March 23, 1995

Chairman's Summary on The Second Expert Meeting
on
Acid Precipitation Monitoring Network in East Asia

1. The Second Expert Meeting on Acid Precipitation Monitoring Network in East Asia was held on 22 and 23 of March, 1995 in Tokyo, Japan. It was chaired by Mr. Saburo Kato and organized by the Environment Agency of Japan. Keynote addresses were made by three invited experts: Mr. Bob Wilson (UN Economic Commission for Europe (UNECE)), Dr. Ramesh Ramankutty (the World Bank), and Dr. Soon Ting Kueh (Malaysian Scientific Association).

2. The Meeting was attended by 58 administrators and researchers from China, Indonesia, Japan, Korea, Malaysia, Mongolia, Philippines, Russia, and Thailand, as well as 6 experts from the Acid Rain Network in South, East and Southeast Asia (ARNSESEA), UNECE, the United Nations Environmental Programme (UNEP), and the World Bank. The Meeting was also attended by about one hundred observers, mostly from local governments, universities and public organizations.

3. The major objectives of the Meeting were finalization of the draft Guidelines for Monitoring Acid Precipitation in the East Asia Region, and elaboration of the draft Conceptual Design of an Acid Precipitation Monitoring Network in East Asia. The finalization of these objectives meets the needs expressed in the Chairman's Summary of the First Expert Meeting.

4. The participants discussed in detail issues relating to the above objectives by setting up the following three groups. The first group, chaired by Dr. RTM Sutamihardja of Indonesia, discussed the conceptual design of the acid precipitation monitoring network. The second group, chaired by Prof. Wang Wenxing of China, examined guidelines for monitoring acid precipitation. The third group, chaired by Assoc. Prof. Muhamad Bin Awang of Malaysia, examined guidelines for monitoring soil, vegetation and inland aquatic environments. Final discussion of the issues was completed at the plenary session.

5. As a result of their discussion, the participants agreed to use the term "acid deposition," rather than "acid precipitation," in order to accommodate all aspects of so-called acid rain issues in the future development of the network.

6. The Meeting adopted the Guidelines for Monitoring Acid Deposition in the East Asia Region (**Attachment I**). The participants recommended that countries in the East Asia region refer to the Guidelines in developing and implementing acid deposition monitoring systems appropriate to the conditions in their respective countries.

7. The participants agreed that practical step-by-step application of the Guidelines should be accepted in light of different national priorities and capabilities in conducting acid deposition monitoring.

8. The following recommendations were made regarding further development of the Guidelines.

   1) For effective implementation of the agreed Guidelines, it is essential to have a technical manual. It was felt that the necessary work for preparation of such a manual should be started as soon as possible. One possible means of carrying out this task is to set up a working group consisting of experts from participating countries in the region, as well as other international experts.

2) The importance of monitoring dry deposition was emphasized, even though the methodology is still in a preliminary stage. Therefore, the monitoring of dry deposition (gases and aerosols) should be discussed in more detail at the Third Expert Meeting.

3) The appropriate aspects of QA/QC should be reflected in each chapter of the Guidelines. Existing Chapter 4 on QA/QC should be retained and expanded to include sections on accuracy, precision, completeness, representativeness and comparability. Further sections on training and the organization of QA/QC should also be included.

4) Chapter 5 on data management and applications should be expanded to include sections on data collection, transfer, assessment, and use of the results. A further section on data management, including data dissemination, should also be included. It was further recommended that a section be included in this chapter describing research methods, e.g., paleolimnology (diatoms, etc.), dendrochronology (tree ring analysis), and soil profile analysis, by which historical records of pollution levels can be produced and related to long-term changes in acidification.

5) In view of the specialized terms used in the Guidelines, it is recommended that a glossary be produced.

6) Wherever possible, monitoring of air pollutant concentrations and depositions and their impacts on soil, vegetation and inland waters should be conducted at the same site. Such an approach would be compatible with that adopted by the UNECE Integrated Monitoring Program, and the UNEP GEMS program.

9. Elaborations on the conceptual design of an acid deposition monitoring network are summarized in **Attachment 2**.

10. The document titled "Conceptual Design of an Acid Precipitation Monitoring Network in East Asia" was well received as a basis for further elaboration. The participants agreed that an acid deposition monitoring network should be dedicated to a common understanding of acid deposition for countries and organizations of the East Asia region, and to providing useful inputs for policy-making to determine measures to prevent acid deposition problems.

11. The participants also agreed on five principal components of an acid deposition monitoring network in East Asia: 1) establishment of national acid deposition monitoring systems, 2) establishment of a monitoring network center(s) in the region, 3) data, experience and information exchange among participating countries, 4) central compilation and analysis of monitoring data, 5) capacity building activities.

12. A number of points were emphasized regarding the monitoring network, for example, the importance of capacity building, practical step-by-step implementation of monitoring activities, and the main functions of the proposed monitoring network center(s).

13. The participants agreed that availability of financial resources for meeting the objectives of the proposed network is a major issue, and recommended exploration of funding instruments.

14. The participants considered issues requiring further discussion (see **Paragraph 4 of Attachment 2**), and requested that the Secretariat of the Meeting report on those issues at the Third Expert Meeting. In this connection, the importance of intensive discussion and consultation among participating countries was stressed as being necessary for arriving at successful agreements at the Third Expert Meeting.

15. A need for policy-making level decisions on the establishment of a monitoring network was

emphasized and it was recognized that the achievements of the Expert Meetings would be reported to high level meetings, such as ECO-ASIA, ESCAP and APEC.

16. The participants agreed on the need for collaboration between the network and other related activities/agencies, such as the RAINS-ASIA project, Environmental Assessment Program-Asia Pacific of UNEP, ARNSESEA, UNECE, and the United States National Acid Precipitation Assessment Program (NAPAP).

