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3.3 Busan

Situational Analysis

Busan is located on the south-eastern tip of the Korean Peninsula at longitude 128° east and latitude 35° north. It is an international city linking the continent and the sea. Busan's location is similar to that of Tokyo, Kabul, Los Angeles, Memphis, Beirut and Algiers as it is prone to high pollution levels due to inland winds that carry pollution from coastal sources and land breezes that carry pollution from the peninsula. Busan has a population of 3,812,400 with 1,120,186 households and a population density of 4,831 persons/km². In Busan, the number of vehicles was 234,936 in 1989 and 760,699 in 1999 giving an average growth rate of 22 per cent per year. The number of vehicles in 2001 was 862,699 of which 68 per cent were passenger cars and 29 per cent were diesel-fuelled. Freight vehicles accounted for 22 per cent of the total and it is these vehicles that tend to cause traffic congestion, and incur additional costs and air pollution (Busan, 2001a).

Air Quality Trends

In Busan, the levels of sulphur dioxide (SO₂) and total suspended particulate matter (TSP) have decreased over recent years due to clean fuel policies initiated by the local and national governments and strict control of dust emissions. The levels of nitrogen dioxide (NO₂) increased steadily until 1996 when they started to decrease. Currently however, the concentrations of NO₂ have levelled off. On the other hand, ozone (O₃) is continually increasing, so the Busan Metropolitan Government has taken measures to alleviate the problem with a fleet of CNG buses (Busan, 2001b).

For particulate matter (PM), TSP pollution levels have been measured since 1984 and from 1995 onwards, monitoring has been extended to include PM₁₀ (particulate matter with diameters less than 10 µm in diameter), particles of this size being of most relevance for human health. In January 2000, all PM monitoring instruments were converted to measure PM₁₀ only.

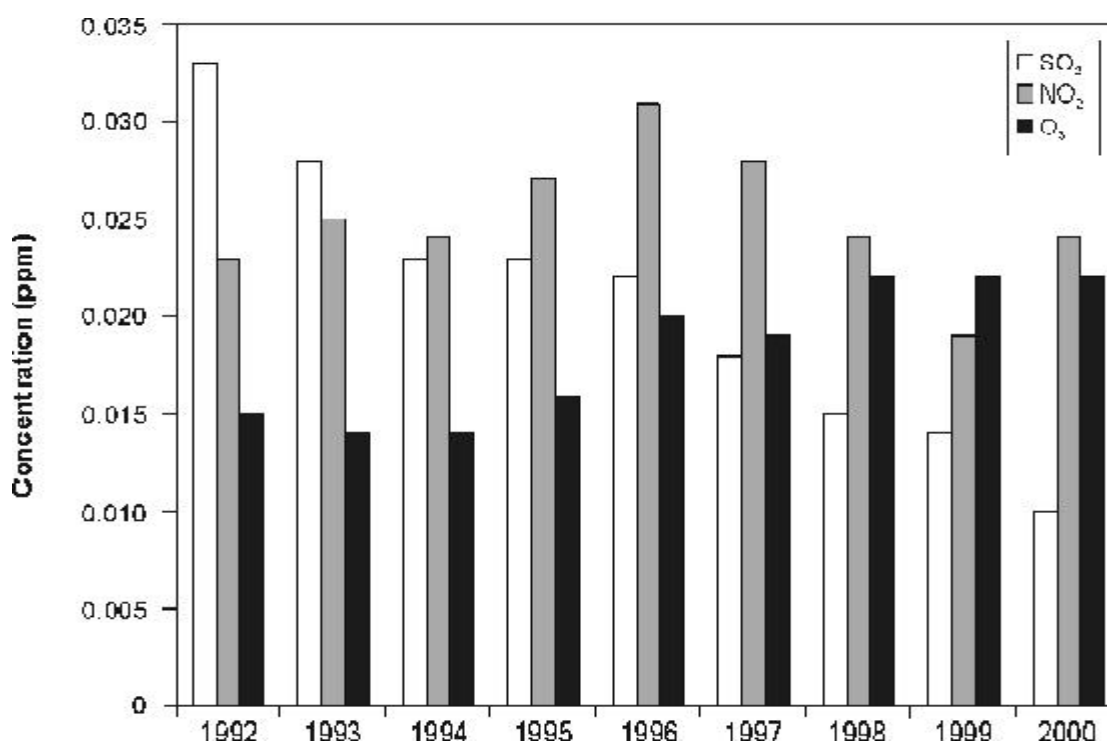


Figure 3.3.1 Mean concentration trends for air pollutants in Busan (1992–2000)
Source: MOE (2001)

Air Quality Monitoring

Busan presently monitors 47 air pollutants under the current National Air Quality Conservation Law of six (PM_{10} , SO_2 , nitrogen oxides (NOx), carbon monoxide (CO), and O_3) are continuously monitored by automatic stations. The first monitoring station was established in 1976 and currently Busan has 14 auto-monitoring stations (Figure 3.3.2) (Busan, 2001b).

