NOWPAP POMRAC

Northwest Pacific Action Plan
Pollution Monitoring Regional Activity Center

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National Reports on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

POMRAC, Vladivostok, Russian Federation
2006

POMRAC Technical Report No. 1

Pollution Monitoring Regional Activity Center of UNEP Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (POMRAC NOWPAP)

Региональный Центр по мониторингу загрязнения окружающей среды Плана действия ЮНЕП по охране, управлению и развитию морской и прибрежной среды в регионе северо-западной Пацифики (POMRAC NOWPAP)

National Reports on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

POMRAC, Vladivostok, Russian Federation

Национальные доклады об атмосферном выпадении загрязняющих веществ в морскую и прибрежную среду региона Северо-Западной Пацифики (NOWPAP)

POMRAC, Владивосток, Россия

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Preface

1. The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) and three Resolutions were adopted at the First Intergovernmental Meeting (Seoul, Republic of Korea, 14 September 1994: UNEP(OCA)/NOWPAP/IG.1/5). Resolution 1 identified five areas of priority for implementation of the Action Plan, one of which was NOWPAP/3: Establishment of a collaborative, regional monitoring programme.

2. Following the decision of the 3rd NOWPAP Intergovernmental Meeting, the responsibility for NOWPAP/3 (Regional Monitoring Programme) was jointly shared by the Special Monitoring and Coastal Environmental Assessment Regional Activity Center (CEARAC) and the Pollution Monitoring Regional Activity Center (POMRAC) to carry out regional activities.

3. Pollution Monitoring Regional Activity Center (POMRAC) of UNEP Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region was established by Ministry of Natural Resources and Russian Academy of Sciences in compliance with decision of the 4th Intergovernmental Meeting of NOWPAP Countries (Beijing, People's Republic of China, 6-7 April 1999).

4. The functions of the Pollution Monitoring Regional Activity Center (POMRAC), as set forth by the decision of the 4th Intergovernmental Meeting of NOWPAP Countries, are performed by Pacific Geographical Institute of Far Eastern Branch of Russian Academy of Sciences, directed by Center for International Projects of Ministry of Natural Resources of Russia.

5. Following the results of discussions at the First NOWPAP/3 Meeting (Beijing, China, 21-22 May 2001), the 7th NOWPAP Intergovernmental Meeting (Vladivostok, Russia, 20-22 March 2002) approved the resolution 3.6, "the demarcation of the responsibilities and activities between CEARAC and POMRAC as presented by the secretariat in document UNEP/NOWPAP IG.7/8". Subsequently POMRAC was allocated with the responsibility to implement activities related to Working Group (WG) 1 "Atmospheric Deposition of Contaminants" and WG 2 – "River and Direct Inputs of Contaminants".

6. The 1st Focal Points Meeting of POMRAC (Vladivostok, Russia, 9-11 April 2003) decided that the main task of WG 1 should be to establish regional assessment programs to evaluate the atmospheric deposition of contaminants into the marine and coastal environment in NOWPAP Region.

7. The First Joint Meeting of NOWPAP Working Groups WG 1 and WG 2 agreed on the structure and content of the National Reports (UNEP/NOWPAP/POMRAC/WG1 WG2 1/6).

8. The 2nd Focal Points Meeting of POMRAC (Vladivostok, Russia, 26-27 May 2004) adopted the structure and content of the National Reports (see below) and the procedure for the compilation and preparation of National Reports for WG 1.

9. The 2nd 'back-to-back' Meetings of NOWPAP Working Group 1 and Working Group 2 (Vladivostok, Russia, 10-11 October, 2005) have reviewed the National Reports, prepared by NOWPAP Members, and provided recommendations

on their harmonization and publishing.

Structure and Content of National Reports on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

1. **Executive Summary**
2. **Introduction**
   - Goals and objectives of this report
   - General background information on NOWPAP (set the report in the context of NOWPAP, short history, decisions)
   - General information/introduction on the atmospheric deposition (what is it, why is it important, relevance to the region etc.)
   - Geographical scope (geographical coverage of the report, characteristics of the country and it's environment related to the issue, e.g. major rivers, coasts, mountains, cities, climatic systems, physical geography etc.)
   - Institutional arrangements for developing this report (who prepared this report)
3. **Social and economic situation** (short overview of relevant social and economic aspects related to atmospheric deposition, e.g. population, distribution of communities in the country (mainly coastal or inland communities), main income, anthropogenic activities which cause atmospheric deposition, transport, industry)
4. **National monitoring and research activities related to atmospheric deposition of contaminants**
   - **4.1 National programmes** (major scientific or administrative programmes, actors/organizations etc., institutional framework, regular or irregular activities/projects, number and location of stations, existing monitoring parameters (chemical, physical and others) and frequency, etc.)
   - **4.2 Methodologies/procedures** (including equipment used, detection limits and accuracy – preferably in tabular form, QA/QC procedures applicable to atmospheric deposition used in each NOWPAP country)
   - **4.3 Research activities** (related to atmospheric deposition in NOWPAP Region)
   - **4.4 Training activities** (related to atmospheric deposition)
5. **Present situation** of atmospheric deposition of contaminants (based on 2002 data) and long term trends, if available.
6. **Recommendations for future regional activities and priorities** (related to atmospheric deposition in NOWPAP Region)
7. **Conclusions**
8. **References** (related publications, websites and other information sources available related to atmospheric deposition)

<u>Annex (s):</u> **National Laws and Regulations** (overview of relevant policies and laws related to the subject)

10. After harmonization by NOWPAP Countries, final versions of the National Reports (Atmospheric Deposition of Contaminants) are published in the mentioned book.

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National Report of Japan on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

1. Executive Summary

This report presents the overall national activities on the research for atmospheric deposition of contaminants in Japan and the monitoring data collected within the NOWPAP region, together with the regional background on natural and social/economical conditions.

The annual average precipitation of the region is around 1,800 mm and seasonal winds from Eurasia cause heavy snowfalls in winter. The population of 33.67 million in the region consisting of 16 prefectures accounts for 26.4% of the national population. A population density of 193 persons/km^2 in the region is rather small compared to the national population density of 340 persons/km^2. Only four prefectures in the region surpass the national annual average value for industrial output of 2.02 million yen per capita.

In accordance with the Air Pollution Control Law, the Air Pollution Monitoring System has been set up by MOE together with the monitoring network for Environmental Investigation on Chemical Substances in accordance with the Law Concerning the Examination and Manufacture of Chemical Substances. In addition, Long-term Monitoring of Acid Deposition has been carried out nationwide while taking leadership for EANET activities.

Monitoring results of air quality in the major cities of the subject region are; 0.012 – 0.031 mg/m^3 in SPM, 0.001 – 0.004 ppm in SO_2, and 0.011 – 0.048 ppm in NO_2. The concentrations of each pollutant appear to be gradually decreasing or leveling-off year by year. The table below shows the annual amount of acid deposition observed in 2002.

Table 1-1 Annual amount of acid deposition (mmol m^{-2} year^{-1}, 2002)

Name of Site	SO_4^{2-}	nss-SO_4^{2-}	NO_3^-	Cl^-	NH_4^+	Na^+	K^+	Ca^{2+}	nss-Ca^{2+}	Mg^{2+}	H^+
Rishiri	26.1	14.9	12.9	207	19.2	188	4.86	9.73	5.66	21.4	14.4
Tappi	30.2	17.1	22.5	253	19.6	219	5.41	12.0	7.30	26.1	27.8
Sado	40.4	18.8	21.4	439	20.7	384	9.30	13.0	4.86	44.0	32.5
Oki	55.4	21.2	23.7	658	19.5	570	15.0	18.1	6.14	63.8	29.2
Banryu	24.8	18.6	25.0	116	23.4	104	3.76	6.99	4.76	12.1	26.5

Note: nss - non-sea-salt

2. Introduction

2.1 Purpose of the Report

The Regional Seas Programme of the United Nations Environment Programme (UNEP) has been promoted as an action-oriented program for management of marine and coastal environment in collaboration with regional countries. As a part of the program, the Northwest Pacific Action Plan (NOWPAP) was adopted at the First Intergovernmental Meeting (IGM) in Seoul, Korea, in September 1994, attended by China, Japan, Korea, and Russia.

The Pollution Monitoring Regional Activity Centre (POMRAC) was established as one of four Regional Activity Centres of NOWPAP. POMRAC Working Group 1 (WG1) focuses on atmospheric deposition, while Working Group 2 (WG2) focuses on pollution discharged from rivers directly into the marine environment.

This report summarizes national programs which may be used for evaluation of atmospheric deposition of contaminants into marine and coastal environments of the target region, the NOWPAP Region.

2.2 Background. General briefing of NOWPAP

For nearly three decades UNEP has fostered regional cooperation on behalf of the marine and coastal environment. It has accomplished the cooperation by stimulating the creation of “Action Plans”- prescriptions for sound environmental management- for each region. Now, there are more than 140 coastal States and Territories participating in 13 Regional Seas Programmes established under UNEP’s auspices. Five partner programs are also fully operational.

NOWPAP or, in full, “Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region” is one of the 'Action Plans' which covers the Northwest Pacific region. The Northwest Pacific is among the most highly populated parts of the world, resulting in enormous pressures and demands on the environment. The countries of the region, the People’s Republic of China, Japan, the Republic of Korea and the Russian Federation participate in NOWPAP by joining forces.

NOWPAP was adopted at the First Intergovernmental Meeting (IGM) in 1994, following a series of meetings of experts and National Focal points that started as early as 1991.

The overall goal of the NOWPAP is "the wise use, development and management of the coastal and marine environment so as to obtain the utmost long-term benefits for the human populations of the region, while protecting human health, ecological integrity and the region's sustainability for future generations".

The IGM, made up of senior representatives of the NOWPAP members, provides policy guidance and decision-making for NOWPAP. The plan incorporates seven priority projects to be implemented through a network of Regional Activity Centres (RACs)- CEARAC, DINRAC, MERRAC and POMRAC. The RACs play a central role in coordinating regional activities in specific fields of priority projects. NOWPAP’s Regional Coordinating Unit (RCU), co-hosted by Japan and the Republic of Korea, serves as the nerve center and command post of the Action Plan's activities. (Figure 2-1)

The settlement of two RCU offices in Toyama city, Japan, and Busan city, Korea was agreed at the 6th IGM in December 2000, and these two offices were established in November 2004.

The activities agreed upon as part of the implementation of NOWPAP are financed principally by contributions from the Members, international organizations and non-governmental organizations, to the NOWPAP Trust Fund

Priority Projects of NOWPAP

NOWPAP 1: Establishment of a comprehensive database and information management system

NOWPAP 2: Survey of national environmental legislation, objectives, strategies and policies

NOWPAP 3: Establishment of a collaborative regional monitoring program

NOWPAP 4: Development of effective measures for regional cooperation in marine pollution preparedness and response

NOWPAP 5: Regional Activity Centre (RAC) and its network

NOWPAP 6: Public awareness of the marine coastal, and associated freshwater environment

NOWPAP 7: Assessment and management of land-based activities

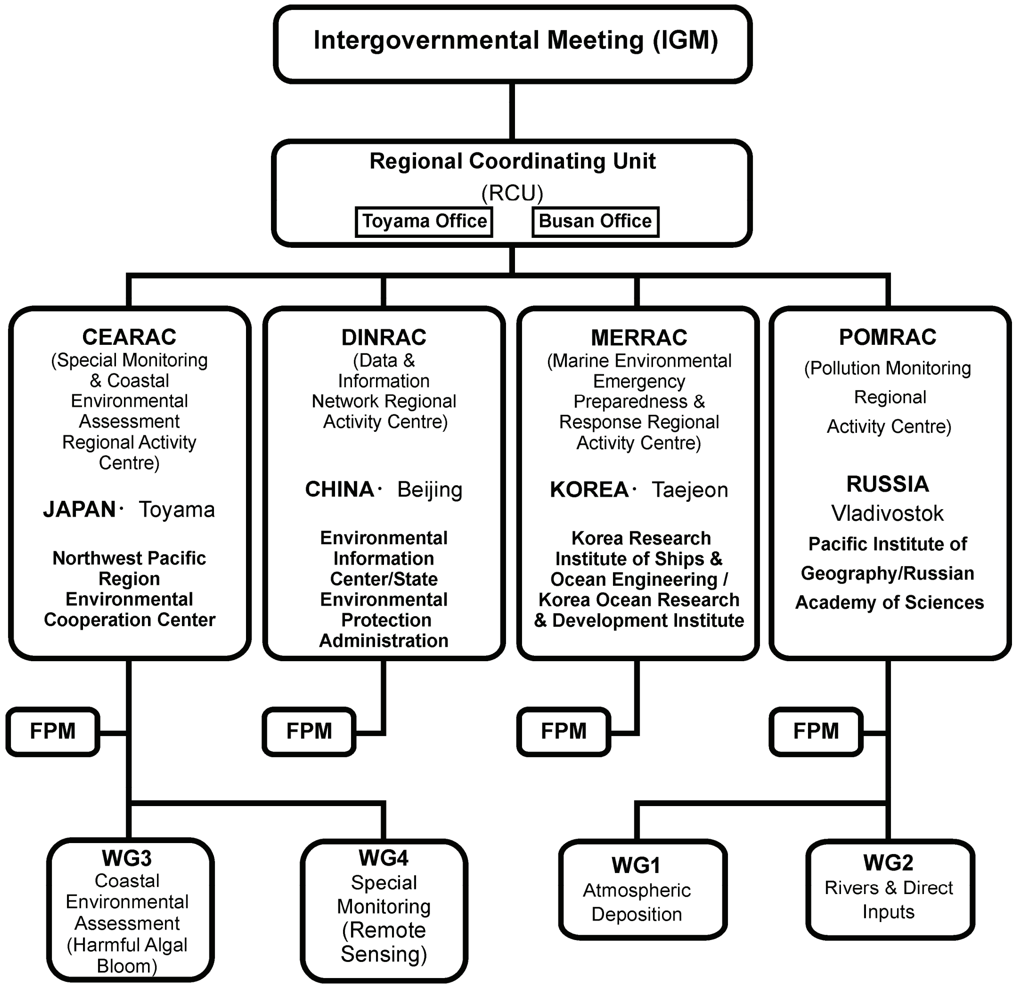


Figure 2-1 NOWPAP Organization

* Focal Points Meeting (FPM) is established for each RAC in order to review and advise the RAC on its activities.

2.3 General Information on Atmospheric Deposition

In Japan, the Air Pollution Monitoring System has been set up by the Ministry of the Environment (MOE) collaborating with the local governments in accordance with the Air Pollution Control Law. The number of monitoring stations is 2,134 in total (1,704 Ambient Air Pollution Monitoring Stations and 430 Roadside Air Pollution Monitoring Stations) as of the end of 2002, in addition to the national monitoring networks. The parameters for the continuous monitoring stations are sulfur dioxide (SO_2), nitrogen oxides (NO_x), suspended particulate matter (SPM), oxidant (O_x) and carbon monoxide (CO) which have environmental standards. Besides the basic parameters, a series of hazardous chemicals which affects human health has been monitored by the MOE since 1985. The local governments have also carried out monitoring in accordance with the Air Pollution Control Law since 1997. For hazardous air pollutants, the monitoring frequency is once per month and data are reduced to annual mean values.

Acid deposition results primarily from the presence of sulfuric and nitric acids in the atmosphere. These acids are formed in the atmosphere from sulfur oxides and nitrogen oxides generated by combustion of fossil fuels. These acids are incorporated into clouds and fall onto the ground along with rain, snow, and mists. These deposited acids increase acidity of soils and inland water, such as lakes and rivers, and cause impacts on forests, fishes, and other living creatures. The acid deposition also damages trees and cultural assets. The Acid Deposition Survey has been conducted by MOE since 1983. The Survey consists of four parts; wet deposition, dry deposition, soil/vegetation and the aquatic environment. The survey results show that the level of acidity (pH 4.77 in 20-year average) is the same as in Europe and the USA. It is believed that the acid deposition might be caused by sources located on the continent.

Accounting for one-third of the worlds population, the countries of the East Asian region have faced serious air pollution problems. Many of these countries face serious air pollution problems because of their dependence on high-sulfur coal for the energy supplies that have enabled them to accomplish remarkable economic growth in recent years. This high-sulfur coal emits large amounts of SOx and NOx that cause air pollution. Expert meetings of the Acid Deposition Monitoring Network in East Asia (EANET) were held on four occasions since 1993 to discuss the current state of acid deposition. These meetings had the effect of profoundly influencing the direction of regional cooperation and preparatory activities in air pollution issues.

The results of preparatory phase activities were evaluated during the 2nd Intergovernmental Meeting held in 2000. EANET started its activities on regular basis in January 2001. Twelve countries now participate in EANET by conducting acid deposition monitoring using common methodologies; compiling, evaluating, storing, and disseminating data; performing quality assurance and quality control (QA/QC) activities, and promoting research. According to EANET's monitoring data, acidity in areas of southern China is the same or higher than levels observed in Japan.

2.4 Geographical Scope

2.4.1 Subject Region

The subject of this report is the NOWPAP Region, which is assumed to include the seas, coastal areas and islands located between the Asian Continent and Japan. Figure 2-2 shows the subject region.

The surface area, mean depth, and maximum depth of the sea in the NOWPAP Region are around a million square kilometers, 1,350 meters, and 3,700 meters, respectively. The straits connecting the sea are all shallow; less than 140 m in

Tsushima and Tsugaru, 60 m in Soya, and 10 m in Tatar Straits at maximum depth. Based on the narrow conditions of the straits, the NOWPAP Region is characterized as being isolated from the open oceans. This isolation creates conditions unique to the subject region.

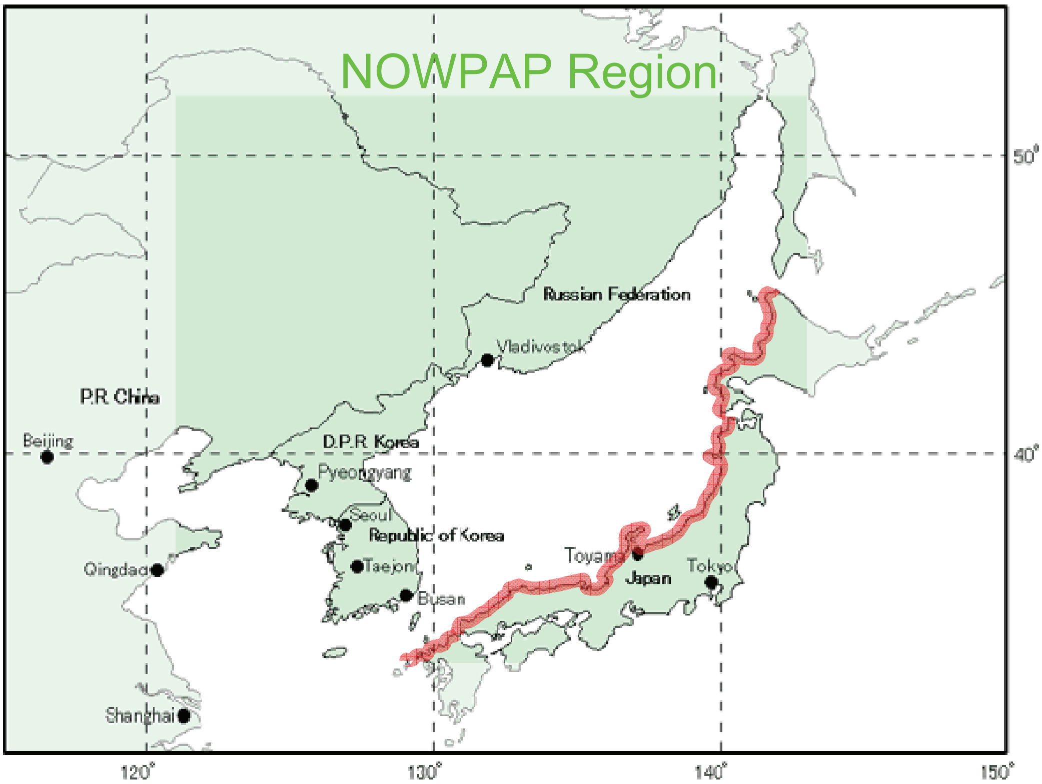


Figure 2-2 Map of the NOWPAP Region

Note: The dark grey line shows the subject region

2.4.2 Outline of Regional Area

Table 2-1 shows the area and the length of the coastlines (includes coast of the Pacific Ocean) of each prefecture of the subject region.

Table 2-1 Area and coastline of each prefecture

Prefecture	Area (km^2)	Length of coastline (km)
Hokkaido	83,454	4,377
Aomori	9,235	744
Akita	11,434	304
Yamagata	7,394	110
Niigata	10,939	585
Toyama	2,802	117
Ishikawa	4,185	581
Fukui	4,189	397
Kyoto	4,613	310
Hyogo	8,393	783
Tottori	3,507	144
Shimane	6,707	814
Yamaguchi	6,111	1,398
Fukuoka	4,841	589
Saga	2,439	357
Nagasaki	4,094	4,137
Total	174,337	15,747

Area: Data in 2002 (Environmental Statistical Book, 2004)
Coastline: Annual Report on Maritime Safety (Maritime Safety Agency, Sep. 1987)

2.4.3 Outline of Climate

Mean climatic data for the years 1971-2000 are summarized in Table 2-2, referred from the Japanese Climate Table (The Japan Meteorological Agency, 2001). A particular feature of climate along the NOWPAP Region is the frequent snowfall brought by damp northwest monsoons in winter.

Table 2-2 Averages of climate properties observed in main meteorological stations (1971-2000)

Meteorological station	Temperature (^oC)	Moisture (%)	Wind direction (upwind)	Wind velocity (m/s)	Precipitation (mm)	Maximum snow cover (cm)
Otaru	8.4	72	SW	2.6	1218	118
Akita	11.4	73	SE	4.4	1713	41
Niigata	13.5	73	S	3.5	1776	39
Toyama	13.7	77	SW	2.9	2245	69
Maizuru	14.3	77	WSW	2.2	1786	37
Matsue	14.6	77	W	3.3	1799	24
Oki	14.0	76	NW	3.4	1750	28
Fukuoka	16.6	69	SE	2.9	1632	3
Tsushima	15.5	71	NNW	3.0	2133	0

2.4.4 State of Land Use

Table 2-3 summarizes the current state of land uses broken down into five categories. As indicted by the table, forest lands comprise the largest land use category in all the prefectures listed.

Table 2-3 State of land use

Prefecture	Private land[1] (km^2)						Natural Park[2]
	Total	Urban	Paddy	Farm	Forest	Others	(km^2)
Hokkaido	27,742	979	2,431	8,611	11,111	4,611	8,629
Aomori	3,940	274	885	730	1,514	537	1,145
Akita	4,279	238	1,314	243	1,858	626	1,232
Yamagata	3,550	241	1,020	352	1,625	313	1,548
Niigata	4,920	434	1,614	369	2,150	353	3,170
Toyama	1,379	225	621	62	378	93	1,198
Ishikawa	1,631	177	423	150	781	100	525
Fukui	1,557	154	402	53	879	69	614
Kyoto	1,555	208	279	97	877	94	87
Hyogo	3,976	537	744	127	2,297	270	1,660
Tottori	1,341	101	264	160	653	163	491
Shimane	3,234	128	399	169	2,401	136	405
Yamaguchi	3,342	258	501	174	2,227	181	427
Fukuoka	2,839	593	744	294	931	277	881
Saga	1,540	143	458	227	598	114	270
Nagasaki	2,045	187	289	467	907	195	1,263
Nationwide	162,311	15,746	27,288	25,011	78,410	15,856	5,366,182

(Source: Statistical Almanac in Japan: 1) as of January 1, 2002 2) as of the end of March, 2002)

2.5 Institutional Arrangements for Developing this Report

This report was prepared by the Northwest Pacific Region Environmental Cooperation Center (NPEC) in cooperation with the Global Environmental Issues Division, the Global Environment Bureau of the Ministry of the Environment (MOE).

3. Social and Economic Conditions

Social and economic conditions that relate to the atmospheric deposition of air pollutants within the subject region are summarized below:

3.1 Population Distribution

Table 3-1 summarizes the population of subject region in 2002, the population density in 2002, and the changes in transition of the population for the ten-year period from 1990 to 2000 by each prefecture.

The population of the subject region as of 2002 comprises 26.4% of total population of Japan, a total of 33.673 million. The population density in the region is 193 people/km^2, considerably smaller than the national average of 340 people/km^2. The population density in the region has tended to decrease by 0.4 percent during the ten-year period from 1990 to 2000. The decrease in population density is the highest in Akita, Shimane, and Yamaguchi Prefectures, in that order.

Table 3-1 Population in subject region

(Unit of population: thousand persons)

Prefecture	Population in 1990	Population in 1995	Year 2000			Population in 2002	Ratio vs nationwide (%)
			Population	Ratio vs 1990	Density (per km^2)		
Nationwide	123,611	125,570	126,926	2.7%	340	127,435	100.00
Hokkaido	5,644	5,692	5,683	0.7%	73	5,670	4.45
Aomori	1,483	1,482	1,476	-0.5%	154	1,469	1.15
Akita	1,227	1,214	1,189	-3.1%	102	1,176	0.92
Yamagata	1,258	1,257	1,244	-1.1%	133	1,235	0.97
Niigata	2,475	2,488	2,476	0.0%	197	2,465	1.93
Toyama	1,120	1,123	1,121	0.1%	264	1,119	0.88
Ishikawa	1,165	1,180	1,181	1.4%	282	1,180	0.93
Fukui	824	827	829	0.6%	198	828	0.65
Kyoto	2,602	2,630	2,644	1.6%	573	2,642	2.07
Hyogo	5,405	5,402	5,551	2.7%	661	5,578	4.38
Tottori	616	615	613	-0.5%	175	612	0.48
Shimane	781	771	762	-2.4%	114	757	0.59
Yamaguchi	1,573	1,556	1,528	-2.9%	250	1,518	1.19
Fukuoka	4,811	4,933	5,016	4.3%	1,009	5,043	3.96
Saga	878	884	877	-0.1%	359	874	0.69
Nagasaki	1,536	1,545	1,517	-1.2%	371	1,507	1.18
Total of object region	33,425	33,599	33,707	-0.4%	193	33,673	26.42

(Source: "National Census Report", "Estimate Population Annual", Statistic Bureau, Ministry of Public Management)

3.2 Population of Major Cities

Table 3-2 lists the cities with more than 50,000 people in the subject regions.

Three cities within the region that have populations of one million or more, are Sapporo (1,823,000 people), Fukuoka (1,302,500 people), and Kita-Kyushu (999,800 people). The cities with populations of 300,000-500,000 are Niigata, Kanazawa, Asahikawa, Toyama, Akita, Yamagata, Fukui, and Shimonoseki, in descending order.

Table 3-2 Population of major cities

City	Population	City	Population
Hokkaido		Fukui-ken	
Asahikawa	361,372	Fukui	249,656
Otaru	148,667	Tsuruga	67,888
Sapporo	1,822,992	Takefu	71,183
Ishikari	55,526	Sabae	65,761
Aomori-ken		Kyoto-fu	
Hirosaki	176,252	Fukuchiyama	67,777
Goshogawara	50,367	Maizuru	93,503
Akita-ken		Tottori-ken	
Noshiro	53,762	Tottori	148,357
Odate	66,594	Yonago	139,333
Akita	312,926	Shimane-ken	
Yamagata-ken		Matsue	147,909
Sakata	100,534	Izumo	86,610
Tsuruoka	100,000	Masuda	50,342
Tendo	63,032	Yamaguchi-ken	
Yamagata	250,316	Shimonoseki	246,924
Yonezawa	92,330	Fukuoka-ken	
Niigata-ken		Kitakyushu	999,806
Niigata	514,678	Fukuoka	1,302,454
Nagaoka	190,718	Nogata	60,434
Sanjo	85,768	Iizuka	80,339
Kashiwazaki	86,085	Kasuga	106,490
Shibata	81,271	Onojo	90,550
Niitsu	67,624	Munakata	81,887
Toyosaka	50,288	Dazaifu	65,129
Joetsu	132,925	Maebara	66,260
Toyama-ken		Saga-ken	
Toyama	321,049	Karatsu	79,795
Takaoka	172,257	Imari	59,819
Himi	57,626		
Ishikawa-ken			
Kanazawa	439,892		
Komatsu	109,307		
Kaga	68,134		
Matto	67,027		

(Source: "Basic Resident Register", March 31, 2002, Home Affair Bureau, Ministry of Public Management)

3.3 Industries

Table 3-3 summarizes the number of employees in each industrial category within the subject region compared with the whole country.

Table 3-3 Number of employees by industries

(Unit of population: thousand people)

		Total number	Agriculture, forestry & fishery	Mining	Construction	Manufacturing	Utilities	Transportation & communication	Food and drink sales	Finance & insurance	Real estate	Service industry	Official duties
Nationwide	1991	60,019	259	78	5,282	14,096	314	3,680	16,913	2,084	923	14,613	1,777
	1996	62,781	260	64	5,775	12,930	341	3,896	18,248	1,976	934	16,508	1,850
	2001	60,158	248 (0.41)	47 (0.08)	4,944 (8.22)	11,134 (18.51)	324 (0.54)	3,756 (6.24)	17,608 (29.27)	1,657 (2.75)	922 (1.53)	17,640 (29.32)	1,877 (3.12)
Hokkaido		2,585	37	5	286	249	15	183	757	71	41	811	131
Aomori		633	8	1	76	78	3	37	183	16	6	190	36
Akita		523	5	1	64	93	3	27	140	12	3	151	22
Yamagata		570	3	1	64	132	3	26	148	16	5	151	22
Niigata		1,178	10	3	145	251	7	62	311	25	9	321	36
Toyama		579	4	1	60	146	5	30	146	14	4	154	15
Ishikawa		601	3	0	58	118	3	34	169	16	6	174	20
Fukui		422	1	0	45	100	5	21	110	10	3	114	13
Kyoto		1,202	2	1	71	233	6	65	379	30	21	354	40
Hyogo		2,330	4	1	167	475	12	151	699	53	40	662	65
Tottori		280	3	0	30	49	1	15	76	7	2	85	12
Shimane		352	4	1	44	56	2	17	91	9	3	109	16
Yamaguchi		687	3	1	71	121	5	47	190	16	6	199	27
Fukuoka		2,255	5	1	195	286	12	155	739	65	34	692	71
Saga		388	3	0	38	68	3	22	107	9	3	119	16
Nagasaki		630	7	2	62	78	4	37	182	17	5	204	34
Total in Region		16,623	109 (0.67)	19 (0.12)	1,626 (9.70)	2,931 (16.65)	98 (0.58)	993 (6.11)	4,772 (29.10)	415 (2.54)	207 (1.26)	4,849 (29.51)	603 (3.79)

(Source: "Statistic Survey on Enterprises/Businesses" Oct-1, 2001. Figures in parentheses show the percent for total number.)

On a nationwide basis, the ratio of employees working in primary industries, secondary industries, and tertiary industries appeared as 0.5%, 30% and 70%, respectively in 2001. The service industry and the food and drink industry account for 29.3% each, totaling about 60% of all employees within the region. Employment statistics indicate that the number of people employed in primary and secondary industries has decreased over the ten-period from 1991 to 2001, while the number of people employed in tertiary industries has increased.

The tendency toward greater employment in tertiary industries within the subject region resembles the nationwide tendency, i.e. the number of employees nationwide is being concentrated in the tertiary industries.

Table 3-4 summarizes the exports of various categories of industrial products being shipped from different prefectures within the subject region in 2002. Hyogo and Fukuoka prefectures are the largest producers of goods being shipped from the region, while Shimane prefecture appears to be the smallest producer of industrial products[1].

[1] Note: Hyogo prefecture faces the Japan Sea in the northern part, and faces the Seto Inland Sea in the southern part, and the watershed divide runs from east to west in the center. The amount of the manufacturing shipment in the southern part has increased than the northern part actually.

Table 3-4 Amount of products shipment in 2002 (by industries with four employees or more)

(Unit: Hundred million yen)

Prefecture	Total amount	Foods	Beverage, cigarette, and fodder	Textile industry	Clothes and other textile goods	Wood and wood manufacture	Furniture and interior	Pulp and paper	Printing	Chemical industry	Oil & coal products	Plastics	Rubber	Tanning & fur product	Pottery	Steel	Nonferrous metals	Metal manufacture	General machinery	Electric machinery	Telecommuni-cation	Electronic parts and devices	Transport machine	Precision machine	Other products
Hokkaido	51,569	17,534	3,964	46	171	1,813	602	4,184	1,618	1,382	4,974	922	136	67	2,493	1,871	86	2,705	1,311	713	1,214	1,250	2,107	68	337
Aomori	10,700	2,884	736	3	113	201	54	1,087	218	296	74	128	24	10	548	505	74	335	622	684	786	1,007	94	155	64
Akita	12,063	955	415	0	221	746	118	375	165	336	74	198	87	21	504	178	163	496	570	301	257	4,888	271	588	137
Yamagata	25,635	2,570	513	153	470	242	326	266	348	1,286	71	563	33	210	1,025	191	380	639	2,049	1,711	6,158	4,369	985	364	713
Niigata	39,309	5,804	766	405	746	432	504	1,654	854	3,122	237	1,281	143	28	1,338	1,433	544	4,220	4,366	2,238	1,436	4,978	1,195	1,072	512
Toyama	30,761	1,296	500	377	270	738	356	1,374	385	4,228	726	1,599	109	15	886	839	2,353	4,592	3,187	544	146	3,977	1,152	95	1,017
Ishikawa	21,470	1,449	1,912	812	199	247	418	224	789	1,144	71	525	34	3	665	222	264	877	4,426	816	2,583	2,883	571	31	305
Fukui	14,930	643	65	903	649	315	188	520	244	1,675	39	1,064	11	4	730	68	1,032	575	757	1,136	232	2,521	598	773	187
Kyoto	43,729	3,905	5,311	743	385	461	316	927	2,322	1,784	51	1,034	106	90	1,898	395	712	1,319	3,567	4,676	853	3,238	4,734	1,644	3,259
Hyogo	119,079	12,564	5,728	656	767	549	701	3,546	2,058	11,970	2,908	3,213	1,372	913	2,946	9,379	2,000	6,778	17,243	12,383	5,904	4,378	8,392	544	2,185
Tottori	9,751	1,118	1,143	7	243	177	51	846	123	21	40	141	17	45	205	74	16	233	352	1,033	931	2,764	116	17	40
Shimane	9,379	722	181	153	99	346	103	210	183	208	34	188	63	10	548	989	105	264	947	257	2,305	979	353	95	34
Yamaguchi	48,354	2,410	443	61	119	484	85	970	388	13,136	7,304	810	866	3	1,911	4,136	802	1,319	2,107	589	2	1,765	8,267	214	165
Fukuoka	67,386	7,900	4,779	120	359	719	1,292	800	2,376	4,005	438	1,487	1,461	48	3,330	5,015	594	3,628	3,942	2,345	531	4,314	17,272	120	512
Saga	13,403	2,587	486	68	123	178	172	565	226	1,041	33	408	595	76	582	159	330	925	1,176	1,312	132	433	1,214	17	567
Nagasaki	14,184	2,241	293	26	248	76	56	60	212	72	31	157	5	4	583	140	7	452	2,829	877	407	1,745	3,298	7	359

(Source: Industrial Statistic Survey by each Prefecture, 2002)

Figure 3-1 illustrates the comparison between industrial products being shipped from the subject region and nationwide during the period from 1998 to 2002. The industrial output from the subject region accounts for about 30% of the national output, but has tended to decrease in recent years.

Figure 3-2 compares the yearly change in the numbers of people employed within the subject region and nationwide between 1998 and 2002. The number of employees in the subject region accounts for about 35% of the nationwide total, and shows a similar downward trend as the amount of products shipped.

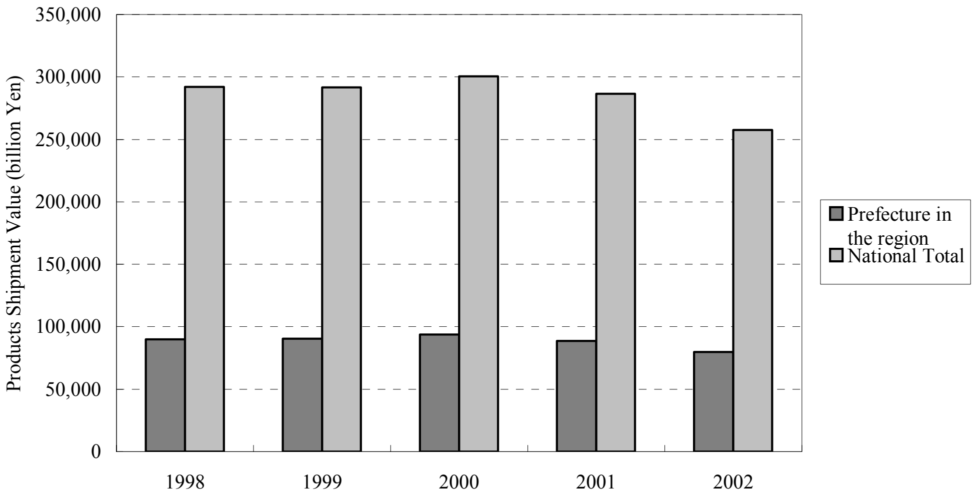


Figure 3-1 Change in the value of products shipped

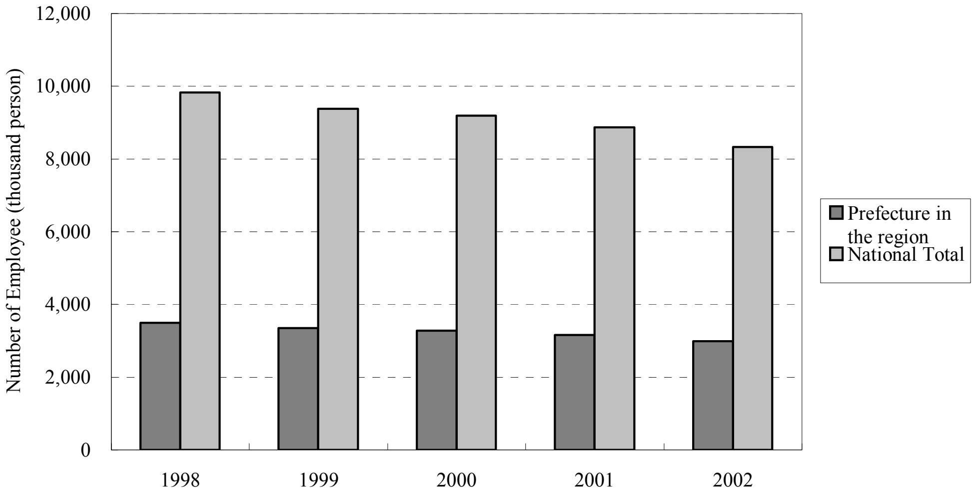


Figure 3-2 Change in the number of employees

Figure 3-3 compares the amount of industrial products shipped per capita from the subject region with the national average. Yamaguchi Prefecture appears to be the largest per capita producer of industrial products in the region, followed by Toyama and Hyogo Prefectures. The smallest per capita production is in Aomori Prefecture. Table 3-5 shows the breakdown of the amount of products shipped from the three highest-ranking prefectures.

Table 3-5 Main products in the three highest-ranking prefectures

	Yamaguchi	**Toyama**	**Hyogo**
1st	Chemical products	Metal products	General machinery
2nd	Transport machinery	Chemical products	Electric machinery
3rd	Oil & coal products	Electronic devices	Foods

Note: Yamaguchi and Hyogo prefecture face not only the NOWPAP region but also the Inland Sea. The main industrial zones of these prefectures are located on coastal areas of the Inland Sea.

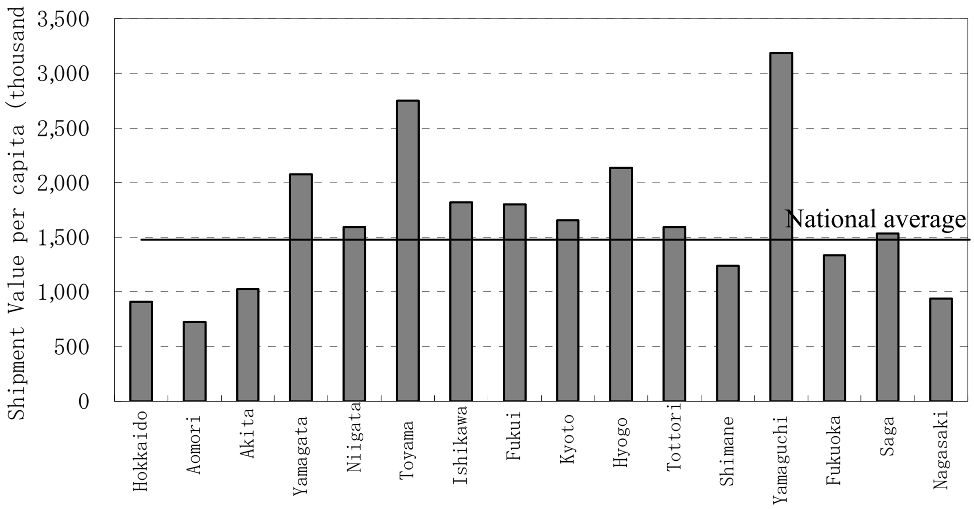


Figure 3-3 Per capita value of products shipped in 2002

3.4 Transportation

Table 3-6 summarizes the traffic volumes for specific prefectures within the subject region in 2002.