17. The Meeting welcomed the kind offer of the Niigata Prefectural Government to host the Third Expert Meeting. It is expected that at this meeting concrete results will be achieved toward realization of the proposed acid deposition monitoring network.

Annex 1

Guidelines for Monitoring Acid Deposition in the East Asia Region

Adopted at:
The Second Expert Meeting on Acid Precipitation Monitoring Network in East Asia – March 1995, Tokyo

Organized by:
Environmental Agency, Government of Japan

Contents

2. Analytical Methods

Chapter 4: Quality Assurance and Quality Control (QA/QC)

Chapter 5: Data Management and Their Application

Introduction

Acid deposition is not just a domestic concern; it is also a regional environmental problem that transcends national boundaries. As emphasized in Chapter 9 of Agenda 21 (on transboundary atmospheric pollution), adopted at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, acid deposition is a problem that requires international cooperative efforts for its solution.

East Asia is receiving considerable international attention. The East Asia region contains 21 percent of the Earth's landmass and 35 percent of the world's population, and in recent years has shown rapid economic growth. Currently, the economic growth rate of most countries in East Asia is five to ten percent per year, and energy consumption is increasing in many countries. As a result, East Asia already accounts for one-third of total air pollutants released world-wide, and the region's overall rate of increase is higher than that of any other region in the world. If current trends continue, there is great cause for concern that adverse effects from air pollution and acid deposition will develop over large areas of the region. Of particular concern are potential impacts on ecosystems, due to the fact that the acid-neutralization capacity of soils over a substantial part of East Asia is as low as that in parts of North America and Europe.

So far, there have been no official reports of extensive damage due to acid deposition in the region. However, damage attributable to acid deposition, including deforestation and degradation of buildings, has been pointed out in some countries. The region is increasingly facing threats from acid deposition, and it is becoming essential to undertake measures to meet these threats, both in the respective countries of the region and through regional cooperation.

Having the participation from ten countries in the region, (i.e. China, Indonesia, Japan, Korea, Malaysia, Mongolia, Philippines, Singapore, Russia and Thailand), the First Expert Meeting on Acid Precipitation Monitoring Network in East Asia was held in October 1993. The Chairman's Summary of the Meeting recognized that a regional acid precipitation monitoring network was needed and concluded that, "regional cooperation being essential to this end, it was stressed that an appropriate way of collaborative monitoring should be studied to assess the state of acid precipitation in East Asia. Taking into account the fact that the monitoring methods vary with countries, the participants found it beneficial to have guidelines suitable for this region."

Based on the results of the First Expert Meeting, draft guidelines had been prepared by the Environment Agency of Japan. Through the careful review and discussion among the participating countries, these guidelines have been adopted at the Second Expert Meeting on Acid Precipitation Monitoring Network in East Asia, which was held in March 1995, Tokyo.

These guidelines include the basic elements that should be considered when countries in the East Asia region conduct monitoring of the three environmental media of atmosphere, soils and vegetation and inland aquatic environments. Taking into account the present state of monitoring being conducted in East Asian countries, and noting practical exemplary cases in Western countries, these guidelines were formulated to serve as standard methods applicable given the geographical, meteorological, social, and other characteristics of the East Asia region.

It is hoped that the countries in the East Asia region refer to these guidelines in developing and implementing monitoring systems appropriate to the conditions in their respective countries. Each country's monitoring will be based on appropriate modifications of these guidelines in accordance with the respective country's natural conditions (such as geology and meteorology) and socioeconomic situation. Each country should endeavor to formulate plans and implement technical training for monitoring activities, as well as to improve the quality of monitoring results. It is also desirable that each country analyze and assess the monitoring data, disseminate the results, and exchange information with other collaborating countries and related organizations.

These guidelines will be reviewed and updated in a timely and appropriate fashion, in keeping with advances in scientific understanding. It is desirable that the countries in the East Asia region endeavor to improve monitoring systems for acid deposition by making effective use of these guidelines.

Chapter 1: Guidelines for Monitoring Acid Deposition

I. Purpose

This chapter describes the basic factors to be considered in conducting monitoring of acid deposition. Monitoring data obtained from systematic observations based on these guidelines can be utilized to assess impacts of acid deposition on ecosystems (such as forests) and effects on structures (such as urban buildings). The resulting data can also be utilized for evaluation of long-range transport and deposition models, detection of long-term changes in air quality, and identification of emission sources of acid precursor substances. In the future, it is expected that such monitoring will provide the basis for cooperative studies with other acid deposition monitoring networks and will contribute to the formulation of proposals to governments for control of the emission sources of acid deposition.

II. Selection of Acid Deposition Sampling Sites

Selection of sampling sites is a critical factor in the collection of deposition samples. Sampling sites should be located in areas suitable to the purpose of the survey, should be free from the influence of nearby emissions sources, and should properly represent the area in question. Sites should also be selected in places where monitoring can be continued over a long period. It is recommended that sites be located within the boundary layer. In addition, it is desirable that sites be located at existing meteorological monitoring stations, or in their vicinity.

1. Considerations for Sampling Site Selection

a) Urban Sites

Urban sites are to be selected for the assessment of the state of acid deposition in large urban areas. The assessment can be used, for instance, to evaluate the effects on structures and historical monuments. Acid deposition measurements at these sites will also be useful for the assessment of levels of air pollution and their trends in urban areas. Therefore, the sites should be selected to represent mean levels of air pollution and acid deposition in the urban area. The area surrounding the site should be free from continuous structural change. The influence of surrounding buildings on acid deposition sampling should be kept to a minimum.

b) Rural Sites

Rural sites are to be selected for the assessment of the state of the acid deposition in rural areas. The assessment can be used, for instance, to evaluate the effects on agriculture and livestock farming. The sites should represent mean levels of acid deposition in the areas, and therefore should be free from local sources of acidic substances such as from nearby industries, freeways, and windblown soil.

c) Remote Sites

Remote sampling sites are to be selected for the evaluation of long-range transport and deposition of acidic substances. Therefore, the sites should be free from the influence of industrialized and urbanized areas, power stations and other significant emission sources. Minimizing local influences from agricultural activities should also be considered. The sampling sites also must be little affected by line sources such as freeways, airports, and railways. Rural sites which satisfy the above criteria may also be regarded as a remote site.

d) Sites in ecological areas

Sites should be selected within areas where ecosystems remain in good condition. It is desirable for soil/vegetation and/or river/lake monitoring to be conducted at the site.

