3.6 Hong Kong

Situational Analysis and Urban Air Quality Trends

Hong Kong, now a Special Administrative Region (SAR) of China, is located to the southeast of Mainland China and comprises Hong Kong Island, the mountainous Kowloon (Jiulong) peninsula, and the New Territories. The hilly topography adds to the effect of the many high-rise buildings in the urban centres, restricting the flow of air and inhibiting dispersion of air pollutants, leading to a build up of smoke, respirable suspended particulates (RSP) and nitrogen oxide (NO_x) concentrations in the urban area and acute nuisances in the streets (Hong Kong EPD, 2002). Weather conditions also have very significant effects on the concentration of air pollutants, much more so than can be explained by day-to-day change in emissions. Hong Kong's position on the coast of the large Asian landmass, its rugged terrain and uneven coastlines mean that it is subject to prevailing summer and winter monsoons with strong land-sea breezes which can cause the local wind to deviate significantly from the prevailing situation. Pollution can thus be trapped locally. Usually the worst air pollution situation in Hong Kong occurs when it is on the edge of a typhoon, where humidity is low, wind is light and dispersion is weak. Similar situations also occur during the transition between the two monsoons in March–April or August–September. (Hong Kong EPD, 2002)

Hong Kong is one of Asia's largest commercial centres and one of its most developed. The industry of Hong Kong consists of the manufacture of consumer goods, such a toys, textiles and electronics, shipbuilding, cement manufacturing, steel and food processing. A large proportion of the city's production is for export; thus, the harbour is an important source of pollution. The main fuel used for domestic heating and cooking is town gas, followed by electricity and fuel oil. Hong Kong has four major coal and oil burning power-generation plants.

Private car ownership and usage are low compared to countries with similar per capita income. There are 340,568 licensed private cars, accounting for 64.8 per cent of all vehicles. However, the number of vehicles and the respective kilometres travelled has been steadily increasing in Hong Kong, thus leading to higher emissions. There are about 275 licensed vehicles for every kilometre of road and the topography makes it increasingly difficult to provide additional road capacity in the heavily built-up areas. However, Hong Kong has the world's only mass transit system (subway) that is financially self-sustaining because of the high level of public transport usage. Every day, over 11 million passenger journeys are made on an efficient and multi-modal public transport system which includes two high-capacity railways, trams, buses, minibuses, taxis and ferries. Public transport services are provided by private institutions or public corporations operated on prudent commercial principles and without direct subsidy from the Government. About 90 per cent of the population depend on public transport (Hong Kong EPD, 2001). Another significant factor in Hong Kong's transport is its relationship with Mainland China. In 2001, cross-border traffic consisted of 65 million tonnes by water and 38 million tonnes by land (Hong Kong EPD, 2000).

Hong Kong's major air pollution problem stems from mobile sources, particularly diesel emissions. Because of its high diesel vehicle usage, Hong Kong has higher levels of air pollutants associated with diesel emissions, i.e. particulates and nitrogen dioxide (NO_2), with the situation being worse at busy roadsides in high traffic areas. Sulphur dioxide (SO_2) levels in Hong Kong have improved since high sulphur fuels were banned in the early 1990s and are currently below WHO guideline levels (Figure 3.6.1). However, SO_2 still remains a problem because of the persistence of cheap, pirated, illegal, diesel fuel from China, which has a high sulphur content. It is estimated that 25 per cent of the diesel fuel used in Hong Kong is illegal, high-sulphur fuel.

NO_2 levels are below standard levels in ambient air readings (Figure 3.6.2) but violate standards at the roadside. Carbon monoxide (CO) levels are considered to be within guidelines as are ambient levels of lead (Pb) (Figures 3.6.3 and 3.6.4). Leaded gasoline is banned in Hong Kong.