In comparison with the nationwide traffic volume, the ratio of car usage within the region comprises 27.6 %, though the freight tonnage carried accounts for about one third of the whole country.

Table 3-6 Traffic volume by prefectures in 2002

Prefecture	Freight tonnage carried (million ton)		Number of passenger (million)		Number of vehicles owned		
	Business	Private	Bus	Car	Car	Freight car	Bus
Nationwide	2,813	2,390	6,286	40,506	55,288	17,015	232
Hokkaido	324	122	326	2,371	2,654	751	15
Aomori	38	46	82	478	670	263	5
Akita	26	28	45	400	559	219	3
Yamagata	28	32	39	432	631	233	3
Niigata	53	77	129	801	1,230	429	7
Toyama	33	36	33	428	633	186	2
Ishikawa	32	31	60	449	634	178	3
Fukui	20	20	28	315	452	149	2
Kyoto	35	43	199	793	964	283	4
Hyogo	97	90	306	1,503	2,118	581	8
Tottori	15	13	20	183	304	126	1
Shimane	18	17	25	220	363	151	2
Yamaguchi	39	28	54	474	744	249	3
Fukuoka	107	84	342	1,652	2,223	667	10
Saga	29	19	32	283	425	168	2
Nagasaki	29	25	120	413	612	231	4
Total in object region	923	711	1,840	11,195	15,216	4,864	74
Ratio to nation (%)	32.8	29.7	29.3	27.6	27.5	28.6	31.9

(Source: Japan Statistic Yearbook 2002, Ministry of Internal Affairs and Communications)

3.5 Energy

Table 3-7 summarizes the domestic supply of primary energy in Japan.

In comparison with the total supply amount of the primary energy, crude oil represents around 40 % of the supply amount. Next to crude oil, coal and natural gas account for 19.5 % and 14.0 %, respectively.

Table 3-7 Domestic supply of primary energy in 2002

Type of energy	Energy supply (peta-joule)	Ratio to total supply (%)
Coal & Coal products	4,294	19.3
Crude oil & Oil products	10,908	48.9
Natural gas	3,113	14.0
Large-scale hydraulic	741	3.3
Nuclear energy	2,656	11.9
Others	572	2.6
Total domestic supply	22,285	100

Note: Figures of this table are derived from the source documents shown below. (Source: Japan Statistic Yearbook 2002, Ministry of Internal Affairs and Communications. Agency for Natural Resources and Energy)

4. National Monitoring and Research Activities

4.1 National Program

4.1.1 Air Pollution Monitoring System

A. National Network

To understand the status of air pollution nationwide through obtaining basic information necessary for improving the air quality, a national monitoring network called the Air Pollution Monitoring System has been set up. The monitoring stations within this national system consist of two categories: Ambient Air Pollution Monitoring Stations and Roadside Air Pollution Monitoring Stations.

The roles of national monitoring stations are as follows:

1) Provide reference stations for local monitoring networks,

2) Act as pilot stations to monitor air quality on regular basis,

3) Provide representative stations to track essential pollutants, such as hazardous chemicals and acid deposition,

4) Act as ideal stations for atmospheric background in term of air pollution,

5) Provide field sites for education and training for environmental monitoring systems.

Figure 4-1 shows the national monitoring stations for air quality and acid deposition.

B. Local Network for Air Monitoring

In accordance with the Air Pollution Control Law, air pollution monitoring is implemented by local governments in each prefecture and designated city. Moreover, the amount of fuel used and sulfur dioxide emissions from air pollution sources are observed regularly. Telemeter devices that transmit the measurement results to a central control center have also been prepared.

In order to maintain and expand the network, the central government assists the local governments by sharing the leasing and the maintenance fees for measuring equipment necessary for the monitoring activities. The central government also assists the local governments in the monitoring of hazardous air pollutants, including Dioxins (Polychlorinated dibenzo-para-dioxin (PCDD), Polychlorinated dibenzofuran (PCDF), and coplanar PCB).

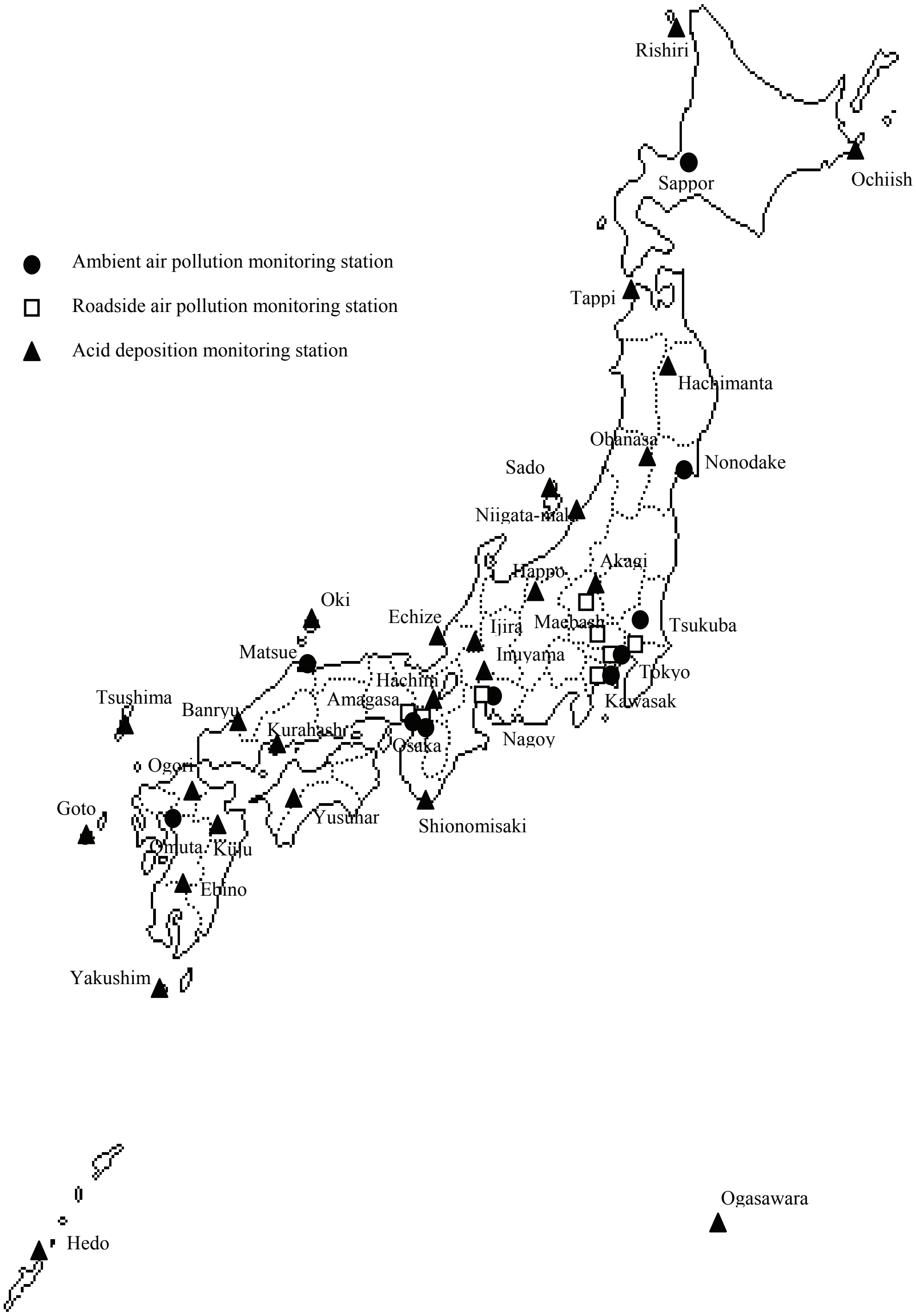


Figure 4-1 National monitoring stations

Moreover, the monitoring data is collected in real time (prompt report) by the Atmospheric Environmental Regional Observation System (AEROS) and is open to the public through the Internet.

Table 4-1 Number of monitoring stations in the subject region in 2002

Prefecture	Regular monitoring		Benzene as a hazardous chemical			Dioxins	
	Ambient	Roadside	Ambient	Point of release	Roadside	Ambient	Point of release
Nationwide	1,489	417	252	83	114	732	228
Hokkaido	87	17	12	3	4	18	12
Aomori	9	4	2	0	1	6	6
Akita	21	5	4	1	2	10	1
Yamagata	17	1	2	0	1	2	2
Niigata	35	6	3	5	2	13	0
Toyama	25	6	3	2	1	10	6
Ishikawa	25	4	3	0	2	9	6
Fukui	27	4	2	2	1	6	6
Kyoto	28	9	3	1	5	19	4
Hyogo	71	29	12	3	4	32	6
Tottori	3	1	3	0	1	4	0
Shimane	7	2	2	1	1	10	1
Yamaguchi	34	1	5	0	0	14	0
Fukuoka	43	18	7	6	5	12	13
Saga	17	3	4	0	0	5	2
Nagasaki	23	5	3	0	4	10	0
Total in object region	472	115	70	24	34	180	65

(Source: Japan Statistic Yearbook 2002, Ministry of Internal Affairs and Communications)

C. Hazardous Air Pollutants

Hazardous air pollutants are defined by Article 2 Clause 9 of the Air Pollution Control Law as "Those air pollutants that can lead to degradation of human health through chronic exposure, excluding substances that are regulated especially for factories and industries by the Air Pollution Control Law ".

A total of 234 substances were identified as potential hazardous air pollutants in the report entitled, *Measures for Hazardous Air Pollutant in the Future (the Second Report)* which was published by the Central Council for Environmental Pollution Control on October 18, 1996. Among those, 22 substances are selected as hazardous air pollutants (priority substances) that have a higher probability of causing human health risks (Table 4-2).

According to Article 18 of the Air Pollution Control Law, the central and local governments are responsible for conducting "The investigation to understand the situation of air pollution by hazardous air pollutants", that is, through environmental monitoring. According to Article 22, 19 of the prioritized hazardous air pollutants whose measurement methods have already been established must be measured based on "the standards for data processing for air pollution monitoring system", as well as on the standards provided in the current measurement manual provided at the same time. For dioxins, environmental investigations have been executed following the Law Concerning Special Measures against Dioxins.

Table 4-2 Hazardous air pollutants

Substance	Standards	Monitoring
Acrylonitrile	2 μg/m^3 (*)	x
Acetaldehyde	-	x
Vinylchloride	10 μg/m^3 (*)	x
Chloroform	-	x
Ethyleneoxyde	-	x
1,2-Dichloromethane	-	x
Dichloromethane	150 μg/m^3	x
Tetrachloroethylene	200 μg/m^3	x
Trichloroethylene	200 μg/m^3	x
1,3-Butadiene	-	x
Benzene	3 μg/m^3	x
Benzo(a)pyrene	-	x
Formaldehyde	-	x
Mercury and its compounds	0.04 μg/m^3 (*)	x
Nickel and its compounds	0.025 μg/m^3 (*)	x
Arsenic and its compounds	-	x
Beryllium and its compounds	-	x
Manganese and its compounds	-	x
Chromium(VI) compounds	-	x
Chloromethylmethylether	-	-
Talc (containing Asbestos)	-	-
Dioxines	0.6 pg-TEQ/m^3 (**)	x

Note: (*) - Guideline standards enacted in 2003
(**) - TEQ stands for Toxicity Equivalency Quantity.

4.1.2 Environmental Investigation of Chemical Substances

MOE has been conducting successive investigations on the persistence of chemical substances in the general environment since 1974 and has published the results in "Chemicals in the Environment."

The "Environmental Investigation on Chemical Substances" commenced when the "Law Concerning the Examination and Manufacture of Chemical Substances (Chemical Substances Control Law)" was enacted in 1973. The first investigation on the safety of chemical substances based on a priority list consisting of about 2,000 chemicals was executed from 1979 to 1988 as part of a 10-year plan. "The second investigation on the safety of overhaul chemicals" covering a second priority list consisting of about 1,100 chemicals was executed as a 10-year plan continuously since 1989. These chemical investigations were executed together with other related surveys, such as biological monitoring, follow-up surveys for unintentionally generated chemicals, water and sediment quality monitoring, and surveys for specific chemicals.

In addition, the Screening Committee for Chemicals Concerning the Environmental Pollution was set up in 2002 in order to deal with the changing situation of chemical and environmental issues, and related policy matters, such as enactment of the Law Concerning Reporting, of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management, and the Stockholm Convention on Persistent Organic Pollutants (POPs). Adopting screening methods for the chemicals requested by the authority and specialists of risk assessment, preliminary surveys, exposure surveys and monitoring have been executed as part of a chemical survey related to chemical waste or residual products.

The atmospheric monitoring in 2002 was conducted for the target substances of the POPs Treaty, namely PCBs, HBC, Aldrin, Ddieldrin, Endrin, p.p'-DDT, trans-Crolden, cis-Crolden, and Heptacrol. A total of 102 samples were taken at 34 locations during the 2002 monitoring program.

Table 4-3 Outline of the environmental survey for air (fiscal year 1998 – 2002)

FY 1998 (7-16 points)		FY 1999 (6-16 points)		FY 2000 (8-15 points)		FY 2001 (7-16 points)		FY 2002 (34 points)	
Substance	Range* (ng/m^3)	Substance	Range* (ng/m^3)	Substance	Range* (ng/m^3)	Substance	Range* (ng/m^3)	Substance	Range* (pg/m^3)
Methyl bromide	49 - 340	1,2,3-Trichlorobennzene	0.018 - 11	1,4-Dioxane	15 - 1200	1,1,1-Trichloroethane	170 - 420	PCBs	16 - 880
Ethyl bromide	nd	1,2,4-Trichlorobennzene	0.12 - 40	Isobutyl acetate	73 - 710	1,1,2-Trichloroethane	20 - 27	HCB	57 - 3,000
Vinyl chloride	16 - 1300	1,3,5-Trichlorobennzene	0.036 - 1.4	Ethyl acetate	170 - 160000	Ethyl chloride	14 - 540	Aldrin	nd - 3.2
1,2-Dibromoethane	nd	1,2,3,4-Tetrachlorobennzene	0.039 - 0.94	Vinyl acetate	120 - 5500	Methyl chloride	750 - 16000	Dieldrin	0.73 - 110
2-Bromopropane	nd	1,2,3,5-Tetrachlorobennzene	0.015 - 0.65	Butyl acetate	110 - 13000	Dimethyl terephthalate	0.074 - 0.093	Endrin	nd - 2.5
1-Chlorobutane	38 - 1400	1,2,4,5-Tetrachlorobennzene	0.019 - 0.40	α-Methylstyrene	1.9 - 110	Diethyl terephthalate	0.16 - 0.22	*p,p'*-DDT	0.25 - 22
3,4-Dichloro-1-buthene	80	Pentachlorobennzene	0.012 - 1.1	cis-β-Methylstyrene + o-Methylstyrene + p-Methylstyrene	5.4 - 190	Methyl acrylate	nd	*p,p'*-DDE	0.56 - 28
Toluene	1100 - 85000	Hexachlorobennzene	0.013 - 1.1	m-Methylstyrene	2.6 - 190	Ethyl acrylate	0.6 - 1.8	*p,p'*-DDD	nd - 0.76
Chlorobenzene	20 - 160	Ethylbenzene	89 - 10000	trans-β-Methylstyrene	2.4 - 22	Acetonitrile	93 - 1200	*o,p'*-DDT	0.41 - 40
o-Xylene	330 - 9500	1,1-Dichloroethane	11月24日	2-Ethoxyethanol	2.3 - 950	Diisononyl phthalate	0.42 - 22	*o,p'*-DDE	0.11 - 8.5
m-Xylene + p-Xylene	550 - 35000	1-Bromo-3-Chloropropane	20 - 34	2-Methoxyethanol	6.7 - 97	Di-i-decyl phthalate	0.30 - 1.3	*o,p'*-DDD	nd - 0.85
Stylene	39 - 2700	o-Dichloricide	34 - 420	2-Butoxyethanol	4.8 - 560	Diisotridecyl phthalate	nd	*trans*-Chlordane	0.62 - 820
Dichloromethane	280 - 24000	m-Dichloricide	23 - 370	Hexabromobenzene	0.031 - 0.1	Polybromodiphenylether	0.00007 - 0.067	*cis*-Chlordane	0.86 - 670
1,2,4-Trimethylbennzene	370 - 10000	p-Dichloricide	160 - 17000	Polychlorinated terphenyl	0.00092 - 0.0060	Bromodiphenylether	0.0004 - 0.0020	*trans*-Nonachlor	0.64 - 550
1,3,5-Trimethylbennzene	90 - 3200	Methyl-t-butyl ether	22 - 330	Monochloroterphenyl	0.00092 - 0.0060	Dibromodiphenylether	0.0002 - 0.012	*cis*-Nonachlor	0.071 - 62
Polychlorinated naphthalene (75 substances)	0.011 - 0.86	Benzo[e]pyrene	0.074 - 3.7	Dichloro-terphenyl	0.00055 - 0.0011	Tribromodiphenylether	0.00007 - 0.0079	Oxychlordane	nd - 8.3
Tris(2-chloroethyl) phosphate	0.3 - 1.4	Benzo[g,h,i]perylene	0.10 - 4.1	Trichloro-terphenyl	nd	Tetrabromodiphenylether	0.0005 - 0.010	Heptachlor	0.20 - 220
Tributyl phosphate	0.22 - 7.5	Benzo [b+ j+ k] Fluoranthene	0.36 - 7.8	Tetrachloro-terphenyl	nd	Pentabromodiphenylether	0.00010 - 0.0093		
Tricresyl phosphate	1.2 - 2.6	Dibenz[a,h] Anthracene	0.24 - 1.4	Pentachloro-terphenyl	nd	Hexabromodiphenylether	0.00011 - 0.011		
Bis(2-ethylhexyl) adipate	1.0 - 26	Pyrene	0.39 - 8.1			Heptabromodiphenylether	0.00021 - 0.038		
Methylnaphthalenes (2 substances)	3.2 - 310	Phenanthrene	1.6 - 29						
Dimethylnaphthalene(9 substances)	0.09 - 70	Fluoranthene	0.58 - 10						
Crotonaldehyde	15 - 330	Chrysene	0.26 - 3.9						
		Methyl methacrylate	28 - 170						
		Ethyl methacrylate	nd						
		PCBs	0.11 - 2.1						

Note: Number of sampling point is varied by the substances exept for FY2002.
* Detected range: minimum - maximum

4.1.3 Long-term Monitoring of Acid Deposition

In order to understand the actual situations of acid deposition in Japan, MOE initiated the Phase I Acid Deposition Survey as a 5-year program in 1983, under the guidance of the Committee on Acid Deposition and Its Effect established by MOE. The program aimed to research of the component analysis of acid depositions and its impact on inland aquatic environment and soil/vegetation. “Measurement Manual for Acid Depositions (MOE Air Quality Management Bureau, March 1988)” has published as a result of studies went through the survey activities.

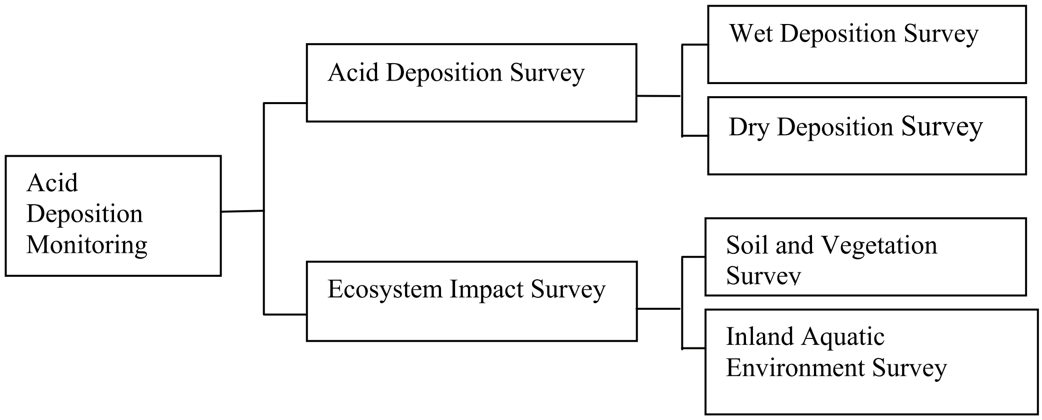
The acid deposition survey has been conducted from the beginning of Phase I Survey in 1983 until the end of Phase IV Survey in 2000. The survey results of four environmental media; atmosphere, soil, vegetation, and inland aquatic environments, indicated that the acidity of precipitation in the NOWPAP region was at the same level as in Europe and North America, but tending to increase in acidity along the NOWPAP Region in winter. Meanwhile, the Acid Deposition Monitoring Network in East Asia (EANET) was established to promote acid deposition monitoring based on international cooperation in the East Asian region. The preparatory phase activities for this cooperative monitoring were executed in April 1998 with ten countries, and the monitoring activities were implemented on regular basis beginning in January 2001 in participating with twelve countries now.

Based on the background mentioned above, MOE has promoted the Long-term Monitoring of Acid Deposition and the Study Research on Acid Deposition in East Asia, in accordance with EANET and international collaborations since 2001.

The purpose of long-term monitoring of acid deposition is to detect early impacts of acid deposition, characterize long-range transmission of acidifying substances, and identify long-term trends of acid deposition. In order to predict the impacts caused by acid deposition in the future, acid deposition monitoring and ecological monitoring will be conducted together with EANET activities.

A. Description of the Monitoring

The monitoring program is classified into two categories: Acid Deposition Survey and Ecosystem Impact Survey. Further, the former program is divided into the Wet Deposition Survey and Dry Deposition Survey, and the latter one is divided into the Soil and Vegetation Survey and Inland Aquatic Environment Survey.



The monitoring activities are implemented by the following organizations:

Item	Organization
1) Planning and arrangement	Ministry of the Environment Acid Deposition and Oxidant Research Center
2) Sampling	Trust Municipalities, Organization and/or Company
3) Measurement/Analysis	Trust Municipalities, Organization and/or Company Acid Deposition and Oxidant Research Center
4) QA/QC	Acid Deposition and Oxidant Research Center
5) Compilation and Evaluation of Data	Ministry of the Environment Acid Deposition and Oxidant Research Center

Objectives of the long-term monitoring of acid deposition

The long-term monitoring of acid deposition aims to evaluate the concentration of oxidized materials including ozone and the actual status of deposition in Japan. This evaluation is conducted for the following locations or sources:

1) remote sites along coastal areas and plains;
2) remote mountains sites;
3) rural sites;
4) suburb mountainous sites;
5) urban sites;
6) natural sources of acid deposition such as volcanoes;
7) ecosystems, including forest and inland waters.

Parameters and Sampling Frequency

The parameters and frequency of deposition monitoring is summarized, as follows:

a) Wet Deposition

Parameters: Electric conductivity (EC), pH, Cl^-, SO_4^{2-}, NO_3^-, Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+

Frequency: daily

b) Dry Deposition

- Automatic measurement

Parameters: SO_2, O_3, NO_X and PM_{10} (partially as $PM_{2.5}$)

Frequency: Continuously, hourly average

- Manual measurement (EANET stations only)

Parameters: SO_2, HNO_3, HCl, NH_3 and particulate matter components

Frequency: weekly

Site of Acid Deposition Monitoring

While there are 31 sites for acid deposition monitoring in the whole country, 10 sites in the subject region are shown in Table 4-4. Among these sites, five stations also take roles for EANET.

Locations of the acid deposition monitoring stations are classified into the remote sites, the rural sites and the urban sites. The purposes and location criteria for each type of monitoring site are summarized as follows:

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 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. Therefore, remote sites should be located with sufficient distance from significant stationary sources such as urban areas, thermal power plants, large factories, and significant mobile sources such as major highways, ports, and railways, to minimize these influences.

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, for instance, to evaluate the effects of acid deposition on agricultural crops and forests. The location of these sites should be selected in areas with minor influence from local emission and contamination sources. Therefore, 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, and the areas immediately outside such areas, can be included. The monitoring data can be used, for instance, to evaluate the effects of acid deposition on buildings and historical monuments. Monitoring data at these sites may also be useful for the assessment of acidity of precipitation and the trends in urban areas.

The location of the acid deposition monitoring sites are shown in Figure 4-2 and the classification and the measuring parameters for the stations in the subject region are shown in Table 4-4.

Table 4-4 Acid deposition monitoring sites in the object region

Name of sites	Prefecture	Site classification	Measuring parameter					Note
			NO_X	SO_2	O_3	PM_{10}	$PM_{2.5}$	
Rishiri	Hokkaido	Remote	+	+	+	+	+	EANET site
Sapporo		Urban	+	+	+			
Tappi	Aomori	Remote	+	+	+	+		EANET site
Sado-Seki	Niigata	Remote	+	+	+	+		EANET site
Niigata-Maki		Rural						for Training
Echizen	Fukui	Remote						
Oki	Shimane	Remote	+	+	+	+	+	EANET site
Banryu		Urban	+	+	+	+		EANET site
Tsushima	Nagasaki	Remote			+			
Goto		Remote						

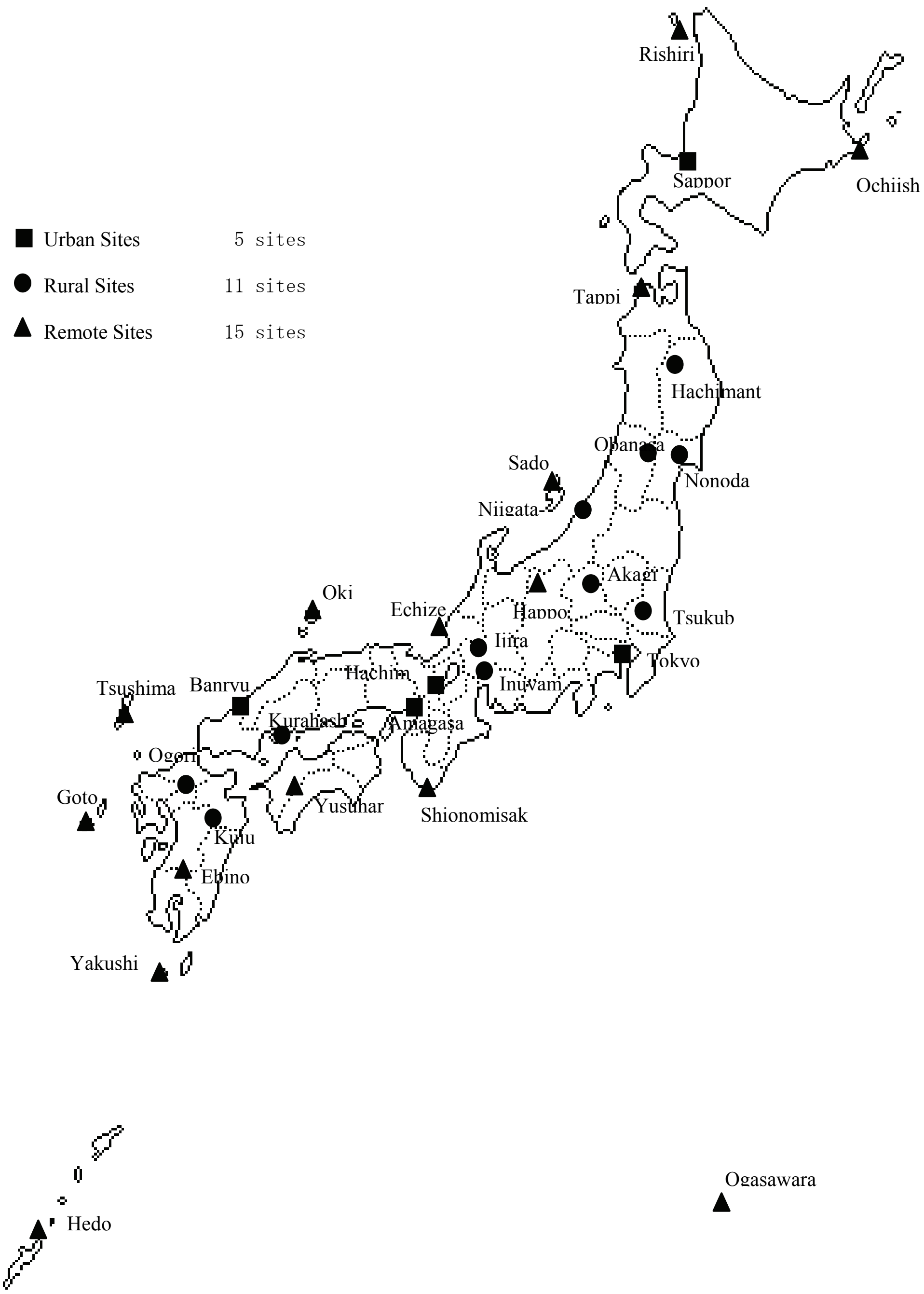


Figure 4-2 Locations for Acid Deposition Monitoring Sites

B. Acid Deposition Survey

MOE has conducted a series of acid deposition surveys since 1983. Table 4-5 shows the outline of these surveys.

Table 4-5 Outline of Acid Deposition Survey（1983 – 2002）

	Phase I FY 1983 – 1987	**Phase II FY 1983 – 1992**	**Phase III FY 1993 – 1997**	**Phase IV FY 1998 – 2000**	**— FY 2001 – 2002**
Number of sites for atmospheric survey	34 ('83) 14('84 - '85) 29('86 – '87)	29	48	55	48
pH in average	4.4 – 5.5	4.5 – 5.8	4.4 – 5.9	4.47 – 6.15	4.34 – 6.25
Number of sites for soil survey	12	43	88	20	18
Number of sites lake survey	133 (for screening)	5	33	17	12
Others	-	Snow survey (Hokkaido and Niigata)	-	-	-

A series of survey results recorded over two decades, consisting of the first through the fourth acid deposition survey and the acid deposition surveys for fiscal year in 2001 and 2002 were presented by the Committee on Acid Deposition and Its Effect on July 2004.

The acid deposition survey results are summarized, as follows:

1) pH (acidity);

- The overall, site-wide 20-year average of precipitation pH was 4.77, with a range of pH 4.49 (Ijira)- to pH 5.85 (Ube).

- Precipitation with a pH of less than 3, from which plant life would suffer acute damage was not observed. However, precipitation samples exhibition a pH of less than 4 accounted for about 5% of all samples collected, and the precipitation is acidic comparable to that in Europe still in 2000 to 2002 fiscal year.

2) Composition of acid deposition;

- A regional difference was seen in the seasonal variation of the deposition of non-sea-salt sulfate and nitrate. The maximum deposition of non-sea-salt sulfate and nitrate occurred in the NOWPAP Region during the winter season, whereas the maximum deposition occurred during the summer on the Pacific Ocean and the Inland Sea coasts. It is known that the atmospheric concentrations of sulfur and nitrogen oxides increase in these regions in winter.

- As for the deposition of non-sea-salt calcium ion, it was suggested that the maximum concentration occurred in all regions during the spring season, and the influence of Asian dust appears in the whole country.

- It was suggested that the increase of ozone concentration was seen in springtime, and the contribution of long-term transportation of air pollution seems to be high in the whole country.

3) Comparative study on international;

- The pH of precipitation in Japan has stabilized within a range of 4.4 to 5.0. Despite the concentrations of non-sea-salt sulfate and nitrate in precipitation are not so high in comparison with those in China, the acid deposition level is larger due to the high precipitation rate.

C. Acid Deposition Monitoring Network in East Asia (EANET)

After the preparatory phase activities from 1998 to 2000, EANET activities have been cooperatively implemented on regular basis since January 2001.

UNEP was designated as the secretariat for EANET, and the Acid Deposition and Oxidant Research Center (ADORC), a branch office of Japan Environmental Sanitation Center, was designated as the network center of EANET.

In 2004, the participating countries increased to 12 countries: China, Japan, Mongolia, Republic of Korea, and Russian Federation from North-East Asia and Indonesia, Malaysia, Philippines, Thailand, Laos, Cambodia and Vietnam from South-East Asia.

Objectives:

The objectives of EANET include the following:

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

Major Activities:

EANET's major activities include the following:

1) Implementation of acid deposition monitoring in the participating countries using common methodologies, such as:

- wet deposition monitoring;
- dry deposition monitoring;
- soil and vegetation monitoring;
- monitoring inland aquatic environment

2) Compilation, evaluation, storage and provision of data obtained through the EANET monitoring;

3) Promotion of quality assurance/quality control (QA/QC) activities to obtain high quality monitoring data;

4) Preparation and publication of periodic reports on the state of acid

deposition in East Asia;

5) Promotion of research and studies related to acid deposition; and

6) Other activities necessary to achieve the objectives of the Network.

Acid deposition monitoring on EANET covers four environmental items – wet deposition, dry deposition, soil and vegetation, and inland aquatic environment. Monitoring of wet and dry deposition has been implemented in order to observe concentrations and to evaluate fluxes of acidic substances deposited to the land surface, while monitoring for soil/vegetation and inland aquatic environment was put into action to assess adverse impacts on terrestrial and aquatic ecosystems. These monitoring data will be utilized to assess the state of acid deposition as well as the impact on ecosystems.

4.2 Methodologies/Procedures

This section summarizes the methodologies and procedures employed by EANET.

4.2.1 Air Pollution Monitoring System

A. Methods for Monitoring

Table 4-6 shows the measuring methods provided in the Japanese Industrial Standards（JIS）.

Table 4-6 JIS methods for air quality measurement

Parameter	Method		Reporting limit
SO_2	JIS B 7952	Conductometric	0.001 ppm
		Ultraviolet fluorescence	
NO_x	JIS B 7953	Absorptiometry	0.001 ppm
		Chemiluminescene	
O_x	JIS B 7957	Absorptiometry	0.001 ppm
		Ultraviolet absorption	
SPM	JIS B 7954	Beta-ray absorption	0.001 mg/m^3
HC	JIS B 7956	Hydrogen flame ionization method	0.1 ppm-C
CO	JIS B 7951	Infrared absorption method	0.1 ppm

The following manuals show the methods for hazardous air pollutants and dioxins.

- "Measurement Manual for Hazardous Air Pollutants", MOE Air Quality Management Bureau, 1997 – 2001

For the hazardous air pollutants, verified methods that have been developed through investigation are described together with established standard methods and QA/QC procedures.

- "Measurement Manual for Dioxins in Air", MOE Environmental Management Bureau, August 2001

For dioxins in ambient air, verified methods are indicated with standards and conditions to ensure the accuracy of data.

B. QA/QC Program

Environmental measurement and analysis are very important tools for assessing environmental conditions for the purpose of guiding conservation programs or activities. Precise analysis techniques and adequate management are required to ensure the accuracy and reliability of the data being collected.

Therefore, since 1975, MOE has implemented a data QA/QC system to ensure the reliability of the environmental measurement and analysis. This system is called the Standardized QA/QC for Environmental Measurements and

Analyses. The analytical parameters targeted for examination under the QA/QC system are selected based on yearly needs, and the types of examination that have been executed. One part of this system consists of the uniform preparation of standards that are sent to environmental laboratories throughout the country. In addition, data from laboratories nationwide are subjected to statistical analysis to check their performance. In this manner, the reliability and accuracy of environmental data are maintained at a high level or improved, when needed. Through QA/QC system, technical problems can be identified and feed-back can be provided to the participating laboratories by holding briefings on the results of QA/QC investigations and statistical analyses conducted on an annual basis.

Table 4-7 shows results of the Standardized QA/QC for Environmental Measurements and Analyses that related to ambient air and acid deposition after 1991.

Table 4-7 Summary of Standardized QA/QC Program for Ambient Air (1991 – 2003)

Parameter	Set-up conc.	Number of reply	Average of reply	Standard deviation	C.V. (%)	Unit
Simulated "acid rain", 1991						
pH		279	4.13	0.0962	2.3	pH unit
EC		268	76.7	2.96	3.9	μS/cm
Na^+	3.93	275	3.94	0.431	10.9	mg/l
K^+	0.387	266	0.433	0.103	33.8	
NH_4^+	1.36	266	1.37	0.118	8.6	
Ca^{2+}	1.47	274	1.33	0.301	15.1	
Mg^{2+}	0.287	271	0.284	0.0298	10.5	
Cl^-	7.04	261	7.03	0.350	5.0	
NO_3^-	5.18	253	5.04	0.239	4.7	
SO_4^{2-}	7.17	261	6.80	0.618	9.1	
Air sample absorbed on activated carbon, 1996						
Trichloroethylene	0.0058	79	0.00580	0.00137	23.6	mg/ column
Tetrachloroethylene	0.0032	68	0.00327	0.00038	23.6	
Air sample absorbed on activated carbon, 1997						
Benzene	0.0009	168	0.000856	0.000258	30.1	mg/ column
Trichloroethylene	0.0029	200	0.00299	0.000635	21.3	

Tetrachloroethylene	0.0032	199	0.00325	0.000650	20.0	
Air sample, 2002						
Benzene	41.6	99	43.9	10.8	25.0	$\mu g/m^3$
Trichloroethylene	121	99	119	27.8	23.5	
Tetrachloroethylene	175	96	185	39.6	21.4	
Dichloromethane	63.2	100	69.2	20.4	29.5	
Air sample, 2003						
Benzene	1.00	108	1.02	0.171	16.7	$\mu g/m^3$
Trichloroethylene	1.20	109	1.13	0.196	17.4	
Tetrachloroethylene	1.88	110	1.88	0.304	16.2	
Dichloromethane	1.54	106	1.56	0.267	17.1	

(Source: Survey Results of Standardized QA/QC for Environmental Measurements and Analysis, MOE)

4.2.2 Acid Deposition Survey

A. Monitoring Methods

Measuring methods applied to the Long-term Monitoring of Acid Deposition are shown in Table 4-8 and Table 4-9.

Table 4-8 Methods for wet deposition analysis

Analysis item	Instrumental method
Electric conductivity (EC)	Conductivity Cell
pH	Glass electrode
Anions (Cl^-, NO_3^-, SO_4^{2-})	Ion Chromatography
Ammonium ion ($NH4^+$)	Ion Chromatography Spectrophotometry (Indophenol blue)
Cations (Na^+, K^+, Ca^{2+}, Mg^{2+})	Ion Chromatography Atomic Absorption Spectrometry

Table 4-9 Methods for dry deposition analysis

Parameter	Manual methods	Instrumental methods
SO_2	Filter packs	Ultraviolet fluorescent method
O_3		Ultraviolet photometric method
NO/NO_2		Chemi-luminescence detection
HNO_3	Filter packs	
NH_3	Filter packs	
PM		β-ray absorption method TEOM method
Concentration of Ions	Filter packs	

B. QA/QC Program

In the program of acid deposition long-term monitoring, ADORC takes part in the QA/QC activities to ensure the data's reliability. Auditing the monitoring sites and inter-laboratory comparison projects are implemented.

4.3 Research Activities

The National Institute for Environmental Studies (NIES) and related institutes and universities, are discussing on the scientific explanation for large-scale air pollution in East Asia.

A series of research projects related to acid deposition, currently in progress in Japan are briefly presented in NIES Research Booklet No. 12, as follows:

Theme 1: Aircraft observation research above the sea around Japan (1990 – 2001)

To examine large-scale air pollution in East Asia, a research project in which aircraft make observations concerning ozone, NO_x, SO_2, and the chemical constituents of aerosols was implemented in the sky above the NOWPAP Region, the Yellow Sea and the East China Sea. As a result of this project, the situation of large-scale transportation of air pollutants from the Asian continent to Japan caused by the winter monsoon, and atmospheric high and low pressure zone has been observed in detail.

Theme 2: Research on long-term monitoring of air pollutants, like ozone and aerosols (1990 – 2001)

The concentration of ozone and inorganic ions in aerosols was continuously measured at Henoto in Okinawa, Happo in Nagano, Goto islands, Yasaka in Kyoto and Mondy in Russia. A short-term, focused observation of these air pollutants was also conducted in various places.

Theme 3: Development of long-range transportation model for "acid rain" (1993 – 1998)

A long-range transportation model for "acid rain" was developed in order to built a clear persuasive picture of cross-border air pollution within the region.

Theme 4: Research on source inventory of air pollutant in the East Asian region (1996 – 2004)

A map showing the sources of air pollutants, such as NO_x, SO_2, ammonia and a non-methane VOCs, in the East Asian region was created, and recorded onto a CD-ROM.

Theme 5: Research on the source-receptor matrix using the long-range transportation model (1999 – 2004)

The accuracy of the long-range transportation model for “acid rain” was proven to be high by comparing the model’s predicted results with the observation results. Then, a source-receptor matrix was developed to predict depositional loads from region to region.

Theme 6: Aircraft observation research in China (2001 – 2005)

Aircraft observations for ozone, NO_x, SO_2 and chemicals in aerosols were made above the countryside surroundings of Shanghai, China (Chanchou, Ningbo, Wenzhou, and Aoshima, etc.), the Chinese Gulf of Pohai (Tairen, Dandong, Aoshima, and Brocade States, etc.), and Shanghai - Wuhan - Chungking and Chengdu in the southern part of China. Moreover, the same kind of observations were made on the ground at Aoshima, Funayama, and Mayuyama, etc., in synchronization with the aircraft observations.

