Report on the Acid Deposition Monitoring of EANET during the Preparatory Phase
- Its Results, Major Constraints and Ways to Overcome Them -

August 2000
Interim Scientific Advisory Group

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1. Introduction

1.1. EANET and its preparatory-phase activities

1. The objectives of the Acid Deposition Monitoring Network in East Asia (EANET) are:

(i) to create a common understanding of the state of the acid deposition problems in East Asia;
(ii) to provide useful inputs for decision-making at local, national and regional levels aimed at preventing or reducing adverse impacts on the environment due to acid deposition; and
(iii) to promote cooperation on the issue of acid deposition among participating countries of the Network.

2. The First Intergovernmental Meeting of EANET, held in March 1998 in Yokohama, Japan decided to start the preparatory-phase activities of the Network from April 1998 with the objectives

(i) to examine the feasibility of the designed Network activities and relevant guidelines and technical manuals;
(ii) to provide time for participating countries to further develop national monitoring systems for the Network; and
(iii) to formulate policy recommendations for the future development of the Network.

3. The major activities to be implemented during the preparatory-phase included:

(i) Establishment of interim bodies;
(ii) Development and implementation of the QA/QC programs;
(iii) Development and implementation of training programs;
(iv) Implementation of the preparatory-phase national monitoring (monitoring for wet deposition, dry deposition, soil and vegetation and inland aquatic environment);
(v) Compilation, evaluation and storage of, and access to information;
(vi) Preparation of a report on the state of the acid deposition problems in East Asia;and
(vii) Other relevant activities.

4. As of July 2000, ten countries in East Asia, namely, China, Indonesia, Japan, Malaysia, Mongolia, the Philippines, Republic of Korea, Russia, Thailand and Vietnam

are participating in the Network.

5. Regarding the institutional arrangements for the preparatory-phase, it was agreed that the Interim Secretariat, the Interim Network Center (INC) and the Interim Scientific Advisory Group (ISAG) should be established. The Environment Agency of Japan was designated as the Interim Secretariat and the Acid Deposition and Oxidant Research Center (ADORC), which was to be established in April 1998, was designated as INC. Each participating country nominated its members of ISAG before the First ISAG Meeting in October 1998 in Yokohama, Japan. In addition, for the institutional arrangements at the country level, all the participating countries nominated their national focal points, designated their national centers of EANET.

6. All the participating countries prepared their draft national monitoring plans and informed them to the Interim Secretariat. These were reviewed by the First ISAG Meeting and reported to the Third WG Meeting in October 1998. Although only five countries officially informed their finalized plans, the preparatory-phase activities of all the countries have been implemented in accordance with their national monitoring plans.

7. It was expected that the participating countries would start the national monitoring for EANET at the latest from January 1999. Some countries, however, started their national monitoring later than that time (the latest country started the monitoring from August 1999).

8. During the preparatory-phase, wet deposition monitoring for EANET started at 38 sites, including 16 remote, 8 rural and 14 urban sites respectively. Out of these sites, 21, 11, and 6 sites adopted daily, weekly and event samplings respectively. At most sites, wet only samplers are used but manual sampling is adopted at some sites. Most laboratories participating in the preparatory-phase monitoring have equipment required for analysis of wet deposition samples. During the preparatory phase, dry deposition monitoring for EANET started at 31 sites, including 14 remote, 5 rural and 12 urban sites respectively. Out of these sites, automatic instruments are used at 21 sites, and filter packs are used at 8 sites. Low volume air samplers, denuders are used at some sites. Data on soil and vegetation survey were submitted to INC for 6 sites from 5 countries. Data from China and Malaysia will be submitted soon. The vegetation monitoring data from Philippines are also to be submitted soon. Data on inland aquatic environment were submitted to INC for 7 sites from 6 countries. Data from China are expected to be submitted soon.

1.2. Major objectives and the scope of the report

1.2.1. Background

9. The First Intergovernmental Meeting of EANET decided among others, that:

(i) INC will, following the guidance of ISAG, prepare a data report on the acid deposition in the East Asian Region; and
(ii) ISAG will prepare a report on the state of the acid deposition in the East Asian Region (hereinafter referred to as the “Report”), based on the data report by INC.

10. The data report on the acid deposition in the East Asian Region (first draft) was prepared by INC and presented at the First Informal ISAG Meeting, 25-27 January in Niigata, Japan. At the same meeting, INC also presented a proposal for the preparation of the Report. Intensive discussions were held on this topic, and various diverse comments and suggestions were presented. The major conclusions relevant to the Report included:

- There were unanimous feeling that it was premature to prepare a comprehensive report on the state of the acid deposition in East Asia with very limited data. The title and scope of the report should be reconsidered at the Second ISAG Meeting.
- For verification, an ad hoc group should be established in INC to verify the data submitted from the participating countries.
- It was clarified that the report should be finalized at the Third ISAG Meeting, possibly to be held in July 2000.
- It was emphasized that the role of national QA/QC managers for verification of the data was important.
- The steps for the preparation of the report were agreed as described in the Attachment (attached as Annex of the report of the First Informal ISAG Meeting).

11. Based on the request by the meeting, INC formed an ad hoc group on data quality assessment in February 2000, and undertook more rigorous data quality assessment. INC also sent in February 2000 a draft structure of the Report to all the ISAG members as well as the national focal points and heads of the national centers of EANET for their comments. Taking account of the comments by the ISAG members, the revised draft was prepared for further review and possible adoption at the Second ISAG Meeting, 13-15 March in Jakarta, Indonesia.

12. At the Second ISAG Meeting, INC presented the revised data report (second draft) and the draft structure of the Report. Major discussions on these reports included:

- The revised draft structure could be generally endorsed. Short description on regional atmospheric circulation and precipitation pattern might be included in the report. The proposed title of the report (Report on the Acid Deposition Monitoring of EANET during the Preparatory Phase – its results, major constraints and ways to overcome them) should be endorsed.
- The data to be used for the report could be up to September 1999, however, data beyond then might be used if they could be verified. Because data in wintertime were quite important for the evaluation of deposition monitoring, the available data for winter 1998/1999 might be used for the Report.
- The data quality assessment should be performed before the preparation of the Report. INC should make its best effort to complete the data quality assessment possibly by 15 April 2000.
- INC would prepare, under the direction of ISAG, a preliminary draft Report by 31 May 2000 for circulation among the ISAG members for comments. Taking into account the comments by ISAG members by 30 June 2000, the revised draft would be prepared for consideration and possible adoption at the Third ISAG Meeting.

1.2.2. Scope of the report

13. Considering that the Report must be based on the very limited data from small number of network monitoring sites in the region and limited periods of monitoring, the scope of the Report will mainly cover the evaluation of the preparatory-phase monitoring activities by the participating countries, with emphasis on the verification of submitted data, evaluation of data quality, attempt to evaluate the monitoring results, identification of major constraints among the participating countries, and ways and means to further improve the monitoring in the region.

2. Present status of acid deposition monitoring in the East Asian Region

14. Many countries of the region had some experience on acid deposition monitoring prior to the preparatory phase, mainly concerning pH values of precipitation. The present status of acid deposition monitoring in the participating countries is briefly described below. (More detailed information is attached as Annex 2).

China

China National Environmental Monitoring Centre (CNEMC) has been accumulating nation-wide monitoring data on pH values of precipitation. State Environmental Protection Administration (SEPA) is responsible for acid deposition monitoring. CNEMC was designated as the National Center of EANET, and four cities, namely Chongqing, Xi'an, Xiamen and Zhuhai were designated to participate in EANET. As of July 2000, China operates nine Network monitoring sites for wet deposition in these cities. Data on dry deposition, soil and vegetation and inland aquatic environment were also accumulated in these cities during the preparatory phase.

Indonesia

Meteorological and Geophysical Agency (BMG) has been monitoring wet deposition at 27 nation-wide monitoring sites. Ministry of Environment is responsible for acid deposition monitoring. Environmental Management Center (EMC) was designated as the National Center of EANET, and started its monitoring from April 1998. National Institute of Aeronautics and Space (LAPAN) started wet deposition monitoring from January 1999. As of July 2000, the Network monitoring for wet deposition is carried out at two sites by BMG, one each by EMC and LAPAN. Monitoring for dry deposition, soil and vegetation and inland aquatic environment has been also attempted.

Japan

Environment Agency is responsible for acid deposition monitoring and has been operating about fifty wet deposition monitoring sites. Acid Deposition and Oxidant Research Center (ADORC) was designated as the National Center of EANET. As of July 2000, ten Network monitoring sites for wet and dry deposition are operated by Environment Agency. Monitoring for soil/vegetation and inland aquatic environment was carried out at two sites.

Malaysia

Malaysian Meteorological Service (MMS) is responsible for acid deposition monitoring and has been monitoring wet deposition at nation-wide 23 monitoring sites. It was designated as the National Center of EANET. As of July 2000, it operates two Network monitoring sites for wet and dry deposition.

Mongolia

National Agency for Meteorology, Hydrology and Environmental Monitoring is responsible for acid deposition monitoring. Central Laboratory of Environmental

Monitoring (CLEM) of this organization was designated as the National Center of EANET. As of July 2000, CLEM is operating two network monitoring sites for wet and dry deposition.

Philippines

Environmental Management Bureau (EMB) of Department of Environment and Natural Resources (DENR) is responsible for acid deposition monitoring. It was designated as the National Center of EANET, and as of July 2000, is operating two network monitoring sites for wet and dry deposition. Monitoring for soil/vegetation and inland aquatic environment were also carried out during the preparatory phase.

Republic of Korea

Ministry of Environment (MOE) is responsible for acid deposition monitoring and has been operating about seventy monitoring sites for wet deposition. National Institute of Environmental Research (NIER) was designated as the National Center of EANET and compiling the wet deposition monitoring data in the country. As of July 2000, two Network monitoring sites are under operation for wet deposition. Dry deposition is planned to be monitored at one of these sites.

Russia

State Committee of Russian Federation on Environmental Protection is responsible for acid deposition monitoring and was designated as the National Center of EANET. During the preparatory phase, Limnological Institute, Russian Academy of Science/Siberian Branch (RAS/SB) has been playing a key role for acid deposition monitoring in Siberia. As of July 2000, Limnological Institute operates one Network monitoring site for wet and dry deposition. Monitoring for soil/vegetation and inland aquatic environment was also carried out during the preparatory phase.

Thailand

Pollution Control Department (PCD), Ministry of Science, Technology and Environment (MOSTE) is responsible for acid deposition monitoring. About ten monitoring sites has been operated by PCD, Environmental Research and Training Center (ERTC) and Meteorological Department (MD). PCD was designated as the National Center of EANET. As of July 2000, four Network monitoring sites are operated by PCD, ERTC and MD. Monitoring for soil/vegetation and inland aquatic environment was also carried out during the preparatory phase.

Vietnam

Hydrometeorological Service (HMS) is responsible for acid deposition monitoring and has been monitoring wet deposition at its 22 air quality monitoring stations. National Environment Agency (NEA) also carries out wet deposition monitoring at about ten monitoring sites. Water and Atmospheric Environment Research Center (WAERC) of Institute of Meteorology and Hydrology (IMH), Hydro-Met Service (HMS) was designated as the National Center of EANET and as of July 2000, operates two Network monitoring sites for wet and dry deposition. Monitoring for soil/vegetation and inland aquatic environment was also carried out during the preparatory phase.