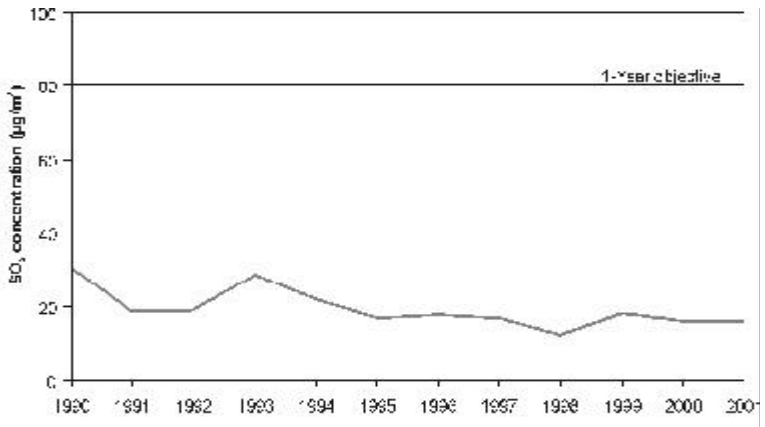

Figure 3.6.1 Long term trend in Hong Kong's general[1] ambient SO_2 concentration

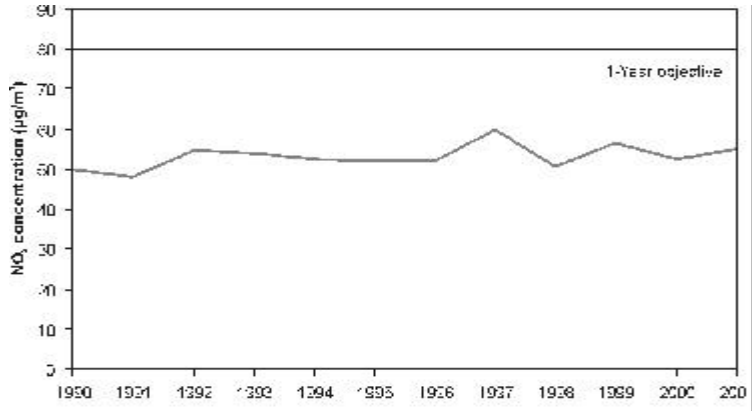

Figure 3.6.2 Long term trend in Hong Kong's general ambient NO_2 concentration

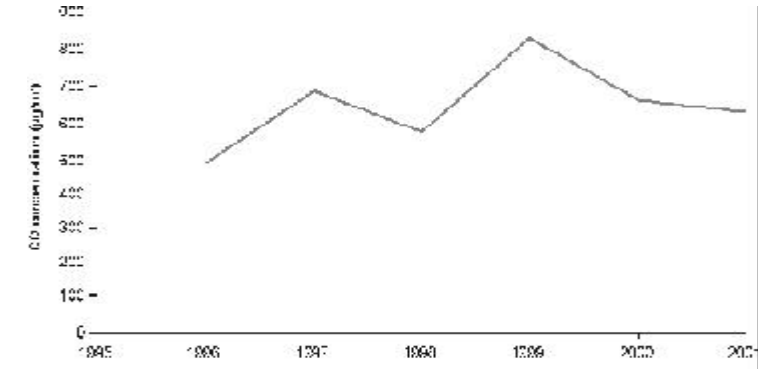

Figure 3.6.3 Long term trend in Hong Kong's general ambient CO concentration

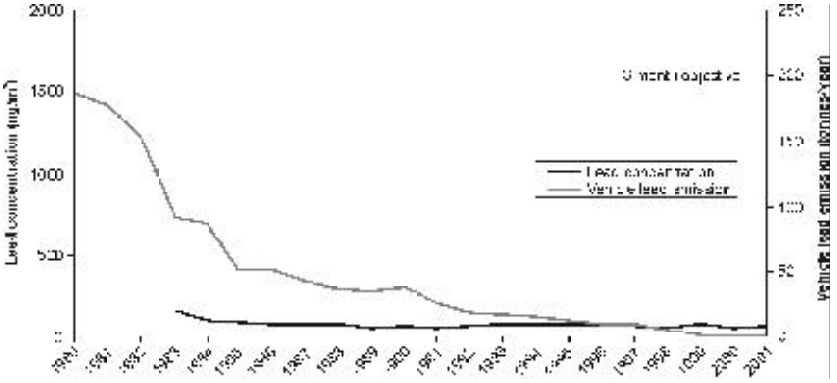

Figure 3.6.4 Long term trend in Hong Kong's general ambient lead concentration

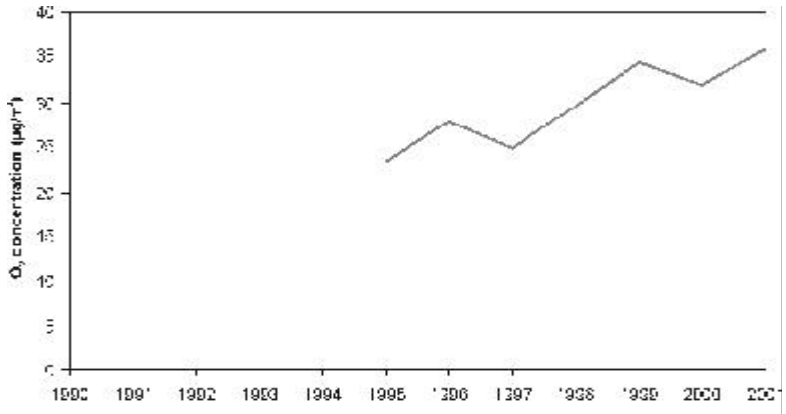

Figure 3.6.5 Long term trend in Hong Kong's general ambient ozone concentration

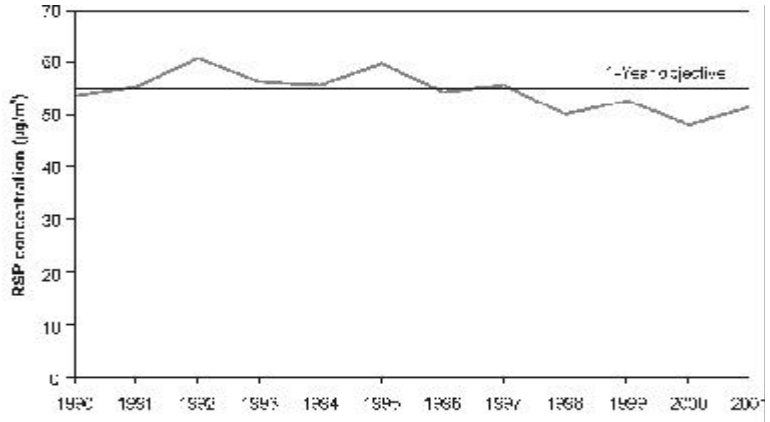

Figure 3.6.6 Long term trend in Hong Kong's general RSP concentration

There is an increasing trend of ozone (O_3) concentrations in Hong Kong (Figure 3.6.5). Ground level O_3 levels tend to be highest on sunny, windless days in Hong Kong, especially in the afternoon. O_3 levels have risen by at least 80 per cent in Hong Kong over the past decade.

Hong Kong's biggest air pollution problem is high levels of fine particulates, known as Respirable Suspended Particulates (RSP) (Figure 3.6.6). It is estimated that diesel vehicles account for 50 per cent of RSP in Hong Kong. In 1996, nearly half of those districts monitored failed to meet standards for RSP; only one of these monitoring stations, in Mong Kok, was then at street level. The level of RSP there was 50 per cent higher than the health standard and higher than the average concentration in Taipei, Tokyo, Los Angeles, London and New York (Hong Kong EPD, CD-ROM). A Government study of street level air pollution in Causeway Bay showed levels of more than twice the annual limits. (Hong Kong EPD, 1998)

Air Quality Monitoring

As of July 1999, the Hong Kong Environmental Protection Department's (EPD) air quality monitoring network (Figure 3.6.7) comprised fourteen fixed monitoring stations to meet the following objectives:

- To understand air pollution problems in order that cost-effective policies and solutions can be developed;
- To assess how far standards and targets are being achieved or violated;
- To assist the assessment of public's exposure to air pollution; and
- To provide public information on current and forecast air quality.

