

Assessing the impact of air pollution sources in Hong Kong, a densely populated city

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Abstract— As the simple dispersion model tested is not sufficiently accurate to predict the SO₂ concentration in complex terrain commonly encountered amongst high rise buildings in Hong Kong, and the lack of comprehensive local wind data at most sites prevents the use of more advanced dispersion model to assess the impact of major air pollutant sources, a receptor model approach is adopted for the apportionment of air pollution sources in Hong Kong. The preliminary results obtained are presented and discussed.

Keywords: environmental impact assessment; dispersion model; receptor model.

INTRODUCTION

As a result of the rise in the population of Hong Kong from 4 to 5.5 millions in the past 15 years (Census and Statistics Department, 1986), the availability of limited land area (about 100 km²), the associated rapid pace of economic and industrial development in recent years and the inadequate zoning allowance of the urban and industrial areas, a high degree of intermixing of the industrial and residential areas has occurred in several districts of Hong Kong, in particular at large established industrial areas. Moreover, most of the industries in Hong Kong are small in scale and housed in multi-storey buildings (SIT, 1978). This creates acute air pollution problems for Hong Kong, especially for the case of having multi-storey industrial buildings sitting next to large residential estates housing tens of thousands of people. This naturally leads to numerous complaints of air pollution from residents near major industrial areas.

Although legislation for controlling air pollution in Hong Kong had been introduced ten years ago, effective control measures were only taken in the past six years after the establishment of the Environmental Protection Agency (Environmental Protection Department since 1986) and the introduction of regulations specifying actions and guidelines used for enforcement (Environmental Protection Agency, 1984). As the prime objective of the law at present is to prevent the deterioration of existing air

quality, a knowledge about the existing relative contributions of major air pollution sources will provide important information for drafting realistic legislation for controlling major air pollution sources.

In collaboration with the Air Pollution Control Division in the Hong Kong Government, a survey was conducted to determine the chemical characteristics of air pollutants emitted from selected trades in Hong Kong which are at present under licence control (Fung, 1983 ; 1984; 1985; 1986) . The aim is to obtain the existing levels of emission and to form a data base for regulation use. A more thorough study had been conducted on major sources of air pollutant such as power stations and incinerators. Assessment of the impact of major air pollution sources on the air quality at nearby high population centers had been conducted at various sites in Hong Kong (Fung, 1986) . A simple dispersion model was tested for applicability in Hong Kong as it only required the input of fuel data and prevailing wind direction and speed. However, the results obtained are not sufficiently accurate to predict the SO₂ concentration in the complex terrain commonly encountered among high rise buildings in there. Thus, the receptor model approach was used to apportion the contribution of major air pollution sources at given sites. Preliminary results will be presented and discussed in this paper.

EXPERIMENTAL

Sampling of gas, vapour and particulate matter

For sampling of particulate matter in the stack, the EPA (U.S.A) method 5 was used and isokinetic conditions were maintained during sampling. For sampling ambient particulate matter, air was drawn through 0.8 μm millipore filter for 8 hours with normal air pumps. The pump rate was checked at the beginning and end of the collection cycle.

For sampling sulphur oxides and other gases in the stack, the EPA (U. S. A.) method 8 was used. Isokinetic conditions were similarly maintained as for particulate sampling and the flue gas was drawn for a given period of time through impinges containing suitable absorbing solutions.

For the sampling of organic vapours, two sampling methods were used, depending on the relative concentrations of the organic vapours. For stack sampling which normally involved a high concentration of organic vapour, glass sampling bulbs were used to collect snap samples. For ambient sampling, carbon absorption tubes were used for reconcentration in order to collect sufficient organic compounds for analysis.

Analysis of gases and particulate matter

The SO₂ levels were determined by the spectrophotometric method using pararosaniline as the dye. Potassium tetrachloromercurate complex (West, 1956; Scaringelli, 1967) was used to absorb SO₂ in the field and EDTA was added to reduce heavy metal interference. Formaldehyde was then added in the laboratory to release the sulfamic acid for reaction with pararosaniline to form the coloured complex with maximum absorbance at 548 nm. For analyzing stack gases, due to their high concentrations, the Orsat apparatus was used and the change in volume of the absorbing solution upon absorption of the gases was measured to indicate the percentage of the gas present.

For particulate matter analysis, the gravimetric analysis was performed using the Mettler AE 163 electronic semi-micro analytical balance. The membrane filter paper was weighed after precondition for at least 24 hours. For trace element determination, the Atomic Absorption Spectrophotometry and the ICP-AAS method were used for metal analysis. To avoid contamination, only distilled HNO₃ and demineralized water was used to dissolve the metal from the particulate matter for analysis; the recovery of metal was checked against NBS standard. Trace metals in blank filters were determined to a certain the accuracy of the analysis.

Analysis of organic vapours

Gas Chromatography was used for the analyses of organic vapours. Sampling bulbs were used for gas sampling. The standard organic vapours were generated using the headspace method by sampling vapours over pure organic solvents maintained at a given temperature in a sealed container with rubber septum. For sampling using charcoal absorption tube, the U. S. National Institute for Occupational Safety and Health analytical method (U. S. Department of Health and Human Services, 1984) was used, employing CS₂ as the solvent to elute the adsorbed organic compounds from the charcoal tube. The standards were similarly prepared using the same solvent. For detection, the Flame Ionization Detector was used and nitrogen or air with low hydrocarbon content was used as the carrier gas. Porapak Q was used as the column packing material.