2. Areas Surrounding Sampling Sites

The areas surrounding the selected sampling sites should meet the following conditions:

- Landuse in the vicinity of the selected sites is expected to remain in almost the same condition for several decades.
- Sampling sites should not be placed where they receive less deposition than other surrounding areas due to the interference of structures, canyons or hills. They should not be located in areas dominated by local effects, such as coastal areas which receive sea spray.
- There should be no structures other than the monitoring station in the vicinity of the site. There should be no obstacles within a vertical aperture angle of 45 degrees from the sampling site.
- The area around the monitoring station should be a flat grassland, sparsely forested area, or other similar area that does not generate dust.

III. Wet Deposition Monitoring Methods

As monitoring methods for dry deposition have yet to be standardized, only the basic concepts underlying wet deposition monitoring methods will be presented here.

1. Collection and Handling of Samples

All samples referred to here are "wet only" samples. The most appropriate device is a wet-only sampler. However, also acceptable are wet/dry versions which are composed of two collection buckets, one for collection during the wet period and another for collection during the dry period. A lid alternatively covers the bucket not in use. All samplers need not be of the same type. Already several different types are in use in various countries.

The sampler basically consists of a collecting funnel, a lid that can be opened and closed, a rain sensor, and a sample container. It is desirable that the sampler contain a filtration unit. A refrigeration unit or biocide should be used for preservation of samples.

The sampling of snow is difficult, and no standard snow sampler has been developed at present. One method is to collect snow with a cylindrical container. Another method is to install a rain sensor and heat the collecting funnel with a heater in order to melt snow before collection. Due attention should be paid in order to minimize the loss of sampled water by evaporation. It is desirable to attach a device (e.g. Nipher-shield) to the sampler, or to install wind shields to minimize the effect of wind on the sampling of snow.

Samples should be collected every 24 hours. Collection can also be conducted for each precipitation event. It is desirable that pH be measured immediately after collection. If the sample can not be collected every 24 hours, then it is highly recommended that first, a sampler containing a filtration unit be used, and second, a refrigeration unit or biocide be used to preserve the sample. It is desirable to collect meteorological data at the monitoring site or in the vicinity.

Precipitation amount must be measured and recorded at the sampling site with each country's standard precipitation gauge or its equivalent. If this is not possible, precipitation amount should be estimated, e.g., by precipitation data obtained from a nearby meteorological station.

Permanent signs to identify sampling locations should be installed in order for all samples to be taken at the same location every time.

2. Transportation and Storage of Wet Deposition Samples

Care should be taken to prevent deterioration of samples during transport from the site to the laboratory for analysis. An ice box or biocide should be used to preserve the sample during transportation. After sample collection, the sample should be filtrated as soon as possible, either at the site or in the laboratory. Samples should be refrigerated to prevent deterioration after their collection.

IV. Measurement Parameters and Analytical Methods of Wet Deposition

1. Measurement Parameters

Parameters that should be measured are: pH, electric conductivity, SO_4^{2-}, NO_3^-, NH_4^+, Ca^{2+}, Na^+, Cl^-, Mg^{2+}, and K^+. Measurements of insoluble components and minor ions, including F^-, $HCOO^-$ and CH_3COO^- should be considered for future monitoring.

2. Analytical Methods

Ideally, analysis should be conducted separately for each sample. If necessary, due to unavoidable reasons, samples collected over a one-week period could be combined and analyzed as a single sample.

The most preferable means of measuring pH is with a pH meter using a glass electrode.

The most preferable means of analyzing anions is with an ion chromatograph (IC). Wet chemical analysis, such as colorimetry and turbidimetry, may be employed if an IC is not available.
Ammonium ion is usually analyzed by colorimetry, whereas Na^+, K^+, Mg^{2+}, and Ca^{2+} are usually analyzed by atomic absorption spectrophotometry. However, to simplify analytical procedures, these five cations may be analyzed simultaneously using an IC.

3. Ion Balance and Conductivity Checks

Data quality should be assessed by calculating the ratio of the cation sum to anion sum (R1), and the ratio of calculated conductivity to measured conductivity (R2). If the ratios differ significantly from unity, the discrepancy should be resolved, e.g. by re-analysis of the samples.

V. Wet Deposition Data Reporting

Notes should be recorded of relevant facts related to the processes of sampling, transportation, preparation, chemical analysis, sampling storage, etc. Two distinct types of data should be reported: one type includes precipitation chemistry and precipitation amount together with remarks and notes, and the other type includes information about sites, collectors, instrumentation, etc.

Appendix: Basic Concepts Underlying Methods of Measuring Dry Deposition

Dry deposition is the process by which gases or airborne particulate substances (aerosols) are directly transported and collected on the Earth's surfaces, including the surfaces of buildings, plants, and water surfaces, without the mediation of precipitation. Even in areas having relatively high precipitation, such as Japan, the annual amount of dry deposition is comparable to that of wet deposition. Dry deposition is not only locally dominant near emissions sources, is also believed to be predominant in the arid regions of East Asia, and during the dry season in areas marked by distinct cycles of dry and wet seasons, such as Southeast Asia.

