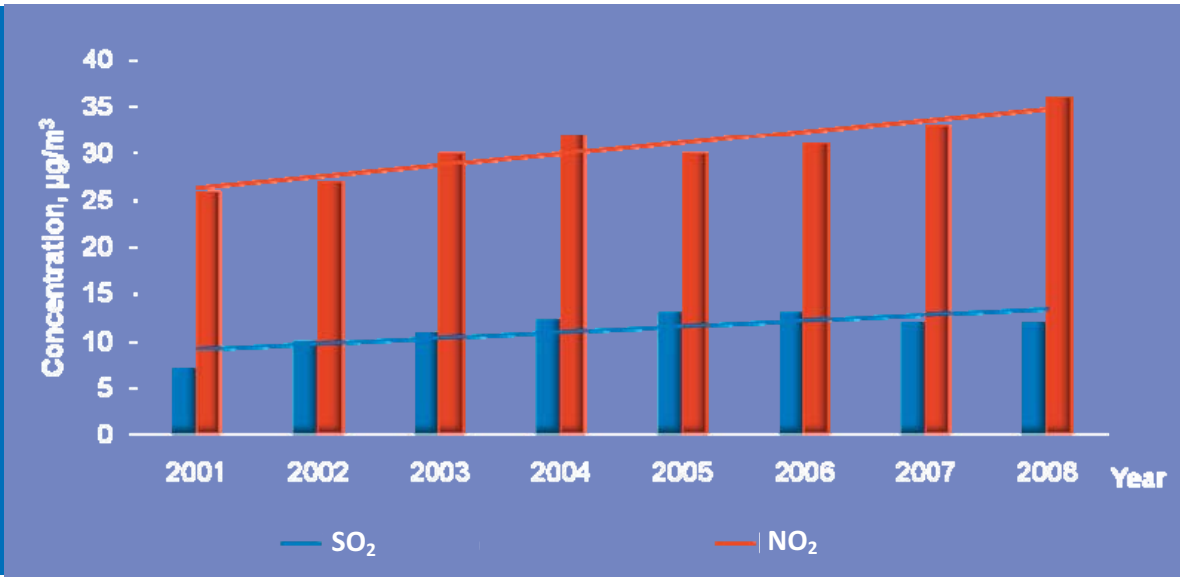

Ger area 9:00AM

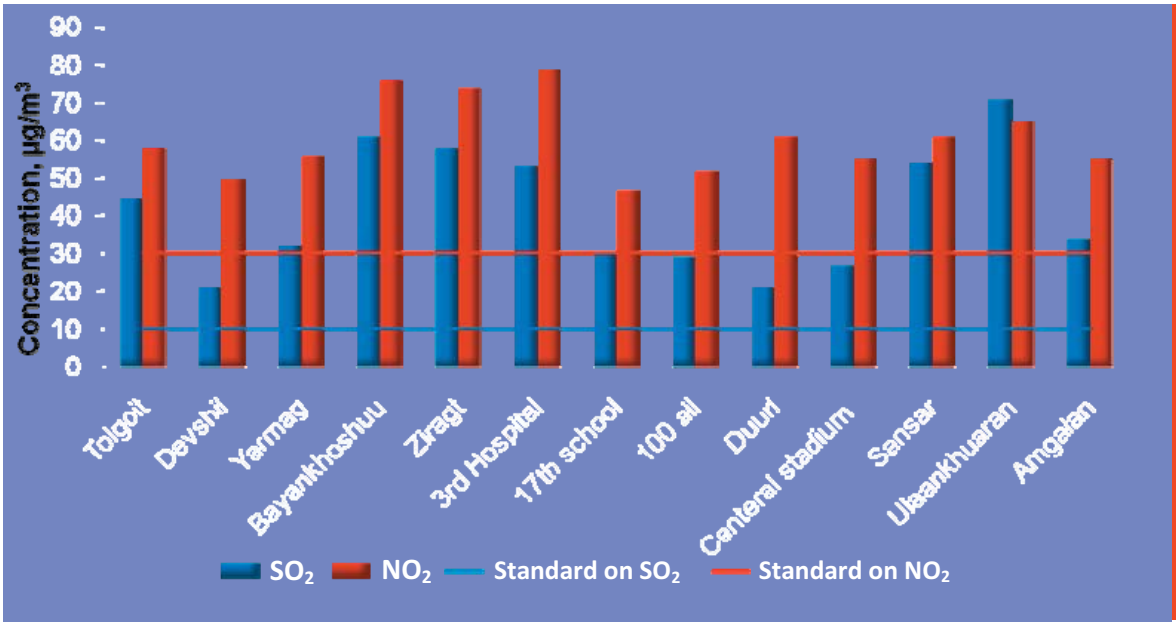
Air Quality Monitoring Stations

- Six stationary stations
- Transportation (automobile)


UB_1 air quality monitoring station

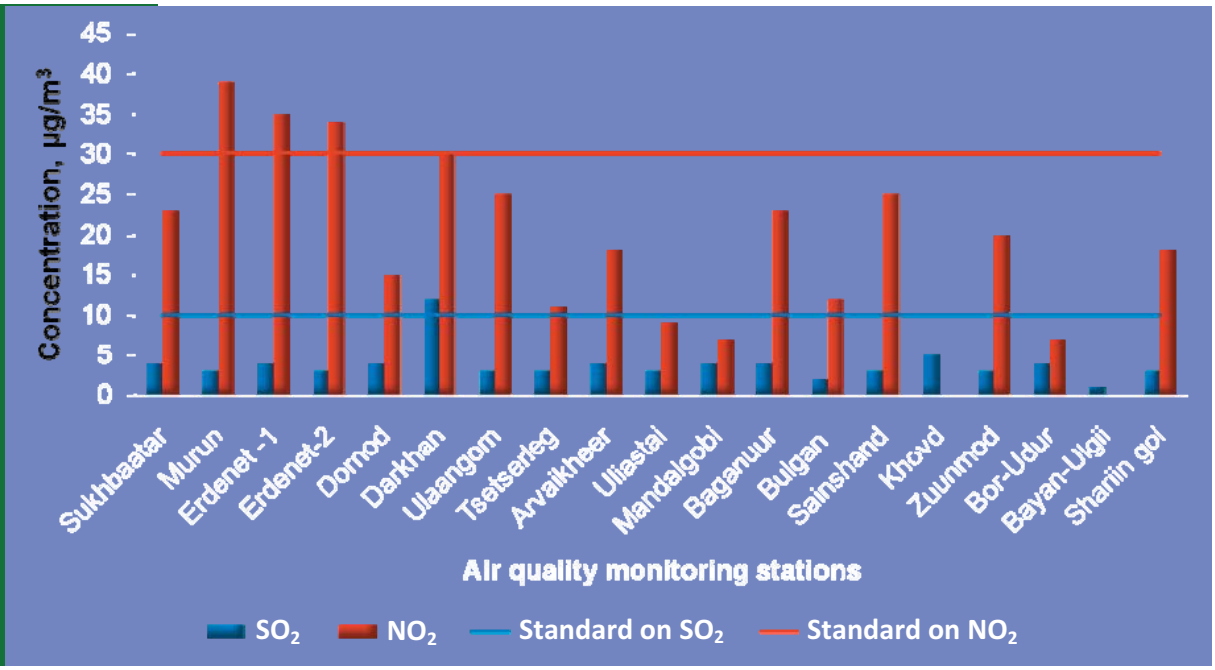
The annual concentration of NO_2 and SO_2 in 4 air quality monitoring stations in Ulaanbaatar city for recent years.





The monthly average concentration of NO_2 and SO_2 in 13 none-stationary air quality monitoring stations (winter time) in Ulaanbaatar city, by January 2008.

The results of sampling and investigation of NO_2 and SO_2 from stations of air quality control of major cities, by 2008.



Measures to Improve Air Quality in the Present and the Future

Inadequate services have resulted in significant air pollution from traffic congestion, coal burning in residential areas and old technology in energy sector. On the fact that air quality is worsening in the major cities, the Mongolian government has attached a particular attention to the air pollution problem and it has been identified as one of the highest priority problems.

Actions taken by the government

- National Air Quality Office is established.
- Air quality monitoring and capacity buildings have been improving. For example UB1 and UB2 stations are equipped with automatic apparatus that is manufactured by "Ecotech" LLC in Australia for determining content of CO, NO-NOx-NO_2, SO_2, PM_{10} in ambient air.
- Consumption of briquette is raising.
- Fuel consumption of automobiles has been tending to use gases.
- Develop laws and legislations for liabilities of air and environmental pollution.

Actions taken by the foreign organizations

- "Improved Household stoves" project sponsored by World Bank (WB) / Global Environment Facility (GEF)
  - Serial drama on FM radio
  - Promotion "Improved Household stoves" on TV
- "Climate Change " project sponsored by GEF.
- "Air quality monitoring and health impact in UB city" project sponsored by WB.

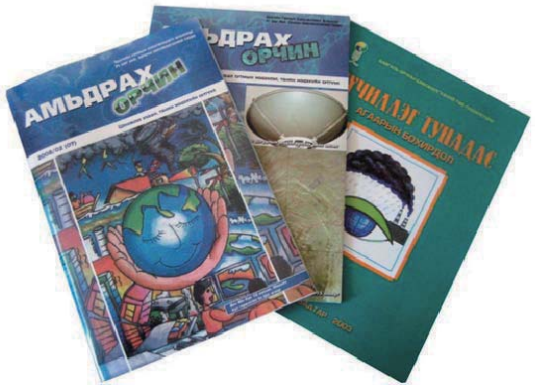
We are proposing to implement new activities as a perspective in the future such as:

- To develop laws and legislations for liabilities of air and environmental pollution;
- To increase construction (to decrease ger area);
- To provide the residents of the ger area with environmentally friendly, standard stoves;
- To invent the processed fuels that are adaptable to the condition of Mongolia and its distribution; and
- To expand the green zone of the city as well as support the production of fast burning fuel in winter.

Public Awareness and Broadcasting

Air quality monitoring data is submitted to NAQO and is published every ten days in the agro meteorological and environmental bulletin and our website by bigger cities. Air quality monitoring data is delivered to policy makers every week.

- Every month data is submitted to National Statistical Office.
- "Four colour" broadcasted by "Education channel TV" everyday.
- "Living Environment" magazine published every month.