4.4 Training Activities

A variety of training activities are conducted in conjunction with regional air pollution monitoring programs, as described in this section.

<u>1) National Environmental Research and Training Institute</u>

The National Environmental Research and Training Institute was established as an institute for personnel involved in MOE-related administration work. The institute has conducted courses on environmental administration for large numbers of national and local government officers involved in environmental work.

In fiscal year 2004, the training program is divided into 1) environmental administration, 2) international cooperation, 3) measurement and analysis, 4) environmental official training, and 5) administrative practice. The training program for measurement and analysis involves the course for atmospheric monitoring.

2) Acid Deposition and Oxidant Research Center (ADORC)

ADORC has conducted the following training program as part of tasks for the National Center and the Network Center of EANET.

- Execution of individual training
- Dispatching of technical mission
- Holding of training workshop

ADORC is located in Niigata City, together with one of the monitoring sites for the national network for the Air Pollution Monitoring System. The Niigata-Maki site could serve as a training site for atmospheric monitoring for wet and dry depositions.

5. Present Status

This section presents the current situation with regard to air pollution in the NOWPAP region based on the monitoring results that have been obtained, to date.

5.1 Air Pollution Monitoring

The annual average concentrations of air pollutants observed in the major cities within the subject region in 2002 are shown in Table 5-1.

Figure 5-1 illustrates the changes in the concentrations of the air pollutants (yearly mean values) in the major cities within the subject region over a ten-year period beginning in 1993. The concentrations of each pollutant tend to gradually decrease or level-off year by year in all cities.

5.2 Acid Deposition

The results of the wet deposition at EANET stations within the subject region (Rishiri, Tappi, Sado-seki, Oki, and Banryu) are shown in Table 5-2. Table 5-3 shows the monthly depositions in 2002.

Table 5-4 shows the survey results with respect to dry deposition at five EANET stations, and Table 5-5 shows the ion components contained in particulate matter investigated in the subject region.

Table 5-1 Annual average concentration of air pollutants (2002)

Parameter	Major cities within the subject region												Environmental standard
	Asahikawa	Sapporo	Akita	Sakata	Niigata	Toyama	Kanazawa	Fukui	Tottori	Matsue	Kitakyusyu	Fukuoka	
SPM (mg/m^3)	0.018	0.012	0.017	0.018	0.023	0.025	0.021	0.025	0.020	0.020	0.029	0.031	0.10
NO_2 (ppm)	0.044	0.048	0.023	0.015	0.028	0.025	0.025	0.029	0.017	0.011	0.039	0.036	0.04 – 0.06
SO_2 (ppm)	0.003	0.004	0.002	0.002	0.003	0.003	0.004	0.004	0.001	0.001	0.004	0.004	0.04
O_x (ppm)	0.018	0.026	0.033	0.037	0.032	0.035	0.034	0.029	0.033	0.039	0.027	0.031	0.06
NMHC (ppm)	-	0.20	0.14	-	0.16	-	0.12	0.12	0.10	0.09	0.18	0.20	-
CO (ppm)													
Air pollution monitoring station	-	0.5	-	0.3	0.2	-	0.3	0.4	0.3	0.3	0.6	-	10
Automobile exhaust monitoring station	0.6	0.8	0.6	-	0.5	0.5	0.8	0.6	0.7	0.6	0.9	0.9	
Benzene ($\mu g/m^3$)	1.5	2.2	1.4	0.89	1.5	0.99	1.2	1.5	1.2	0.77	1.6	1.9	3
Trichloroethylene ($\mu g/m^3$)	0.13	0.30	0.063	0.087	0.62	0.23	0.14	0.65	0.11	0.069	0.082	0.11	200
Tetrachloroethylene ($\mu g/m^3$)	0.073	0.34	0.25	0.053	0.52	0.13	0.090	0.18	0.10	0.054	0.10	0.29	200
Dioxins (pg-TEQ/m^3)	-	0.038	0.027	-	0.043	0.027	0.031	0.093	0.046	0.030	0.038	0.047	0.6
Dichloromethane ($\mu g/m^3$)	0.78	3.1	0.33	0.63	2.4	1.6	2.0	1.8	0.64	0.37	0.49	1.0	150
Acrylonitrile ($\mu g/m^3$)	-	0.82	-	0.0051	0.034	0.024	-	0.027	0.065	0.048	0.12	0.15	-
Acetaldehyde ($\mu g/m^3$)	-	2.0	-	1.7	2.5	2.1	-	-	0.24	2.1	2.3	2.3	-

Parameter	Major cities within the subject region												Environmental standard
	Asahikawa	Sapporo	Akita	Sakata	Niigata	Toyama	Kanazawa	Fukui	Tottori	Matsue	Kitakyusyu	Fukuoka	
Vinylchloride ($\mu g/m^3$)	-	0.006	-	0.018	0.006	0.24	-	0.082	0.031	0.021	0.047	0.066	-
Chloroform ($\mu g/m^3$)	-	1.1	-	0.23	0.16	0.70	-	-	0.16	0.13	0.17	0.18	-
Ethyleneoxyde ($\mu g/m^3$)	-	0.20	-	-	0.088	0.16	-	0.055	0.054	0.050	0.039	0.082	-
1,2-Dichloroethane ($\mu g/m^3$)	-	0.12	-	0.20	0.15	0.066	-	-	0.092	0.065	0.13	0.12	-
1,3-Butadiene ($\mu g/m^3$)	-	0.26	-	-	0.10	0.17	-	-	0.090	0.057	0.17	0.21	-
Benzo(a)pyrene (ng/m^3)	0.38	0.30	-	-	0.090	0.098	-	-	0.099	0.20	0.60	0.28	-
Formaldehyde ($\mu g/m^3$)	-	2.4	-	2.6	3.4	3.0	-	-	0.42	1.3	2.8	2.7	-
Hg (ng/m^3)	1.7	1.6	-	-	2.1	1.9	-	2.2	1.7	1.9	2.8	2.2	-
Ni (ng/m^3)	-	2.7	-	2.3	2.5	2.0	-	-	3.3	2.5	9.7	5.1	-
As (ng/m^3)	-	0.51	-	1.1	0.78	1.3	-	0.92	1.3	1.9	3.9	3.0	-
Be (ng/m^3)	-	0.049	-	0.020	0.040	0.021	-	-	0.045	0.040	0.17	0.13	-
Mn (ng/m^3)	-	17	-	16	13	13	-	-	14	27	110	42	-
Cr (ng/m^3)	-	2.2	-	2.0	1.6	3.4	-	-	1.1	3.5	30	7.1	-

(Source: *State of Air Quality in Japan* (FY 2003), Society for the Study of Legislation System for Air Pollution)
Note: The values are averaged when the number of monitoring station is plural.

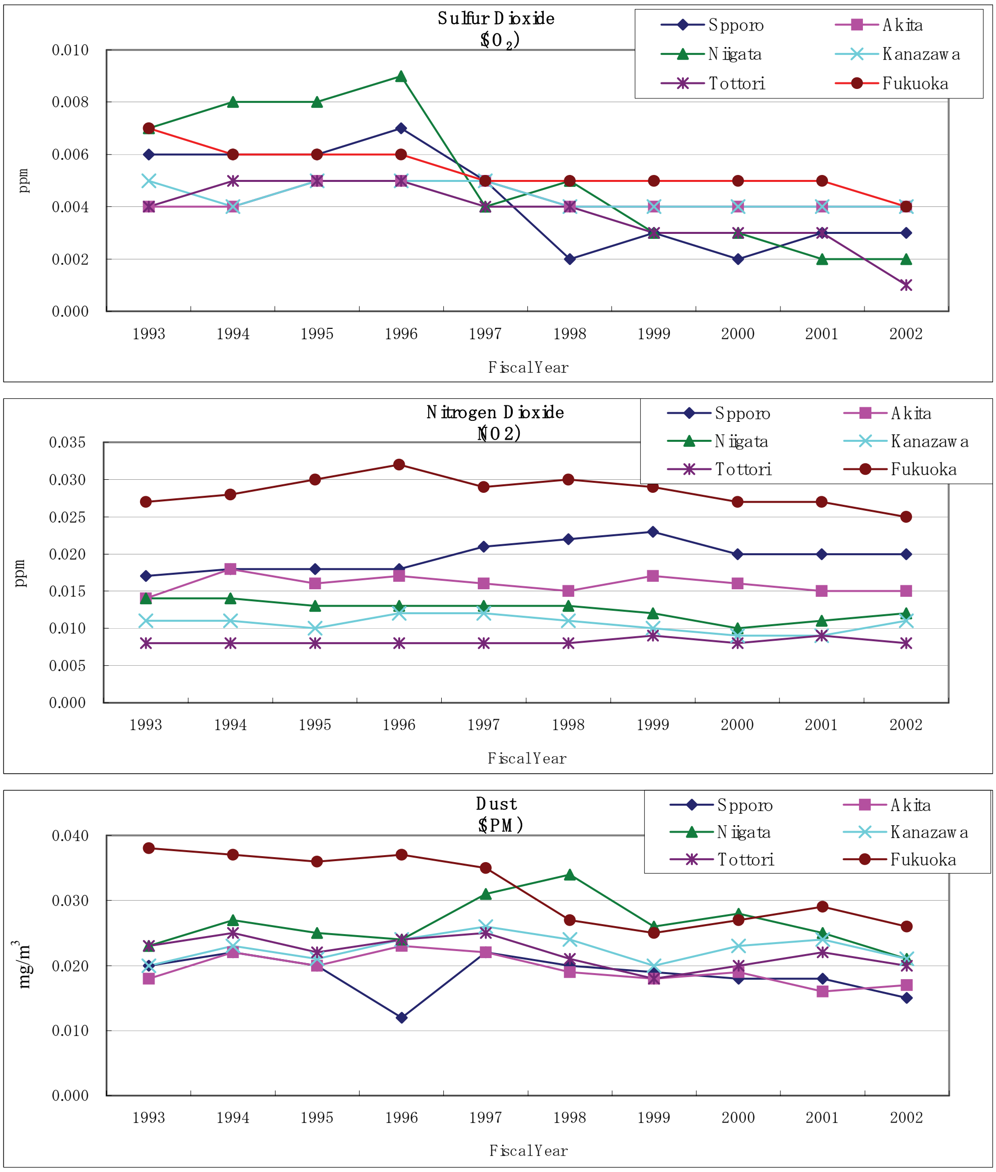


Figure 5-1 Change in air pollutants concentrations in major cities (1993 – 2002)

Table 5-2 Monthly weighted averages of each component in 2002

Month	Precipitation (mm)	pH	SO_4^{2-} (μmol/l)	nss-SO_4^{2-} (μmol/l)	NO_3^- (μmol/l)	Cl^- (μmol/l)	NH_4^+ (μmol/l)	Na^+ (μmol/l)	K^+ (μmol/l)	Ca^{2+} (μmol/l)	nss-Ca^{2+} (μmol/l)	Mg^{2+} (μmol/l)	EC (mS/m)
Rishiri													
Jan.	40.3	4.88	28.5	14.1	9.6	268	11.4	239	6.1	8.2	3.1	27.7	4.60
Feb.	36.8	4.44	40.0	29.5	30.5	181	31.9	175	5.8	11.0	7.3	21.1	5.24
Mar.	10.5	5.70	81.5	66.2	96.3	289	85.8	255	13.5	69.9	64.3	35.0	7.52
Apr.	63.4	5.90	38.9	30.0	25.8	162	20.9	148	5.3	39.9	36.7	17.5	4.01
May	32.5	4.71	25.7	23.0	19.4	50.7	35.1	46.1	2.8	6.2	5.2	6.4	2.46
June	29.5	4.77	19.7	16.0	10.5	70.1	22.7	61.4	2.6	4.3	3.0	7.7	2.28
July	188.5	4.77	19.0	17.9	13.5	21.7	31.5	19.0	1.9	1.4	1.0	2.5	1.59
Aug.	89.6	4.54	16.8	15.5	19.3	23.6	19.6	21.4	1.1	1.2	0.8	2.5	2.04
Sep.	27.6	4.95	12.3	7.6	11.8	87.3	20.6	78.6	2.0	2.7	1.0	8.1	2.18
Oct.	181.4	4.91	30.4	7.7	7.5	424	13.3	386	8.3	11.2	2.9	42.2	6.65
Nov.	196.6	4.98	32.5	11.8	7.4	381	11.3	346	7.5	13.4	5.9	39.0	6.16
Dec.	60.4	4.88	25.4	12.2	6.6	242	9.2	219	4.7	6.6	1.9	26.1	4.38
Tappi													
Jan.	80.0	4.55	26.5	15.1	13.9	215	7.8	188	4.4	6.1	2.1	22.1	4.43
Feb.	33.0	4.46	45.2	32.0	43.8	250	40.1	218	7.9	18.8	14.0	26.5	5.93
Mar.	50.0	4.76	66.2	41.3	49.9	472	45.5	413	12.5	53.2	44.3	50.4	9.01
Apr.	67.0	5.04	44.1	31.6	43.1	217	41.0	209	6.3	33.3	28.8	26.6	5.16
May	39.0	4.71	14.3	10.1	11.8	77.9	6.8	70.1	2.1	5.8	4.3	9.9	2.32
June	105.5	4.78	14.6	9.0	12.5	110	15.5	93.3	2.9	3.7	1.7	11.0	2.61
July	171.0	4.66	8.0	6.7	14.4	26.5	8.9	22.7	0.9	1.8	1.4	3.6	1.54
Aug.	440.4	4.84	7.5	5.9	8.2	30.6	9.4	25.6	0.5	1.1	0.6	3.5	1.22
Sep.	61.0	4.72	8.7	2.9	6.4	120	3.3	97.4	1.9	2.7	0.6	11.2	2.45
Oct.	156.0	4.75	23.2	5.4	9.9	335	9.5	301	6.3	7.7	1.4	33.6	5.51
Nov.	85.8	4.34	47.7	27.3	29.1	422	22.9	338	8.8	12.6	5.3	41.3	7.99
Dec.	40.6	4.38	40.7	20.2	28.4	418	11.3	341	6.8	9.8	2.4	39.1	7.12

Sado-Seki													
Jan.	143.5	4.51	61.1	18.1	19.0	809	18.2	725	15.9	16.0	1.2	79.1	11.9
Feb.	32.0	4.33	120	52.1	86.3	1620	72.2	1480	31.1	55.1	23.5	159	20.0
Mar.	62.0	4.80	19.8	6.9	12.6	246	5.9	213	3.4	6.5	1.9	22.6	4.19
Apr.	31.5	*	*	*	*	*	*	*	*	*	*	*	*
May	120.5	4.78	14.5	13.1	12.0	26.9	10.6	22.3	2.6	4.3	3.9	4.3	1.52
June	54.5	4.67	13.2	12.0	11.8	24.5	11.3	19.3	1.5	3.6	3.2	3.4	1.52
July	413.7	4.90	7.3	6.3	6.8	17.8	8.6	16.5	1.3	1.7	1.3	2.6	1.09
Aug.	147.8	4.63	11.1	8.6	14.5	49.7	10.9	40.9	<1.0	2.4	1.5	5.7	1.92
Sep.	73.5	4.58	12.7	11.7	10.4	22.0	10.2	16.7	1.2	2.5	2.1	3.1	1.69
Oct.	120.9	4.82	42.6	7.0	10.6	672	13.2	637	14.0	18.7	5.0	69.6	10.8
Nov.	186.3	4.32	63.6	31.0	26.9	707	27.8	566	14.5	19.9	7.7	69.2	11.2
Dec.	46.7	4.52	58.0	23.0	21.4	717	13.4	581	11.8	20.6	8.0	67.6	7.49
Oki													
Jan.	200.2	4.70	78.7	19.1	16.4	1150	16.0	989	25.2	26.9	5.8	111	15.9
Feb.	44.0	4.64	75.8	24.8	31.3	1000	24.0	846	24.2	29.3	11.0	95.4	14.7
Mar.	94.4	4.83	29.1	17.9	23.8	212	18.9	185	5.9	15.6	11.6	22.4	3.89
Apr.	140.6	5.19	11.7	8.6	11.8	54.2	11.8	51.9	3.4	5.1	4.0	6.0	1.33
May	133.6	4.85	9.1	8.7	9.6	9.0	5.8	7.2	<1.0	1.3	1.2	1.1	0.90
June	42.0	4.88	15.6	11.5	18.9	76.7	20.0	67.4	3.7	6.3	4.9	8.8	2.01
July	293.9	5.27	1.5	1.3	2.6	5.9	1.1	3.8	0.3	0.4	0.3	<0.4	0.32
Aug.	28.1	4.98	9.7	7.6	8.7	38.0	5.2	36.5	1.1	2.2	1.4	4.3	1.07
Sep.	228.7	4.70	12.1	9.1	11.1	50.3	5.9	49.8	1.3	1.5	0.6	4.9	1.81
Oct.	122.2	4.50	51.6	29.0	25.1	432	34.1	387	12.1	15.0	6.7	40.8	8.01
Nov.	100.1	4.45	58.6	22.1	25.4	691	15.3	605	15.8	19.9	7.1	72.5	11.5
Dec.	143.1	4.66	52.3	10.6	15.1	822	8.4	699	14.5	16.1	2.4	76.1	11.8

Banryu													
Jan.	132.5	4.54	27.6	18.2	25.2	174	19.0	156	4.9	9.1	5.7	18.7	4.17
Feb.	34.5	4.41	51.5	33.1	51.2	345	48.3	305	10.7	20.5	13.9	36.4	7.59
Mar.	197.5	4.84	15.3	13.7	19.6	27.8	19.1	26.5	1.7	6.8	6.2	3.7	1.51
Apr.	100.5	5.39	8.0	7.1	11.1	7.7	7.8	14.3	1.2	2.0	1.7	1.0	0.53
May	213.5	4.93	9.9	9.2	11.3	15.1	10.9	12.0	<1.0	2.1	1.8	1.3	0.95
June	96.0	4.67	18.5	17.5	22.3	20.4	33.3	17.3	2.1	2.4	2.1	1.8	1.87
July	91.0	*	*	*	*	*	*	*	*	*	*	*	*
Aug.	57.0	5.18	4.1	3.9	4.7	5.9	2.4	3.8	<1.0	<0.2	<0.2	<0.4	0.35
Sep.	114.5	4.65	15.1	11.6	13.4	65.0	8.0	56.9	1.6	2.1	0.9	6.1	2.14
Oct.	136.0	4.54	24.7	16.7	21.0	152	21.7	132	4.3	5.8	2.9	15.2	3.97
Nov.	68.0	4.43	26.1	17.3	33.7	154	29.0	147	4.6	8.2	5.0	18.1	4.56
Dec.	62.0	4.39	46.3	26.6	29.2	372	26.3	326	8.9	13.2	6.1	38.1	7.49

Note:*- not measured

Table 5-3 Monthly deposition of each component in 2002

	Wet Depositions, mmol m^{-2}									
Month	SO_4^{2-}	nss-SO_4^{2-}	NO_3^-	Cl^-	NH_4^+	Na^+	K^+	Ca^{2+}	nss-Ca^{2+}	Mg^{2+}	H^+
Rishiri											
Jan.	1.15	0.57	0.39	10.8	0.46	9.62	0.25	0.33	0.12	1.12	0.53
Feb.	1.47	1.08	1.12	6.65	1.17	6.44	0.21	0.41	0.27	0.78	1.32
Mar.	0.86	0.70	1.01	3.04	0.90	2.69	0.14	0.74	0.68	0.37	0.02
Apr.	2.47	1.90	1.64	10.3	1.32	9.36	0.34	2.53	2.32	1.11	0.08
May	0.84	0.75	0.63	1.65	1.14	1.50	0.09	0.20	0.17	0.21	0.64
June	0.58	0.47	0.31	2.07	0.67	1.81	0.08	0.13	0.09	0.23	0.50
July	3.58	3.37	2.55	4.08	5.93	3.59	0.36	0.26	0.18	0.47	3.22
Aug.	1.50	1.39	1.73	2.11	1.76	1.92	0.10	0.11	0.07	0.22	2.61
Sep.	0.34	0.21	0.33	2.40	0.57	2.17	0.05	0.07	0.03	0.22	0.31
Oct.	5.52	1.39	1.36	77.0	2.40	70.1	1.51	2.04	0.53	7.66	2.22
Nov.	6.40	2.32	1.45	74.9	2.22	68.0	1.48	2.63	1.16	7.67	2.05
Dec.	1.53	0.74	0.40	14.6	0.55	13.2	0.29	0.40	0.11	1.58	0.79
Annual	26.1	14.9	12.9	207	19.2	188	4.86	9.73	5.66	21.4	14.4
Tappi											
Jan.	2.12	1.21	1.11	17.2	0.62	15.0	0.36	0.49	0.17	1.77	2.23
Feb.	1.49	1.06	1.45	8.27	1.32	7.21	0.26	0.62	0.46	0.88	1.14
Mar.	3.31	2.06	2.50	23.6	2.27	20.6	0.63	2.66	2.22	2.52	0.87
Apr.	2.96	2.12	2.89	14.5	2.74	14.0	0.42	2.23	1.93	1.79	0.62
May	0.56	0.39	0.46	3.04	0.26	2.73	0.08	0.23	0.17	0.39	0.76
June	1.54	0.95	1.32	11.6	1.64	9.84	0.31	0.39	0.18	1.16	1.75
July	1.37	1.14	2.47	4.52	1.53	3.88	0.15	0.32	0.23	0.62	3.78
Aug.	3.30	2.62	3.62	13.5	4.12	11.3	0.22	0.50	0.26	1.55	6.39
Sep.	0.53	0.17	0.39	7.29	0.20	5.94	0.11	0.17	0.04	0.68	1.16
Oct.	3.62	0.85	1.54	52.2	1.47	47.0	0.98	1.20	0.22	5.24	2.76

Nov.	4.09	2.34	2.49	36.2	1.97	29.0	0.75	1.08	0.45	3.54	3.89
Dec.	1.65	0.82	1.15	17.0	0.46	13.9	0.28	0.40	0.10	1.59	1.70
Annual	30.2	17.1	22.5	253	19.6	219	5.41	12.0	7.30	26.1	27.8
Sado -Seki											
Jan.	8.77	2.60	2.73	116	2.62	104	2.28	2.30	0.18	11.3	4.40
Feb.	3.83	1.67	2.76	51.8	2.31	47.3	1.00	1.76	0.75	5.09	1.50
Mar.	1.23	0.43	0.78	15.2	0.36	13.2	0.21	0.40	0.12	1.40	0.99
Apr.	*	*	*	*	*	*	*	*	*	*	*
May	1.75	1.58	1.45	3.24	1.27	2.69	0.31	0.52	0.47	0.52	2.00
June	0.72	0.66	0.64	1.33	0.61	1.05	0.08	0.20	0.17	0.19	1.17
July	3.02	2.61	2.83	7.37	3.58	6.84	0.55	0.69	0.55	1.08	5.23
Aug.	1.64	1.27	2.14	7.34	1.62	6.04	0.14	0.36	0.23	0.84	3.46
Sep.	0.93	0.86	0.76	1.62	0.75	1.23	0.09	0.18	0.15	0.23	1.92
Oct.	5.15	0.85	1.28	81.2	1.59	77.0	1.69	2.26	0.60	8.41	1.84
Nov.	11.9	5.78	5.01	132	5.18	105	2.70	3.71	1.43	12.9	8.82
Dec.	2.71	1.07	1.00	33.5	0.63	27.1	0.55	0.96	0.38	3.16	1.41
Annual	40.4	18.8	21.4	439	20.7	384	9.30	13.0	4.86	44.0	32.5
Oki											
Jan.	15.8	3.83	3.28	230	3.20	198	5.05	5.39	1.16	22.2	3.98
Feb.	3.33	1.09	1.38	44.0	1.06	37.2	1.06	1.29	0.48	4.20	1.01
Mar.	2.75	1.69	2.25	20.0	1.79	17.5	0.56	1.47	1.10	2.12	1.39
Apr.	1.64	1.20	1.66	7.62	1.66	7.29	0.48	0.72	0.56	0.85	0.90
May	1.22	1.16	1.28	1.20	0.77	0.96	0.12	0.18	0.16	0.15	1.91
June	0.65	0.48	0.79	3.22	0.84	2.83	0.15	0.27	0.20	0.37	0.55
July	0.44	0.37	0.76	1.73	0.33	1.13	0.09	0.12	0.10	0.10	1.58
Aug.	0.27	0.21	0.25	1.07	0.15	1.02	0.03	0.06	0.04	0.12	0.29
Sep.	2.77	2.08	2.55	11.5	1.35	11.4	0.30	0.35	0.13	1.13	4.57
Oct.	6.31	3.54	3.06	52.8	4.16	47.3	1.48	1.84	0.82	4.99	3.88
Nov.	5.86	2.21	2.55	69.2	1.53	60.5	1.58	1.99	0.71	7.25	3.58

Dec.	7.48	1.52	2.16	118	1.21	100	2.08	2.30	0.34	10.9	3.14
Annual	55.4	21.2	23.7	658	19.5	570	15.0	18.1	6.14	63.8	29.2
Banryu											
Jan.	3.66	2.41	3.34	23.1	2.52	20.7	0.66	1.20	0.75	2.48	3.78
Feb.	1.78	1.14	1.77	11.9	1.67	10.5	0.37	0.71	0.48	1.25	1.33
Mar.	3.02	2.71	3.86	5.49	3.78	5.24	0.33	1.34	1.22	0.72	2.83
Apr.	0.80	0.72	1.12	0.78	0.79	1.44	0.12	0.20	0.17	0.10	0.41
May	2.11	1.96	2.42	3.22	2.32	2.57	0.20	0.44	0.38	0.27	2.53
June	1.78	1.68	2.14	1.96	3.20	1.66	0.20	0.23	0.20	0.18	2.05
July	*	*	*	*	*	*	*	*	*	*	*
Aug.	0.23	0.22	0.27	0.34	0.14	0.21	0.01	<0.01	<0.01	<0.01	0.38
Sep.	1.73	1.33	1.54	7.44	0.91	6.51	0.18	0.25	0.10	0.70	2.59
Oct.	3.36	2.28	2.86	20.7	2.95	17.9	0.58	0.79	0.40	2.06	3.95
Nov.	1.77	1.17	2.29	10.4	1.97	9.98	0.31	0.56	0.34	1.23	2.53
Dec.	2.87	1.65	1.81	23.1	1.63	20.2	0.55	0.82	0.38	2.37	2.50
Annual	24.8	18.6	25.0	116	23.4	104	3.76	6.99	4.76	12.1	26.5

Table 5-4 Results of dry deposition (air concentration) monitoring in 2002

Month	SO_2 (ppb)	HNO_3 (ppb)	HCl (ppb)	NH_3 (ppb)	NO (ppb)	NO_2 (ppb)	NO_x (ppb)	O_3 (ppb)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)
Rishiri										
Jan.	0.2	-	-	-	N.D.		0.7	39	8	6
Feb.	0.6	-	-	-	N.D.		1.2	48	18	12
Mar.	0.1	-	-	-	N.D.		0.9	47	45	13
Apr.	N.D.	-	-	-	N.D.		1.0	51	35	12
May	0.2	-	-	-	N.D.		1.0	55	18	9
June	N.D.	-	-	-	N.D.		0.8	37	13	7
July	N.D.	N.D.	0.3	0.5	0.1		1.1	28	9	6
Aug.	N.D.	N.D.	00.4	0.5	N.D.		0.5	29	9	6
Sep.	N.D.	N.D.	0.3	0.6	N.D.		0.6	35	12	6
Oct.	N.D.	N.D.	0.2	0.4	N.D.		0.6	39	15	7
Nov.	0.3	N.D.	0.3	0.3	N.D.		0.8	41	18	8
Dec.	0.5	N.D.	0.1	0.3	N.D.		0.8	41	13	7
Tappi										
Jan.	0.5				N.D.		1.0	42	16	
Feb.	0.6				N.D.		1.0	48	20	
Mar.	0.3				0.1		1.3	52	83	
Apr.	0.2				0.1		1.9	55	70	
May	0.3				0.1		1.7	58	15	
June	0.3				0.2		2.0	44	14	
July	0.1				0.2		1.7	37	15	
Aug.	0.1				N.D.		0.9	37	12	
Sep.	0.2				N.D.		1.1	43	13	
Oct.	0.2				N.D.		0.9	50	22	
Nov.	0.5				N.D.		0.9	46	21	
Dec.	0.6				N.D.		0.9	45	14	

Sado-Seki										
Jan.	1.0				N.D.		2.1	32	14	
Feb.	1.1				N.D.		2.9	39	18	
Mar.	0.5				0.2		2.8	45	70	
Apr.	0.5				N.D.		3.0	47	77	
May	0.2				N.D.		0.8	41	18	
June	0.6				N.D.		1.2	50	19	
July	0.3				N.D.		1.1	41	18	
Aug.	0.3				N.D.		0.6	36	18	
Sep.	0.3				N.D.		1.0	44	15	
Oct.	0.4				N.D.		1.5	52	26	
Nov.	0.5				N.D.		1.3	43	17	
Dec.	0.3				N.D.		1.2	43	16	
Oki										
Jan.	1.3	-	-	-	N.D.		1.0	40	30	13
Feb.	1.2	-	-	-	N.D.		2.0	46	31	15
Mar.	0.6	-	-	-	N.D.		2.1	50	42	23
Apr.	0.4	0.1	0.3	2.5	N.D.		1.7	54	79	23
May	0.3	0.1	0.2	0.9	N.D.		1.2	52	22	13
June	0.3	0.3	0.2	1.4	N.D.		1.6	51	28	17
July	0.2	0.3	0.3	1.2	N.D.		1.5	34	23	14
Aug.	0.1	N.D.	0.3	1.1	N.D.		2.1	25	17	9
Sep.	N.D.	N.D.	0.3	0.9	N.D.		1.7	24	18	9
Oct.	N.D.	0.2	0.3	1.1	N.D.		1.7	34	28	13
Nov.	0.3	N.D.	0.2	0.4	N.D.		1.5	34	32	13
Dec.	0.2	N.D.	0.2	0.3	N.D.		1.3	33	21	8

Banryu										
Jan.	1.7				0.3	4.4	4.6	36	31	
Feb.	1.0				0.3	4.8	5.0	38	28	
Mar.	1.2				0.2	4.5	4.7	45	76	
Apr.	0.7				0.2	3.3	3.5	47	71	
May	0.6				0.2	3.4	3.6	57	25	
June	0.7				0.2	3.1	3.3	44	36	
July	0.7				0.4	3.2	3.7	27	24	
Aug.	0.6				0.4	2.6	2.9	24	18	
Sep.	0.8				0.2	3.4	3.6	33	23	
Oct.	1.0				0.2	3.9	4.1	35	32	
Nov.	0.9				0.3	4.0	4.2	29	32	
Dec.	1.1				0.3	4.0	4.3	31	22	

Table 5-5 Particulate matter components in 2002

Month	SO_4^{2-} (μg/m³)	NO_3^- (μg/m³)	Cl^- (μg/m³)	NH_4^+ (μg/m³)	Na^+ (μg/m³)	K^+ (μg/m³)	Ca^{2+} (μg/m³)	Mg^{2+} (μg/m³)
Rishiri								
Jan.	-	-	-	-	-	-	-	-
Feb.	-	-	-	-	-	-	-	-
Mar.	-	-	-	-	-	-	-	-
Apr.	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-
July	1.8	0.3	0.3	0.4	0.5	N.D.	N.D.	N.D.
Aug.	1.7	0.4	0.9	0.2	1.0	N.D.	N.D.	0.1
Sep.	0.9	0.2	2.6	0.2	1.7	N.D.	N.D.	0.2
Oct.	1.6	0.3	4.1	0.3	2.6	0.1	0.1	0.3
Nov.	3.1	0.7	5.1	0.7	3.3	0.2	0.3	0.4
Dec.	1.4	0.2	1.3	0.3	0.9	N.D.	N.D.	0.1
Oki								
Jan.	-	-	-	-	-	-	-	-
Feb.	-	-	-	-	-	-	-	-
Mar.	-	-	-	-	-	-	-	-
Apr.	5.5	1.9	1.7	0.4	4.3	0.3	1.0	0.4
May	3.1	0.6	0.1	0.9	0.8	0.1	0.1	N.D.
June	8.8	0.4	N.D.	2.7	1.4	0.4	0.2	0.1
July	5.3	0.6	N.D.	1.0	1.4	0.1	N.D.	0.1
Aug.	2.5	0.6	0.4	0.4	1.0	N.D.	N.D.	N.D.
Sep.	2.9	0.9	0.5	0.6	1.0	0.1	N.D.	0.1
Oct.	5.6	1.1	2.6	0.8	3.3	0.3	0.4	0.3
Nov.	3.0	0.9	4.1	0.3	4.0	0.2	0.3	0.4
Dec.	2.8	0.7	3.3	0.3	3.8	0.2	0.2	0.4

Figure 5-2 illustrates the trends in wet deposition of nss-salt sulfate, nitrate, and ammonium at EANET sites in the subject region (2000 – 2002).

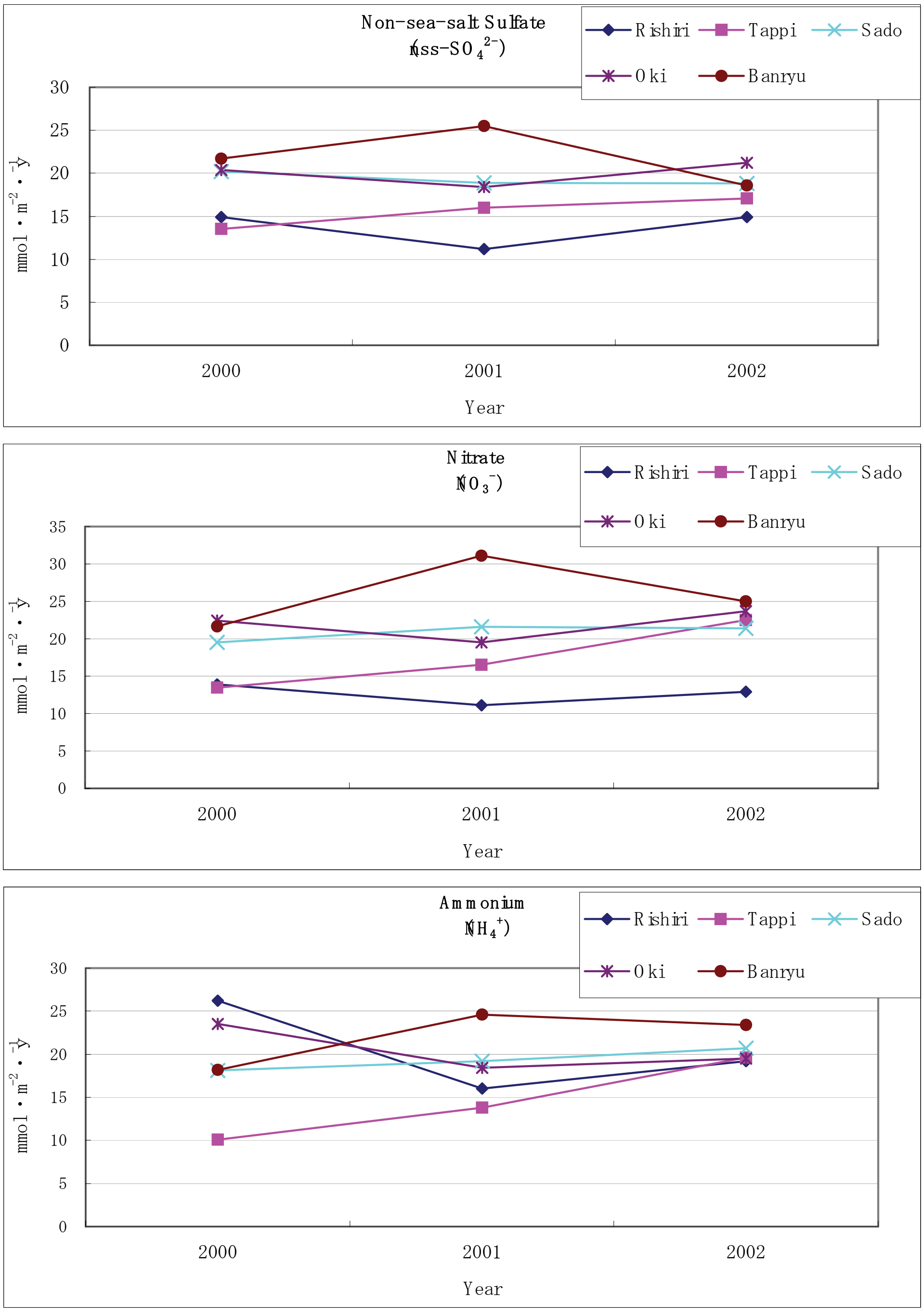


Figure 5-2 Trends in wet deposition (2000 – 2002)

The results of atmospheric monitoring for chemical substances in accordance with the Chemical Substances Control Law are presented in Table 4-3, Section 4 on this report.

6. Recommendations for Future Regional Activities and Priorities

Results of a series of surveys carried out over two decades, consisting of the Phase I – IV acid deposition survey and the acid deposition surveys for fiscal years 2001 and 2002, were analyzed and summarized by the Committee on Acid Deposition and Its Effect. The results of the committee's analysis, indicate the following:

・ The impact caused by acid deposition is hard to comprehend without a long-term monitoring survey, and, in the case of small lakes and soils with little buffering capacity, the affects of acid deposition due to long-term accumulation appear suddenly. Therefore, a long-term, continuous monitoring survey for acid deposition should be required.

・ Because it is deemed necessary for the countries of eastern Asian to take measures to address acid deposition, assistance in developing monitoring networks and countermeasures for acid deposition should be implemented by coordinating investigative activities through EANET.

・ In order to assess the impact of acid deposition on ecosystems, a comprehensive monitoring system which covers the air, vegetation, soil and inland aquatic environments should be established. Further, an integrated monitoring system for watersheds that are suspected of being impacted by acid deposition is required, such as in the case of Ijira Lake.

・ Investigation/research required in the future are: [1] investigation on the mechanisms by which acid deposition impacts ecosystems, [2] investigation on mechanisms of long-range transportation of air pollution, and [3] development of a comprehensive assessment model for the acid deposition problems in eastern Asia.

7. Conclusions

This report summarizes current research on atmospheric deposition of contaminants in Japan and the monitoring data collected within the NOWPAP region.

Two types of monitoring program are in progress to grasp the atmospheric deposition in Japan:

1) Air Pollution Monitoring System

- Continuous monitoring system for air pollutants, such as SO_2, NO_2 and SPM in concentration in accordance with the Air Pollution Control Law
- Monitoring program to evaluate environmental hazards from chemical substances, in accordance with the Chemical Substances Control Law

2) Acid Deposition Survey program

- Long-term program for measures against acid deposition, including of wet deposition and dry deposition survey
- Monitoring results collected by the Air Pollution Monitoring System in the major cities of the object region are; 0.012 – 0.031 mg/m^3 in SPM, 0.001 – 0.004 ppm in SO_2, and 0.011 – 0.048 ppm in NO_2. Each pollutant appears a gradual decrease tendency or a level-off year by year.
- Meanwhile, the annual amounts of wet depositions, non-sea-salt sulfate, nitrate and ammonium, of the object region are in the range of 10 – 25 mmol/m^2 year in the years from 2000 to 2002.
- A series of research projects related to acid deposition, such as source

inventory of air pollutant, aircraft observation and the long-range transportation model, are implemented by NIES and related institutes.

Based on a series of survey results of acid depositions recorded over two decades, the Committee on Acid Deposition and Its Effect indicated the followings as investigation/research required in the future:

- Investigation on the mechanisms by which acid deposition impacts ecosystems,
- Investigation on mechanisms of long-range transportation of air pollution, and
- Development of a comprehensive assessment model for the acid deposition problems in eastern Asia.

8. References

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ANNEX

National Laws and Regulations Related to Atmospheric Deposition Monitoring

The Basic Environmental Law, Law No. 91 of 1993

Purpose:

The purpose of this law is to comprehensively and systematically promote policies for environmental conservation to ensure healthy and cultured living for both the present and future generations of the nation as well as to contribute to the welfare of mankind, through articulating the basic principles, clarifying the responsibilities of the State, local governments, corporations and citizens, and prescribing the basic policy considerations for environmental conservation.

Section 5 Implementation of Policies for Environmental Conservation by the State

Article 28 Implementation of Research

The State shall conduct surveys on the state of the environment, researches on forecast of environmental change s and other studies for formulation of policies with regard to environmental conservation.

Article 29 Improvement in Systems for Monitoring and Others

The State shall make efforts to establish systems of monitoring, patrolling, observations, measurements, examinations and inspections in order to ascertain the state of the environment and to properly implement the policies with regard to environmental conservation.