In light of the fact that such situations exist, it is obvious that the measurement of dry deposition is essential for evaluation of models of long-range transport and deposition of air pollutants, as well as for an understanding of the impacts of acidic substances on ecosystems. However, the process of dry deposition is far more complicated than wet deposition because it is governed by micrometeorological conditions near the ground surface and the conditions of the surface itself. Methods to assess dry deposition have not yet been standardized. A method of measurement considered desirable is presented here.

As described below, this method is based on measurements of the ambient air concentration of deposited pollutants. Dry deposition flux is calculated using these concentrations and separate determinations of deposition velocities. The concentrations of gases and aerosols used in these calculations can also be employed to indicate the status of air pollution itself. Dry deposition flux (F) is usually expressed by the following equation:

$$F = V_d(Z_r) \times C(Z_r)$$

where F = deposition flux; $V_d(Z_r)$ = dry deposition velocity at a selected reference height, Z_r; and $C(Z_r)$ = concentration of deposited substance at the same height.

In assessing dry deposition, usually the concentration (C) is measured, whereas the deposition velocity (V_d) is estimated from existing data. Since V_d depends on the height above the surface at which deposition occurs, it is necessary to record the reference height Z_r at the time of the measurement of the concentration. In addition, since the deposition velocity of aerosol particles depends on particle size, it is desirable to measure the concentration of particulate matter as a function of particle size. However, the measurement of particle size distribution for each aerosol component demands considerable effort. A more practical method is to measure the total mass concentration of each component, determine the mean diameter (or effective diameter) for that component, and then use the appropriate deposition velocity for that given mean diameter.

Measurement Method

a) Major gaseous and particulate components to be measured include the following: (gases) SO_2, NO_2, HNO_3, O_3, NH_3, and HCl, (aerosols) SO_4^{2-}, NO_3^-, Cl^-, K^+, NH_4^+, Na^+, Ca^{2+}, and Mg^{2+}.

   Measurement of gas concentrations is usually conducted by the filter pack method, automatic measurement method, or diffusion denuder method. If the filter pack method is used, it is possible to measure simultaneously the following gaseous and particulate components: SO_2 and SO_4^{2-}, HNO_3 and NO_3^-, NH_3 and NH_4^+. However, precautions should be taken since the filter pack method can produce artifacts in the measurement of NH_3 and HNO_3 at high ambient temperatures, whereas the measurement of SO_2 involves no such problems. Artifact-free measurement can be conducted by using a denuder. If the filter pack method is used, collection efficiency should be determined under different conditions, since the efficiency decreases at low relative humidity.

   Mean values of gaseous and aerosol concentrations should be obtained on the basis of, at minimum, a two-week, or preferably, one-month long field measurements, except for automatic measurement methods. The sample collection point should be positioned approximately 2 m above the ground.

b) Because the determination of dry deposition velocity (V_d) requires special equipment or facilities, it is impossible at present to conduct routine measurements over a large area. In the usual approach, measurement data for V_d are accumulated through field observations, or laboratory experiments under controlled conditions, and these are used for the estimation of the V_d value for the place and time for which the amount of dry deposition is to be determined. As noted above, it is necessary to maintain consistency between the height at which V_d is assessed and the height at which pollutant concentrations are measured. There are several methods to estimate V_d, such as deriving the value from model calculations based on measurements of several meteorological variables (including wind speed, temperature, and solar radiation), or, more simply, by assigning empirical values determined for the depositing substance and the characteristics of the deposition surface.

Extensive study will be required in order to determine the extent to which estimated values for V_d, derived from the above-mentioned methods, can be utilized reliably in assessments of dry deposition. Because there are vegetation types and ground surfaces that are unique to East Asia, it is desirable to measure V_d values for such surfaces.

Chapter 2: Guidelines for Monitoring Soil and Vegetation

I. Purpose

This chapter describes guidelines for the monitoring of impacts of acid deposition on soils and vegetation in the East Asia region. Extending from tropical to boreal zones, the countries of the region are diverse in terms of climate, soils and vegetation. Each country should select indicators suited to their circumstances in order to conduct monitoring of the impacts of acid deposition.

Moreover, it would be desirable to collect basic data necessary for future regional assessments of deposition (effective loads) on terrestrial ecosystems of given acid deposition impacts on soils and vegetation. Such data would be necessary to develop the critical loads (deposition) and critical levels (gaseous concentrations) approaches.

II. Collection of Information on Soils, Vegetation and Other Characteristics

In order to clarify the impacts of acid deposition on ecosystems in the East Asia region, standard maps of a uniform scale should be collated for soils, vegetation, surface geology and other characteristics. For vegetation, plant-sociological vegetation maps are desirable; however, physiognomic vegetation maps based on satellite photography are also useful. It is desirable to collect land-use maps that present the current patterns of land use. In addition, since climate and weather data are indispensable for soils and vegetation monitoring, it is desirable to collect such data to the greatest extent possible.

1. Distribution of Soil and Vegetation

a) Soil Maps

East Asian countries already possess their own soil maps. It is desirable to collect comparable maps with standardized international taxonomy. If these are not available, maps must be accompanied by columnar sections of representative soil profiles and analytical data that clarify the nature of the soils. It is desirable that the analytical data contain information which enables estimation of each soil's acid-neutralization capacity or sensitivity to acids. Surface geology maps can also be useful for the estimation of each soil's acid-neutralization capacity.

Large-scale soil maps of the vicinity around survey sites should be collected for use as basic reference data for the surveys and for determination of sampling methods.

It should be noted that FAO-UNESCO World Soil Maps are available as a series of soil maps covering the entire area of the East Asia region using unified taxonomical soil units.

b) Vegetation Maps

East Asian countries already possess their own plantsociological vegetation maps, physiognomic vegetation maps and/or land-use maps. It is desirable to collect maps that correspond with the international taxonomy.