National Center

Central Laboratory of Environment and Metrology (CLEM)

Khan-Uul-3, Chingis Avenue
Ulaanbaatar-36, Mongolia

Secretariat

United Nations Environment Programme Regional Resource Center for Asia and the Pacific (UNEP RRC.AP)

c/o Asian Institute of Technology, 3rd Floor, Outreach Building, P.O. Box 4, Klongluang, Pathumthani 12120, Thailand

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EANET

Acid Deposition Monitoring Network in East Asia

MYANMAR

Country efforts and achievements in combating acid deposition

MYANMAR

Policies and Practices Concerning Acid Deposition

Institutional Arrangement

➢ Department of Meteorology and Hydrology (DMH) has initiated rain water collection and measuring its pH and EC since 2003. Thereafter, Myanmar was approved as a participating country of EANET in 2005 and DMH became the National Center for EANET, while the Director General of DMH has been appointed as the National Focal Point.

➢ Yangon (Kaba Aye - location of DMH) was chosen as an urban site for wet deposition monitoring. Systematic sampling of rain water was able to carry out after the installation of wet sampler in June 2007, which was provided by Acid Deposition and Oxidant Research Center (ADORC), the Network Center for EANET.

➢ The pH and EC are measured by Horiba pH meter and YSI EC meter.

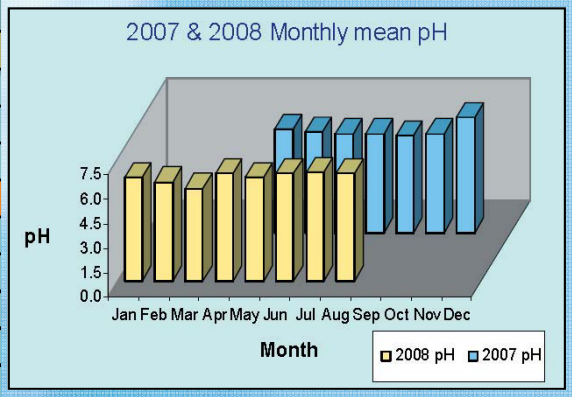
Responsible Governmental Agencies on Air Quality and Water Quality Monitoring

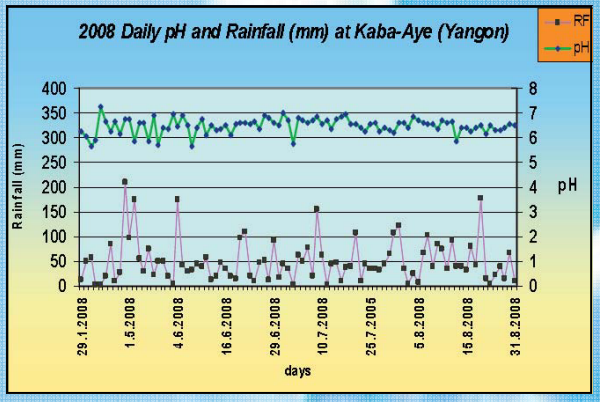
- ✓ Yangon City Development Committee - YCDC
- ✓ Mandalay City Development Committee - MCDC
- ✓ Department of Meteorology and Hydrology—DMH
- ✓ Department of Forestry - DOF
- ✓ Department of Medical Research - DMR
- ✓ Department of Health - DOH
- ✓ Department of Atomic Energy - DAE
- ✓ National Commission for Environmental Affair - NCEA
- ✓ Irrigation Department - ID
- ✓ Water Resources Utilization Department - WRUD
- ✓ Directorate of Water Resources and Improvement of river systems - DWIR
- ✓ Department of Development Affair – DDA

State of Acid Deposition

➢ Among the observed data from the urban site, minimum pH value for 2007 and 2008 are 4.4 and 5.6 respectively; however, most of the measured pH values throughout the year were between 6 and 7. Hence, it can be generally concluded that acid deposition is still less in Yangon area.

Month	2007 pH	2008 pH
Jan		6.3
Feb		6.0
Mar		5.6
Apr		6.5
May	6.3	6.3
Jun	6.1	6.5
Jul	6.0	6.6
Aug	6.0	6.5
Sep	5.9	
Oct	6.0	
Nov	7.0	
Dec		

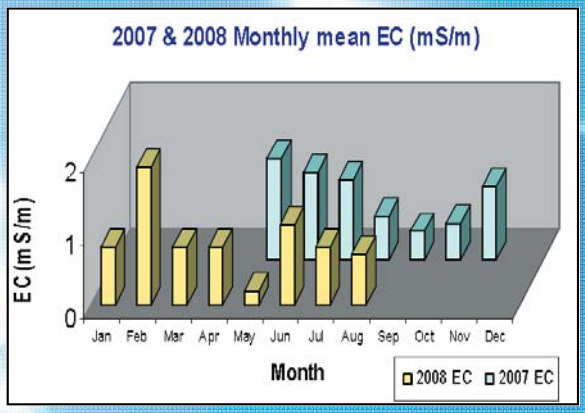


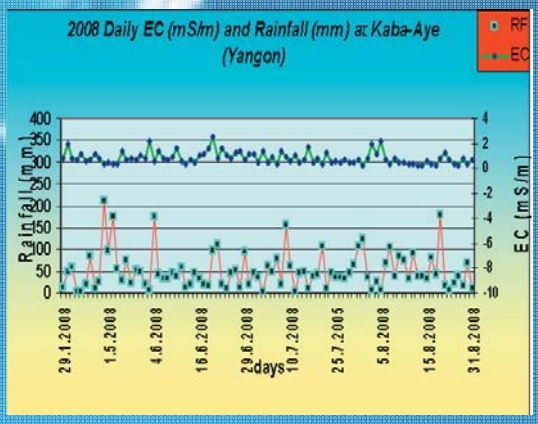


EC Measurement

➢ Regarding the value of EC, the maximum of 2.5 mS/m was recorded on 19 June 2008 while the minimum of 0.2 mS/m was recorded on 14 August 2008. Meteorological data such as wind direction, wind speed, temperature, humidity and sunshine hours were also observed together with precipitation at the site.

Month	2007 EC	2008 EC
Jan		0.8
Feb		1.9
Mar		0.8
Apr		0.8
May	1.4	0.2
Jun	1.2	1.1
Jul	1.1	0.8
Aug	0.6	0.7
Sep	0.4	
Oct	0.5	
Nov	1.0	
Dec		





Environmental Protection

➢ To protect the environment in the country, Myanmar has adopted an environmental policy in 1994 and the policy emphasizes to integrate environmental protection in the developmental activities for the benefit of present and future generations. In line with this policy, Myanmar takes environmental consideration in every developmental activity and accepts sustainable development as its ultimate goal. Therefore, the country is trying to make sure that every development should be sustainable and should not impair the environment because future development depends on healthy ecology, sustained economy and good social basis.

➢ Though the environmental law is in the process of government approval, the country has some sectoral laws which are related to environmental conservation. Myanmar has 61 sectoral environmental laws to date.

➢ Permanent environmental institution/s may be established after enacting the said law and environmental duties may be implemented by them.

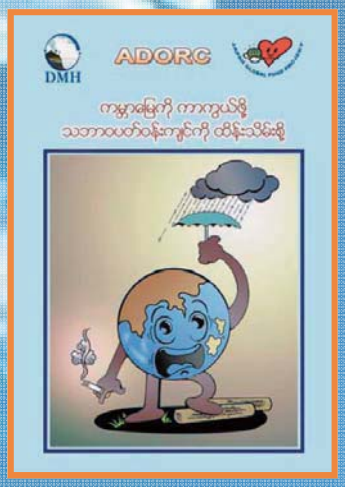
National Achievements

➢In addition to acid deposition monitoring in DMH, Department of Health is implementing air quality monitoring of Yangon City using High Volume Sampler at 3 selected sites since 2008.

➢ National commission for Environmental Affair had also conducted a pilot study on air quality monitoring at three selected areas of Yangon during April 2007.

➢ To obtain baseline data for total suspended particulate matter, Department of Atomic Energy (DAE) has initiated the monitoring of urban air quality in Yangon city (Yankin, Bahan) since 2001.

Public Awareness on Acid Deposition



➢ Regarding Public Awareness on acid deposition, DMH has had an opportunity to compile the Myanmar brochure on acid deposition problem with financial support from Japan Fund for Global Environment. These brochures have been distributed to schools, universities, libraries, governmental departments and NGOs, etc. Moreover, under the public education programme of Myanmar television, a talk on the cause and impact of acid deposition is disseminated frequently through MRTV 4 channel.

Poster Exhibition

Writing Articles in Newspaper & Journals

Future Activities

➢ To hold public Awareness workshop on acid deposition by inviting all stakeholders

➢ Continue to distribute brochure, pamphlet & VCD on acid deposition

➢ To disseminate the message on acid deposition through radio and television

➢ Writing articles related to acid deposition in Newspaper, Journals & Newsletter

Public Education on Acid Deposition

National Center

Department of Meteorology and Hydrology (DMH), Ministry of Transport

Kaba-Aye Pagoda Road, Mayagon 11061
Yangon, Myanmar

Secretariat

United Nations Environment Programme Regional Resource Center for Asia and the Pacific (UNEP RRC.AP)

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EANET

Acid Deposition Monitoring Network in East Asia

PHILIPPINES

Country efforts and achievements in combating acid deposition

PHILIPPINES

Acid Deposition in the Philippines: Achievements in Monitoring and Control Measures

Acid deposition activities in the Philippines during the regular phase of Acid Deposition Monitoring Network in East Asia (EANET) could be categorized into the following: (1) implementation of the National Monitoring through the conduct of the four monitoring media; (2) participation in inter-laboratory comparison exercises for wet deposition, dry deposition, soil and inland aquatic environment; and (3) conduct of public awareness activities through acid deposition brochures, conduct of seminar-workshops for stakeholders, and initiation of a "Rain Watch " project with selected elementary schools in Metro Manila. At the regional level, the Philippines also participates in sessions of the (1) Senior Technical Managers that discuss the results of monitoring and quality assurance/quality control activities; (2) Scientific Advisory Committee that provides advice from scientific and technical viewpoints; and (3) Intergovernmental Meeting that sets the policy and makes decisions relative to EANET work plan, budget and operations.

Acid Deposition Monitoring

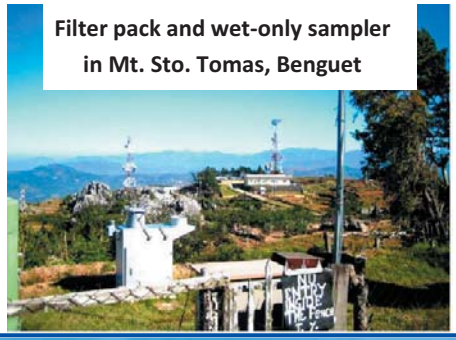
The Philippines is one of the first ten participating countries that participated in the establishment of EANET in 1998. The Environmental Management Bureau - Department of Environment and Natural Resources (EMB/DENR) serves as the National Center of EANET. The country's national monitoring plan is based on the guidelines for acid deposition monitoring developed by EANET. The National Monitoring Plan was developed in 1999 with the assistance of the Government of Japan. The Plan was revised in 2008.

