Long-term Acid Deposition Monitoring

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Ministry of the Environment

Index

1. Introduction

The economy in East Asia is rapidly developing causing serious environmental issues such as air pollution, and the transboundary air pollutions including air deposition is expected to deteriorate in the future.

The Ministry of the Environment conducted the first acid deposition monitoring survey in 1983 and has continued to monitor the acid deposition in, air, soil and vegetation, and inland aquatic environment up to the fourth survey so far. As the result of them, it has confirmed that as much acid deposition as in Europe or the United States is observed and the acid ingredients is increasing in the Japan Sea side in winter. It also proposed the Acid Deposition Monitoring Network in East Asia (EANET) to promote the acid deposition measures based on the international cooperation. Ten countries have joined the network and it started the preparatory-phase activities in April 1998 and the regular-phase activities in January 1991.

With this background, the Ministry of the Environment is planning to promote "Long-term Acid Deposition Monitoring" and "East Asia Acid Deposition Survey" based on EANET and the international cooperation starting from 2001.

This plan was drawn up by the Ministry of the Environment to set the middle to long-term direction in Japan to conduct the long-term, extensive and continuous acid deposition monitoring, based on the discussion in the Committee on Acid Deposition Survey.

2. Objectives of long-term acid deposition monitoring

The objectives of long-term acid deposition monitoring is to grasp the effect of acidification in the early stage, the long distance and transboundary transportation of causative agent of acid deposition and the long-term trend. It also operates to capture the changes of acidification amount by time or space and its effect, by cooperating closely with the Acid Deposition Monitoring Network in East Asia(EANET) and conducting the long-term acidification and ecological impact monitoring.

3. Implementation scheme of long-term acid deposition monitoring

3.1 Implementation Agency

Following agencies conduct the operation of long-term acid deposition monitoring.

Item	Agency

1. Planning and coordination	Ministry of the Environment Acid Deposition and Oxidant Research Center of the Japan Environmental Sanitation Center
2. Sampling	Contracted local government Other contracted agencies
3. Analysis	Contracted local government Acid Deposition and Oxidant Research Center of the Japan Environmental Sanitation Center Other contracted agencies
4. QA/QC	Acid Deposition and Oxidant Research Center of the Japan Environmental Sanitation Center
5. Compilation, analysis and evaluation of data	Ministry of the Environment Acid Deposition and Oxidant Research Center of the Japan Environmental Sanitation Center

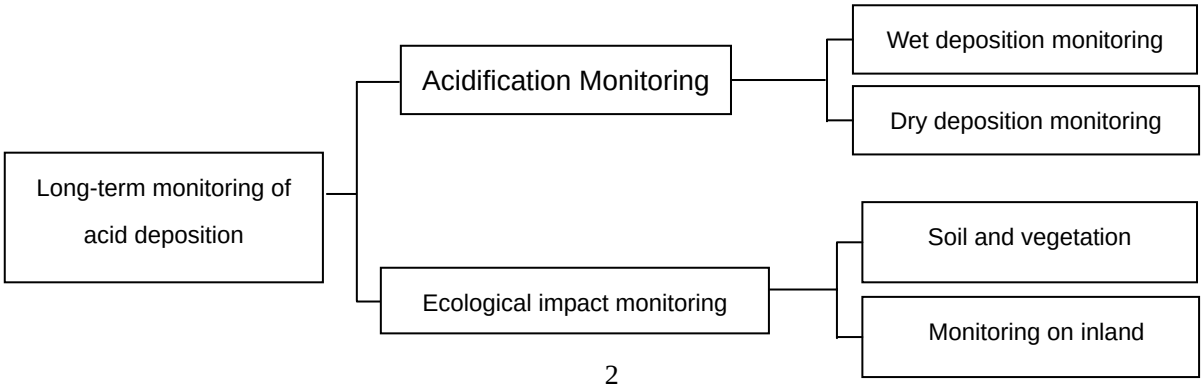
3.2 Related Agencies

The Ministry of the Environment cooperates closely with the following agencies to conduct the long-term acid deposition monitoring, as required.

- Secretariat for the Acid Deposition Monitoring Network in East Asia (UNEP/RRC.AP)
- Related agencies (Forestry Agency, Japan Meteorological Agency, etc.)
- Related local government

4. Implementation of long-term acid deposition monitoring

The long-term acid deposition monitoring consists of "Acid Deposition Monitoring" and "Ecological Impact Monitoring." The former is categorized in "Wet Deposition Monitoring" and "Dry Deposition Monitoring" and the latter is sub-categorized as "Soil and Vegetation Monitoring" and "Monitoring on Inland Aquatic Environment" respectively.



4.1 Acid Deposition Monitoring

4.1.1 Objectives of Acid Deposition Monitoring

The acid deposition monitoring is conducted "to evaluate the concentration and deposition status of the acid substances and acidification substances including ozone etc.(acid/acidification substances) in Japan". The status of acid/acidification substance deposition is evaluated based on: 1. Evaluation of acid deposition in remote coastal and plain area, 2. Evaluation of acid deposition in remote mountain area, 3. Evaluation of acid deposition in rural area, 4. Evaluation of acid deposition in suburban mountainous area, 5. Evaluation of acid deposition of urban area, 6. Evaluation of special natural source such as volcano, 7. Evaluation of total ecological impact of acid deposition including on forest and inland water.

4.1.2 Parameters, Frequency and Method of Monitoring

4.1.2.1 specifies for the wet deposition and 4.1.2.2 specifies for the dry deposition. And, the meteorological condition such as precipitation is captured as required.

4.1.2.1 Wet Deposition

(1) Monitoring parameters Electric conductivity, pH, Cl, SO_4^{2-}, NO_3^-, Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+

(2) Monitoring frequency

The sampling is conducted every 24 hours in principle.

(3) Method

The sample is taken from the wet only sampler when it rains by the method described in the following table.

Parameters	Instrumental method
Electric Conductivity (EC)	Electric conductivity unit (Conductivity Cell)
pH	pH meter (Glass Electrode)
Cl, NO_3^-, SO_4^{2-}	Ion Chromatography
NH_4^+	Ion Chromatography or Spectrophotometry (Indophenol blue)
Na^+, K^+, Ca^{2+}, Mg^{2+}	Ion Chromatographyd or Atomic Absorption Spectrometry

4.1.2.2 Dry Deposition (air concentration monitoring)

(1) Automatic monitoring

a. Monitoring parameters

SO_2, O_3 , NOx (NO/NOx*) and PM_{10} ($PM_{2.5}$ is also monitored in some monitoring stations))

The monitoring parameters for respective monitoring station is described in the separate document.

b. Monitoring frequency

Monitoring should be carried out continuously and hourly data are expected.

c. Method

The automatic monitoring unit is conducted by automatic instrument.

Item	Automatic monitoring
SO_2	Ultraviolet Fluorescence Methodt (high sensitivity type in remote area))
O_3	Ultraviolet Photometric Method
NO_X	Chemiluminescence Detection Method
$PM_{10}/PM_{2.5}$	TEOM Method or β -ray Absorption Method

(2) Manual Monitoring (EANET station only)

a. Monitoring parametersSO_2, HNO_3, HCl, NH_3 and particulate components

b. Monitoring frequency

Weekly sampling is expected ina principle.If weekly sampling is difficult to be carried out because of low concentration , biweekly sampling could also be acceptable.

c. Method

Parameter	Manual monitoring
SO_2	Filter Pack Method
HNO_3	Filter Pack Method
HCl	Filter Pack Method
NH_3	Filter Pack Method
Particulate Components	Filter Pack Method

4.1.3 Acid Deposition Monitoring Site

The monitoring is conducted at the following locations.

	Monitoring Station	City	Climate classification	Classification			EANET
1	Ochiisi	Hokkaido	2. South East Hokkaido			Remote	EANET
2	Rishiri	Hokkai	3. North West Hokkaido			Remote	EANET

		do					
3	Sapporo	Hokkaido	〃	Urban			
4	Hachimantai	Iwate	5. East Tohoku Region		Rural		
5	Nonodake	Miyagi	Same as above〃		Rural		
6	Tappi	Aomori	West Tohoku Region			Remote	EANET
7	Obanazawa	Yamagata	〃		Rural		
8	Tsukuba	Ibaragi	7. Kanto Region		Rural		
9	Akagi	Gunma	〃		Rural		
10	Tokyo	Tokyo	〃	Urban			EANET
11	Sado-seki	Niigata	8. Hokuriku Region			Remote	EANET
12	Niigata-maki	Niigata	〃		Rural		Training purpose
13	Ridge	Nagano	〃			Remote	EANET
14	Echizenmisaki	Fukui	〃			Remote	
15	Ijira	Gifu	9. Tosan Region		Rural		EANET
16	Inuyama	Aichi	10. Tohoku Region		Rural		
17	Kyoto-yawata	Kyoto	11. Kinki Region	Urban			
18	Amagasaki	Hyogo	12. Setouchi Region	Urban			
19	Kurahashijima	Hiroshima	〃		Rural		
20	Oitakuju	Oita	〃		Rural		
21	Shionomisaki	Wakayama	13. Nankai Region			Remote	
22	Yusuhara	Kouchi	〃			Remote	EANET
23	Oki	Shimane	14. Sanin Region			Remote	EANET
24	Banryu	Shimane	〃	Urban			EANET

25	Tsushima	Nagasaki	15. West Sanin Region, North West Kitakyushu Region			Remote	
26	Chikugo-ogori	Fukuoka	〃		Rural		
27	Gotoo	Nagasaki	〃			Remote	
28	Ebino	Miyazaki	16. South Kyushu Region			(Remote)	
29	Yakushima	Kagoshima	〃			Remote	
30	Hedo	Okinawa	—			Remote	EANET
31	Ogasawara	Tokyo	—			Remote	EANET

<Automatic Air Concentration Monitoring Parameters>

Monitoring Station	Classification	Automatic Air Concentration Monitoring Parameters				
		NO_X	SO_2	O_3	PM_{10}	PM_{25}
Ochiisi	Remote	✓	✓	✓	✓	
Rishiri	Remote	✓	✓	✓	✓	✓
Sapporo	Urban			✓		
Hachimantai	Rural			✓		
Nonodake	Rural			✓		
Tappi	Remote	✓	✓	✓	✓	
Obanazawa	Rural			✓		
Tsukuba	Rural			✓		
Akagi	Rural			✓		
Tokyo	Urban	✓	✓	✓	✓	
Sado-seki	Remote	✓	✓	✓	✓	
Niigata-maki	Rural			✓		
Happo Ridge	Remote	✓	✓	✓	✓	
Echizenmisaki	Remote		✓	✓		
Ijira	Rural	✓	✓	✓	✓	
Inuyama	Rural			✓		
Kyoto-yawata	Urban			✓		

Amagasaki	Urban			✓		
Kurahashijima	Rural			✓		
Oitakuju	Rural			✓		
Shionomisaki	Remote		✓	✓		
Yusuhara	Remote	✓	✓	✓	✓	
Oki	Remote	✓	✓	✓	✓	✓
Banryu	Urban	✓	✓	✓	✓	
Tsushima	Remote		✓	✓		
Chikugoogori	Rural			✓		
Gotoo	Remote		✓	✓		
Ebino	(Remote)		✓	✓		
Yakushima	Remote		✓	✓		
Hedo	Remote	✓	✓	✓	✓	
Ogasawara	Remote	✓	✓	✓	✓	

4.2 Ecological Impact Monitoring

4.2.1 Soil and Vegetation Monitoring

4.2.1.1 Objectives of Soil and Vegetation Monitoring

The objectives of soil and vegetation monitoring is "to establish the baseline data of soil and forest in Japanese representative forests and detect the ecological impact caused by acid deposition at the early stage."

