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3.12 Taipei

Situational Analysis and Urban Air Quality Trends

Air pollution in Taiwan is most obvious in Taipei – the country's capital and largest city. Located in northern Taiwan, Taipei essentially sits in a 'bowl' surrounded by mountains. While most other industrial centres in Taiwan are located along coastal areas, the unique topography of Taipei contributes to the city's high levels of air pollution.

The primary cause of urban air pollution in Taipei is the large number of motorbikes and scooters which are the main means of transportation for millions of the city's residents. There are approximately 15 million motorbikes in Taiwan, and the number is expected to continue growing at a rate of 1 million a year. Taiwan's Environmental Protection Agency (EPA) has attempted to solve its motorbike problem through several initiatives. In July 1999, the EPA began issuing monetary awards to residents who reported cars and motorbikes that emitted unusual amounts of dark exhaust. More recently, the agency has encouraged the purchase of exhaust-free electric motorbikes through generous subsidies of \$1,000 per vehicle. The overall number of motor vehicles has drastically increased following rises in GNP while road construction has failed to match the speed of this growth resulting in an overburdened road transportation system in the city. In recent years, the formation of the rapid transit network incorporated with transit buses makes the public transportation

system increasingly convenient. Citizens are also more willing to use public transportation instead of individual transportation means, thus slowing the growth in motor vehicle numbers.

Taipei describes ambient air pollution in terms of a pollutant standards index (PSI). Table 3.12.1 presents the air quality standards for Taipei in terms of the PSI for each pollutant. The PSI is determined by the exceedence of one or more of these air quality standards. In 1999, there were 189 days on which the PSI was more than 100, slightly more than the 174 exceedences of the previous year (1998). Between January and April 2000, there were 255 exceedences of the PSI due to the effect of a sandstorm from mainland China, although it has been estimated that the number of exceedences would have been 177 if the effects of the sandstorm are excluded. The goal of 197 exceedences was met in 2001.

According to monthly statistics, days with a PSI more than 100 caused by particulate matter (PM₁₀) mainly occur in the January–April period. Ozone (O₃) has its greatest impact on air quality in the April–September period.

Over the past few years, it has become increasingly clear that the occurrence of sandstorms in mainland China is a key factor influencing the island's air quality.

However, after excluding the sandstorm influence, the number of days with a PSI more than 100 recorded

Table 3.12.1 Air quality standards in Taipei for the year 2000

PSI	PM ₁₀ 24-hour averaging time µg/m ³	SO ₂ 24-hour averaging time ppb	CO 8-hour averaging time ppm	O ₃ 1-hour averaging time ppb	NO ₂ 1-hour averaging time ppb
50	50	30	4.5	60	-
100	150	140	9	120	-
200	350	300	15	200	600
300	420	600	30	400	1200
400	500	800	40	500	1600
500	600	1000	50	600	2000

by three out of the five air quality monitoring stations showed an annual decline from 1997–2000, while the remaining two stations showed a rise.

Air Quality Monitoring

Taipei City is located within the northern air quality control basin (Taipei County) and the Environmental Protection Agency (EPA) has set up 19 stations in this basin to monitor the air quality.

The Taiwan EPA has seven automatic monitoring stations in Taipei City, comprising five air quality monitoring stations, one traffic monitoring station and one meteorological station. As of 1998, there were 72 air quality monitoring stations in Taiwan including 4 traffic stations, 4 background stations, 3 industrial stations and 2 national park stations. There are five different types of air quality monitoring stations being operated in Taiwan: ambient stations, traffic air quality monitoring stations, industrial stations, national park air monitoring stations, and background air monitoring stations. Of these, only the first three types of monitoring station are used in Taipei City.

The monitored pollutants include sulphur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), particulate matter with diameters less than 10 microns (PM₁₀) and hydrocarbons (HC). They also include meteorological instruments measuring wind direction, wind speed, temperature, dew point and precipitation which help to make the air quality forecasts more exact. Traffic counters are set in the traffic air monitoring stations to determine the actual number of vehicles that pass by the stations. The atmospheric pressure and solar radiation monitoring data are used in support of air quality modelling.

The EPA considers the following criteria when siting the air monitoring stations in Taiwan:

1. The types of air monitoring stations;
2. The characteristics of pollutants;
3. Geometrical and meteorological conditions;
4. Population distribution and traffic conditions;
5. Easy to assess the effectiveness of emission control programs;
6. Urban developing plan.

The following considerations are taken into account by the EPA when sampling air pollutants:

1. Avoidance of direct influence by emitted pollutants;
2. Avoidance of buildings nearby which may interfere with air flow and pollutant concentrations;
3. Avoidance of buildings' surface which might be interfering with pollutant concentrations; and

4. The determination of probe height should consider the vertical distribution of pollutant concentrations.

To avoid interaction between the probe and sampling gas, a glass or Teflon tube is often used. Furthermore, heating or air conditioning systems are also often used to eliminate the moisture condensation of sample gas in the probe.

Impacts of Air Pollution

Numerous health studies on the adverse effects of air pollution on the health of children have been conducted in Taipei. In one study, the objective was to evaluate the effects of ambient air pollution on respiratory symptoms and diseases in school children, in addition to considering indoor air pollution. It was found that the school children in the urban communities had significantly more respiratory symptoms (day or night cough, chronic cough, shortness of breath, and nasal symptoms) and diseases (sinusitis, wheezing or asthma, allergic rhinitis and bronchitis) when compared with those living in the rural community (Chen *et al.*, 1998).