It is desirable to collect large-scale vegetation maps which include the vicinity around the survey sites. If these are not available, it is also effective to use aerial photographs which show vegetation.

It should be noted that FAO-UNESCO World Vegetation Maps are available as a series of vegetation maps covering the entire area of the East Asia region using unified taxonomical vegetation units.

2. Scales of Soil Maps and Vegetation Maps

In order to draw effective load maps in the future based on the maps of soil and vegetation, such maps using a scale of approximately 1:2,000,000 should be collected, as a minimum requirement.

The scale of vegetation maps and soil maps describing the vicinities of sampling sites should be approximately 1:1000. The taxonomical units used in these maps should ideally correspond to the international taxonomy.

3. Climate and Meteorological Data

Each country should use weather observation stations to collect meteorological data, including temperature, precipitation, evaporation, wind direction, wind speed and insolation (e.g. photosynthetically active radiation, PAR).

4. Effective Load Maps

In the future, effective load maps should be constructed based on information concerning weather, soils, vegetation, land use, etc. collected for this survey and the load from acid deposition to indicate potential loads of acid deposition impacting ecosystems. Such effective load maps should be drawn to the scale of approximately 1:2,000,000.

III. Considerations for Selection of Indicator Soils and Indicator Plants

1. Indicator Soils

Select some soil types that have low acid buffering capacity. Some control sites with higher buffering capacity would also be useful.

A soil's capacity to neutralize the acidity of acid deposition varies depending on the type of bedrock, the type of soil, the content of exchangeable bases, topography and other factors. In particular, sensitivity to acid deposition tends to be high in areas where acidic bedrock is distributed, the soil pH is low, the soil is oligotrophic with a low base saturation percentage and the content of exchangeable aluminum is high. In such areas, continuous acid deposition tends to suppress the growth of plants.

2. Indicator Plants

In order to evaluate the impacts of acid deposition on vegetation, appropriate indicator plants (plant groups) that are highly sensitive to acid deposition should be selected. Such indicator plants (plant groups) should be placed artificially at the monitoring site and the growth of these plants, as well as those of specified naturally occurring plants (and groups), should be monitored.

Ideally, the plants used as indicator plants should: 1) show specific reactions to specific environmental changes, 2) react sensitively to environmental changes, 3) allow quantitative understanding of the relationship between environmental changes and the reaction of the plants and 4) react continuously over long periods so that the cumulative impact of environmental changes can be assessed.

Selection of indicator plants and methods for assessing impacts should be developed by each country, based on basic data and information collected. For this purpose, specialized training of technical experts must be conducted.

It is known that many plants show visible injury on leaves when exposed to low pH precipitation. Such indicator plants could be utilized for monitoring in areas afflicted by acid fog (for example of pH 3 or less).

IV. Selection of Soil and Vegetation Monitoring Sites

1. Preliminary Surveys

Preliminary surveys should be conducted over extensive areas in order to select sites for continuous monitoring to understand impacts of acid deposition on soils and vegetation. The geographical coverage of such surveys should preferably cover the area within approximately 50 km of acid deposition sampling sites (urban, rural, remote and ecological).

a) Soils

Distribution of soil types should be examined through field surveys or through study of soil maps, over the same geographical extent as those studied for vegetation in following b).

b) Vegetation

A survey line should be drawn from an emission source, large city or industrial area to an area that is considered to be relatively free from pollution. Locations along roads where similar vegetation occurs should be selected. The vegetation selected for monitoring should preferably be natural forests; however, other locations, such as parks, botanical gardens, orchards, roadside trees, artificial forests and others may be chosen, as long as species convenient for comparison are distributed there. Wherever possible, these surveys should be undertaken in areas where other environmental data are available or can be collected.

Abnormal reactions and changes of trees should be recorded; these abnormalities include the presence of dead trees, die-back trees, trees of abnormal growth and trees with defoliated branches; necrosis, chlorosis and color changes of leaves; and the presence of abnormal defoliation. Abnormalities should be detected more easily from the observation of forest margins, which have a higher degree of exposure. The results of such preliminary surveys should be recorded on a map.

2. Establishment of Monitoring Sites

Monitoring sites should be established by paying attention to the following considerations, so that continuous surveys of soil and vegetation can be conducted at the same sites. Sites should allow for continuous monitoring (at irregular intervals) and sites should be chosen where land use patterns around the sites are not expected to change for several decades.

a) Soil

Multiple sites (each roughly 1 ha in size) should be selected for continuous monitoring, based on the results of the preliminary survey. Some sites should be those with soils sensitive to acid deposition or for which impacts on vegetation are expected; other sites should be those areas in which such situations do not exist (control sites).

b) Vegetation

Multiple sites for continuous monitoring should be selected based on the results of the preliminary survey, including both those areas that showed abnormalities and those areas that did not. Preferably each monitoring site should be located in an area in which there is a closed natural stand measuring 1 ha or more and containing the representative vegetation of the area or an indicator tree species common to multiple monitoring sites. These conditions need not be met if a substantial area of natural stand does not exist, such as in suburban areas, although such survey sites must be located so as to be surrounded by a buffer zone.

V. Monitoring Methods

1. Soil

To compare data from various monitoring sites in order to examine the relationship between conditions found at monitoring sites and the growth of trees, soil profile surveys should be conducted at a single point representative of the average soil found at each monitoring site. Ideally, a monitoring site should not have more than one soil type.

The methods for soil surveys, survey variables and soil taxonomy should be unified according to FAO-UNESCO standards. Compatibility of soil survey information provided by each country should be assured through the provision of descriptions of the standard survey methods used in each country. Soil sampling should be conducted once every several years. The number of necessary sampling points necessary to achieve statistical significance should be determined beforehand. If the number of sampling points is too large, samples from different points may be combined to reduce the number of samples subjected to analysis. A large-scale map of the relevant area, indicating the location of the site should be attached.