Section 6 International Cooperation for Global Environmental Conservation

Article 33 Ensuring International Cooperation for Monitoring, Observation and Others

The State shall make efforts to ensure international collaboration so as to effectively promote the monitoring, observation and measurement of the environment situation with regard to global environmental conservation, etc. It shall also make efforts to promote international cooperation to carry out surveys, examinations and researches with regard to global environmental conservation, etc.

Air Pollution Control Law, Law No. 97 of 1968

Purpose:

1) To protect the public health and preserve the living environment with respect to air pollution, by controlling emissions of soot, smoke and particulate from the business activities of factories and business establishments; by controlling emissions of particulate while buildings are being demolished; by promoting various measures concerning hazardous air pollutants; and, by setting maximum permissible limits for automobile exhaust gases, etc.

2) To help victims of air pollution-related health damage by providing a liability regime health damage caused by air pollution from business activities.

Chapter 4 Monitoring of the level of Air Pollution

Article 22 Monitoring and Surveillance

The governor of the prefecture shall monitor and survey from time to time the level of air pollution.

Article 23 Emergency Measures, etc.

1. In cases where the air pollution reaches the extent, designated by Cabinet Order, which may cause damage to human health or the living environment, the governor of the prefecture shall call attention to such a situation and at the same time ask soot and smoke emitting persons, or users or drivers of motor vehicles who are likely to further aggravate the air pollution to cooperate in reducing the level of soot and smoke emissions or in voluntarily curtailing the

operation of their motor vehicles.

2. In cases where a situation arises where on account of the meteorological conditions the air pollution suddenly reaches the extent designated by Cabinet Order, which may cause serious damage to human health or the living environment, the governor of the prefecture shall order, in accordance with the provisions by Order of the Prime Minister's Office, soot and smoke emitting persons to take necessary measures, such as reduction of the volume and density of soot and smoke emission, decrease of the operation of facilities when such a situation is attributable to soot and smoke, or he shall demand the Prefectural Public Safety commission to take measures under the provisions of the Road Traffic Law when such a situation is attributable to motor vehicle exhausts.

Article 24 Public Announcement

The governor of the prefecture shall publish the conditions of air pollution in the areas under his jurisdiction.

The Law Concerning the Examination and Manufacture, etc. of Chemical Substances; Law No. 117 of 1973

Purpose:

1) Prevention of environmental pollution by the chemical substances that are hardly degradable and have the risk of affecting human health;

2) Enactment of necessary regulations on the production, import, and use of new chemical substances in response to the examination results of their characteristics.

Contents: Regulation (substantial prohibition) on production and import of “Class 1 Specified Chemical Substance” that are hardly degradable, highly accumulative and chronically toxic. Regulation (notification of production, import amount, etc.) on production and import of hardly degradable and chronically toxic "Class 2 Specified Chemical Substance", and regulation (notification of production, import amount, etc.) on "Designated Chemical Substance" that are suspected as being hardly degradable and chronically toxic.

The National Report is presented by Global Environmental Issues Division, Global Environment Bureau, Ministry of the Environment, Tokyo 100-8975, Japan

National Report of China
on Atmospheric Deposition of Contaminants
into the Marine and Coastal Environment in NOWPAP Region

Table of Contents

National Report of China on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

1. Executive Summary

This document is a National Report of China for Working Group1 (WG1) based on the decisions of the POMRAC Focal Point Meetings (Vladivostok, Russia, 1st Meeting on 9-11, April 2002, the 2nd Meeting, 26-27, May 2003). Specifically, this document summarizes the current conditions with regard to atmospheric contaminants being discharged into marine and the coastal environments in NOWPAP region.

In this report, the natural environmental factors and the socio-economic factors are analyzed as an index of human activities that contribute to pollutant loads in the NOWPAP Region. Particular emphasis is given to the legal and regulatory remedies in China for addressing air pollution issues draining into the NOWPAP Region.

This report also describes the air quality monitoring systems in place within the region, including research activities aimed at improving the interpretation and predictive analysis of monitoring data. There are a total of 5 provinces facing the NOWPAP Region in China.

The regional area accounts for 10.8% of the entire area of China. The population of the subject region is 269,520,000 in fiscal year 2002, which accounts for about 20.9% of the total population of China. The GDP from the related provinces is up to 3784 billion RMB, which 36.5% of the nationwide total, and industrial output keeps increasing up to now.

China National Environmental Monitoring Center has organized 47 key environmental-protection cities to carry on air quality daily report and forecast

since 2000, and the monitoring items including SO_2、NO_2 and PM_{10}. The 47 cities all have realized air quality daily forecast since June 2001. 180 cities (including 111 of 113 key air-pollution protection cities) in China had realized air quality daily report, among which 90 cities realized air quality forecast at the end of 2003.

2. Introduction

2.1 Goals and Objectives of this Report

The Regional Seas Programme of the United Nations Environment Programme (UNEP) has been promoted as an action-oriented program for management of marine and coastal environments in collaboration with regional countries. As a part of the program, the Northwest Pacific Action Plan (NOWPAP) was adopted at the First Intergovernmental Meeting (IGM) in Seoul, Korea, on September 1994, attended by China, Japan, Korea, and Russia.

The Pollution Monitoring Regional Activity Centre (POMRAC) was established as one of four Regional Activity Centres of NOWPAP. POMRAC Working Group 1 (WG1) focuses on the area of atmospheric deposition, while Working Group 2 (WG2) focuses on water pollution discharged to rivers or directly into the marine environment.

This report introduces the national programs for evaluation of atmospheric deposition of contaminants into the marine and coastal environment of the NOWPAP region, which should be useful for assessment by WG1.

2.2 General Background Information on NOWPAP

For nearly three decades, UNEP has fostered regional cooperation on behalf of the marine and coastal environment. It has accomplished the cooperation by stimulating the creation of “Action Plans”- prescriptions for sound environmental management- for each region. Now, more than 140 coastal countries are participating in 13 Regional Seas Programmes established under UNEP auspices. Five partner programs are also fully operational.

NOWPAP or, in full, Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region is one of the 'Action Plans' which covers the Northwest Pacific region. The area surrounding the Northwest Pacific is one of the most highly populated parts of the world and is receiving enormous pressures on the environment. The countries of the region, the People's Republic of China, Japan, the Republic Korea and the Russian Federation participate in NOWPAP by joining forces.

NOWPAP was adopted at the First Intergovernmental Meeting (IGM) in 1994, following a series of meetings of experts and National Focal Point Meetings that started as early as 1991.

The overall goal of the NOWPAP is "the wise use, development and management of the coastal and marine environment so as to obtain the utmost long-term benefits for the human beings of the region, while protecting human health, ecological integrity and the region's sustainability for future generations".

The IGM, made up of senior representatives of the NOWPAP members, provides policy guidance and decision-making for NOWPAP. The plan incorporates seven priority projects to be implemented through a network of Regional Activity Centres (RACs) - CEARAC, DINRAC, MERRAC and POMRAC. The RACs play a central role in coordinating regional activities in specific fields of priority projects. NOWPAP's Regional Coordinating Unit (RCU), co-hosted by Japan and the Republic of Korea, serves as nerve center and command post of the Action Plan's activities (Figure 2-1).

The activities agreed upon as part of the implementation of NOWPAP are financed principally by contributions from the Members, international organizations and non-governmental organizations to the NOWPAP Trust Fund.

Priority Projects of NOWPAP:

NOWPAP 1: Establishment of a comprehensive database and information management system;

NOWPAP 2: Formation of a survey of national environmental legislation, objectives, strategies and policies;

NOWPAP 3: Establishment of a collaborative regional monitoring program;

NOWPAP 4: Development of effective measures for regional cooperation in marine pollution preparedness and response;

NOWPAP 5: Establishment of Regional Activity Centre (RAC) and the network among these centers;

NOWPAP 6: Promotion of public awareness of the marine, coastal, and associated freshwater environments;

NOWPAP 7: Assessment and management of land-based activities.

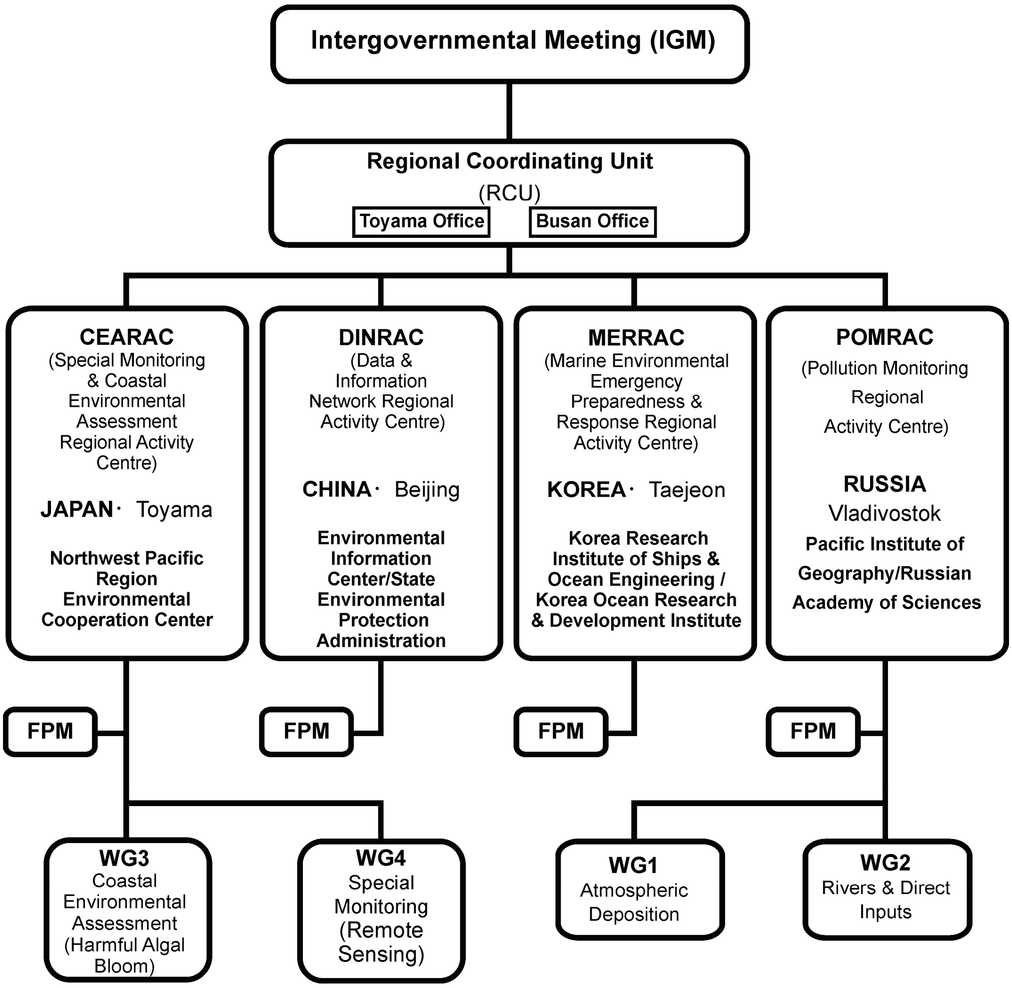

Figure 2-1 NOWPAP Organization

2.3 General Introduction on the Atmospheric Deposition

An *air pollutant* is any substance in the air which causes damage to life, ecosystems or property. Air pollution arises mostly from human activity, but there are also natural sources such as volcanoes and forest fires. Since airborne pollutants can travel very long distances, identifying sources to a body of water can be very complicated

Pollution from the air may deposit into water bodies and affect water quality in these systems. Airborne pollution can fall to the ground in raindrops, in dust or simply due to gravity. As the pollution falls, it may end up in streams, lakes, or estuaries and can affect the water quality there. For example, studies show that 21% of the nitrogen pollution-entering Chesapeake Bay comes from the air (Great Waters 3rd Report to Congress, 2000).

Both natural and man-made processes can lead to air pollution. Volcanoes, forest fires and storms are all natural processes that can place large amounts of harmful substances into the atmosphere. Volcanoes release various sulfur compounds, carbon dioxide, soot, and other pollutants. In some parts of the world, natural lake processes can also release large amounts of toxic material in rare, catastrophic events. There are also many man-made, or *anthropogenic*, sources of air pollution. Driving cars, operating power plants and spraying pesticides all release pollutants into the atmosphere. As human activities increase, the amount of air pollution also increases. There are five categories of atmospheric pollutants with the greatest potential to harm water quality. The categories include: nitrogen compounds, mercury, other metals, pesticides, and *combustion emissions*. These categories are based on both method of emission and other characteristics of the pollutants. Mercury is in its own category since it behaves so much differently in the environment than other metals. Combustion of fossil fuels is a major source of *nitrogen oxides* to the atmosphere. However, nitrogen is in its own category since its effects on ecosystems is so much different than other *combustion emissions*. Pesticides and *combustion emissions* are exclusively man-made while mercury, other metals, and nitrogen compounds arise from both natural and man-made sources.

Atmospheric deposition of nitrogen compounds can lead to degradation of water quality. Most commonly, nitrogen pollution leads to *eutrophication*, or harmful increases in the growth of algae. In some cases, however, nitrogen pollution can also contribute to *acidification* of water bodies. Exposure to high concentrations of mercury most often results from eating contaminated fish. This can have an impact on fish-eating birds and mammals as well as humans. *Atmospheric deposition* of pesticides is recognized as a source of toxic substances to water bodies. The likelihood that a pesticide will become an *atmospheric deposition* problem depends on its use, its chemical characteristics, how much pesticide already exists in a receiving water body, and how it reaches the water body (*direct deposition* vs. *indirect deposition* through agricultural runoff).

Besides, Acidification deposition affects ecosystems in many ways. Aquatic organisms in acidified waters often suffer from calcium deficiencies, which can weaken bones and exoskeletons and can cause eggs to be weak or brittle. It also affects the permeability of fish membranes and particularly, the ability of gills to take in oxygen from water. Additionally, increasing amounts of acid in a water body changes the mobility of certain trace metals like aluminum, cadmium, manganese, iron, arsenic, and mercury. Species that are sensitive to these metals, particularly fish, can suffer as a result. The effects of acidification on aluminum mobility have received the most attention because this metal is toxic to fish. The effects of increasing levels of cadmium and mercury, which are atmospheric pollutants of concern for water quality, are also becoming known.

2.4 Geographical Scope

2.4.1 Geographical Coverage of the Report

The NOWPAP regions have been marked in the Figure 2-2, which mainly include the five provinces: Heilongjiang, Jilin, Liaoning, Shandong and Jiangsu from North to South. The total land surface area of the basin and the total length of the coastline is about 1,004,000 km^2 and 6054 km, respectively. The regional area accounts for 10.8% of the entire area of China. The number of major rivers in these basins is *7*, and the amount of a total discharge was about 1193.1 billion tons/year in fiscal year 2002.

Figure 2-2 Geographical outline of the NOWPAP Region

2.4.2 Characteristics of the Country

1) Major cities, rivers and coastline

The major cities include Harbin, Changchun, Shenyang, Dalian, Yantai, Qingdao, Lianyungang and Shanghai, whose locations have been noted in

Figure 2-3. The red line is the coastline of the appointed region. The GDP from the related provinces is up to 3784 billion RMB, which 36.5% of the nationwide total, and industrial output keep increasing up to now.

The major rivers of the region include Songhua River, Liao River, Yellow River, Yangtse River, Huai River and Hai River.

Table 2-1 Annual discharges of major rivers

Items	Songhua River	Liao River	Hai River	Yellow River	Huai River	Yangtse River
Area ($10^4 m^2$)	55.7	22.9	26.4	75.2	26.9	180.9
Length (km)	2308	1390	1090	5456	1000	6300
Annual precipitation (mm)	527	473	559	475	889	1070
Average discharge (billion m^3)	76.2	14.8	22.8	65.8	62.2	951.3

2) Climate systems

Climate of Jiangsu province and Shandong province belong to warm temperate zone half moist continent monsoon climate, four seasons distinct. South wind is popular in Summer of Shandong province and Jiangsu province is often attacked by Typhoon. The average value of annual temperature of the two provinces is above 5°C. The annual precipitation value of Jiangsu province is about 1000 mm, while 550 ~ 950 mm of Shandong province.

The other three provinces belong to temperate continental monsoon climate with more drought and cloudy days in spring and hot and rainy days in summer. The winter days last longer than other provinces of China. Of the three provinces, annual precipitation of Liaoning province is most abundant with 600-1100 mm.

3) Physical geography

The major relief of Jiangsu province, Shandong province and Liaoning province are hilly and plain regions, while mountanious regions cover a big proportion in the other two provinces. Besides, water area of Jiangsu province is quite large with 17% of the whole province.

Figure 2-3 The major rivers and cities in this region

The vegetation rate of Liaoning province , Heilongjiang province and Jilin province is separately 28.7%, 41.9% and 42.4%. Contrast with the three provinces, the vegetation rate of the other two provinces is much lower with 21.5% of Shandong province and 10.56% of Jiangsu province.

Of the five provinces, Heilongjiang and Liaoning province is abundant in protected natural areas with a total number 84 and 81 separately, covering 2.3 million hectares occupying 5.05% area of whole province and 2.848 million hectares occupying 9.7% area of the whole province separately. Secondly, there are 66 protected natural areas in Shandong province covering about 6% area of whole province. At last, number of Jiangsu and Jilin provinces is relatively fewer with 26 and 27 separately covering 0.738 million hectares and 1.846 million hectares.

2.5 Institutional Arrangements for Developing this Reports

They are Chinese Research Academy of Environmental Sciences and China National Environmental Monitoring Center.

3. Overview of Social and Economic Situation

3.1 Population, Distribution of Communities in the Country

The areas of the five Provinces are 100,000 (Jiangsu) to 460,000 (Heilongjiang) km^2, GDP per capita are 1166 (Jilin) to 2102 (Jiangsu) USD/person, Population are 38.15 (Heilongjiang) to 91.250 (Shandong) million, referring to Table 3-1.

Table 3-1 Geographical characteristics and economic situation of the main provinces in 2002

Province	Square, km^2	GDP per capita, USD/person	Population (million)
Jiangsu	100,000	2102	74.058
Shandong	150,000	1703	91.250
Liaoning	150,000	1782	42.10
Jilin	180,000	1166	27.037
Heilongjiang	460,000	1453	38.15

3.2 Industrial Condition of Major Provinces (2002)

The GDP of Heilongjiang Province is 388.2 billion RMB in 2002, which had increased by 11.0% than year 2001. Heilongjiang Province is abundant in green food, which is the major industry in this region.

The GDP of Jilin Province is 224.6 billion RMB in 2002, among which the wealth from enterprises accounts for 70.1%. The preponderant industry of Jilin Province is resources exploitation and manufacturing industry, including petrol and natural gas exploitation, tobacco manufacturing, black metal smelt, and transportation devices manufacturing, etc.

The GDP of Liaoning Province is 545.8 billion RMB in 2002, which had increased by 15.3% than year 2001. The major industries of Liaoning Province are metallurgy industry, oil and petrifaction industry and electronics manufacturing industry, etc.

The GDP of Shandong Province is 1055.2 billion RMB in 2002, which had increased by 17.3% than year 2001. The branch industry includes petroleum and natural gas exploitation industry, food manufacturing industry, textile industry, chemical materials manufacturing industry, non-metal mineral manufacturing industry, and wiring manufacturing industry, whose production value account for the 54.8% of the whole.

The GDP of Jiangsu Province is 1063.2 billion RMB in 2002, which had increased by 14.0% by the year 2001. The added production value of heavy industry is beyond that of light industry, focused on textile industry, electronics industry, chemicals manufacturing industry, etc.

The Gross Domestic Product refer Table 3.2 by five Provinces in 2002

Table 3-2 Gross domestic product by region in 2002 (unit in billion RMB)

Province	Gross domestic product	Primary industry	Secondary industry			Tertiary industry
				industry	construction	
Jiangsu	1063.2	111.9	555.1	482.7	72.4	396.2
Shandong	1055.2	139.0	531.0	463.0	68.0	385.3
Liaoning	545.8	59.0	261.0	233.2	27.8	225.8
Jilin	224.6	44.6	97.8	80.4	17.5	82.2
Heilongjiang	388.2	44.7	216.9	191.6	25.3	126.6

3.3 Energy

The total energy consumption in 2002 is equivalent to 1.5 billion tons coal, that is 0.5 billion tons more than that in 1990 with an average annual rate of 3.6%. Of which, coal occupies 66.1%, petrol occupies 23.4%, natural gas occupies 2.7% and water-electricity and nucleus energy occupies 7.8%. The changes of total consumption of Energy of China refer to Figure 3-1.

High-grade energy such as petrol and natural gas occupied 33.7% of the whole energy consumption in 2002, which has increased by 9.9% than in 1990. While, the energy consumption level is still lower than developed countries with the energy consumption per capita is 156 KWh, which is only 7.7 % of Japan and 4% of USA. The Composition of Energy Consumption of China in 2002 refer to Figure 3-2.

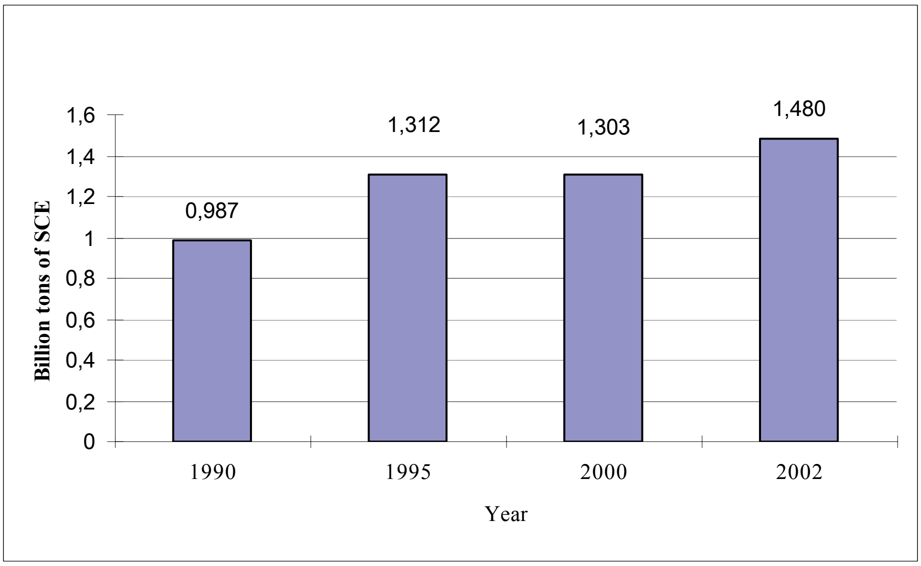

Figure 3-1 The change of total consumption of energy of China

3.4 Transportation

The numbers of civil vehicles owned of the five Province are 0.48 (Jilin) to 1.51 (Shandong) million, including Passenger Vehicles 0.30 (Jilin) to 0.82 (Shandong) million, Trucks 0.65 (Shandong) to 0.17 (Jilin) and Others, in 2002, referring to Table 3-3.

The Total Traffic Volumes of the five Province are 306.4 (Jilin) to 1101.8 (Shandong) million tons, including 247.8 (Jilin) to 915.7 (Shandong) million tons by highways, referring to Table 3-4.

Total numbers of passengers are 249.4 (Jilin) to 1157.2 (JIiangsu) million persons, including 199.0 (Jilin) to 1101.4 (JIiangsu) million persons by highways, referring to Table 3-4.

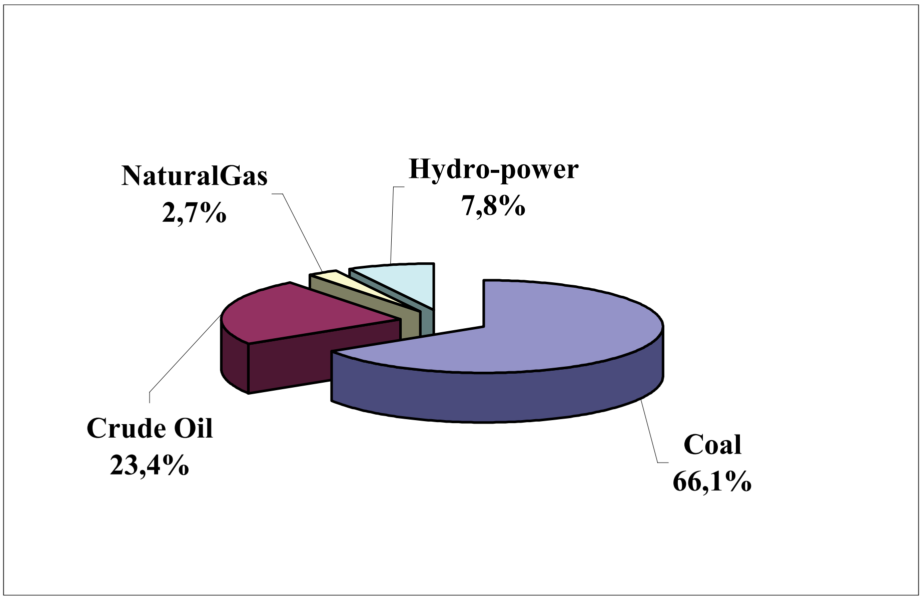

Figure 3-2 The composition of energy consumption of China in 2002

Table 3-3 Number of civil vehicles owned in 2002

(Unit in million)

Province	Total	Passenger Vehicles	Trucks	Others
Jiangsu	1.05	0.65	0.37	0.02
Shandong	1.51	0.82	0.65	0.04
Liaoning	0.89	0.52	0.35	0.01
Jilin	0.48	0.30	0.17	0.002
Heilongjiang	0.60	0.34	0.24	0.008

Table 3-4 Traffic volumes by region in 2002

Province	Freight traffic (Million ton)		Numbers of passengers (Million persons)	
	Total	Highways	Total	Highways
Jiangsu	878.2	603.0	1157.2	1101.4
Shandong	1101.8	915.7	765.4	718.0
Liaoning	810.4	641.0	538.9	435.5
Jilin	306.4	247.8	249.4	199.0
Heilongjiang	543.9	403.2	509.4	414.9

4. National Monitoring and Research Activities Related to Atmospheric Deposition of Contaminants

4.1 National Programmes

Environmental quality monitoring began in 1970s in China and the national environmental monitoring networks were built in 1980s. Total of 2356 of environmental monitoring stations have come into existence since then and the number of people who are working for environmental monitoring work reaches 46515 in the whole country.

Chinese environmental monitoring network has been working in the fields of monitoring of urban air quality, air pollutant emission, acid rain, water quality of ground water and surface water, seawater quality of offshore area, urban noise, radiation, ecological state in some typical regions, industrial sewerage, solid waste, serious pollution accidents, etc.

China National Environmental Monitoring Center （CNENC） is an institution directly affiliated to State Environmental Protection Administration (SEPA). It provides technical support supervision and technical service for the environmental supervision management of SEPA, plays a role as network center, technical center, information center and training center of national environmental monitoring and provides professional management and provides guidance for the national monitoring system.

The numbers of provincial level, city level and county level environmental monitoring centers are 40, 401 and 1914, respectively. The Composition of Environmental Monitoring Framework in Chin refers to Figure 4-1.

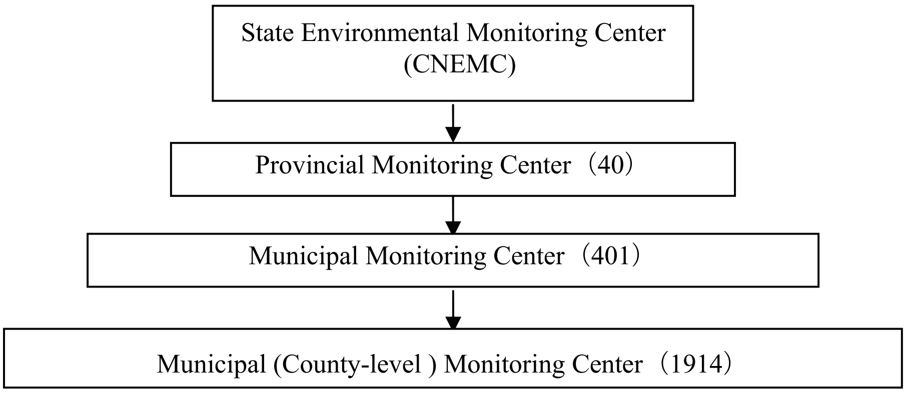

Figure 4-1 Composition of environmental monitoring framework in China

Each provincial environmental monitoring center provides technical support supervision and technical service for the environmental supervision management of EPB of each province. It plays a role as network center in each province; it is the technical center, information center and training center of provincial environmental monitoring and provides professional management. It is responsible for collecting, verifying and managing the environmental monitoring information and environmental statistic data in each province.

Each urban environmental monitoring center or station (for cities directly under province) provides technical support, supervision and technical service for the environmental supervision management of EPB of the city. It plays a role as network center in the city; it is technical center, information center and training center of urban environmental monitoring and provides professional management. It is responsible for collecting, verifying and managing the environmental monitoring information and environmental statistic data in the city.

Each county environmental monitoring station provides technical support, supervision and technical service for the environmental supervision management of EPB of each city or county; it is responsible for monitoring, managing the environmental monitoring information and environmental statistic data of ambient air quality monitoring in the city or county.

In China, the air pollution monitoring work is mainly carried out by cities. There are more than 1800 of city/county environmental monitoring stations that have the capabilities on air quality monitoring in China. 343 city/county monitoring centers report air quality data to CNEMC every year. The locations of these cities are shown in Figure 4-1. There are 118 cities, reporting the automatic-monitored data to CNEMC everyday, and their locations are showed in Figure 4-2.

The main responsibility of air quality monitoring in China is to assess air quality, analysis the tendency of air quality and provide technical support for environmental management, decision-making and pollution prevention. The air quality monitoring networks are mainly consisted of ambient air quality monitoring network, precipitation (acid rain) monitoring network and sand and dust storm monitoring network.

A national wide acid rain investigation was carried out in 2002. There are totally 698 cities/counties involved in this work. 1207 acid rain monitoring sites are set up for the investigation, among them 803 sites locate in urban area, 404 sites locate in rural area. In order to clarify the special distribution and pollution degree of acid rain, it is decided by SEPA that the investigation will be continued in 2004 and 2005 year.

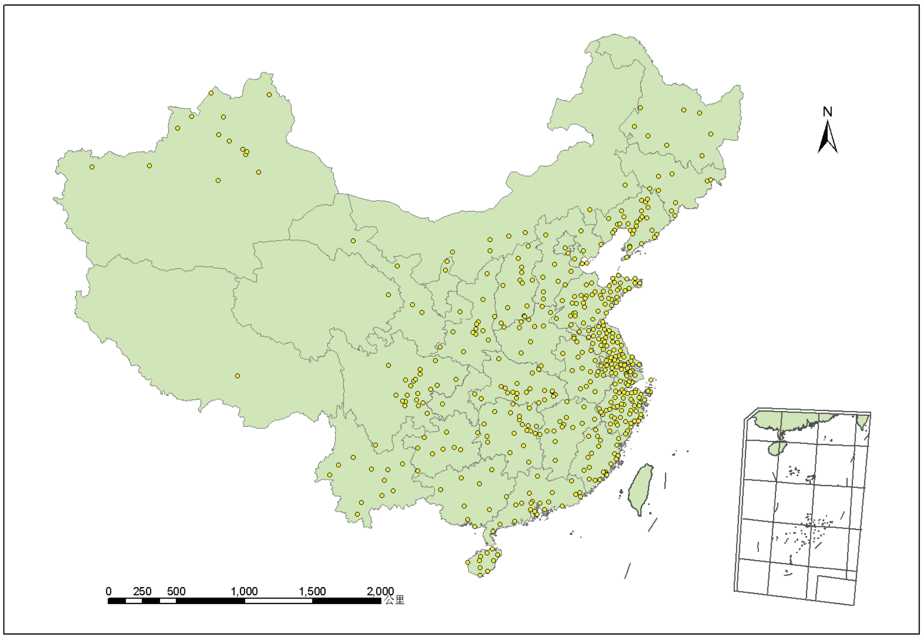

Figure 4-2 The locations of cities (counties) that report air quality data to CNEMC annually

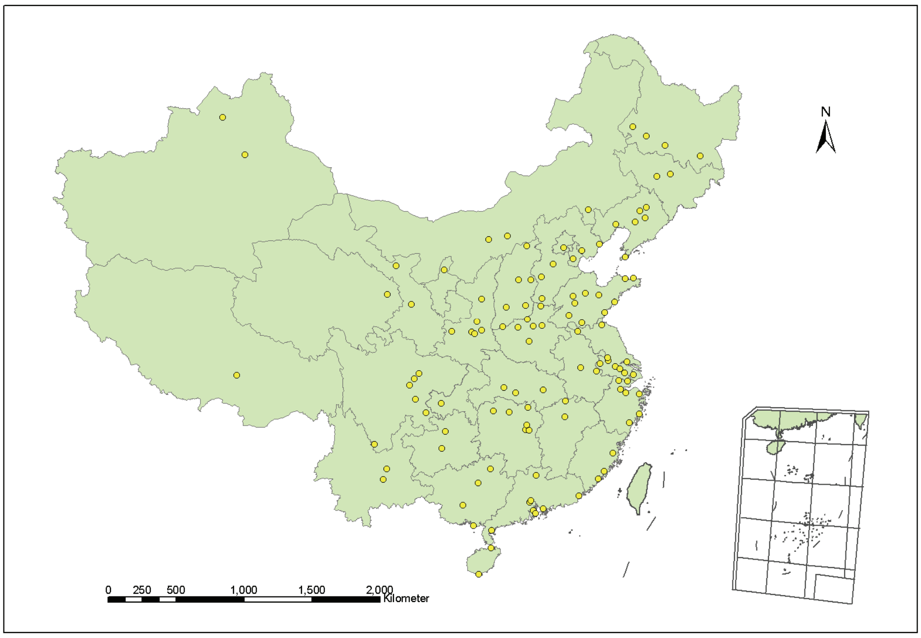

Figure 4-3 The locations of cities which report automatic monitored air quality data to CNEMC every day

Acid rain mainly occurs in areas to the south of Yangzi River and east of Tibet Plateau, and there is also acid rain in some part of the north China. According to precipitation monitoring in 555 cities and counties, the annual average pH value ranges from 4.03 (Lin'an, Zhejiang Province) to 8.31 (Jiayuguan, Gansu Province) in 2002. Acid rain occurs in 279 cities and counties, which accounts for 50.3% of the total. The annual average pH value in 181 cities and counties isn't greater than 5.6, which accounts for 32.6% of the total. The special distribution of annual average pH value of precipitation is showed in Figure 4-3.

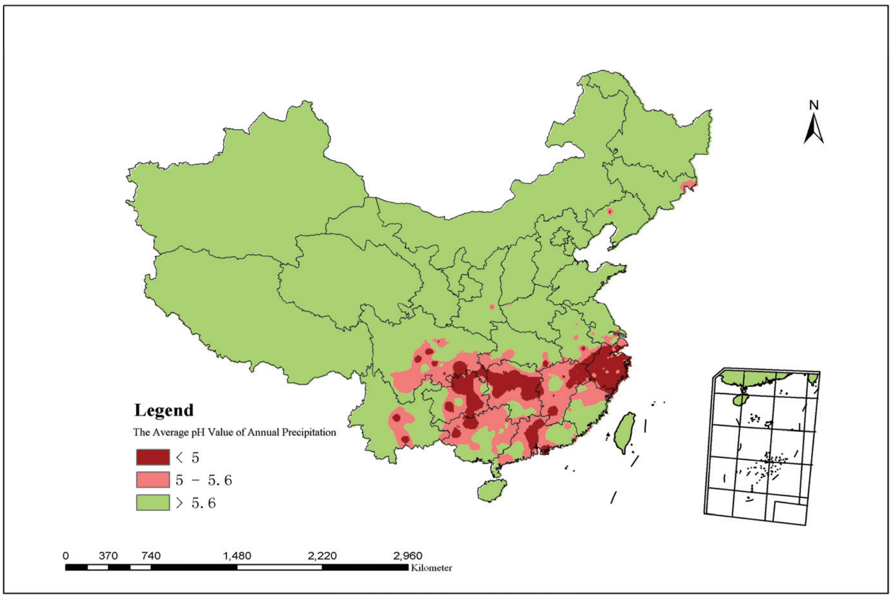

Figure 4-4 Spacial distributions on annual average pH value of precipitation in China in 2002

Table 4-1 Number of stations for different kinds of monitoring in 2002

Kind of monitoring	Number of national sites
Air pollution	550
Chemical composition of precipitation	800
Acidity of Precipitation	1207
Acid rain (EANET*)	9

Note: EANET - Acid Deposition Monitoring Network in East Asia

Table 4-2 Frequency of observations at different monitoring stations

Kind of monitoring	Frequency
Air pollution	Daily
Precipitation composition	Daily
Snow cover composition	Daily
Precipitation acidity	Daily
EANET, dry deposition	Daily
EANET, wet deposition	Daily

4.2 Methodologies

The methods of ambient air quality monitoring have been established for the past 20 years in China. They have been published in the forms of handbooks or Criterion, etc. They are methods of sampling and analysis for environmental monitoring. Some of them are listed below:

1) «Technical Regulation for Environmental Monitoring» 1986.

It is criterion for the monitoring of atmosphere, water and bodies of water, noise and radioactivity.

2) «Analytical Methods for atmosphere and emission source» , 1990.

There are 148 methods for 80 parameters in the handbook.

3) «Handbook for QA/QC of ambient air quality monitoring».

4) «Technical Regulation For Urban Ambient Air Quality Daily Report» (will be issued).

5) «Technical Regulation For Urban Ambient Air Quality Forecast Report» (will be issued).

6) National Standards of Ambient Air Quality Monitoring Methods.

(1) GB 6921-86 Determination of the concentration of airborne particulate matters

(2) GB 8969-88 Air quality - Determination of nitrogen oxides in ambient air - Griess-Saltzman method

(3) GB 8970-88 Air quality - Determination of sulfur dioxide in

		ambient air-tetrachloromercurate(TCM) - Pararosaniline method
(4)	GB 8971-88	Air quality - Determination of benzo (a) pyrene in flying dust - Acetylated paper chromatography fluorescence spectrophotometric method
(5)	GB 9801-88	Air quality - Determination of carbon monoxide - Non-dispersive infrared spectrometry
(6)	GB/T 13906-92	Air quality - Determination of nitrogen oxides
(7)	GB 13580.1-92	General principles for analytical methods of the wet precipitation
(8)	GB 13580.2-92	Collection and preservation of the wet precipitation sample
(9)	GB 13580.3-92	Determination of specific conductance in the wet precipitation
(10)	GB 13580.4-92	Determination of PH value of wet precipitation - Glass electrode method
(11)	GB 13580.5-92	Determination of fluoride, chloride, ntrite, nitrate, sulfate in the wet precipitation - Ion chromatography
(12)	GB 13580.6-92	Determination of sulfate in the wet precipitation
(13)	GB 13580.7-92	Determination of nitrite in the wet precipitation - N-(1-naphthyl)-1,2-diaminothane dihydrochloride spectrophotometry
(14)	GB 13580.8-92	Determination of nitrate in the wet precipitation
(15)	GB 13580.9-92	Determination of chloride in wet precipitation - Ferrithiocyanate spectrophotometry
(16)	GB 13580.10-92	Determination of fluoride in the wet precipitation - Fluor reagent spectrophotometry
(17)	GB 13580.11-92	Determination of ammonium in the wet precipitation
(18)	GB 13580.12-92	Determination of sodium and potassium in the wet precipitation-Atomic absorption spectrophotometry
(19)	GB 13580.13-92	Determination of calcium and magnesium in the wet precipitation - Atomic absorption spectrophotometry
(20)	GB/T 14675-93	Air quality - Determination of odor-triangle - odor bag

method

(21）GB/T 14676-93 Air quality - Determination of trimethylamine - Gas chromatography

(22）GB/T 14677-93 Air quality - Determination of toluene, dimethyl benzene and styrene - Gas chromatography

(23）GB/T 14678-93 Air quality - Determination of sulfuretted hydrogen, methyl sulfhydryl, dimethyl sulfide and dimethyl disulfide - Gas chromatography

(24）GB/T 14679-93 Air quality - Determination of ammonia - Sodium salicylate-sodium hypochlorite spectrophotometric method

(25）GB/T 14680-93 Air quality - Determination of carbon - Disulfide-diethylamine spectrophotometric method

(26）GB/T 14668-93 Air quality - Determination of ammonia - Nessler's reagent colorimetric method

(27）GB/T 14669-93 Air quality - Determination of ammonia-Ion selective electrode method

(28）GB/T 14670-93 Air quality - Determination of styrene - Gas chromatography

(29）GB/T 15262-94 Ambient air - Determination of sulfur dioxide - Formaldehyde absorbing-pararosaniline spectrophotometry

(30）GB/T 15263-94 Ambient air - Determination of total hydrocarbons - Gas chromatographic method

(31）GB/T 15264-94 Ambient air - Determination of lead - Flame atomic absorption spectrophotometric method

(32）GB/T 15265-94 Ambient air - Determination of dustfall - Gravimetric method

(33）GB/T 15501-95 Air quality - Determination of nitrobenzene (mononitro and dinitro-compound) - Reduction by zinc-N-(1-Naphthyl) ethylene diamine dihydrochloride spectrophotometric method

(34）GB/T 15502-95 Air quality - Determination of aniline-N- (1-naphthy) ethylene diamine dihydrochloride - spectrophotometric method

(35）GB/T 15516-95	Air quality - Determination of formaldehyde - Acetylacetone spectrophotometric method
(36）GB/T 15432-95	Ambient air - Determination of total suspended particulates - Gravimetric method
(37）GB/T 15433-95	Ambient air - Determination of the fluoride - Method by lime-paper sampling and fluorine ion-selective electrode analysis
(38）GB/T 15434-95	Ambient air - Determination of the concentration of fluoride - Method by filter sampling and fluorine ion-selective electrode analysis
(39）GB/T 15435-95	Ambient air - Determination of nitrogen dioxide - Saltzman method
(40）GB/T 15436-95	Ambient air - Determination of nitrogen oxides - Saltzman method
(41）GB/T 15437-95	Ambient air - Determination of ozone - Indigo disulphonate spectrophotometry
(42）GB/T 15438-95	Ambient air - Determination of ozone - Ultraviolet photometric method
(43）GB/T 15439-95	Air quality - Determination of benz(a)pyrene in ambient air - High performance liquid chromatography
(44）GB/T 3840-91	Technical methods for making local emission standards of air pollutants
(45）HJ/T 14-1996	Principle and technical methods for regionalizing ambient air quality function

Table 4-3 Monitoring parameters and analytical methods used (air pollution measurements)

Parameter	Method	Measurement range（ppm）	Accuracy（ppm）
TSP	Gravimetric method	1-10 mg/m^3	0.001 mg/m^3
CO	Non-diffused infrared spectrometry	0-50	0.5
NO	Chemiluminescence detection method	0-0.5	0.002
NO_2	Chemiluminescence detection method	0-0.5	0.002
NOx	Chemiluminescence detection method	0-0.5	0.002
SO_2	Ultraviolet fluorescent method	0-0.5	0.002
PM_{10}	β-ray, or TEOM	0-10 mg/m^3	0.001 mg/m^3
O_3	Ultraviolet photometric method	0-1	0.002

Table 4-4 Monitoring parameters and analytical methods for acid deposition

Parameter	Method	Measurement range umol/l	Accuracy umol/l
NH_4^+	Ion chromatography	3-1000	1
NO_3^-	Ion chromatography	1-100	0.3
Na	Ion chromatography	2-900	1
K	Ion chromatography	1-100	0.3
Ca	Ion chromatography	0.5-300	0.2
Mg	Ion chromatography	1-200	0.4
pH	pH meter	-	0.05
Conductivity	Conductivity cell	-	-
SO_4	Ion chromatography	1-200	1
Cl	Ion chromatography	1-1000	1

4.3 Research Activities and International Cooperation

(1) The cooperation project between USA and China - Research on Air Pollution's Impact on Human Breath Health during 1994-2001, which aims to seek after the relationship between indoor - outdoor air pollution exposure and human breath health.