3. Monitoring data during the preparatory phase

3.1. Brief description of Network monitoring sites

15. There are 38 monitoring sites for wet deposition monitoring in the preparatory phase activities of EANET. These monitoring sites cover vast area of East Asia between lat.51°N to lat.6°S across ten participating countries. Monitoring sites are classified into three categories depending on the characteristics of individual site. They are 16 remote sites, 8 rural sites, and 14 urban sites. Most countries have at least one urban and one remote site. Geographical distribution of EANET is described in the "location of Network monitoring sites during the preparatory-phase (Fig.3.1)". It can be seen that there is a lack of sites in South-east Asian countries like Cambodia, Laos, and Myanmar. The number of sites in Northern countries like Russia and Northern part of China is also few.

16. Other than wet deposition monitoring, activities of each monitoring site are limited. About ten sites are equipped with filter packs and about twenty sites with automatic monitor to measure air concentration of atmospheric pollutants. At the vicinities of about ten sites, monitoring for soil/vegetation and inland aquatic environment is carried out.

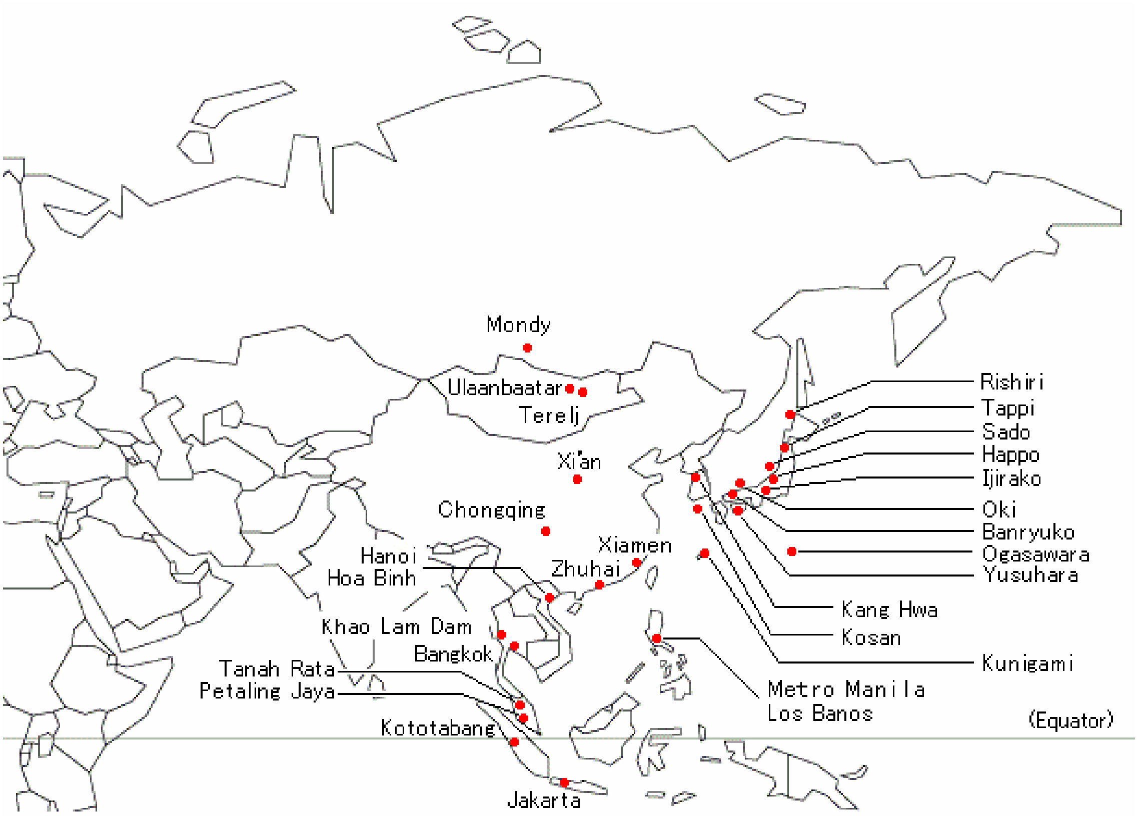


Fig. 3.1 Locations of Network monitoring sites during the preparatory-phase

(Note: “Xi’an” includes 3 sites, and “Chongqing”, “Xiamen”, “Zhuhai” includes 2 sites, respectively. “Jakarta” includes also nearby “Serpong” and “Bandung” sites, and “Bangkok” includes also nearby “Samutprakarn” and “Patumthani” sites. “Metro Manila”/“Los Banos” and “Hanoi”/“Hoa Binh” are described as one point, respectively.)

3.2. Network monitoring components

17. Monitoring components during the preparatory phase are as follows:

<u>Wet deposition monitoring</u>

Major ions related to acidification such as SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, and pH and electric conductivity of precipitation samples are measured.

<u>Dry deposition monitoring</u>

Air concentration monitoring is carried out as the first step of the dry deposition monitoring. The First Interim Scientific Advisory Group (ISAG) Meeting on EANET, held on October 1998 in Yokohama, intensively discussed the future strategy on dry deposition monitoring, and agreed on the identification of the priority chemicals as follows:

1st priority: NO_2(urban), SO_2, O_3, and NO and particulate mass concentration;
2nd priority: NO_2(rural and remote), HNO_3, NH_3, particles (SO_4^{2-}, NO_3^-, NH_4^+, and Ca^{2+})

During the preparatory-phase, gases and particles monitoring has been carried out using available methods such as filter packs, automatic monitors, passive samplers and other manual samplers (low volume air samplers etc.). Along with wet and dry deposition monitoring, meteorological parameters such as wind direction, wind speed, temperature, humidity, precipitation amounts, and solar radiation have been measured at the same site or nearby meteorological observatory.

Soil and vegetation monitoring

Soil properties and decline of trees are considered as major issues. Measurement of pH(H_2O), pH(KCl), cation exchange capacity(CEC) and concentrations of exchangeable ions (Na^+, K^+, Ca^{2+}, and Mg^{2+}) and observation of decline of trees and abnormalities of leaves have been carried out. Other optional parameters such as concentrations of exchangeable Al^{3+}, SO_4^{2-}, and available phosphate in soil and chemical components of fresh leaves have also been measured.

Monitoring for inland aquatic environment

pH, electric conductivity, and alkalinity of targeted lakes or other inland aquatic bodies have been measured as required parameters, and concentrations of SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, and Mg^{2+} as optional parameters.

Monitoring interval

Sample should be collected every 24 hours in principle. Collection can also be conducted for each precipitation event. On the other hand, monitoring interval of inland aquatic environment is specified more than four times a year, and monitoring interval of soil and vegetation is more than once during the preparatory phase.

Major monitoring components of each monitoring item are summarized in Table 3.1.

Table 3.1 Major monitoring components of the preparatory-phase activities of EANET

Items	Parameters and interval
Wet deposition	Monitoring interval: every 24 hours or every precipitation event[a)] Parameters: pH, EC, concentration of SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, and Mg^{2+} Meteorological measurement: [b)]
Dry deposition (air concentration)	Monitoring interval: every two weeks to one month [c)] Parameters: concentration of SO_2, NO_2, NO [d)], O_3 and PM Meteorological measurement: [b)]
Soil and vegetation	Monitoring interval: more than once during the preparatory -phase Parameters: (Soil) pH, cation exchange capacity (CEC), and concentration of exchangeable ions (Na^+, K^+, Ca^{2+}, and Mg^{2+}) (Vegetation) degree of decline of trees, and abnormalities of leaves and branches
Inland aquatic environment	Monitoring interval: more than four times a year (seasonally) Parameters: pH, EC and alkalinity

[a)] Precipitation sampling is carried out by the wet-only sampler

[b)] Wind direction/speed, air temperature, humidity, precipitation amount, and solar radiation

[c)] Every hour when measured by automatic instruments

[d)] Only if the chemiluminescence method is available

3.3. Summary of obtained monitoring data

18. The preparatory phase activities of EANET started from April 1998, and monitoring data until September 1999 (December 1999) were expected to be submitted to INC. Concerning wet deposition, only limited sites accumulated monitoring data of the whole period, because it took time for preparation of the national monitoring plan and/or establishment of monitoring systems in individual countries. About ten monitoring sites submitted data of almost the whole period, and other monitoring sites submitted monitoring data from several months through a year.

19. For wet deposition monitoring, almost all sites are using the wet-only sampler which is designed to collect precipitation samples only during the precipitation period by installing the precipitation sensor and motor-driven tightfitting lid to cover a collecting bucket or funnel. Therefore, concerning the sampling method of precipitation sample, there are not serious problems, though some countries are still using analytical methods which have poor analytical sensitivity. On the other hand, for

air concentration measurements of dry deposition monitoring, harmonization of methods has not been achieved and there are still monitoring data with different detection limits by different methods. For example, concerning SO_2 monitoring at remote sites, weekly monitoring by filter packs gives certain atmospheric concentration data, while hourly monitoring by automatic instruments give many low atmospheric concentration data below detection limit.

20. For wet deposition monitoring, monitoring data for two of 38 monitoring sites were not submitted data because late preparation of these monitoring sites, for instance, installation of sampling equipments, establishment of monitoring system had not been completed by the time for data submission. These monitoring sites are expected to accumulate monitoring data in the future.

21. For dry deposition monitoring, air concentration monitoring data (SO_2) for about twenty sites were submitted, including filter packs, automatic monitors, and passive samplers. Compared with SO_2, the number of sites from which monitoring data on NOx, O_3, and particulate matters were submitted are rather few.

22. For soil and vegetation monitoring, monitoring data for 6 monitoring sites were submitted. Soil properties were measured in all sites, however tree decline data were submitted from three sites, and fresh leave analysis was carried out in two sites.

23. For monitoring on inland aquatic environment, monitoring data from 7 targeted lakes or reservoirs were submitted. Seasonal monitoring has not been carried out at some lakes or reservoirs, because the monitoring period for these sites was rather short. Seasonal monitoring in these lakes and reservoirs are expected in the future.

24. Data submitted on wet deposition monitoring, air concentration monitoring, soil and vegetation monitoring, and inland aquatic environment monitoring are summarized in Table 3.2 through Table 3.6, respectively, followed by the profile of wet and dry deposition monitoring sites.

