Second Report for Policy Makers

CLEAN AIR FOR A SUSTAINABLE FUTURE

Secretariat and Network Center

Acid Deposition Monitoring Network in East Asia (EANET)

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ADORC

This report has been prepared on the basis of the available reports, scientific data from EANET, and it is also supplemented with information obtained from various sources, which are duly acknowledged. The contents of the report do not necessarily reflect the views, policies or opinions of any participating country and organization.

PREFACE

This Report for Policy Makers on Acid Deposition in East Asia is produced by the Secretariat for Acid Deposition Monitoring Network in East Asia (EANET) in collaboration with the Network Center for EANET (NC) on the basis of the available reports and scientific data from EANET, and is supplemented with information obtained from various duly acknowledged sources.

This is the Second Report for Policy Makers on EANET. The first report was published in November 2005, aimed at policy makers and geared towards attaining better air quality management; strengthening awareness and knowledge on the inter-linkages of acid deposition and air pollution with other environmental problems and issues; and promoting timely action by integrating prevention and mitigation of air pollution and acid deposition.

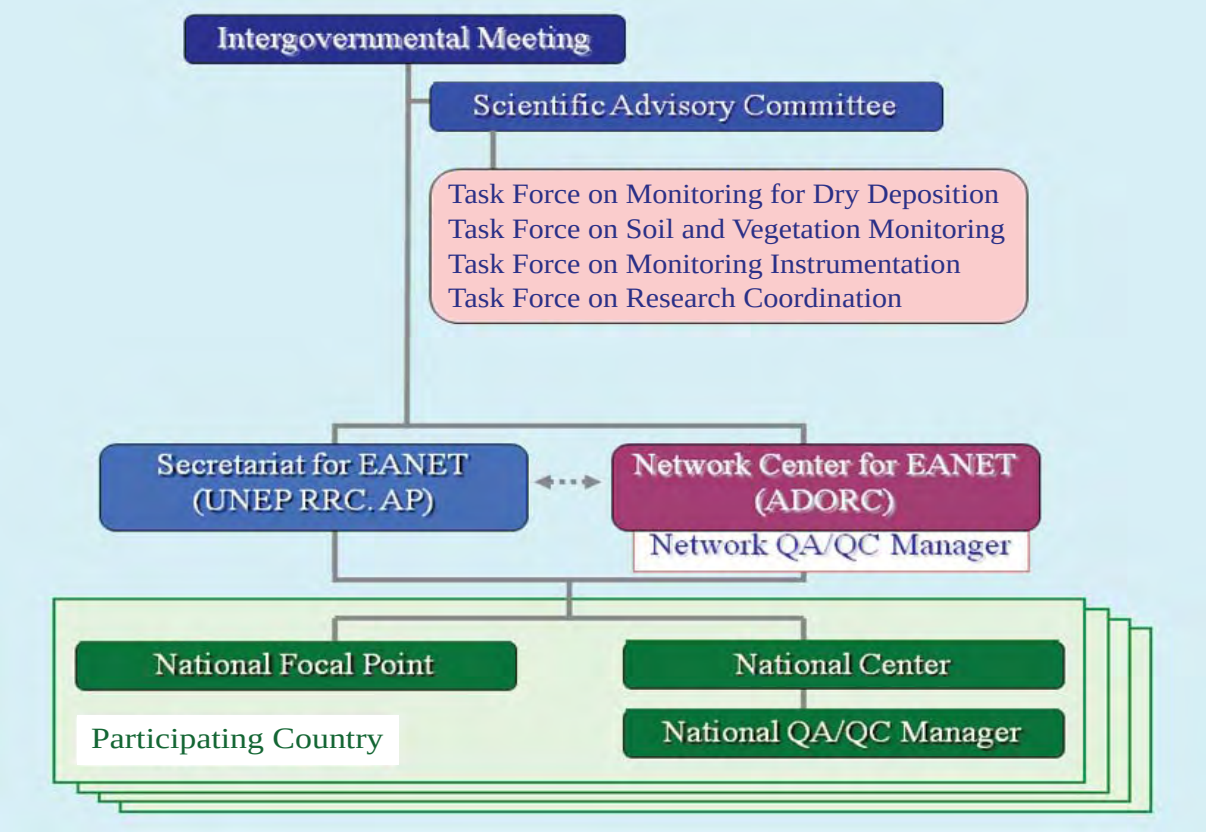
The report is integrated and structured to build linkages between the EANET community and the relevant policy framework of participating countries, and addresses acid deposition problems including descriptions of the current and actual situation of air pollution and its adverse effects to the environment and ecosystems in East Asia.

ACID DEPOSITION MONITORING NETWORK IN EAST ASIA (EANET)

EANET is an intergovernmental initiative to address the problem of acid deposition in East Asia through regional cooperation. It has three objectives:

- To create a common understanding of the state of the acid deposition problems in East Asia;
- To provide useful inputs for decision-making at local, national and regional levels aimed at preventing or reducing adverse impacts on the environment caused by acid deposition; and
- To contribute to cooperation on the issues related to acid deposition among the participating countries.

The current thirteen participating countries are Cambodia, China, Indonesia, Japan, Lao PDR, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Russia, Thailand and Viet Nam.



Organizational Structure of EANET

As the institutional framework for EANET, the Intergovernmental Meeting (IG) is the decision-making body of EANET. The Scientific Advisory Committee (SAC) was established under the Intergovernmental Meeting, and the Secretariat and the Network Center were designated to support the network. Several Task Forces and Expert Groups were established under the SAC. These organizations promote the network activities in close communication, coordination and collaboration with the National Focal Points, National Centers and National Quality Assurance/Quality Control (QA/QC) Managers in the participating countries.

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EXECUTIVE SUMMARY

The acid deposition phenomenon, although scientifically understood, is not yet generally known to the public. Industries, agriculture, transportation, and forest and land fires emit large quantities of pollutants (sulfur and nitrogen oxides, particulates, and ammonia), which through atmospheric chemical reactions produce acids and other toxic compounds that harm human health and the environment. Sulfuric and nitric acids were identified as the major acidifying species. Some sites in several northern parts of East Asia receive high depositions of sulfate and nitrate ions due to high emissions, while some sites in Southeast Asia receive high depositions mainly due to the heavy precipitation. Large amounts of nitrate ions were also detected at the urban sites of Southeast Asia. Large deposition fluxes of ammonium ions were observed in certain parts of Northeast Asia followed by Southeast Asia.

EANET is an innovative regional response to this pressing global problem, and through its participating countries, EANET acts locally in coordination with regional partners. EANET's major activities which include: monitoring, training and education, research, and public awareness and communication/ information sharing have proven to yield useful results. Some of the major achievements of participating countries in the recent years are highlighted in this report. But while a lot has been achieved, much more still need to be done possibly including improvements in monitoring and data quality, addition of new monitoring sites, expanding the scope of monitoring to include other important pollutants, adopting a common procedure for estimating dry deposition flux, developing emission inventories, application of modeling, and strengthening of EANET's institutional framework.

There might be a need to address the air pollution problem in an integrated fashion and to develop policies to prevent and reduce air pollution that are based on scientific knowledge and evidences. Policy makers could be abreast of the critical issues in order to design and decide on appropriate policy options: technological, regulatory, economic, and capacity building. These policy options include measures on alternative energy sources, combustion efficiency, exhaust technology efficiency, catalytic converters and alternative fuels for motor vehicle, air quality standards, financial incentives or disincentives, and human and institutional capacity building. Some of these policies are applied and highlighted in the country achievements portion of this report.