4.2.1.2 Items, Frequency and Methods of Monitoring

The following monitoring is conducted.

1. Forest Monitoring (General description of forest, and Survey of tree decline)
2. Soil Monitoring

4.2.1.2.1 Forest Monitoring

(1) Parameters

1. Required Parameters

General description of forest (Description of trees (name of tree species, diameter at breast height (DBH), and height of tree), Understory vegetation, Survey of tree decline

(observation of tree decline))

2. Optional Parameters

Survey of tree decline (photographic record of tree decline, and estimation of decline causes)

(2) Frequency

Once in five years for the General description of forest (Description of trees, and Understory Vegetation Survey) and once a year for the Tree Decline Survey (observation, record and estimation)

(3) Procedures for establishment of plots

1. Area focusing on impact on trees

One plot for General description of forest and Survey of tree decline is established in the selected forest.

2. EANET registered monitoring site

One plot for two types of soil (total of two plots) that were selected based on the concept of soil monitoring described below is established according to the EANET Technical Manual.

3. Area focusing on impact on soil (to accumulate baseline data on soil types and tree growth)

One plot for two types of soil (total of two plots) that were selected based on the concept of soil monitoring described below is established according to the EANET Technical Manual.

4.2.1.2.2 Soil Monitoring

(1) Parameters and Methods

1. Required Parameters

Moisture content, pH (H_2O), pH (KCl), Exchangeable base cations (Ca, Mg, K, and Na), Exchangeable acidity*, Exchangeable Al and H, Effective Cation Exchange Capacity (ECEC)**,), Carbonate (Limestone soil only).

* Exchangeable acidity can be analyzed in the analytical procedures for exchangeable Al and H.

**Effective Cation Exchange Capacity (ECEC) is calculated as sum of exchangeable cations.

2. Optional Parameters

Total nitrogen content, Total carbon content, Available phosphate, Sulphate, Soil physical properties (Fine earth bulk density, Penetration resistance).

3. Methods

Parameters	Equipments and methods
Moisture content	Weighed after Oven-drying
pH (H_2O), pH (KCl)	Glass Electronode Method

Exchangeable base cations (Ca, Mg, K, and Na)	Extracted by CH_3COONH_4 Analyzed by Atomic Absorption Spectrometry, ICP-Atomic Emission Spectrometry or ICP-Mass Spectrometry, etc.
Exchangeable Acidity	Titration (KCl extraction)
Exchangeable Al and H	Same as above
Effective Cation Exchange Capacity (ECEC)	Calculated as sum of exchangeable cations
Carbonate content (Limestone soil only)	Volumetric calcimeter

(2) Frequency

Once in five years.

(3) Procedures for establishment of plots

The procedures for establishment of plots depend on the regional categorization.

1. Area focusing on impact on trees (to evaluate the direct impact on trees)

   Two plots for soil (one type) are established in the selected forest (total of two plots).

2. EANET registered sites and areas focusing on impact on soil

   The physical and chemical characteristics of soil are analyzed according to EANET Technical Manual by selecting two types of soil with different sensitivities to acid deposition in the area, in order to accumulate the baseline data. Two plots for each soil type are established (total of four plots).)

4.2.1.3 Monitoring Sites (candidate)

The soil and vegetation monitoring is conducted in the following areas (candidate) where the ecological impacts should be considered and the EANET registered monitoring points. In this case, the areas focusing on the impact on trees will be selected at the first, and then the areas focusing on the impact on soil will be selected. Also, the monitoring points on inland aquatic environment should be taken into consideration and the areas focusing on the relationship to impacts on inland aquatic environment should be selected (from 25 to 30 areas in total).

Classification	Regional Characteristics	Targeted tree species example (*)	Remarks (**)	
			Nearest acid deposition Monitoring Station	Climate Classification

Area where ecological impact is expected	Area focusing on impact on trees (focusing on natural forest)	Shiretoko National Park (Hokkaido)	Sakhalin fir, Japanese oak	Ochiisi	2
		Shikotsutoya National Park (Hokkaido)	Sakhalin fir, Erman's birch (Gold birch)	Sapporo	3
		Shirakami Mountain (Aomori Prefecture)	Japanese beech	Cape Tappi	6
		Towada Hachimantai National Park (Iwate Prefecture)	Japanese beech, Maries fir	Hachimantai	5
		Bandai-Asahi National Park (Yamagata or Niigata Prefecture)	Japanese beech	Obanazawa	6
		Nikko National Park (Tochigi Prefecture)	Japanese beech, Japanese oak	Akagi	7
		Jyoshinetsu Kogen National Park (Gunma Prefecture)	Japanese beech	Akagi	7
		Cyubu Sangaku National Park (Nagano or Toyama Prefecture)	Japanese beech	Happo Ridge	8
		Hakusan National Park (Ishikawa Prefecture)	Japanese beech	Cape Echizen	8
		Yoshino-Kumano National Park (Mie, Nara and Wakayama Prefecture)	Japanese beech	Cape Shio	13
		Daisen Oki National Park (Shimane Prefecture)	Japanese beech, Japanese oak	(Lake Banryu)	14
		Ishizuchi National Park (Kouchi Prefecture)	*Abies veitchii* var. *sikokiana*, Japanese beech, Erman's birch (Gold birch)	Yusuhara	13
		Aso-Kujyu National Part (Kumamoto Prefecture)	Japanese beech, Japanese oak	Oitakusumi	12
		Kirishima-Yaku National Park and Yakushima island (Kagoshima Prefecture)	Japanese cedar (natural cedar)	Yaku Island	16

	Area focusing on impact on soil	The area will be selected based on the soil sensitivity to acid deposition taking into account the area focusing on impact on trees.		
	Areas focusing on the relation ship with impact on inland water	Several points will be selected taking into account the geology and the soil types around the monitoring point on inland aquatic environment		
EANET registered monitoring point		Lake Ijira (Gifu prefecture)	Lake Ijira	9
		Lake Banryu (Shimane prefecture)	Lake Banryu	14

(*) When more than two tree species are selected to monitor in the "area selected focusing on the impact on trees" above, setting the plots by individual tree species can be considered.

(**) The nearest acid deposition monitoring station and climate classification above referred from 4.1.3 "Acid Deposition Monitoring Site".

4.2.1.4 Monitoring Design

The monitoring is designed considering the items and frequency described above.

1. Forest monitoring (General Description of Forest) and Soil Monitoring: The monitoring points are divided into five groups and monitored every five years.
2. Forest Monitoring (Survey of tree decline): Monitored every year at the target area.

4.2.2 Monitoring on Inland Aquatic Environment

4.2.2.1 Objective of Monitoring on Inland Aquatic Environment

The objective of monitoring on inland aquatic environment is " to detect possible impacts of acid deposition on lakes and ponds at the early stage."

4.2.2.2 Parameters, Frequency and Methods of Monitoring on Inland Aquatic Environment

(1) Parameters

1. Water quality: (a) Water temperature, pH, Conductivity, Alkalinity (pH4.8) Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, SO_4^{2-}, NO_3^{-}, Cl^{-}

   (b) Transparency, Water color, DOC (or COD), NO_2^{-} and PO_4^{3-}

2. Sediment (pore water): NO_3^{-}, NH_4^{+} and SO_4^{2-}

(2) Frequency

1. Water quality: Four times a year for the items (a) above. (Spring: April to May, Summer: July

to August, Autumn: October to November, Winter :January to March))

Once a year for the items (b) above. (As a principle, the circulation season in spring (April to May)))

2. Sediment: Once in five years. (The monitoring sites on inland aquatic environment are divided into five groups and the respective groups carried out the item in turn.)

(3) Method

1. Water quality

Parameters	Monitoring unit and method
Electric conductivity (EC)	Electric conductivity unit (Electric Conductivity Cell Method)
pH	pH meter (Glass Electronode Method)
Alkalinity	Titration method using burette or digital burette with pH meter
NO_3^-, NO_2^-, PO_4^{3-}, SO_4^{2-}	Ion Chromatography (preferably with suppressor) or Spectrophotometry
NH_4^+	Ion Chromatography or Spectrophotometry (Indophenol blue Method)
Na^+, K^+, Ca^{2+}, Mg^{2+}	Ion Chromatography or Atomic Absorption Spectrometry /Optical Emission Spectrometry
Cl^-	Ion Chromatography or Titration method
DOC	Combustion - Infrared Method or Wet-Oxidation Method
Transparency	Secchi Disc Method
Water color	Visual inspection

2. Bottom sediment

Parameters	Monitoring unit and method
NO_3^-	Ion Chromatography or Spectrophotometry
NH_4^+	Ion Chromatography or Spectrophotometry (Indophenol blue Method)
SO_4^{2-}	Ion Chromatography or Turbidimetry

4.2.2.3 Monitoring sites on inland aquatic environment

The monitoring on inland aquatic environment is conducted at the following sites.

	Lake and reservoir	Location	Remark
1	Lake Imagamioike	Yamagata (Tozawamura)	

2	Karikomiko	Tochigi (Nikkou City)	
3	Lake Futagoike	Nagano (Sakumachi)	
4	Lake Sankyonoike	Niigata (Ryozu City)	
5	Lake Ohataike	Ishikawa (Kanazawa City, etc.)	
6	Lake Yashagaike	Fukui (Imajyocho)	
7	Lake Ijira	Gifu (Ijiramura)	EANET station
8	Lake Sawanoike	Kyoto (Kyoto City)	
9	Yamanokuchi Dam	Yamaguchi (Fukusakaeson)	
10	Lake Banryu	Shimane (Masuda City)	EANET station
11	Lake Nagatomiike	Kagawa (Ayauta County)	
12	Konoura Dam	Nagasaki (Nishisono County)	

Note: For the lakes and reservoirs in North Tohoku and Hokkaido regions, the possibility will be considered taking the existing materials and information into account.

5. Aggregation, Evaluation and Publishing Result of Long-term Acid Deposition Monitoring

The monitored data for the year should be confirmed and published as soon as possible after the year ends.

The monitored data for five years should be aggregated and reviewed in the Committee on Acid Deposition Survey and published by the Ministry of the Environment .

And when evaluating the monitoring result, the monitored data by the related agencies such as the Forestry Agency, Japan Meteorological Agency and the local government should be leveraged.

6. Start and Preparation of Long-term Acid Deposition Monitoring Plan

This plan should start from JFY 2003 and the necessary system should be prepared in phases.