2. Vegetation

A detailed vegetation survey covering indicator trees should be conducted at each monitoring site, to quantify changes to forests caused by both direct and indirect impacts of acid deposition. A representative number of upper-story trees should be selected as survey trees. These trees should be located regularly to the north, south, east and west of the center of the monitoring site. In addition to assessing the visual damage and the degree of decline of each tree, photographic records should be made showing the general view of the monitoring site, the forest canopy, the whole sky, abnormalities of leaves and branches, etc. The structure of vegetation at the time of the survey should be analyzed. To facilitate analysis of growth, including comparison of results with those of the next survey, each tree should be marked with a tree number and the position at which its diameter was measured should be indicated.

For sampling mature leaves, current leaves of dominant trees (preferably indicator plants) in at survey site should be taken from the upper parts of the tree crowns receiving sufficient wind and sunshine. Because leaf components differ for each individual tree and the part of each tree, sampling conditions must be confirmed carefully. The timing of sampling should coincide with the period in which the tree species being studied has the highest activity. However, if decline of the tree occurs in a specific period, sampling should be done during that period. The evaluation of the contents of metals and sulfur in leaves may need particular consideration. Since the data for these pollutants are often sparse in non-polluted areas, basic data may have to be collected before conducting evaluation of these pollutants.

In addition, it is desirable to select appropriate indicator plants, place them artificially in monitoring areas and regularly study their growth, the occurrence of visual injury on leaf surfaces, defoliation percentage and other characteristics.

3. Analysis of Ecosystems

Impacts of acid deposition on vegetation can occur in the form of long-term cumulative impacts. Such impacts can be detected by analyzing ecosystems from the standpoint of the material cycle in the monitoring site.

A survey of litter should be conducted annually to estimate the amount of the material cycle attributable to litter. A comparison of results from annual surveys for 2 or 3 years should be conducted to measure the quantity and quality of litter fall. It is possible to detect abnormal defoliation from such a survey.
In addition, it is desirable to conduct a survey of the surface organic layer (A_0 layer) to judge the state of degradation of litter and the nutrient cycle in the deposit of organic matter. Since the root system is likely to show the first signs of impacts caused by any acidification of the soil and any accumulation of toxic metals related to acidification, it is desirable to conduct root system surveys to compare the growth and decline of root systems in the surface soil.

When a survey is conducted to measure the load derived from acid deposition in a forest ecosystem, it is possible to evaluate impacts on the material cycle in the forest ecosystem by collecting and analyzing through-fall or stem-flow.

VI. Measurement Parameters and Analytical Methods

1. Soil

Soil samples collected at monitoring sites should be analyzed to clarify the physicochemical properties of each soil profile and to compare changes between years.

For the chemical analysis of soil samples, pH (H_2O) and pH (KCl) related to acidity should be measured by the glass electrode method. CEC (cation exchange capacity) should be measured using extraction by semi-micro Schollenberger method, although simple filtration may be used instead of this process. Although the measurement of exchangeable Na, K, Ca and Mg should preferably be conducted by spectrophotometry or atomic absorption spectrochemical analysis, the standard methods utilized in each country may be used instead. Exchangeable Al should be measured by neutralization titration after KCl extraction. Total carbon content and total nitrogen content should be measured by the Kjeldahl method or CN-analyzer method. Available phosphate is usually measured by the Truog method.

At the same time, the three-phase distribution and soil hardness of the soil profile should be measured.

2. Plant Material

The amount of sulfur contained in mature leaves should be measured in order to determine acid deposition at monitoring sites. Carbon, nitrogen and metals should be analyzed in order to detect factors causing abnormal growth, such as the absorption of nutrients or metals via the root system, acid deposition on leaves, etc.
Sulfur (total sulfur) in mature leaves should be determined by the combustion method. Total carbon and total nitrogen should be determined by the CN-analyzer method (Dumas' method). Nutrients such as Na, K, Ca and Mg and metals such as Al, Zn, Cu and Pb are preferably measured by atomic absorption spectrochemical analysis or spectrophotometry after wet ashing, although standard methods utilized in each country may be substituted.

Some plants accumulate particular pollutants. Samples from these plants in particular, but also from other clearly damaged plants and from the soil in which they are growing should be preserved for future analysis.

Chapter 3: Guidelines for Monitoring Inland Aquatic Environments

I. Purpose

In Northern Europe and North America, lake water pH levels decreased in the 1970's compared to the levels of the 1930's and damage resulting from this decrease, such as declining fish populations, was reported. The cause of this pH decline is believed to have been deposition of acidic substances into lakes in excess of their neutralization or buffering capacity.

According to the results of discussions at the specialist meeting of the Stockholm Conference on Acidification of the Environment held in 1982, acidification was acknowledged in many of the lakes in Sweden, Norway, Canada and the U.S. that were highly sensitive to acid deposition (i.e., lakes having low alkalinity and receiving considerable deposition of sulfate ions in their catchment basins). As these results indicated, inland bodies of water having low alkalinity and low electric conductivity are prone to acidification by acid deposition. Therefore it is necessary to conduct continuous monitoring of water bodies and aquatic fauna and flora. Effective ways to study past acidification processes include analyses of lake sediment cores for both chemical composition and changes in the species composition of plankton populations.

These guidelines address monitoring of acidification of inland bodies of water due to acid deposition and related impacts on aquatic ecosystems. This chapter describes basic factors to be considered in conducting monitoring of inland water systems in order to obtain basic information related to 1) determining present conditions, 2) analyzing historical trends, 3) forecasting future changes and 4) mitigating acidification when it affects water utilization.