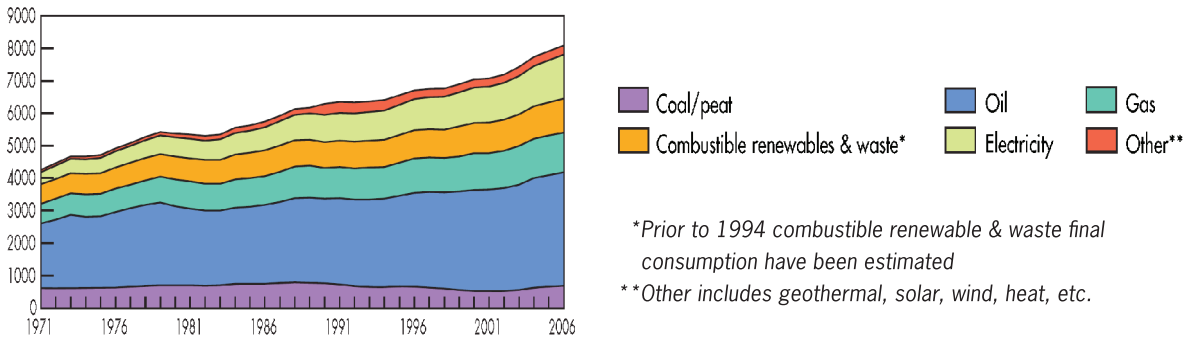
It is important to learn from the experiences of other participating countries, and in this regard EANET can provide an effective platform on which data and information are shared, and strategies, tactics and policy options are discussed while appropriate actions that commensurate with local conditions are taken by national authorities. Addressing the issue of acid deposition needs to be done in the context of the whole sustainability notion, which is based on a holistic approach to sustainable development, explicitly recognizing its three pillars which include: Environment, Economy and Society. It is imperative that EANET has the necessary means and support to realize its noble cause and attain its aspirations. EANET is an important intergovernmental initiative and an alliance for regional cooperation. Every participating country has an obligation to make EANET strong and prosper to better address its mission.

1 STATE OF AIR ENVIRONMENT GLOBALLY AND IN EAST ASIA

1.1 Serious air pollution problems affecting countries in East Asia

Air, water, land and biodiversity in ecosystems are essential for supporting human life on the planet Earth. But ironically though, the ability and capacity of these systems to support human existence have been imperiled by humans themselves through economic activities. There is evidence of unprecedented environmental changes at the global and regional levels, and these changes have major implications on human well-being, locally.

Figure 1(a) shows increasing trends of world energy consumption based on type of fuel and Figures 1(b) and 1(c) show modeled annual trend of emissions of nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs) in Asia. It is believed that anthropogenic emissions of air pollutants in East Asia are the causes of many serious air pollution problems experienced by countries. The situation is serious in that unless the fossil-based fuel consumptions and their environmental aftermath are curtailed, the damage they cause to human health and the environment will continue and become more serious in the decades to come.



*Prior to 1994 combustible renewable & waste final consumption have been estimated

**Other includes geothermal, solar, wind, heat, etc.

Figure 1(a). World total energy consumption in million tonne of oil equivalent, by fuel

(Source: International Energy Agency (IEA), Key World Energy Statistics 2008)

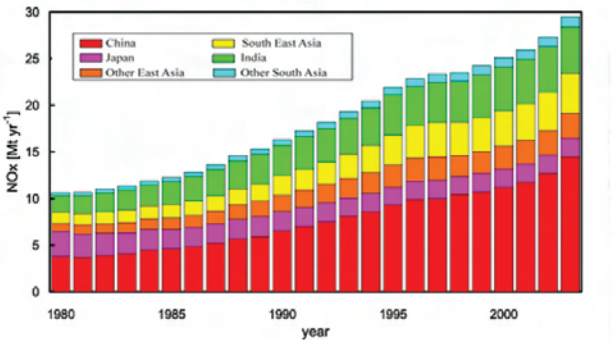


Figure 1(b). Trend of NOx emissions in Asia (1980-2003)

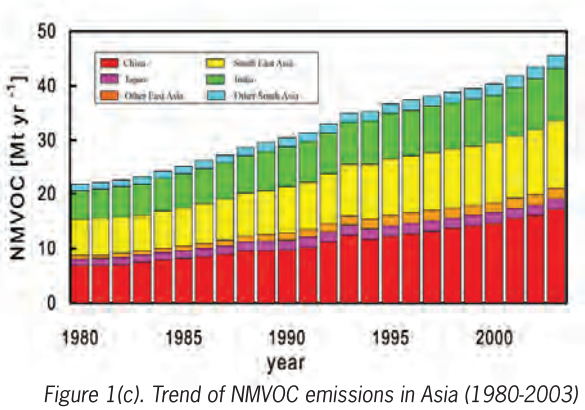


Figure 1(c). Trend of NMVOC emissions in Asia (1980-2003)

Source: Ohara et al. Atmospheric Chemistry and Physics, Vol.7 (2007) (modeled results)

1.2 Transboundary nature of air pollution

Understanding how pollutants are generated, transported and transformed in the atmosphere as they move from their source to locations where their effects are observed, is the key to air quality management. Major air pollutants, those gases or particles emitted from sources directly, which, are prevalent in East Asia are sulfur dioxide (SO_2), NO_x, particulate matter (PM), volatile organic compounds (VOCs), carbon monoxide (CO), and toxic elements (e.g. lead (Pb), fluorine (F), mercury (Hg)). Secondary pollutants, those gases or particles formed by atmospheric reactions of precursor or primary emissions are surface ozone (O_3) and photochemical oxidants, which are also prevalent in East Asia. Figure 2 shows the general relationships among sources, pollutants, effects and receptors for the air pollution problems.

The sources that produce SO_2, NO_x and ammonia (NH_3) that are responsible for acidification, also produce fine particulates, carbon dioxide (CO_2) and other toxic chemicals such as heavy metals that are linked to poor visibility, formation of regional haze, smog and global warming issues. Nitrogen is a major driver of biodiversity loss and has the potential to change plant community composition. It is also a precursor pollutant for the formation of tropospheric (surface) ozone, in the presence of VOCs. The final receptors of these effects are common.

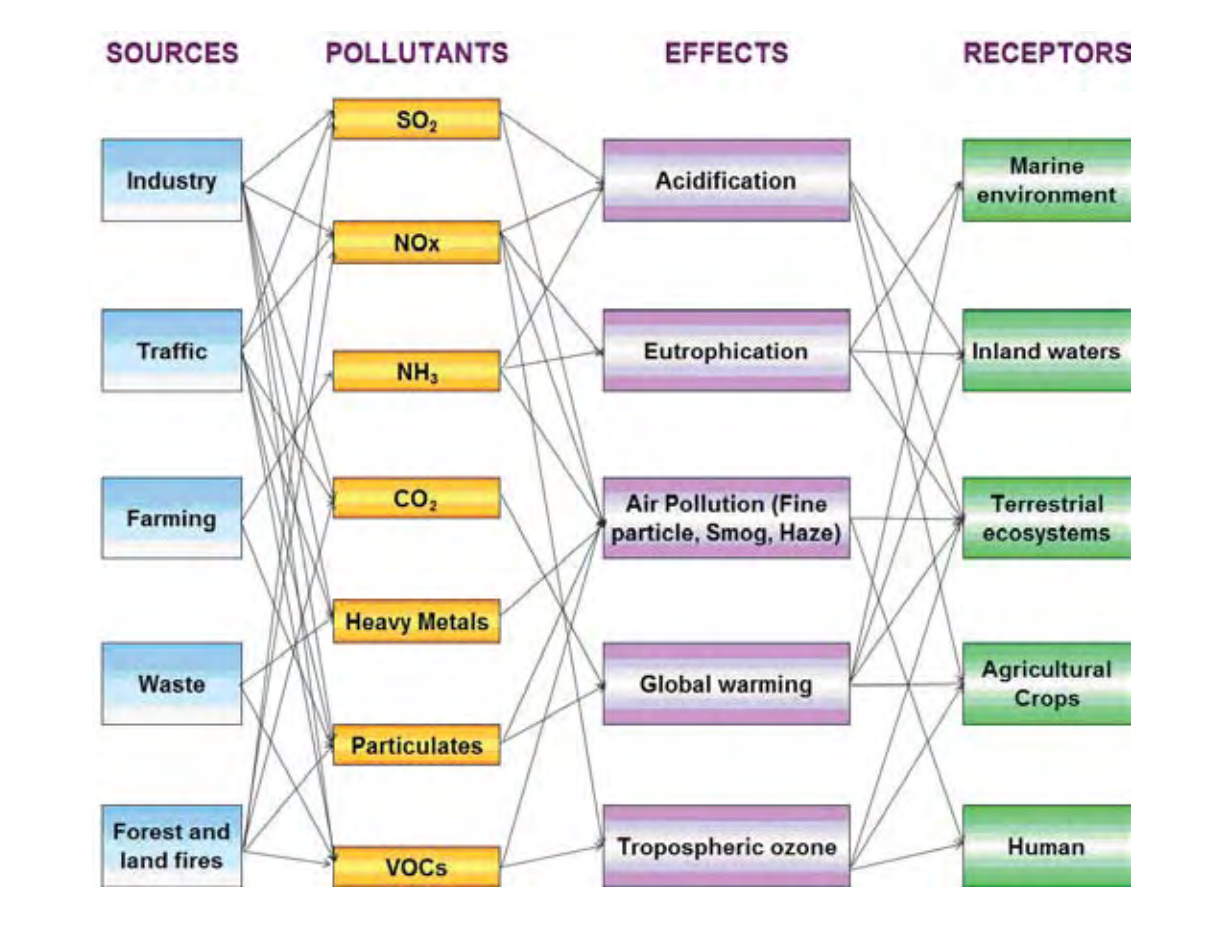


Figure 2. Sources, compounds, effects and receptors for the regional air pollution problems