Measurement Parameters, Monitoring Sites and Monitoring Interval

Monitoring Media	Measurement parameters	Monitoring site	Monitoring interval
Wet deposition	pH, EC, concentrations of NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, NO_3^- and Cl^-	1. Metro Manila (MM) - urban 2. Los Baños (LB) - rural 3. Mt. Sto. Tomas, Tuba, Benguet (MST) - remote	Weekly
Dry deposition	Gases: SO_2, HNO_3, HCl, and NH_3 Aerosol: SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+} and Mg^{2+}	1. MM—urban 2. LB—rural 3. MST—remote	Weekly
Soil ———— Vegetation	pH (H_2O), pH (KCl), ECEC, exchangeable Na^+, K^+, Ca^{2+}, Mg^{2+}, exchangeable acidity Al, H, T-N, T-C ———— Degree of decline of trees, Abnormalities of leaves and branches: Description of trees in the sampling plots (species name, DBH, tree height), Understorey vegetation, Tree decline and Photographic record	1. La Mesa Dam watershed (urban) 2. Mt. Makiling Forest Reserve (rural) 3. UP Quezon-Laguna Land Grant (rural) 4. ERDS Research Station, Binga, Itogon, Benguet (remote)	Every 3 years
Inland aquatic environment	Water temperature, pH, EC, alkalinity, concentrations of SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, NO_2^-, PO_4^{3-}, BOD_5, DO and transparency	1. Pandin Lake, San Pablo, Laguna (rural) 2. Ambulalakao Lake, Kabayan, Benguet (remore)	Quarterly (4 times/year)

Measurements data on the required parameters have been generated in accordance with EANET's technical documents. Meteorological data are gathered from the sites nearby stations of the Philippine Atmospheric, Geophysical and Astronomical Services Administration. Monitoring data are consolidated on an annual basis. Based on the technical documents, nine monitoring sites, all located in Luzon area, have been established for the four environmental media.

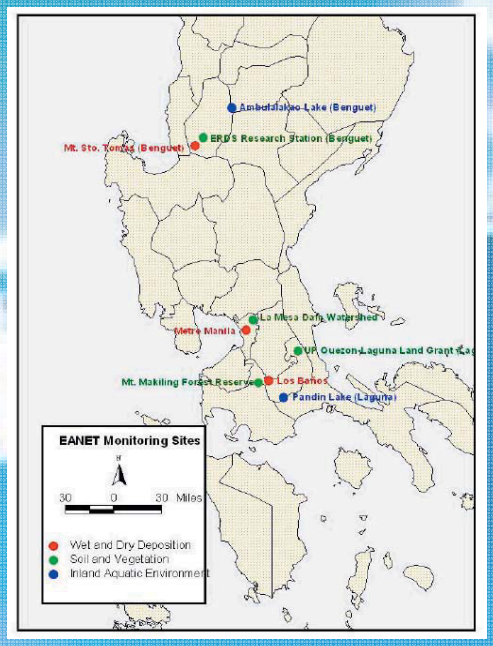
Since the regular phase of EANET in 2001 to 2007, dry deposition monitoring data show that in Metro Manila, urban site, sulfur dioxide (SO_2) had the highest annual mean concentrations, but of a decreasing trend, from 22.2 -7.28 ug/m^3. Next was ammonia (NH_3) with annual means ranging from 4.49 - 7.94 ug/m^3. Nitric acid (HNO_3) and hydrogen chloride (HCl) concentration levels were below 5 ug/m^3. This is also true of all the gases monitored in the rural and remote sites except for HCl in Los Baños in 2001. Overall, SO_2 level in the urban site was around eight times higher than the rural level and 70 times higher than the remote level. The NH_3 level was twice that of the rural site and was 22 times the level in remote site. HNO_3 in Metro Manila tripled the level in Los Baños and was eight times higher than the level in Mount Sto.Tomas. The HCl level in Metro



Filter pack and wet-only sampler in Mt. Sto. Tomas, Benguet

Wet-only sampler in Los Baños

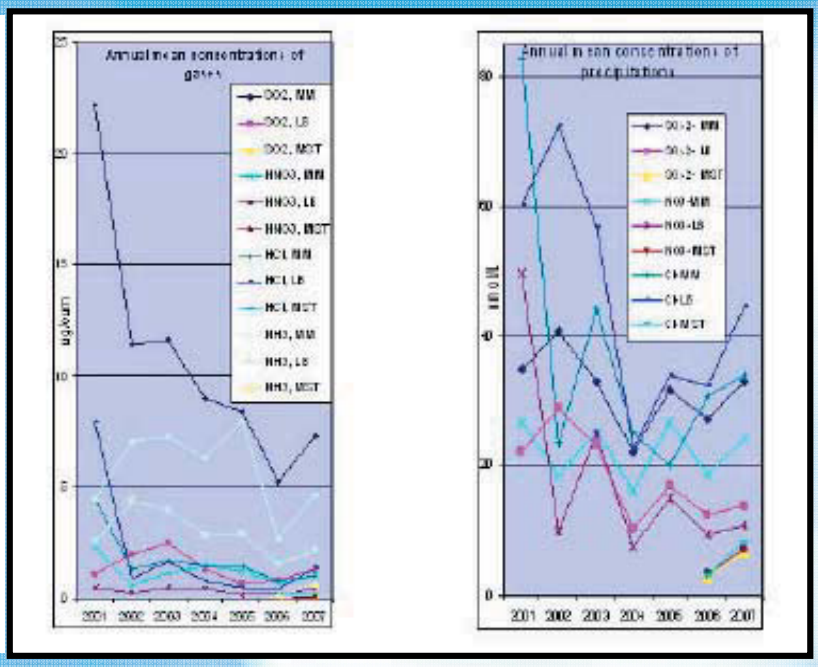
Acid Deposition Monitoring



Ambulalakao Lake in Benguet

Soil and vegetation monitoring in Mt. Makiling, Los Baños

In wet deposition, the overall pH annual mean ranged from 5.42 – 6.53. Of the annual mean concentrations of the anions sulfate (SO_4^{2-}), nitrate (NO_3^-) and chloride (Cl^-), Cl^- were highest. Los Baños levels ranged from 22.7 – 72.3 umol/L while Metro Manila levels were from 20.2 – 82.7 umol/L. SO_4^{2-} and NO_3^- levels in the urban site were higher than those in the rural site. Overall SO_4^{2-} and NO_3^- ranged from 3.08 – 40.6 umol/L and 3.43 – 49.7 umol/L, respectively. Data gathered from the urban and rural sites show decreasing trends except for NO_3^- in Metro Manila with an overall average of 22.3 umol/L. In Mt. Sto. Tomas, remote site, levels of these anions were around 5 umol/L in 2006 – 2007.



Control Measures

There is no specific law for acid deposition control in the Philippines but air pollution control from mobile and stationary sources such as sulfur dioxide and nitrogen dioxide, among others, which are known to be major causes of acid deposition are regulated and controlled as early as the mid-seventies. The Philippine Clean Air Act of 1999 or Republic Act (RA) No. 8749 is the mother law for air pollution control in the Philippines. It provides, among others, air quality standards (emission and ambient) for stationary sources, exhaust emission limits for all types of in -use motor vehicles, Type Approval Standards for new motor vehicles and fuel quality of conventional fuels (automotive and industrial diesel and gasoline) and mandates the phase-out of lead in gasoline.

Two laws on alternative fuels were recently enacted namely: (1) Biofuels Act of 2006 or RA 9367 or "An Act directing the use of biofuels, establishing for this purpose the Biofuels Program, Appropriating Funds there for, and for other purposes" was signed into law by the President on January 12, 2007 and became effective on February 6, 2007; (2) Renewable Energy Act of 2008 or RA 9513 which was signed in January 2009. Pursuant to RA 9367, automotive diesel is blended with 2% bio-diesel while 10% ethanol blended in gasoline (E10) is available in the market. The Philippines is contemplating on a higher biodiesel blend in automotive diesel and replacing all conventional gasoline to E10 by 2011.

Control Measures

Air Pollution Control from Stationary Sources:

New projects shall undergo environmental impact assessments pursuant to Presidential Decree No. 1586 prior to operation. No projects are to be implemented without having passed and satisfied environmental impact assessment as evidenced by an Environmental Clearance Certificate.

All stationary sources of air pollution shall comply with the air quality standards (emission and ambient) prior to operation as evidenced by a Permit to Operate issued by the Environmental Management Bureau.

Some power plants have already switched to Compressed Natural Gas (CNG) while others still use coal as fuel. Those using coal have add-on pollution control devices such as Flue Gas Desulfurizers, wet scrubbers and electrostatic precipitators/baghouse with fabric filters.

At present, EMB is in the process of revising the emission standards.

Air Pollution Control from Mobile Sources:

Euro 2 Type Approval Standards for new motor vehicles were started to be enforced effective January 2008.This means that all gasoline-fueled motor vehicles have to be fitted with "three-way catalytic converters", while diesel-fueled vehicles have to be equipped with "exhaust gas recirculation system"

All motorcycles introduced into commerce effective mid-2006 are fitted with four-stroke engines.

All types of motor vehicles (new, in-use and imported secondhand and rebuilt) including motorcycles/ tricycles are required to comply with the prescribed exhaust emission standards for smoke opacity and carbon monoxide (CO) and hydrocarbon (HC) during initial registration, renewal of registration and after roadside apprehension through actual emission test.

Imported secondhand motor vehicles have to comply with more stringent standards than in-use motor vehicles.

Use of alternative fuels such as LPG and CNG in public transport

The Philippine Government, through the Department of Transportation and Communications, and in coordination with the Land Bank of the Philippines, opened a one billion-peso credit facility to jeepney operators who intend to convert their diesel-fuelled vehicles to LPG-run engines.

Economic Incentives

Industries which shall install pollution control devices or retrofit their existing facilities with mechanisms that reduce pollution are entitled to tax incentives such as but not limited to tax credits and accelerated depreciation deductions.

Three (3) Executive Orders (396, 164 & 488) were issued by the President of the Philippines which provides 0% duties and tariffs on alternative fuels such as CNG on the pilot phase and 1% on the commercial phase.

Public Awareness

Continuous public awareness and education programs on air pollution and acid deposition issues are also being pursued.