II. Selection of Inland Aquatic Environment Monitoring Sites

1. Collection of Information Concerning Lakes

A list of lakes (including human-constructed reservoirs) located in the country in question should be compiled, along with additional information concerning the following:

- Origin
- Area
- Depth (maximum, average)
- Volume
- Catchment area and land use in the area
- Precipitation
- Number and flow rate of rivers flowing into and out of the lake
- Water residence time
- Water utilization
- Water quality (pH, electric conductivity, transparency, alkalinity, inorganic nitrogen, sulfate ions, etc.)
- Fauna and flora (phytoplankton, zooplankton, fish, etc.)

2. Selection of Lakes for Monitoring

It is desirable to monitor acidification of inland bodies of water by monitoring lakes. If there are no appropriate lakes, however, water from springs, river fountainheads or other similar water sources should be studied.

a) Criteria for Selection of Lakes for Monitoring

Lakes should be located within 50 km from a rural, remote or ecological site used for acid deposition monitoring. The minimum number of lakes to be selected is approximately as shown below:

- Rural	4 lakes
- Remote or ecological	3 lakes

b) Nature of Lakes, Springs for Monitoring

- Lakes

  Lakes chosen for monitoring should be harmonic type lakes, preferably having a depth of approximately 10 m or less, a water residence time of 1 year or less, an area of 1 ha or more, low alkalinity and electric conductivity, minimal anthropogenic water pollution and no coverage of the surface with aquatic organisms.

- Fountainheads and Springs

  A minimum of human activities such as deforestation, slash-and-burn farming or cultivation should be conducted or planned in the upstream area, which is the catchment area of the water sampling site. Nature protection areas are desirable.

III. Monitoring Methods

1. Lakes

a) Water Quality

Surface water should be sampled at one location at the center of the lake. In principle, measurement of pH and electric conductivity should be conducted at the site. Water samples for later analysis should be put in a tightly stoppered glass bottle or other container and kept in a cool dark place. Analyses should be performed at a laboratory as soon as possible after collection.

b) Plankton

Plankton should be gathered with a plankton net (mesh size: NXX25, pore diameter: approx. 0.1 mm) drawn vertically from the bottom of the lake to the surface at one location at the center of the lake. The sample should be fixed for storage in an appropriate preservative.

c) Lake sediment

If possible, it is desirable to estimate past changes in water quality by examining samples of lake sediment for the information recorded within. Lake sediment cores should be obtained at one location at the center of the lake with a core sampler of at least 5 cm diameter. The sediment sample should then be divided into strata as appropriate based on its condition and structure and measured to determine the chemical composition and composition of plankton species in the various strata.

The results of analysis of sediment core samples should be used to provide clues to assess the yearly trends of lake acidification when past water quality data are not available.

2. Fountainheads and Springs

a) Water Quality

Surface water should be sampled from one location at which water is moving. The sample should be treated and analyzed in the same manner as lake water.

b) Epiphytic Algae

Epiphytic algae should be sampled over a given surface area on gravel near the site of water sampling. The sample should be fixed and stored in an appropriate preservative.

3. Frequency

It should be certain, based on the size of the lake studied, that the sampling site at the center of the lake is adequately stable in terms of both water quality and sediment to represent the lake's conditions. Seasonal fluctuations in water quality, plankton and epiphytic algae can be understood by conducting sampling approximately 4 times each year, in the seasons shown below. It might be better in temperate and boreal areas to monitor so-called acid shock which takes place in very restricted period in spring while snow starts melting. The sampling of lake sediment is needed only once at the beginning of a survey, as this sample is considered sufficient for the analysis of past yearly trends up to the present.

- Temperate and boreal areas: 4 times a year (once each in spring, summer, autumn and winter)
- Tropical areas: 4 times a year (once each in wet and dry seasons, twice in transitional seasons)

IV Measurement Parameters and Analytical Methods

1. Measurement Parameters

a) Lakes

- Water Quality:
  pH, electric conductivity, alkalinity (pH 4.8 baseline)
  NH_4^+, Ca^{2+}, Na^+, Mg^{2+}, K^+, total Al^{3+} and if practical, inorganic Al^{3+}, NO_3^-, SO_4^{2-}, Cl^-, PO_4^{3-}

- Plankton:
  Species composition of diatoms

- Lake Sediments:
  SO_4^{2-}, NO_3^-, NH_4^+, Pb and, if possible, sulfur stable isotopes ratio and sedimentation date (lead-210 method)

- Plankton:
  Species composition of diatoms

b) Fountainheads and Springs

- Water Quality
  Same as lake water

- Epiphytic Algae
  Species composition of diatoms

2. Analytical Methods

a) Water Quality

- Alkalinity
  Alkalinity at pH 4.8 should be determined by titration using a pH meter.

- Other Components
  Use the same analytical methods as for acid deposition samples.

b) Plankton and Epiphytic Alga

After the sample is concentrated, identification of species and counting of the number of cells should be conducted under a microscope. Organisms should be classified by species according to their acid tolerance and the result should be expressed as a biotic index.

Chapter 4: Quality Assurance and Quality Control (QA/QC)

Quality assurance and quality control (QA/QC) should be incorporated in all aspects of measurement, operations in the field and laboratory, and data management. Quality assurance and quality control should be practiced for reported data sets in terms of the following five elements: accuracy, precision, completeness, representativeness and comparability.

1. Before sampling, the following should be practiced in order to improve the accuracy of the data:

   - Field audits should be conducted by two types personnel: those engaged in the surveys, and those engaged in quality assurance/quality control.

2. During and after sampling, it is important to practice the following:

   - Permanent signs to identify sampling locations should be installed in order that all samples to be taken at the same location every time.

   - Notes should be recorded of relevant facts related to the processes of sampling, transportation, preparation, and chemical analysis of samples, sample storage, etc.