Table 3.2 Profile of Wet and Dry Deposition (Air Concentration) Monitoring Sites

Country	Name of sites	Characteristics of sites	Latitude	Longitude	Height above sea
China	Chongqing				
	-Guanyinqiao	Urban	29° 35'N	106° 32'E	262m
	-Nanshan	Rural	29° 33'N	106° 38'E	570m
	Xi'an				
	-Jiancezhan	Urban	34° 14'N	108° 57'E	400m
	-Weishuiyuan	Rural	34° 22'N	108° 52'E	360m
	-Dabagou	Remote	33° 54'N	108° 51'E	1,200m
	Xiamen				
	-Hongwen	Urban	24° 28' N	118° 08' E	50m
	-Xiaoping	Remote	24° 51' N	118° 02' E	686m
	Zhuhai				
	-Jiancezhan	Urban	22° 16'N	113° 35'E	40m
	-Zhuxian Cavern	Urban	22° 12'N	113° 31'E	45m
Indonesia	Jakarta(BMG)	Urban	6° 11' S	106° 50' E	7m
	Serpong(EMC)	Rural	6° 15' S	106° 34' E	46m
	Kototabang	Remote	0° 12' S	100° 19' E	864m
	Bandung(LAPAN)	Urban	6° 54' S	107° 35' E	743m
Japan	Rishiri	Remote	45° 07' N	141° 14' E	40m
	Tappi	Remote	41° 15' N	141° 21' E	105m
	Ogasawara	Remote	27° 05' N	142° 13' E	230m
	Sado/(Sado-seki)	Remote	38° 03' N (38° 15' N)	138° 14' E (138° 24' E)	100m (110m)
	Happo	Remote	36° 41' N	137° 48' E	1,850m
	Oki	Remote	36° 17' N	133° 11' E	90m
	Ashizuri	Remote	32° 44' N	132° 59' E	225m
	Kunigami	Remote	26° 47' N	128° 14' E	50m
	Lake Ijira	Rural/Ecolog.	35° 34' N	136° 42' E	140m
	Lake Banryu	Urban/Ecolog.	34° 40' N	131° 42' E	60m
Republic of Korea	Kanghwa	Rural	37° 37' N	126° 22' E	150m
	Kosan	Remote	33° 17' N	126° 10' E	72m
Malaysia	Petaling Jaya	Urban	03° 06' N	101° 39' E	87m
	Tanah Rata	Remote	04° 28' N	101° 23' E	1,470m
Mongolia	Ulaanbaatar	Urban	47° 54' N	106° 49' E	1,282m
	Terelj	Remote	47° 59' N	107° 29' E	1,540m
Philippines	Metro Manila	Urban	14° 38' N	121° 04' E	54m
	Los Banos	Rural	14° 11' N	121° 15' E	35m
Russia	Mondy	Remote	51° 40' N	101° 0' E	2,000m
Thailand	Bangkok(OEPP)	Urban	13° 46' N	100° 32' E	2m
	Samutprakarn(MD)	Urban	13° 44' N	100° 34' E	2m
	Patumthani(ERTC)	Rural	14° 02' N	100° 46' E	2m
	Khao Lam	Remote	14° 46' N	98° 35' E	170m
Vietnam	Hanoi	Urban	21° 01' N	105° 51' E	5m
	Hoa Binh	Rural	20° 49' N	105° 20' E	23m

Table 3.3 Summary of wet deposition monitoring data

Site Name	Classification	Sample Interval	Start Month	Available Data
<China>				
Chongqing				
-Guanyinqiao	Urban	event	April '99	6 months
-Nanshan	Rural	weekly	April '99	6 months
Xi'an				
-Jiancezhan	Urban	event	April '99	7 months
-Weishuiyuan	Rural	event	April '99	7 months
-Dabagou	Remote	event	April '99	7 months
Xiamen				
-Hongwen	Urban	daily	April '99	6 months
-Xiaoping	Remote	daily	April '99	6 months
Zhuhai				
-Jiancezhan	Urban	daily	May '99	8 months
-Zhuxian Cavern	Urban	daily	December '99	- ***
<Indonesia>				
Jakarta(BMG)	Urban	weekly*	April '98	9 months
Serpong(EMC)	Rural	event	April '98	9 months
Kototabang(BMG)	Remote	weekly*	April '98	9 months
Bandung(LAPAN)	Urban	event*	January '99	- ****
<Japan>				
Rishiri	Remote	daily	April '98	18 months
Tappi	Remote	daily	April '98	18 months
Ogasawara	Remote	monthly/(daily)	April'98(May'99)	18 months
Sado/(Sado-seki)	Remote	biweekly/(daily)	April'98(April'99)	18 months
Happo	Remote	daily	April '98	18 months
Oki	Remote	daily	April '98	18 months
Ashizuri	Remote	daily	April '98	18 months
Kunigami	Remote	daily	April '98	18 months
Lake Ijira	Rural/Ecolog.	weekly	June '99	4 months
Lake Banryu	Urban/Ecolog.	weekly	May '99	5 months
<Korea>				
Kanghwa	Rural	weekly	March '99	8 months
Kosan	Remote	weekly	April '99	7 months
<Malaysia>				
Petaling Jaya	Urban	weekly*	April '98	17 months
Tanah Rata	Remote	weekly*	January '99	12 months
<Mongolia>				
Ulaanbaatar	Urban	daily	August '98	9 months
Terelj	Remote	daily	September '98	7 months
<Philippines>				
Metro Manila	Urban	weekly	April '99	8 months
Los Banos	Rural	weekly	April '99	8 months
<Russia>				
Mondy	Remote	daily	May '99	4 months
<Thailand>				
Bangkok(OEPP)	Urban	daily	April '99	7 months
Samutprakarn(MD)	Urban	daily	April '99	- ***
Patumthani(ERTC)	Rural	daily	March '99	8 months
Khao Lam	Remote	daily	April '99	7 months
<Vietnam>				
Hanoi	Urban	daily**	August '99	5 months
Hoa Binh	Rural	daily**	August '99	5 months

Note)*: Biocides are added to precipitation samples, **Chemical analysis is carried out for weekly composite samples, ***Expected to be submitted soon, ****Under data processing.

Table 3.4 Summary of dry deposition (air concentration) monitoring data

Site Name	Classification	Method	Parameter	Interval	Data
<China>					
Chongqing					
-Guanyinqiao	Urban	AT	SO_2, NO_x, O_3	1hr.	-
-Nanshan	Rural	-	None	-	-
Xi'an					
-Jiancezhan	Urban	-	None	-	-
-Weishuiyuan	Rural	Bubbl.	SO_2,NO_x	24hr.	-
-Dabagou	Remote	-	None	-	-
Xiamen					
-Hongwen	Urban	AT	SO_2,NO_2,O_3,NH_3,HCl	1hr.	-
-Xiaoping	Remote	-	None	-	
Zhuhai					
-Jiancezhan	Urban	AT	SO_2,NO_2	1hr.	o
-Zhuxian Cavern	Urban	-	None	-	-
<Indonesia>					
Jakarta(BMG)	Urban	AT	O_3	1hr.	-
Serpong(EMC)	Rural	AT	SO_2,NO_x,O_3	1hr.	o
Kototabang(BMG)	Remote	AT	O_3	1hr.	-
Bandung(LAPAN)	Urban	AT	SO_2,NO_x,O_3	1hr.	-
<Japan>					
Rishiri	Remote	AT	SO_2,NO_x,O_3	1hr.	o
Tappi	Remote	AT	SO_2,NO_x,O_3	1hr.	o
Ogasawara	Remote	AT	SO_2,NO_x,O_3	1hr.	o
Sado/(Sado-seki)	Remote	AT	SO_2,NO_x,O_3,PM_{10}	1hr.	o
Happo	Remote	AT	SO_2,NO_x,O_3	1hr.	o
Oki	Remote	AT	SO_2,NO_x,O_3,PM_{10}	1hr.	o
Ashizuri	Remote	AT	SO_2,NO_x,O_3	1hr.	-
Kunigami	Remote	AT	SO_2,NO_x,O_3	1hr.	-
Lake Ijira	Rural/Ecolog.	AT	SO_2,NO_x,O_3,PM_{10}	1hr.	o
Lake Banryu	Urban/Ecolog.	AT	SO_2,NO_x,O_3,PM_{10}	1hr.	-
<Korea>					
Kanghwa	Rural	-	None	-	-
Kosan	Remote	-	None	-	-
<Malaysia>					
Petaling Jaya	Urban	LV,(PS)	PM_{10} (SO_2,NO_2,HNO_3)	7day	o
Tanah Rata	Remote	FP(PS)	SO_2,NO_2,HNO_3	7day	o
		AT,(LV)	O_3 (PM_{10})	1hr/7day	o
<Mongolia>					
Ulaanbaatar	Urban	FP	SO_2,HNO_3,HCl,NH_3,PM	7day	o
Terelj	Remote	FP	SO_2,HNO_3,HCl,NH_3,PM	14day	o
<Philippines>					
Metro Manila	Urban	FP	SO_2,HNO_3,HCl,NH_3,PM	7day	-
Los Banos	Rural	FP	SO_2,HNO_3,HCl,NH_3,PM	7day	-
<Russia>					
Mondy	Remote	FP	SO_2,HNO_3,HCl,NH_3,PM	14day	o
<Thailand>					
Bangkok(OEPP)	Urban	AT,DN	SO_2,NO_x,O_3,HNO_3,NH_3,PM	1hr/14day	o
Samutprakarn(MD)	Urban	AT	SO_2,PM,NO_x,O_3	1hr	o
Patumthani(ERTC)	Rural	-	None	-	-
Khao Lam	Remote	AT,DN	SO_2,NO_x,O_3,HNO_3,NH_3,PM	1hr/14day	o
<Vietnam>					
Hanoi	Urban	FP	SO_2,HNO_3,HCl,NH_3,PM	7day	o
Hoa Binh	Rural	FP	SO_2,HNO_3,HCl,NH_3,PM	7day	o

Note)AT:Automatic monitor, FP:Filter pack, DN:Denuder, LV:Lo-vol, o:submitted data

Table 3.5 Summary of soil and vegetation monitoring data

Country	Name of sites	Characteristics of sites	Parameter	Interval	Data*
China	Chongqing -Nanshan Xi'an -Dabagou Xiamen -Xiaoping Zhuhai -Zhuxian Cavern	Rural Remote Remote Urban	Decline, K etc. in leaves & ions soil Decline, K etc. in leaves & ions in soil Decline, K etc. in leaves & ions in soil Decline, K etc. in leaves & ions in soil	Once/yr. Once/yr. Once/yr. Once/yr.	- - - -
Indonesia	Serpong(EMC)	Rural	Decline, K etc. in leaves & ions in soil	Once	-
Japan	Lake Ijira Lake Banryu	Rural/Ecolog. Urban/Ecolog.	(Decline, & ions in soil) Decline, K etc. in leaves & ions in soil	(Once) Once	o o
Malaysia	(Pasoh)	Remote	-	-	-
Philippines	Los Banos	Rural	Decline, & ions in soil	Once	o
Russia	Mondy	Remote	Decline, & ions in soil	Once	o
Thailand	Khao Lam	Remote	Decline, K etc. in leaves & ions in soil	2times	o
Vietnam	Hoa Binh	Rural	Decline, & ions in soil	Once	o

Note)*o: submitted data

Table 3.6 Summary of data on inland aquatic environment monitoring

Country	Name of Lake	Characteristics of sites	Parameter	Interval	Data*
China	Chongqing -Nanshan Xi'an -Dabagou Xiamen -Xiaoping Zhuhai -Zhuxian Cavern	Rural Remote Remote Urban	Water quality of Nanshan (Pond) Water quality of Dabagou (Stream) Water quality of Xiaoping (Stream) Water quality of reservoir	4times/yr. 4times/yr. 4times/yr. 4times/yr.	- - - -
Indonesia	Lake Patenggang	Rural	Water quality of Patenggang	4times/yr.	o
Japan	Lake Ijira Lake Banryu	Rural/Ecolog. Urban/Ecolog.	Water quality of Ijira Water quality of Banryu	4times/yr. 4times/yr.	o o
Philippines	Lake Mojicap	Rural	Water quality Mojicap	4times/yr.	o
Russia	Lake Ilchir	Remote	Water quality of Ilchir	12times/yr.	o
Thailand	Khao Lam Dam	Remote	Water quality of Khao Lam Dam	4times/yr.	o
Vietnam	Hoa Binh Reservoir	Rural	Water quality of Hoa Binh Reservoir	4times/yr.	o

Note)*o: submitted data

4. Quality of the monitoring data submitted to the Interim Network Center

4.1 Data quality assessment

25. For the preparation of the data report, INC encouraged early submission of monitoring data from participating countries. However, some of monitoring data were submitted later than the initially scheduled date of October 1999. Additionally, for some monitoring data, INC took time to adjust to the format of EANET, because they were submitted by using other reporting formats. Despite of these problems, with strong support and contribution of participating countries, INC prepared the data report on the acid deposition in the East Asia Region (first draft), and submitted it to the First Informal Scientific Advisory Group (ISAG) Meeting of EANET which was held on 25-27 January 2000 in Niigata, Japan.