National Center

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DENR Compound, Visayas Avenue, Diliman, Quezon City 1116, Philippines

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Network Center (NC)

Asia Center for Air Pollution Research (ACAP)

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For further information, visit EANET web site: http://www.eanet.cc

EANET

Acid Deposition Monitoring Network in East Asia

REPUBLIC OF KOREA

Country efforts and achievements in combating acid deposition

REPUBLIC OF KOREA

Achievements in Acid Deposition Monitoring

Republic of Korea has been participating in EANET since 1999. The experts from several governmental authorities and institutes related to environmental monitoring took part in expert meetings and workshops with contributing to the preparation of technical documents and guidelines for monitoring operation and chemical analysis.

Monitoring on EANET Program

Classification	Site Name	Sampling Period	Measuring Items
Ambient Air Quality	Gangwha	Continuous	SO_2, NO_2, O_3, CO, PM_{10}
	Imsil		
	Jeju		
Wet Deposition	Gangwha	Daily	➢ pH, EC ➢ Cation(NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}) ➢ Anion(SO_4^{2-} , NO_3^- , Cl^-)
	Imsil	Weekly	
	Jeju	Daily	
Dry Deposition	Gangwha	1day in 6day Cycle 3 Stage Filter Pack Method	➢ $PM_{2.5}$ mass ➢ Composition in $PM_{2.5}$ • Cation(NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}) • Anion(SO_4^{2-} , NO_3^- , Cl^-) • HCl, HNO_3, NH_3
	Imsil		
	Jeju		

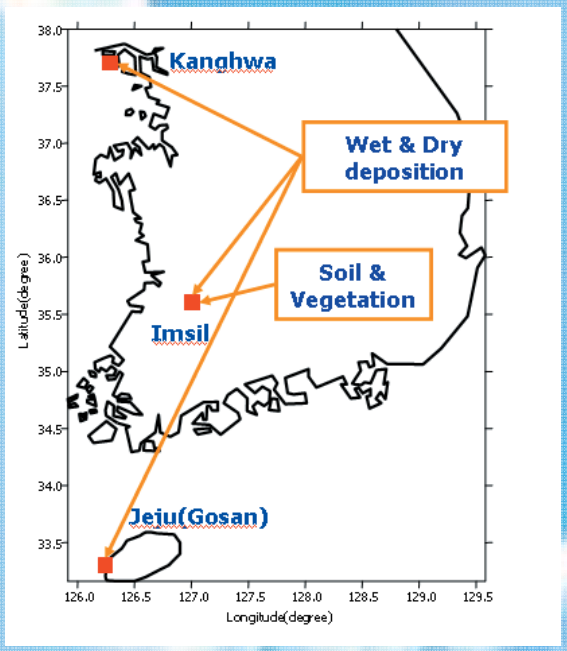
Instrument used in the NIER at the EANET Program

Item	Method	Instrument
pH	Glass electrode	Accument 50
Electric Conductivity	Conductivity cell	YSI 3100
Anions(SO_4^{2-} , NO_3^- , Cl^-)	Ion Chromatography	Dionex system ICS-2000
Cations (NH_4^+, Na^+, K^+, Ca_2^+, Mg_2^+)	Ion Chromatography	Dionex system ICS-1000
SO_2	UV Fluorescense	Thermo Environmental Instrument 43C
NO_2	Chemiluminescense	Thermo Environmental Instrument 42C
O_3	UV Photometric	Thermo Environmental Instrument 49C

Precipitation collector (AQUA, RM8300)

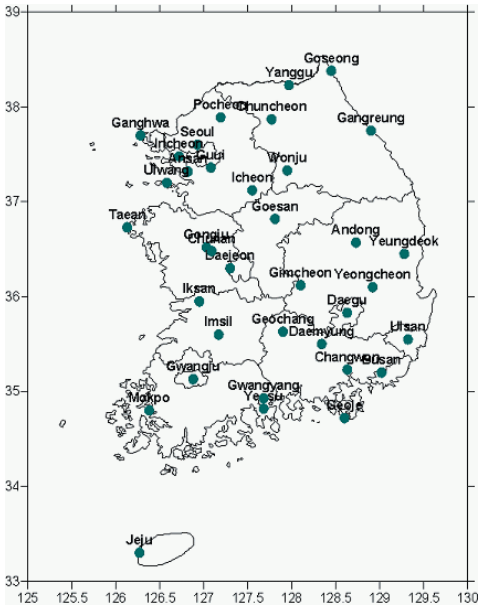
URG 3 stage $PM_{2.5}$ Sequential Sampler

Location of Korea monitoring site (EANET)



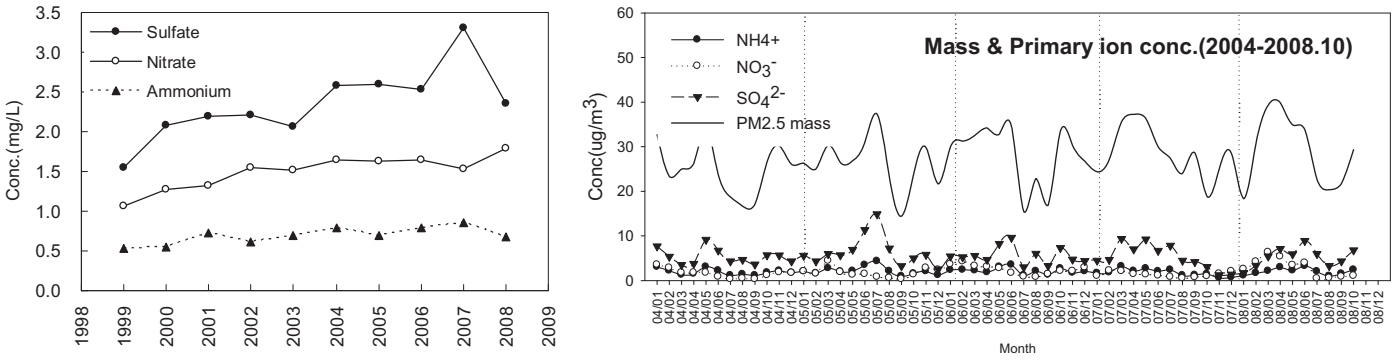
EANET monitoring sites in Korea were established in the western parts of Korea peninsula. They have produced the measurement data in accordance with unified EANET programs using the manuals and technical documents adopted by the Network. Besides them there is the number of the monitoring stations of national networks operated under the management of National Institute of Environmental Research (NIER). The programs also include the sampling and measurement of acid deposition.

Practices Concerning Acid Deposition



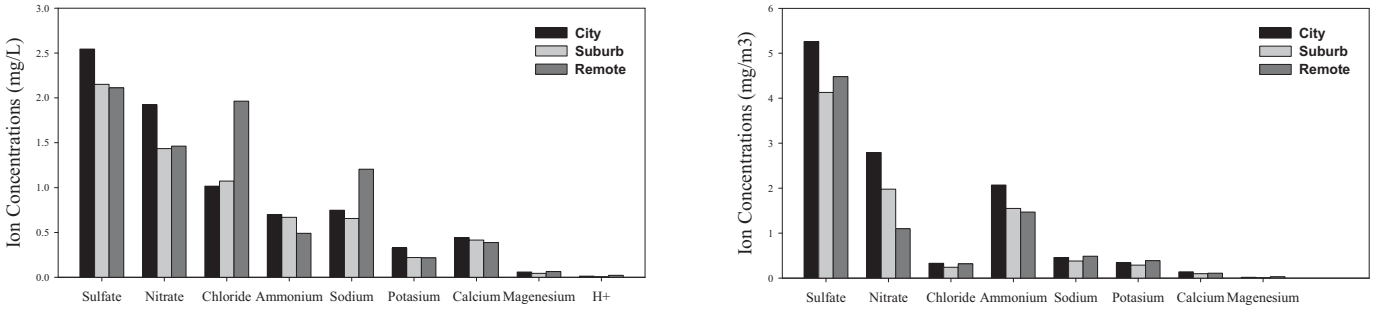
National monitoring of acid deposition in Korea started from 1999. Now, Korean national acid deposition monitoring network is expanded to 38 monitoring sites. The network consists of urban, rural, and remote monitoring sites, where precipitation, gaseous and particulate pollutants are measured. The monitoring and analysis results have been annually published with evaluation of total acidic deposition in a number of report: "Acid deposition monitoring and impact assessment" (NIER).

Long-term monitoring data obtained from the national monitoring sites shows that sulfate and nitrate in precipitation are gradually increasing. On the other hand, $PM_{2.5}$ mass concentration concerned with the dry deposition was relatively stable in spite of some fluctuation.



Long-term and seasonal trends of sulfate, nitrate, and ammonium concentrations (mg/L) in precipitations and aerosols in Korea

Generally, urban sites show higher concentration of sulfate, nitrate and ammonium in precipitation and $PM_{2.5}$ than suburban and remote sites. On the other hand, chloride and sodium were mainly detected in remote sites implying the influence of sea-salt.



Anion concentrations in precipitation and $PM_{2.5}$ at urban, rural, and remote sites in Korea

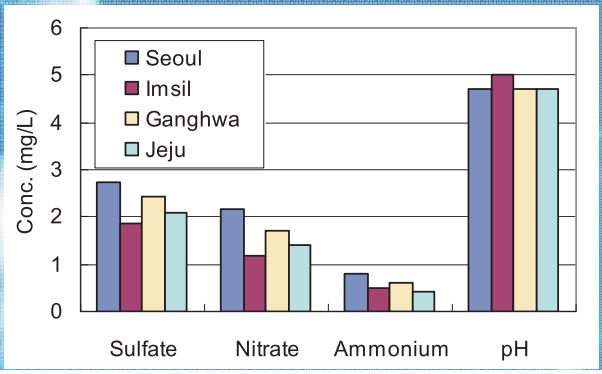
Main Results in Acid Deposition Monitoring

EANET PROGRAM

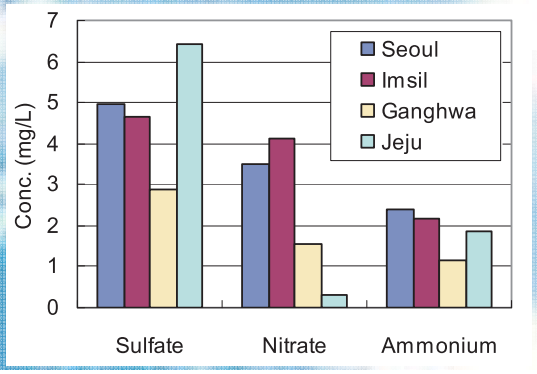
EANET sites in Korea such as Ganghwa, Imsil, Jeju are included in national acid deposition monitoring network. Among them, Ganghwa and Jeju are classified as remote sites, while Imsil is a suburban site. These sites showed lower concentrations of major ion components in precipitation. On the other hand, sulfate in $PM_{2.5}$ was highest in Jeju in spite of its location in a remote area of Korea. This result suggests that acid deposition in Jeju can be influenced by the long-range transport of aerosol.

