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3.10 Seoul

Situational Analysis and Urban Air Quality Trends

Encircled by high mountains, Seoul has topographical conditions susceptible to lingering air pollutants. With nearly 10 million people, the Seoul Metropolitan area faces many urban air quality problems, mainly due to mobile sources of pollution. Seoul itself has more than 2.2 million automobiles with one-third of them being diesel vehicles. Although some measures to encourage switching to cleaner fuels have been implemented, motor vehicle exhaust emissions remain one of the major sources of air pollution in Seoul. As a result, Seoul suffers from poor air quality and poor visibility in both the city and suburban areas due to the smog formed from suspended particulate matter (SPM) throughout the year (Moon, 1994). However, annual-average concentrations for primary air pollutants in Seoul indicate a dramatic improvement in sulphur dioxide (SO₂) and total suspended particulates (TSP) during the 1990s. The concentrations of TSP decreased from 216 µg/m³ to 85 µg/m³ and concentrations of SO₂ from 115 ppm to 85 ppm. However, the levels of ozone (O₃) have been increasingly high enough to violate Seoul's ambient air standards. With the rapid increase of motor vehicles since the late 1980s the major pollutants in Seoul's air have been gradually changed from SO₂ to nitrogen oxides (NO_x) and O₃.

Although Seoul has achieved some successes in mitigating primary air pollution, there are new concerns about secondary air pollution, trace hazardous air pollutants and long-range transboundary air pollutants. Secondary air pollution, such as photochemical ozone and smog, and volatile organic compounds (VOCs) are gaining more public attention. In particular, the widespread location of municipal waste incineration plants have begun to raise public concerns about hazardous air pollutants, most notably dioxins. In addition, long-range transboundary air pollutants from neighbouring countries, which constitutes about 30 to 50 per cent of the total annual SO₂ concentration, have seriously contributed to air pollution in Seoul (Moon, 1999).

Air Quality Monitoring

Seoul's automatic air pollution monitoring network continuously measures six atmospheric pollutants including TSP and SO₂. In 1996, the national system included 111 stations taking measurements in 47 cities. Among them, the City of Seoul has 20 monitoring stations, 10 stations of which are operated by the Korean Ministry of Environment (MOE) and the other 10 stations by the Seoul municipal government. The data collected at these stations are electronically transmitted via a telemetry system (TMS) to the Regional Environmental Management Offices and to the MOE. Each station measures the concentration of six substances: SPM, SO₂, NO₂, CO, Pb and O₃. In order to share the data on pollution measured at stationary and mobile units across the whole nation in real time, the MOE has been setting up TMS, an information system linking every monitoring station with the computer centre of each Regional Environmental Management Office and the MOE computer centre. It is expected that local government will establish and operate their own monitoring facilities. The Metropolitan City of Seoul has already established 10 stations of its own. In addition, a fleet of vans equipped with air pollution monitoring device covers heavily polluted area or areas in which stationary units have not yet been established. They are also sent to areas where continuous pollution monitoring is required, e.g. near roads carrying heavy traffic. Several mobile vans were in operation at the end of 1998.

Seoul also has a detailed emissions inventory which accounts for SO₂, NO₂, CO, particulate matter with diameters <10 microns (PM₁₀) and hydrocarbons (HC). This emissions inventory is compiled using energy consumption and transportation activity data. It was reported by the City of Seoul in 1996 that the transportation sector produced 325,726 tons of pollutants, accounting for 82 per cent of all emissions, the remainder being accounted for by the heating and industry sectors. An examination of the percentage of emissions for each pollutant by sector, shows that the transportation sector accounted for the largest portion of all pollutants except SO₂ for which the heating

sector was the major source. It was also determined that most particulate matter (96 per cent) was produced from diesel vehicles. City buses accounted for 65 per cent of total particulate emissions from vehicles.

Impacts of Air Pollution

The Korea Environment Institute (KEI) reported in 2001 that economic losses from air pollution nationwide in the Republic of Korea (ROK) ranged from 32 trillion won (US \$24 billion) to 60 billion (US \$45 billion) won in recent years, with an average figure of about 45 billion won (US \$34 billion). KEI based its figures on estimates of social damage caused by air pollution, including medical expenses for the treatment of respiratory disease, lost time and lower productivity of workers, losses in agriculture and fisheries production and expenses involved in repairing corrosion to structures. The economic loss figures, according to KEI, amounted to between 7 and 13 per cent of gross national income. However, losses from carbon dioxide pollution were not included. (MOE, 2002)

In addition, during the yellow dust storm phenomenon in the spring, when transboundary air pollution combines with dust storms from the deserts of northern China and Mongolia, there have been serious health impacts on the citizens of Seoul. According to the Korea Meteorological Administration, on 21 March 2002, the PM₁₀ levels reached a peak of 1,407 µg/m³, nearly 10 times the environmental standard of 150 µg/m³. The number of deaths reported

on so-called 'yellow sand days' is higher than the daily average and in particular, deaths attributed to cardiovascular and respiratory problems rise dramatically. Research tracing the rate of deaths among Seoul residents from March to May, 1995-1998, showed the death rate on yellow sand days to be 1.7 per cent greater than on normal days, everything else being equal. Deaths related to cardiovascular illnesses, asthma and other respiratory illnesses increased by 4.1 per cent, and the death rate in people over 65 years old went up 2.2 per cent. Upon inhalation, the tiny particles can enter the lungs, causing pneumonia or thrombosis, and aggravating cardiovascular conditions. During the study period, PM₁₀ concentrations on yellow sand days averaged 101 µg/m³ compared to an average of 73 µg/m³ on days without the yellow sand (Kim, 2002)

Enforcement and Control Strategies

In the ROK, environmental quality standards pertaining to six air pollutants, as well as that of noise, apply to the entire country (see Table 3.10.1). Each local government also has the authority to enact their municipal ordinances for environmental quality standards in consideration of characteristics of regions under its jurisdiction. The City of Seoul implemented new air quality standards in March 1998 which are more stringent than the national standards for SO₂, NO₂ and PM₁₀.