Enforcement and Control Strategies

The Environmental Protection Administration (EPA) of Taiwan is the main regulatory agency that oversees air pollution related policies. The regulatory framework of all air quality management policies are based on the following legislation: the Air Pollution Control Act (1992), Implementation Rules for the Air Pollution Control Act (1993), and the Ordinance for the Management of Agencies in Charge of the Testing of Pollutant Emissions and Noises Produced by Automobiles and Motorcycles (1998). Since Taipei was reorganized into a municipality, some air quality laws and regulations were amended to address urban air quality issues, and a specialized agency in the Taipei City Government has been set up to take charge of all environmental cleaning jobs, such as pollution control for air and water, control of unpleasant noise, environmental sterilization, and disposition of human manure and garbage. The Technical Division of the Bureau of Environmental Protection (EPB) of Taipei City oversees environmental quality inspections and monitoring.

For the past few years, the Taipei EPB has implemented a programme to improve air quality and

has succeeded in continuously reducing polluting emissions (Table 3.12.2). The major measures promoted to control air pollution include:

- Controlling Mobile sources – includes the promotion of low emission vehicles, the enhancement of testing and the elimination of high contamination vehicles, and so on.
- Controlling Point sources – reinforces the inspection of businesses such as restaurants, automobile repair shops, laundries, gas stations, and industrial facilities located in the city, as well providing assistance in improving emission controls.
- Controlling Fugitive sources – controlling pollutant emissions from construction sites and associated measures such as street-sweeping.
- Integrative Management project – overall air quality assessment and capacity building, and public awareness raising.

In order to reinforce the promotion of the National Environmental Protection Project, the EPB focuses on the characteristics of pollution in the city and the goal of reducing air pollutant emissions, and evaluates each enforcing instrument in order to draw up the ‘Policy of Restrain Air Pollution in Taipei Municipal’. As mentioned above, apart from a few point and fugitive sources, air pollution in the city mainly comes from motor vehicles. In order to control the mobile sources, the EPB has been formulating progressively stricter standards for vehicle emissions. Compared with the policies of other countries, the standards of Taipei are regarded as relatively strict. However, the experience of other countries has shown that, in addition to controlling mobile source emissions, traffic management practices are an important aspect of the overall transportation strategy. Traffic management

schemes can reduce traffic congestion, reduce engine idling time and reduce the number of kilometres travelled for the whole traffic fleet. Also, fuel consumption will be reduced so that total emissions to the atmosphere can be lessened.

With the air-pollution allowance subsidised by the Bureau of Transportation, Taipei city continuously enhances related control measures. The EPB has implemented a number of strategies to control mobile source emissions. These measures have included educating the public to undertake periodical maintenance and examination of their vehicles in order to ensure that the vehicle complies with environmental protection regulations. EPB projects in 2001, included:

- an examination of diesel vehicles exhaust fumes,
- an electric motorcycle promotion programme,
- publicizing periodic examinations of motorcycle exhaust,
- auditing and assessment of motorcycle exhaust
- periodic examination of petrol stations in Taipei City, and
- control and investigation of air pollution from mobile sources through roadside inspection of motorcycles.

Future strategies to control mobile sources in Taipei include:

- promotion of low-pollution vehicles (electric motorcycles, electric bicycles, liquefied petroleum gas (LPG) cars, compressed natural gas (CNG) buses, and those automobiles powered by other alternative fuels);
- surveys on pollution characteristics to facilitate formulating control counter measures;
- replacement of high-pollution vehicles with ones that comply with stricter emissions standards;
- promotion of automobile pollution control devices

Table 3.12.2 Effects of enforcing the reduction strategy for pollutants in Taipei

Total Suspended Particulates (TSP)	Reductions achieved mainly from point sources, the control programme for construction sites, and the improvement of the emission test for diesel vehicles
PM ₁₀	Reductions achieved mainly from the examination and spot checks of new automobiles, but also from the emission testing of diesel vehicles and the phase-out of diesel buses
Oxides of sulphur (SO _x)	Reductions achieved mainly from the control of the sulphur contained in diesel fuel and partly from the control of point sources
Oxides of nitrogen (NO _x), Non-methane hydrocarbons (NMHC), CO	In addition to reductions from fixed sources, NO _x , NMHC, and CO have also been reduced from mobile source. (e.g. by enacting stricter emission standards for exhausts). A secondary cause is the effect of exclusive lanes for buses and the chessboard-style road network of bus routes

Source: Taipei City Environmental Protection Bureau

through subsidies of diesel exhaust upgrades;

- reduction of motorcycle pollutant emissions through regular inspections, regulations and publicity campaigns; and
- medium-to-long term control strategies for mobile sources.

An overall assessment of transportation systems and traffic control strategies are also underway in Taipei.

In addition to the continual strengthening of emission controls for various air pollutants, the air pollution control strategy in Taipei City will also be required to address the emissions of greenhouse gases (GHGs). The EPB will increase citizens' awareness of climate change issues in order to reduce GHG emissions. Because mobile sources are the primary cause of air pollution in the city, the EPB will co-operate with the other city authorities concerned in order to increase the control of mobile sources and co-ordinate activities. Furthermore, due to advances in technology and lifestyle changes, the EPB is examining the most appropriate management and control measures. The aim of such actions is to maintain citizens' health,

enhance quality of life and protect the environment.

Conclusions

Taipei has one of the most comprehensive air quality management systems in Asia. Integration of national and municipal policies are updated regularly in accordance with current air quality needs. The national and Taipei city air quality monitoring systems are well established and have quality assurance and quality control for their measurements of most major ambient air pollutants.