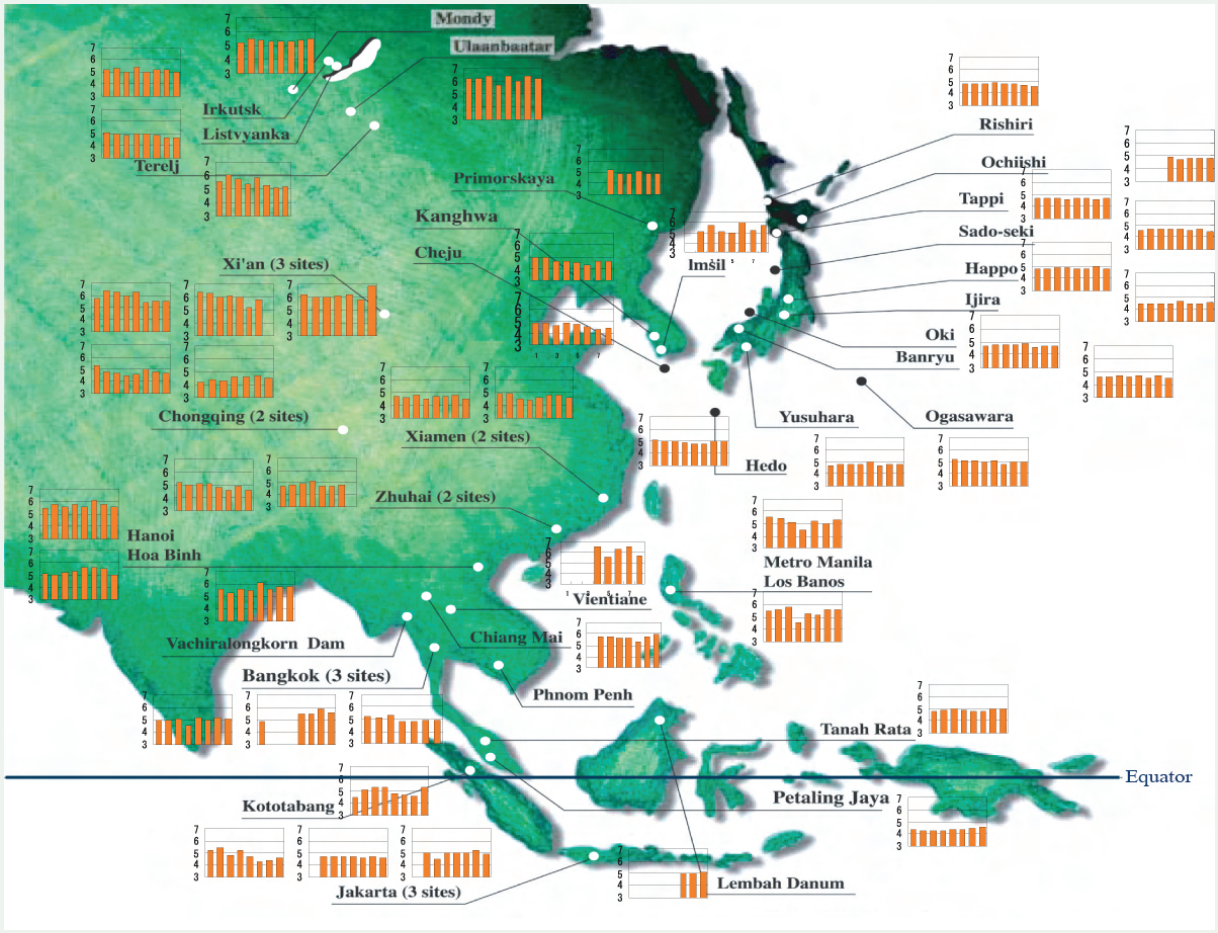


Figure 3. Trend of annual pH of precipitation (2000-2007)

1.3 State of acid deposition in East Asia

East Asia is vast and characterized by considerable contrasts and differences. The regional geography and climatology have a substantial influence on the spatial and temporal distribution of acid deposition. Precipitation in the entire region is influenced by the Asian monsoon, which causes alternating dry and rainy seasons in the subtropical and temperate regions. Tropical cyclones and typhoons also deliver a large amount of precipitation to these regions, mainly in summer and autumn.

Atmospheric deposition consists of both wet and dry deposition. In wet deposition, sulfuric acid and nitric acid were identified as the major acidifying species. Figure 3 shows the trend of annual pH of precipitation (2000-2007) at the monitoring sites in EANET countries. The lowest pH values observed were comparable with those in Europe and North America. Figure 4 shows the average of the annual values of wet deposition of sulfate and nitrate ions from 2000 to 2007 at the same sites. Some sites in China receive high deposition of sulfate ions with relatively low precipitation amounts. High deposition of sulfate ion was also detected at several sites in Japan, Indonesia, Malaysia and the Philippines, but this was mainly due to the large amounts of precipitation. Large amounts of nitrate ions are deposited at the urban sites of Southeast Asia. Their annual deposition rates ranged widely reflecting the difference in precipitation in the region. The lowest levels of deposition were at remote sites in Mongolia, Russia, Thailand and Japan, due to either low atmospheric concentrations or low precipitation levels.

The annual deposition rates of ammonium ions varied widely depending on the precipitation rate. Large deposition fluxes were observed in the northern part of China due to their high concentrations in soil dust, followed by Southeast Asia, while low deposition rates were observed at sites in Russia and Japan.

The amount of dry deposition is generally considered to be about the same level as that of wet deposition although it sometimes exceeds wet deposition levels, for example in arid and semi-arid areas. Air concentrations of sulfur dioxide ranged widely with higher concentrations found in or near the urban areas. The concentrations of gaseous nitric acid and nitrate particles were also higher at rural and urban areas than at remote sites.