26. After the intensive discussion in the meeting, it was pointed out that further assessment of submitted data was requested. In this connection, it was requested to establish an ad hoc group in the Interim Network Center (INC) to assess the data submitted from the participating countries by 10 February 2000. It was also recommended that sub-groups for wet deposition, dry deposition, soil and vegetation monitoring and monitoring for inland aquatic environment should be formed.

27. Major comments from members of the data quality assessment sub-group on wet deposition monitoring were as follows:

- R1 and R2 check is a useful tool to assess a quality of wet deposition monitoring data. In general, where data are not within the R1 and R2 allowable range, analytical imprecision could be a major factor and there might be a need to improve accuracy/precision of the chemical analyses. Sample history should be reviewed for outlying data that are found out by R1 and R2 check;
- With respect to the plots of ion balances (R1), a large spread of the results indicates random errors.
- However, in EANET, diversity of monitoring sites should be taken into account. Possible causes of outlying R1/R2 may include: (i)when pH is greater than 6, there is a need to consider bicarbonate/carbonate data, (ii)preserved by biocide, trace organic acids such as formate, acetate, and oxalate give greater R1 bias, and (iii) other anions such as fluoride, nitrite, and phosphate may also give greater R1 bias;
- There were comments on treatment of data lower than detection limit and treatment of significant digits.

28. Major comments from members of the data quality assessment sub-group on

dry deposition monitoring were as follows:

- Measuring methods of automatic monitor should be described, because different methods have different analytical performance such as detection limits and so on;
- To assess the cause of higher concentration, there is a need to verify hourly raw data;
- In some cases, "median" value to evaluate the monitoring data, may be used, taking into account the distribution of data, because the "median" value is preferable when there is some extreme values and a lots of data under detection limits.

29. Major comments from members of the data quality assessment sub-group on soil and vegetation monitoring were as follows:

- Sulfur contents of fresh leaves in some data were remarkably high.
- Amounts of exchangeable cations of soil in some data were high.

30. Major comments from members of the data quality assessment sub-group on inland aquatic environment monitoring were as follows:

- Not all the mandatory parameters were measured, and because of late start of the monitoring, the required frequency of monitoring (more than 4 times per year) was not followed in some lakes/reservoirs.
- Some sites (targeted lakes/reservoirs) had high alkalinity and EC values, and did not meet the criteria of site selection of EANET. These sites should be reviewed and if necessary, changed to more appropriate sites.

31. According to the comments of ad hoc data quality assessment group, INC communicated with relevant National Centers (NCs) of participating countries and made necessary corrections based on the information from NCs. Then INC prepared and presented the Data Report on the Acid Deposition in the East Asian Region (second draft) to the Second ISAG Meeting of EANET which was held on 13-15 March 2000 in Jakarta, Indonesia.

32. At the Second ISAG meeting, following comments were expressed at the discussion, and INC was requested to make effort to complete the data quality assessment, possibly by 15 April 2000:

- National center should conduct data quality assessment and then submit the assessed data to INC for further verification;
- The monitoring results should include the information on which month min/max values are obtained during the monitoring period.
- The time series of monitoring data should also be presented for evaluation of

data.

- The data completeness of wet deposition monitoring should further be examined in terms of the number of samples in respective monitoring sites.
- As one of the future tasks, INC should perform a comparative study of automatic SO_2 monitor and filter pack method, particularly at the remote sites to assess the reliability of these methods.

4.2 Wet deposition monitoring data

4.2.1 R1 and R2 check

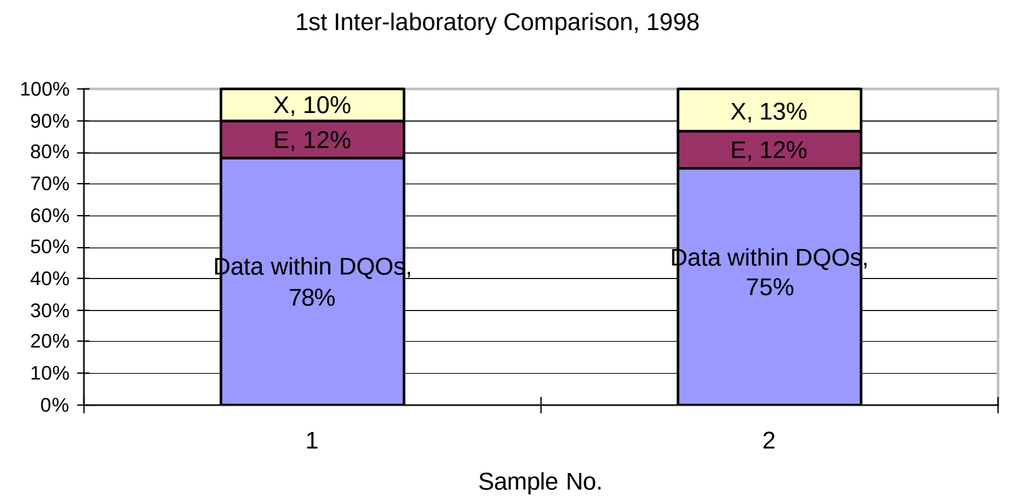
33. Ion balance (R1) and conductivity agreement (R2) check was performed for wet deposition samples which have all measurement parameters. At 12 sites, more than 80% of samples were within the allowable range of R1, and at 21 sites more than 50% of samples were within the allowable range of R1. At 17 sites, more than 80% of samples were within the allowable range of R2, and at 27 sites, more than 50% of samples were within the allowable range of R2. Therefore, at some sites, R1 and R2 values were not within allowable ranges. However, as pointed out by ad hoc data quality assessment group members, taking into account the diversity of EANET monitoring sites, R1 and R2 check is not an only way of data evaluation. In some sites, existence of unidentified ions such as bicarbonate/carbonate, fluoride, and organic acids may need to be considered.

4.2.2 Inter-laboratory comparison

34. The First Inter-laboratory Comparison Project (round robin analysis survey of uniformly prepared artificial rainwater samples) was conducted in 1998 with the participation of the 24 analytical laboratories of EANET, followed by the Second one which was conducted in 1999. Main purpose of the project is to recognize the analytical precision and accuracy of the data in each participating laboratory, and give an opportunity to improve the quality of the analysis on wet deposition monitoring.

35. The Data Quality Objective (DQO) on accuracy and precision of data obtained by the preparatory-phase activities of EANET was specified for every constituent as ± 15% by the QA/QC program for wet deposition monitoring of EANET. For the evaluation of inter-laboratory comparison data, the flag "E" was put to the data that exceed by a factor of 2 of the DQO (±15%~30%), and the flag "X" was put to the data that exceed more than a factor of 2 of the DQO (<-30% or >30%). As described in Fig.4.1, in the First Inter-laboratory Comparison Project, data meeting DQOs were between 75% to 80% of whole data both for the sample No.1 (high concentrations) and the sample No.2 (low concentrations). Data meeting DQOs increased in the Second

Inter-laboratory Comparison Project. Around 90% of data for the sample No.1 and the sample No.2 met DQOs, though at present, the data submitted only from 20 laboratories, out of 23 laboratories which participated in the preparatory phase activities of EANET in 1999. (Numbers of participating laboratory decreased from 24 to 23 in 1999, because numbers of Japanese laboratories decreased from 8 to 7). This remarkable improvement of results of the inter-laboratory comparison indicates the effort of each participating laboratory.



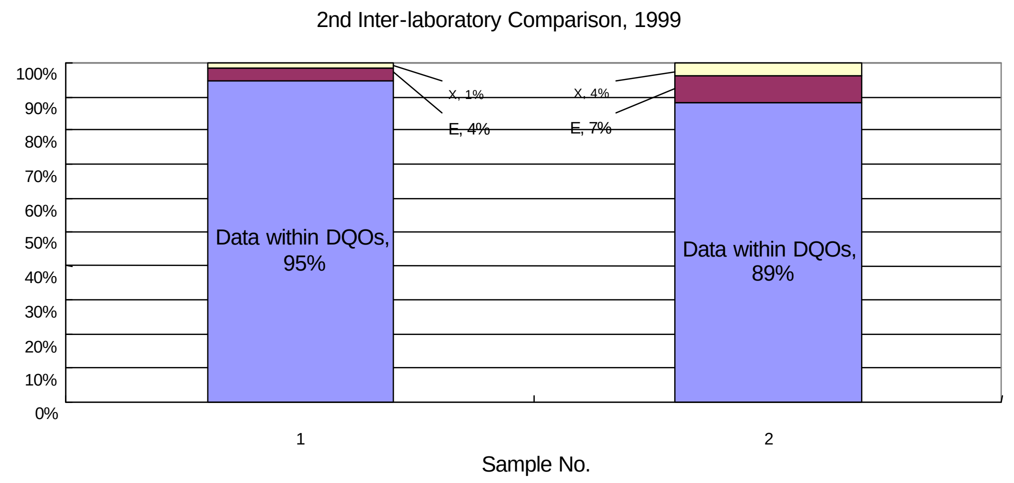


Fig.4.1 Results of inter-laboratory comparison of artificial rainwater sample (The 1st survey: 24 laboratories participated, The 2nd survey: 19 laboratories out of 23 laboratories submitted analytical results as of May 30, 2000)

4.3 Dry deposition (air concentration) monitoring data

36. Participating countries of EANET are usually using automatic instruments, filter packs. Few countries are using denuders for monitoring of these gaseous species. Advantage of the filter pack method is its reasonably simple structure, which contains four types of filters in sequence: Teflon filter (for particles sampling), nylon filter (for HNO_3, HCl, and SO_2 sampling), cellulose filter impregnated by alkali (e.g. K_2CO_3, for SO_2 sampling), and cellulose filter impregnated by acid (e.g. H_3PO_4, for NH_3 sampling). Acid Deposition and Oxidant Research Center (ADORC) carried out a comparative study of filter packs from July 1998 to March 1999 in Niigata, Japan. Three sets of filter packs are operated in parallel once a week every month at suction rate of approximately 1 liter per minute. Collected filters were shipped to the laboratory and its extract solutions were analyzed by ion chromatography. As shown in Table 4.1, the Coefficient of Variances (CV) for measurement by filter packs for SO_2, HNO_3, SO_4^{2-}, NO_3^-, NH_4^+, and Ca^{2+} were less than 10%. Only for NH_3, the CV was slightly over 10%. Although this experiment didn't consider the effects of artifacts on the filter such as volatilization of particulate NH_4Cl, the results show an example of the precision of concentration measurements on these chemical species in the atmosphere.