The network is designed and operated to meet the most stringent international QA/QC standards and is certified by the Hong Kong Laboratory Accreditation Scheme. In addition to the Hong Kong EPD monitoring stations, other independent monitoring units are operated, for example, those being operated by the

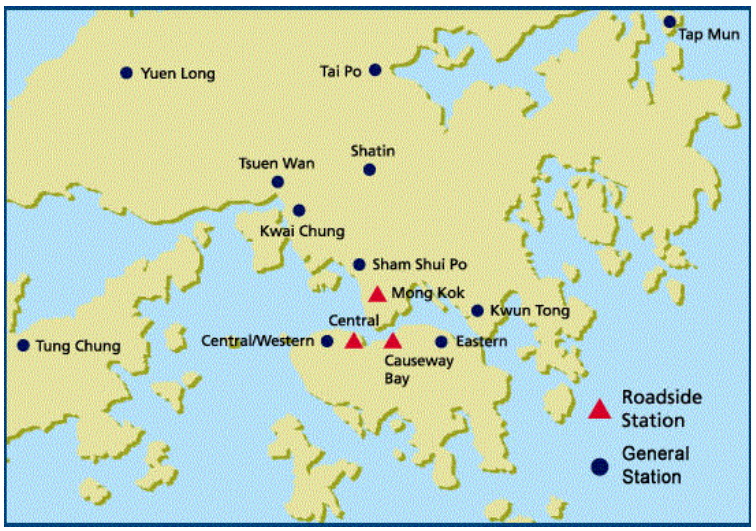

Figure 3.6.7 A map of the Hong Kong EDP monitoring stations

power companies in order to assess the air quality impact of their power stations.

Hong Kong uses an Air Pollution Index (API), which is a simple way of describing air pollution levels to provide timely information about air pollution to the public and to enhance awareness. Since June 1995, the EPD has been reporting the API and making a forecast for the following day. In Hong Kong, the API converts air pollution data from several types of pollutants into a value ranging from 0 to 500. Similar systems are widely used in many other places such as the United States, Singapore, Malaysia, Taiwan and the Philippines.

Starting from 1998, the Hong Kong EPD began reporting the urban roadside APIs. The roadside API provides information on the level of pollution very close to vehicle emission sources in busy streets and roads. The roadside API will, therefore, naturally be higher than the general API on a given day.

The Hong Kong EPD reports the latest general and roadside APIs hourly on their air quality monitoring website (see http://www.epd-asg.gov.hk). These indices are calculated by comparing the measured concentrations of the major air pollutants (NO_2, SO_2, O_3, CO and RSP) with their respective health related Air Quality Objectives (AQOs) established under the Air Pollution Control Ordinance. APIs for each of the five pollutants are calculated and the highest API number is reported as the API of that hour. The general API makes reference to the measurements at ambient monitoring stations located on 4 to 6-floor buildings.

Impacts of Air Pollution

The Hong Kong EPD commissioned various studies on the health effects of air pollution. Studies were conducted by the University of Hong Kong in 1997/98 to examine the short-term effects of ambient air pollution on public health, using available local data. The study revealed that, similar to other studies overseas, there were significant correlations between the level of individual criteria pollutants (i.e. NO_2, SO_2, RSP and O_3) and the hospital admissions and mortalities for respiratory and cardiovascular diseases. Based on the preliminary findings of the two health studies, an economic impact study was conducted to determine the economic values associated with the morbidity and mortality rates in Hong Kong attributable to ambient air pollution. The 'total' cost of illness (i.e. morbidity plus mortality) ranged from $ HK 9.7 million (for SO_2) to $ HK 73 million (for NO_2) for every microgram per cubic metre increase in the concentration of the single air pollutant. Higher values are obtained when using the willingness-to-pay approach, ranging from $ HK 16.7 million (for SO_2) to $ HK 105.1 million (for NO_2) for every microgram per cubic metre increase in the concentration level of the pollutant. The public are, in fact, exposed to multiple pollutants in the real situation and for that reason, a composite score model is used (as recommended in the study by the University of Hong Kong) to take into account the cumulative effect. The economic cost of morbidity and mortality is calculated using the composite score based on the

concentration levels of the individual criteria air pollutants at the respective annual averages. For 1996, the economic cost is estimated to be $ HK 3,841 million which is approximately equal to 0.35 per cent of Hong Kong's gross domestic product (GDP). For the purpose of reference only, the figure can be as high as $ HK 5,637 million or 0.51 per cent of the GDP when the willingness-to-pay approach is adopted.

Enforcement and Control Strategies

The Hong Kong EPD Air Division administers most of Hong Kong's air quality management under the Air Pollution Control Ordinance. The air quality objectives for Hong Kong are shown in Table 3.6.1.