   - If necessary data is lacking after assessing data accuracy by ion balances, etc., if possible, the data should be obtained through repeated analysis.

   - If samples are analyzed in different laboratories, the accuracy of analysis should be cross-checked between those laboratories.

3. The reported data and the results of quality assurance analysis should be stored in a database (not necessarily computerized). The key information includes site category, sample collector types, transportation, preparation and storage of samples, equipment used in chemical analysis, available information about accuracy, precision and detection limits, etc. This information will improve the usefulness of the reported data, in particular its future application.

4. Training of specialists is an important part of QA/QC. Training programs should include training in monitoring methods at the monitoring sites and laboratory analysis, compilation of data, data analysis, evaluation of results, and QA/QC method.

Chapter 5: Data Management and Their Application

1. Based on archival data, a data report should be produced periodically. Basic statistical parameters, including means and ranges of concentrations and precipitation amounts, should be compiled in the data report. A brief statistical analysis and its interpretation should also be included.

2. Furthermore, descriptions concerning the state of acid deposition should be included in the data report along with maps, figures, and tables. Integrated evaluation of the monitoring results, both of deposition and effects should also be included.

3. In addition to clarifying the regional distribution of acid deposition, the monitoring results can be used to evaluate levels of acidification impacts on inland water environments, soils and vegetation. It is also important to develop methods to assess and predict changes in acidification over the long-term, based on acid deposition data.

4. In order to make a comprehensive assessment of the state of acid deposition in the East Asia region, as well as to facilitate data exchange among East Asian countries, standardization of statistical reporting methods and formats should be promoted. Moreover, results of monitoring should be distributed on an annual basis to other countries and international organizations to allow for the exchange of related information.

5. It is hoped that the monitoring results based on these guidelines can be compiled by an appropriate organization in the region, and comprehensive assessments performed using the compiled data.

Annex 2

REPORT OF SESSION 1
ON
CONCEPTUAL DESIGN OF AN ACID DEPOSITION MONITORING NETWORK IN EAST ASIA

1. At the Session 1 meeting, the document entitled Conceptual Design of an Acid Precipitation Monitoring Network in East Asia (DOC/AP/2.3/R1) was discussed by the participants, and was well received. As the components of an acid deposition monitoring network in East Asia, a) each country's implementation of acid deposition monitoring, b) establishment of (a) monitoring network center(s) in the region, c) data, experience and information exchange among participating countries, d) central compilation and analysis of monitoring data, and e) capacity building activities were agreed. Concerns were raised about the geographical area to be covered by the network, and it was agreed that there should be no specific limitations on what countries could participate, although the phrase "East Asia" may need to be amended in the future.

2. At the same time, a number of comments and proposals were made concerning the functions of the network, as follows:

a) Regarding monitoring in participating countries, importance should be placed on institutional strengthening and capacity building.

b) Due to the wide range of conditions in participating countries (economic, social, geographical, etc.), monitoring should be implemented on a practical step-by-step basis, with full-scale monitoring to be implemented over time.

c) The functions of the monitoring network center(s) should include:

- Coordination and enhancement of communication among the participating countries

- Technical and financial support to the participating countries for their capacity building

d) The function of the monitoring network center as a data center should not be limited to compilation of information and the distribution of compiled information: raw data should also be made available upon request. Such information should be available to scientists throughout the world, not just in participating countries.

3. In addition, a few points were raised concerning difficulties in establishing the network:

a) Decision-making method among participating countries. On this particular point, some options were proposed, for example, adoption of decisions at the policy-making level such as ESCAP, ECO-ASIA, and APEC fora, and decisions at the expert level.

b) Scope of the network. The activities of the network should start from feasible areas such as the gathering, analysis and sharing of information and the production of useful inputs to the policy-making processes for determining effective measures for preventing impacts of acid deposition in the region.

4. Finally, the session considered that the following issues required further discussion, and requested that the Secretariat of the meeting report on those issues including feasibility considerations at the Third Meeting.

It was deeply felt that, after this meeting, intensive discussion and consultation should take place among the participating countries to reach an agreement on the details of the acid deposition monitoring network to the extent possible.

a) Ways and means for enhancing acid deposition monitoring in participating countries.

Each country's acid deposition monitoring should be implemented based on the agreed Monitoring Guidelines to ensure comparative and comprehensive analysis of the monitoring results within the region. It is appropriate for the countries to formulate a strategy/plan for that purpose. Elements of such strategies and plans, including establishment of a national center, should be elaborated.

Effective ways to technically and financially support national efforts should be explored by bilateral, regional and/or multilateral assistance. In this connection, funding needs and options should be identified.

b) Monitoring Network Center

A monitoring network center(s) is expected to play a key role within the monitoring network. The detailed design of the monitoring network center(s) should be developed focusing on the following issues:

- Necessary functions to be furnished, including programs at initial phase

- Effective organizational structure of the center(s) with a regional steering committee, consisting of representatives of the participating countries, and an international scientific advisory committee

- Appropriate location of the center(s)

- Effective operation and administration of the center(s)

c) Data, experience and information exchange

Ways and procedures should be formulated to systematically process the results of acid deposition monitoring within participating countries and then submit them to the proposed monitoring center(s).

A continuous platform for dialogues among countries should be considered in order to exchange ideas and experiences, and strengthen international collaboration for the monitoring network.

d) Future development of the monitoring network

In parallel with construction and implementation of the monitoring network, priority work for its future development should be identified such as emission inventory development for SOx and NOx, modeling of acid deposition, joint/cooperative surveys and studies.

e) Scenario for approval and instruction at a higher level

Agreements and proposals of the three Expert Meetings should be transmitted to the policy-making level for their approval and instruction. A procedure to this end should be suggested including identification of appropriate meetings and fora.