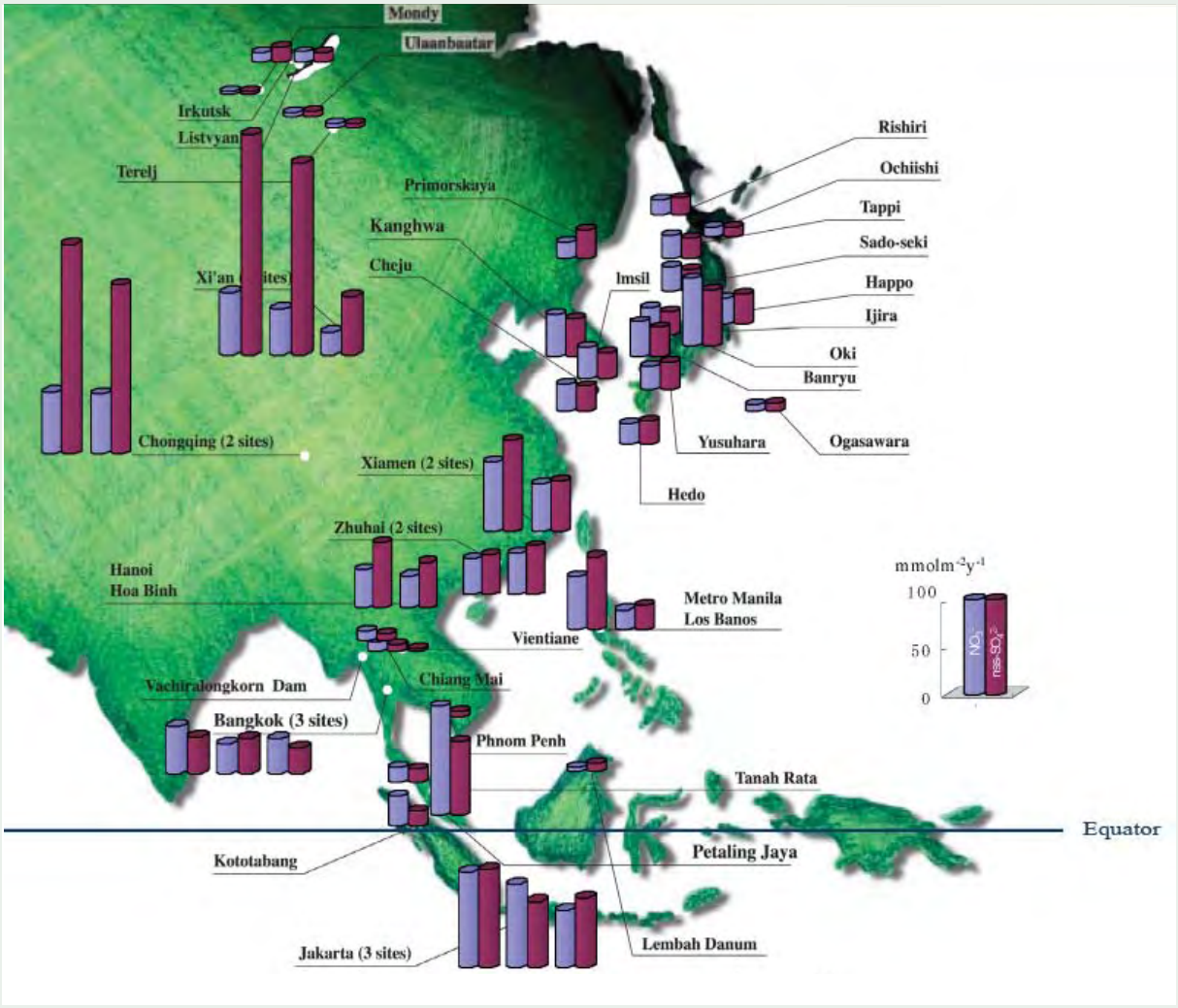


Figure 4. Distribution of average annual wet deposition of nss-SO_4^{2-} and NO_3^- for 2000-2007

2 THE ACID DEPOSITION PHENOMENA AND THEIR EFFECTS

2.1 The phenomena

Sulfur and nitrogen oxides are emitted into the atmosphere with other pollutants during combustion of fossil fuels (oil, coal, etc.) by industries and power plants as well as in engines of motor vehicles. These gases are transformed by chemical reactions with air constituents into sulfuric and nitric acids which come down to the surface of the earth far from the emission sources. The acid deposition phenomena are realized in two types of processes as shown in Figure 5. One process is “wet deposition” when acids are taken by cloud waters and brought down to land and water bodies with rain, snow or fog. The large amount of dissolved acids causes the strong acidity of precipitation commonly known as “acid rain”. By another process called “dry deposition”, airborne acids are removed from the air during fine and cloudy days. They pass through air to the ground and deposit on water bodies, grasses, trees, buildings, and even inhaled into the human respiratory system causing health problem.

Although ammonia, emitted from fertilizers and livestock, does not fall under the criteria as an air pollutant affecting human health, it reacts with nitric and sulfuric acids in the atmosphere to form fine particulate matter through the process of neutralization. After deposition on the ground, ammonium compounds are oxidized into nitrate in soil and produces acid. Moreover, excess nitrogen loads by nitrate and ammonium disturb the nutrient cycles of ecosystems.

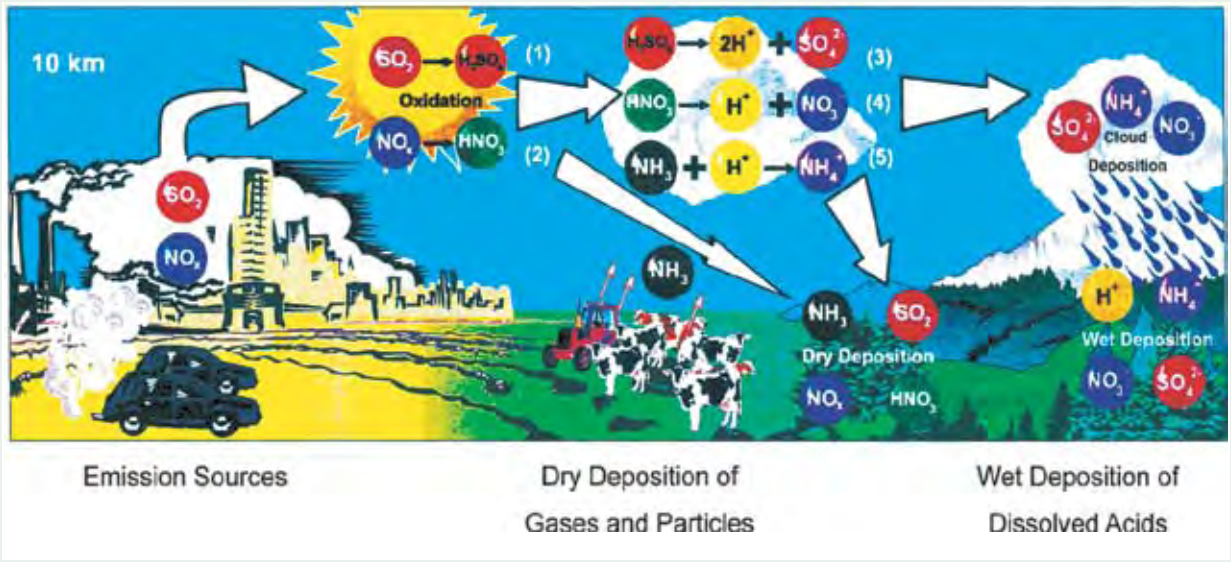


Figure 5. Acid deposition process

2.2 Effects of acid deposition and related air pollution

Impacts on Human Health

More than 2 million people die prematurely each year due to air pollution. The most important air pollutant from a disease perspective is fine particulate matter. The World Health Organization (WHO) estimated that particulates in urban areas worldwide cause about 2 per cent of mortality from cardiopulmonary disease in adults, 5 per cent of mortality from cancers of the trachea, bronchus and lung, and about 1 per cent of mortality from acute respiratory infections in children, amounting to about 1 per cent of premature deaths in the world each year (WHO 2002). Exposure to fine particulate matter in ambient air has been linked to a number of health problems including transient changes in the respiratory tract and impairment of pulmonary function, increased risk of symptoms requiring hospital treatment, and increased risk of death from cardiovascular and respiratory diseases or lung cancer. People with pre-existing heart and lung diseases, asthmatics, socially disadvantaged and poorly educated people, elderly and children belong to the more vulnerable groups.

Ground level ozone relates to health threat. The strong oxidizing action causes a variety of damage to living cells. Most common symptoms are acute effects - stinging of the eyes, tears, sore throat and coughing due to irritation of the mucous membranes of eyes, nose and throat.

Impacts on Ecosystems

Acidic bedrock areas with poor buffering capacity are particularly susceptible to soil acidification which could lead to acidification of rivers and lakes and the so-called acid shock during the snow melting season. Since East Asia is a vast region of diversity, it has various types of vegetation, depending on the varied climates – tropical rainforest, tropical seasonal forest, temperate evergreen forest, temperate deciduous forest, sub-arctic taiga (boreal) forest, and sub-alpine needle-leaved trees. Decline of tree conditions have been observed in some forests in some countries. The causes of tree decline are still being investigated to determine whether it is due to natural factors or air pollutants or their combined effects.

High ozone concentrations are known to have harmful effects on vegetations, including trees and crops. Reduction of growth rates and visible injury of leaves are known to occur from exposure to high concentrations of ozone. If ozone concentrations continue to increase in the region, the yield loss of important agricultural crops such as wheat, soybean, cotton etc. which are sensitive to ozone will be significant.