Table 4.1 Results of parallel measurements of atmospheric pollutants by filter packs

Parameter	Average Conc. ($nmol/m^3$)	Standard Deviation ($nmol/m^3$)	CV*%
SO_2	136.6	7.5	5.3
HNO_3	30.1	2.2	8.6
NH_3	146.8	15.9	10.4
SO_4^{2-}	49.5	3.1	6.1
NO_3^-	34.5	2.5	7.3
NH_4^+	96.6	4.9	4.8
Ca^{2+}	9.5	0.9	8.4

Note) Three sets of filter packs were operated in parallel at Niigata from July 1998 through March 1999, once a week every month.
*CV: Coefficients of Variance

37. Automatic monitor for SO_2 (UV fluorescence method), O_3 (UV photometric method), and NO (chemiluminescence detection method) are suitable to obtain one-hour averaged values of these species for air quality monitoring. However, some problems

occurred on measurements of low concentration gases in remote or rural sites, particularly for SO_2, and NOx: (i) most of monitoring data of SO_2 obtained in remote sites are around detection limit even using a high-sensitivity type instrument, and therefore it is difficult to estimate ordinary concentration of SO_2 at some sites, (ii)since commercial "NOx chemiluminescence instruments" with molybdenum converter in its NOx mode responds not only to NO/NO_2 but also to HNO_3 and other organic nitrates unspecifically, it is not adequate to evaluate data at remote and rural sites. The data obtained by this instrument could be used to evaluate NO/NOx* (NO, NO_2, PAN and partial HNO_3) at remote and rural sites. Its use in urban sites near emission sources may be acceptable for NO_2 measurement, because major components of NOx would be NO_2 and NO in such areas.

4.4 Soil and vegetation monitoring data

38. The data of the 1st Inter-laboratory Comparison Program for chemical analysis on soil were submitted from nine laboratories of seven countries at present. The variance of the interim data may be considered relatively small in the soil pH, and relatively large in the amount of exchangeable ions, although it will take time to evaluate all the data.

39. In order to evaluate the reproducibility-within-laboratory, chemical analysis for each sample should be repeated. At present, Vietnam and Japan repeated the chemical analysis according to the QA/QC program. These data were submitted to INC although the data quality assessment has not been completed for the Lake Banryu, Japan. The results of the first and second analysis are similar; e.g. less than 5% for most data in Vietnam. From these data, it may be indicated that the analyses were carried out with the same condition.

40. At present, most National Centers of the participating countries do not have specialists on soil and vegetation in their institution. For the soil and vegetation monitoring, specialists in the universities and relevant institutions have cooperated with the National Centers in both fieldwork and laboratory chemical analysis. The close communication between the National Centers and these specialists may be necessary to obtain the high quality data of soil and vegetation monitoring.

4.5 Monitoring data on inland aquatic environment

41. In general, inland water bodies having low alkalinity and low electric conductivities are prone to be sensitive to acidification by acid deposition, e.g. alkalinity less than 0.05meq/l. Therefore, the participating countries of preparatory-phase

activities of EANET are expected to monitor the water quality at the sensitive sites for acid deposition. However, because of lack of existing monitoring data and/or suitable targeted monitoring sites, some countries monitored sites which do not seem to be sufficiently sensitive.

42. Obtained monitoring data in each participating country were checked by calculation of ion balance (R1) and comparison between calculation and measurement in electric conductivity (R2). Consideration of carbonate correspondent to alkalinity for inland aquatic environment samples is a difference from wet deposition samples. In most sites, calculated R1 and R2 values were within the allowable range. However, at some monitoring sites, whole parameters required for calculation of R1 and R2 were not available, and the calculation could not be carried out.

5. Evaluation of the monitoring results

43. Although the data obtained from the participating countries are insufficient in terms of geographical and temporary terms, an attempt is made to the extent possible in this Chapter to evaluate the state of acid deposition in East Asia. The data used for this Chapter are attached as Annex 3.

5.1 Wet deposition monitoring

44. In the absence of complete annual data records spanning all seasons, at all geographic locations, the initial discussion of results can be illustrative only, rather than quantitative. Nevertheless, it is worth reviewing the data obtained at most sites at one common period, the months (June, July and August) of 1999, to illustrate the range encountered in data values across the network. Average concentrations and deposition of the ions were summarized in Table 5.1 and Table 5.2 together with related parameters.

45. The data quality was then assessed for the data during these three months in terms of ion balance measures R1 and R2, which are also given in Table 5.1. Considerable fractions of the available data in the common period did not meet the criteria for R1 and R2. Nevertheless, for this preliminary analysis all available data are displayed, in order to illustrate the likely range in results to be expected in the long term. Data shown in these tables satisfied all of the following conditions, except the data in hatched column:

- Raw data are available for three months period monitoring data;
- More than two valid monthly values are available;
- Data completeness of three months period is more than 80%PCL (Precipitation Coverage Length, percent measured days);
- Data completeness of three months period is more than 80%TP (Total Precipitation, percent total precipitation).

46. In sea coast areas and remote islands, sea salt dominates the chemistry of precipitation. Concentration of Na^+ and Cl^- in these monitoring sites such as Kunigami are higher than other monitoring sites. Sea salt diminishes rapidly in inland areas, and concentrations of soil oriented base cations are elevated. Concentrations of Ca^{2+}, K^+ are higher in some inland wet deposition monitoring sites in China and Mongolia. Sulfates and nitrates concentrations are generally affected by emissions from industrial and automotive sources.

Table 5.1(a) June 1999 - August 1999 seasonal weighted averages (Remote)

Country	Name of sites	precipitation amounts (mm)	SO_4^{2-} (μmol/L)	nss-SO_4^{2-} (μmol/L)	NO_3^- (μmol/L)	Cl^- (μmol/L)	NH_4^+ (μmol/L)	Na^+ (μmol/L)	K^+ (μmol/L)	Ca^{2+} (μmol/L)	nss-Ca^{2+} (μmol/L)	Mg^{2+} (μmol/L)	H^+ (μmol/L)	pH	EC (mS/m)	R1(AA) (%)	R2(AA) (%)
China	Xi'an																
	-Dabagou	310.4	116	115	40.1	28.7	253	7.0	13.5	148	148	7.4	0.2	6.66	5.28	8	54
	Xiamen																
	-Xiaoping	575.1	18.2	17.3	13.0	20.2	44.2	15.7	2.4	6.4	6.1	2.4	9.2	5.04	1.54	47	91
Indonesia	Kototabang																
Japan	Rishiri	572.5	10.5	8.6	10.8	42.7	12.7	31.6	1.2	1.4	0.7	5.1	15.8	4.80	1.49	100	100
	Tappi	244.5	13.2	8.8	13.0	85.7	10.0	72.8	2.0	2.3	0.8	8.0	15.9	4.80	2.17	100	100
	Sado/(Sado-seki)	529.1	8.7	7.5	11.6	24.7	8.2	20.2	0.7	1.0	0.6	2.1	18.2	4.74	1.31	100	100
	Happo	752.5	3.9	3.8	6.5	2.7	5.9	0.9	0.2	0.5	0.5	1.1	9.3	5.03	0.55	95	100
	Oki	482.5	6.3	4.2	7.3	38.6	5.9	35.1	1.6	1.4	0.6	3.8	11.7	4.93	1.27	72	100
	Ashizuri	876.5	8.4	1.4	2.3	143	1.3	127	4.7	4.4	1.6	14.0	5.2	5.28	2.32	93	100
	Ogasawara	319.0	5.6	2.2	1.5	68.6	1.0	55.7	1.8	5.1	3.9	7.4	4.7	5.32	1.42	95	100
	Kunigami	708.3	10.8	4.7	5.7	141	6.9	104	2.1	2.3	0.5	10.8	4.6	5.34	1.94	58	83
Korea	Kosan	1551.9	9.3	4.8	4.5	121	26.9	74.8	3.3	3.9	2.4	9.9	4.1	5.39	1.83	88	75
Malaysia	Tanah Rata	717.1	5.2	5.0	7.0	3.4	14.2	3.3	1.6	3.0	2.9	0.6	10.9	4.96	--	8	--
Mongolia	Terelj	221.9	12.2	11.7	13.3	9.5	32.8	11.0	6.1	17.4	17.2	2.5	2.8	5.55	1.03	26	89
Russia	Mondy	199.6	5.4	5.3	5.0	10.0	14.8	1.8	1.9	3.5	3.5	1.0	7.3	5.14	0.50	80	55
Thailand	Khao Lam	150.3	4.0	1.6	3.6	13.1	10.7	66.0	4.8	1.7	1.3	0.9	1.6	5.78	0.61	20	47

Table 5.1(b) June 1999 - August 1999 seasonal weighted averages (Rural)

Country	Name of sites	precipitation amounts (mm)	SO_4^{2-} (μmol/L)	nss-SO_4^{2-} (μmol/L)	NO_3^- (μmol/L)	Cl^- (μmol/L)	NH_4^+ (μmol/L)	Na^+ (μmol/L)	K^+ (μmol/L)	Ca^{2+} (μmol/L)	nss-Ca^{2+} (μmol/L)	Mg^{2+} (μmol/L)	H^+ (μmol/L)	pH	EC (mS/m)	R1(AA) (%)	R2(AA) (%)
China	Chongquing																
	-Nanshan	603.6	80.7	80.5	26.6	5.6	61.3	3.1	7.7	30.7	30.6	2.0	137	3.86	3.74	30	40
	Xi'an																
	-Weishuiyuan	215.8	99.7	98.5	22.6	57.5	146	19.6	14.7	111	110	8.0	0.1	6.90	9.72	33	22
Indonesia	Serpong	292.3	40.1	38.0	38.9	17.9	47.4	35.1	15.4	7.3	6.8	5.1	49.0	4.31	2.80	22	67
Japan	Ijira	905.5	14.3	13.4	27.0	14.2	15.1	14.9	2.3	7.4	7.1	2.0	33.1	4.48	1.94	70	100
Korea	Kanghwa	969.0	3.9	3.5	9.3	10.8	9.1	7.7	1.0	4.4	4.2	1.2	6.1	5.22	0.67	100	80
Philippines	Los Banos	328.5	10.4	9.8	52.0	28.2	14.3	8.0	2.2	2.7	2.6	3.4	253	3.60	3.28	50	0
Thailand	Patumthani	399.7	21.4	20.8	15.5	10.7	34.1	10.0	2.9	13.0	12.8	2.0	7.9	5.10	1.41	56	74
Vietnam	Hoa Binh	81.1	6.4	5.3	10.4	26.2	5.5	18.0	<1.0	8.2	7.8	4.3	2.7	5.57	0.67	100	100

Table 5.1(c) June 1999 - August 1999 seasonal weighted averages (Urban)