7. Review of Long-term Acid Deposition Monitoring Plan

This plan should be reviewed at the Committee on Acid Deposition Survey as required depending on the scientific and technological development and changes in the related circumstances in the future.

Footnote on Acid Deposition Monitoring

1. Objectives of acid deposition monitoring

According to the EANET Wet Deposition Monitoring Technical Manual, the objectives of acidification monitoring is to evaluate the acidification status in the background area in rural site, the rural area in rural site, and the background or urban area in urban site.

And the monitoring data gathered in remote site can be used for evaluation of long-range transport model in East Asia and the impact of acid deposition on agricultural crops and forests, and the monitoring data gathered in urban site can be used for evaluation of the effect on buildings or historical monuments and the assessment of acidity of precipitation and the trends in urban area.

2. Parameters, frequency and method of monitoring

The acid deposition monitoring is conducted according to the required items specified in the EANET Deposition Monitoring Technical Manual and QA/QC program. For Dry Deposition Monitoring, all of the air concentration monitoring items proposed in the strategy paper are monitored, and in the station except the EANET stations, SO_2(remote station (high sensitivity type only)) and O_3 are monitored.

3. Selection of Deposition Monitoring Sites

See separate document "Selection of Acid Deposition Monitoring Sites."

Selection of Acid Deposition Monitoring Sites

1 Classification of Monitoring Sites

The acid deposition monitoring sitess are classified into three sub-categories: remote sites, rural sites and urban sites.. The objectives of monitoring in each site is the following, according to the EANET guideline.

(1) Remote sites

Remote sites are to be established for the assessment of the state of acid deposition in background areas. The monitoring data can be used to evaluate the long-range transport and transmission models of acidic substances. The location of these sites should be selected in areas with no or least influence from local emission and contamination sources. Remote sites should be located with sufficient distance from significant stationary sources.

(2) Rural sites

Rural sites are to be established for the assessment of the state of acid deposition in rural areas or hinterlands. The monitoring data can be used to evaluate the effects of the acid deposition impact on agricultural crops and forests. The location of these sites should be selected in areas with miner influence from local emission and contamination sources. Rural sites should be sited away from significant stationary and mobile sources, and should be free from these influences to the extent possible.

(3) Urban sites

Urban sites are to be established for the assessment of the state of acid deposition in urban areas. Urban and industrialized areas are included. The monitoring data can be used to evaluate the effects of acid deposition t on buildings and historical monuments and the assessment of acidity of precipitation and the trends in urban areas.

(4) Ecological survey sites

The ecological survey sites are established to evaluate the deposition impact on the overall ecosystems including forests and inland water.

2. Principle of Selecting Monitoring Sitest

(1) To conduct the monitoring efficiently and rationally, 49 stations that were used in the Fourth Acid Deposition Survey should be reviewed and consolidated.

(2) The number and location of monitoring sites should be set to grasp the national status of acid

deposition and to respond appropriately to international network activities. They should be determined based on the regional balance taking the climate classification into consideration, in addition to various characteristics of monitoring stations. Currently, approximate 30 stations are expected to be selected.

(3) The monitoring sites should be considered based on the existing monitoring stations. However, the moving the existing stations or setting the new monitoring stations are considered in the future as required.

(4) For the climate classification, the one proposed by Mr. Saito (et al.)(Land Area 16 Classification, see figure) similar to the government classification is used, following the suggestion by Mr. Fujita (et al.*).

*) Shingi Fujita, Akira Takahashi, Akira Nishinomiya (1994), "Status of acid deposition in Japan, Building observation network of deposition", Environmental Scientific Academy Journal, 7(2) 107-120

1. Benefit of selecting monitoring points based on climate classification

It is considered to be appropriate to use the climate classification as the evaluation filed of deposition content concentration and the characteristics change of acidification to grasp the current status of acid deposition. This is because within the certain climate classification, the climate condition values (annual precipitation, monthly precipitation change, number of precipitation days, snow depth, monthly average temperature, daylight time, monthly highest and lowest temperature, etc.) can be regarded roughly consistent and under the same climate condition, the distribution of wet deposition depends on the precipitation and the annual average concentration will be somewhat typical of the climate classification. Also, the calculation of acidification in the area from the concentration of representative monitoring sites and the distribution of precipitation. (suggested by Mr. Fujita and others of Central Research Institute of Electric Power Industry).

2. Using Saito's climate classification

Mr./Ms. Sekiguchi and others' climate classification can be also used, but this category has missing areas and the boundary is ambiguous. The climate classification by Saito and others** clearly defines the border using the prefectural border. It traces the existing numerous climate classifications and adopts the most overlapped 16 land areas.

**) Saito, R. et al. (1957) The climate of Japan and her meteorological disasters, Geophys. Mag., 28, 89.

(5) The characteristics of monitoring station is evaluated against the following object and categorization of monitoring sites.

I. Remote area monitoring sites (acid deposition evaluation in the background area)
   a. Evaluation of acidification in coastal and plain area
   b. Evaluation of acidification in mountain area

II. Rural area monitoring sites
   a. Evaluation of acidification in rural area

b. Evaluation of acidification in suburban mountain area

III. Urban area monitoring sites

Evaluation of acidification in urban and industry area (including evaluation of the acidification impact on buildings and historical monuments))

IV. Monitoring sites from other perspectives

a. Evaluation of acid deposition from the natural source such as volcano

b. Evaluation for the impact of acid deposition on the overall ecosystem including forests and inland water

(6) If the multiple monitoring sites are set near from each other, the one with better surrounding condition should be selected. (such as Ca influence from nearby source or automobile exhaustion).)

(7) As a principle, the monitoring is conducted in the monitoring stations where continuous monitoring throughout the year is possible.

(8) Basically, the monitoring stations in urban areas should be reviewed and reduced by defining the monitoring object, but some number of EANET monitoring stations should be accepted considering the relationship with EANET countries.

(9) As same as before, the EANET stations should be set in the location that are appropriate to evaluate the ecological impact and the "remote" monitoring site to grasp the status of long distance transportation. Basically the existing monitoring stations are maintained for the continuity, except the EANET station is newly added to Ochiishi located on the tip of Nemuro peninsula, the north east edge of Japan, to enable the evaluation of background of acid deposition by Siberia and Pacific air mass.

Also, "urban" monitoring site can be added in relation with the monitoring sites set by other participating countries. And Tokyo monitoring station, located in most representative city in Japan is added as an EANET monitoring station.

After evaluating the location of existing monitoring stations (49 stations) based on above, the following acidification monitoring stations are selected.

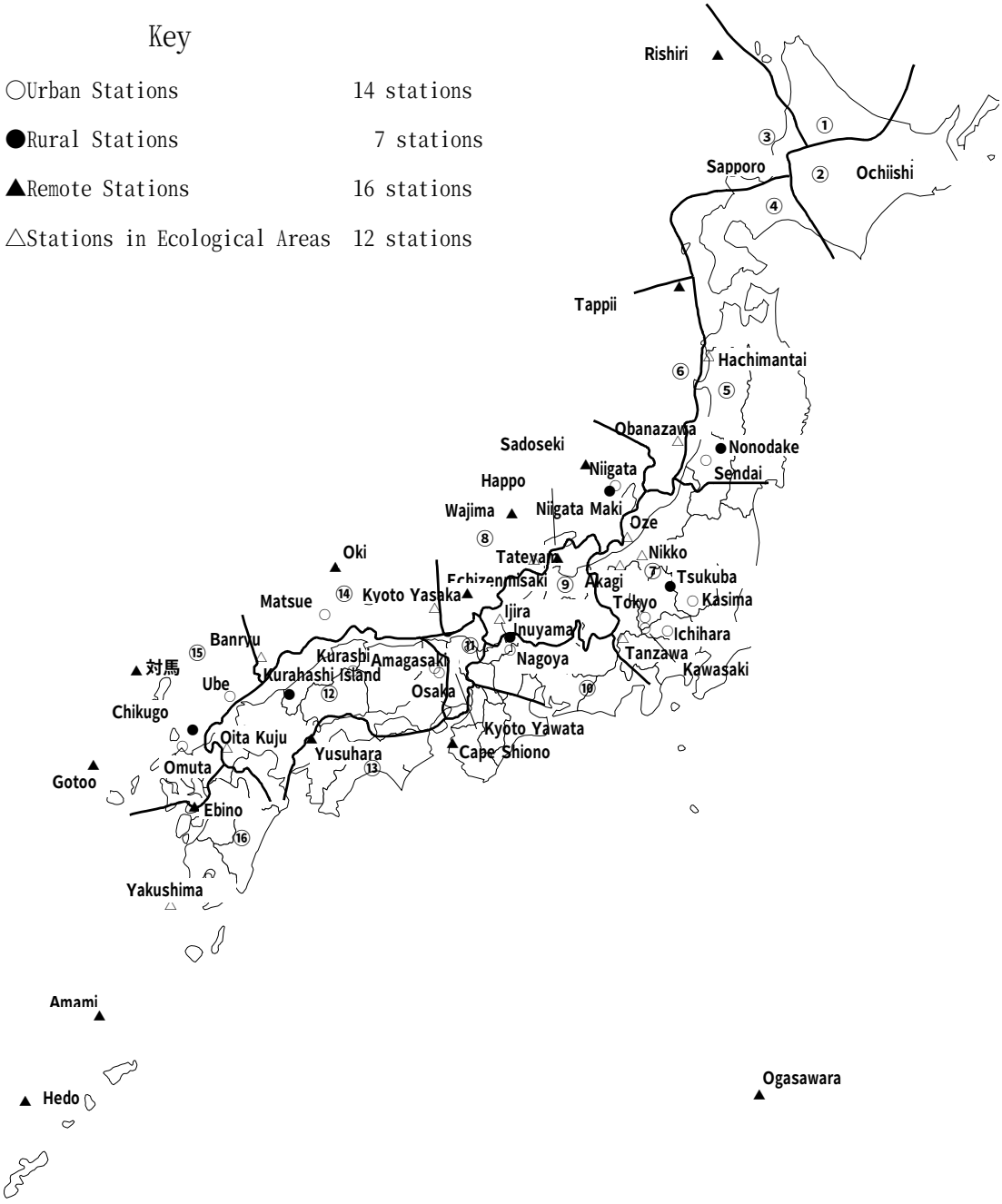
<(Evaluation of existing monitoring stations (49 stations)>

Climate classification	Monitoring Station	Category	Object	Use	Remark
2	Ochiishi	Remote	I a	0	Background location in East Hokkaido
3	Rishiri	Remote	I a	0	Evaluation of long distance transportation from Russia
	Sapporo	City	III	0	Representative city in north