Main Results in Acid Deposition Monitoring

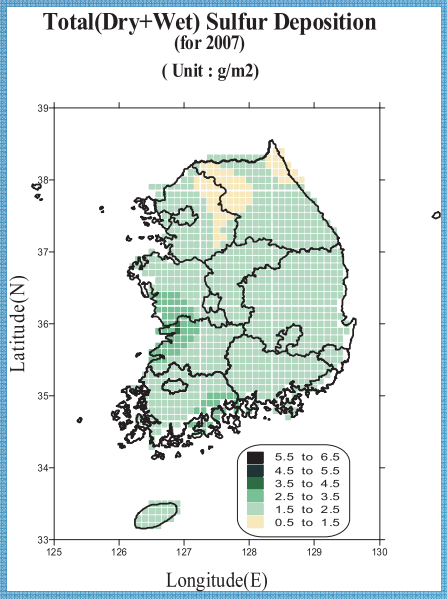
In Precipitation (2007)

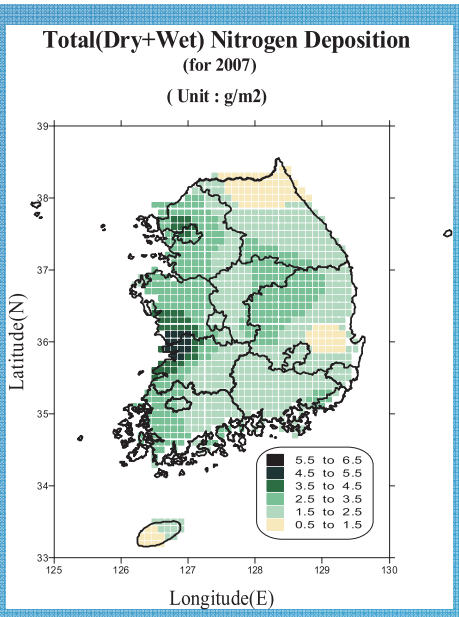


In $PM_{2.5}$ (2007)



Comparison of average region concentrations of sulfate, nitrate, and ammonium ions in precipitation and $PM_{2.5}$ with EANET data in 2007 for remote(Ganghwa, Jeju), suburban (Imsil), and urban (Seoul) sites.

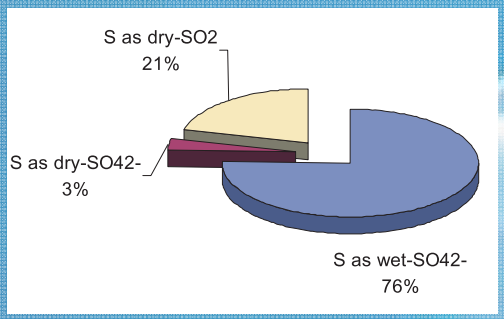


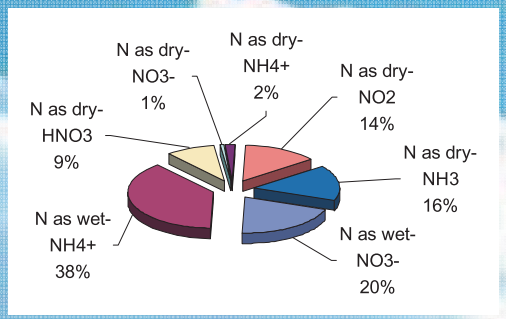


Spatial distribution of total sulfur and nitrogen deposition

The influence of urban and industrial centers have resulted to increasing of total sulfur and nitrogen deposition at urban and regional sites as compared with background level at remote sites.

Evaluation of a spatial distribution of sulfur and nitrogen compounds both in dry and wet deposition shows their maximums over the western part of Korea.





Spatial distribution of total sulfur and nitrogen deposition

Future Activities in Korea

National monitoring plan is continued to the next 5 years. During the period, monitoring network will be expanded to 40 acid deposition monitoring sites.

National Center

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EANET

Acid Deposition Monitoring Network in East Asia

RUSSIA

Country efforts and achievements in combating acid deposition

RUSSIA

Achievements in Acid Deposition Monitoring

Russian Federation has been participating in EANET since 1998 with the start of activities during the preparatory phase. The experts from several governmental authorities and institutes related to environmental monitoring took part in expert meetings and workshops which contributed to the preparation of technical documents and guidelines for monitoring operation and chemical analysis.

Monitoring on EANET Programme

Items	Measurement parameters	Monitoring interval
Wet deposition	pH, EC, Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, HCO_3^-, Cl^-, NO_3^-, NO_2^-, PO_4^{3-}, Br^-	Daily (every precipitation event)
Dry deposition	SO_2, HNO_3, HCl, NH_3 Components in PM (the same as in wet deposition)	Regular (weekly/two weeks)
Soil	pH (H_2O), pH (KCl), exchangeable (Na^+, K^+, Mg^{2+}, Ca^{2+}, Al^{3+}, H^+) exchangeable acidity, ECEC, Carbonate, T-C, T-N	3- 5 years
Vegetation	1.Observation of tree decline, 2. Description of trees	3- 5 years
Inland aquatic environment	T^0C water, pH, EC, alkalinity, Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, HCO_3^-, Cl^-, NO_3^-, NO_2^-, PO_4^{3-}, Water colour, DOC (COD)	4 times a year


Atomic-adsorptive spectrometry


Chromatography «Milichrom A-02»


Precipitation collector


Spectrophotometry

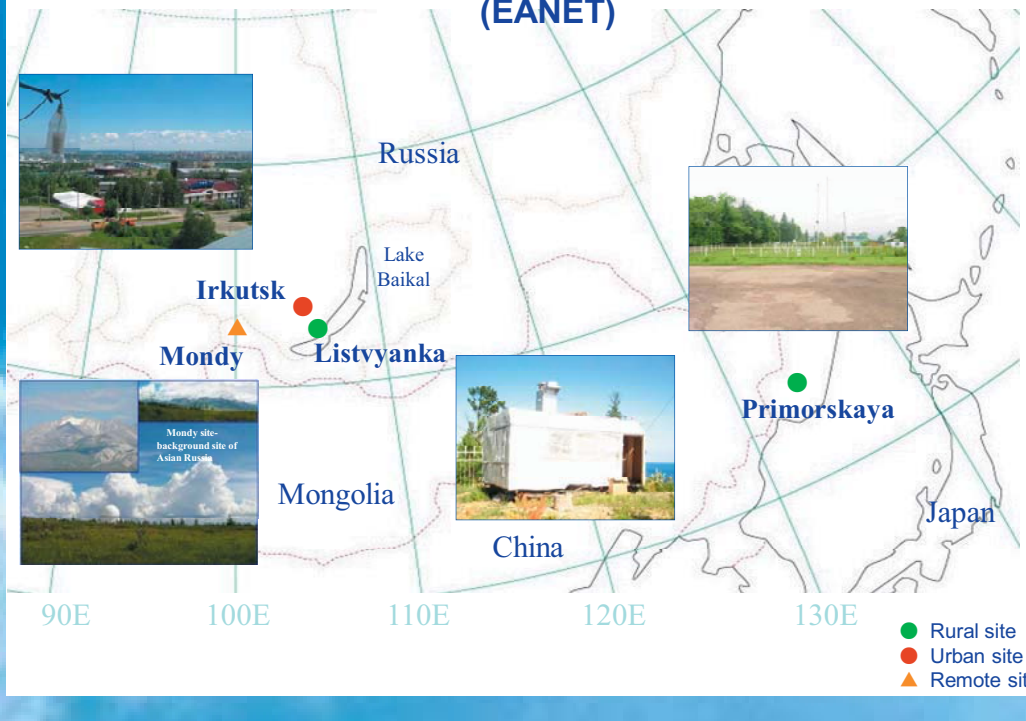

ICP-MS spectrometry


pH-meter

Instruments used in the Limnological Institute at the EANET Programme

Russian EANET monitoring stations were established in the South-Eastern parts of Asian Russia including Far East region. Together with LIN (Limnological Institute) they produced the measurement data in accordance with unified EANET programs using the manuals and technical documents adopted by the Network. Besides, there is the number of the monitoring stations of national networks operated under the management of Roshydromet. Their programs also include the sampling and measurement of atmospheric deposition of airborne pollutants, soil and vegetation and inland aquatic environment.

LOCATION OF RUSSIAN MONITORING SITES (EANET)



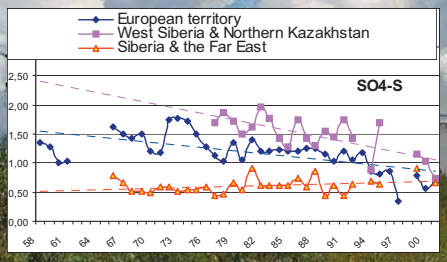

Collection and handling of samples on the Pereemnaya river

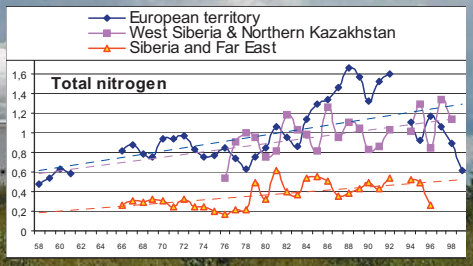

Photographic record of tree decline, Mondy

Policies and Practices Concerning Acid Deposition

Russian national acid deposition monitoring network consists of regional and remote precipitation chemistry and acidity monitoring sites; urban sites, where pollutants concentration in both air and precipitation are measured; and snow monitoring network. Analysis and generalization of monitoring results, their interpretation, and evaluation of the state of the environment according to these data are annually published in a number of issues. The most complete of them is "Review of the state of the environmental pollution in Russian Federation" (Roshydromet).

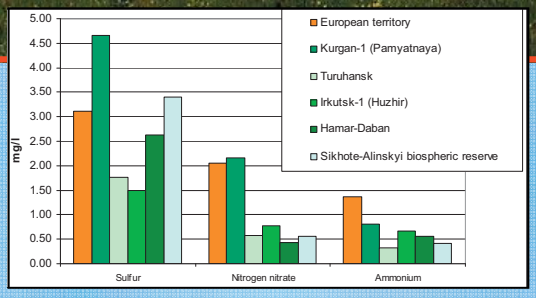
Long term monitoring data obtained from the background monitoring stations over Russia shows that generally for Russia territory there is a tendency for decreasing of sulfur and increasing of nitrogen concentrations. At the same time, sulfur concentration in precipitations of Siberian and Far East background regions stays practically stable and even a bit increases during more than 30 years measurement period.