Country	Name of sites	precipitation amounts (mm)	SO_4^{2-} (μmol/L)	nss-SO_4^{2-} (μmol/L)	NO_3^- (μmol/L)	Cl^- (μmol/L)	NH_4^+ (μmol/L)	Na^+ (μmol/L)	K^+ (μmol/L)	Ca^{2+} (μmol/L)	nss-Ca^{2+} (μmol/L)	Mg^{2+} (μmol/L)	H^+ (μmol/L)	pH	EC (mS/m)	R1(AA) (%)	R2(AA) (%)
China	Chongquing																
	-Guanyinqiao	586.0	115	115	29.3	14.9	109	8.1	11.8	86.0	85.9	8.9	47.0	4.33	4.65	41	66
	Xi'an																
	-Jiancezhan	263.2	147	146	48.1	37.4	399	9.5	10.9	162	162	12.4	0.7	6.18	7.30	0	58
	Xiamen																
	-Hongwen	366.0	17.1	15.3	12.7	38.5	30.3	29.0	4.1	2.8	2.3	3.8	6.3	5.20	1.37	71	82
	Zhuhai																
	-Jiancezhan	322.6	31.4	27.1	21.3	42.5	24.6	144	22.6	98.7	95.6	34.0	3.0	5.52	3.08	17	25
	-Zhuxian Cavern																
Indonesia	Jakarta																
	Bandung																
Japan	Banryu	724.5	5.9	5.2	6.1	12.8	14.1	11.0	1.1	0.4	0.2	1.0	11.4	4.94	0.88	73	100
Malaysia	Petaling Jaya	387.7	22.9	22.6	21.0	7.1	14.0	4.7	1.3	4.5	4.4	1.6	51.6	4.29	--	27	--
Mongolia	Ulaanbaatar	161.1	16.8	16.1	15.8	11.8	52.5	12.9	5.6	24.6	24.3	2.9	1.0	5.99	1.47	3	81
Philippines	Metro Manila	123.4	14.1	12.3	2.8	51.0	17.9	30.0	2.1	3.4	2.7	3.4	10.5	4.98	2.66	0	25
Thailand	Bangkok	464.6	18.0	17.1	17.7	11.3	50.8	15.6	3.5	13.2	12.9	3.1	3.5	5.45	1.40	17	72
	Samutprakarn																
Vietnam	Hanoi	97.1	5.8	5.3	10.1	33.6	9.3	8.2	2.6	21.2	21.1	3.7	0.5	6.30	0.86	0	100

note) Data in hatched columns are only for the reference because data which do not satisfied the data completeness (For Hoa Binh and Hanoi, only one month data are available).

Table 5.2(a) June 1999 - August 1999 seasonal deposition amounts (Remote)

Country	Name of sites	SO_4^{2-} (mmol/m^2)	nss-SO_4^{2-} (mmol/m^2)	NO_3^- (mmol/m^2)	Cl^- (mmol/m^2)	NH_4^+ (mmol/m^2)	Na^+ (mmol/m^2)	K^+ (mmol/m^2)	Ca^{2+} (mmol/m^2)	nss-Ca^{2+} (mmol/m^2)	Mg^{2+} (mmol/m^2)	H^+ (mmol/m^2)
China	Xi'an -Dabagou	35.9	35.8	12.4	8.90	78.6	2.19	4.20	46.0	45.9	2.31	0.07
	Xiamen -Xiaoping	10.5	9.94	7.45	11.6	25.4	9.01	1.40	3.68	3.49	1.40	5.30
Indonesia	Kototabang											
Japan	Rishiri	5.98	4.90	6.16	24.4	7.26	18.1	0.69	0.82	0.43	2.93	9.03
	Tappi	3.22	2.16	3.19	21.0	2.46	17.8	0.48	0.56	0.19	1.96	3.90
	Sado/(Sado-seki)	4.61	3.96	6.12	13.0	4.35	10.7	0.35	0.55	0.32	1.13	9.66
	Happo	2.93	2.89	4.92	2.00	4.43	0.64	0.17	0.39	0.38	0.80	7.01
	Oki	3.03	2.01	3.52	18.6	2.83	16.95	0.76	0.68	0.31	1.85	5.63
	Ashizuri	7.34	1.19	2.00	125	1.15	111	4.11	3.84	1.43	12.3	4.60
	Ogasawara	1.77	0.71	0.47	21.9	0.31	17.8	0.57	1.63	1.24	2.37	1.51
	Kunigami	7.66	3.30	4.03	100	4.91	73.5	1.46	1.63	0.32	7.62	3.23
Korea	Kosan	14.41	7.43	6.92	188	41.7	116.1	5.14	6.09	3.68	15.38	6.32
Malaysia	Tanah Rata	3.76	3.62	5.04	2.42	10.2	2.37	1.18	2.16	2.11	0.44	7.78
Mongolia	Terelj	2.71	2.59	2.95	2.11	7.29	2.44	1.36	3.86	3.82	0.56	0.62
Russia	Mondy	1.08	1.06	1.00	2.00	2.95	0.35	0.37	0.70	0.69	0.20	1.45
Thailand	Khao Lam	0.60	0.24	0.53	1.97	1.60	9.92	0.72	0.26	0.20	0.14	0.25

Table 5.2(b) June 1999 - August 1999 seasonal deposition amounts (Rural)

Country	Name of sites	SO_4^{2-} (mmol/m^2)	nss-SO_4^{2-} (mmol/m^2)	NO_3^- (mmol/m^2)	Cl^- (mmol/m^2)	NH_4^+ (mmol/m^2)	Na^+ (mmol/m^2)	K^+ (mmol/m^2)	Ca^{2+} (mmol/m^2)	nss-Ca^{2+} (mmol/m^2)	Mg^{2+} (mmol/m^2)	H^+ (mmol/m^2)
China	Chongquing -Nanshan	48.7	48.6	16.0	3.36	37.0	1.87	4.65	18.5	18.5	1.20	82.6
	Xi'an -Weishuiyuan	21.5	21.3	4.87	12.4	31.5	4.23	3.17	23.9	23.8	1.72	0.03
Indonesia	Serpong	11.7	11.1	11.4	5.24	13.9	10.3	4.51	2.15	1.98	1.50	14.3
Japan	Ijira	13.0	12.2	24.4	12.9	13.7	13.5	2.09	6.72	6.43	1.85	29.9
Korea	Kanghwa	3.81	3.37	8.97	10.5	8.78	7.44	1.01	4.22	4.06	1.21	5.88
Philippines	Los Banos	3.42	3.21	17.1	9.26	4.69	2.64	0.72	0.90	0.84	1.11	83.0
Thailand	Patumthani	8.55	8.31	6.21	4.29	13.6	3.98	1.18	5.19	5.11	0.80	3.14
Vietnam	Hoa Binh	0.52	0.43	0.84	2.12	0.45	1.46	0.07	0.66	0.63	0.35	0.22

Table 5.2(c) June 1999 - August 1999 seasonal deposition amounts (Urban)

Country	Name of sites	SO_4^{2-} (mmol/m^2)	nss-SO_4^{2-} (mmol/m^2)	NO_3^- (mmol/m^2)	Cl^- (mmol/m^2)	NH_4^+ (mmol/m^2)	Na^+ (mmol/m^2)	K^+ (mmol/m^2)	Ca^{2+} (mmol/m^2)	nss-Ca^{2+} (mmol/m^2)	Mg^{2+} (mmol/m^2)	H^+ (mmol/m^2)
China	Chongquing -Guanyinqiao	67.7	67.4	17.2	8.71	63.7	4.74	6.90	50.4	50.3	5.20	27.6
	Xi'an -Jiancezhan	38.6	38.5	12.6	9.85	105	2.50	2.88	42.6	42.5	3.26	0.18
	Xiamen -Hongwen	6.25	5.61	4.63	14.1	11.1	10.6	1.49	1.01	0.83	1.38	2.30
	Zhuhai -Jiancezhan	10.1	8.75	6.88	13.7	7.94	46.4	7.28	31.8	30.8	11.0	0.98
	-Zhuxian Cavern											
Indonesia	Jakarta											
	Bandung											
Japan	Banryu	4.27	3.80	4.40	9.25	10.2	7.98	0.78	0.31	0.13	0.72	8.25
Malaysia	Petaling Jaya	8.89	8.78	8.16	2.77	5.43	1.82	0.50	1.74	1.70	0.61	20.0
Mongolia	Ulaanbaatar	2.71	2.59	2.55	1.91	8.45	2.07	0.90	3.97	3.92	0.46	0.17
Philippines	Metro Manila	1.75	1.52	0.35	6.29	2.21	3.70	0.26	0.42	0.34	0.42	1.30
Thailand	Bangkok	8.37	7.94	8.21	5.26	23.6	7.26	1.64	6.13	5.98	1.42	1.64
	Samutprakarn											
Vietnam	Hanoi	0.56	0.51	0.98	3.26	0.91	0.80	0.26	2.06	2.05	0.36	0.05

note) Data in hatched columns are only for the reference because data which do not satisfied the data completeness (For Hoa Binh and Hanoi, only one month data are available).

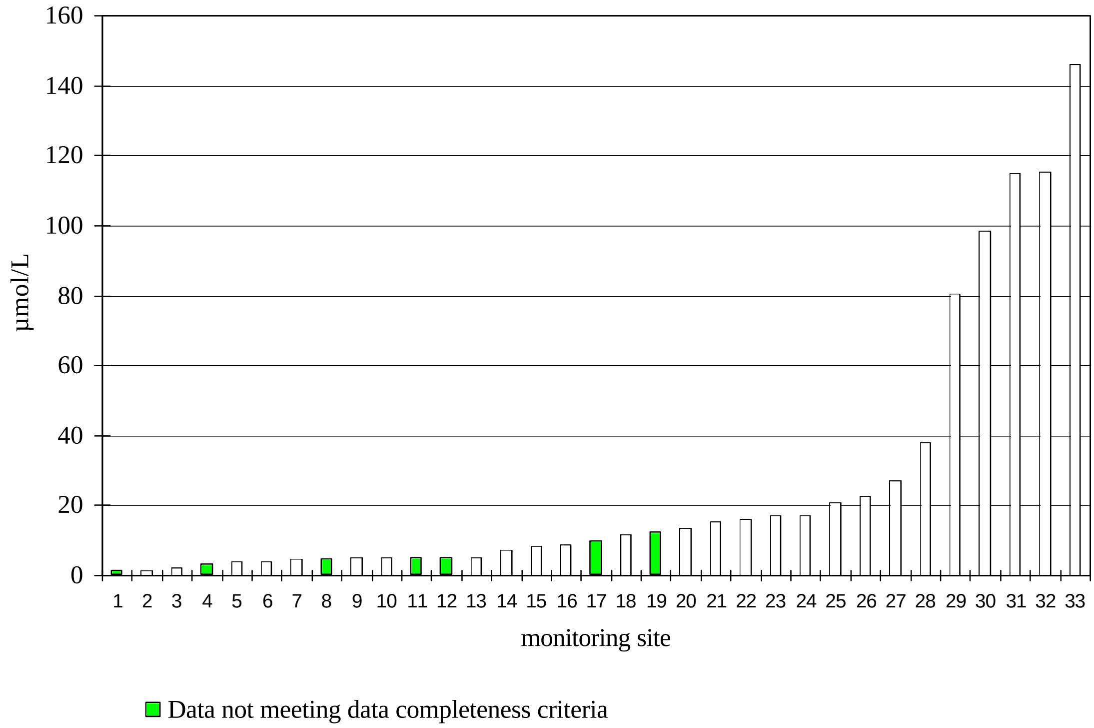


Fig. 5.1 June 1999 - August 1999 seasonal weighted averages of nss-SO_4^{2-} concentration