5	Hachimantai	Rural	II a	0	Representative city in Central Tohoku region
	Nonodake	Rural	II a	0	Adjacent to the station of Japan Meteorological Agency
	Sendai	Urban		×	Nearby station (Nonodake) can substitute
6	Tappi	Remote	I a	0	Representative point in north of Japan Sea side in Tohoku region
	Obanazawa	Rural	II a	0	Representative point in Japan Sea side in Tohoku region
7	Oze	Ecosystem		×	No continuous monitoring is possible
	Tsukuba	Rural	II a	0	Representative location in north of Tokyo city
	Kashima	Urban		×	Industrial area
	Nikko	Rural	II b	△	If moving to the location where continuous observation throughout year is possible, this can be used
	Akagi	Rural	II b	△	If Nikko station can be used, this should not be used.
	Ichihara	Urban		×	Influence from the source in the vicinity exists
	Tokyo	Urban	III	0	Necessary to set. Representative city of Japan
	Kawasaki	Urban		×	Ca influence from the source in the vicinity Influence from the automobile exhaustion exists
	Tanzawa	Ecosystem	II b	×	From the local perspective rather than the national environment protection
8	Sado-seki	Remote	I a	0	For long distance transportation from Korea and north of China
	Niigata	Urban		×	Nearby station (Niigatamaki, Cape Sadogaseki) can substitute
	Niigata-maki	Rural	II a	0	Mainly for research and training purpose
	Tateyama	Ecosystem		×	Nearby station (Happo) can substitute
	Happo	Remote	I b	0	Representative point in remote mountain area For evaluation of long distance higher layer transportation
	Wajima	Remote		×	Nearby station (Echizenmisaki) can substitute
	Echizenmisaki	Remote	I a	0	Representative point in Hokuriku region
9	Ijira	Ecosystem	IVb, II a	0	Representative point in Mainland Inland region
10	Nagoya	Urban		×	Nearby station (Inuyama) can substitute
	Inuyama	Rural	II a	0	

11	Kyotoyasaka	Ecosystem		×	The reason why this is set as an ecosystem monitoring station is unknown Nearby station (Cape Echizen) can substitute
	Kyoto Hachiman	Rural	IIa,III	0	Necessary to move to evaluate the impact on the Kyoto cultural treasure.
12	Osaka	Urban		×	Influence from the automobile exhaustion exists
	Amagasaki	Urban	III	0	Representative city of Osaka area
	Kurashiki	Urban		×	Influence from the industrial complex exists
	Kurahashijima	Rural	II a	0	Representative city in Setouchi region
	Ooitakusumi	Rural	II a	0	Representative city in Kyushu and Setonai Sea side region
13	Cape Shio	Remote	I a	0	Representative remote point in Nanki region
	Yusuhara	Remote	I a	0	Representative point in Shikoku and Pacific Ocean side region
14	Matsue	Urban		×	Rural point Near Lake Shinji
	Oki	Remote	I a	0	Evaluation of long distance transportation from R. of Korea
	Lake Banryu	Ecosystem	IVb,III	0	
15	Ube	Urban		×	Ca influence from the source in the vicinity
	Tsushima	Remote	I a	0	Evaluation of transportation from R. of Korea
	Chikugoogori	Rural	II a	0	Typical city in Kita Kyusyu region
	Omuta	Urban		×	Influence from the factories exists Nearby station (Chikugoogori) can substitute
	Gotoo	Remote	I a	0	Evaluation of long distance transportation from China
16	Ebino	(Remote)	IVa	0	Typical city in South Kyusyu region Evaluation of impact from Sakura Island
	Yakushima	Remote	I a	0	Background area of Osumi Islands
	Amami	Remote		×	Bad location. Nearby station can substitute.
0	Hedo	Remote	I a	0	Evaluation of long distance transportation from China
0	Ogasawara	Remote	I a	0	Evaluation of middle distance transportation from Japan mainland

<Reference> Location of monitoring stations (existing 49 stations)>



Footnote on Soil and Vegetation Monitoring

1. Objectives of Soil and Vegetation Monitoring

According to the EANET Soil and Vegetation Monitoring Technical Manual, the objectives of soil and vegetation monitoring is to "establish the baseline database" and "detect possible impacts of acid deposition in the early stage."

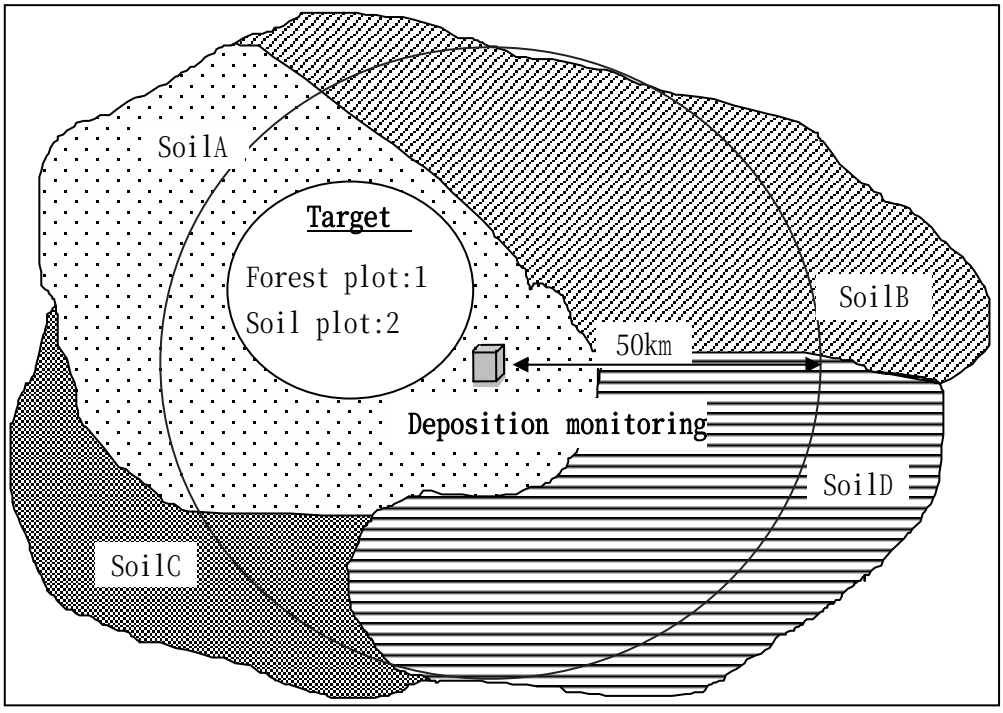
To achieve these purposes, it is important to accumulate various and extensive data on vegetation and soil and some data of man-made forest are collected in the acid deposition monitoring conducted by the Forestry Ministry. The Ministry of the Environment conducts the long-term monitoring to accumulate the baseline data in the forest area where direct and indirect impact on soil and vegetation is expected in near future and provides data related to the status of soil and vegetation to grasp the impact in the early stage. The targeted areas are mainly where active environmental protection should be promoted such as Japanese representative vegetation area (natural forest) and natural protection area.

2. Type of monitoring

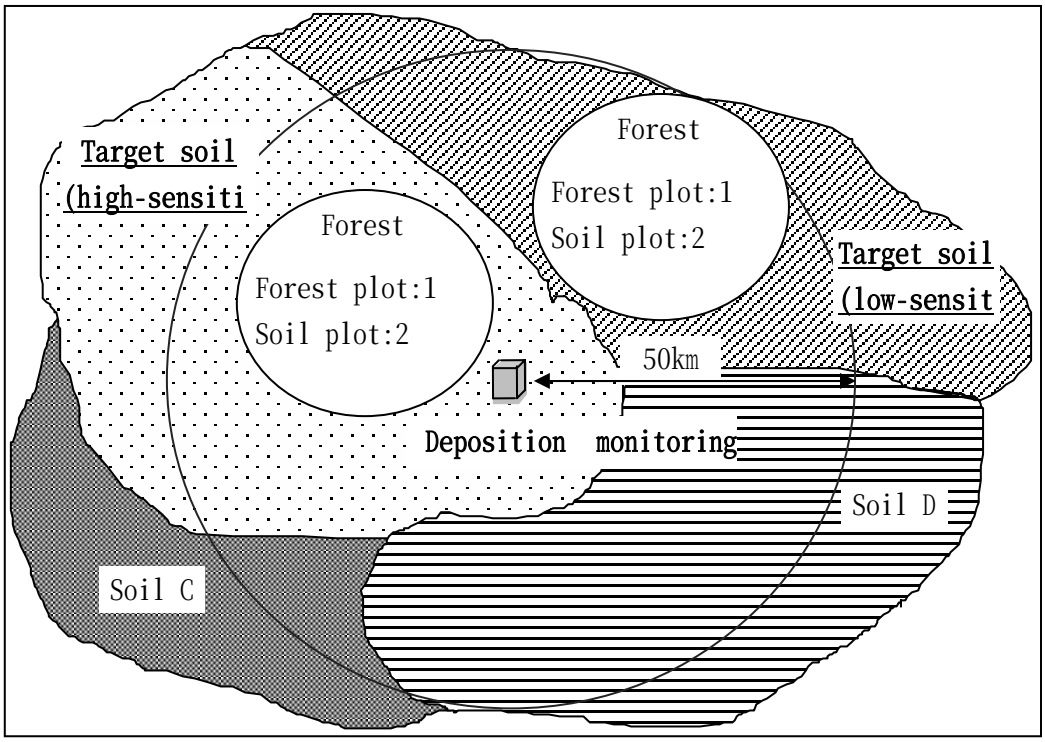
The long-term acid deposition monitoring plan 4.2.1.2, 1."Forest Monitoring (General description of forest and Survey of tree decline) and 2."Soil Monitoring" is described as "Basic Survey" in the EANET Technical Manual.

3. Method of plot setting of Forest Monitoring and Soil Monitoring

(1) In case of "Monitoring point focusing on impact on forest"



(2) In case of "Monitoring point focusing on impact on soil" and "EANET registered monitoring point"



4. Frequency of forest monitoring

Because the main objective of Description of trees and Understory vegetation survey is to track the important and graduate changes such as the changes of forest growth speed or specie composition, it is conducted once every five years along with the soil monitoring described below. Because the tree decline is influenced by the air concentration changes as well as the natural environmental causes such as typhoons or other events, it should be conducted continuously to detect the impact at the early stage. These frequencies are the same as in Europe.

5. Survey for quantitative capturing of forest status with hemispherical photograph

"Quantitative understanding of forest status with hemispherical photogarah" is the item described in the technical manual as the method to accumulate the basic data to evaluate the ecological impact in East Asia area, and it is considered to be an effective method to capture the data such as overall forest growth conveniently and quantitively in the future. After conducting the preliminary survey using the Global Environment Research Fund mainly in the Acid Deposition and Oxidant Research Center of the Japan, and reviewing the survey method and frequency, it will be adopted for monitoring in the near future.

6. Frequency of soil monitoring

Because the change in scientific and chemical property of soil is determined only by the long-term monitoring and the change is relatively graduate, one monitoring in several years is considered to be enough and EANET conducts it once in three to five year. In Europe, it is conducted once in ten years and even though some experts from the ICP Forests pointed out that "once in three to five years" in EANET is an excess, once in five years is currently considered to be appropriate in terms of accumulating basic data in East Asia and according to the discussion in EANET so far.

7. Design of monitoring

Because it is a long-term, continuous monitoring in the selected candidate points, the soil monitoring is conducted in a rolling method among five groups of monitoring points every five years aligning with the survey frequency of Forest and Soil monitoring.