The EPD has successfully used the following procedure to address some of Hong Kong's air pollution problems:

- Conduct air quality tests to find out the actual source of the air pollution problem;
- Inform the public to obtain their support;
- Form policies to tackle each problem;
- Continue monitoring to evaluate the results and effectiveness of the measures; and
- Revise policies if necessary.

With this system, Hong Kong has introduced the following legislation and control programmes to deal with specific air pollution problems in Hong Kong.

a) Control of Emissions from Stationary Sources

- Licensing control of major air polluting activities which are called specified processes (31 manufacturing processes which include power stations, petrochemical works, cement plants and incinerators);
- Control on the installation and modification design of furnaces, ovens and chimneys;
- Improved smoke emission standards;
- Introduction of cleaner industrial fuel with lower sulphur content;
- Prohibition of open burning of construction waste, tyres, cable and wire; and
- Control of dust emissions from construction activities.

b) Control of Emissions from Motor Vehicles

The Hong Kong Government has adopted an integrated motor vehicle emission control strategy which has 5 major elements:

- clean alternatives to diesel vehicles;
- stringent vehicle emission and fuel standards;
- strengthened emission inspection;
- strengthened enforcement against smokey vehicles; and
- education and publicity.

At the end of 1998, 75 per cent of petrol cars were fitted with 3-way catalytic converters and using unleaded petrol. Hong Kong's diesel vehicle emission standards are in line with European standards. Hong Kong's motor diesel standard is the cleanest in Asia with a sulphur content of 0.005 per cent. However, illegal high-sulphur diesel fuel from the Mainland poses a problem. A trial is in place to pave the way for full-scale introduction of liquefied petroleum gas (LPG) taxis.

Hong Kong has also committed itself to abatement measures for regional air pollution. Vehicles, industry and power plants in Hong Kong and the Pearl River Delta area all contribute to a regional air pollution problem, commonly seen as smog. The Hong Kong

Table 3.6.1 Hong Kong air quality objectives (in µg/m^3)

Air Pollutants	1-hour [1]	8-hour [2]	24-hour[2]	3-month	1-year
Sulphur dioxide	800	--	350	--	80
Nitrogen dioxide	300	--	150	--	80
Carbon monoxide	30000	10000	--	--	--
Ozone	240	--	--	--	--
Total suspended particulates	--	--	260	--	80
Respirable suspended particulates	--	--	180	--	55
Lead	--	--	--	1.5	--

Note: [1] Not to be exceeded more than three times per year
[2] Not to be exceeded more than once per year

and Guangdong governments are working on a joint plan to reduce the total amount of emissions and stop air quality from further deteriorating as soon as practicable, and in the long term to achieve good air quality for the whole region. (Hong Kong EPD, 2002).

Conclusions

About 90 per cent of the population depend on public transport and so private car ownership and usage are relatively low in Hong Kong. However, the number of vehicles and the respective kilometres travelled has been steadily increasing thus leading to higher emissions. Mobile sources are the major contributors to Hong Kong's air pollution – particularly diesel emissions (such as particulates and NO_x). Hong Kong's biggest air pollution problem is the high levels of Respirable Suspended Particulates (RSP). In 1996, nearly half of those districts monitored failed to meet RSP standards and a study of street-level air pollution showed levels of more than three times the annual limits. NO_2 levels frequently violate standards at the roadside and ground-level O_3 concentrations have risen 80 per cent over the past decade. Correlations between the level of air pollutants and hospital admissions and mortalities for respiratory and cardiovascular diseases are evidence of the negative impacts of Hong Kong's poor air quality.

The Hong Kong Environmental Protection Department has successfully addressed some of Hong Kong's air pollution problems by having a comprehensive monitoring programme combined with appropriate legislation, control programmes and public awareness-raising campaigns. In addition to legislation to control emissions from stationary sources, an integrated motor vehicle emission control strategy includes policies to introduce clean alternatives to diesel vehicles (e.g. LPG in taxis) and stringent vehicle emission and fuel standards.

Footnotes

[1] "General" refers to the general air quality measured at the General Air Quality Monitoring Stations (AQMS), which are located on top of 4 to 6 storey buildings. Air quality measured by the General AQMS represents the average outdoor ambient air quality in different districts in Hong Kong, including rural, urban and new towns.