The harmful effects of acid deposition on fish populations and other aquatic organisms are well known from the experiences of Europe and North America. These effects vary depending on their acid sensitivity. Acidification of rivers in mountainous areas has been reported in a certain area in East Asia.

Impacts on Cultural Heritage and Building Structures

The effects of acidification on cultural heritage and building structure are important since East Asian countries are famous for their historical built environments and buildings. The effects of wind and weather naturally mean that all materials will decay sooner or later, but air pollution speeds up this process.

Objects made of limestone and some types of sandstone are especially vulnerable to acid substances. Acid can corrode materials such as marble, concrete, bronze, etc. An example of the damage due to acid deposition is shown in Figure 6.

Figure 6. Impact on statue at Ueno Park, Tokyo (Provided by Mr. Takeo Kadokura)

3 NEED FOR REGIONAL COOPERATION TO COMBAT ACID DEPOSITION PROBLEMS

3.1 Response of EANET

EANET was formed as an innovative regional response to the immediate need for action to address acid deposition issues, with a far-reaching vision to create a clean and sustainable air environment in East Asia.

3.2 Major activities of EANET

EANET addresses the acid deposition issues in an integrated approach embarking on the following major activities:

Monitoring

The monitoring of wet deposition, dry deposition, inland aquatic environments, and soil and vegetation under EANET is conducted following a set of monitoring guidelines and technical manuals. The recommended monitoring parameters are:

- Wet deposition (rainwater): Rainwater acidity and concentrations of ions due to acids and bases
- Dry deposition (air concentration): Air concentrations of gaseous and particulate forms of acidic and basic compounds as well as ozone
- Soil and vegetation (in forest areas): Chemical and physical properties of soil, forest vegetation characteristics, and condition of tree decline
- Inland aquatic environments (lake and river water): Concentrations of ions, alkalinity, and some chemical and biological parameters

Monitoring sites are classified as either acid deposition monitoring sites or ecological survey sites. The number of sites in the network has increased from 42 acid deposition monitoring sites in 2001 (the start of the regular EANET monitoring activities) to 56 sites (21 urban, 12 rural, and 23 remote sites) in 2009 (Figure 7). As a result of the coordinated efforts of EANET participating countries, monitoring of soil and forest vegetation is now being conducted in 28 forests in 20 areas, and monitoring of inland aquatic environments is being done in 12 lakes and 6 rivers.

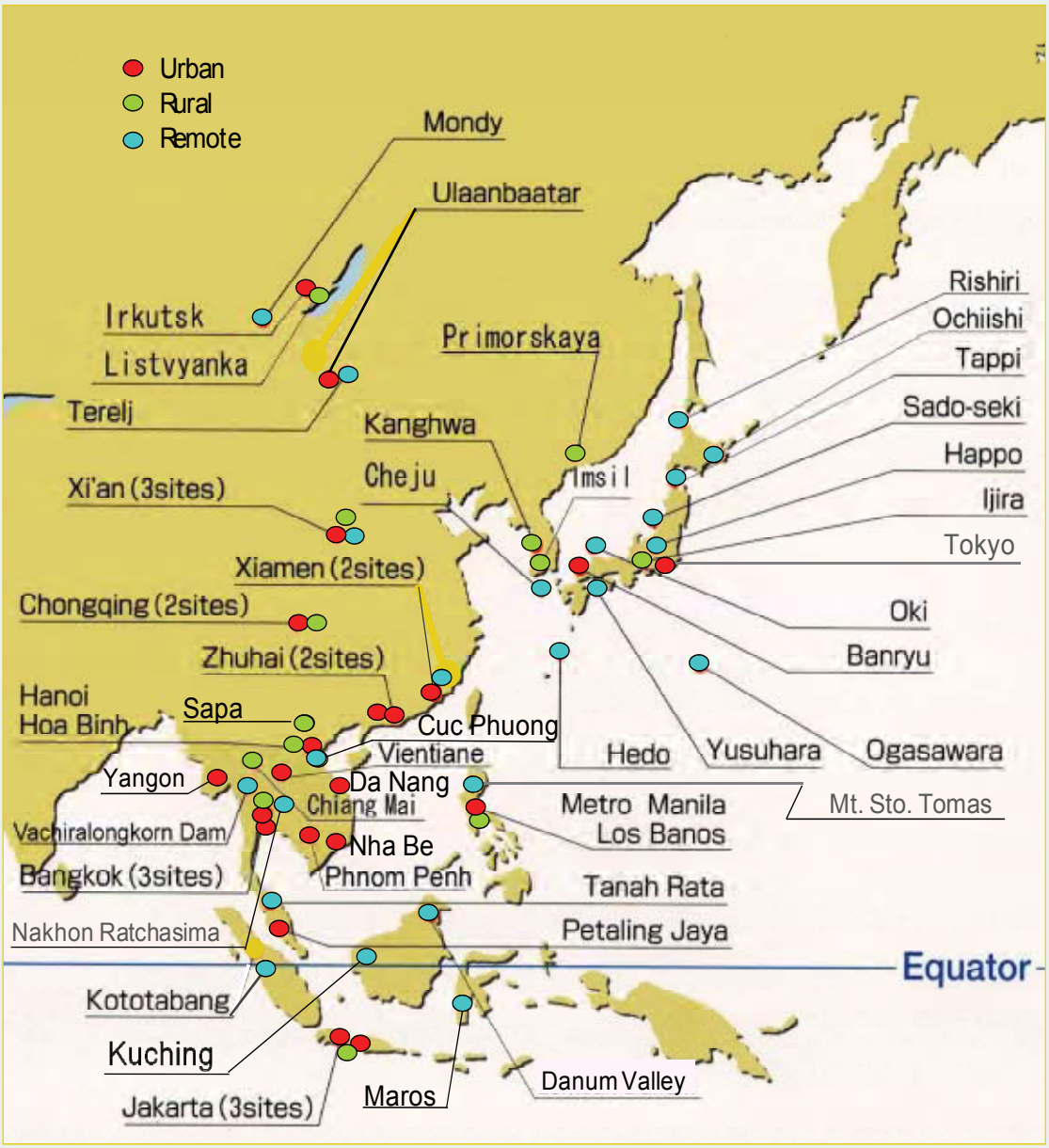


Figure 7. EANET acid deposition monitoring sites as of 2009

Quality assurance and quality control (QA/QC) activities are conducted according to the QA/QC program of EANET with the objective of obtaining reliable data that are comparable among the countries of the East Asian region by ensuring data accuracy, precision, representativeness, and completeness in acid deposition monitoring. The national monitoring centers and the analytical laboratories of the participating countries execute various QA/QC activities, including developing national QA/QC programs, and Standard Operating Procedures (SOPs). Inter-laboratory comparison projects are conducted by the Network Center annually, involving the analytical laboratories in the participating countries.

Capacity Building

Various kinds of training and education programs have been implemented by EANET to build capacity to address acid deposition problems. Altogether a total of 57 individuals from the participating countries have received training on acid deposition monitoring at the Network Center. In addition, EANET had utilized various training and technical assistance programs implemented by donor organizations such as Japan International Cooperation Agency (JICA) to provide further training to the participating countries. EANET dispatched technical missions annually to participating countries to provide advice and assistance in their monitoring activities.

Public Awareness Raising

Awareness about acid deposition among the general public, including school children and teachers, has been addressed through a number of activities supported by EANET. A special report for policy makers titled "Goals, Achievements and Way Forward" was prepared in 2005. EANET has undertaken joint projects with participating countries to develop brochures and videos on acid deposition in the national languages and conducted environmental education programs for school children. EANET has also organized workshops on Public Awareness on Acid Deposition Problems in the participating countries.

The EANET website includes the monitoring results, meeting reports, scientific publications and other useful information. An e-learning program on acid deposition problems is also available on the website for environmental education. Some of the public awareness materials produced by EANET are shown in Figure 8.