Because "Forest Monitoring (Survey of tree decline)" is considered to require more frequent monitoring to detect the impact at the early stage, it is conducted even in the year "Forest Monitoring (General description of forests) and Soil Monitoring" are not conducted.

8. Selection of Soil and Vegetation Monitoring sites

See separate "Selection of Soil and Vegetation Monitoring sites."

Selection of Soil and Vegetation Monitoring Sites

1. Principle of selecting monitoring sites

The Soil and Vegetation Monitoring is conducted in the area where direct or indirect impacts on ecosystem especially for soil and vegetation are suspected in the future. The forest and soil monitoring site is selected from the natural forest and the natural protection area in the mountain region especially focusing on where active protection by the Ministry of the Environment is needed. The candidate location is selected also considering the soil sensitivity to acid deposition in order to accumulate the baseline data of soil. Additionally, the monitoring in the lake and reservoir watershed area is conducted which is important to evaluate the impact on inland water.

(1) Selecting area focusing on tree

Some results are gained by the wide area monitoring conducted by the Forestry Agency on 1,000 grid count over 20 km of man-made forest in the approximately same items as the survey conducted by the Ministry of the Environment, such as survey of tree decline, growth and soil chemistry. However, enough data has not been gained on the natural forest which is considered to be important from the environmental and natural protection perspective. The area for long-term monitoring system should be selected mainly on the natural forest in the mountain region where the direct acidification impact on trees, the indirect impact through soil, and the combination of impact of natural environmental cause are expected in the future.

(2) Selecting area focusing on soil

The soil sensitivity to acid deposition which is largely related to indirect impacts through soil, is described in the EANET Technical Manual as the major standard for selecting the monitoring area. The soil type and its sensitivity in Japan is considered and investigated also in the first to third Acid Deposition Survey conducted by the Ministry of the Environment and some results were gained. For example, in the third Acid Deposition Survey, the data on representative soil types is gained through the survey conducted at 84 monitoring points during 1993 to1997. However, since there are only seven monitoring points for immature soil and three monitoring points for red-yellow soil that are considered to have a high sensitivity, more data needs to be gathered. In the long-term monitoring system, the indirect impact on forest should be taken into consideration and the baseline data on these high sensitivity soils that are expected to be acidified in future should be collected.

(3) Selecting area focusing on relationship with impact on inland water

For example, the appropriate lakes and reservoirs such as Lake Ijira and Lake Banryu are considered for the monitoring points.

2 Procedure to select monitoring point

(1) Selecting area focusing on impact on tree

The area (natural forest) where the impact in the future is concerned judging from the current state of the forest should be considered. The continuous monitoring should be conducted on the natural protection area. The following conditions are considered when selecting the monitoring areas.

Natural Protection Area (e.g. National Park)

The following forest areas that are designated as national parks are selected where active protection is needed because they are relatively vulnerable for exterior stress because of their harsh natural environment.

Shiretoko National Park, Shikotsutoya National Park, Towada Hachimantai National Park, Bandai Asahi National Park, Nikko National Park, Jyoshinetsu National Park, Cyubu Sangaku National Park, Hakusan National Park, Yoshino Kumano National Park, Daisen Oki National Park, Aso Kujyu National Park, Kirishima Yaku National Park, etc.

Also, there are natural forests not specified as a national park above such as Shirakami Mountain (Natural Environment Protection Area) and the representative natural forest in Shikoku region, Ishizuchi Quash-National Park.

The following are the candidates for monitoring point including the nearby acid deposition monitoring stations that meet the conditions above.

Shiretoko National Park (Hokkaido): Ochiishi

Shikotsutoya National Park (Hokkaido): Sapporo

Shirakami Mountain (Aomori prefecture): Tappi

Towada Hachimantai National Park (Iwate prefecture): Hachimantai

Bandai Asahi National Park (Yamagata and Niigata prefecture): Obanazawa

Nikko National Park (Tochigi prefecture): Akagi

Jyoshinetsu Kogen National Park (Gunma, Nagano and Niigata prefecture) : Akagi (*1)

Cyubu Sangaku National Park (Nagano and Toyama prefecture): Happo

Hakusan National Park (Ishikawa): Echizenmisaki

Yoshino Kumano National Park (Mie, Nara and Wakayama Prefecture): Shionomisaki

Daisen Oki National Park (Shimane): Banryu

Ishizuchi National Park (Kouchi): Yusuhara

Aso Kujyu National Park (Kumamoto): Oitakuju

Kirishma Yaku National Park, Yakushima Island (Kagoshima prefecture): Yakushima

(*1) The nearby air monitoring station if the monitoring is conducted within Gunma prefecture. There are no nearby monitoring station in Niigata or Nagano prefecture.

Upon selection of candidate area, vegetation, endemic and rare species should be taken into

consideration. The following is the major natural vegetation (in parenthesis) aggregated from the grid count of representative tree specie and natural vegetation in the national and quasi-national parks above.

Shiretoko National Park: Yeddo spruce, fir tree, Japanese oak (bamboo grass - birch community)
Shikotsutoya National Park: Yeddo spruce, fir tree, birch (*Acer mono* v. *glabrum* - Tilia japonica community)
Hakusan mountain: Japanese beech (dwarf bamboo – Japanese beech community)
Towada Hachimantai National Park :Japanese beech, fir tree (*Sasa kurilensis* – Japanese beech community)
Bandai Asahi National Park :Japanese beech (Sasa kurilensis – Japanese beech community)
Nikko National Park :Japanese beech, Japanese oak (*Sasa kurilensis* – Japanese beech community)
Jyoetsu Kogen National Park: Japanese beech *(Sasa kurilensis* – Japanese beech community)
Cyubu Sangaku National Park: Japanese beech, cedar tree (*Smilacina viridiflora* – birch community)
Hakusan National Park: Japanese beech (*Sasa kurilensis* – Japanese beech community)
Yoshino Kumano National Park : spruce, Japanese oak (*Sasamorpha borealis* – Japanese beech community)
Ishizuchi Quasi- National Park : *Abies veitchii* Lindl, fir tree, *Tsuga sieboldii*, Japanese beech, birch (Sasamorpha borealis – Japanese beech community)
Daisen National Park: Japanese beech, Japanese oak (*Lindera umbellata* – Japanese beech community)
Aso Kujyu National Park: *Rhododendron metternichii*, Japanese beech, *Quercus acutissima*, Japanese oak (oak -Clethra barvinervis community)
Kirishma Yaku National Park, Yaku Island: Japanese cedar tree (fir tree - *Illicium anisatum* community)

In the natural protection area such as national parks, Japanese beech, fir tree (family), birch, Japanese oak (family) that are common in many areas are focused. Also, in Yakushima Isaland, Japanese cedar tree (natural forest) is focused because there are many cedar trees of over 1,000 years old in the island and it will also supplement the survey conducted by the Forestry Agency on man-made Japanese cedar forest.

The monitoring points are determined by considering the relationship with inland water monitoring points as much as possible, and narrowing the area to some extent by WG and it should also be discussed with local government specialists.

(2) Selecting area focusing on soil

The following soil types are categorized as high sensitivity for acidification according to the first and second Acid Deposition Survey conducted by the Ministry of Environment, and the local governments having these types of soil are selected as the candidates.

- Red-yellow soil (red-yellow podzolic/lithosolic soil)
- Pyroclastic Regosols (Volcanogeneous Regosols (immature soil))

In the area where the soil distribution above is observed, one monitoring point is selected for the

soil above and another for the soil to be compared (relatively low sensitivity soil) each. For red-yellow soil, relatively large number of distribution is observed mainly in West Japan and the monitoring is already conducted in several monitoring points selected in 2001. The Volcanogeneous Regosols is observed only in the limited area such as volcanic area.

Several monitoring sites are selected considering the consistency with "the area focusing on the impact on tree" and "the area focusing on the impact on inland water," and supplemental effect for the existing data.

(3) Selecting area focusing on relationship with impact on inland water

For the areas except Lake Ijira and Lake Banryu, the appropriate lakes and reservoirs are incrementally reviewed as the monitoring point candidates.

(4) EANET registered point (Lake Ijira, Gifu prefecture, Lake Banryu, Shimane prefecture)

Because the data has been accumulated and also the set of air, soil, vegetation and inland water has been monitored at two EANET registered points (Lake Ijira, Gifu prefecture, Lake Banryu, Shimane prefecture), the monitoring will be continued in these points.

Footnote on Monitoring on Inland Aquatic Environment

1. Objective of Monitoring on Inland Aquatic Environment

The objective of Inland Aquatic Environment Monitoring is not clearly defined in the EANET Technical Manual. Therefore, to define the ultimate and initial objectives as defined in the Soil and Vegetation Monitoring Technical Manual, the questionnaire survey was conducted for the method on the inland aquatic environment monitoring among the Working Group (WG) on Inland Aquatic Environment in 2000 and the survey result was reported at the third WG meeting held in February 28 (Wed.), 2001. The discussion in the meeting is still in the process of summarization.

2. Item

SS and Chlorophyll *a* will be also reviewed as the new items.

Also, microbe indicator will be reviewed after further research.

3. Frequency

When monitoring the impact on algea, the possibility of monitoring transparency, water color, DOC (or COD), NO2, PO43 (Long-term acid deposition monitoring plan 4.2.2.2(1)1.(b)) four times a year will be reviewed in the future.

Even though the frequency of sediment monitoring is defined "once in three to five years" in EANET Technical Documents for Monitoring on Inland Aquatic Environment, it is monitored once in five year aligned with the soil and vegetation monitoring frequency.

4. Water area except lake and reservoir

The survey on acid shock in mountain stream will be reviewed as a future monitoring subject. In that case, the upper major inflowing rivers connecting to the monitored lakes and reservoirs will be reviewed to be selected as the target mountain streams.

5. Selection of Inland Water Monitoring point

See separate "Selection of Inland Water Monitoring point."

Selection of Monitoring Sites on Inland Aquatic Environment

1. Principle of selecting monitoring sites

The monitoring sites are selected based on the EANET Technical Manual to be closely related with the Acid Deposition Monitoring Network in Ease Asia and to compare data among different countries. The selection is conducted referring to the principle of "EANET Inland Aquatic Environment Monitoring Site Selection (preliminary)" summarized by the "Working Group on Inland Aquatic Environment Monitoring " established in the Acid Deposition and Oxidant Research Center in 2000.

The lake and reservoir to be selected are the monitored lakes and reservoirs (42 lakes and reservoirs) in the second, third and fourth Acid Deposition Survey conducted between 1988 to 2000.

2 Procedure to select monitoring sites

(1) Screening based on the selection criteria

The screening is conducted with the following criteria based on 1. above. a. and b. are the criteria to select lakes and reservoirs that are sensitive to acid deposition, and c. is for anthropogenic pollution. However, if the evaluation result for the following criteria of the lake and reservoir is not known, it should not be excluded since it still has the possibility of being the candidate for monitoring.