(2) The applied research on FTIR in toxic atmospheric contaminants monitoring during 1994-2000 cooperated with USA.

(3) Research on PAHs exposure and metabolize assessment during 2001-2004

cooperated with USA.

(4) The joint research with France - National Air quality Monitoring System during 2001-2002, and France supply the consultant of monitoring system standardization construction.

(5) The joint research with Norway - State Environmental Monitoring Information System building during 2002-2004

(6) The joint research with Japan during 1996-2001 on «State Environmental Monitoring Strategy in 21st century», «Wet-deposition Monitoring Quality Assurance», «East-Asia Acid Deposition Monitoring System», etc.

(7) East-Asia acid deposition monitoring system- branch monitoring station of China during 1998 to now.

(8) Global Environmental Monitoring Network (GEMS) during 1992-1997.

4.4 Training Activities

The provincial environmental monitoring training activities are held by province environmental monitoring centers every year in the five provinces. They also take part in national training activities and international training activities.

The training activities are including analytical methods, QA/QC, evaluation of environmental quality in the fields of urban air quality, air pollutant emission, acid rain, water quality of ground water and surface water, seawater quality of offshore area, urban noise, radiation, ecological state in some typical regions, industrial sewerage, solid waste, serious pollution accidents, etc.

Some of the international training activities they took part in are listed below.

(1) Training class on fixed air pollution source monitoring and sampling in 1992, and more than 130 all over the country attended this training.

(2) Workshop on environmental monitoring was conducted with Environmental Institute of Canada, and experts from two countries had a good intercommunion with each other on technique rules, quality assurance, analysis method and data treatment, etc.

(3) Workshop on environmental monitoring between China, USA and Japan was held in China National Environmental Monitoring center, and more than 60 persons attended this workshop.

(4) Organic contaminants workshop between China and USA was held in Beijing in Sep, 1998, and more than 100 delegates attended from different monitoring centers of China.

(5) During the construction of East-Asia deposition monitoring network, monitoring workers at each monitoring centers are trained with QA/QC in Aug. 1999.

(6) ENSIS workshop between China and Norway was conducted in Mar, 2001. The delegates from Heilongjiang Province, Yantai and Guangzhou introduced the use of ENSYS.

(7) The seminars on China-Japan cooperation since 1997, has supplied 12 workshops or training classes and more than 700 persons took part in, including “The function and management of air quality automatic monitoring workshop” and “ Gross control and monitoring techniques”. All these trainings have make great contribution to acid rain monitoring management, network construction and urban air quality forecast.

Relative international meetings are convened such as：NOWPAP project, the joint environmental survey of Yellow Sea conducted by China and Korea, East-Asian Sea and GPA project, etc.

5. Present Situation of Atmospheric Deposition of Contaminants

In 2002, there were 343 cities (counties) that reported air quality monitored data to CNEMC. The assessment results show that 116 cities have met the National Ambient Air Quality Standard (NAQAS) for Grade II, which accounts for 33.8% of the total. Among them are 11 cities such as Haikou that are graded as I. 120 cities are graded as III, which counts for 35.0% and 107 as grade III plus for 31.2%. The Result also shows that air pollution in big and metropolitans cities is more serious than in small or medium-sized cities. Refer to Table 5-1

Particulate is the dominating pollutant that affects urban air quality. 63.5% of cities fail to meet the national standard for Grade II air quality, in respect of TSP or PM10 annual mean. In general, particulate pollution in the north is more serious than in the south. Table 5-1 shows the general situation on city air quality assessment in 1998, 2000 and 2002 in China. 22.4% of the cities fail to meet the standard for urban sulphur dioxide, which are mainly located in Shanxi, Hebei, Guizhou, Sichuan, Gansu and Chongqing. All data-collected cities in 2002 meet the national standard for Grade II air quality in terms of nitrogen dioxide. Nitrogen dioxide concentration is comparatively higher in some large cities.

The contents of some pollutants in the air of major cities in the region refer to Table 5-2.

Table 5-1 Grades of particulate concentration in cities

Ritio / Concentration degree	1998	2000	2002
Grade II (compliance), %	32.1	36.9	36.5
Worse than Grade II, %	67.9	63.1	63.5
Among which worse than Grade III %	37.7	30.3	29.8
National TSP average (mg/m^3)	0.289	0.270	0.268

The chemical compositions of precipitation of Dalian refer to Table 5-3 and Table 5-4.

The monitoring data transfer in china and the transmission of ambient air monitoring data in China refer to Figure 5-1 and Figure 5-2

Table 5-2 Contents of some pollutants in the air of major cities (average for 2002)

Cities	PM_{10} (mg/m^3)	SO_2 (mg/m^3)	NO_2 (mg/m^3)
Harbin	0.132	0.042	0.054
Changchun	0.099	0.009	0.022
Shenyang	0.173	0.064	0.045
Dalian	0.091	0.035	0.023
Yantai	0.077	0.039	0.025
Qingdao	0.097	0.054	0.026
Lianyungang	0.121	0.035	0.021
Shanghai	0.109	0.036	0.058

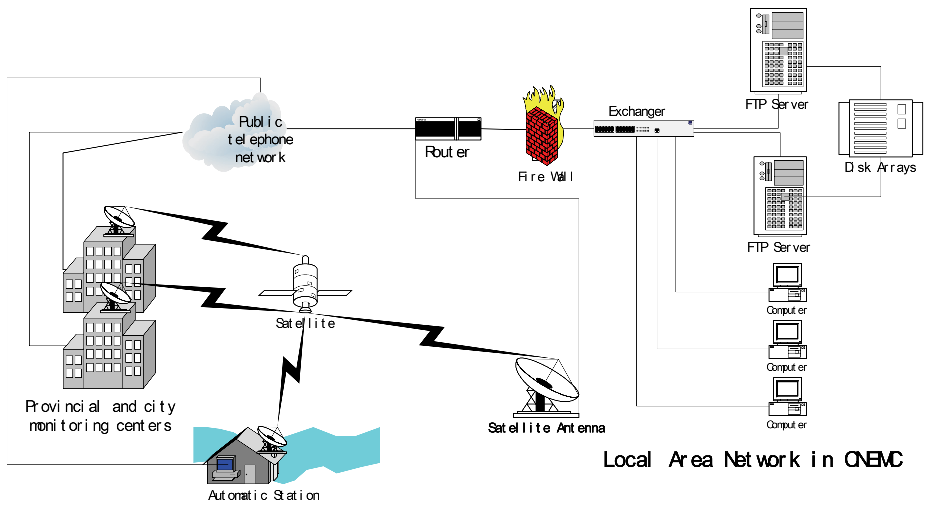

Figure 5-1 Monitoring data transfer in China

Table 5-3 Chemical composition of precipitation of Dalian (monthly averaged for 2002)

Month	SO_4^{2-}	NO^{3-}	Cl-	NH_4^+	Na^+	K^+	Ca^{2+}	Mg^{2+}	H^+	pH	EC
	umol/l	umol/l	umol/l	umol/l	umol/l	umol/l	umol/l	umol/l	umol/l		mS/m
Jan.	-	-	-	-	-	-	-	-	-	-	-
Feb	-	-	-	-	-	-	-	-	-	-	-
Mar.	-	-	-	-	-	-	-	-	-	-	-
Apr.	223.3	47.8	733.4	278.3	291.4	42.5	285.7	3.1	0.0049	8.31	500.0
May	-	-	-	-	-	-	-	-	-	-	-
Jun.	357.7	74.1	235.8	136.1	143.2	25.9	259.6	32.4	0.0813	7.09	224.5
Jul.	603.8	87.1	440.1	78.7	61.8	10.6	92.1	14.4	0.0891	7.05	300.0
Aug.	111.4	18.2	106.1	110.9	32.2	5.9	22.7	1.0	0.0724	7.14	210.0
Sept.	353.9	100.8	200.8	110.9	36.2	5.2	21.3	1.7	0.0708	7.15	230.0
Oct.	417.4	234.1	499.6	205.1	49.1	8.8	42.9	7.9	0.0873	7.06	261.8
Nov.	-	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	-	-	-	-	-	-	-	-	-
Annul average	282.7	65.5	345.4	164.4	139.7	22.7	180.5	14.4	0.06	7.22	293.0

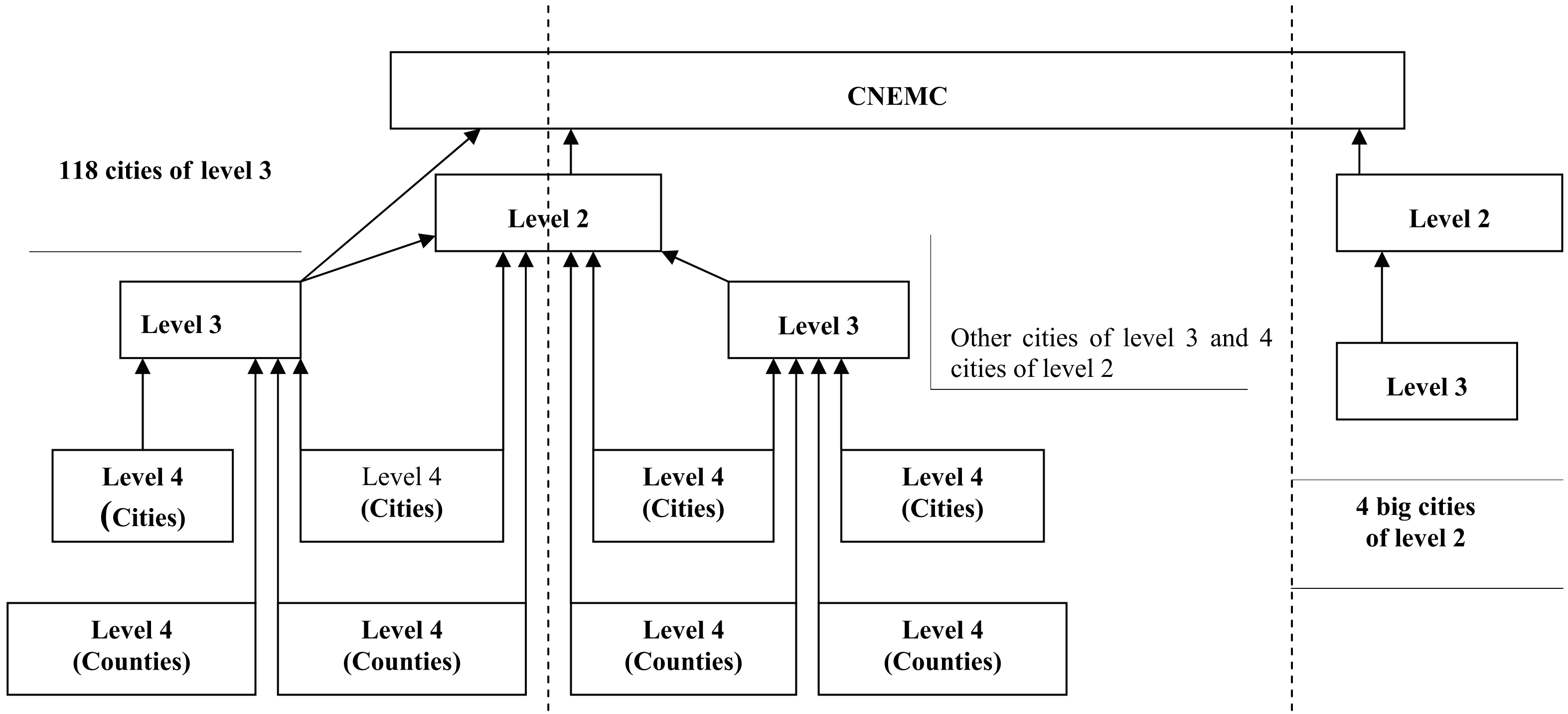

Figure 5-2 Transmission of ambient air monitoring data in China

Table 5-4 Chemical composition of precipitation for territorial objects (annual averaged for 2002, mg/l)

Cities	pH	Na	K	Ca	Mg	SO_4	NO_3	Cl
Harbin	7.15	-	-	-	-	-	-	-
Changchun	6.81	1.394	0.904	5.972	0.804	5.951	3.506	1.943
Shenyang	6.58	1.22	1.30	7.88	2.02	16.66	3.30	3.82
Dalian	7.02	1.59	0.46	7.24	0.47	21.38	4.39	5.21
Yantai	6.53	3.52	3.41	7.65	0.86	18.5	3.95	6.87
Qingdao	5.1	1.527	0.5	2.919	0.527	8.61	2.979	2.714
Lianyungang	6.14	0.628	0.24	2.584	0.414	16.782	1.165	6.42
Shanghai	5.03	0.527	0.396	2.638	0.233	20.249	2.942	2.390

6. Plan and Activities for Air Pollution Control

(1) "Five-year plan" of China

- There is a control and protection plan about "acid rain control zone and SO_2 emission zone" constituted by central government for 2000-2005.
- There is a control and protection plan of air plan for113 key cities constituted by central government

(2) Capability building on city air quality automatic monitoring system

Air quality should be automatic monitored in all cities in China in recent three years. Hitherto, 208 cities have established their air quality automatic monitoring system. 42 cities will finish building automatic monitoring system in the end of 2004; there are still 29 cities that have no air quality automatic monitoring system.

(3) Distribution plan of quota for SO_2 emission control

The distribution plan of quota for SO_2 emission control in electric power industry has carried in Jiansu for controlling SO_2 emission.

(4) Beijing clean air action

Beijing government constituted a plan to modify the Beijing air quality, and the rate the days of Grade II (compliance) is over 55% at 2002.

(5) SO_2 emission control

3800 projects were finished about reducing SO_2 emission in the end of 2002

(6) The cars emission control

SEPA published 3 catalogues for 300 new mobile vehicle-emissions standard in 2002.

7. Recommendations for Future Regional Activities and Priorities

(1) Strengthening dust and sand storm monitoring

Dust and sand storm monitoring networks should be built further more. Dust and sand moving route and there influence bound, their origination shall be studied based on monitoring. The construction-building site must control construction dust to meet with the environmental protection standard, as well as strengthening the traffic dust prevention.

(2) Strengthening monitoring information system

Information construction should be consolidated to build data collection system and set up information sharing mechanism, which will help to strengthen the monitoring and integrated management abilities.

(3) Essential training for monitoring workers

Propagandistic and educated activities should be strengthened to improve the people' sense of marine environmental protection by using every kinds of media. News and consensus supervision should be consolidated too.

(4) Enhance the legislation construction

Legislation on marine environmental protection should be strengthened, and other laws and rule relative marine environment should be actualized as soon as possible. The government should execute the law strictly and correctly.

(5) Control secondary pollution

Measures should be taken to control secondary particles production and ozone pollution. At the same time, VOC emission should be controlled too.

(6) Promote ecological environmental construction

Promote urban virescence and beautification by setting up an ecological barrier.

8. Conclusions

China and the national environmental monitoring networks were built in 1980s, it has been working in the fields of monitoring of urban air quality, air pollutant emission, acid rain, water quality of ground water and surface water, seawater quality of offshore area, urban noise, radiation, ecological state in some typical regions, industrial sewerage, solid waste, serious pollution accidents, etc.

The methods of monitoring have been established for the past 20 years in China. They have been published in the forms of handbooks or Criterion, etc.

In 2002, 343 cities (counties) reported air quality monitored data to CNEMC in China. Among them, 116 cities have met the National Ambient Air Quality Standard (NAQAS) for Grade II, which accounts for 33.8% of the total. 120 cities are graded as III, which counts for 35.0% and 107 as grade III plus for 31.2%. Particulate is the dominating pollutant that affects urban air quality. 63.5% of cities fail to meet the national standard for Grade II air quality, in respect of TSP or PM10 annual mean.

Acid rain mainly occurs in areas to the south of Yangzi River and east of Tibet Plateau， and there is also acid rain in some part of the north China.

9. References

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12. Yearbook of Liaoning Province， 2002.
13. China Statistical yearbook, 2003.

Annex 1. National Law and Regulations of China

Approximately 150 environmental regulatory instruments, including major environmental laws adopted by the National People's Congress or its Standing Committee. There is a Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution and 8 regulations about Prevention and Control of Atmospheric Pollution.

1. Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution

This Law's adoption date is1995-08-29, amendment date is 2000-04-29 and effective date: 2000-09-01.

The Law is formulated for the purpose of preventing and controlling atmospheric pollution, protecting and improving people's environment and the ecological environment, safeguarding human health, and promoting the sustainable development of economy and society.

2. Environmental Regulations about Prevention and Control of Air Pollution

There are 8 Environmental Regulations about Prevention and Control of Air Pollution listed below:

(1) Circular of Stopping Production, Sale and Use of the Leader Gasoline Within a Time Limit by the General Office of the State Council [issued date: 19990701] [effective date: 20000101] Canonical Documents Issued by the State Council

(2) Technical Policies on the Prevention and Control of Pollution by Motor Vehicle Emissions [issued date: 19990528]

(3) Reply on the Concerned Issues of "Acid Rain Control Zone"and "Sulfur Dioxide Pollution Control Zone" by the State Council[issued date: 19980112]

Canonical Documents Issued by the State Council

(4) Official Reply on the Concerned Issues of "Acid Rain Control Zone" and" Sulfur Dioxide Pollution Control Zone" by the State Council[issued date: 19980112] Canonical Documents Issued by the State Council

(5) The First Catalogue of Eliminated Technologies & Equipment Causing Serious Air Pollution [issued date: 19970605]

6) Industrial Policy on Automobiles (excerpts of environment-related provisions) [issued date: 19940312]

(7) Regulations on the Administration of National Monitoring for Tailing Gas Exhaust Emission of Motor Vehicles (Tentative) [issued date: 19910222] [effective date: 19910222] Decrees Issued by the SEPA

(8) Supervision for the Automobile Exhaust Pollution [issued date: 19900815] [effective date: 19900815] Supervisions and Regulations.

Annex 2. Ambient Air Quality Standard of China

Table 10-1 Ambient Air Quality Standard of China GB3095-1996

Parameter	Values	Standard Values: First level	Second level	Third level	
SO_2	Year	0.02	0.06	0.10	mg/m^3 (standard state)
	Day	0.05	0.15	0.25	
	Hour	0.15	0.50	0.70	
TSP	Year	0.08	0.20	0.30	
	Day	0.12	0.30	0.50	
PM_{10}	Year	0.04	0.10	0.15	
	Day	0.05	0.15	0.25	
NO_2	Year	0.04	0.08	0.08	
	Day	0.08	0.12	0.12	
	Hour	0.12	0.24	0.24	
CO	Day	4.00	4.00	6.00	
	Hour	10.00	10.00	20.00	
O3	Hour	0.16	0.20	0.20	
Pb	Quarter	1.50			$\mu g/m^3$ (standard state)
	Year	1.0			
B(a)p	Day	0.01			
F	Day	7[1]			
	Hour	20[1]			
	Month	1.8[2]	3.0[3]		$\mu g/(dm^2.d)$
	Growth-season	1.2[2]	2.0[3]		

Note: * standard state: 273 K and 101325Pa.

[1] Urban area

[2] Pasturing area

[3] Farm belt and forest area

<u>The hour average values</u>: For SO_2, NO_2, CO and O_3, it must be sampled more than 45 min

<u>The daily average values:</u> For TSP, PM_{10}, B(a)P and Pb, it must be sampled more than 12 hours; For SO_2, NO_2 , CO and F, it must be sampled more than 18 hours;

<u>The annual average values:</u> For SO_2, NO_2 and CO, it must be sampled more than 144 the daily average values that are distributed equally in the year and more than 12 the daily average values that are distributed equally in each month; For TSP, PM_{10} and Pb, it must be sampled more than 60 the daily average values that are distributed equally in the year and more than 5 the daily average values that are distributed equally in each month.

Annex 3. The Status of Legal about Ambient Air Quality Monitoring in China

1. Central government

- Constitute national laws for ambient air protection and ambient air monitoring
- Issue national standards for ambient air quality and standard methods for ambient air quality monitoring
- Establish national environmental monitoring network to implement ambient air quality monitoring
- Supervise the implementation of national ambient air quality monitoring

2. Provincial government and large municipal government

- Implement national legal requirements and standards for ambient air quality
- Constitute local laws and standards for ambient air quality if need
- Be responsible for locus ambient air monitoring including establishment of local monitoring center and local environmental monitoring network
- Supervise the implementation of ambient air quality monitoring in district

3. Municipal government directly under province

- Implement national legal requirements and standards for ambient air quality
- Implement local legal requirements and standards for ambient air quality

- Be responsible for urban ambient air monitoring including establishment of urban monitoring center and urban environmental monitoring network in district

4. Municipal government (county-level) and county government

- Implement national legal requirements and standards for ambient air quality monitoring
- Implement local legal requirements and standards for ambient air quality
- Be responsible for county ambient air monitoring including establishment of county monitoring station in districts

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National Report of Republic of Korea on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

Table of Contents

National Report of Republic of Korea on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

1. Executive Summary

This report is the Korean national report on the atmospheric deposition contaminants monitoring in Korea. The report contains social and economic situation, national monitoring and research activities related to atmospheric deposition of contaminants in Korea.

The major courses of air pollution were the industrialization and urbanization by rapid growth rate of economy. The population in seven cities (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon and Ulsan) known as metropolitan in Korea accounted for almost 50%. The ratios of urbanization were in the range of 98-100% in those cities. The number of motor vehicles in Korea totaled 14 million in 2002. Motor vehicles are the largest contributors to urban air pollution in Korea. Among them, 94.5% was private motor vehicles. High levels of PM_{10}, NO_2, and O_3 concentrations are generated due to increased emissions of NOx and VOCs from motor vehicles.

According to Ministry of Environment (MOE) and local governments who are responsible for the air quality monitoring in Korea (10 air monitoring programme), the status of the air quality in Korea for 10 years were as follows;

- The concentration of SO_2 has showed the decreasing trend since 1990s.
- The concentration of NO_2 did not improve over years.
- Due to vehicle gas emissions and frequent occurrences of Asian dust, the concentration of PM_{10} did not appear any improvement in 2001 and 2002.
- O_3 has kept a similar level since 1997.

- The concentration of CO has marked the decreasing trend since 1990s.
- The acid rain of below pH 5 was not found in all stations.
- The concentrations of heavy metals were below the air quality standards of MOE.
- Even though the concentration of yellow sand dust did not show any trend on the increasing or decreasing, the duration was clearly increasing trend.

Transboundary air pollution (TAP) has recently been highlighted as a major problem due to the considerable level of air pollutants emitted due to industrial and anthropogenic activities. Therefore, the report, which contains all kinds of data and information on the air pollution monitoring performing in Korea, will contribute the preparation of the regional air pollution monitoring strategy to reserve the marine and coastal environment in the NOWPAP region.

2. Introduction

2.1 Goals and Objectives of this Report

The present report, National Report on the Atmospheric Deposition in Korea, has been prepared in response to decision of the 2nd Northwest Pacific Action Plan Pollution Monitoring Regional Activity Centre Focal Points Meeting (NOWPAP POMRAC FP) in May 26-27, 2004, in which the POMRAC focal points adopted the Terms of Reference for WG1. Like many other developing countries in Asia, Korea has witnessed a rapid increase in urbanization and industrialization over the past few decades. This industrial development in cities along with the accompanying urban expansion has been the primary causes for the substantial increase in vehicle emissions and stationary fuel combustion that have contributed to the deterioration of the Korean atmospheric environment. This report aims to discuss the status on the Korean air pollution obtained through the air monitoring.

2.2 General Background Information on NOWPAP

For nearly three decades the United Nations Environment Programme (UNEP) has fostered regional cooperation on behalf of the marine and coastal environment. It has accomplished the cooperation by stimulating the creation of 'Action Plans'- prescriptions for sound environmental management- for each region. Now, there are more than 140 coastal States and Territories participating in 13 Regional Seas Programme established under UNEP auspices.

The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) is one of the 'Action Plans' which was adopted at the First Intergovernment Meeting (IGM) in Seoul, Republic of Korea, September 1994, attended by People's Republic of China, Japan, Republic of Korea and Russian Federation. Three Resolutions were also adopted. Resolution 1 identified five areas of priority for implementation of the Action Plan, one of which was NOWPAP/3: Establishment of collaboration, regional monitoring programme.

Following the decision of the 3rd Intergovernment meeting, the responsibility for NOWPAP/3 (Regional Monitoring Programme) was jointly shared by the Special Monitoring and Coastal Environmental Assessment Regional Activity Center (CEARAC) and the Pollution Monitoring Regional Activity Center (POMRAC) to carry out regional activity.

The 7th intergovernmental Meeting of NOWPAP (Vladivostok, 20-20 March 2002), have decided that POMRAC will be responsible for two working groups: WG1-Atmospheric Deposition of Contaminants into the Marine and Coastal Environment; and WG2-River and Direct inputs of Contaminants into the Marine and Coastal Environment. The 2nd Focal Points Meeting of

POMRAC (Vladivostok, Russia, 26-28 May 2004) adopted the TOR for WG1.

2.3 General Information/Introduction on the Atmospheric Deposition

Transboundary air pollution (TAP) has recently been highlighted as a major problem due to the considerable level of air pollutants emitted due to industrial and anthropogenic activities. Transboundary pollution can be defined as any pollution caused by a country that has effects in either another country or a shared area which is not under the jurisdiction of any one country such as Antarctica.

The North-west Asia (in particular China, Korea and Japan) is densely populated and highly industrialized. Also, each country in the region is at a different stage of economic development and may have a different standard on environmental quality. In the region, transboundary (TAP) can lead to significant degradation of air quality if no efforts are made to address the problem. The Male Declaration on Control and Prevention of Air Pollution. Which was adopted at South Asia Cooperative Environment Programme (SACEP)s and EANET (Acid Deposition Monitoring Network for East Asia) are examples of such efforts.

Korea has had one of the fastest growing economies in the world since the 1960s, but the focus on economic development has been at the expense of the environment. Every part of the environment has suffered with increased air, water, and noise pollution, increased waste management problems, and reduced quality of life.

2.4 Geographical Scope

The Korean Peninsula extends for about 1,000 kilometers southward from the northeast part of the Asian continental landmass. The west coast of the peninsula is bordered by the Yellow Sea to the south; the east coast is bordered by the East Sea. The 2,413- kilometer coastline is highly indented. More than 3,000 islands lie adjacent to the peninsula. Most of them are found along the south and west coasts (Figure 2-1).

Figure 2-1 The map on NOWPAP area (a) and Korea Peninsular (b)

The total land area of the peninsula, including the islands, is 98,477 square kilometers. Although the eastern coastline of South Korea is generally unindented, the southern and western coasts are jagged and irregular. The difference is caused by the fact that the eastern coast is gradually rising, while the southern and western coasts are subsiding.

The Naktong is South Korea's longest river (521 kilometers). The Han River, which flows through Seoul, is 514 kilometers long, and the Kum River is 401 kilometers long. Other major rivers include the Imjin, which flows through both North Korea and South Korea and forms an estuary with the Han River;

the Pukhan, a tributary of the Han that also flows out of North Korea; and the Somjin. The major rivers flow north to south or east to west and empty into the Yellow Sea or the Korea Strait. They tend to be broad and shallow and to have wide seasonal variations in water flow.

The tallest mountain in South Korea is Mount Halla (1,950 meters), which is the cone of a volcanic formation constituting Cheju Island. There are three major mountain ranges within South Korea: the T'aebaek, and Sobaek ranges, and the Chiri Massif

The local climate is relatively temperate, with precipitation heavier in summer during a short rainy season called jangma, and winters that can be bitterly cold on occasion. In Seoul the average January temperature range is -7 °C to 1 °C (19 °F to 33 °F), and the average July temperature range is 22 °C to 29 °C (71 °F to 83 °F). Winter temperatures are higher along the southern coast and considerably lower in the mountainous interior. Rainfall is concentrated in the summer months of June through September. The southern coast is subject to late summer typhoons that bring strong winds and heavy rains. The average annual precipitation in Seoul is 1370 millimeters (54 inches). In Busan, it is 1470 mm (58 inches).

2.5 Institutional Arrangements for Developing this Report

The Ministry of Environment (MOE) and the local governments are responsible for the air quality monitoring in Korea. Ten types of air monitoring stations (372 sites) established to understand the nationwide air quality status in Korea is operating (Table 2-1).

Table 2-1 The area in the special city, metropolitan cities and provinces in Korea

Government		Area (km^2)
Special city	Seoul	607
Metropolitan city	Busan	762.92
	Incheon	964.53
	Daegu	885.62
	Daejeon	539.84
	Gwangju	501.36
	Ulsan	1,056.7
Province	Gyeonggi-do	10,867
	Gangwon-do	16,894
	Chungcheongbuk-do	7,436
	Chungcheongnam-do	8,352
	Jeolabuk-do	8,043
	Jeolanam-do	11,858
	Gyeongsangbuk-do	19,440
	Gyeongsangnam-do	11,859
	Jeju-do	1,845.55

3. Social and Economic Situation

Air pollution comes from many different sources such as factories, power plants, dry cleaners, cars, buses, trucks and even windblown dust and wildfires. Air pollution can threaten the health of human beings, trees, lakes, crops, and animals, as well as damage the ozone layer and buildings. Air pollution also can cause haze, reducing visibility in national parks and wilderness areas. Pollution sources that move, such as trucks, snowblowers, bulldozers, and trains, are known as "mobile sources." Examples of all other (non-mobile) sources of air pollution include power plants, factories, and manufacturing processes.

3.1 Population

In 2002, Korea's population stood at 48.4 million (Figure 3-1). The population density is very high in the cities. The seven largest cities (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon and Ulsan) accounted for almost half the population and their ratios of urbanization were in the range of 98-100% (Table

3-1).

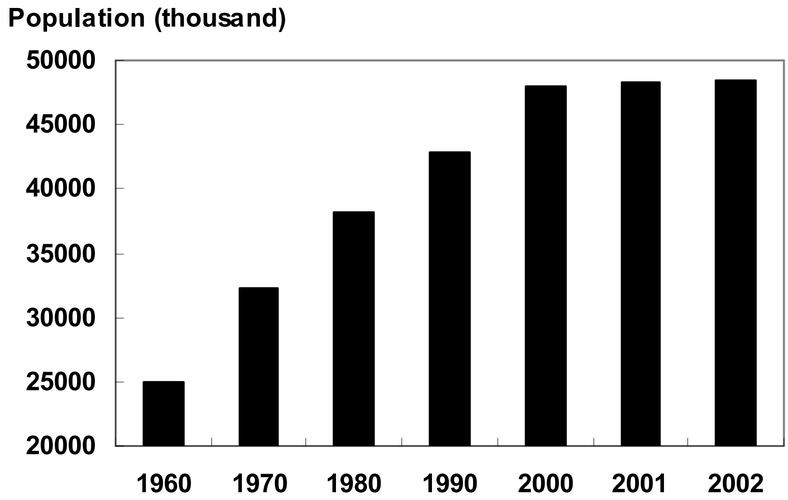

Figure 3-1 Estimates of population in Korea

Table 3-1 Trend of Urbanization

(Unit: thousand)

Divizion / Year	Whole population (A)	Administrative District		Ratio of Urbanization (%)
		Urban (B)	Country (C=A-B)	(B/A*100)
Seoul	10.277	10.277	0	100.0
Busan	3.711	3.711	0	100.0
Daegu	2.544	25.445	0	100.0
Incheon	2.601	2.536	66	97.5
Gwangji	1.400	1.401	0	100.0
Daejeon	1.432	1.432	0	100.0
Ulsan	1.075	1.054	21	98.1
Gyeonggi	10.362	9.348	1.014	90.2
Gangwon	1.533	1.221	313	79.6
Chungbuk	1.462	1.122	339	76.8
Chungnam	1.920	1.154	766	60.1
Jeonbuk	1.963	1.438	524	73.3
Jeonnam	2.024	1.255	769	62.0
Gyengbuk	2.738	2.065	672	75.4
Gyengnam	3.097	2.277	820	73.5
Jeju	554	517	36	93.4

The 3% population growth rate of the 1960s declined sharply to 2% in the 1970s due to improved social and financial living standards, changed social perspective on population issues, and campaigns to control the growing population. The rate has dropped further to below 1% since 1985. If this trend continues, according to the United Nations population data, the average national birth rate late year was 10 per thousand.

Korea's senior population ratio stood at 7.1% in 2000, thus making Korea an emerging aging society according to UN standards which define a society with the senior population over 7% as an aging society and over 14% as an aged society.

3.2 Industrial Activities

Korea has taken aggressive measures for economic development since the 1970s which prompted high year-on-year economic growth rate, attaining an average annual growth rate 8.8% between 1986 and 1995. Rapid growth in trade has established Korea as the world's 11th largest economy.

In the course of last three decades, real gross domestic product (GDP) has grown at an average annual rate of 7.3% between 1999 and 2002. The manufacturing sector, in particular, has expanded at a high speed. Korea's GDP climbed to 9.5 percent in 1999 and fell to 7.0 percent in 2002 (Figure 3-2).

According to the central bank's report, exports of semiconductor chips and metal products saw significant reductions in growth. "Unexpected factors, both domestic and overseas, have been continuously emerging that have been causing uncertainties in the economy, such as high oil prices that lasted longer than expected.

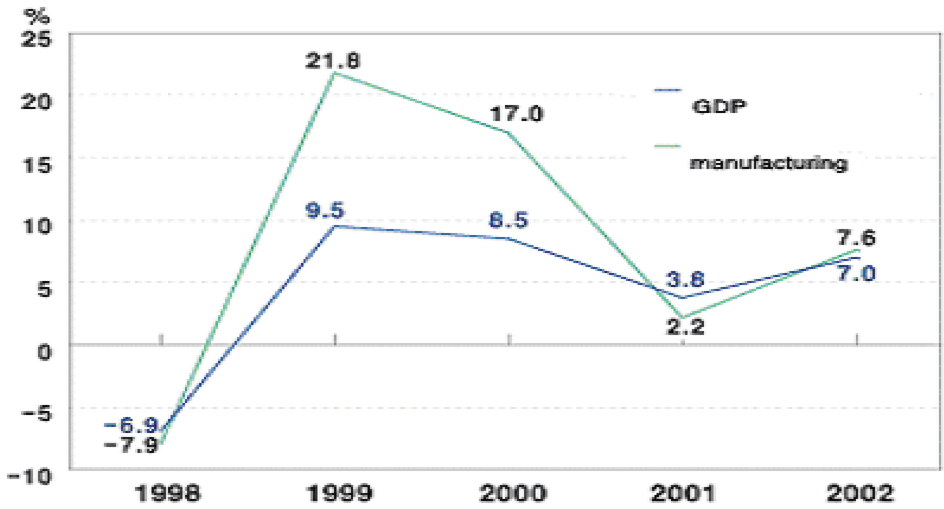

Figure 3-2 Growth rate of GDP and manufacturing in Korea

The three major industrial activities in Korea were service, commercial and manufacturing with Korea's leading industries such as shipbuilding, semiconductors, electronics and auto manufacturing.

The current Korean agriculture and fisheries industry are facing great challenges, showing very low occupation of <1 percent to the workers of the total industrial activities. The number of workers engaged in agriculture and fisheries nationwide has reduced year by year, while that in service has increased recently (Figure 3-3).

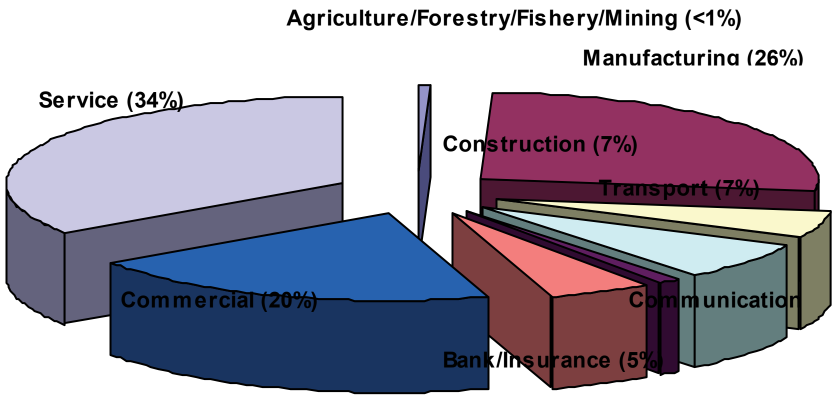

Figure 3-3 Industrial structures in Korea

3.3 Energy

Fossil fuels (coal, oil, and natural gas) are Korea's primary source of energy, accounting for 83 percent of current Korea fuel use Energy. In 2002, oil accounted for 49% of the fuel mix, coal 24%, nuclear power 14%, LNG 11%, hydro-power and others 2% (Figure 3-4).

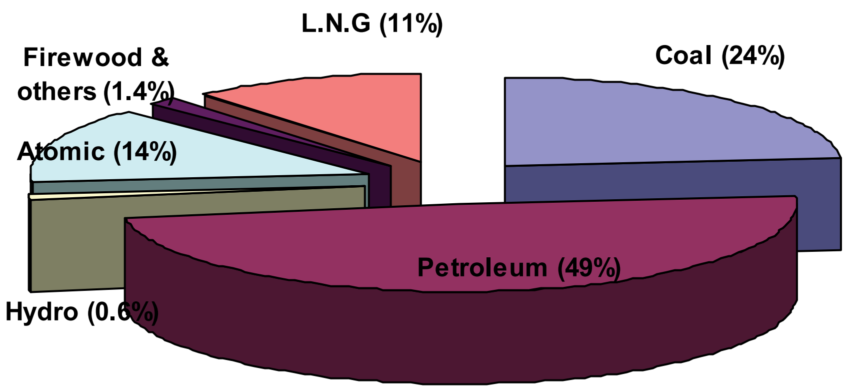

Figure 3-4 Primary energy consumption in Korea

Korea, the world's fourth-largest oil buyer, relies on imports for crude oil. Korea imports 97 percent of its energy. Due to higher international crude oil prices, importing energy has become a heavier burden. In addition, crude oil is being exhausted globally, and if the Kyoto Protocol to the Framework Convention on Climate Change takes effect, it will become more difficult to use fossil fuel.

The growing importance of securing sufficient energy has prompted the Korean government to reinforce its efforts in exploring stable, cost-efficient and durable energy resources. As a part of those efforts, the Korean government is seeking to expand the percentage of electricity generated with renewable sources, such as water power, to 13.9 percent. But this is not realistic. Currently, only 2.1 percent of our electricity comes from such sources. What's more, Korea's geography is unsuitable for generating power with water or wind.