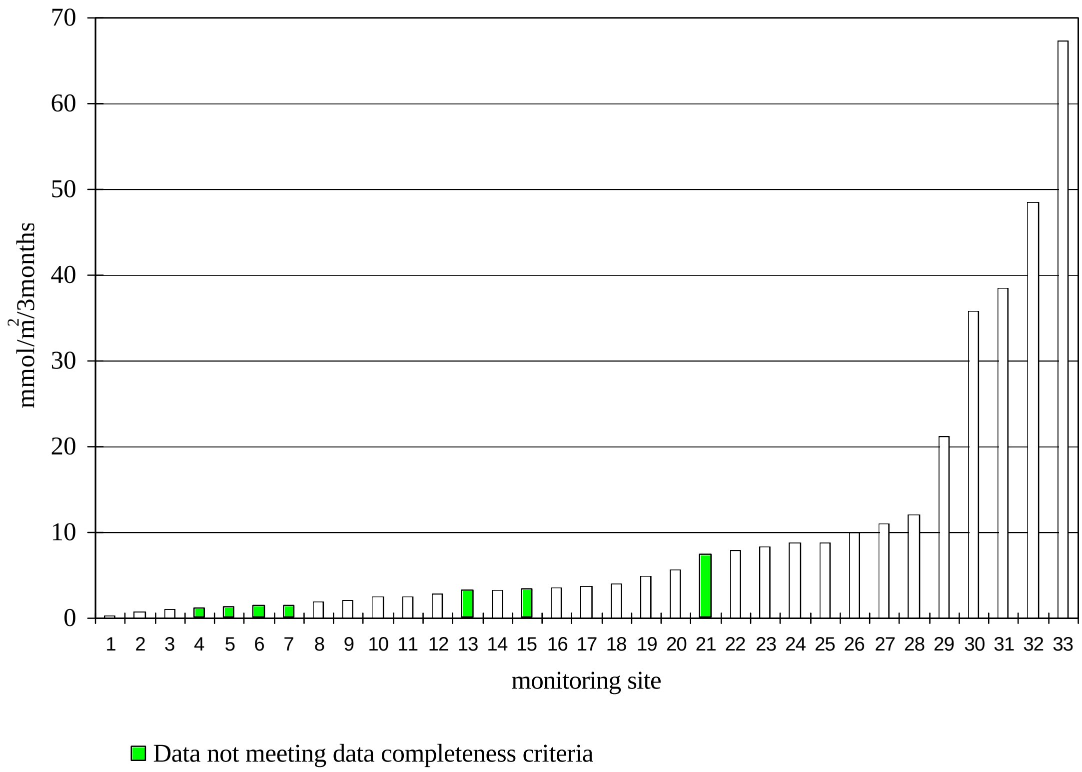


Fig. 5.2 June 1999 - August 1999 seasonal nss-SO_4^{2-} deposition amounts

5.2 Dry deposition monitoring

5.2.1 Concentration and deposition of sulfur dioxides

47. In the preparatory phase, eight countries reported concentration data of sulfur dioxides, which is one of the main chemical species to be a cause of acid deposition. Fig.5.3 indicates average concentrations of sulfur dioxides, in August - September 1999, measured by automatic monitor. The concentrations show the level about 0 ppb - 10ppb.

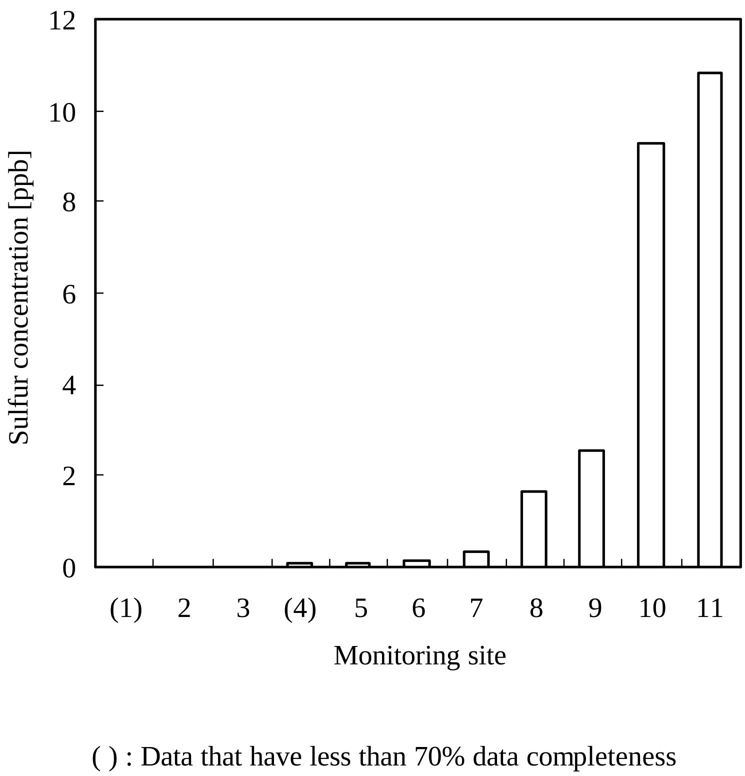


Fig. 5.3. Average SO_2 concentrations, measured by automatic monitor from August to September 1999.

48. Dry deposition velocities should be inferred from some measured parameters, for example wind speed, temperature, humidity, solar radiation, surface wetness, leaf area index, biological species distribution and so on. The methodology to infer dry deposition velocity in East Asia should be established through researches in reference sites, following the step-wise approach indicated in the "Strategy Paper for Future Direction of Dry Deposition Monitoring of EANET". In this report, attempt to

evaluate dry deposition was carried out taking into account the results of the concentration monitoring of sulfur dioxides.

49. In the literature, deposition velocity ranges are reported about 0.1 - 2 cm/sec for various surfaces, such as conifer forests, deciduous forests, heath land, crop, grasslands, water and bare soil, (reviewed by Erisman and Baldocche (1994)). Figure 5.4 shows an example of dry deposition rates as a function of deposition velocity at low SO_2 levels. If a deposition velocity of 0.5 cm/s is assumed for SO_2 in terrestrial environments (Fujita et al.1991) and SO_2 lies in the range 0.1 - 1 ppb, then estimated dry deposition of 0.05 - 0.5 mmol/m^2/month is implied. Comparison of these values with monthly nss-SO_4^{2-} wet deposition rates at sites reporting low SO_2 level shows that dry deposition cannot be ignored even at low SO_2 levels.

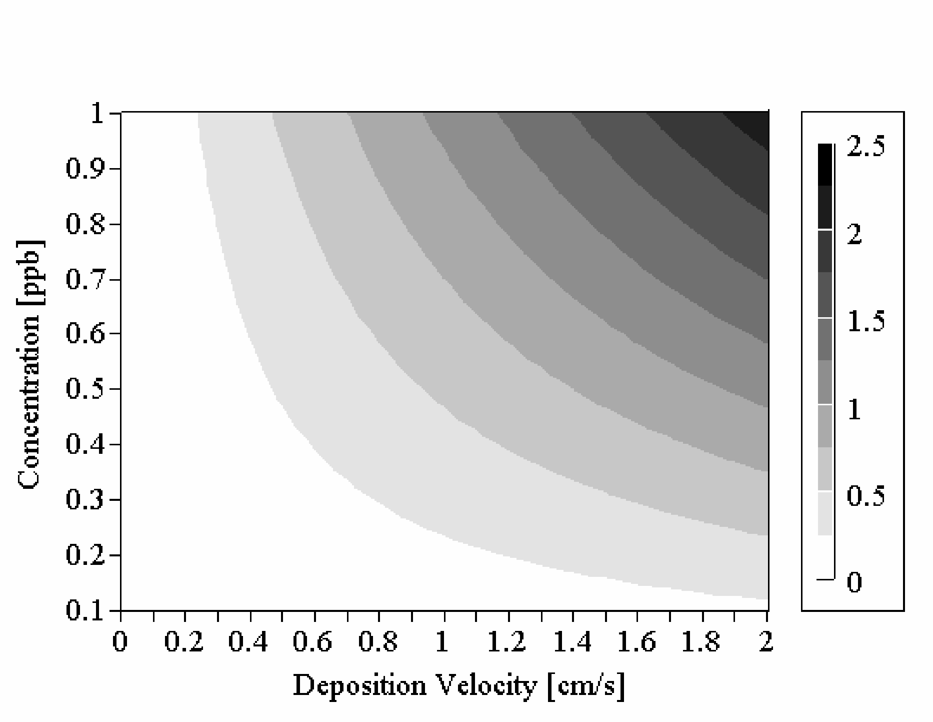


Fig.5.4 An example of calculated dry deposition (unit: mmol/m^2/month) for remote sites.

50. These results indicate that estimation of dry deposition is important to know the status of acid deposition in East Asia. It is expected to establish the methodology to infer dry deposition velocity in East Asia (following the step-wise approach indicated in the “Strategy Paper for Future Direction of Dry Deposition Monitoring of EANET”).

5.2.2 Evaluation of the Filter Pack monitoring results

51. In the preparatory phase, air concentration monitoring was carried out using available methods such as automatic monitors, filter packs, passive samplers and so on. Harmonization of the data measured by different methods is difficult in this stage. On the other hand, filter pack monitoring was carried out in 5 countries with the same method of 4 stages and weekly (biweekly) sampling. Table 5.3 shows the mean concentrations from August to September in 1999 measured at EANET sites of Mondy, Ulaanbaatar, Terelj, Tanah Rata, Hanoi and Hoa Binh.

52. Although there are some problems, such as artifacts on filters, the filter pack method has been applied to other monitoring networks such as EMEP, CASTNet, CAPMoN and many scientific research projects. The results of efficiency tests indicate its reliability (e.g. Sickles et al.,1999; Eatough et al, 1988; Hastie et al., 1988), but there are few experiences of efficiency tests using it in tropical and frigid regions. The concentrations of sulfur, nitrogen and chloride compounds at selected sites are shown in Table 5.3. The concentration of sulfur (SO_2+sulfate), nitrogen (HNO_3+nitrate) and chlorine (HCl+chloride) compound are shown in Fig.5.5. Since the difference of the artifact by the climate difference between sites was not clear, they were treated as the total concentrations, which added particulate and gaseous concentration. The ratio of three components in each site does not show much difference except in Terelj.