1) Selection criteria 1: Alkalinity should be less than 0.2 meq/L > 21 out of 42 lakes and reservoirs

2) Selection criteria 2: Should be the harmonic type lakes and reservoir (volcanic acid, dystrophic, siderotrophic and alkaline lake is excluded))

> Lake Odanoike is excluded since it is dystrophic. > 20 out of 21 lakes and reservoirs

3) Selection criteria 3: Small amount of anthropogenic water pollution.

> If less than 5mg/L COD is set as the condition, all of 20 lakes above are qualified.

> 20 out of 20 lakes and reservoirs

Note: Criteria about access (possibility of four samplings a year)

It is desirable to select the lakes and reservoirs where four samplings (seasonal) a year can be easily possible for the survey.

> Lake Goshikinuma and Lake Karikomiko (both in Tochigi prefecture) can not be accessed at all during the winter to spring period (December to May), out of 20 lakes selected up to the criteria 3.

> Also, the access to Lake Sugenuma (Gunma prefecture), Lake Sankyonoike (Niigata prefecture), Lake Futagoike (Nagano prefecture) and Lake Yashagaike (Fukui prefecture) is expected to be hard only when it snows"

However, since it is important to collect data from snowy area, they should not be excluded simply because the monitoring in the winter is not possible.

(2) Consideration for regional balance

Most (19 lakes and reservoirs) of 20 lakes and reservoirs that meet up to the criteria 3 are located in mainland and only one (Kounoura Dam) is located in Kyusyu (Nagasaki prefecture) and none of them is in Hokkaido or Shikoku region. The following four lakes and reservoirs from the previous (second to fourth) survey belong to these regions. (None of them meet the alkanity criteria 1 in (1) above.))

Hokkaido: Lake Kuttara, Lake Panke, Shikoku: Lake Nagatomiike, Kirimi Dam

(3) Narrowing candidates considering status of watershed

The detailed data of 24 lakes and reservoirs (20 lakes and reservoirs up to the criteria 3 in (1) above plus four lakes and reservoirs in (2) above) is listed in [Appendix 2].

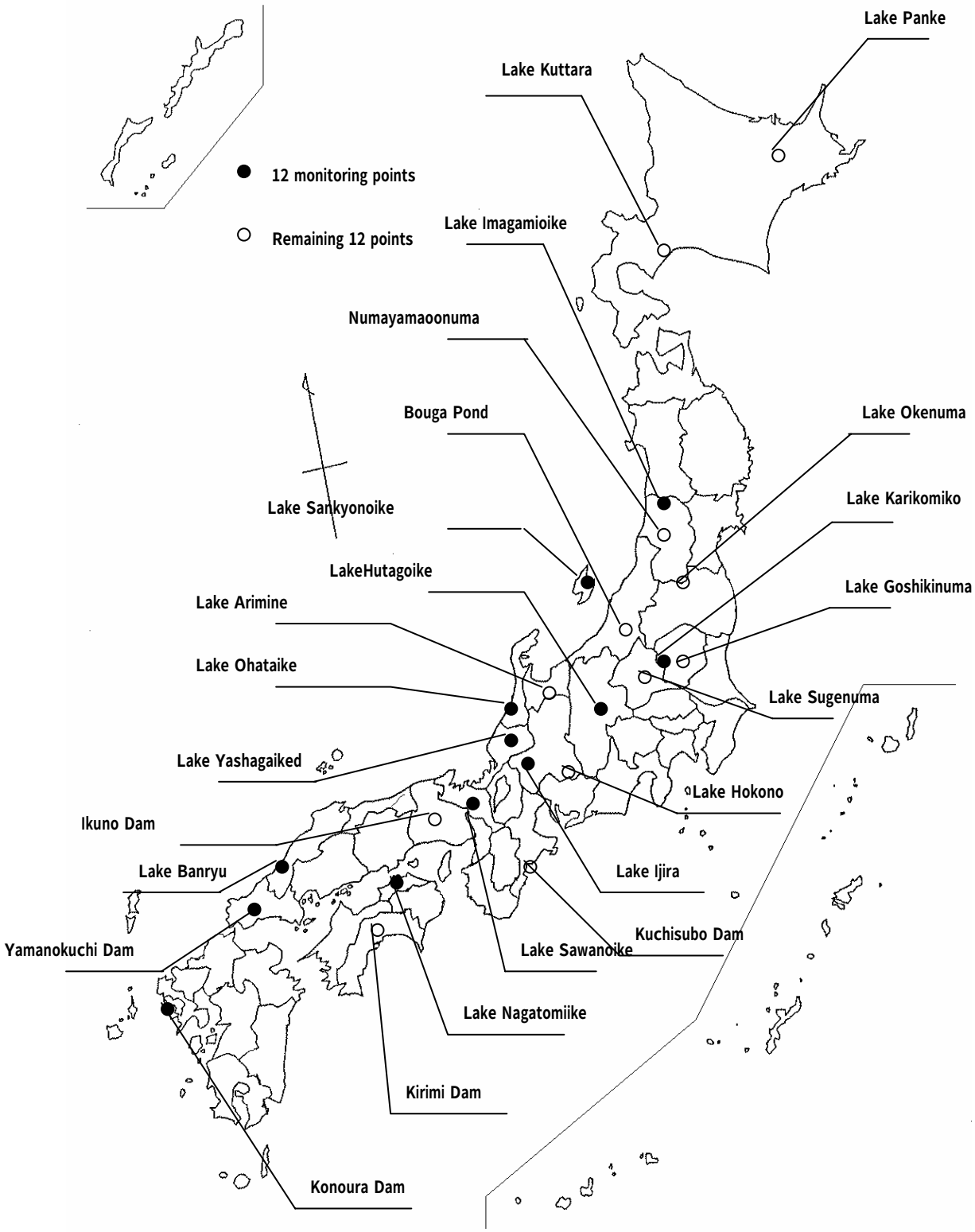
Out of 24 lakes and reservoirs, Lake Kuttara and Lake Panke in Hokkaido are not selected since both of them are larger than 200 ha and their residence time is long. In the future, the selection in Hokkaido will be reviewed with the reference to the survey data collected by Hokkaido Institute of Environmental Sciences For Shikoku region, one lake with the low alkanity should be selected. For the rest 20 lakes and reservoirs, considering the regionality (multiple lakes and reservoirs should not be monitored within the same prefecture) and the extent of anthropogenic water pollution (the lakes and reservoirs with high authropogenic water pollution should not be monitored), 12 lakes and reservoirs in the next table (see ・ in [Appendix 1]) are expected to be the candidate of monitoring point (see [Appendix 3] for the status of watershed in 24 lakes and reservoirs).

Long-term Acid Deposition Monitoring Sites

Lake and reservoir	Location	Status of recent survey (3rd and 4th)									Remark
		5	6	7	8	9	10	11	12	13	
Lake Imagamioike	Yamagata (Tozawamura)			✓				✓		✓	Yamagata prefectural natural protection area
Lake Karikomiko	Tochigi (Nikko City)						✓	✓	✓		Small amount of man-made pollution Nikko National Park
Lake Hutagoike	Nagano (Sakumachi)				✓		✓	✓	✓	✓	Comparison of Osu Pond and Mesu Pond
Lake Sankyonoike	Niigata (Ryozu City)						✓	✓	✓	✓	Small amount of man-made pollution Sado
Lake Ohataike	Ishikawa (Kanazawa City, etc.)			✓							Small amount of man-made pollution

Lake Yashagaike	Fukui (Imajyocho)		✓				✓		✓	✓	From the 3rd survey result
Lake Ijirako	Gifu (Ijiramura)						✓	✓	✓	✓	EANET site
Lake Sawanoike	Kyoto (Kyoto City)							✓		✓	Research on diatom is conducted. Sampling throughout year is possible.
Lake Banryu	Shimane (Masuda city)						✓	✓	✓	✓	EANET site
Yamanokuchi Dam	Yamaguchi (Fukusakaemura)		✓								Low man-made pollution. Sampling throughout year is possible.
Lake Nagatomiike	Kagawa (Ayauta County)	✓									Low man-made pollution. Sampling throughout year is possible. Higher alkanity than Kirimi Dam (Kouchi). (0.35meq/L)
Konoura Dam	Nagasaki (Nishisono County)			✓							Sampling throughout year is possible.

[Appendix 1] Location of Monitoring Point



[Appendix 2] Detailed data of candidate sites

Name of lake and reservoir	City	Detailed data								Average of lake surface (center)					Measured data source
		(type of lake and reservoir)	Qualitative property of lake and reservoir	Height above sea level of water (m)	Area (ha)	Average water depth (m)	Maximum water depth (m)	Area of watershed area (km2)	Residence time	PH	EC (mS/m)	Alkalinity (meq/L)	COD (mg/L)	Water temperature (degrees C)	
Lake Kuttara	Hokkaido	Volcanic lake	Low nutrient lake	258	470	105.1	148	3.41	28.69 year	7.23	5.60	0.2985		15.9	2nd Acid Deposition Survey result
Lake Panke	Hokkaido	Dammed lake	Low nutrient lake	450	283	23.9	50.0	-	1.38 year	7.38	9.15	0.567	1.1	10.7	3rd Acid Deposition Survey Data
Imagami Oike	Yamagata	Volcanic lake	Low nutrient lake	400	1.6	3.3	7.3	0.06	-	6.3	3.5	0.04	4.2	22.2	1999 survey result
Lake Numayama Oonuma	Yamagata	Dammed lake	Low nutrient lake	410	10	11.4	31.7	1.17	130 days	6.30	4.4	0.071	3.0	20.9	1998 survey result
Lake Okenuma	Fukushima	Crater lake	Low nutrient lake	1590	1	-	14	0.024	-	5.81	0.714	0.015	1.3	18.0	1999 survey result
Lake Goshikinuma	Tochigi	Volcanic lake	Low nutrient lake	2175	5	2.2	5.2	1.2	-	5.8	0.79	0.042	1.2	13.4	3rd Acid Deposition Survey Data
Lake Karikomi	Tochigi	Dammed lake	Low nutrient lake	1610	6	10	15.2	7.1	-	6.6	3.47	0.14	2.0	15.3	1999 survey result
Lake Sugenuma	Gunma	Dammed lake	Low nutrient lake	1731	77	38.1	75	9.7	96.1 days	6.58	4.59	0.14	1.5	15.7	3rd Acid Deposition Survey Data
Lake Futagoike (Oike and Meike)	Nagano	Dammed lake	Extremely low nutrient lake (Osu Pond) 2050 Extremely low nutrient lake (Osu Pond)		1.9 (Osu Pond) 1.7(Mesu Pond)	3.82 (Osu Pond) 2.65(Mesu Pond)	7.7 (Osu Pond) 5.1(Mesu Pond)	0.488 (Osu Pond) 0.338 (Mesu Pond)	-	6.95 (Osu Pond) 5.91 (Mesu Pond)	1.809 (Osu Pond) 0.724 (Mesu Pond)	0.108 (Osu Pond) 0.025 (Mesu Pond)	1.5 (Osu Pond) 2.4(Mesu Pond)	13.6 (Osu Pond) 15.8 (Mesu Pond)	1999 survey result
Lake Bougaike	Niigata	Dammed lake	Low nutrient lake	460	9.1	14.3	33.1	0.28	-	7.04	5.49	0.19	1.4	17.5	3rd Acid Deposition Survey Data
Lake Sankyonoike	Niigata	Dammed lake	Low nutrient lake	330	2	4.5	8.6	0.08	Variable	6.62	8.30	0.106	3.2	18.1	1999 survey result
Lake Arimine	Toyama	Man-made lake	Low nutrient lake	1088	512	43	128	49.95	Approximately 1507.3 days	2.4	0.20	2.8	16.9		1999 survey result