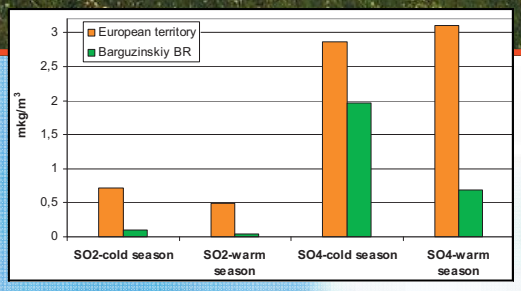




Long-term trends of sulfur (a) and nitrogen (b) concentrations (mg/l) in precipitations over Russian territory.

This analysis is almost based on the data from the background monitoring sites operated over the territory of Russia at the period from the end of 1980s to 2000. Evaluation of a spatial distribution of sulfur and nitrogen compounds both in the air and precipitations shows their maximums over the western part of Russia with a general decreasing toward to the east direction.





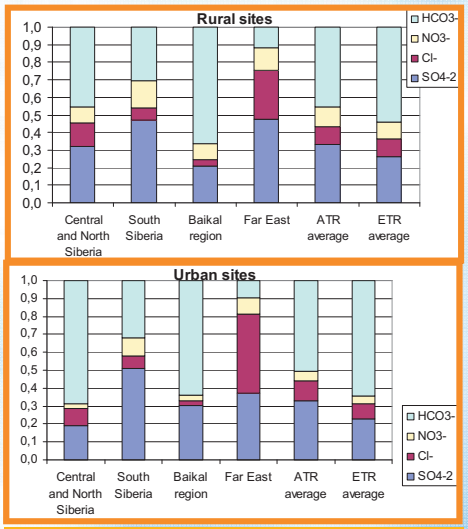
Comparison of European and Asian levels of acid compounds concentrations in air (a) and precipitation (b) in Russia in 1990-2000.

The influence of urban and industrial centers at the territory of Siberia and the Far East region has resulted in increasing of sulfate ion concentration in precipitation and sulfur dioxide concentration in air at urban and regional sites as compared with background level.

Concentration of nitrogen compounds in urban sites is almost the same or 1.5 times higher than in rural ones.

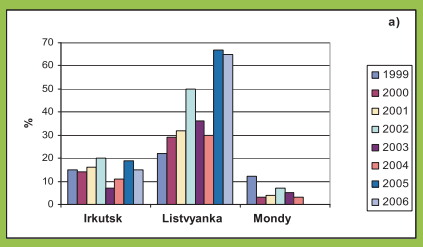
Average annual wet deposition of sulfur, nitrogen and ion sum (t/km² per year)

Regions	$S(SO_4^{2-})$	$N(NO_3^-)$	$N(NH_4^+)$	$\sum N$	M	$S/\sum N$	$N(NH_4)/N(NO_3^-)$
Central and North Siberia	0.36	0.07	0.18	0.24	4.6	1.5	2.6
South Siberia	1.11	0.25	0.34	0.58	8.5	1.9	1.4
Baikal region	0.49	0.14	0.09	0.23	8.8	2.1	0.6
Far East	1.00	0.18	0.23	0.41	9.0	2.4	1.3
ATR average	0.70	0.16	0.20	0.36	7.1	2.0	1.2
ETR average	0.70	0.16	0.30	0.46	10.8	1.5	1.8

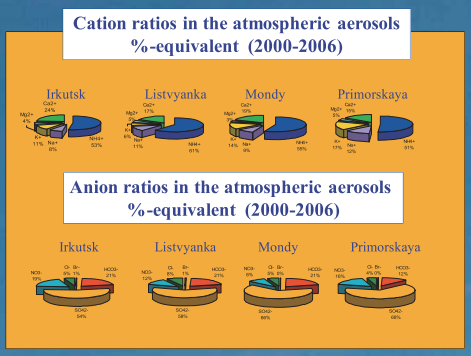


Anions ratio in precipitation of urban and rural sites of the Asian territory of Russia

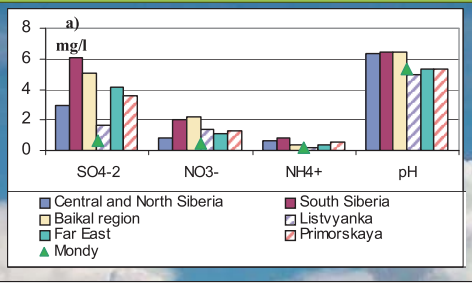
Main Results in Acid Deposition Monitoring

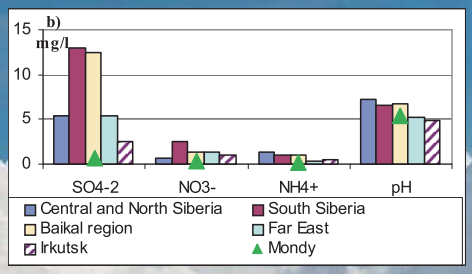


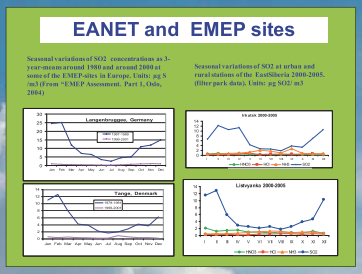
Inter-annual dynamics of the percentage of precipitations with pH < 5.0

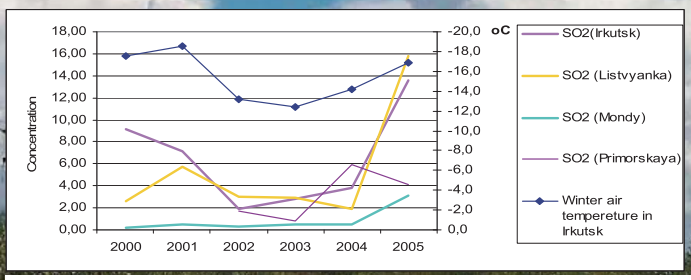


Comparison of average region concentrations of sulfate, nitrate and ammonium ions in precipitations (according to national monitoring network) with background levels (Mondy) and EANET data (Listvyanka, Primorskiy) in 2004 for a) rural and b) urban sites.









Inter-annual variations of the SO_2 concentration at monitoring sites, μg·m^{-3}

At all the monitoring sites, SO_2 predominates among the other small gaseous admixtures in the atmosphere. Its highest content observed in Irkutsk and Listvyanka during cold season when the amount of burning fuel (mostly coal) increases and the atmosphere mixing was low due to anticyclone.

Public Awareness

Special course "Environmental protection" for university students, which includes acid deposition and effects of acid deposition for environment.

Publication "Acid precipitation", 2004 was developed for public awareness and education (EANET, NC, ADORC).

New ecological school in Baikal museum, where special lectures about Acid Deposition were held.

Long-term data on atmosphere parameters obtained at Mondy site allowed to refer this site to a background one. In the future, this site is planned to be used as a global background site for Asian Russia.

Future Activities

The national conference on "Development of Monitoring System of Atmosphere Composition" was held in Moscow on 16-18 2007. Representatives and heads of federal authorities and the World Meteorological Organization, scientists and experts from 48 organizations and 18 departments, as well as representatives of public organizations were presented at this conference. The conference discussed the necessity in creating a modern state monitoring system of atmosphere (SMSA) on the new modern technological basis.

In 1990-2004, the total volume of emission into atmosphere from stationary sources increased in Russia by 5%, while from motor transport – by 20%.

The conference suggested to develop a target state programme for 2009-2015 based on the creation of the integrated monitoring system of atmosphere in Russia which included: 1) ground network of state (federal and territorial), city, regional and global stations; 2) network of correspondent stations belonging to non-governmental structures; 3) mobile stations on railway platforms, planes, balloons and scientific-research ships; 4) space means of observations; 5) calibration centers; 6) archiving centers of complex analysis results and data assimilation with numerical atmosphere models.

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EANET

Acid Deposition Monitoring Network in East Asia

THAILAND

Country efforts and achievements in combating acid deposition

THAILAND

Policies and Practices Concerning Acid Deposition

Institutional Arrangement for Acid Deposition

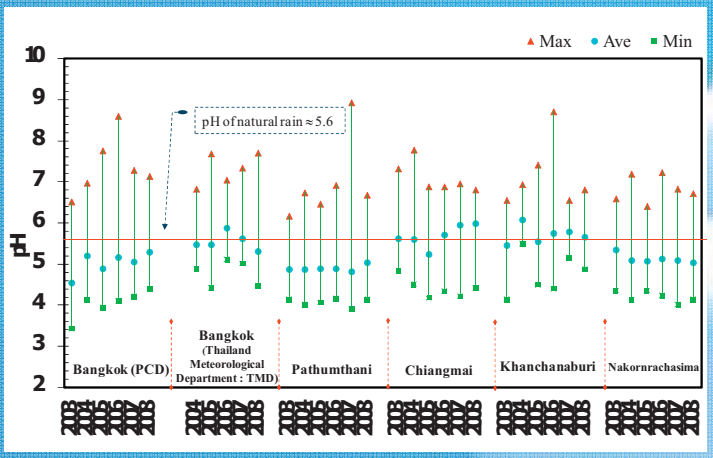
Acid deposition monitoring includes a wide range of activities, such as monitoring of both wet and dry depositions and monitoring of ecological impacts on soil, vegetation and inland aquatic environments which involve various agencies in Thailand. A sub-committee on Acid Deposition Monitoring Network in Thailand was established by the Pollution Control Board to oversee the implementation of acid deposition monitoring activities in Thailand.

The committee chaired by the Deputy Director General of the Pollution Control Department of the Ministry of Natural Resources and Environment is composed of representatives from relevant agencies. The Pollution Control Department (PCD) serves as the secretariat of the committee.