The Korean government, dependent on the importation of 97% of its total energy demand due to a shortage of domestic natural resources, has also extended nuclear energy development as a reliable alternative energy source, especially after experiencing the oil shocks of the 1970s. Korea overcomes chronic power shortage through the expansion of its nuclear energy program and improvements in nuclear energy operations. Nuclear energy has played a key role in the economic development of the country since the 1980s by securing long term stability in power supply, demand, and electricity tariffs in Korea .

3.4 Transportation

Mobile sources pollute the air through combustion and fuel evaporation. These emissions contribute greatly to air pollution nationwide and are the primary cause of air pollution in many urban areas.

Rapid economic growth and increase in personal income have led to a sharp growth in the demand for transportation. The number of cars has increased from 127,000 in 1970 to 12,694,000 in 2001, recording a 100-fold growth in thirty years. Among cars that are used for various purposes (private, official or business), the increase rate of private passenger cars recorded the highest. The number of privately owned cars increased at a moderate pace from 61,000 in 1970 to 249,000 in 1980. After 1985, however, the number rapidly increased to 8,889,000 by 2001. The number of people per car was 531 in 1970, 153 in 1980, 21 in 1990 and under 6 in 2001. The number of motor vehicles in Korea totaled 14 million in 2002. Among them, 94.5% was private motor vehicles (Figure 3-5).

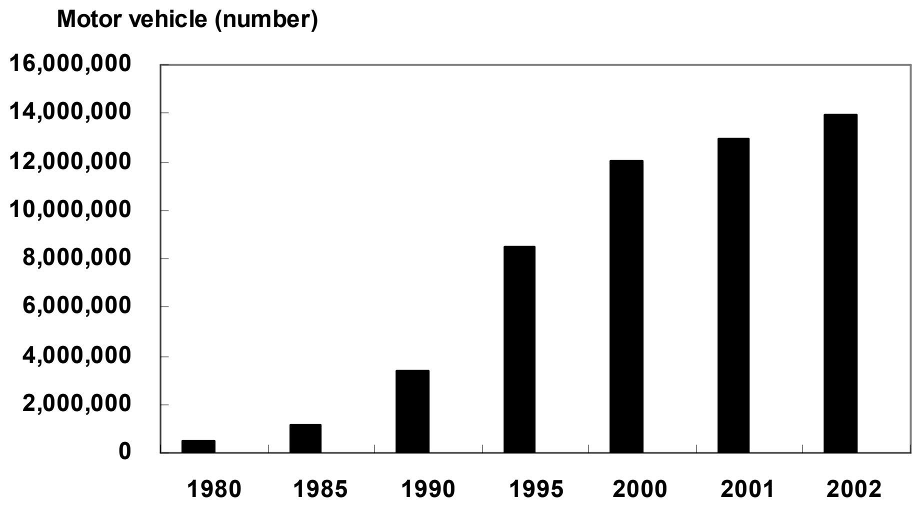

Figure 3-5 Number of registered motor vehicles

The number of passengers utilizing Korea’s transportation systems shows a rapid increase in the use of subways and domestic aviation, moderate increase in the use of railways and roads and none in aviation. The high increase in the use of domestic aviation is a phenomenon characteristic of the high increase in national income.

The characteristics of Korea's freight transportation can be summarized as high increase in domestic shipping, or aviation, moderate increase in public roads and none in railways.

4. National Monitoring and Research Activities Related to Atmospheric Deposition of Contaminants

4.1. National Programs

Ministry of Environment (MOE) and local governments are responsible for the air quality monitoring in Korea. Ten automatic air pollution monitoring networks monitor atmospheric pollutants in 2002 (Table 4-1); a local air monitoring network (164 sites), a road side monitoring network (17 sites), an acid rain monitoring network (28 sites), a national background monitoring network (5 sites), a local background monitoring network (11 sites), an atmospheric heavy metal monitoring network (40 sites), an hazardous atmospheric monitoring network (16 sites), photochemical pollutants monitoring network (15 sites), a visibility monitoring network (2 sites), and a global air quality monitoring network (1 site). The automatic monitoring sites are mainly located in major cities and industrial complexes. As of the end of 2002, there are a total of 309 monitoring sites in 71 cities or provinces. MOE is responsible for the operation of 73 sites in 29 cities or provinces and local governments for the remaining 236 sites in 48 cities or provinces. Monitoring data collected at these sites are electronically transmitted via a telemetry monitoring system (TMS) to MOE and local Environmental Offices (Figure 4-1).

Table 4-1 Air quality monitoring stations and monitoring items in Korea

Network	Number of sites			Monitoring items	Frequency
	Total	MOE	Local government		
Local air monitoring	174 (57 cities, provinces)	63 (32 cities, provinces)	98 (33 cities)	SO_2, NO_x, O_3, CO, PM_{10}, Wind speed, Wind direction, Temp., Relative humidity	Continuous /1hr
Road side monitoring	17 (7 cities)	1 (3 cities)	16 (7 cities)	SO_2, NO_x, O_3, CO, PM_{10}, Wind speed and direction, Temp.	Continuous /1hr
Acid rain monitoring	28 (28 cities, provinces)	28 (28 cities, provinces)	-	pH, Precipitation, Conductivity, Ion-concentration	Rainy day
National background monitoring	5 (5 cities, provinces)	5 (5 cities, provinces)	-	SO_2, NO_x, O_3, CO, PM_{10}, Wind speed and direction, Temp.	Continuous /1hr
Local background monitoring	11 (9 cities, provinces)	8 (8 cities, provinces)	3 (1 city)	SO_2, NO_x, O_3, CO, PM_{10}, Wind speed and direction, Temp.	Continuous /1hr
Air heavy metal monitoring	40 (12 cities)	-	40 (12 cities)	Pb, Cd, Cr, Cu, Mn, Fe, Ni	Five times/month
Hazardous atmospheric network	16 (11 cities)	16 (11 cities)	-	VOCs (12 items), PAHs (7 items)	Four times/year
Photochemical pollutants	15 (7 cities, provinces)	8 (7 cities, provinces)	7 (1 city)	VOCs (56 items)	Continuous/ 1hr
Visibility	2 (2 cities)	-	2 (2 cities)	Visibility	Continuous/ 1hr
Global air quality	1 (1 province)	1 (1 province)	-	CO_2, CH_4, N_2O (CFCs)	Continuous/ 1hr
Total	307 (71 cities, provinces)	73 (29 cities, provinces)	236 (48 cities, provinces)		

A monitoring station measures the density of six air pollutants of dust, SO_2, NO_2, VOCs, CO, and O_3 . National Institute Environmental Research (NIER) is responsible for the control of database on the all automatic air pollution monitoring data reported.

The real time air quality is measured at 16 sites in 10 major cities. Monitoring devices installed inside smokestacks of many factories measure concentrations of SO_x.

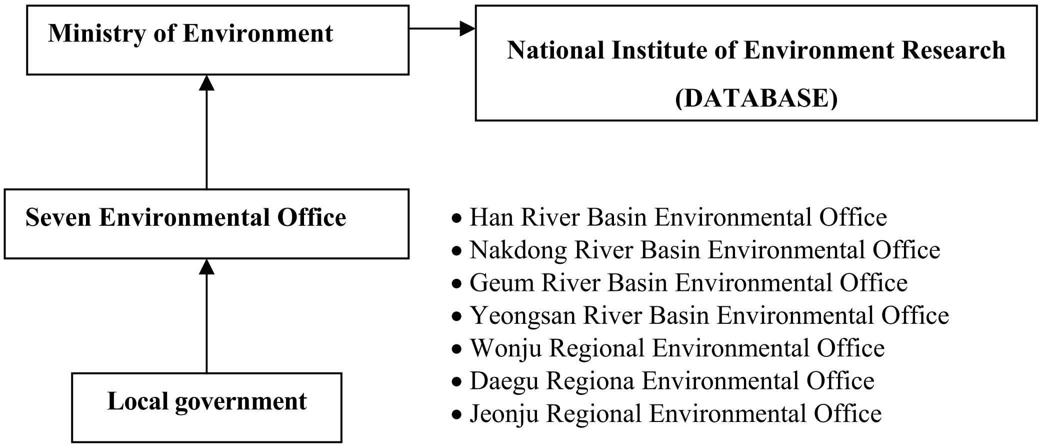

Figure 4-1 The flow chart on the reporting of air quality monitoring results

NO_x, NH_3, HCl, HF, and CO in every five minutes and relay the data to MOE and local Environmental Offices. A fleet of automobiles equipped with air pollution monitoring devices covers heavily polluted areas or areas in which stationary units have not yet been installed. They are also sent to areas where continuous monitoring is required, such as roadsides with heavy traffic.

Real-time monitoring data are provided on the web site of NIER (http://www.nier.go.kr) for general parameters, and publishes annual reports for air quality. Table 4-2 shows the air quality guidelines for the individual component of Korea.

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Table 4-2 Air quality guidelines in Korea

Category	Guidelines
SO_2	- yearly average <0.02 ppm - 24-hour average < 0.05 ppm - 1-hour average < 0.15 ppm
CO (revised 1995.1.1)	- 8-hour average < 9 ppm - 1-hour average < 25 ppm
NO_2	- yearly average < 0.05 ppm - 24-hour average < 0.08 ppm - 1-hour average < 0.15 ppm
PM-10 (revised 1995.1.1)	- yearly average < 70 μg/m³ - 24-hour average < 150 μg/m³
O_3	- 8-hour average < 0.06 ppm - 1-hour average < 0.1 ppm
Pb	- yearly average < 0.5 μg/m³

4.2 Air Quality Monitoring Results

1) Sulfide oxygen (SO_2)

In general, the contamination of SO_2 in the air of Korea has showed the decreasing trend since 1990s as shown in Figure 4-2. This was due to air pollution reduction policies of the government such as the use of clean fuels, expanded supply of low sulfur fuels, and introduction of low-emission vehicles. In particular, the level of SO_2 in Seoul, which is a specially managed site for air pollution, was 0.094 ppm in 1980, 0.062 ppm in 1990, 0.019 ppm in 1994, and 0.006 ppm in 2002. The yearly average of all cities was between 0.004 to 0.010ppm, showing relatively good quality.

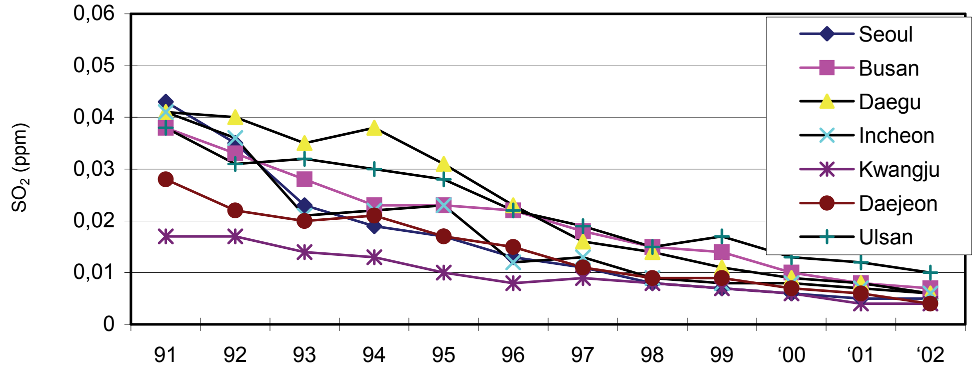

Figure 4-2 Air quality trends of SO_2 in major cities of Korea for the past 12 years

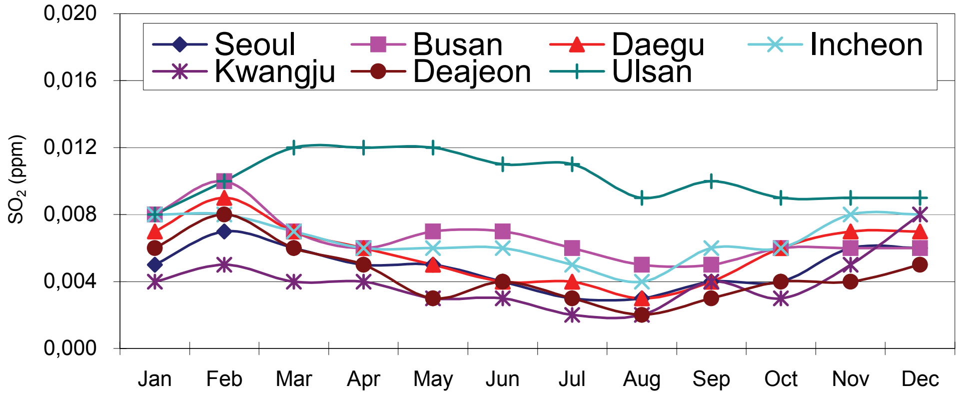

Figure 4-3 Monthly variation of SO_2 in major cities of Korea in 2002

Figure 4-3 shows the monthly variation of SO_2 in major cities in Korea for the year 2002. As this figure shows, the SO_2 concentration is high in winter and low in summer, showing the typical trend of primary pollutants. The high in winter is owing to the stratification of atmosphere and low in summer is owing to the rain. However, the city of Ulsan shows unusual trend of SO_2 distribution. This may due to the fact that the monitoring facility is close to industrial area in the case of Ulsan. The figure shows that the city of Ulsan and Incheon are relatively high SO_2 concentration than other cities.

2) Nitrogen Oxygen (NO_2)

The levels of NO_2 in the air of Korea did not show any improvement over the years. This trend is observed possibly by the increasing number of automobiles and vehicles. Based on the Figure 4-4, the NO_2 concentration is proportional to the number of of automobiles. As we can see in this figure, Seoul, which has the most in number of automobiles, shows the highest NO_2 concentration of all the cities. Seoul showed the yearly average of 0.036 ppm in 2002 and 0.019 ppm for Ulsan, which showed the lowest concentration. Ulsan has the least automobiles among the cities shown.

The monthly variation of NO_2 concentration in major cities shows the similar trend as SO_2 as shown in Figure 4-5.

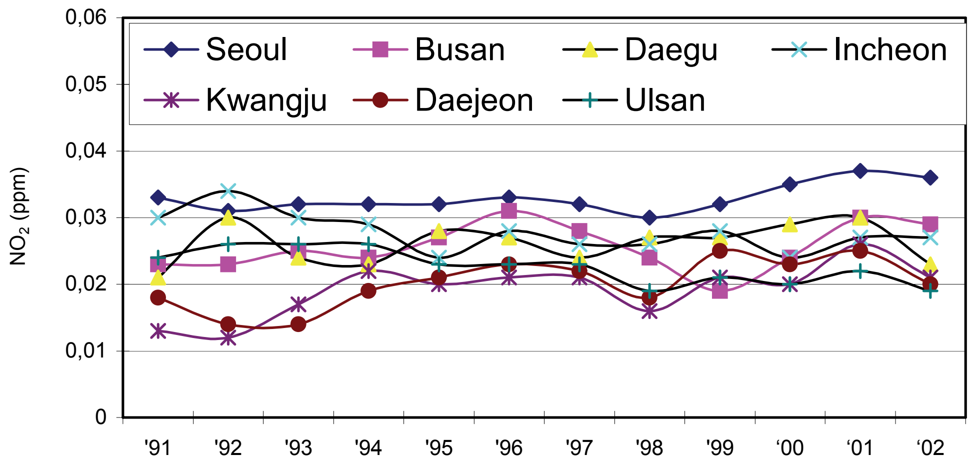

Figure 4-4 Air quality trends of NO_2 in major cities of Korea for the past 12 years

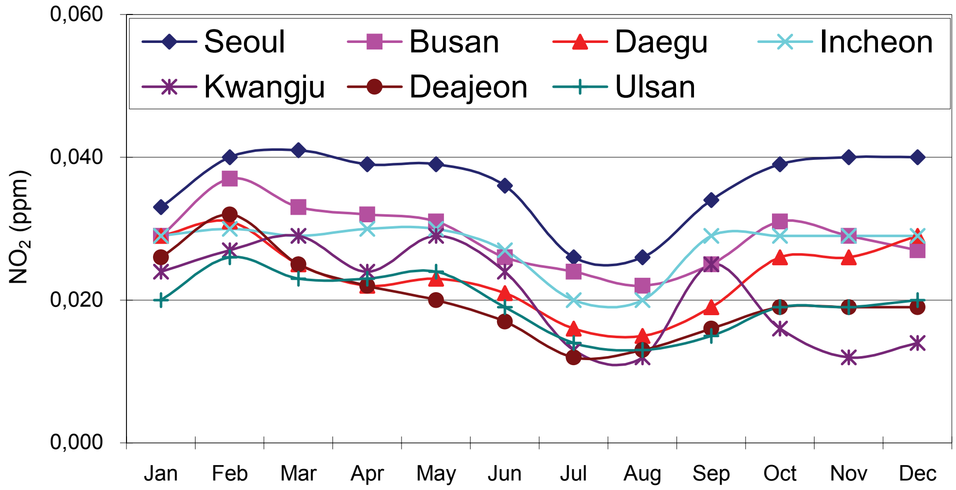

Figure 4-5 Monthly variation of NO_2 in major cities of Korea in 2002

3) Dust (PM_{10})

Dust may combine with sulfurous acid gases in air to cause respiratory diseases and visibility reduction. From 1984, total suspended particles (TSP) levels were measured in major cities in Korea. However, since 1995, TSP measurement has begun to replace with PM_{10} measurement due to its adverse effect on human health.

As shown in Figure 4-6, PM_{10} measurement has short history. To examine the long time trend of concentration, the measurement data should be accumulated for some time. Based on the available data, PM_{10} concentration is a little increasing in most major cities in 2002 except for Kwangju.

In the case of Seoul, PM_{10} levels posted 78 $\mu g/m^3$ in 1995, 68 $\mu g/m^3$ in 1997, 66 $\mu g/m^3$ in 1999, 71 $\mu g/m^3$ in 2001, and 76 $\mu g/m^3$ in 2002. There are not much reduction was shown due to vehicle gas emissions and frequent occurrences of Asian dust (yellow sand) event.

The seasonal variation in PM_{10} concentration showed the low concentration in summer due to rain deposition as shown in Figure 4-7.

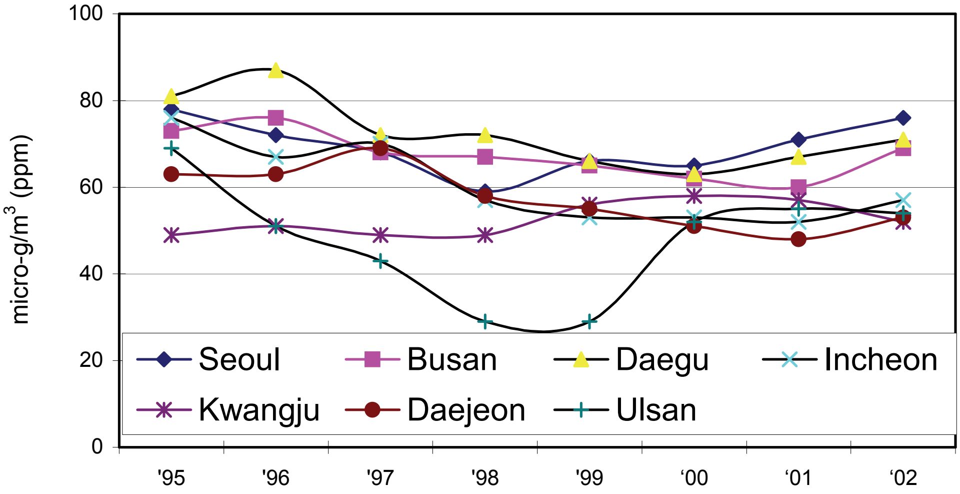

Figure 4-6 Air quality trends of PM_{10} in major cities of Korea for the past 8 years

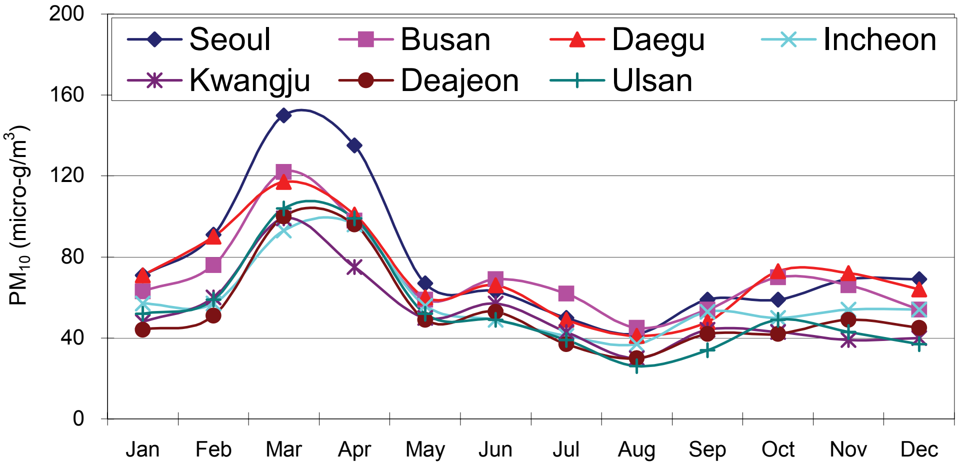

Figure 4-7 Monthly variation of PM_{10} in major cities of Korea in 2002

4) Ozone (O_3)

Ozone (O_3) is an undesirable pollutant in the atmosphere. It is a toxic pollutant and a mild overdose causes labored breathing, a feeling of chest pressure, cough and irritated eyes. The levels of O_3 has been increasing for all major cities of Korea over the past years, however, the levels of O_3 has kept similar since 1997 as shown in Figure 4-8 due to heavy regulations and environmental policies regarding O_3 pollution by the Korean government. The increasing O_3

level in Korea is associated with other air pollutants such as NO_2, CO and VOCs because O_3 was derived from the photochemical reactions of these pollutants in the atmosphere.

The seasonal variation of O_3 concentration revealed that the spring is the highest among other seasons as shown in Figure 4-9. Busan reports relatively high concentration due to relatively warmer than other cities. The production of O_3 is affected by rain as can be seen in the figure.

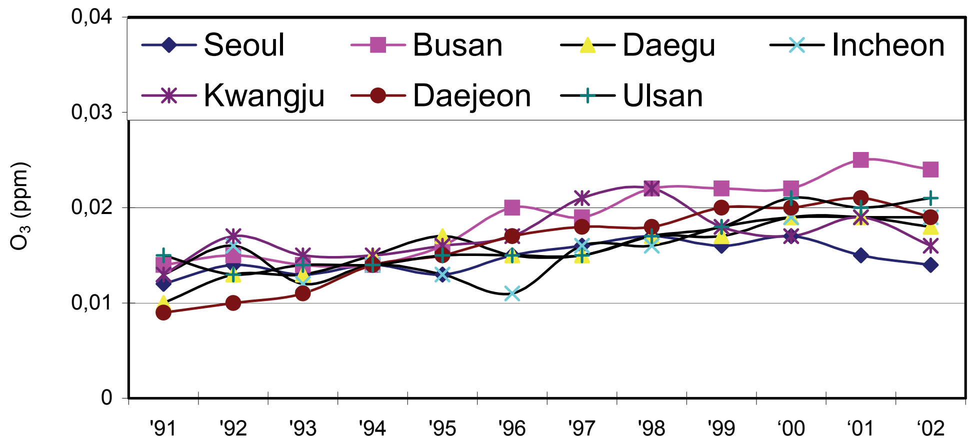

Figure 4-8 Air quality trends of ozone (O_3) in major cities of Korea for the past 12 years

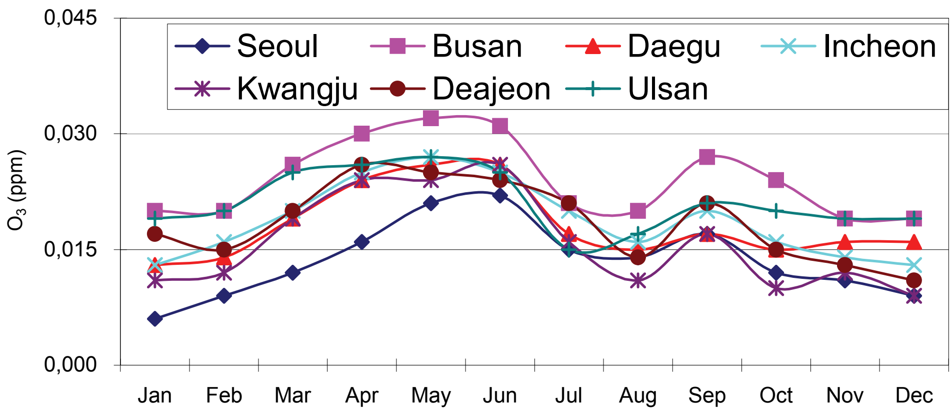

Figure 4-9 Monthly variation of O_3 in major cities of Korea in 2002

5) Carbon Mono-oxide (CO)

The most obvious factor contributing to increased atmospheric carbon mono-oxide (CO) is consumption of carbon-containing fossil fuels. In general, the levels of CO in the air of Korea showed the decreasing trend since 1990s as shown in Figure 4-10. This is due to the government effort including the use of clean fuels and the development of combustion processes for various coal based fuels.

Monthly variation of CO concentration showed the typical primary pollutant pattern (Figure 4-11). Except for the rainy season during the summer, there is not much variation in CO concentration in major cities. Average concentration was from 0.6 ~ 0.9 ppm in 2002.

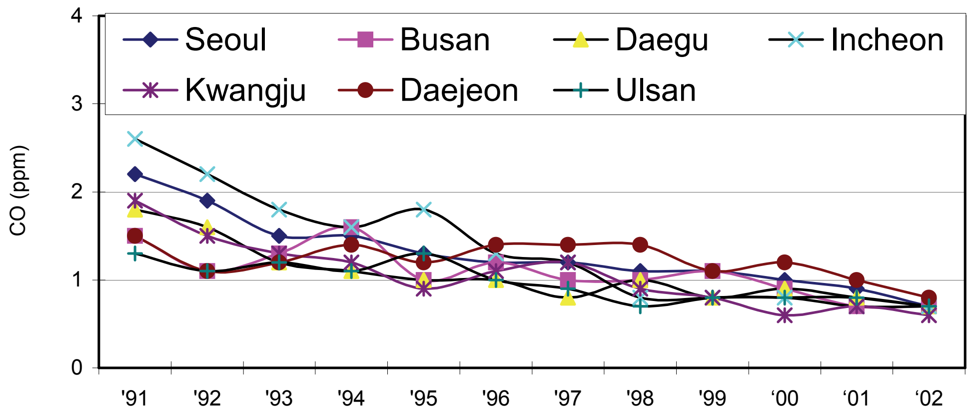

Figure 4-10 Air quality trends of CO in major cities of Korea for the past 12 years

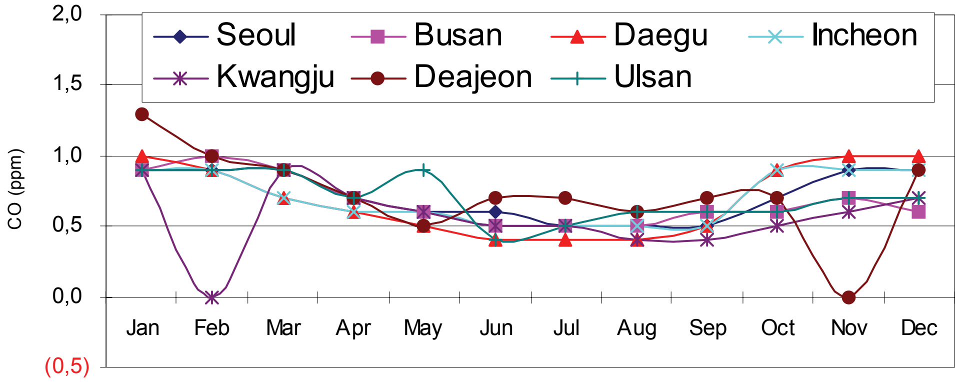

Figure 4-11 Monthly variation of CO in major cities of Korea in 2002

6) Acid rain

Emissions of gas phase pollutants from industrial operations and fossil fuel combustion is the major sources of acid rain. Acid rain with long-range transport has been encountered not only in source areas but also in areas far from source. Figure 4-13 shows the acid rain deposition monitoring sites in Korea. There are 28 monitoring sites currently operating. Among these monitoring sites, acid rain depositions in 7 major cities were presented in Figure 18. The pH trend in Korea over the past years showed a large fluctuation as shown in Figure 4-14. As can be seen in this figure, strong acid rain was not measured in all stations.

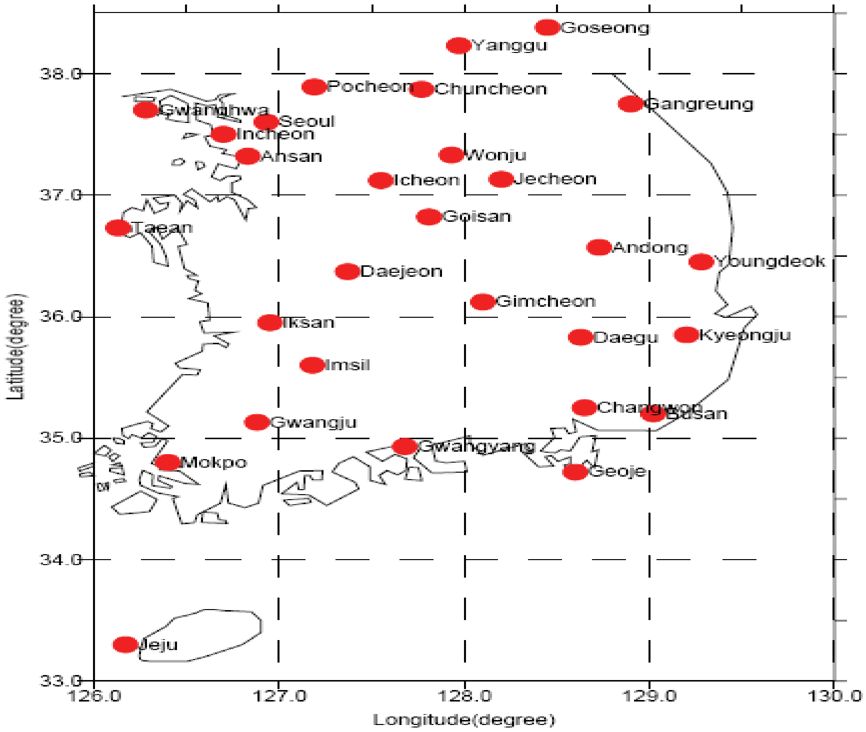

Figure 4-13 Acid rain deposition monitoring sites in Korea

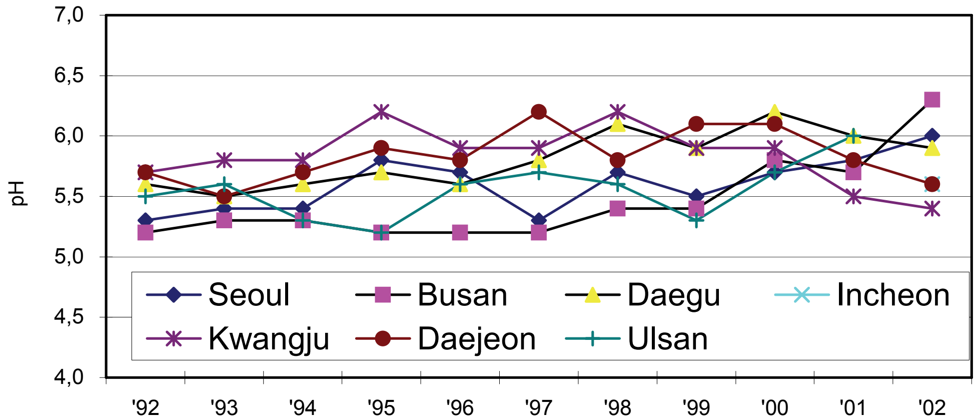

Figure 4-14 Yearly average trend of acid rain in major cities of Korea

7) Yellow sand dust

Yellow sand dust originated from P.R. China is very serious problem in Korea due to its impact on health and aesthetic conditions. Table 4-3 shows the trend in yellow sand dust appearance for the last 13 years. Although it is hard to tell whether it is increasing or not, the duration is clearly increasing. Thus, Korea puts significant efforts to reduce the yellow sand dust internally and internationally. Joint project between China and Korea is on going for the reduction of trans-boundary environmental issues.

Figure 4-15 presents the comparison of heavy metal concentrations in the yellow sand and non-yellow sand period in Seoul, Korea. In this figure, heavy metal concentrations are clearly increasing during the yellow sand dust period. Thus, the yellow sand dust can impose the high risk of health problem.

Table 4-3 Yearly yellows sand dust observation in Seoul

Year	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02
Duration(days)	3	11	8	14	0	13	1	1	13	6	10	27	16
Frequency	1	3	3	5	0	4	1	1	3	3	6	7	7

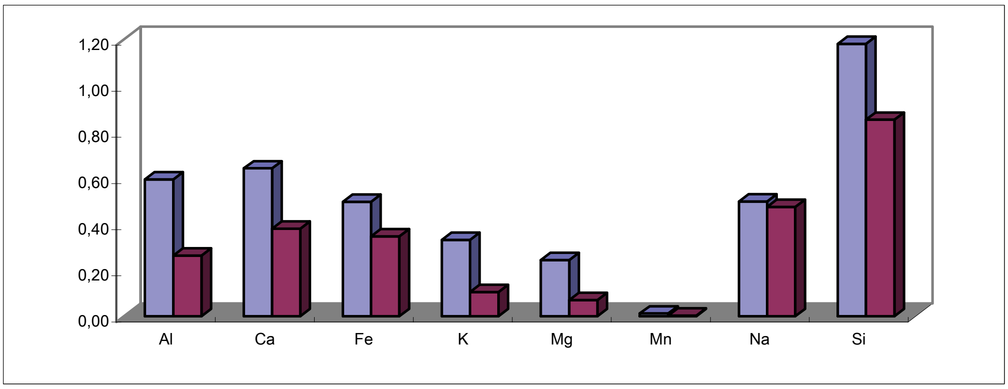

Figure 4-15 Comparison of heavy metal concentrations in the yellow sand and non-yellow sand dust period in Seoul, Korea

8) Heavy metals

The heavy metals in atmosphere including lead, cadmium, chromium, copper, manganese, iron, and nickel, are regularly monitored for their concentration. The monitoring results showed that the trend is almost identical to their previous results. Table 4-4 shows the result of heavy metal measurements in major cities in Korea in 2002. As shown in this table, the heavy metal concentrations were below the limit set by Ministry of Environment.

Table 4-4 The heavy metal concentrations in atmosphere in major cities in Korea (2002)

(Unit : μg/m^3)

City	Pb	Cd	Cr	Cu	Mn	Fe	Ni
Seoul	0.0932	0.0036	0.0252	0.2660	0.0629	1.6297	0.1342
Busan	0.0751	0.0025	0.0098	0.2491	0.0698	1.8372	0.0118
Daegu	0.0698	0.0029	0.0168	0.4005	0.0675	1.9523	0.0179
Incheon	0.1059	0.0071	0.0130	0.2273	0.1145	2.8999	0.0194
Kwangju	0.0331	0.0016	0.0130	0.1572	0.0403	0.9735	0.0072
Daejeon	0.0492	0.0009	0.0020	0.0434	0.0307	0.7141	0.0097
Ulsan	0.0634	0.0052	0.0099	0.1455	0.0568	1.3254	0.0152

4.3 Methodologies/Procedures

Korea adopted Type Approval System for the QA/QC of air quality measurement analyzers. Only approved analyzers can be used as official ambient quality measurement analyzers. Agencies, which are legally licensed by the government can implement the periodic precision test once a year. MOE regularly updates the information on methodologies and equipments for the tests. Table 4-5 shows the analytical methods for each measurement parameters.

4.4 Research Activities

Many research activities on atmospheric deposition of pollutants except the regular national air quality monitoring are on going in Korea. The major research activities are conducted at the Advanced Environmental Monitoring Research Center (ADEMRC) in Gwangju Institute of Science and Technology (GIST). The center is currently funded by the Ministry of Science and Technology (MOST) for $1million/year for 9 years. The center is actively conducting the basic research on air quality monitoring technology, remote sensing technology, manpower producing, and international cooperation.

Table 4-5 Measurement parameters and analytical methods for air quality monitoring

Parameters		Analytical methods	Monitoring network
SO_2		Pulse U.V. fluorescence method	Local network Road side National background Local background
CO		Non-dispersive infrared method	
NO_2		Chemiluminiscent method	
O_3		U.V. photometric method	
Dust	TSP	Beta-ray absorption method	
	PM_{10}	Beta-ray absorption method	
Pb, Cd, Cr, Cu, Mn, Fe, Ni (Dry deposition) Al, Si, Ca, Mg (Yellow sand)		Atomic Absorption Spectrometry, ICP-MS, High volume air sampler	Heavy metal
PH conductivity Cl, NO_3, SO_4, HH_4, pH Na, K, Ca, Mg		Glass electrode Conductivity cell Ion chromatography Ion chromatography, Indophenol Ion chromatography, Atomic Absorption Spectrometry	Acid rain

Another active research field is yellow sand dust research. Ministry of Environment set up $1 million/year for 5 year to tackle the prevention of yellow sand dust. Also, UNEP and ESCAP provided the GEF fund for $1 million for joint project with China, Japan, and Mongolia. The Ministry of Maritime Affairs and Fisheries (MOMAF) launched the research project to search the effect of yellow sand dust on the marine ecosystem. The project is sponsored by MOMAF for $300,000/year for 6 years.

Many basic researches regarding atmospheric deposition are funded by Korea Science and Engineering Foundation (KOSEF), which is a subsidiary of Ministry of Science and Technology (MOST). From the year 2000, 12 individual research projects were funded for the total of $476,000 and 10 medium size (2~3 professors involved) research projects were funded with the total of $2 million.

4.5 Training Activities (related to atmospheric deposition)

Most of the training activities are incorporated with the research projects such as ADEMRC. The center hosted training courses and field experiments. Up to now, center produced more than 100 skilled trainees.

5. Present Situation

As shown in the monitoring results of section 4.1.1, the current air quality of Korea is very stable compared to the previous years. Also, the air quality is slowly improving. This may due to the strong air quality regulations, systematic monitoring, NGO's participation in air quality campaign, and governmental efforts. Korea is very serious about the air quality because of limited size of the territory.

With the activation of the Kyoto protocol of United Nations Framework Convention on Climate Change (UNFCCC), Korea tries hard to innovate the energy consumption and generation. Korea is one of most energy consuming countries in the world. This means that Korea is very much dependant on the imported energy source, especially petroleum. To overcome the energy crisis, which may be presented by the Kyoto protocol, Korea launched the strategic action plan for the UNFCCC. These efforts may result in the reduction of air quality deteriorating agents due to the clean energy development and sustainable consumption of energy sources in the future.

6. Recommendations for Future Regional Activities and Priority

Trans-boundary movement of air pollutants is emerging as a critical issue in the world including the North-west Asia (in particular China, Korea and Japan) densely populated and highly industrialized. Therefore, the strategies on environmental cooperation to control the air pollution within the region should be developed.

During recent years, much emphasis has been placed on the development of air pollution control technologies. Individual reactions to air pollutants depend upon the type of pollutant, how much of the pollutant is present, the degree of exposure, and the kinds and levels of individual activity.

The future regional activities and priority are as follows:

- Construction of regional database on the scientific data obtained in the national air pollution monitoring and information on the national air pollution control policy
- Establishment of national and regional strategies to resolve capacity cap among countries (QA/QC through inter-calibration, Capacity building and Training, Determination of monitoring parameters)
- Construction of regional air monitoring network system

7. Conclusion

Korea has been one of the fastest growing economies in the world since the 1960s. The high growth rate in economy has resulted in the accelerated industrialization and the urbanization. The seven largest cities (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon and Ulsan) in Korea account for almost half the population. The vehicles emissions were the primary cause of air pollution in many urban areas. The total number of motor vehicles in Korea was 14 millions by 2002.

The MOE and local government have carried out 10 air pollution monitorings with different objectives. The monitoring results for almost 12 years indicated that the Korean environmental policies to improve the air quality has contributed the reducing of the levels of SO_2 and CO. However, NO_2 and O_3 were still remained to resolve in present and future.

Recently, transboundary pollution through air has been highlighted as a major problem. Therefore, the cooperation among countries is necessary to preserve the marine and coastal environment in NOWPAP region. We should share the data and information with good qualities. For this purpose, we will have to prepare the regional air monitoring strategies.

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Annex. National Polices and Legislations

1.1 Enforcement of the Total Maximum Loading System of Pollutants

Korea sets up the emission allowance standard to control vehicle-generated air pollutants. If regulations address only the concentration of pollutants, however, strengthened emission allowance standards would not prove effective in improving air quality because the total volume of pollutants would continue to increase. For this reason a regional total maximum loading system of pollutants is being introduced in Korea. The system plans to cut 50-70% of the pollutant emission volume from factories, power plants and vehicles by 2012. In combination with the total maximum loading system, the emission trading system will be adopted and operated so as to run the total emission volume system in a cost-effective way.