Lake Ohataike	Ishikawa	Volcanic lake	-	500	1	4	-	0.108	-	6.7	4.01	0.100	3.8	19.0	3rd Acid Deposition Survey Data
Lake Yashagaike	Fukui	Dammed lake	Middle nutrient lake	1099	0.4	2.7	7.7	0.042	-	5.56	1.83	0.054	3.8	19.5	3rd Acid Deposition Survey Data
Lake Hokono	Gifu	Dammed lake	Low to Middle nutrient lake	873	13.9	-	16.48	1.3	-	6.6	1.82	0.095	3.4	17.6	3rd Acid Deposition Survey Data
Lake Ijira	Gifu	Dammed lake	Low to Middle nutrient lake	110	10	5.4	10.9	5.3	23 days	7.2	4.10	0.141	2.2	15.9	1999 survey result
Kuchisubo Dam	Mie	Man-made lake	-	137	21	11.4	35	30	0.015 year	7.0	2.80	0.12	1.4	14.6	3rd Acid Deposition Survey Data
Lake Sawanoike	Kyoto	Reservoir	Low to Middle nutrient lake	371	4.1	2.5	4.8	0.374	Less than year	15.54	1.66	0.015	4.1	17.2	1999 survey result
Ikuno Dam	Hyogo	Multi-purpose dam	Low nutrient lake	392	90	20	42	49	0.3 year	6.90	5.13	0.191	1.9	14.9	3rd Acid Deposition Survey Data
Lake Banryu	Shimane	Inlet dammed lake	Middle nutrient lake	25	12.9	5	9	0.73	Approximately 200 days	6.94	9.3	0.153	4.6	17.8	1999 survey result
Yamanokuchi Dam	Yamaguchi	Irrigation dam	Middle nutrient lake	260	7.2	9.6	20.7	2.1	-	7.0	5.50	0.14	2.1	20.4	3rd Acid Deposition Survey Data
Lake Nagatomiike	Kagawa	Man-made reservoir	Low nutrient lake	200.5	4.4	8.1	15.3	0.94	-	7.3	7.10	0.35	3.4	13.8	3rd Acid Deposition Survey Data
Kirimi Dam	Kouchi	Man-made dammed lake	Middle nutrient lake	107.5-122.5	40	26.8	53.5	49.1	-	9.3	7.40	0.45	2.1	16.6	3rd Acid Deposition Survey Data
Konoura Dam	Nagano	Man-made lake	Low nutrient lake	112.30	41.1	20	51.0	25.0	3.2 times/ year	7.73	6.52	0.18	2.3	18.7	3rd Acid Deposition Survey Data

[Appendix 3] Status of watershed area in candidate sites

Name of lake and reservoir	City	Status of watershed area			Weather observation point
		(Usage status of lake and reservoir)	Information of watershed area	Period when winter sampling is impossible	
Lake Kuttara	Hokkaido	Tourism/Farming	Rental boat business is operated between spring and fall at the lake house in the lake shore. The camping facilities are also operated in summer. The farming of Kokanee salmons is operated. There are no social activities in the surrounding watershed area.	Dec. to April (Impossible to reach because of snow)	-
Lake Panke	Hokkaido	-	The Akan region is in the range of annual average temperature of beyond 4degrees C and below 6degrees C. It is the coldest location second to Kitami in Hokkaido. The man-made pollution is not expected since there are no facilities in the lake shore.	Dec. to April (Impossible to reach because of snow)	-
Lake Imagami oike	Yamagata	None	The watershed is narrow and normally there is no inflow water unless it rains or snows. However, water is constantly sprung from the buttom filling up the lake through out the year and the water is overflowing constantly. There is a spa in the neighborhood but no sewage is inflowing. The area with Imakuma mountain and Imagami Oike is the primitive natural area very rarely conserved as a hill and a low height mountain and it is designated as "Yamagata prefectural natural protection area," as the most valuable area for its geography, geological feature and flora and biota. No man-made pollution is expected.	Middle of Dec. to middle of May (frozen between Dec. to April)	Hijiori (distance: 2.9 km to North West)
Lake Numayama Oonuma	Yamagata	-	The watershed area is narrow and there is no constant inflowing from the major rivers throughout the year even though there are some waterway for the rain flowing into the lake when it rains. And, there is no water spring in the lake and the melted snow is major water source. The lake becomes full in the season when snow melts and the water amount decreases as the water taken out for irrigation starting from May or June. The water is taken out till November when the snow starts, and it goes back to full as the snow melts in the next year. It is impossible to monitor in winter. Monitoring point for impact on fresh water ecosystem No man-made pollution is expected.	Dec. to beginning of May (frozen between Dec. to May)	Ooizawa (distance: 9.8 km to South West)
Lake Okenuma	Fukushima	Drinking water for tourism facilities and rest house (excluding winter)	The crater lake formed by the rain collected in the crater, located in the middle of Azuma mountain range. No inflowing or outflowing rivers in the water shed area. There is a rest house (lower reach) in 500 m to North North East of Oke Pond, and the cabin and the camping ground in 150 m to South East but there is no influence from them since the sewage from both of them flows into outside the water shed area. Because of its height from the sea level, the underground penetration seems not to be possible. There are few fishing people. There is a road for tourists nearby.	Dec. to April (nearby roads are closed)	Washikura weather observation point (distance: 5.5 km to South)
Lake Goshikinuma	Tochigi	-	Mountain lake No man-made pollution is expected.	Beginning of Nov. to May (Impossible to reach because of snow)	Okunikko weather observation point

Lake Karikomi	Tochigi	None, natural area	There is no development and no sewage exists. No man-made pollution is expected.	Beginning of Nov. to May (Impossible to reach because of snow)	National Nikko Acid Deposition Monitoring Station, Nikko Weather Observation Station Utsunomiya local meteorological observatory
Lake Suganuma	Gunma	-	Suga swamp is the lake formed by dammed river with the lava flow from the Shirane Mountain. The two locations are shallow in this swamp and divided into three basins and named Shimizu swamp, Benten Swamp, Hokki Swamp from the east direction respectively. Frozen in winter. Several lodges and camping ground exist. The sewage treatment is unknown.	Dec. to May (lake surface freezes)	Katashina, Fujiwara
Lake Futagoile (Oike and Meike)	Nagano	Tourism	The tourist population of Futago Pond in 1999 is 2700. Some data such as pH is different between two adjacent ponds. It is impossible to monitor in winter. Old lava is influencing the water quality in Osu Pond. There was a garbage problem damped by the campers in late 70's in Osu Pond (COD went up to 4 to 6 mg/L). Capes and crucian carps are farmed and discharged. No discharge in Osu Pond. There is a cabin between Osu Pond and Mesu Pond. The sewage from the toilet is contained and not flushed into the pond. The sewage from the kitchen is not flowing into the pond. The sewage from the toilets in the camping ground is contained and not flushed into the sewage either.	Middle of Oct. to middle of May (During the period above, the sample was collected on foot, but is should be avoided)	Chino City Tateshino Monitoring Station (distance: 3.5 km to South South West)
Lake Bougaike	Niigata	Headwater, irrigation	The lake water is used for tap water and irrigation water. Approximately 1,000 tons per day is used as tap water and the water is taken from 5m below the water surface fixed by the float. Approximately 3,000 tons of water per day is taken for irrigation in the irrigation season. The inflowing rivers are only small ones via Bouga Pond, but 240,000 tons per year is taken from Kushiike river as the irrigation water and the melted snow water. Recently "Hoshino Furusato House" facilitated with rest house, telescope and planetarium run by the village was built, and the tennis court and camping ground were developed in the vicinity of the pond. There is the industrial area in 10 to 15 km west of the pond.	Middle of Nov. to middle of May (can drive up to the water intake point throughout the year)	Dougata Local Precipitaion Observatory (distance: 2 km East)
Lake Sankyonoike	Niigata	Irrigation	The farming of Kokanee salmons has started. The development of camping ground has been attempted but there are not many visitors. There is a toilet (only) on the lake shore but the sewage from it is contained and not flushed into the lake. No man-made pollution is expected.	Middle of Dec. to middle of April	Danzaki Local weather Observation Point (distance: 7 km North East)
Lake Arimine	Toyama	Power generation, tourism	It is built by damming the Wada river headwater (mainstream of Joganji River) in 1959. The largest dam for power generation in the prefecture. There are a dozen of inflowing rivers. The lake water is used for power generation, irrigation, tap water and industrial water. There are beautiful sceneries and rare animals and plants are preserved in the forest in the vicinity and it is designated as the Prefecture Natural Park in 1973. The sewage treated by the Single Type Private Sewage Treatment method from youth house, camping ground, dam management office and Arimine Museum is flowing in directly.	Middle of Nov. to end of May	Arimine Dam Management Office (distance: 2 km North)
Lake Ohataike (Kuragatake Oike)	Ishikawa	Irrigation	It is located near Kuragatake mountain (565m above the sea level, approximately 10 km south of center of Kanazawa city) and there is another pond called "Koike." It is surrounded by forests and there are no houses or agricultural fields. There is no man-made pollution impacting water quality of this pond, but the water seems to be stagnated for a long period of time. However, by applying the environmental standard of lake, and based on its measurement data, it is categorized in to A and B type.	Dec. to middle of April	Kanazawa and Torikoshi Monitoring Station