Busan has an emission inventory system that accounts for SO_2 , nitrogen dioxide (NO_2), CO, PM_{10} and hydrocarbons (HC). This emission inventory is

compiled using energy consumption and transportation activity data and is reported by the Ministry of Environment of Korea (MOE, 2002). Table 3.3.1 shows air pollutant emissions by sector in the city of Busan. The data show that the majority of air pollutants in Busan are emitted by the transportation sector (e.g. 87 per cent of NO_2 and 97 per cent of CO).

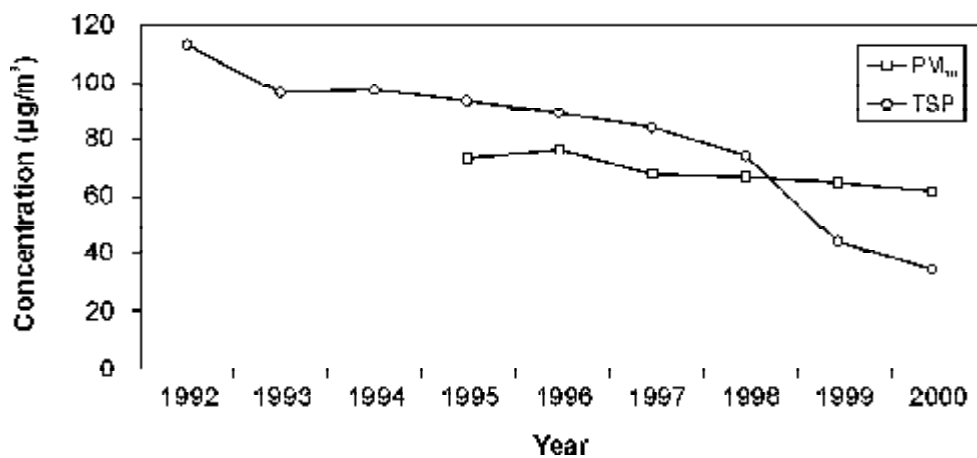


Figure 3.3.2. Mean particulate matter concentration trends for Busan (1992-2000)
Source: MOE (2001)



Figure 3.3.3 Location of Busan's automatic monitoring stations
Source: Busan (2001b)

Table 3.3.1 Air pollutant emission inventory for Busan, 2000 (ton/year)

	Total	Mobile Source	Sub-Total	Industry	Heating
SO ₂	128,349	119,461	8,888	6,294	2,594
NO ₂	76,993	66,903	10,090	3,346	6,744
PM-10	12,541	11,354	1,187	870	317
CO	80,588	78,081	2,507	386	2,121
HC	13,286	13,055	231	69	162

Source : MOE (2002), Environmental Statistics Yearbook (2001) by Ministry of Environment, Korea

Impacts of Air Pollution

There are no studies that have examined the impacts of air pollution in Busan. However, one can infer the economic impacts on the city and people of Busan from Korean national studies. 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 trillion won (US \$45 billion) in recent years, with an average figure of about 45 trillion 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).

Enforcement and Control Strategies

In the ROK, environmental air quality standards pertaining to six air pollutants, as well as that of noise, apply to the entire country including Busan city. Each local government also has the authority to enact municipal ordinances for environmental quality standards taking into consideration the characteristics of the region under its jurisdiction. However, the City of Busan does not have its own air quality standards and follows the national air quality standards.