1.1.1 Preparation for Low-emission Vehicle Adoption

Roughly 80% of the pollutants in Seoul are generated by vehicles so implementing a shringent vehicle emission gas reduction measure is key to improving the air quality. First of all, introduction of low-emission vehicles will be made mandatory in the city. Buses and garbage trucks will also be replaced with CNG or LPG buses and trucks. In addition, freight trucks and other diesel-powered vehicles will have to attach particulate filters and those that do not meet the emission standard will be banned from operation. Furthermore, businesses that operate several vehicles are required to run low-emission vehicles like natural gas vehicles and electric hybrid cars. Economic incentives, such as revising the vehicle tax system, will also be utilized. The vehicles that do not satisfy the emission standards will have their registrations cancelled and be restricted from running.

1.2 Enforcement of Energy and Fuel Policies to Improve Air Quality

Taking into account its air pollution reduction effect, the energy pricing system will be augmented to be more environment-friendly. The new tax system will be reorganized so that prices of LNG, heavy oil, kerosene, coal and other energy sources reflected air pollution and other environmental costs

1.3 Korean Environmental Conservation and International Cooperation

1.3.1 Promotion of Fuel Policies

As part of major policies to reduce air pollution, Korea administers prevention-oriented fuel use regulation system in tandem with an emission allowance standard system for businesses that generate air pollutants. The fuel regulation policies currently in effect include the supply of low-sulfur fuel, restriction on the use of solid fuel, and compulsory use of clean fuel. More recently, the quality standard of vehicle fuels has been tightened.

The sulfur content standard of fuel oils has been tightened since 1981 to reduce the concentration of sulfur dioxide and particulate matter in Seoul and its vicinities. As of the end of February 2002, diesel oil with less than 0.1% sulfur content is being supplied and used nationwide. It is also worth noting that seven cities, including Seoul and Busan, distribute and use 0.3% low-sulfur heavy oil, while 52 provincial cities use 0.5% low-sulfur heavy oil, and the rest approximately 1.0% low-sulfur heavy oil.

Currently 7 major cities, including Seoul and Busan, and 13 air pollution regulation zones are designated as the regions not allowed to use such solid fuels as coal, cokes, wood, charcoal and combustible wastes.

The policy obligating the use of clean fuel has been in force since September 1988 for specific areas and facilities that the Minister of Environment proclaimed from the list of areas that may exceed or have exceeded the environmental standards.

1.3.2 Strengthening of the Emission Allowance Standards

To manage air pollutants emitted from business establishments, emission allowance standards for 18 types of gas substance, 9 types of particle substance and 8 noxious substance types were established out of the total of 52 pollutants specified in the Air Quality Preservation Act. These standards are classified by manufacturing facilities, processes, or fuel types.

In addition, a "rigid emission allowance standard" is applied to emission facilities in the Special Measures Zone for Air Pollution Regulation, such as industrial complexes with high air pollution. Also a "special emission allowance standard" is applied to newly establish pollutant-emitting facilities. Currently the "rigid emission allowance standard" is being enforced in Ulsan, Mipo and Onsan Special Measures Zones, and the "special emission allowance standard" in Yeocheon Special Measures Zone.

The emission allowance standards for vehicles are gradually being reinforced to reduce the pollutant emissions. The current allowance standards for vehicles powered by gasoline and diesel fuel are at the level of EURO II of the European Union or TLEV of the U.S. However, they will be strengthened to the EURO III and TLEV levels in 2002 and to the EURO IV and ULEV standards by 2006.

1.3.3 Use of Economic Incentives

The government offers a variety of economic incentives to minimize the negative side effects of direct regulation on air quality management. Cases in point are the Emission Charge System and the Environmental Improvement Charge System.

In order to prevent air quality degradation from pollutants exceeding the permissible standards and to enforce observance of emission allowance standards, financial charges are levied in proportion to the emission level on businesses that emit air pollutants; the Emission Charge System has been implemented since 1983 to induce businesses to voluntarily lower the pollutant emission

The purpose of the Environmental Improvement Charge System is to induce businesses to cut down on pollution and to secure funding for environmental improvement by making polluters in distribution and retail businesses bear the cost of treating pollutants in accordance with the "Polluter-Pays Principle."

The environmental improvement charge is applied to the owners of distribution and retail facilities larger than 160m² in area and diesel-powered vehicles. The charges levied on diesel vehicles are determined by emission volume, age of vehicle and registration area.

1.3.4 Supply of CNG Buses

Large diesel-powered vehicles like buses and trucks are the main culprits of air pollution in large cities. Large diesel-powered vehicles account for only 4% of the total vehicles but the pollutants emitted by these vehicles take up 47% of the total pollutants. To ameliorate this situation, CNG buses with no exhaust fumes and 70% less ozone pollutant emission have been supplied starting 1998.

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National Report of Russian Federation on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

Table of Contents

National Report of Russian Federation on Atmospheric Deposition of Contaminants into the Marine and Coastal Environment in NOWPAP Region

1. Executive Summary

This reports gives an overview of national activities of the Russian Federation related to atmospheric deposition of contaminants in the NOWPAP region. In Primorsky Kray (part of Russia which belongs to the NOWPAP region), responsibility for routine monitoring of urban air quality and atmospheric deposition of contaminants belongs to the Primorsky Kray Territorial Office on Hydrometeorology and Environmental Monitoring. Research activities on atmospheric deposition were carried out by several scientific institutions: Pacific Geographical Institute, Pacific Oceanological Institute, Far Eastern Regional Hydrometeorological Research Institute.

From the observation data at several Primorsky Kray stations in 2002, the following values of annual wet atmospheric deposition were estimated (g/m^2): **Cl** 0.7-2.0, **SO_4** 1.6-6.2, **NO_3** 0.3-0.7, **NH_4** 0.4-1.0, **Na** 0.3-0.8, **K** 0.2-0.6, **Ca** 0.4-2.1, **Mg** 0.03-0.52, **Zn** 0.07-0.17. These values are comparable with the similar data for the Yellow Sea, North Sea and some coastal areas of the US.

Research activities implemented in the Pacific Geographical Institute, Far East Branch of the Russian Academy of Sciences, allowed to reveal details of atmospheric deposition of nutrients and trace metals precipitation in the Russian Far East (in particular, in the Sikhote-Alin Biosphere Reserve). Analysis of the trajectories of air masses coming to the Sikhote-Alin Biosphere Reserve has shown that about 75% of annual pollution load is being transported from the west, southwest and northwest, i.e. from People's Republic of China. From the other hand, the most polluted air masses are coming from Japan and from Korean peninsula.

The studies conducted by specialists from the Pacific Oceanological Institute, Far East Branch of the Russian Academy of Sciences, have shown the role of atmospheric deposition of trace metals comparing with river and direct inputs. For the small and semi-enclosed Amursky bay (total area 1 10^9 m^2), the main source of contaminants is wastewaters. For the more open and large Ussuriysky bay (total area 1.8 10^9 m^2), atmospheric deposition supplies more than 40% of Zn, Cd and Mn. Therefore, for the whole NOWPAP region atmospheric deposition of contaminants would be the major source of trace metals and some other contaminants. This is true also for other areas of the World Ocean (see, e.g., Windom, 1981; GESAMP, 1985; Hong et al., 1998).

2. Introduction

2.1 General Information

The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) was adopted at the First Intergovernmental Meeting (Seoul, 14 September 1994) by representatives of four States: Japan, People's Republic of China, Republic of Korea and Russian Federation. The geographical scope for this Action Plan is the marine environment and coastal zones from about 121^{o}E to 143^{o}E and from approximately 33^{o}N to 52^{o}N, without prejudice to the sovereign right of any State (UNEP, 1997).

One of five priority projects identified at the First Intergovernmental Meeting is NOWPAP/3, “Establishment of a collaborative, regional monitoring programme”. To oversee the implementation of NOWPAP/3, two Regional Activity Centers (RACs) were established in Toyama, Japan, and Vladivostok, Russia. Under the Pollution Monitoring Regional activity Center (POMRAC) in Vladivostok, two Working Groups were established: WG1 “Atmospheric Deposition of Contaminants” and WG2 “River and Direct Inputs of

Contaminants". Members of both working groups are going to prepare the national reports and, later, regional overviews on these important environmental issues mentioned above.

The goal of this report is to give an overview of national activities of the Russian Federation related to atmospheric deposition of contaminants in the NOWPAP region. Federal Service of Russia on Hydrometeorology and Environmental Monitoring (ROSHYDROMET) is responsible for routine monitoring. In Primorsky Kray, monitoring of contamination of air, inland waters, soil and marine environment is implemented by Primorsky Territorial Office on Hydrometeorology and Environmental Monitoring. Environmental standards (maximum permissible concentrations, emissions, discharges) are being established and enforced by the Ministry of Natural Resources. Research activities are carried out by Institutes of the Far East Branch of the Russian Academy of Sciences (FEBRAS) and other scientific organizations.

2.2 Climate Characteristics Related to Atmospheric Deposition

The Russian Far East (situated within the NOWPAP Region) is affected by the Asian monsoon. Therefore, prevailing winds in winter are from the north and in summer from the south respectively (see Figure 2-1 for Peter the Great Bay as an example). The climate of the Russian Far East is also affected by typhoons in summer and autumn and by strong cold outbreaks from Siberia in winter.

The monthly air temperatures vary between -1.6 and 1.0°C in January and between 21.7 and 24.2°C in August.

The annual number of days with precipitation along the coast of Peter the Great Bay is between 100 and 115 days. The average precipitation in Vladivostok is 806 mm, maximum 1,276 mm. From 80 to 95% of annual precipitation occur during the period from April to October.

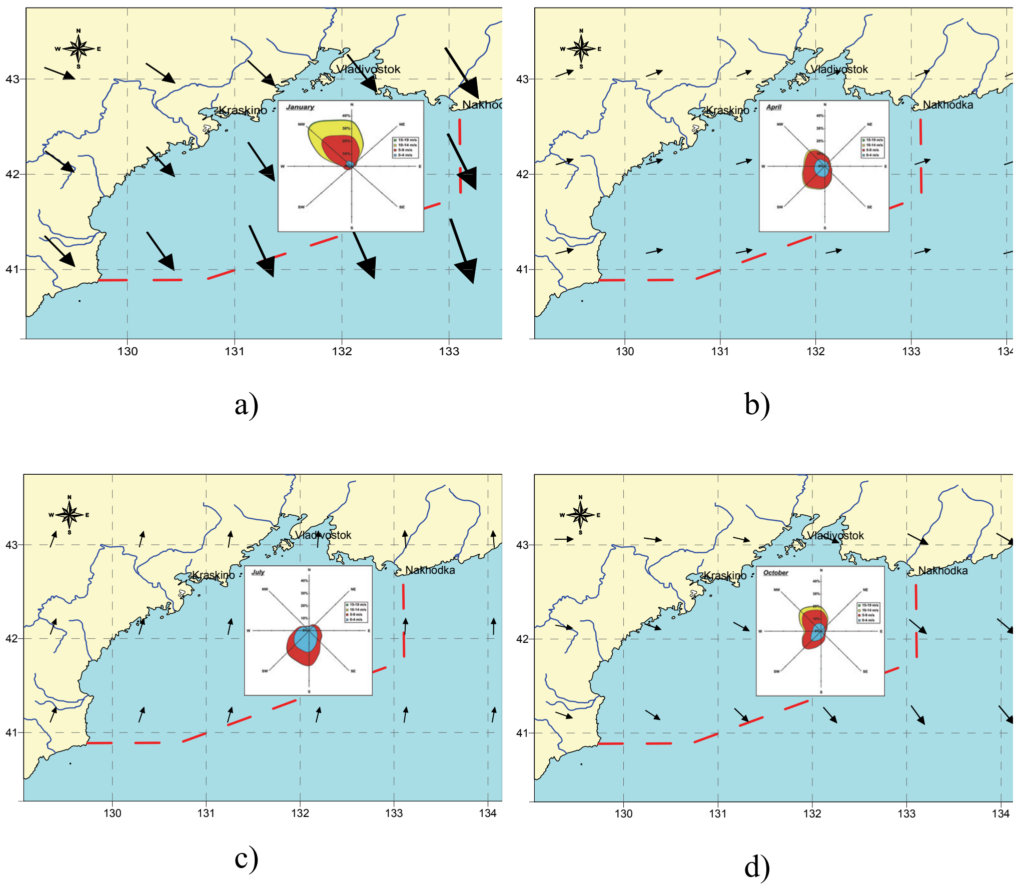


Figure 2-1 Monthly average wind fields and diagrams of wind velocity and direction (frequency of occurrence) for Peter the Great Bay:
a) January; b) April; c) July; d) October

3. Social and Economic Situation

3.1 Population

Population density in the Russian Far East (RFE) is very low (1.1 km^2) comparing to the Russia as a whole (8.5 km^2). The total population of the Russian Far East situated within the NOWPAP region (1.6 million people) consists of population of Primorsky Kray (1.2 million), Khabarovsky Kray (139,000) and Sakhalinskaya Oblast (217,000).

3.2 Economy

The Russian Far East generates about 6% of the national GDP of Russia. Table 3.1 shows some indicators of economic development.

Table 3-1 Some economic characteristics of the Russian coastal regions of NOWPAP sea area

Districts*	Industrial production (US$ million)	Agricultural production (US$ million)	Total production (US$ per capita)
1	9.4	4.5	369
2	404.8	87.2	639
3	243.4	26.3	981
4	61.6	11.8	1,244
5	50.8	4.3	1,093
6	54.9	2.9	783
7	215.6	18.1	1,984
Total	1,040.5	155.1	7,093

Note:*Districts - 1 – Khasansky district; 2 – Nadezhdinsky district plus Vladivostok and Artyom cities, 3 – Shkotovsky and Partizansky districts plus Nakhodka and Fokino cities, 4 – Lazovsky, Olginsky and Kavalerovsky districts, 5 – Dalnegorsky district, 6 -Terneisky and Sovgavansky districts, 7 – south-western districts of Sakhalin Island

3.3 Industry and Transport

Agriculture. The Russian Far East farming sector generates about 5% of Russia’s gross agricultural output. The input of individual RFE territories in agricultural production depends on different natural and climatic factors. Land area amounts to more than 600 million ha and is composed of three main types:

forested land (44%), reindeer pasture (30%) and barren land (22%). Farm land accounts for no more than 1% of the region's land resources. This proportion greatly varies from 10% in Primorye to 1.5% in Khabarovsky Kray and Sakhalin. RFE main agricultural area is its southern part encompassing more than 90% of arable land. More than 36% of arable land is occupied by forage crops. Natural conditions are suitable for growing grain (wheat, barley, oats, corn), vegetables, rice (in southern Primorye), which account for 35% of sown acreage.

Forestry. Forest is one of the principal natural resources in the Russian Far East and covers over 2/3 of this territory. The forest complex includes forestry, logging, woodworking and pulp-and-paper branches. Traditionally, timber processing in the Russian Far East falls behind the scope and dynamic of logging activities and the bulk of timber is exported in round logs. Although the proportion of processed timber was at 47% as recently as in 1990, in the years of economic reform it decreased by two or three times.

The statistical data testify that up to 1,400 fires occur during extreme fire seasons and the forest area affected by fire varies from 300,000 up to 2,000,000 ha and more. On the average 780 fires occur annually, and the average forest area burned is 190,000 ha. The long-term average of fire size is 325 ha/fire.

Fishery and aquaculture. Due to location between the temperate and subtropical zones, the fish fauna of Primorye is characterized by high species diversity (over 360 fish species, including commercially important cod, pollack, salmon, flatfish, sardine, mackerel, anchovy, herring, etc).

The specific composition of the basic commercial fish species is not constant at all. From year to year, the catches involved either salmon or herring, flatfish or sardine and pollack. The reserves of cod, anchovy, capelin and some other species are utilized only slightly. It is considered that the marine biological resources, both on the shelf and in the open sea basically include traditional commercial species, whose reserves have been sufficiently well used for a long time. Of this amount, pelagic fish comprise 73 percent, whereas bottom fishes only 7 percent.

During 1990-96, fish and seafood production in the region fell by one-third and amounted to slightly over 3 million tons in 1996 (65% of 1990 value). Primorye accounted for half of this volume and was followed by Kamchatka (24%), Sakhalin (14%) and Khabarovsky Kray (about 7%). Prediction and actual catch of sea products in 1997-1999 (thousands tons) are shown in Table 3-4 for some areas.

Table 3-4 Prediction and actual catch of sea products in the Russian part of the NOWPAP Region

	1997		1998		1999	
	Primorye	West Sakhalin	Primorye	West Sakhalin	Primorye	West Sakhalin
Prediction	192.23	37.23	387.267	40.593	385.339	77.070
Fact	34.48	22.514	45.492	16.679	46.879	17.325

Transport. There are 32 sea ports, of which 22 are commercial ports and 10 are fishing ports, and about 300 harbors with available wharfs and anchorage, scattered along the Russian Far East coast. In total, there are about 270 for-profit businesses performing port functions in the region. The major ports, situated here, are capable of handling up to 100 million tons of cargo annually. In 1997, they handled a total of 28 million tons which is equal to 74% of the Russian Far East's total turnover in sea ports. The region's largest ports, Vladivostok, Nakhodka, Vostochny, Vanino, are connected with the Trans-Siberian Railway and the Baikal-Amur Railway, which makes them key points in attracting transit cargo flows via Russia to the East and Central Europe nations. Total length of automobile roads, including corporate ones, in the Russian Far East is 78,300 km.

4. National Monitoring and Research Activities Related to Atmospheric Deposition of Contaminants

4.1 National Program

The Federal Service of Russia on Hydrometeorology and Environmental Monitoring (ROSHYDROMET) is responsible for routine monitoring. In Primorsky Kray, monitoring of contamination of air, inland waters, soil and marine environment is implemented by Primorsky Territorial Office on Hydrometeorology and Environmental Monitoring.

The location of stations for monitoring of air pollution and atmospheric deposition of contaminants in Primorsky Kray is shown on Figure 4.1-4.2.

Unfortunately, due to lack of government funding, number of monitoring stations decreased in recent decades (e.g., precipitation and snow cover monitoring stations – from 36 in 1990 to 26 in 2003, air pollution monitoring stations – from 15 to 13).

4.2 Methodologies/Procedures

Information on number of stations of different types, frequency of observations and analytical methods used in laboratories are given in Tables 4.1-4.5.

The QA/QC procedures in Primorsky Kray Environmental Monitoring Center are being performed according to the following documents/programs:

- Recommendation No. 2335-95 of the State Committee of Russia on Standards, Metrology and Certification, *"The Government System of Ensuring the Uniformity of Measurements. Internal Quality Control of Quantitative Chemical Analysis"*.

- Program of the Main Geophysical Laboratory (Saint Petersburg) *"Periodic External Quality Control of Measurements of Air Pollutants"*.
- Program of External Quality Control of the Center of Accreditation, Scientific-Production Association "Typhoon" (Obninsk).
- International Intercalibration Program (ADORC).

Internal quality control includes the following procedures:

- *Operational internal control of accuracy, precision and repeatability.* This procedure is necessary to take timely necessary measures in such situations when measurement errors are not in compliance with the established standards.
- *Internal statistical control.* This is random statistical check of repeatability and accuracy in order to estimate the real quality of quantitative chemical measurements and to take necessary measures to improve this quality.

External quality control by the Main Geophysical Laboratory (Saint Petersburg) and the Center of Accreditation, Scientific-Production Association "Typhoon" (Obninsk) is being done by sending blind samples (not less than once a year).

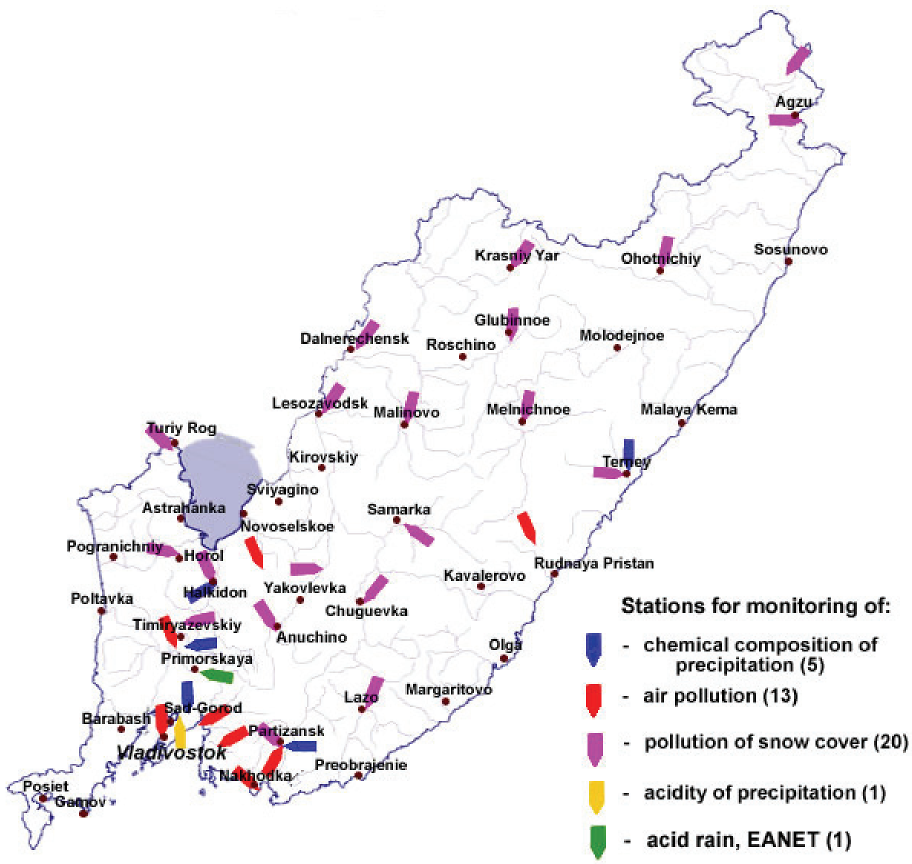


Figure 4-1 Stations for monitoring of air pollution and atmospheric deposition of contaminants in Primorsky Kray

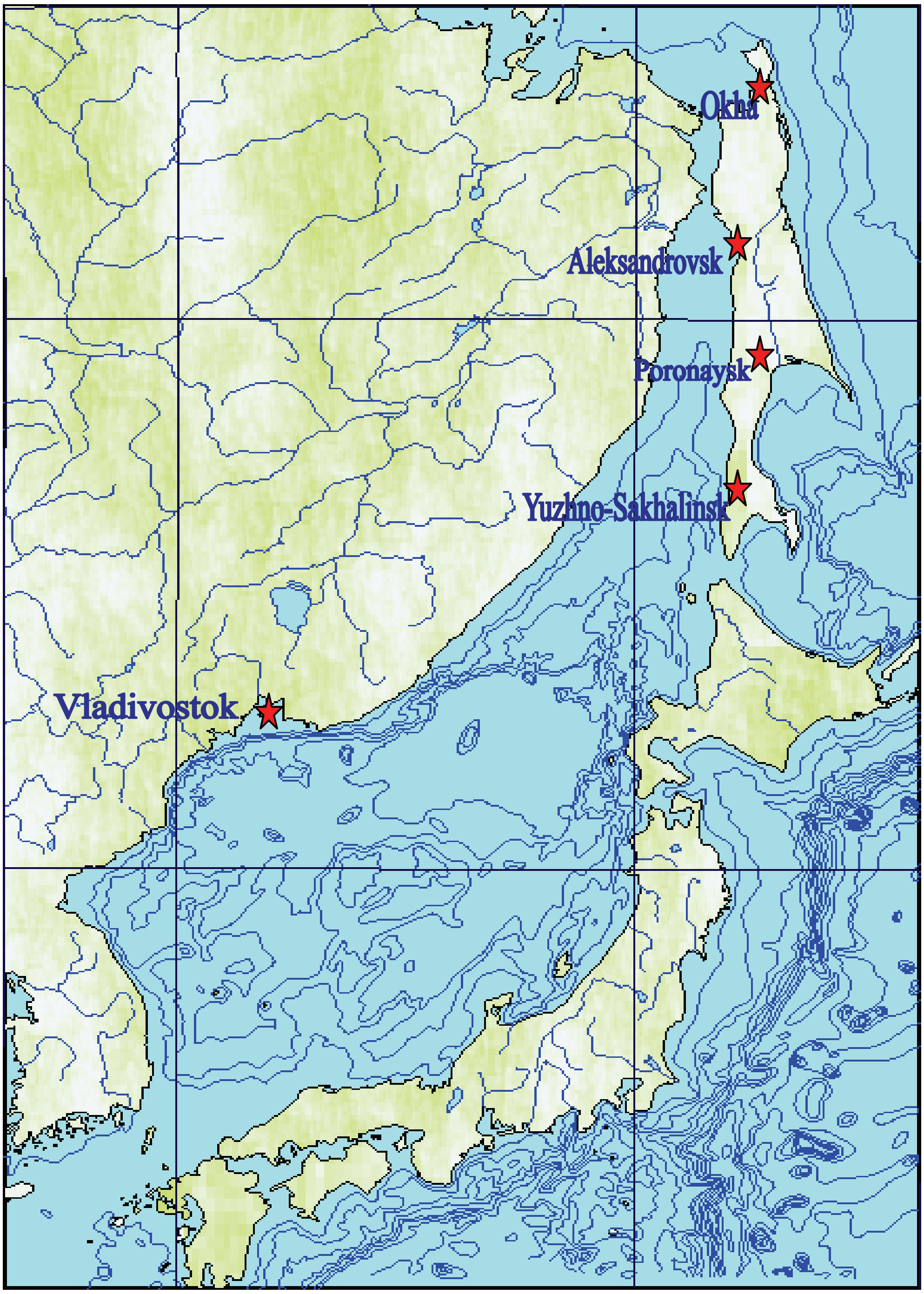


Figure 4-2 Main stations for monitoring of air pollution and atmospheric deposition of contaminants around the Sea of Japan in Russia

Table 4-1 Number of stations for different kinds of monitoring in Primorsky Kray

Kind of monitoring	Number of stations
Air pollution	13 (in 8 cities)
Chemical composition of precipitation	5
Pollution of snow cover	20
Acidity of precipitation	1
Acid rain (EANET*)	1

Note: *EANET - Acid Deposition Monitoring Network in East Asia

Table 4-2 Frequency of observations at different monitoring stations in Primorsky Kray

Kind of monitoring	Frequency
Air pollution	three times a day
Precipitation composition	once a month
Snow cover composition	once a winter
Precipitation acidity	every rain event
EANET, dry deposition	every two weeks
EANET, wet deposition	every rain event

Table 4-3 Monitoring parameters and analytical methods used in Primorsky Kray (air pollution measurements)

Parameter	Method	Measurement range	Precision
Suspended solids (SS) or dust	Gravimetric	0.26-50 mg/m^3	±25%
CO	Electrochemical	0.75-50 mg/m^3	±10%
NH_3	Spectrophotometry	0.03-6.0 mg/m^3	±15%
NO	Spectrophotometry	0.016-0.94 mg/m^3	±25%
NO_2	Spectrophotometry	0.02-1.4 mg/m^3	±18%
SO_2	Spectrophotometry	0.05-1.0 mg/m^3	±12%
H_2S	Spectrophotometry	0.003-0.075 mg/m^3	±25%
Formaldehyde	Spectrophotometry	0.01-0.22 mg/m^3	±20%
SO_4	Nephelometric	0.005-3.0 mg/m^3	±25%
Co, Cr, Cu, Fe, Mn, Ni, Zn	Atomic Absorption Spectrometry	0.01-1.5 $\mu g/m^3$	±15%
Cd	Atomic Absorption Spectrometry	0.002-0.24 $\mu g/m^3$	±15%
Pb	Atomic Absorption Spectrometry	0.06-1.5 $\mu g/m^3$	±15%
Benz(a)pyrene	Luminiscence	$1\ 10^{-7} – 1\ 10^{-2}$ mg/m^3	±15%

Table 4-4 Monitoring parameters and analytical methods used in Primorsky Kray (precipitation and snow cover composition)

Parameter	Method	Measurement range	Precision
NH_4	Spectrophotometry	0.05-5.0 mg/l	±10%
NO_3	Spectrophotometry	0.05-1.50 mg/l	±10%
Na, K	Flame spectrophotometry	0.05-5.0 mg/l	±10%
Ca, Mg	Flame spectrophotometry	0.05-5.0 mg/l	±8%
Zn	Atomic Absorption Spectrometry	0.05-5.0 mg/l	±8%
pH	Potentiometric	2-10	±10%
Conductivity	Conductometry	2-500 Sm/cm	±20%
SO_4	Nephelometric	0.5-30 mg/l	±30%
Cl	Potentiometric	0.2-10.0 mg/l	±10%
HCO_3	Potentiometric	0-50 mg/l	±10%

Table 4-5 Monitoring parameters and analytical methods used in Primorsky Kray for acid deposition monitoring (EANET).
EANET sampler is shown on Figure 4-3

Parameters	Methods
Wet deposition (the same parameters as precipitation)	The same methods as for precipitation composition
Dry deposition (NH_4, NO_3, SO_4, Cl, K, Na, Ca, Mg)	Ion chromatography (analysis is performed in Irkutsk)

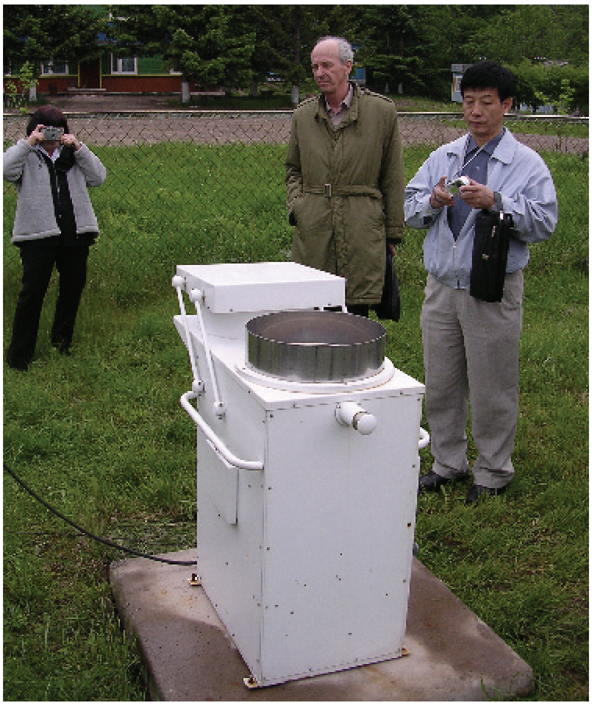


Figure 4-3 EANET sampler in Primorsky Kray

4.3 Research Activities

4.3.1 PGI and FERHRI Studies

The research of air pollution and atmospheric deposition in the Russian Far East has been carried out in the Pacific Geographical Institute (PGI), Far East Branch of the Russian Academy of Sciences, from 1972 to 1990 within some international programmes (e.g., Man and Biosphere). To study atmospheric deposition of contaminants, samples of precipitation (rain and snow) were taken (from 1980 – in cooperation with the Far Eastern Regional Hydrometeorological Research Institute). Sampling sites are shown on Figure 4-4. Full-scale sampling (105 sites) was implemented every 5 years, every 1-2 years sampling was done at several fixed polygons.

Figure 4-4 Atmospheric precipitation sampling sites

One of these polygons was located in the Sikhote-Alin Biosphere Reserve. The most intensive sampling period in this polygon has been done in 1981-1985. The results of investigations were published in several research papers by authors from PGI and FERHRI (e.g., Kachur, Tkalin, 2000; Svinukhov et al., 1993; Svinukhov, 1997), some results are shown on Figure 4-5 and Figure 4-6.

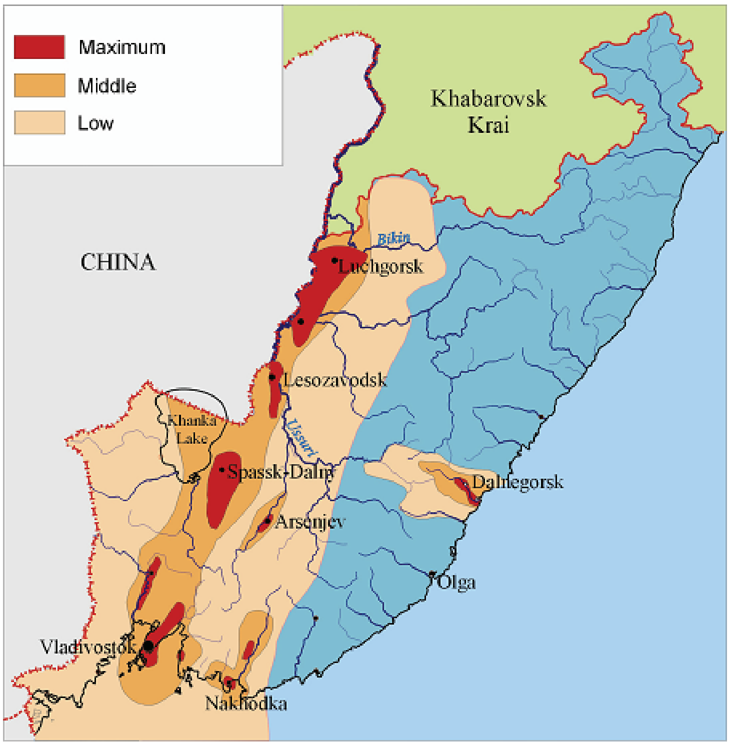


Figure 4-5 Relative density of atmospheric deposition of contaminants (rain and snow data)

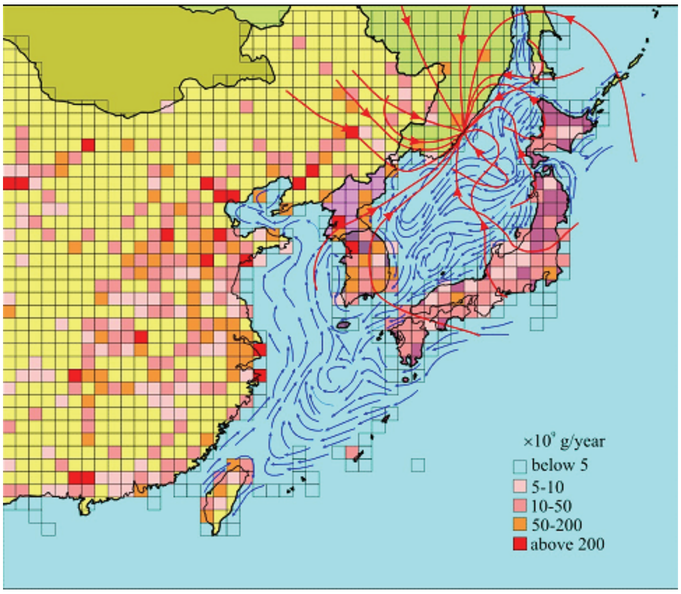


Figure 4-6 Anthropogenic emissions of SO_2 and trajectories of air masses coming to Sikhote-Alin Biosphere Reserve

The air pollution (and atmospheric deposition of contaminants) in the Russian Far East depends on global, regional and local sources (Figure 4-4 as an example). Some regional and local features are as follows:

- With increasing distance from the seashore, contents of ions of marine origin (Na, Cl and, to a lesser extent, Mg) decrease, while concentrations of ions of continental origin (Fe, Mn and others) increase.
- Due to monsoon climate (prevailing winds from south-southeast in summer and from north-northwest in winter), seasonal changes in atmospheric precipitation chemistry are evident.
- For ions of mixed origin (marine/continental), as Ca or SO_4, impact of local pollution sources might be important.
- Distribution of trace metals in the atmosphere also depends on local and regional sources.

In general, total mineralization of atmospheric precipitation in the Russian Far East is below 3-4 mg/l. mean values for Sikhote-Alin Biosphere Reserve for 1981-1985 are shown in Table 4-6.

Table 4-6 Chemical composition of atmospheric precipitation in Sikhote-Alin Biosphere Reserve (1981-1985)

pH	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
	mg l^{-1}					
4.7	0.59	1.54	0.24	0.27	0.59	0.27

Fe	Mn	Cu	Pb	Cd	Zn	Al
Dissolved (μg l^{-1}) / Particulate (% of total aerosol weight)						
19 / 1.8	7 / 0.018	3.4 / 0.021	4.7 / 0.044	0.18 / 0.004	44 / 0.134	16 / N/D

The trajectories of air masses coming to the Sikhote-Alin Biosphere Reserve are shown on Figure 4-5 (results of joint research of PGI and FERHRI). About 75% of annual pollution load is being transported from the west, southwest and northwest, i.e. from People's Republic of China. From the other hand, the most polluted air masses are coming from Japan and from Korean peninsula.

4.3.2 POI Studies

Research on chemical composition and transport of aerosols in the Russian Far East is being done by specialists of the Pacific Oceanological Institute (POI), Far East Branch of the Russian Academy of Sciences. The sampling of atmospheric aerosols is carried out using Japanese samplers and a technique adopted in the SEAREX program (Uematsu et al., 1983). In addition, rain and snow (after melting), river and waste waters were sampled and then particulate and dissolved substances were separated by filtration (40 μm). Element concentrations in aerosol, rain, snow, river and waster waters were determined by neutron activation and atomic absorption analysis. Aerosol sampling stations were located in Vladivostok, Okha (northern Sakhalin island), Paratunka (central Kamchatka peninsula) and also during marine expeditions on research vessels.

Table 4-7 demonstrates correlation coefficients between concentrations of elements in aerosols for Vladivostok. Only Fe closely correlates with dust concentration. We observed the correlation between concentrations of Ca, Mg, Cu, Fe, Mn, Co, Ni, and Zn.

Table 4-7 Correlation coefficients between concentrations of elements in aerosols for Vladivostok

	Dust conc.	**Ca**	**Mg**	**Cu**	**Fe**	**Mn**	**Co**	**Ni**	**Pb**	**Cd**	**Cr**	**Zn**
Dust concent.	1											
Ca	0.471	1										
Mg	0.375	0.986	1									
Cu	-0.089	0.765	0.830	1								
Fe	0.834	0.834	0.795	0.467	1							
Mn	0.265	0.962	0.986	0.876	0.720	1						
Co	0.467	0.952	0.945	0.745	0.820	0.954	1					
Ni	-0.051	0.585	0.607	0.816	0.374	0.699	0.678	1				
Pb	-0.322	0.551	0.637	0.934	0.229	0.679	0.470	0.691	1			
Cd	-0.324	0.032	0.127	0.519	0.005	0.234	0.197	0.725	0.522	1		
Cr	-0.271	-0.252	-0.284	-0.250	-0.395	-0.187	-0.132	0.208	-0.291	0.168	1	
Zn	0.323	0.722	0.774	0.785	0.734	0.797	0.811	0.776	0.606	0.649	-0.188	1

For samples from the Okha (Table 4-8) all elements negatively correlate with dust concentration but closely correlate each other. For aerosols from the Paratunka we observed correlation between Mn, Zn, Fe, Co, Pb (Table 4-9). For samples from Sapporo we determined correlation between a) Ca c Cd, Co, Ni; b) Mg c Cd, Co, Ni, Cr; c) Fe c Cu, Mn (Table 4-10).

This correlation analysis demonstrates that different sources influence on chemical composition of aerosols in far-eastern region of Russia.

Table 4-8 Correlation coefficients between concentrations of elements in aerosols for Okha

	Dust conc.	Ca	Mg	Cu	Fe	Mn	Co	Ni	Pb	Cd	Zn
Dust concent.	1										
Ca	-0.401	1									
Mg	-0.396	0.890	1								
Cu	-0.418	0.802	0.921	1							
Fe	-0.383	0.734	0.814	0.900	1						
Mn	-0.420	0.725	0.745	0.733	0.858	1					
Co	-0.400	0.878	0.959	0.936	0.868	0.805	1				
Ni	-0.320	0.815	0.970	0.864	0.721	0.593	0.894	1			
Pb	-0.471	0.787	0.846	0.925	0.939	0.814	0.904	0.753	1		
Cd	-0.354	0.599	0.817	0.800	0.775	0.784	0.856	0.742	0.764	1	
Zn	-0.445	0.768	0.873	0.972	0.960	0.799	0.906	0.793	0.962	0.789	1

Table 4-9 Correlation coefficients between concentrations of elements in aerosols for Paratunka

	Mn	Zn	Cu	Fe	Ni	Co	Cd	Pb
Mn	1							
Zn	0.79062	1						
Cu	0.312925	0.510271	1					
Fe	0.802607	0.570085	0.413558	1				
Ni	0.535186	0.667936	0.422095	0.461923	1			
Co	0.655122	0.526182	0.31719	0.73167	0.487551	1		
Cd	0.300962	0.423013	0.485862	0.422492	0.442273	0.5034	1	
Pb	0.519244	0.635522	0.298154	0.598745	0.452723	0.526456	0.542414	1

Table 4-10 Correlation coefficients between concentrations of elements in aerosols for Sapporo

	Cd	Cu	Mn	Zn	Co	Ni	Pb	Cr	Fe	Ca	Mg
Cd	1										
Cu	0.121	1									
Mn	0.421	0.632	1								
Zn	-0.009	0.773	0.467	1							
Co	0.873	0.142	0.522	0.066	1						
Ni	0.832	0.185	0.566	0.069	0.939	1					
Pb	0.214	0.328	0.249	0.464	0.289	0.265	1				
Cr	0.859	0.049	0.268	0.004	0.858	0.774	0.210	1			
Fe	0.264	0.638	0.886	0.399	0.294	0.341	0.105	0.042	1		
Ca	0.521	-0.054	0.257	-0.132	0.659	0.723	0.061	0.455	0.140	1	
Mg	0.770	0.008	0.342	-0.020	0.839	0.863	0.151	0.745	0.122	0.724	1

Vladivostok City is situated on the southern tip of Muraviev-Amursky peninsula between the Amursky Bay to the west-northwest and Ussuriysky Bay to the east-southeast. Climate of Vladivostok is under monsoon influence when in winter the prevailing winds are from the north-northwest (Siberia) and in summer from the south-southeast (i.e. from the sea). The highest atmospheric precipitation is in August (168 mm) and lowest in January (10-12 mm).