Lake Yashagaike	Fukui	-	Even though the watershed area is approximately ten times of the lake area, it has never been dried out. No inflowing river, no spring. According to the precipitation data of Hirono Dam Monitoring Station 5km North West of the pond, the total annual precipitation is 2,800 mm (1998) and 1931 mm (1993). It is located near the top of the mountain and no facilities exist in the vicinity. Many tourists. No camping ground.	Middle of Nov. to beginning of May	Imajo Observatory (Japan Meteorological Agency), Hirono Dam Monitoring Station (Fukui)
Lake Hokono	Gifu	Irrigation, tourism, fishing	Hozan Prefectural Natural Special Zone There are youth hostels and government lodges on the lake shore. Fishing and boating play take place. The sewage process is unknown.	Nov. to March (frozen between Jan. to Feb.)	Ena and Nakatsugawa City Local Weather Observation Point
Lake Ijira	Gifu	Irrigation, tourism, fishing	The camping ground, temple and house along the inflowing river. There is a possibility of inflowing of sewage in summer but the detail is unknown. There are two restaurants in the lake shore.	Unknown It snows in winter (could be less than 1m)	Gifu Meteorological Observatory (distance: 18 km to South South East)
Kuchisubo Dam	Mie	-	There is a commercial garbage processing ground and it caused the problem with neighbors in the lower reaches. Only few fishing people. The property of the reservoir is unknown. Power generation development exists.	Sampling throughout year is possible.	-
Lake Sawanoike	Kyoto	Irrigation until 1950's	Reservoir formed by damming the swamp to provide the irrigation for the rice field in the vicinity of Narutaki in the Edo era. There are no residential houses or facilities but there are visitors for hiking or fishing. Monitoring point for impact on fresh water ecosystem	Sampling throughout year is possible. Occasionally freezes in January.	Kyoto Local Observation Point (Temperature only) (distance: 4 km to South South East)
Ikuno Dam	Hyogo	Irrigation and city use	The east of the dam is set for fishing and fishing by tourists (such as lure for black bass) are often operated. The major inflowing rivers are the mainstream of Ichikawa river and streams around the dam. Four camping grounds are set up along these rivers and there are residential houses but the sewage is treated and it does not flow into the dam.	Sampling throughout year is possible. Not so much snow. No freeze	Ikuno Dam Management Station (Precipitation only)
Lake Banryu	Shimane	Irrigation, tourism	It is designated as a prefectural natural park and it is one of the tourism source in Masuda city. It is used for boat play and as a hiking course and the carps are discharged in the lake. Fishing is also possible if you obtain the license. There are sewage inflowing from one store (rental boat house and shop) each in upper and lower lake (Combined Household Wastewater Treatment Facility). Very bad situation according to Mr./Ms. Ishitobi.	Sampling throughout year is possible. Not so much snow	Masuda (distance: 7 km East South East)
Yamanokuchi Dam	Yamaguchi	Irrigation	The man-made pollution is not expected since there are no facilities in the lake shore and the watershed.	Sampling throughout year is possible. No lingering snow	Hagi meteorological observatory, Tokusa Observatory
Lake Nagatomiike	Kagawa	Irrigation	No facilities and residential houses in the watershed. No man-made pollution is expected.	Sampling throughout year is possible.	Taman Dam
Kirimi Dam	Kouchi	-	No facilities and residential houses in the dam vicinity. Rubble ground in 1 km distance (dynamite is used). A pig farm in 5 km lower reach.	Sampling throughout year is possible.	-
Konoura Dam	Nagano	-	The camping ground, house and cow house along the inflowing river. Whether there is sewage inflowing is unknown. Also, there is an industrial waste treatment facility. Mercury is detected about two years ago but it was below the minimum limit. The red tide occurs several times a year consecutively since 1987 (near the inflowing point).	Sampling throughout year is possible.	-

[Appendix 4] Information of soil and vegetation in candidate point

Name of lake and reservoir	City	Status of watershed area						
		Area (km2)	Height above sea level of water (m)	surface layer geological feature	Type of soil	Vegetation (primary plant)	Number of river	Number of spring
Lake Kuttara	Hokkaido	3.41	-	-	Brown forest soil, coarse volcanic emission unripe soil	Broad-leaved tree forest	Number of inflowing river: 0 Number of inflowing river: Unknown	Exists (Ayoro River)
Lake Panke	Hokkaido	-	-	Pyroxene-andesite with olivine, pyroxene-andesite with quartz hornblende and dacitic welded tuff	Podzolized soil, Damp brown forest soil, moderately moist brown forest soil (wet)	Subarctic zone coniferous trees (jungle), low mixed forest (jungle)	Number of inflowing river: 5 Number of inflowing river:1	Unknown (expected to have more than inflowing vs. outflowing ratio)
Lake Imagamioike	Yamagata	9.0	573-400	Unconsolidated sediment (landslide colluvium), volcanic rock (rhyolite, liparite), consolidated sediment (gunmetal, hard shale)	Dry brown forest soil, brown forest soil	Fagetea crenatae region natural vegetation (Japanese beech – dwarf bamboo community) Fagetea crenatae region natural vegetation (Alnus pendula – Weigela hortensis community)	Number of inflowing river: unknown Number of inflowing river:1	Unknown
Lake Numayama Oonuma	Yamagata	1.17	410	Gunmetal lump-shaped mudstone	Brown forest soil	Broad-leaved tree forest (Magnolia obovata Thunberg, Quercus serrata Murray, Japanese oak, Japanese beech, etc.), partially artificial forest (cedar)	Number of inflowing river: 0 Number of inflowing river:1	None
Lake Okenuma	Fukushima	0.024	1590-1622	Volcanic sediment (Pyroclastic material (II)	Wet podzolized soil	Abies mariesii, Abies veitchii, rowan, Acer tschonoskii	Number of inflowing river: 0 Number of inflowing river:0	0
Lake Goshikinuma	Tochigi	1.2	-	Tertiary period rhyolite kind	Podzoiled soil	Japanese hemlock forest (Japanese hemlock community)	Number of inflowing river: 0 Number of inflowing river: Unknown	Unknown
Lake Karikomi	Tochigi	7.1	1610-2332	Rhyolite, Andesite	Wet podozoil, dry podozoil, rock waste soil	Abies Mariesii, Abies veitchii, Japanese hemlock, Japanese larch, hiba arborvitae, willow	Number of inflowing river: 1 Number of inflowing river:0	Exists (water amount, water quality from the lake bottom spring are unknown)
Lake Suganuma	Gunma	9.7	-	bias length rhyolite (including same quality tuff breccia)	Brown forest soil, Wet podzolized soil	Abies Mariesii—community	Number of inflowing river: Exists Number of inflowing river: Unknown	Unknown

Lake Futagoike (Oike and Meike)	Nagano	0.488 (Osu Pond) 0.338(Mesu Pond)	2050-2260 (Osu Pond) 2050(Mesu Pond)	Lava (Yokodake lave group, Futagomine lava)	Pw(h), IIItype	Sasa-Japanese beech community, Japanese larch, Japanese hemlock community, Abies mariesii -Abies mariesii Masters community	Number of inflowing river: 0 Number of inflowing river: 0 (Osu Pond) Number of inflowing river: about 3 (they dry up when there is no rain) Number of inflowing river: 0 ((they dry up when there is no rain) Mesu Pond)	Unknown (the main source is assumed to be spring but no detailed research done)(Osu Pond) Unknown (existence is assumed to be spring but no detailed research done)(Mesu Pond)
Lake Bougaike	Niigata	0.28	-	Mudstone (Nishiyama layer)	Brown forest soil	Planted Cedar, Japanese cypress, and S. niphonius, planted Japanese larch, Quercus serrata community	Number of inflowing river: 2 Number of inflowing river:1	Expected to exist (spring from the bottom of lake)
Lake Sankyonoike	Niigata	0.08	330-456	Tertiary period middle true masaragawa layer	Brown forest soil	Japanese oak, Castanea, Lindera umbellata var. membranacea, Sapium japonicum, Acer palmatum var. matsumurae, Japanese Red Pine, Tripetaleia paniculata	Number of inflowing river: about 1 (they dry up when there is no rain) Number of inflowing river:1	Unknown
Lake Arimine	Toyama	49.95	1088-1996	Yamadanaka tuff, conglomerate, sandstone, Shale arternated layer, conglomerate layer, North Alps volcanic rock, Sakaigwa volcanic rock, Taibisan acid rock	Dark color brown forest soil, wet podzolized soil, autochthon unripe soil	Japanese beech – Japanese oak community, Japanese pampas grass community	Number of inflowing river: Approximately 10 Number of inflowing river:3	None
Lake Ohataike	Ishikawa	0.108	-	Kuragatake -dacite Welded pyroclastic rocks, surroundings including Ohata Pond – rhyolite and Andesite pyrocrastic materials	Dry brown forest soil ()	Camellia japonica class area (Quercus salicina forest), Quercus serrata and Japanese oak area (Japanese beech forest)	Number of inflowing river: 0 Number of inflowing river:1	1 (no dry out period)
LakeYashagaike	Fukui	0.042	-	Sandstone, Shale	Brown forest soil	Japanese breech forest (Lindera umbellata var. membranacea -Japanese breech community)	Number of inflowing river: 0 Number of inflowing river: Unknown	None
Lake Hokonoko	Gifu	1.3	-	Naegi granite	Kuroboku soil	Planted forest (Cedar, Japanese cypress), Japanese red pine	Number of inflowing river: 2 Number of inflowing river:2	Unknown
Lake Ijira	Gifu	5.4	110-696	Chart	Brown forest soil	conifer (Japanese red pine, Japanese cypress, cedar), broad-leaved tree (Japanese red pine mixed forest)	Number of inflowing river: 2 Number of inflowing river:1	Exists
Kuchisubo Dam	Mie	30.0	-	Sandstone, mudstone alternated layers, Porphyry	Brown forest soil, dry brown forest soil (I)	Cedar – Japanese cypress, Chinquapin -Willow oak young forest	Number of inflowing river: 2? Number of inflowing river:1	None
Lake Sawanoike	Kyoto	0.374	371-540	Chart	Dry brown forest soil	Japanese red pine, Quercus serrata, Rhododendron family	Number of inflowing river: 01 Number of inflowing river:0	(water amount unknown)

Ikuno Dam	Hyogo	49	-	Ikuno layer family – acid volcanic rock in late Cretaceous, rock quality – rhyolite tufa, none iron metal deposit are distributed in the Ikuno layer Ikuno Mine (currently stopped) produced gold, silver and copper, and is adjacent to the south of Ikuno dam.	Dry brown forest soil, brown forest soil. Sparsely rock is exposed.	Planted forest (Cedar, Japanese cypress), Japanese red pine - Rhododendron dilatatum Miquel community, broad leafed tree (Japanese oak – Castanea community, Quercus serrata community	Number of inflowing river: 4 Number of inflowing river:1	None
Lake Banryu	Shimane	0.73	25-84	Fourth period Pleistocene age sediment, stone, sand, clay	Autochthon unripe soil	Japanese red pine, Japanese black pine	Number of inflowing river: 0 Number of inflowing river: 1 each for inflowing entrance and outflowing entrance	Unknown
Yamanokuchi Dam	Yamaguchi	2.1	-	Rhyolite rock	Brown forest soil	Rhododendron reticulatum – Japanese red pine community	Number of inflowing river: 1 Number of inflowing river:1	Unknown
Lake Nagatomiike	Kagawa	0.94	-	Middle to coarse grain granite, stone, sand	Dry brown forest soil, brown forest soil	Japanese red pine community	Number of inflowing river: 1 Number of inflowing river:1	None
Kirimi Dam	Kouchi	49.10	-	Alternated layer with sand, stone, mudstone to sandstone	Dry brown forest soil, brown forest soil	Planted forest (Cedar, Japanese cypress), Chinquapin and oak young forest, Japanese red pine community	Number of inflowing river: 1 Number of inflowing river:1	-
Konoura Dam	Nagano	25.0	-	Black schist, green schist	Dry brown forest soil, brown forest soil, yellow soil	-	Number of inflowing river: 2 Number of inflowing river:1	-