Emission standards for Busan, the same as the ROK national standards, have been set for 26 substances. These standards were strengthened in

Table 3.3.2 Ambient Air Quality Standards

Pollutant	Averaging time	ROK (ppm)	U.S.A. (ppm)
SO ₂	Annual	0.02	0.03
	24 hours	0.05	0.14
	1 hour	0.15	NA
CO	8 hours	9	9
	1 hour	25	35
NO ₂	Annual	0.05	0.053
	24 hours	0.08	NA
	1 hour	0.15	NA
O ₃	8 hours	0.06	NA
	1 hour	0.10	0.12
HC	Annual	Deleted	NA
	1 hour	Deleted	NA
TSP	Annual	Deleted	NA
	24 hours	Deleted	NA
PM ₁₀	Annual	70 µg/m ³	50 µg/m ³
	24 hours	150 µg/m ³	150 µg/m ³
Pb	Annual	0.5 µg/m ³	1.5 µg/m ³

Source: Ministry of Legislation Korea (2002)

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 Busan Metropolitan Government and the MOE has produced some effective measures for the preservation of air quality in Busan. The City of Busan has been taking various measures to reduce air pollution: expansion of clean fuel supply; mandatory installation of catalytic converters; implementation of SO₂ control measures; and the operation of environment vigilante. As a result, the concentrations of air pollutants in Busan in 2000 were much lower (MOE, 2001).

In order to raise awareness of air pollution in large cities, MOE launched the 'Ozone Alert System' in July 1995 to alert the public when the concentration of O₃ exceeds a specific standard 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 including Busan in the ROK. In Busan city an 'Ozone Warning System' has also been in operation from 2000. Furthermore, since high SO₂ levels can be a problem, and fuel combustion in factories, households, motor vehicles and power plants account for the major 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 Busan were drastically reduced by 2000 compared to levels in 1980 before many of these measures were implemented. The improvement in Busan's air in the past few years is also the result of the replacement of coal by cleaner fuels such as liquefied natural gas (LNG) and other low-sulphur fuels for domestic heating and various types of commercial energy consumption. These efforts were particularly effective 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 over 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. In order to reduce O₃ levels, Busan has regulated factories and other sources of ozone precursors.

Busan plans to build on its existing air quality measures through stricter air improvement targets. The Air Quality Management Plan of Busan for the new

Millennium was established in 2002 and it contains many countermeasures to reduce the emissions of NO_x, VOCs and PM₁₀. This plan also encompasses environmental guiding principles for the hosting of international events, such as 2002 FIFA Korea/Japan World Cup and the 2002 Asian Games. The Busan Metropolitan Government is currently considering the following plans in order to improve its air quality.

- Increasing the number of compressed natural gas (CNG) buses on the road to 1800 by 2010 and create public awareness campaigns to stimulate the use of natural gas vehicles.
- Enlarging the current subway system and other modes of public transport. Currently there are 73 subway stations (covering 70.5 km) with plans for a total of 110 stations (covering 111.3 km).
- Establishing telemetry monitoring systems (TMS) in larger emission monitoring stations (Currently there are 8 corporations controlling 10 stations with the goal in 2003 for 25 stations)
- Consolidating countermeasures to reduce O₃ by:
 - Introducing efforts to reduce emissions of O₃-precursors (such as NO_x, VOCs)
 - Raising public awareness about the harm of O₃ and encouraging their participation in anti-ozone campaigns.
 - Providing education to 730 factories which emit unacceptable amounts of VOCs including: gas stations, laundries, oil reservoirs, printing houses, etc.
 - Developing of new model for an O₃ forecasting system
 - Establishing of measuring stations for photochemical pollutants with a total of 3 stations by 2003
- Increasing the use of clean (environmentally friendly) fuels
 - Reducing the sulphur content of heavy oils from 0.5 per cent to 0.3 per cent from July 2001
 - Ensuring stricter management of factories that emit large volume of air pollutants and use petroleum. Conversion of factories currently using heavy oils and diesel fuels to the use of clean fuels such as LNG
 - Supporting the switching of small town buses and garbage trucks from using diesel fuel to LPG
 - Implementing a study on Gashol (mixed fuel: gasoline 90 per cent and alcohol 10 per cent)
- Introducing fugitive dust reduction measures
 - Reducing PM levels by 10 per cent by 2002 (below 56 µg/m³)

- Introducing stricter tests for emissions from diesel vehicles
- Installing vacuum-cleaning vehicles in each district
- Stricter control of factories that emit large volumes of air pollutants and suspended particulate matter
- Establishing re-afforestation projects at deforested sites
- Establishing sprinkler systems in schools
- Enforcing stricter vehicle emission inspections
 - Giving priority to smoke-emitting heavy duty vehicles like buses
 - Giving free vehicle emission tests and distributing public information about the impact from vehicle emissions
 - Issuing local ordinance on idling vehicles

Conclusions

Busan 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 have also harmonized air quality management plans and air quality monitoring data. The Busan Metropolitan government has established further comprehensive air quality management plans and will enforce the measures according to the time schedule. 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 national economic circumstances.