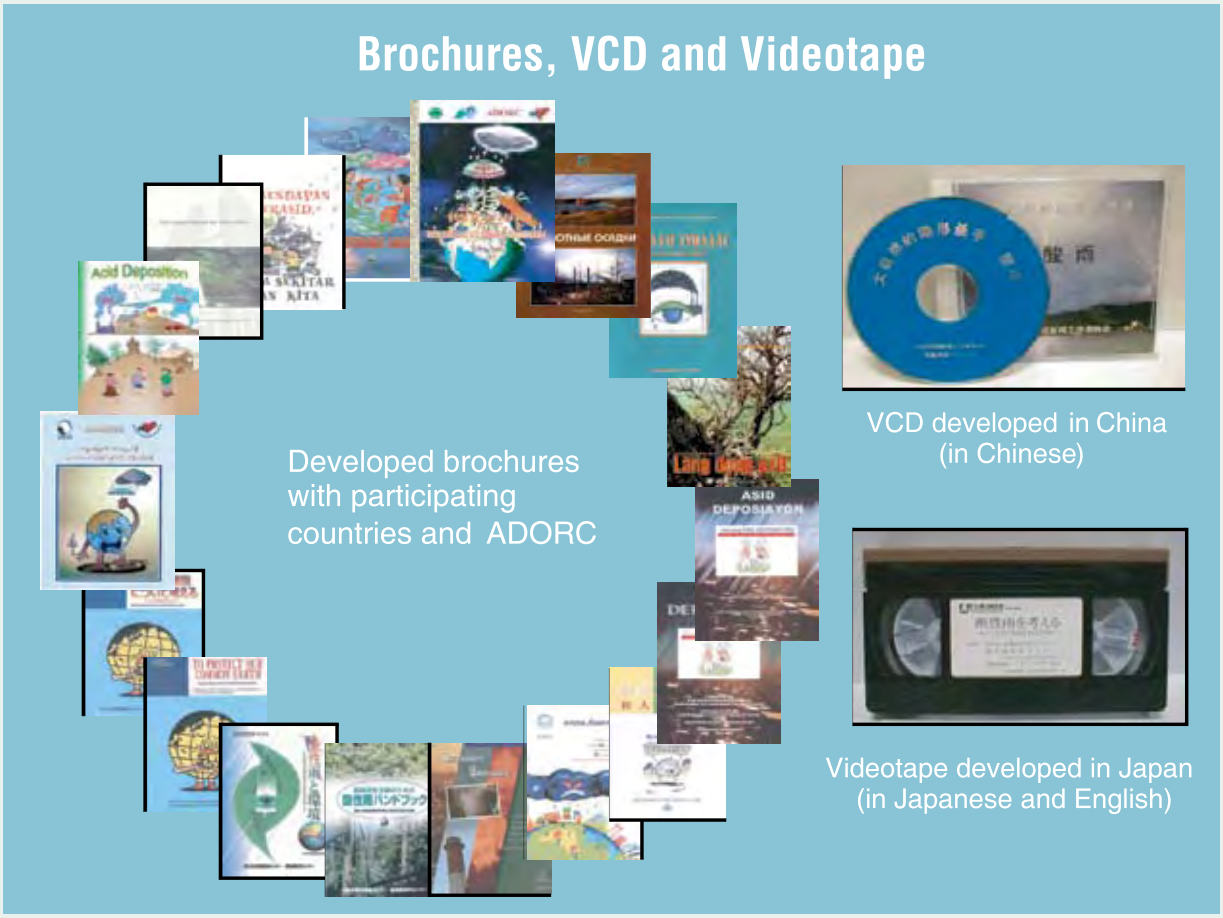


Figure 8. Awareness Materials of EANET

Promotion of Research Studies on Acid Deposition

A number of joint scientific research projects on acid deposition and its effects were conducted by EANET in countries with diverse natural environments and climatic conditions, to improve understanding of the acid deposition problem. Joint projects that were conducted are:

- Joint study with Japan, Malaysia and Thailand on catchment analysis
- Joint study with Mongolia on plant sensitivity
- Joint study with Thailand on dry deposition flux and gas concentration monitoring
- Joint study with Republic of Korea on dry deposition (aerosol concentration) monitoring methodology
- Joint study with Russia on evaluation of East Siberian atmospheric environment
- Model Inter-comparison Study in Asia (a multilateral research activity)

Numerical modeling is an important tool to obtain a better understanding of the atmospheric transport and deposition processes and consider likely effects of various prevention and control measures. Some modeling activities have been developed to understand pollutant transport and deposition in the region including a regional modeling study of anthropogenic sulfur in Southeast Asia, simulated regional distributions of surface ozone in Asia, and the Long-range Transboundary Air Pollutants in Northeast Asia Project (LTP) led by the Republic of Korea. To have a better understanding of the performance and uncertainties of existing models, an international intercomparison study was initiated between EANET and International Institute for Applied Systems Analysis (IIASA) with the participation of experts from China, Japan, Republic of Korea, Thailand and other countries in Europe and North America.

Emission inventories are important for scientific studies and policy-making. Although emission inventories have not yet been fully developed under the EANET initiative, several studies have been conducted in the region, and their outputs have been reported in scientific publications over the past decade. A "Workshop on Emission Inventory" was organized by Acid Deposition and Oxidant Research Center (ADORC) in 2007 to introduce the emission inventories available and their applications to participating countries.

3.3 Recent Achievements of EANET

The Seventh Session of the Intergovernmental Meeting (IG7) adopted the Decision 1/IG7 (Niigata Decision) which decides that the participating countries of EANET should begin a process to discuss an appropriate instrument and its legal status to provide a sound basis for financial contribution to EANET and report the results of the discussion to the Tenth Session of the Intergovernmental Meeting (IG10) for its consideration. The draft Instrument will be further discussed and considered by IG in 2009.

The first Periodic Report on the State of Acid Deposition in East Asia was produced in 2007 as a comprehensive scientific assessment report describing the outcome of five years of EANET's monitoring activities (2000-2004). Part I: Regional Assessment presents the activities of EANET and provides an assessment of the state of acid deposition based on the data acquired from the network to date including future directions and possible impacts of pollutants on inland aquatic systems, forests, and soils. Part II: National Assessment is a compilation of National Assessments describing the national monitoring activities, air quality assessments, and control measures implemented at the national level in the countries.

The Strategy on EANET Development (2006-2010) which was approved by the Eighth Session of the Intergovernmental Meeting (IG8) in 2006 focused on the whole activities of EANET with clearly stated targets, activities to be undertaken and expected results at the end of the mentioned period.

3.4 Country achievements related to acid deposition monitoring and air pollution control measures

Participating countries' achievements and progress are summarized below.

Cambodia

Ambient air quality is good according to the National Standard. Although brochure of acid deposition problem was developed and public awareness activities have been implemented, the Cambodian people are not sufficiently aware of acid deposition issue. So, further awareness campaign is needed in order to prevent any damage caused by acid deposition in the future.

China

During the "10th Five-Year Plan" period, the national ambient air quality monitoring capacity has been enhanced. More than 280 cities conducted automatic monitoring of ambient air. National media published Daily Report of Ambient Air Quality. The 11th "Five-Year" Plan period includes: equipping provincial monitoring stations with air quality control instruments; installing automatic ambient air monitoring equipments; and establishing and improving national acid rain monitoring network, etc. China promoted pollution reduction through industrial restructuring, implementation of relevant projects, improvement of management and released a series of industrial, fiscal, taxation and pricing policies so as to honor the commitment of 10% reduction of total discharge of major pollutants during the 11th "Five-Year" Plan period. In 2007 and the first half of 2008, the total domestic discharge volume of two major pollutants have witnessed a "double fall". Specifically, the total SO_2 emission in 2007 dropped by 4.66% in comparison to that of 2006, and Chemical Oxygen Demand (COD) discharge dropped by 3.14%. SO_2 emission in the first half of 2008 went down by 3.96% compared with that of 2007, and COD discharge down by 2.48%.

Indonesia

Policy measures to combat the acid deposition have been covered through the policies in related sectors. To mitigate the emissions of SO_x and NO_x, policies were embedded on the emission standard for motor vehicle through the Ministry of Environment Decree No. 35/1995 and on emission standards for industries through Ministry of Environment Decree No. 13/1995, and also the National Energy Policy. Strategies and action plans for air pollution such as energy conservation, provision of non-lead gasoline, Blue Sky Program and evaluation of company performance have been implemented. To increase the capacity of local government in monitoring of acid deposition, training on sampling and analysis had been done.