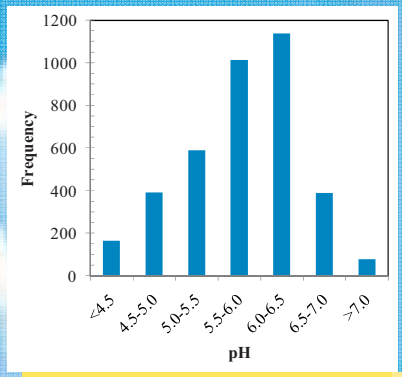
Organization Chart of Sub-committee on Acid Deposition Monitoring Network in Thailand

State of Acid Deposition

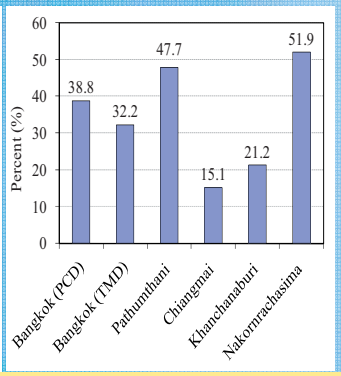
As part of EANET, Thailand had established an acid deposition monitoring program and collaborated with the acid deposition measurement networks across the member countries in the East Asian region. This section summarizes the results from the measurement of wet deposition and its chemical composition during 2001-2008 of 6 EANET



Average pH during 2003-2008

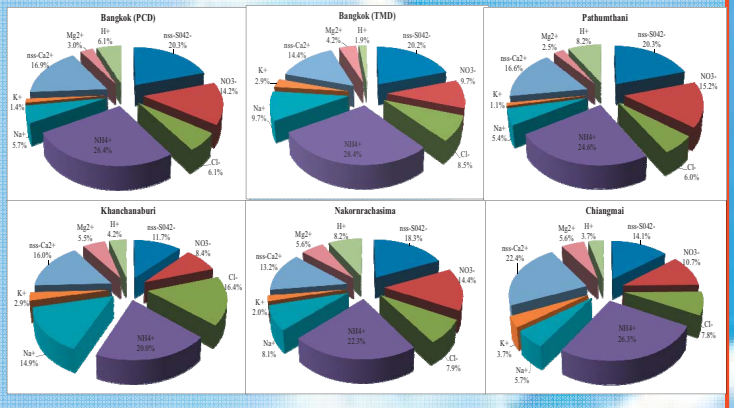


pH distribution of precipitation in Thailand (2001-2008)



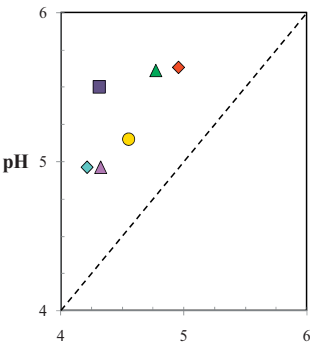
Percentage of pH value <5.6 during 2001-2008

The average pH values during 2003-2008 at each site have no significant changes. The percentage of rainwater samples having pH < 5.6 ranged from 15.1 to 51.9. The fractional contribution of each cation to the total cation concentration indicated that the majority cation found in the rain samples was NH_4^+ at all sites. Among anion, SO_4^{2-} was the most abundant anion at all sites except for Khanchanaburi which Cl^- was the major anion.

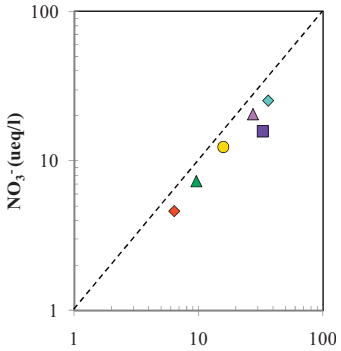


Fractional contribution of ion species during 2001-2008

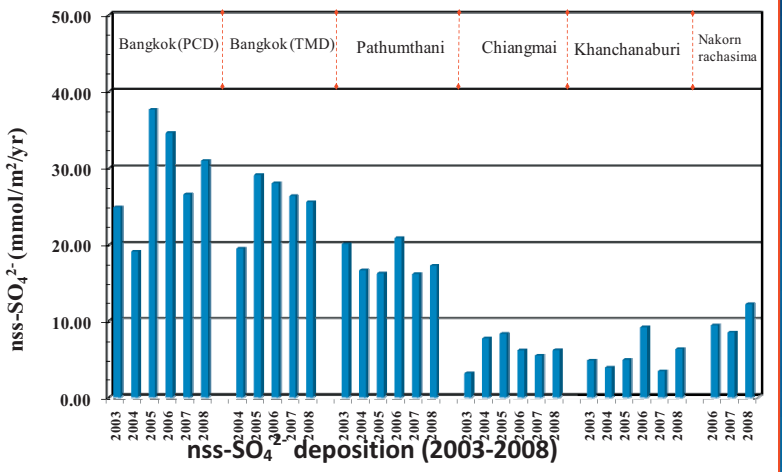
State of Acid Deposition



pH versus pAi values (2001-2008)



nss-SO_4^{2-} versus NO_3^- (2001-2008)



nss-SO_4^{2-} deposition (2003-2008)

The pAi-pH relations provide information on acid and base balance in precipitation. The pH values were always higher than pAi values at all EANET sites in Thailand. The correlation of nss-SO_4^{2-} and NO_3^- indicated that SO_4^{2-} was the major acidifying substances at all sites. The annual mean of nss-SO_4^{2-} deposition of precipitation ranges from 3.2 to 37.6 mmol/m^2/yr which Bangkok (PCD) having the highest deposition.

Air Pollution Management (including acid deposition)

The ambient air quality and emission standards have been established under the Enhancement and Conservation of National Environmental Quality Act, enacted in 1992. The Draft Economic Instruments for Environmental Management Act is being considered by the government. The ambient air quality monitoring system has been well developed. There are many commendable initiatives in combating air pollution and acid deposition which include: pioneering leaded gasoline phase-out in the region; setting up the new laws and stringent emissions standards, resulting in fuel quality and engine specification improvement and large factories moved to cleaner production, energy efficiency and advanced emission control technologies; implementing mass rapid transit systems; approving the National Master Plan on Open Burning Control, implemented since 2004; establishing of environmental and emission standard of VOCs in 2007 and substantially reducing the use of ozone depleting substances. The study to estimate health impact and costs by PM_{10}, the study on Acid Deposition Control Strategy, and the 3rd Country Training Course of EANET have been conducted. On the international level, Thailand has demonstrated its commitment by ratifying the Kyoto and Montreal Protocols as well as ASEAN Agreement on Transboundary Haze Pollution.

Ambient Air Quality Monitoring Network in Thailand (operated by PCD)

National Achievements in Acid Deposition Monitoring

Thailand participated in the preparatory phase of the Acid Deposition Monitoring Network in East Asia (EANET) during 1998-2000 and jointly implemented EANET activities on a regular basis, as adopted at the Second Intergovernmental Meeting held in Japan during October 25-26, 2000. The National Monitoring Plan of Thailand is developed for the EANET by Air Quality and Noise Management Bureau, Pollution Control Department, Ministry of Natural Resources and Environment which has been designated by the Royal Thai Government as the National Center for EANET. There are 6 monitoring sites in Thailand designated for EANET. The monitoring of acid deposition in Thailand are carried out in accordance with EANET guidelines which include sampling and measurement of wet and dry deposition, soil and vegetation and inland aquatic environment.

National Achievements in Air Pollution Monitoring

Monitoring on EANET Program

Items	Measurement parameters	Monitoring interval
Wet deposition	1.pH, 2.EC, 3.NH_4^+ 4.Na^+ , 5.K^+ 6.Ca^{2+} , 7.Mg^{2+} , 8.$SO4^{2-}$, 9.$NO3^-$, 10.Cl^- , 11. Amount of precipitation 12. CH_3COO^-, 13.$HCOO^-$, 14.PO_4^{3-}	daily
Dry deposition - Automatic analyzers - Filter pack	1.SO_2, 2.NO_2, 3.NO, 4.O_3, 5. Particulate Matter (PM-10) 1.HNO_3, 2. SO_2, 3. NH_3, 4. HCl 5. Aerosol	- hourly - every 10 days
Soil	1.pH (H_2O), 2.pH (KCl), 3.exchangeable (Na^+,K^+, Ca^{2+},Mg^{2+}), 4 Exchangeable acidity, 5. ECEC, 6. Moisture content	Once a year
Vegetation	1. observation of tree decline, 2. description of trees	Once a year
Inland aquatic environment	1. water temperature, 2. pH, 3. EC, 4 alkalinity, 5 $NH4^+$, 6. Na^+ , 7. K^+ , 8. Ca^{2+}, 9. Mg^{2+} , 10. $SO4^{2-}$ 11 $NO3^-$, 12. Cl^- ,13. NO_3^- ,PO_4^{3-} , COD, transparency	4 times/year

EANET Monitoring Sites in Thailand

Public awareness activities

To promote the public awareness program on acid deposition problem in Thailand, 3 versions of brochure relating to acid deposition were produced. The workshop on public awareness program on acid deposition in Thailand was held in Bangkok in July 2000 to disseminate the technical information related to the problems as well as state of acid deposition activities in Thailand. PCD produced 500 copies of video-CD entitle "Transboundary Acid Deposition" in 2006. They have been distributed to concerned agencies in order to publicize the knowledge on acid deposition. From 2007, the project to enhance environmental education activities on acid deposition problems has been carried out at Wat Samaedam School in Bangkok and the activities are expanded to Wathuaypong School in Rayong Province in 2009. The environmental education program relating to acid deposition has also been implemented along with the Rayong Province Environmental Protection Volunteer Program. Rayong is known as the province of industries and facing pollution problems.

Future Activities

Monitoring activities/research : Enhancement of the knowledge development for the abilities and skills on sampling and analysis of acid deposition samples; Set up new EANET monitoring sites in Thailand particularly in remote area by upgrading the national monitoring sites; and Promotion of research activity on carrying capacity, particularly in industrial area.

Regulation/legislation : Enforcement of monitor and control regulation on the major emission sources of SO_2 and NO_x such as the installation of CEMs system; and Improvement of fuel quality and engine specification through a combination of new laws and regulations and imposed the higher emissions standards for new and in-use vehicles.

Action plan : Further development of strategy and action plan for air quality management in Thailand include: monitoring, source inventory, open burning control, emission control as well as broadening public awareness and participation program.