The experimental results on aerosol concentrations in 1991-1998 in Vladivostok are shown on Figure 4-7. The analysis of available data shows that for Vladivostok an increase of the aerosol contents is observed in winter and spring.

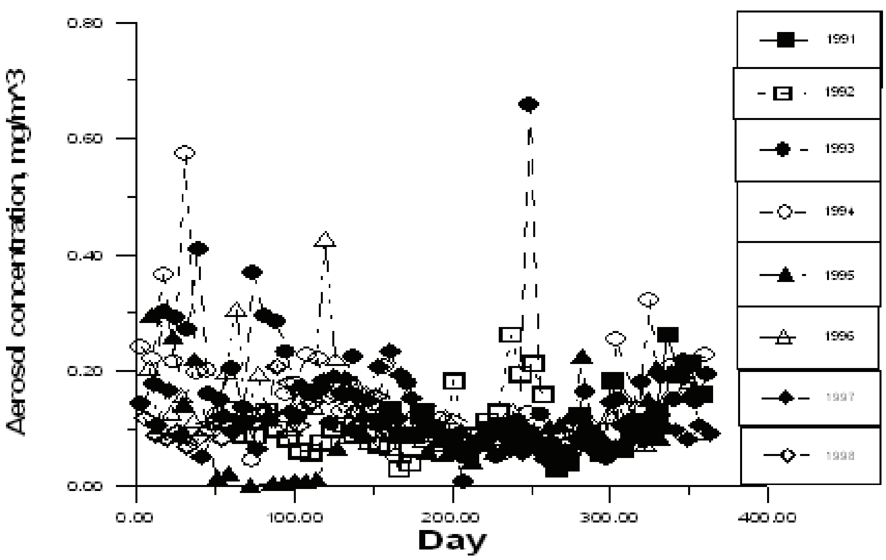


Figure 4-7 The dust concentration in Vladivostok, 1991-1998

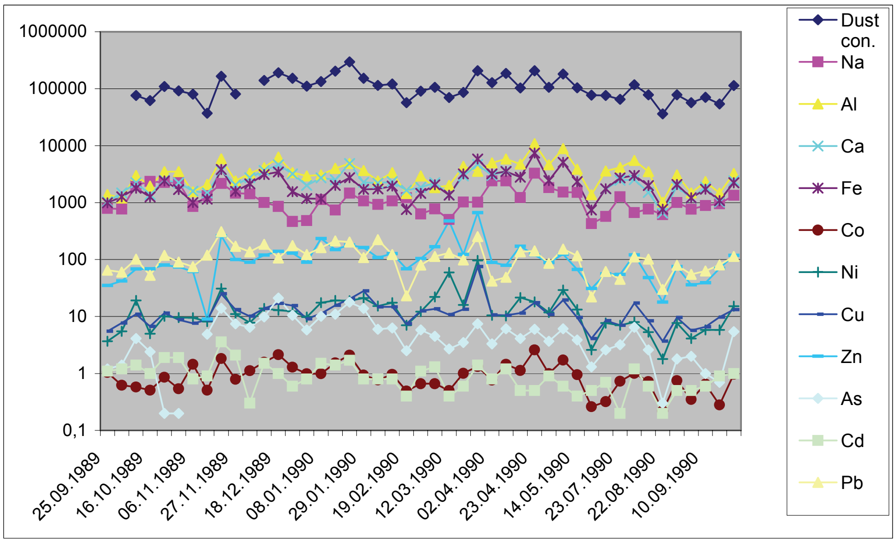


Figure 4-8 Distribution of dust and element concentrations (ng/m^3) in aerosols in Vladivostok, 1989-1990

The distribution of element concentrations in aerosols from Vladivostok is shown on Figure 4-8. Most of measured elements can be divided into three major groups as follows:

1. Macroelements (Na, Al, Ca, Fe);
2. Trace elements of anthropogenic origin (Pb, Zn, Cd, Co);
3. Trace elements of natural origin (Ni, Cu).

An increase of the macroelement contents (K, Ba, Fe, Al, Ca, Na) in atmosphere of Vladivostok in a winter-spring period can be clearly seen. In general, the average concentrations of trace elements in atmosphere of Vladivostok are higher then in atmosphere of Sapporo (Michoukov et al., 1997).

Comparing of natural dust storms and anthropogenic effects of Vladivostok City on air quality was done on 2004 data set (Figure 4-9). In the beginning of sampling the highest concentrations of element in aerosols were connected with strong dust storm in China. Then concentration decreased sharply to background levels with some oscillations. Local minimum data were observed when wind directions are mainly from west to north and element concentrations in aerosol are not influenced by the anthropogenic sources of Vladivostok's industry and transport.

For identification and account of the contributions of sources of elements in a content of aerosols Target Transformation Factor Analysis (TTFA) was applied (Mishukov et al., 2004). This analysis has some advantages so for instance method of chemical balance and regression analysis need to know the quantity, location and character of sources but traditional Factor Analysis determine only quantity of influencing factors. Usually we do not know capacity, period of action, location, mechanism and effect of each source on chemical composition of aerosols.

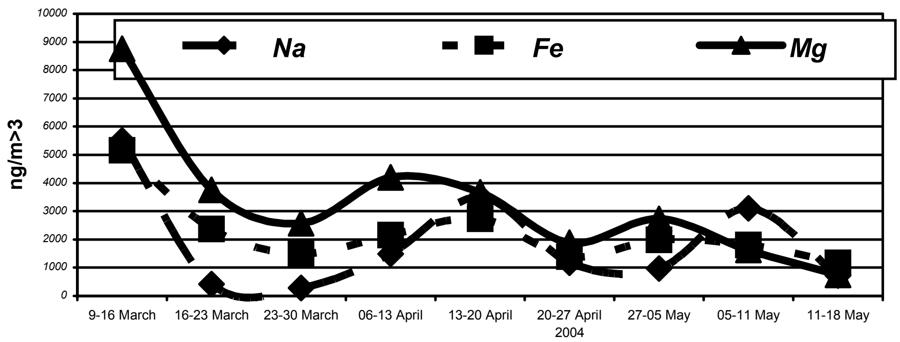
Main problem at realization of mathematical processing of results is allocation of sources of element in atmosphere. Method of TTFA does not require *a priory* knowledge of quantity and character of sources and permit to define an input of each source in the contents of anyone element in each aerosol sample.

The application TTFA is based on the assumption, that each significance of concentration of an element (x_{ij}) can be submitted in a kind of a sum of the contributions from various sources (factors)

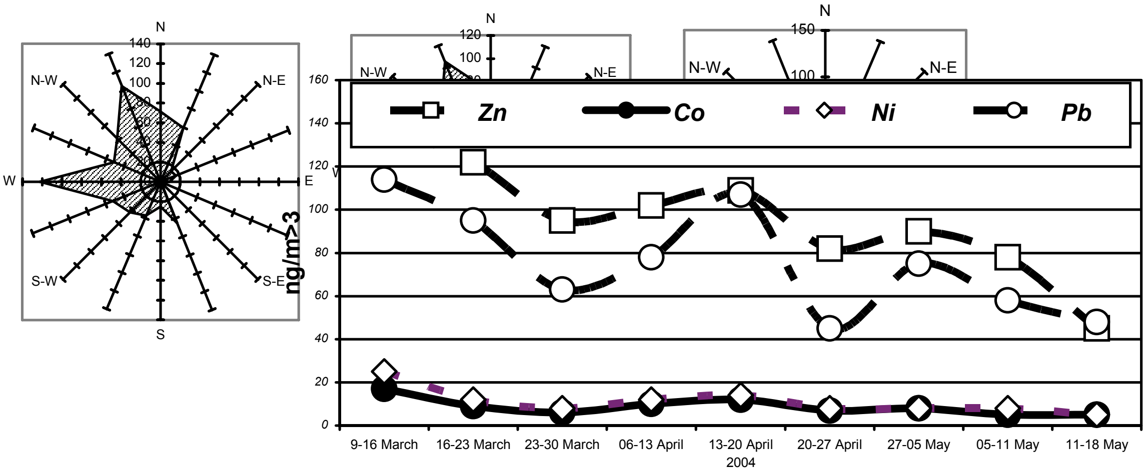
$$x_{ij} = a_{i1} f_{1j} + a_{i2} f_{2j} + \dots + a_{ip} f_{pj} = \sum_{p=1}^{p} a_{ip} f_{pj}$$

where: a_{ik} - concentration of i- element in a k - source (Table 4-11, 4-12), f_{kj} - contribution of k - source in unit of volume of j - sample, i (1...m), m - quantity of elements, j (1...n), n - quantity of samples, k (1...p), p - quantity of sources.

a) Time variations of elements in aerosols over Vladivostok



b) Wind directions:
23-30 March 2004 20-27 April 2004 11-18 May 2004



c) Time variations of heavy metals in aerosols over Vladivostok

Figure 4-9 Time variations of macroelements (a) and heavy metals (c) in aerosols over Vladivostok and wind directions (b) during sampling (Mishukov et al., 2004)

The general circuit of the analysis of data is indicated on Figure 4-10. The extraction of 8 factors accounted for 92% of variance in the data. For total set of data in 2004 TTFA demonstrated that clay and slates, sandstones and soil are most important natural sources of elements (54,42% - Na; 43% -_Fe; 59% - Mg; 47% - Mn; 31% - Cu; 1,96% - Zn; 41.8% - Co; 32% - Ni; 36.0% - Pb)_but coal fly ash is first anthropogenic source (20,5% - Na; 39.9% -_Fe; 25.9% - Mg; 48.1%- Mn; 57.9% - Cu; 26.9% - Zn; 45.8% - Co; 31.8% - Ni; 47.0%- Pb)

The set x_{ij} will form an X of data matrix.

DATA INPUT $X(m,n)$

INPUT OF TEST-VECTORS B (b_{ik})
(Tables 4.11, 4.12)

Account of correlation matrix $C(n,n) = (XV)^t (XV)$

V - matrix with elements $v_{ij} = \delta_{ij} (\Sigma \quad x_{ij}^2)^{-1/2}$, $\delta_{ij} = 0 \ (i \neq j)$, $\delta_{ij} = 1 \ (i = j)$

t - operation of transposing of a matrix

Calculation of own significances and own vectors $Q(n,n)$

$Q^{-1} C Q = \Lambda$, $\quad Q^t = Q^{-1}$, $\quad Q^t (XV)^t (XV) Q = \Lambda$

Λ - diagonal matrix of own significances

Calculation of factor loads $A = XVQ$ and factor significances $F = Q^t V^{-1}$

Calculation of matrix R of rotation vectors $r = \Lambda^{-1} A^t b$
of profiles of sources $B = A R$
of investment of sources $F' = R^{-1} F$

Figure 4-10 Target Transformation Factor Analysis

In the beginning of observation the dust storm from China brought to Vladivostok the elements as natural abundance (Na, Fe, and Mg) with strong anthropogenic influence on concentration of Zn, Pb, Co and Ni (Figure 4-9) by coal fly ash. It is not unusually because coal are widely used in China as domestic heater and coal-fired power plants. This result confirm our data about active transport of matter by atmospheric jet currents which can fast and unexpectedly bring various substances to different regions of Russian Far East [21]. After changing of meteorological situation at 16-30 March 2004 (Figure 4-9) we observed sharp decreasing content of elements in atmosphere and the natural sources effect only on aerosol content.

From 6 April 2004 the TTFA analysis revealed that coal fly ash appears to contribute mostly among anthropogenic sources to the aerosol in Vladivostok (Figure 4-11). The coal fly ash mostly determined the concentration of Pb, Co and strong influenced on content of Zn and Ni in atmospheric aerosols near the Vladivostok. Our determinations of atmospheric nitropolycyclic aromatic hydrocarbons in Vladivostok demonstrated similar result (Tang, Mishukov et al, 2005). The effects of local contamination can be assessed from the around domestic heaters and small local coal-fired power plant located at a distance about 1.5 km in south direction. Dramatic effect can be from big coal-fired power plants in the central parts of Vladivostok. Wind from west-northern direction caused lowering of concentration of Zn, Co, Ni, Pb in atmosphere and relative contribution of coal fly ash to chemical composition of aerosol near Vladivostok in 2004.

Table 4-11 Concentration of elements in different natural sources (μ g/g of dry weight) (Mishukov et al., 2004)

Ele-ment	Soil	Clay and slates	Sand-stones	Carbo-nates	Stone meteor ashes	Volcanic ashes	Fly ashes of burning plants	Sea salt in drops after bubble bursting
Na	6300	6600	3300	400	7000	16000	12000	307700
Mn	850	670	1	1100	2000	2000	6300	5,9
Fe	38000	33300	9800	3800	250000	23000	1400	590
Co	10	20	0,3	0,1	800	15	5	0,047
Ni	40	95	2	20	13500	-	90	-
Cu	20	57	1	4	100	270	420	5,7
Zn	50	80	16	20	50	780	5000	2800
Se	0,01	0,6	0,05	0,08	10	-	20	-
Ag	0,01	0,1	0,01	0,01	0,094	-	3	-
Cd	0,5	0,3	0,01	0,035	0,1	4	30	8,2
Sb	2	2	0,01	0,2	0,1	6,7	6	1,1
Cs	5	12	0,1	0,1	0,1	8,3	7,8	-
Ba	500	800	10	10	6	-	430	-
Hg	0,01	0,4	0,03	0,04	3	0,83	1,5	14
Pb	10	20	7	9	0,2	150	140	3,5

Table 4-12 Mean concentration of elements in different anthropogenic sources (μ g/g of dry weight) (Mishukov et al., 2004)

Ele-ment	Coal fly ash	Fuel fly ash	Fly ash of burning of city waste products	Ash of car exhaust	Industrial aerosols
Na	2800	5000	120000	270	8200
Mn	300	270	420	36	1200
Fe	76000	1000	5500	5500	29000
Co	48	230	10	1,8	13
Ni	180	3400	-	39	510
Cu	140	750	3600	190	1000
Zn	360	260	48000	1800	4000
Se	19	17	-	-	21
Ag	1,3	1	150	-	18
Cd	10	15	500	-	41
Ba	640	770	390	640	-
Hg	0,85	0,06	-	-	21
Pb	230	410	17000	120000	6200

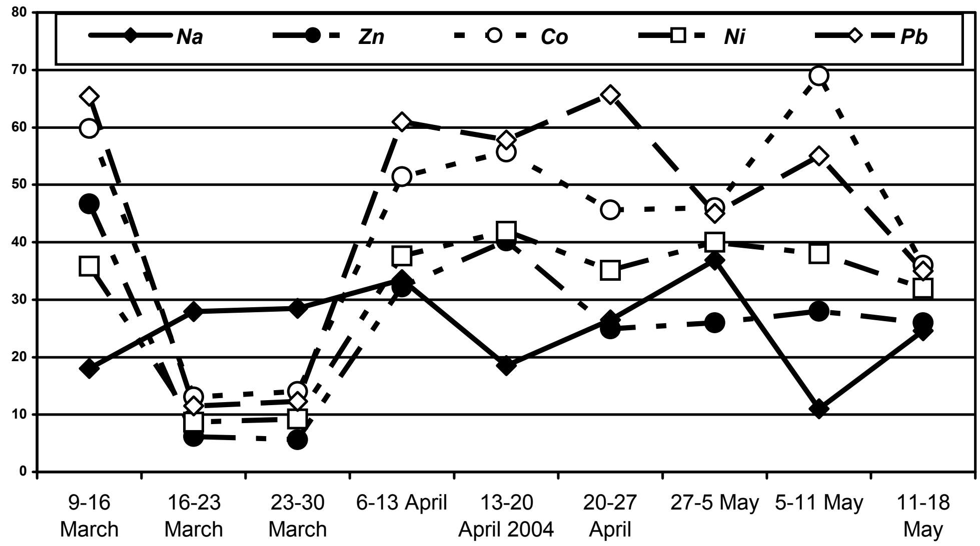


Figure 4-11 Temporal variation in the relative contribution of coal fly ash (in %) to chemical composition of aerosols over the Vladivostok in 2004 (Mishukov et al., 2004)

In Table 4-13, the data on atmospheric deposition of some metals in dissolved and particulate are given for the coastal zone of Vladivostok. More than 50% of these elements are deposited in dissolved form.

The results of calculation of contaminant inputs to the coastal zone from different sources (atmosphere, rivers, sewage) are shown in Table 4-14 (Mishukov et al., 2001). For the small and semi-enclosed Amursky Bay (total area $1x10^9$ m^2), the main source of contaminants is wastewaters (except Mn and suspended solids). For the more open and large Ussuriysky Bay (total area $1.8x10^9$ m^2), atmospheric deposition supplies more than 40% of Zn, Cd and Mn. For comparison, the ratio of annual wastewater discharge to total water volume is 0.6% for Amursky Bay and 0.04% for Ussuriysky Bay (Vaschenko, Pitruk, 2001).

Table 4-13 Element concentrations in atmospheric deposition

Element	Dissolved form		Particulate form	
	snow, μ g/l	rain, μ g/l	μ g/g	% of total flux
Zn	3.4	4.5	386	25
Pb	1.0	1.7	135	28
Cu	2.1	9.6	67	8
Cd	-	0.6	-	-
Ag	0.003	-	1.64	44
Ni	0.48	-	58	26
Mn	9.78	5.2	995	23
Co	0.06	-	6.5	25

Table 4-14 Inputs of trace metals and particulate matter from different sources (in ton/year (%)) to the coastal zone of Vladivostok (Mishukov et al., 2001)

Element	Amursky Bay			Ussuriysky Bay		
	rivers	waste-waters	atmosphere	rivers	waste-waters	atmosphere
Zn	7.39 (29)	14.55 (57)	3.51 (14)	3.17 (25)	3.06 (25)	6.31 (50)
Pb	3.81 (28)	8.64 (64)	1.10 (8)	1.44 (28)	1.82 (35)	1.97 (38)
Cu	3.33 (13)	19.90 (80)	1.80 (7)	2.10 (22)	4.18 (44)	3.24 (34)
Cd	1.17 (12)	7.28 (76)	1.20 (12)	0.21 (5)	1.53 (39)	2.16 (55)
Ag	0.32 (27)	0.88 (73)	-	0.10 (33)	0.19 (63)	0.01 (4)
Ni	3.93(10)	33.40 (88)	0.50 (2)	1.72 (18)	7.01 (73)	0.91 (9)
Mn	54.01 (80)	3.60 (5)	9.81 (15)	22.85 (55)	0.75 (2)	17.66 (430
Co	3.78 (71)	1.50 (28)	0.06 (1)	0.79 (66)	0.30 (25)	0.11 (9)
Particulate matter	13994 (52)	10362 (39)	2300 (9)	6218 (56)	689 (6)	4139 (38)

It's clear that for the whole NOWPAP region atmospheric deposition of contaminants would be the major source of pollution (as well as for other areas of the World Ocean: see, e.g., Windom, 1981; GESAMP, 1985; Hong et al., 1998).

Figure 4-12 demonstrate the spatial distribution of dust and element concentrations in aerosols sampled on top of R/V Khromov (high 10 m above sea level) in cruise 35 (17.05-06.06.1999). We observed the maximum concentrations of all elements in the Niigata port which connected with industrial effects.

For all set of date elements usually correlate each other but not correlate with dust concentration (Table 4-16).

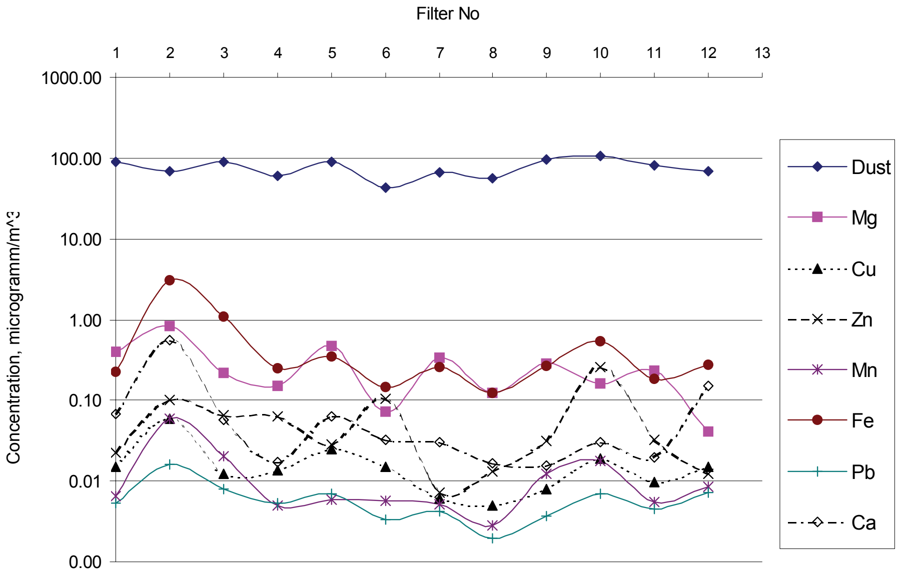


Figure 4-12 Distribution of dust and element concentrations in aerosols samples in the Sea of Japan on section Vladivostok-Niigata in 1999

Filter	Location
1	Crossing from central part of the Sea of Japan to the Niigata
2	The Niigata port
3	After the Niigata port – central part of the Sea of Japan;
4	Station T in the central part of the Sea of Japan;
5	Station F13 in the central part of the Sea of Japan;
6	Station E10 in the central part of the Sea of Japan;
7	Station E10 in the central part of the Sea of Japan;
8	Crossing from St.E10- St.F13
9	Crossing from St.F13 – St.E10
10	Crossing from St.E10 – before the Niigata port
11	After the Niigata port – central part of the Sea of Japan
12	Near the Vladivostok port

Table 4-15 Correlation coefficients between concentrations of dust and elements in aerosol samples in the Sea of Japan on section Vladivostok - Niigata in 1999

	Dust	Mg	Cu	Zn	Mn	Fe	Pb	Ca
Dust	1							
Mg	0.204595	1						
Cu	0.007528	0.79685	1					
Zn	0.291626	-0.02942	0.31377	1				
Mn	0.107874	0.743973	0.893966	0.356773	1			
Fe	0.031377	0.779432	0.902398	0.26175	0.985249	1		
Pb	0.164838	0.743915	0.924629	0.283693	0.921888	0.934991	1	
Ca	-0.114	0.761861	0.933236	0.112032	0.915783	0.92961	0.909275	1

Table 4-16 Fluxes of dust and elements on sea surface in the Sea of Japan on section Vladivostok - Niigata in 1999

Filter No	Dust, kg/	Mg, kg/ km^2day	Cu kg/ km^2day	Zn kg/ km^2day	Mn kg/ km^2day	Fe kg/ km^2day	Pb kg/ km^2day	Ca kg/ km^2day
1	82.6	0.091	0.0034	0.0052	0.0015	0.052	0.0012	0.0155
2	55	0.166	0.0118	0.0197	0.0118	0.605	0.0032	0.1092
3	81.8	0.050	0.0027	0.0146	0.0046	0.243	0.0018	0.0128
4	45	0.028	0.0025	0.0118	0.0009	0.046	0.0010	0.0032
5	82.3	0.105	0.0056	0.0064	0.0014	0.080	0.0016	0.0143
6	27.3	0.011	0.0024	0.0165	0.0009	0.023	0.0005	0.0052
7	51.8	0.064	0.0012	0.0014	0.0010	0.050	0.0008	0.0059
8	41.1	0.023	0.0009	0.0024	0.0005	0.022	0.0004	0.0030
9	91.3	0.068	0.0019	0.0074	0.0028	0.062	0.0009	0.0037
10	104.9	0.040	0.0047	0.0631	0.0044	0.134	0.0017	0.0075
11	70.4	0.051	0.0021	0.0070	0.0012	0.039	0.0010	0.0042
12	54.2	0.008	0.0030	0.0024	0.0017	0.054	0.0014	0.0300
Mean	65.64	0.059	0.0035	0.0132	0.0027	0.118	0.0013	0.0179
Stand	23.32	0.045	0.0029	0.0168	0.0031	0.165	0.0007	0.0298
Mean flux per year on total surface of the Sea of Japan, ton/year								
	254440	22870	1357	5117	1047	45740	504	6939

An experimental ratio between aerosol concentration and flow of particles dropping out on water surface for a coastal zone of the Seas of Japan and Okhotsk is submitted as function $Q= 0.095*C^{1.5}$ (Q - flow of particles mg/m^2*day, C - aerosol concentration microgramm/m^3). An increase of the aerosol contents result in higher rate of input of particles, as dependence obviously not linear (Table 4-16). The high aerosol concentration promotes active input of particles in the sea and influence on element content in seawater (Figure 4-13).

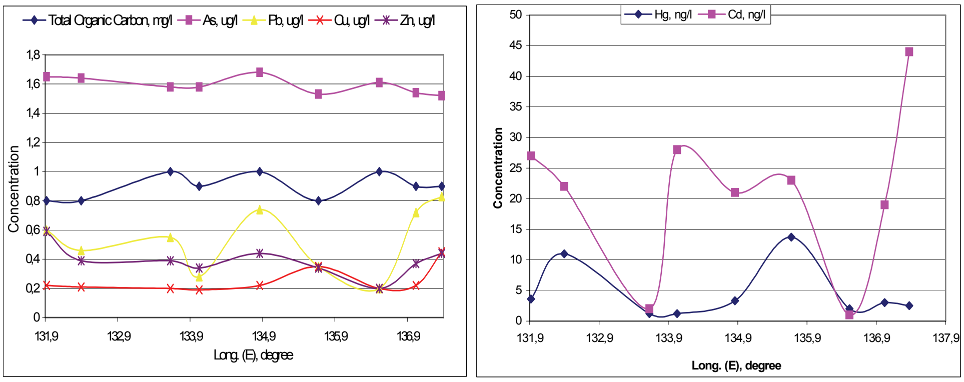


Figure 4-13 Spatial distribution of contaminants in surface water in Vladivostok-Niigata section, 1995

4.4 Training Activities

Training of specialists of Primorsky Hydrometeorological Service is carried our in Moscow and Saint-Petersburg, at ROSHYDROMET central institutions. Depending on funds availability, training of specialists from China, Japan and Korea can be also organized.

In research institutions, training is being done using "hands-on" approach, i.e. young researchers are being trained during field surveys, expeditions, laboratory experiments, etc.

5. Present Situation

5.1 Air Pollution

According to 2002 data, air in Primorsky Kray was mostly contaminated by NO_2 and benz(a)pyrene. The highest NO_2 levels were registered in Artyom, Ussuriysk and Vladivostok (up to 0.28 mg/m^3 or 7 times higher than the maximum permissible concentration (MPC). The highest B(a)P contents were measured in Partizansk, Ussuriysk and Vladivostok (up to 14 ng/m^3 or 14 times higher than MPC). These data are shown in Table 5-1. The main sources of NO_2 are emissions from industrial enterprises (including thermal power plants) and from automobiles. The sources of B(a)P are coal combustion (power plants, heating) and, to a lesser extent, diesel engines.

Table 5-1 Contents of some pollutants in the air of major cities of Primorsky Kray (average for 2002)

Pollutants	Cities						
	Vladivostok	Artyom	Ussuriysk	Spassk	Partizansk	Nakhodka	MPC*
mg/m^3							
Dust	0.14	0.08	0.16	0.08	0.03	0.05	0.15
NO_2	0.08	0.10	0.08	0.08	0.06	0.04	0.04
SO_2	0.003	0.001	0.019	0.001	< 0.001	0.002	0.05
H_2S	<0.001	<0.001	0.001	<0.001	N/A	N/A	0.008
B(a)P	3.0 10^{-6}	N/A	4.2 10^{-6}	N/A	4.5 10^{-6}	1.7 10^{-6}	1.0 10^{-6}
μg/m^3							
Pb	0.10	N/A	0.04	N/A	N/A	N/A	0.3
Cu	0.14	N/A	0.02	N/A	N/A	N/A	2.0
Zn	0.57	N/A	0.06	N/A	N/A	N/A	50

Note:*MPC - maximum permissible concentration, B(a)P = benz(a)pyrene.
Concentrations exceeding MPCs are highlighted in yellow.

The results of air pollution monitoring in Primorsky Kray cities have been published (e.g., Svinukhov et al., 1993; Svinukhov, 1997). The methods of short-term forecast of air pollution in these cities have been also developed.

5.2 Atmospheric Deposition

The data on chemical composition of atmospheric precipitation are shown in Tables 5.2 and 5.3 (separately for warm season, May-October, and for cold season, November-April). Using these data, it’s possible to calculate atmospheric deposition of chemical substances. In Tables 5-4 and 5-5, such results are given for several elements and also for the sum of ions (i.e. all measured ions from both tables except Zn).

Table 5-2 Chemical composition of precipitation for some Primorsky Kray stations (season-averaged for 2002)

Period	Precipitation (mm)	pH	Cl^- mg/l	Na^+ mg/l	K^+ mg/l	Ca^{2+} mg/l	Mg^{2+} mg/l
Timiryazevsky							
May-October	578.1	5.4	0.9	0.3	0.2	0.3	0.0
November-April	99.7	5.8	1.9	0.9	0.5	2.3	0.3
Partizansk							
May-October	760.5	5.5	0.7	0.3	0.3	0.3	0.0
November-April	130.7	5.3	3.0	1.3	0.5	1.4	0.2
Sadgorod							
May-October	746.5	5.4	1.8	0.7	0.4	0.9	0.1
November-April	126.5	6.2	4.3	2.2	1.2	4.7	0.7
Terney							
May-October	757.5	5.5	1.8	0.9	0.7	0.3	0.1
November-April	185.0	5.9	1.2	0.7	0.4	0.9	0.2
Khalkidon							
May-October	656.2	6.2	2.5	0.9	0.3	2.4	0.7
November-April	130.1	6.2	3.0	1.4	0.8	4.4	0.5

Table 5-3 Chemical composition of precipitation for some Primorsky Kray stations (season-averaged for 2002)

Period	SO_4^{2-} mg/l	NO_3^- mg/l	NH_4^+ mg/l	Zn^{2+} mg/l	Sum of ions mg/l
Timiryazevsky					
May-October	2.3	0.40	0.80	0.10	5.7
November-April	8.5	0.90	1.50	0.10	18.9
Partizansk					
May-October	1.4	0.70	0.40	0.10	5.2
November-April	4.3	1.60	0.50	0.30	13.4
Sadgorod					
May-October	4.9	0.60	1.20	0.10	11.9
November-April	13.2	0.80	1.10	0.20	31.5
Terney					
May-October	2.5	0.40	0.50	0.20	8.2
November-April	2.8	0.40	0.40	0.10	8.3
Khalkidon					
May-October	7.0	0.70	0.60	0.10	19.5
November-April	12.3	0.50	0.80	0.20	25.5

Table 5-4 Atmospheric deposition (g/m^2) of chemical substances for some Primorsky Kray stations in 2002

Period	Cl^-	Na^+	K^+	Ca^{2+}	Mg^{2+}
Timiryazevsky					
May-October	0.520	0.173	0.116	0.173	0.000
November-April	0.189	0.090	0.050	0.229	0.030
Year	0.709	0.263	0.166	0.402	0.030
Partizansk					
May-October	0.532	0.228	0.228	0.228	0.000
November-April	0.392	0.170	0.065	0.183	0.026
Year	0.924	0.398	0.293	0.411	0.026
Sadgorod					
May-October	1.344	0.523	0.299	0.672	0.075
November-April	0.544	0.278	0.152	0.595	0.089
Year	1.888	0.801	0.451	1.267	0.164
Terney					
May-October	1.439	0.682	0.530	0.227	0.076
November-April	0.222	0.130	0.074	0.167	0.037
Year	1.661	0.812	0.604	0.394	0.113
Khalkidon					
May-October	1.641	0.591	0.197	1.575	0.459
November-April	0.390	0.182	0.104	0.572	0.065
Year	2.031	0.773	0.301	2.147	0.524

Table 5-5 Atmospheric deposition of (g/m^2) chemical substances for some Primorsky Kray stations in 2002

Period	SO_4^{2-}	NO_3^-	NH_4^+	Zn^{2+}	Sum of ions
Timiryazevsky					
May-October	1.330	0.231	0.462	0.058	3.295
November-April	0.847	0.090	0.150	0.010	1.883
Year	2.177	0.321	0.612	0.068	5.178
Partizansk					
May-October	1.065	0.532	0.304	0.076	3.917
November-April	0.562	0.209	0.065	0.039	1.747
Year	1.627	0.741	0.369	0.115	5.664
Sadgorod					
May-October	3.658	0.448	0.896	0.075	8.883
November-April	1.670	0.101	0.139	0.025	3.990
Year	5.328	0.549	1.035	0.100	12.873
Terney					
May-October	1.894	0.303	0.379	0.152	6.249
November-April	0.555	0.074	0.074	0.019	1.536
Year	2.449	0.377	0.453	0.171	7.785
Khalkidon					
May-October	4.593	0.459	0.394	0.066	12.783
November-April	1.600	0.065	0.104	0.026	3.319
Year	6.193	0.524	0.498	0.092	16.102

6. Recommendations for Future Regional Activities and Priorities

Russian specialists suggest the following activities to be taken within NOWPAP:

1. Publish National Reports on Atmospheric Deposition of Contaminants with detailed information on methods and results for e.g. 2002.

2. Harmonize monitoring methods and air quality criteria among NOWPAP countries.

3. Organize intercomparison exercise on precipitation composition (e.g., nutrients and trace metals).

For the Russian Federation, there are the following priorities related to

Atmospheric Deposition of contaminants in NOWPAP region:

1. Re-establish the monitoring station in the Sikhote-Alin Biosphere Reserve.

2. Increase number of monitoring stations.

3. Increase number of measured parameters (e.g., trace metals, petroleum hydrocarbons).

7. Conclusions

This reports gives an overview of national activities of the Russian Federation related to atmospheric deposition of contaminants in the NOWPAP region. In Primorsky Kray (part of Russia which belongs to the NOWPAP region), responsibility for routine monitoring of urban air quality and atmospheric deposition of contaminants belongs to the Primorsky Kray Territorial Office on Hydrometeorology and Environmental Monitoring. Research activities on atmospheric deposition were carried out by several scientific institutions: Pacific Geographical Institute, Pacific Oceanological Institute, Far Eastern Regional Hydrometeorological Research Institute.

From the observation data at several Primorsky Kray stations in 2002, the following values of annual wet atmospheric deposition were estimated (g/m^2): **Cl** 0.7-2.0, **SO_4** 1.6-6.2, **NO_3** 0.3-0.7, **NH_4** 0.4-1.0, **Na** 0.3-0.8, **K** 0.2-0.6, **Ca** 0.4-2.1, **Mg** 0.03-0.52, **Zn** 0.07-0.17. These values are comparable with the similar data for the Yellow Sea, North Sea and some coastal areas of the US.

Research activities implemented in the Pacific Geographical Institute, Far East Branch of the Russian Academy of Sciences, allowed to reveal details of atmospheric deposition of nutrients and trace metals precipitation in the Russian Far East (in particular, in the Sikhote-Alin Biosphere Reserve). The studies conducted by specialists from the Pacific Oceanological Institute, Far

East Branch of the Russian Academy of Sciences, have shown the role of atmospheric deposition of trace metals comparing with river and direct inputs. For the NOWPAP region, atmospheric deposition of contaminants is the major source of trace metals and some other contaminants. This is true also for other areas of the World Ocean (see, e.g., Windom, 1981; GESAMP, 1985; Hong et al., 1998).

Russian specialists suggest the following activities to be taken within NOWPAP:

- to harmonize monitoring methods and air quality criteria among NOWPAP countries;
- to organize intercomparison exercise on precipitation composition (e.g., nutrients and trace metals).

For the Primorsky Kray of Russia, there are the following priorities related to Atmospheric Deposition of contaminants in NOWPAP region:

- to re-establish the monitoring station in the Sikhote-Alin Biosphere Reserve;
- To increase number of monitoring stations;
- To increase number of measured parameters (e.g., trace metals, petroleum hydrocarbons).

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Annex. National Laws and Regulations Related to Atmospheric Deposition of Contaminants

Basic laws and Decisions regulating legal issues on protection and monitoring of atmosphere in the Russian Federation.

THE FEDERAL LAW «ON ENVIRONMENTAL PROTECTION» (No. 7-FZ of January 10, 2002)

The present Law is called to promote formation and strengthening of the ecological law enforcement and maintenance of ecological safety in the territory of the Russian Federation and republics in structure of the Russian Federation.

Article 1.

“Environmental monitoring (ecological monitoring) is a comprehensive system of observing the condition of the environment, assessing and forecasting of environmental changes resulted from natural and man-made factors”.

“The state environmental monitoring (the state ecological monitoring) is the environmental monitoring performed by the governmental bodies of the Russian Federation and the governmental bodies of the subjects of the Russian Federation”.

The FEDERAL LAW ON PROTECTION of ATMOSPHERIC AIR

Adopted by the State Duma April 02, 1999

Approved by the Federation Council April 22, 1999

The present Federal law lays down legal foundation for protection of atmospheric air and is aimed at realization of constitutional laws of citizens on a favorable environment and authoritative information about its condition.

The DECISION of the GOVERNMENT of the RUSSIAN FEDERATION

No. 31 of January 15, 2001 "ON ADOPTION of the STATEMENT on the STATE CONTROL in the FIELD of PROTECTION of ATMOSPHERIC AIR".

1. The state control in the field of protection of atmospheric air is directed to control legal and physical persons and make them respect legislation requirements of the Russian Federation in the field of protection of atmospheric air aimed at improvement of atmospheric air quality and prevention of its harmful influence on health of the person and surrounding natural environment.

2. The state control in the field of protection of atmospheric air is performed by the Ministry of Natural Resources of the Russian Federation and its territorial bodies. In performing the state control in the field of protection of atmospheric air, the Ministry of Natural Resources of the Russian Federation and its territorial bodies cooperate with other interested federal bodies of executive power and their territorial bodies, executive power of subjects of the Russian Federation, institutions of local government, public organizations and other organizations and citizens.

Other legislative and normative documents regulating activity in the field of ecological monitoring

"The agreement on cooperation in the field of ecological monitoring of the states - participants of the union of the independent states – UIS" (it is approved by the UIS of January 13, 1999 and commissioned within the territory of the Russian Federation by the decision of the Government of the Russian Federation No.299 of April 04,2000);

The Decision of the Government of the Russian Federation No. 177 of March 30,2003 "On organization and realization of the state monitoring of environment (the state ecological monitoring)";

The Decisions of Heads of administrations of the subjects of the Russian Federation on creation of territorial subsystems of ecological monitoring (48 subjects of the Russian Federation);

The Decision of the Government of the Russian Federation No. 622 of August 23, 2000 “On state service of environmental monitoring”;

A number of the articles of Federal laws “On protection of atmospheric air” (No.96 - FZ of May 04.1999), “the Federal law on wildlife” (No.52 - FZ of April 24,1995), “On a special economic zone” (Article 28), “On a continental shelf of the Russian Federation” (Article 33), “On special protected natural territories” (Article 7), “On protection of Lake Baikal” (Article 20).

Statement on organization and realization of the state environmental monitoring (the state ecological monitoring)

(The Decision of the Government of the Russian Federation No. 177 of March 31,2003)

“Ecological monitoring includes monitoring of atmospheric air, land, woods of water objects, objects of fauna, a unique ecological system of Lake Baikal, a continental shelf of the Russian Federation, Earth’s interior, an exclusive economic zone of the Russian Federation, internal waters and the territorial sea of the Russian Federation.

Ministry of Natural Resources (MNR) of Russia:

- Coordinates activity of federal bodies of executive power on organization and realization of ecological monitoring;

- Coordinates methodical and normative - technical documents of federal bodies of executive power on organization and realization of ecological monitoring;

- Provides compatibility of information systems and databases on environmental condition.

MNR of Russia and other federal bodies of executive power:

- Form the state system of observation over a condition of environment and provides functioning of this system;

- Cooperates with the governmental bodies of the subjects of the Russian Federation on organization and realization of ecological monitoring;

- Carries out with participation of executive power of the subjects of the Russian Federation gathering, storage, analytical processing and formation of state information resources on condition of environment and the use of natural resources.

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