Japan

The Environmental Quality Standard for air pollutants, such as SO_2, CO, SPM, NO_2 and O_x, is set under the Basic Environment Law. Air pollutants emitted from stationary sources and vehicles are regulated by emission standards based on the Air Pollution Control Law, which have been strengthened gradually

according to the status of ambient air quality and technological improvement. Various technologies, such as efficient combustion and exhaust gas treatment facilities have been introduced and environmentally friendly vehicles, such as hybrid vehicles and natural gas vehicles, have been popularized based on the Action Plan for Low Emission Vehicles Development and Promotion developed in 2001. Some schemes on the tax reduction and the subsidies for the purchase of clean technologies have been applied to encourage the promotion of these technologies. Japanese Government is supporting some strategic researches on the transboundary pollution of photochemical oxidant and aerosol, and the intensive monitoring in a water catchment basin suspected to be affected by acid deposition.

Lao PDR

Public awareness activities include joint project for compiling brochure on acid deposition control implemented under the cooperation with Niigata Prefectural Environmental Conservation Corporation (NPECC) and ADORC (EANET National Center) supported by the Japan Fund for Global Environment, as well as workshops for public awareness for participants from relevant government, provincial science technology and environment office, private sector, and disseminate the brochures to participants from government agencies, high school teachers, etc.

Malaysia

Environmental regulation for mobile and point sources, public awareness activities for NGOs and private sector, ratification of international environmental initiatives such as Haze Agreement have been undertaken. In addition to those measures, economic instruments and market-based measures are undertaken under the 9th Malaysian Plan (9MP). The 9MP is organized according to the five thrusts of the National Mission, including the thrust on preventive measures to address the environmental issues and intensifying conservation efforts and sustainably managing natural resources.

Mongolia

Mongolia made legal framework of several laws that are closely related to the air quality and pollution control. The regulations and procedures that are issued in conformity with the “Law on Air” provide procedures for emission source inventory, monitoring, impact studies, etc. Urban air quality in the country seems to get worse without strict pollution control measures. Therefore, regulatory actions are still needed for strengthening of legislation enforcement, updating of environmental quality monitoring and emission control system, implementation of emission inventory/estimation program as well as raising public awareness.

Myanmar

Sampling of wet deposition has been implemented since 2003 and pH was analyzed by the Department of Meteorology and Hydrology (DMH). Brochure on acid deposition problems including mechanism of acid deposition, problems caused by acid deposition and other issues which were compiled with the support of the Japan Fund for Global Environment of Environmental Restoration and Conservation Agency was introduced.

Philippines

In the Philippines, 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/baghouses with fabric filters. Some industries have shifted from the use of bunker fuel to low sulfur fuel oil in order to meet sulfur dioxide and particulate matter emissions. With the adoption and implementation of Euro 2 Type Approval Standards for new motor vehicles effective January 2008, all gasoline fueled motor vehicles issued with Certificate of Conformity to emission standards are fitted with "three-way catalytic converters" while diesel-fueled are equipped with "exhaust gas recirculation system". Pursuant to the Philippine Clean Air Act of 1999, 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 (PtO). No projects are to be implemented without having passed and satisfied environmental impact assessment as evidenced by an Environmental Clearance Certificate.

Republic of Korea

In 2007, Bio-Diesel supply has been regularized as a fuel substitution, ambient air quality standards and emission standards have been strengthened. In SO_x case, emissions decreased continuously, thanks to the low-sulfur-oil supply policy. The Emission Cap Regulation in the Metropolitan Area is in force to reduce the air pollutant emissions. The training course is arranged regularly every year to enhance the air pollution measurement and the domestic acid deposition monitoring sites will be expanded to about 40 by 2009.

Russia

The extension of acid deposition monitoring network is provided under the coordination with other national regional monitoring activities with particular concern to its importance for evaluation of transboundary pollution problems. To use the experience and achievements of the international environmental programs, the Joint European Monitoring and Evaluation Programme (EMEP)-EANET Seminar was organized by Roshydromet to evaluate explored approaches for investigation on air pollution problems and to discuss co-benefit cooperation. Coordination with other scientific projects is promoted at the national level including holding of the national conference on monitoring and modeling of atmospheric chemistry (2007), annual reporting of monitoring results, data utilizing from scientific projects, for example, periodical missions of TRans-Siberian Observations Into the Chemistry of the Atmosphere (TROICA) observatory which provided long range measurement profiles (gas and aerosol concentrations, remote sensing data) in accordance with World Meteorological Organization- Global Atmosphere Watch (WMO-GAW) programs along the transcontinental railways. The public awareness on acid deposition problems was stipulated on published national brochure on acid rains, dissemination of EANET assessment materials as well as including topics of related ecological problems into educational programs and university courses.

Thailand

The ambient air quality and emission standards have been set up under the Enhancement and Conservation of National Environmental Quality Act. The Draft Economic Instruments for Environmental Management Act is considered by the government. The ambient air quality monitoring system is 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 new laws and stringent emissions

standards resulting in fuel quality and engine specification improvement, 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 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, the Project on Development of Environmental and Emission Standard of VOCs 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 the ASEAN Agreement on Transboundary Haze Pollution.

Viet Nam

The Environment Protection Law was reformed in 2006. Public awareness-raising activities include production of video set in collaboration with Vietnam Television, publication of brochure on "Answer-Questions on Acid Deposition", and distribution of brochures with acid deposition issues. A project "Motor vehicles emission control in big cities of Vietnam" was approved in 2008 and will be implemented in 2009 to control and reduce the air pollution due to transportation activity. The master plan of national monitoring network for natural resources and environment of Vietnam was approved by the government. The revised National Monitoring Plan for EANET was submitted and is going to be approved by the government in the near future.

3.5 Possible expansion of activities for future development of EANET

EANET has made considerable progress in monitoring, data acquisition and management, research, and other technical issues. Further development of EANET will focus on priorities to achieve the main goals and objectives of the network in line with the Strategy on EANET Development (2006-2010). The measurements collected so far are still not sufficient to draw precise and definite conclusions on temporal trend and spatial distribution of acid deposition. Improvements in monitoring and data quality are among the most important directions for EANET to focus on.

The distribution of monitoring sites in the EANET region is still sparse and inadequate for a comprehensive assessment of the state of acid deposition. Addition of new monitoring sites should be considered, taking into account geographic, climatic and ecological factors. EANET has been promoting the monitoring of not only acidic species but also ozone and other precursors. For the purpose of studying health effects, however, other chemical species such as persistent organic pollutants (POPs) and priority heavy metals should be included on the list of measured chemical compounds; and their air concentrations, together with their content in precipitation and other media, should be monitored to provide important information on factors with potential harmful effect on health.

The levels of QA/QC activities vary in participating laboratories. Some laboratories do not meet all the requirements in the QA/QC programs, while some laboratories have already been certified by ISO 9000 (Quality Management Systems) or ISO/IEC 17025 (The Competence of Testing and Calibration Laboratories) and some are now developing these systems. It is important not only to promote the basic QA/QC activities in EANET but also to support new directions on QA/QC activities to further improve data quality.

High concentrations of ozone have also been reported in EANET participating countries particularly in the spring and summer and during forest and land fires events. Accumulation of ozone data in forest areas and from crop fields by the use of passive samplers and application of surveys of visible injury should be considered for future assessment of ozone impacts.

In the future, EANET is expected to promote activities to develop emission inventories, including QA/QC activities for emission data, similar to the approach that was taken for monitoring. EANET is also expected to promote and encourage modeling activities. The understanding and the countermeasures of acid deposition and transboundary air pollution problem could be considered on a linkage with climate change issues. There might also be a need to strengthen the institutional framework of EANET to enhance its ability to support its expanded activities.

4 INDICATIVE POLICY OPTIONS

4.1 An integrated approach to air quality management

Monitoring of acid deposition and its effects as well as research on acid deposition including inventory of emissions and modeling of transport flows are indispensable to gain comprehensively understanding of the phenomenon of acid deposition including its cause and effect. The scientific results from these activities could be assessed in order to find out the risks on the environment caused by acid deposition, its potential impacts, and policy options. The assessment outcome can provide useful inputs to the decision-making process by society and policy makers which then can set the future policies with comprehensive considerations of the scientific, technical, social and economic aspects, and lead to effective policies to safeguard a cleaner atmosphere. These safeguards can include technological, regulatory and economic measures. Capacity building plays an important role to implement the above all matters, such as monitoring, research activities and safeguards (Figure 9).