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EANET

Acid Deposition Monitoring Network in East Asia

VIETNAM

Country efforts and achievements in combating acid deposition

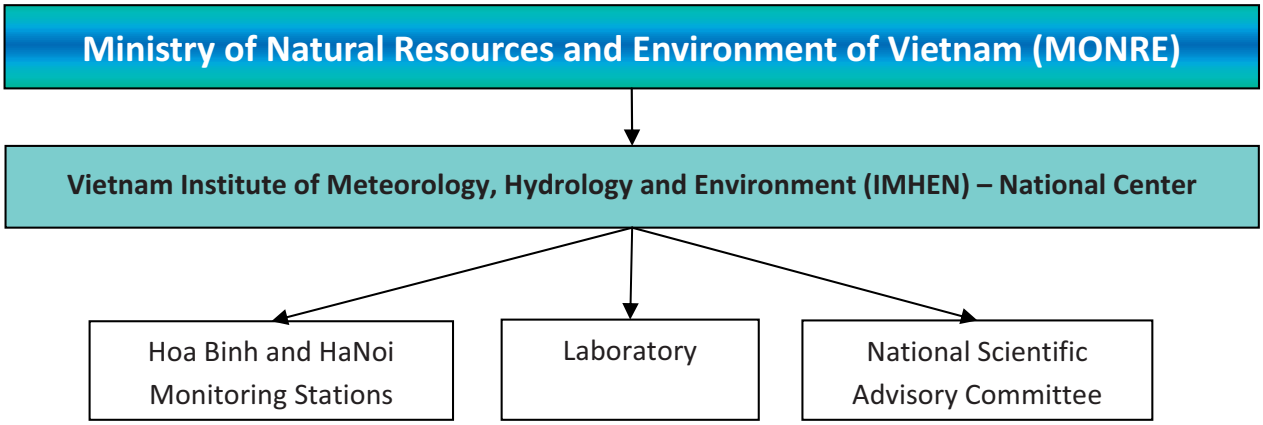
VIETNAM

Policies and Practices Concerning Acid Deposition

Institutional Arrangement for Acid Deposition Monitoring

Vietnam has three systems of national sites for Acid Deposition Monitoring:

- Vietnam Environment Protection Agency (VEPA) system: acid rain monitoring sites;
- Hydro-Meteorology National Center system: 22 acid rain monitoring sites (6 automatic sites for air and rain; 16 for acid rain monitoring sites); and
- EANET system acid deposition monitoring sites.



State of Acid Deposition (National)

Dry deposition monitoring results in 2007

Gas Concentration at Ha Noi site (µg/m^3)				
Parameter	**SO_2**	**HNO_3**	**HCl**	**NH_3**
Max	10.61	6.82	6.43	4.68
Min	1.29	0.60	1.61	1.02
Average	4.54	2.55	3.80	2.95

Gas Concentration at Hoa Binh site (µg/m^3)				
Parameter	**SO_2**	**HNO_3**	**HCl**	**NH_3**
Max	7.45	3.19	23.79	2.35
Min	0.60	0.01	1.02	0.88
Average	3.26	1.03	3.51	1.64

Ionic Concentration in particle at Ha Noi site (µg/m^3)			
Parameter	**Max**	**Min**	**Average**
SO_4^{2-}	93.2	0.38	20.5
NO_3^-	30.8	0.14	6.27
Cl^-	18.1	0.10	2.78
NH_4^+	21.9	0.28	4.04
Na^+	9.55	0.02	1.62
K^+	11.1	0.10	2.10
Mg^{2+}	1.63	0.02	0.43
Ca^{2+}	21.0	0.37	7.56

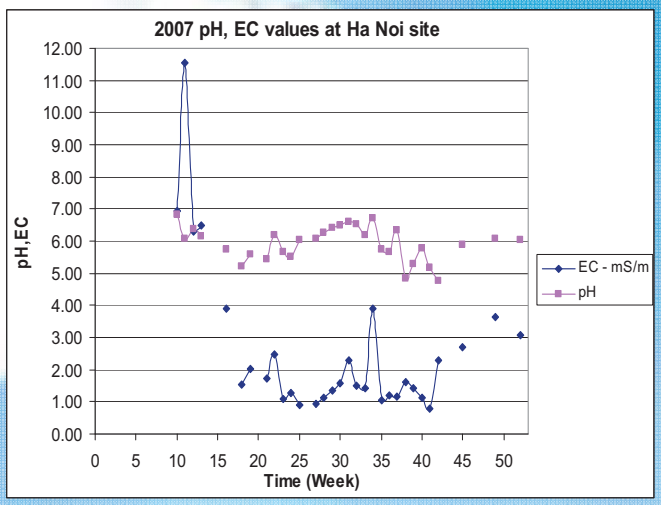
Ionic Concentration in particle at Hoa Binh site (µg/m^3)			
Parameter	**Max**	**Min**	**Average**
SO_4^{2-}	28.1	0.06	8.35
NO_3^-	5.97	0.02	1.49
Cl^-	8.28	0.03	0.60
NH_4^+	7.66	0.10	2.26
Na^+	1.17	N.D	0.29
K^+	5.40	N.D	1.45
Mg^{2+}	0.51	N.D	0.16
Ca^{2+}	11.9	0.01	2.22

Legend: N.D: Non determination;

Wet deposition monitoring results in 2007

Ionic Concentration at Ha Noi site (µmol/l)			
Parameter	**Max**	**Min**	**Average**
SO_4^{2-}	274.8	13.2	57.2
NO_3^-	147.2	4.9	29.5
Cl^-	85.0	3.5	18.8
F^-	24.1	1.5	7.7
NH_4^+	457.6	13.8	91.2
Na^+	81.3	1.2	16.1
K^+	12.9	1.0	4.1
Mg^{2+}	86.5	6.2	25.4
Ca^{2+}	39.0	1.4	6.8

Ionic Concentration at Hoa Binh site (µmol/l)			
Parameter	**Max**	**Min**	**Average**
SO_4^{2-}	194.7	7.2	31.5
NO_3^-	146.0	3.5	21.8
Cl^-	28.6	2.3	7.9
F^-	26.4	0.9	4.7
NH_4^+	206.2	8.3	41.7
Na^+	29.1	0.2	4.2
K^+	23.9	ND	4.3
Mg^{2+}	147.4	1.5	18.8
Ca^{2+}	34.5	0.9	4.4



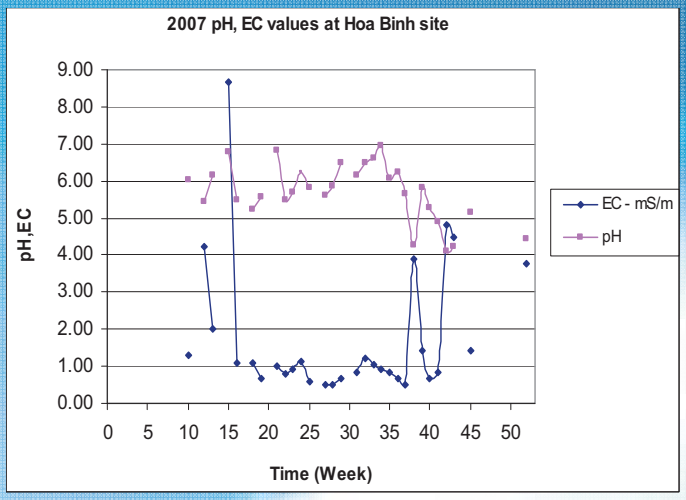
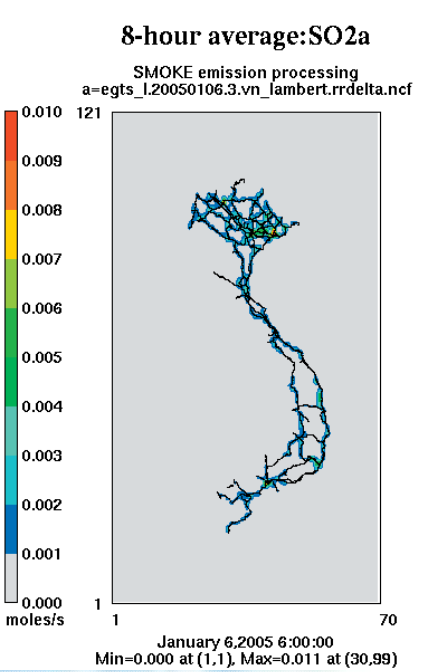


Figure 1. pH and EC values at Hanoi site and Hoa Binh site

To reduce emissions of air pollutants, the following measures should be implemented:

- Fuel switching with less polluted fuel;
- Diffusion of cleaner technologies such as free-CFC technologies, advanced emission control technologies, etc.;
- Afforestation (134, 135 projects); and
- Authorities have to take responsibilities from institutional to local level.



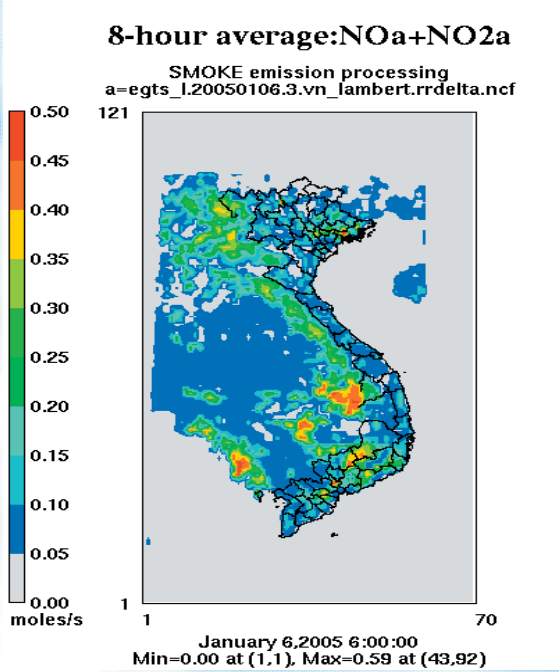


Figure 2. Distribution of SO_2 and NO_x

National Achievements

Monitoring of acid deposition and related air pollution

- Well equipped acid pollutant monitoring facilities;
- Enhanced capacities in monitoring and assessing acid deposition;
- Observed the trace of acid rain in Lao Cai, Nam Dinh, Tra Vinh, Binh Duong, Dong Thap provinces and Ho Chi Minh City, then proposed mitigation measures to reduce acid pollutant emission; and
- Periodic assessment on status of acid deposition in Vietnam.

Research/joint programs

Presenting scientific research results in scientific workshops related to acid deposition in particular and to air pollution/ emission in urban area and proposed mitigation measures in general. There are some researches/projects conducted by IMHEN as follows:

- Emission inventory project in Vietnam supported by Taiwan University;
- Primary research on short-term air quality forecast for Northern Delta was completed in October, 2006; and
- Developing newsletter on air quality forecast of key economic zones will be finished in 2009, etc.

Public Awareness

- Producing VCD on acid deposition problems cooperated with Vietnam Television;
- Developing a brochure on acid deposition containing origin, detection and abatement of the damage of acid deposition intended for school children and non-scientists;
- Organizing a workshop to disseminate the brochure to representatives of schools, universities, institutions and officers:
  - Public awareness enhancement on environment;
  - Environmental education in high school system;
  - Environmental education in universities; and
  - Environmental education in the universities of Ministry of Defence, Ministry of the Interior and People committee, etc.

Future Activities

Monitoring/research

- Institutional framework for Environmental education and public awareness raising;
- Research results related to acid deposition by EANET and other organizations/scientists; and
- Some experiences in conducting actions/activities of environmental education regarding to acid deposition, etc.

Action plan

- Recommendations on the activities to promote the awareness in general public and environmental education in school children in Vietnam;
- Cooperation with organizations/projects in order to integrate and implement activities; and
- Calling investment, etc.

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