Emission standards for Seoul, the same as the ROK national standards, have been set for 26 substances

Table 3.10.1 Ambient Air Quality Standards

Pollutant	Averaging Time	KOREA (ppm)	SEOUL (ppm)	U. S.A. (ppm)
SO ₂	Annual Avg.	0.02	0.01	0.03
	24 Hours	0.05	0.04	0.14
	1 Hour	0.15	0.12	NA
CO	8 Hours	9	9	9
	1 Hour	25	25	35
NO ₂	Annual Avg.	0.05	0.04	0.053
	24 Hours	0.08	0.07	NA
	1 Hour	0.15	0.14	NA
O ₃	8 Hours	0.06	0.06	NA
	1 Hour	0.10	0.10	0.12
PM10	Annual Avg.	70 µg/m ³	60	50 µg/m ³
	24 Hours	150 µg/m ³	120	150 µg/m ³
Pb	Annual	0.5 µg/m ³	1.0 (Quarter)	1.5 µg/m ³

Source: Ministry of Legislation Korea (2002)
Seoul Metropolitan Government (2001)

including six major air pollutants. These were strengthened in February 1991 by up to 80 per cent. ROK's new emission standards, issued on 1st January 1999, are comparable to those of Europe and North America.

A combination of strategies and legislation by the Seoul Metropolitan Government and the MOE has produced some effective measures for the preservation of air quality in Seoul. The City of Seoul has been taking various measures to reduce air pollution: expansion of clean fuel supply, mandatory installation of car exhaust filtration devices, implementation of SO₂ control measures and the operation of environment vigilante. As a result, the SO₂ concentrations in Seoul in 1999 were lower than the WHO-recommended guidelines. (Seoul, 2001)

In order to raise awareness of air pollution in Seoul, MOE launched the 'Ozone Alert System' in July 1995 to alert the public when the concentration of O₃ exceeds specific standards so that the damage to human health and living environment may be minimized. The system was expanded in 1997 to cover the other large cities in the ROK. An 'Ozone Warning System' is also in operation along with the Ozone Alert System in Seoul. Furthermore, since high SO₂ levels are a problem, and fuel combustion in factories, households, motor vehicles and power plants account for the most part of all SO₂ emissions, the MOE has implemented the following:

- expansion of the low-sulphur oil supply;
- obligatory use of clean burning fuels;
- expansion of district heating systems; and
- regulation of solid fuel (coal) consumption.

As a result, SO₂ levels in Seoul were drastically reduced in 1996 compared to 1980 which was before many of these measures were implemented. In order to reduce air pollution by VOCs, the Ministry of Environment has designated Seoul and other large cities as Air Pollution Countermeasure Areas in July 1997. Starting in 1999, those facilities in Seoul, such as gas stations, oil storage facilities, and oil refineries which discharge VOCs with vapour pressures above 27.6 kPa, are required to install emission control facilities and preventive measures. The Seoul Metropolitan Government and national government have also tried to regulate the large number of construction sites to reduce fugitive dust emissions. The improvement in Seoul's air in the past few years is also result of the replacement of coal by cleaner fuels, such as liquefied natural gas (LNG) and low sulphur fuels, for individual household heating and various types of commercial energy consumption. These efforts were particularly effective in reducing the winter-time air pollution, so

that over 70 per cent reductions in the winter-time concentrations of SO₂ and TSP have been achieved during the last decade. In addition, more than a 50 per cent reduction in CO has been achieved during the same period. However, NO_x concentrations have remained at almost the same level for the last decade. Considering the rapid increases in total energy consumption and motor vehicle numbers over this period, maintaining NO_x pollution at this level should not be considered a failure.

To address the problem of transboundary air pollution, the MOE and City of Seoul are pursuing international cooperation more aggressively. Also, prevention of asbestos dust pollution is a high priority and several asbestos dust prevention measures have been taken. Since 1992, asbestos automobile brake pads have been replaced with substitute materials. The Ministry of Labour has also established an industrial health standard limiting asbestos concentrations in the air of workplaces to two particles per cubic centimetre.

Seoul plans to build on its existing air quality measures through stricter standards and goals. The Air Quality Management Plan of Seoul for the new Millennium includes a NO_x reduction target of 10 per cent, further reductions in SO₂, fugitive dust emission reductions and other air quality management plans.

Conclusions

Seoul has a very high air quality management capability. In response to increasing pollution, particularly from mobile sources, it has enacted many policies and enforcement strategies in the transport and energy sectors. The national and municipal government also have harmonized air quality management plans and air quality monitoring data. The Seoul Metropolitan government has enforced stricter standards and more comprehensive air quality management plans than the national government, and these efforts have resulted in some abatement of the problem. However, as the ROK is not yet a fully developed country, it should be noted that air-quality plans and regulation implementations are heavily dependant on the national economic situation.