Table 5.3 Concentrations measured by filter pack method from August to September 1999

[nmol/m^3]	Russia	Mongolia		Malaysia	Vietnam	
	Mondy	Ulaanbaatar	Terelj	Tanah Rata	Hanoi	Hoa Binh
SO_2	2.0	39.8	3.4	4.2	58.8	56.3
HNO_3	3.1	8.2	1.6	6.3	25.4	11.4
HCl	1.9	26.9	12.9	6.3	23.7	18.3
NH_3	32.2	262.0	25.5	18.8	555.6	260.8
SO_4^{2-}	2.8	19.6	1.5	17.2	5.6	16.8
NO_3^-	0.1	23.9	0.6	2.6	1.1	1.5
Cl^-	1.2	17.4	0.7	1.7	0.3	0.0
NH_4^+	5.0	12.2	1.1	25.0	15.3	30.1
Na^+	1.3	18.0	0.8	3.6	3.0	2.7
K^+	0.2	13.9	1.2	3.1	1.1	1.3
Ca^{2+}	1.2	99.9	2.0	0.8	12.0	19.1
Mg^{2+}	0.4	8.6	0.4	0.5	0.0	0.0

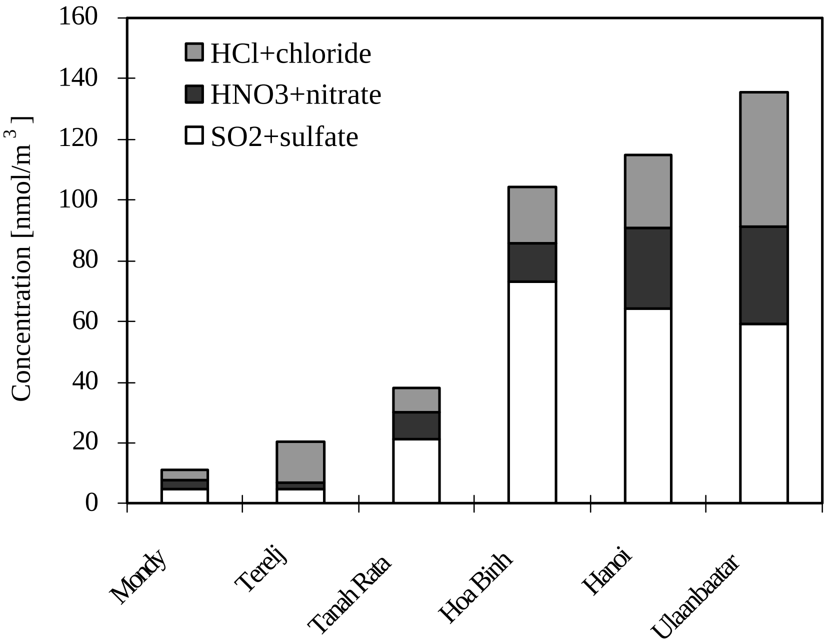


Fig. 5.5 Concentrations of sulfur (SO_2+sulfate), nitrogen (HNO_3+nitrate), chloride (HCl+chloride) compounds measured by filter pack method from August to September 1999.

53. The concentrations of SO_2 in remote site are in many cases, too low to be measured by present automatic monitor. In the case of Japanese remote sites, it happened that over 90% period of a month concentrations could not be measured by automatic monitor because they were below detection limits. The filter packs, which accumulate chemical species and detect concentration, are considered to be suitable for the monitoring in such remote sites. It is expected that the filter pack monitoring in EANET be further sophisticated by the Task Force on Dry Deposition Monitoring.

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5.3 Soil and vegetation monitoring

54. For the evaluation of possible impact of acid deposition on the terrestrial ecosystem, it is very important to carry out soil and vegetation monitoring. Especially for soil, the long term monitoring is necessary since the acidification process of soil may be relatively slow. Thus, it may be difficult to evaluate the condition of the soil and vegetation based on the data only during the preparatory phase. In this subchapter, the present evaluation of the submitted data including the site information is described.

5.3.1 Site

55. In the participating countries, one or a few rural or remote sites were selected for the soil and vegetation monitoring with consideration of the situation of each country (Table 3.5). These rural and remote sites may be useful for accumulation of baseline data and evaluation of effect of long range transport pollution. However, urban site may also be important in order to detect the possible impact of local pollution. For the long term monitoring, conservation of monitoring area is necessary. Since most monitoring sites are selected in forest reserves, such as public parks, the long-term monitoring may be expected.

5.3.2 Soil monitoring

56. For soil monitoring, two soil types, sensitive and non-sensitive soils would preferably be selected in an area within a radius 50km of deposition monitoring sites. The data of different soil types may be informative to evaluate the variances in the sampling process, and also it may be effective for detection of the possible impact by acid deposition. In most monitoring sites, more than two types of soil have been selected. However, it might be difficult to select the ideal pair of soil types. Since the soil properties have been developed based on the climatic, geological, geographical and other environmental factors, the number of soil types which could be found in a relatively small area would usually be limited, especially in tropical region. In Hoa Binh monitoring site of Vietnam, two soil types, Xanthic ferralsol and Humus ferralsol were selected, however type of the both soils could be classified into a kind of red soils (Ferralsols).

57. Many factors in pedogenic process, such as the supply speed of organic substances and weathering rate of minerals, could affect the chemical properties in addition to the parent material of soil. These factors may be closely related with temperature, precipitation amount and other climatic conditions. The East Asian region is latitudinally wide area, and climatic conditions are diverse. A number of soil types

with different chemical properties could be found in the participating countries. The soils, which were collected for the preparatory-phase activities, had significantly different properties. For instance, the soil type “Helic gleysol” in Russia has high content of exchangeable Ca (e.g. 98.2 cmol(+)/kg for AB horizon) probably due to high concentration of organic matters, while “Arenosol” in Japan which is a kind of sand-dune soil has significantly lower content (e.g. 0.4 cmol(+)/kg for A horizon). For the future evaluation, these baseline data of many soil types should be accumulated.

5.3.3 Vegetation monitoring

58. The results of survey of tree decline were submitted from three countries. The tree decline was reported only from Japan. However, the natural factors, such as insect damage and suppression by other trees could be considered as causes of tree decline, and the implication between the acid deposition and the decline has not been clarified.

5.4 Monitoring for inland aquatic environment

59. Results of monitoring on inland aquatic environment in seven monitoring lakes/reservoirs are summarized in Table 5.4. Range of parameters which related to acidification of inland aquatic bodies is 6.9 to 8.0 for pH, 0.17meq/l to 1.71meq/l for alkalinity, and 2.7mS/m to 23.8mS/m for electric conductivity. Even at lowest pH (6.9) in Banryu Lake, alkalinity of 0.17meq/l does not seem to be lower than sufficiently sensitive level affected by acid deposition. These obtained data show the present status of target lakes/reservoirs. Continuous monitoring at the same sites or other more sensitive lake/reservoirs for acidification is expected in a future.

Table 5.4 Measured range of major parameters related to the water quality

Site Name	pH	Alkalinity (meq/l)	EC (mS/m)	Area (km^2)	Watershed Area(km^2)	SO_4^{2-} (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)
Ilchir Lake	7.97	1.71	23.8	3.08	52	29.8	32.1	9.20
Ijira Lake	7.5	0.17	3.9	0.1	5.4	4.84	3.45	1.34
Banryu Lake	6.88	0.17	10.1	0.13	0.73	4.33	1.43	1.80
Hoa Binh Reservoir	7.53	1.58	14.3	25	13,700	2.97	22.2	4.6
Mojikap Lake	7.86	-	2.7	-	-	10.0	12.6	13.3
Patenggang Lake	7.8	0.46	7.9	0.6	-	4.3	6.0	2.3
Khao Lam Dam	7.6	-	13.1	388	3,720	1.2	23.2	2.3

6. Major problems and constraints

Site selection

60. Site selection is a critical factor for the monitoring. For wet and dry deposition monitoring in EANET, siting criteria is specified according to the classification of monitoring sites. For example, minimum distance from pollution sources such as power plants and main roads are defined as well as the local criteria around the site.

61. Particularly for monitoring on inland aquatic environment, selection of sensitive lakes /reservoirs is essential to grasp the effects of acid deposition to the targeted sites. However, present site selection criteria for monitoring inland aquatic environment are not easily met in many participating countries. Appropriate sites for monitoring inland aquatic environment should be explored along with the elaboration of site selection criteria.

62. To adequately assess the regional situation of acid deposition, appropriate numbers and locations of monitoring sites may need to be further discussed and elaborated in the future.

Equipment for monitoring and analysis

63. In some countries, precipitation samplers are not still a recommended "wet-only" type ones. Comparable monitoring data can't be obtained by using different types of samplers. In some countries, lack of sophisticated high sensitivity analytical equipment such as ion chromatograph is a main problem to obtain reliable data. Employment of such equipment is expected in those countries.

QA/QC activities

64. During the preparatory phase, many countries have strengthened their QA/QC activities, and some countries have developed their national QA/QC programs. In addition, some laboratories have developed standard operating procedures (SOPs). The two inter-laboratory comparison projects revealed that the QA/QC levels in the participating laboratories have, in general, much improved. However, it seems that there is still room for further improvement for QA/QC activities.

Data quality assessment

65. Ion balance (R1) and conductivity agreement (R2) check is a useful tool to evaluate wet deposition monitoring data. At some sites, R1 and R2 values were not within allowable ranges. As mentioned by some ad hoc data quality assessment group members, the region is so diverse and therefore, R1 and R2 may not meet the criteria due to various reasons. In some sites, existence of unidentified ions such as bicarbonate/carbonate, fluoride, and organic acids, may be the cause. Effort should be made to clarify the reason why R1 and R2 do not meet the criteria in respective sites.

Lack of appropriate sets of data

66. Some monitoring data that had been initially submitted to INC were incomplete data sets that did not include some important information such as the amount of precipitation. In addition, data submission was significantly delayed from some countries, and some monitoring data were not submitted by using the data reporting formats. Although they made the data quality assessment significantly difficult, these problems are expected to be improved by accumulating experiences as well as conducting intensive training.

7. Further steps to improve the monitoring

Review and revision where appropriate, of national monitoring plans for the next phase

67. Based on the experience during the preparatory phase, national monitoring plans should be reviewed and revised where appropriate for the next, more permanent phase. Some countries may wish to review their present monitoring sites and relocate them to more appropriate ones. Some other countries may wish to expand their monitoring sites in a step-wise manner, taking into account the appropriate national and regional distribution of monitoring sites. The results of such review would be reported to the scientific advisory body in the next phase.

Strengthening of QA/QC activities

68. To obtain comparative and reliable data, QA/QC activities should further be strengthened. Inter-laboratory Comparison should be continuously undertaken and the results should be disseminated. A report on the state of QA/QC activities in the participating countries should be prepared and reported to share the experiences.

Capacity building on monitoring methodologies

69. The results of Inter-laboratory Comparisons revealed that there is room for further improvement of analytical accuracy and precision. Intensive training should further be undertaken at national and regional levels by appropriate bodies such as national centers and the (Interim) Network Center. Development and dissemination of training and technical reference materials should be undertaken. Exchange of experiences among the participating countries, as well as other regional networks and international organizations would also be a useful tool to improve the skill of the participating countries.

Further elaboration of monitoring methodologies

70. Considering the significant diversity in the region, effort should be continued to further elaborate monitoring methodologies suitable for this region, such as wet deposition monitoring in frigid zones and soil and vegetation monitoring in tropical zones. Methodologies, in particular, for dry deposition monitoring, and soil and vegetation monitoring in this region need to be further elaborated.

Installation of appropriate equipment

71. Effort should be made to install appropriate equipment for sampling and analysis in those countries that have not done so.