Technological Options

Prevention is indeed superior to treatment and there are proven technological solutions to address the acid deposition problem. Some countries have taken steps towards fuel substitution by switching over to alternative, non-fossil fuels to reduce the consumption of coal and oil. For motor vehicles, switching to bio-fuel and electric technologies or combinations of alternative and gasoline powered vehicles tackle the problem head on. Prevention can also be addressed through efficient combustion technologies such as the improvement of the management on combustion and fluidized bed combustion for power plants. These options may contribute to reduce the emission of carbon dioxide simultaneously.

At the exhaust side, there are energy efficient technologies, and technologies that effectively sequester harmful emissions, that are widely adopted in the EANET region that have shown promising possibilities. Add-on devices such as electrostatic precipitators/fabric filters and flue gas desulphurization systems in power plants and catalytic converters in automobiles are among the technological measures for reducing emission from sources. These are now increasingly used in many countries.

It is therefore important that national policies on choice of alternative fuel, combustion and exhaust technologies, including cleaning up of smokestacks and exhaust pipes, are to be vigorously promoted. There are available decision-making models to evaluate technological options.

Regulatory Measures

The acid deposition problem can also be tackled through regulatory measures such as ambient air quality standards for key pollutants and emission standards for the polluting sources – power plants, industries

and motor vehicles. These regulatory measures should be coupled with pre-investment and pre-project strategic and environmental impact assessments. No projects are to be implemented without having passed and satisfied environmental impact requirements. These assessments are made mandatory in many countries and should be strictly and consistently adhered to.

Economic Measures

Financial incentives or disincentives in the form of taxes, subsidies and concessions have been practiced in some countries for achieving the desired standards and pollution control requirements. Taxation on the basis of pollution load and incentives for clean fuels, technologies and products can serve as potent market-based instruments. Emission trading and preferential price for environment-friendly products are among the instruments. With the ever increasing role of the private sector in economic development and the limitations of regulatory "command and control' measures, the combination of regulatory, fiscal and economic measures including trade agreements can be very effective and thus hereby recommended.

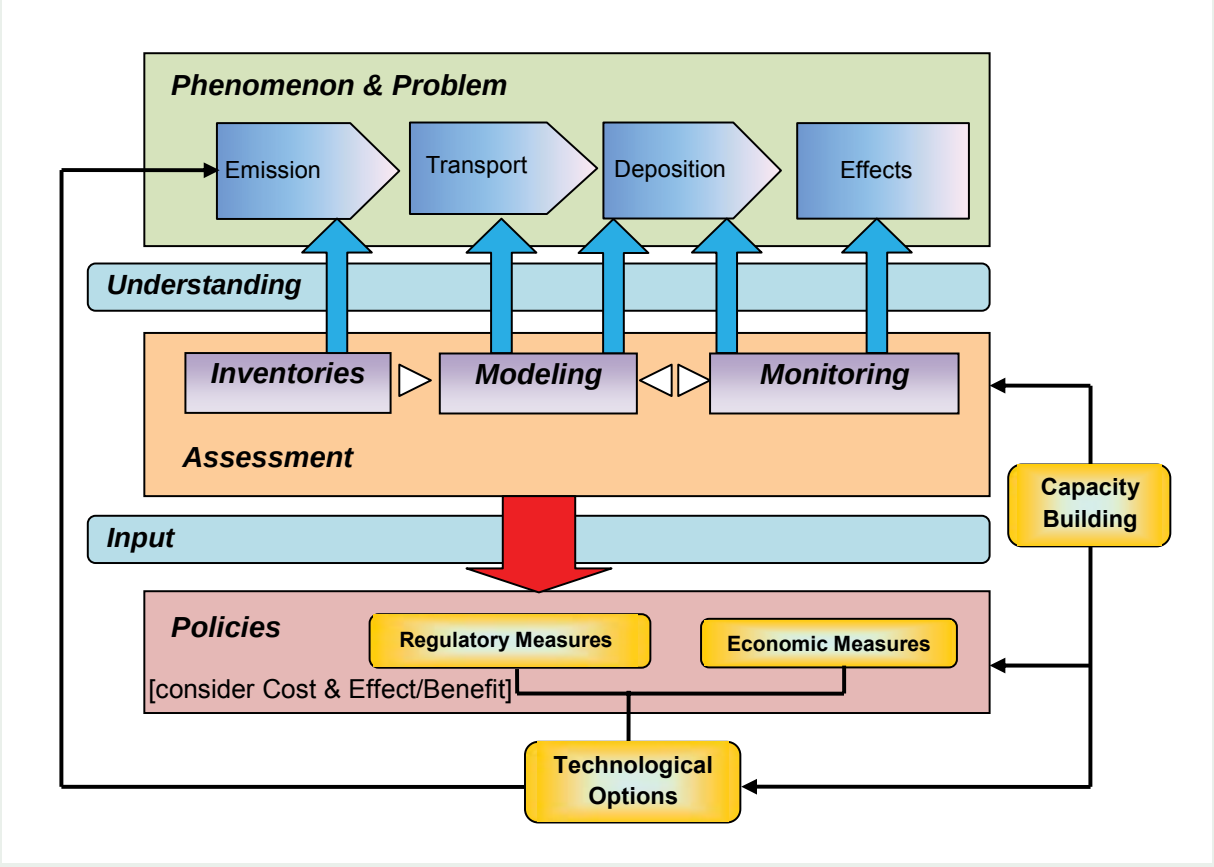


Figure 9. Integrated approach for Air Quality Management

Capacity Building of Institutions

A pragmatic and enabling approach is to tackle the issue of environmental sustainability in a parallel track through technical cooperation and capacity building of institutions and human capital. People and institutions need to understand how acid deposition causes damage to the environment and what changes could be made to the air pollution sources that cause the problem. The answers to these questions help leaders make better decisions about how to control air pollution, and therefore, how to reduce or even eliminate acid deposition. Cooperation and capacity building modalities include information exchange, coordination of efforts in scientific research and development of appropriate technologies, exchange of technical experts and researchers, collaboration in organizing research colloquia and conferences, and collaboration in strengthening knowledge among institutions, research centers and laboratories. Public awareness also reinforces the capacity building of institutions.

There should also be knowledge and action on how to restore environment damage by acid deposition. Each individual can also reduce contribution to the problem and become part of the solution by conserving energy.

4.2 Framework for regional cooperation

EANET is expected to have closer cooperation with other similar global and regional initiatives. For the regional community of EANET participating countries, the acid deposition issue is of great concern and integral to the conservation of the global environment and achieving sustainable development. EANET activities could be integrated with the efforts of other regional networks that are investigating the global and inter-regional dispersal of air pollutants that have harmful effects on human health and environment, and that have potential climate change effects. By encouraging cooperative activities, EANET will in turn learn and acquire good practices for solving regional and transboundary problems, relating to emission inventories and modeling, evaluation of long-term impacts, and mitigation measures, among others. One good example of regional cooperation is the Second Governmental Meeting on Urban Air Quality in Asia held in Bangkok, Thailand in November 2008, which agreed on the long-term vision for Asian cities on urban air quality - "*Healthy people in healthy cities, which put emphasis on prevention of air pollution and which implement effective and appropriate strategies for the abatement of air pollution*".

5 TOWARDS CREATING A SUSTAINABLE FUTURE

Sustainable development, which holistically comprised of Environmental, Social and Economic pillars, is aimed at creating a sustainable future. This can only be achieved through global partnership. The creation of EANET is an act of faith by participating countries and the network's mission constitutes a noble cause.

EANET has achieved a certain level of maturity where it can further build up its strength from its successes. More activities can be done and current ones can be improved on a step-wise basis. The current strategy on EANET development needs all the support – technical expertise, financial or otherwise - it can mobilize from participating countries, organizations and individuals. For EANET to prosper, and to be more responsive to achieve its objectives, it has to strengthen its base, promote scientific surveys and research and expand its scope, promote public awareness, and last but not least, establish a sound financial base from which to grow. EANET is one of the regional initiatives to achieve a better environment for sustainable future growth of the East Asian region.

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