Chemicals and materials

All chemicals used were A.R. grade and for those organic solvents used as standards in G.C. analyses, spectroscopic grades were required. For the scrubbing of SO₂ and SO₃ from flue gas, 100 ml 80% isopropanol and 100 ml 3% H₂O₂ were used respectively. The pararosaniline used for SO₂ analysis was purified by solvent extraction before use (West, 1956; Scaringelli, 1967). For the Orsat apparatus, KOH solution was used to absorb CO₂ and ammoniacal cuprous chloride solution was used to absorb CO (Vogel, 1969).

RESULTS AND DISCUSSION

As most industries in Hong Kong are light industry, with low energy content (Lin, 1983; Chou, 1983), there was no large scale air pollution problem till recently, with the increase in population, the proximity of the residential and industrial areas, and the building of large power stations and incinerators to keep pace with the expanding economy. This is clearly reflected by the distribution of the number of establishments in different trades in the manufacturing industry in Hong Kong as shown in Table 1 (Census and Statistics Department, 1986). The air pollution problem is highly localized and aggravated by the high population density and the limitation of space.

Table 1. The number of establishment in different trades in the manufacturing industry

| Trade | No. of establishment | Percentage, % |
|---|----------------------|---------------|
| Textile and clothes | 13129 | 28.5 |
| Metals and machinery | 12608 | 27.4 |
| Rubber and plastics | 5327 | 11.6 |
| Paper and printing | 4664 | 10.1 |
| Scientific, transport and controlling equipment | 2117 | 4.6 |
| Chemicals, petrochemicals and related products | 796 | 1.7 |
| Others | 7389 | 16.1 |

For economic and other reasons, the fuel for utilities in Hong Kong has switched from petroleum to coal in recent years, with subsequent increase of the output of air pollutants, especially the particulate matter emission. As result of above, virtually all power stations in Hong Kong are coal-fired except a small one at Ap Lei Chau which is in the process of decommissioning as at present. The rapid urbanization of the areas near the power stations and incinerators in recent years leads to concern about the environmental effect on the nearby population centers due to the emission of the pollutants. Thus, an impact assessment is needed to determine the extent of the problem.

In order to protect the public against uncontrolled emission of chemicals and particulate matter and to prevent further deterioration of the air quality, the Air Pollution Control Ordinance (Chapter 311) was revised in 1983, specifying air control zones and air quality objectives. Twenty-three industrial processes are put under licence control (Table 2). However, one needs to know the existing levels of emission before one can set realistic control levels. Thus, in cooperation with the Air Pollution

Control Division/Group in the Labour Department/Environmental Protection Department, a survey had been conducted to determine the levels of emission of particulate matters, organic and inorganic gases and vapours from selected trades in the specified 23 industrial processes at present under licence control. Methods for assessing the impact of the emission at the population centers near to major air pollution sources are also investigated, with an aim to find a simple, rapid and realistic method for assessing the environmental impact under local conditions.

Table 2 23 industrial processes currently under licence control for air pollution (Hong Kong Government, Air Pollution Control Ordinance, 1983)

| Items | Industrial process | Items | Industrial process |
|-------|----------------------|-------|-----------------------------|
| 1 | Acrylates works | 13 | Petrochemical works |
| 2 | Aluminium works | 14 | Sulphuric acid works |
| 3 | Cement works | 15 | Tar and bitumen works |
| 4 | Ceramic works | 16 | Frit works |
| 5 | Chlorine works | 17 | Lead works |
| 6 | Copper works | 18 | Amines works |
| 7 | Electricity works | 19 | Asbestos works |
| 8 | Gas works | 20 | Chemical incineration works |
| 9 | Iron and steel works | 21 | Hydrochloric acid works |
| 10 | Metal recovery works | 22 | Hydrogen cyanide works |
| 11 | Mineral works | 23 | Sulphide works |
| 12 | Incinerators | | |

The survey had been conducted in the summer months over the past four years (Fung, 1983; 1984; 1985; 1986) and several factories in each trade were selected in order to obtain as far as possible representative and realistic emission levels for that particular trade. Major pollutants emitted at the stack in each trade are identified and their levels of emission analyzed. Each site was visited 2 to 9 times, depending on the variability in the emission among different trades. The gas, vapour and particulate matter were sampled at the stacks and analyzed in the laboratory.

The results on the emission of particulate matter, organic and inorganic compounds from selected trades were reported (Fung, 1986; 1987) and are given in Table 3. In general, the sampling areas were selected in such a way that they represented the areas having the highest concentrations of the chemical compounds emitted from that particular trade. Most of the gases and inorganic vapours were sampled at the

stack whereas most of the organic vapours were sampled at the working area where the organic solvents were being used.

The levels of emission of particulate matter from selected trades are shown in Table 4. The results show that although the domestic waste incinerator and the asphalt plant emitted the highest concentration of particulate matter per volume of gas discharge, the power station gave the largest amount of particles due to its sheer volume of gas emitted everyday. Other major particulate emitters are the incinerators, asphalt plants and cement factories. In terms of particulate emission rate, the power stations, the incinerators and the cement factory clearly stand apart from other sources. All three power stations shown are coal-fired. The different dust loading is mainly due to the difference in the amount of fuel burnt per hour. However, the difference in the results amount the three incinerators is due mainly to the fact that incinerator C had installed an electrostatic precipitator and the others had not. The marked difference indicates the effectiveness of the electrostatic precipitator in reducing the dust loading of the emission.

Table 3 The levels of emission of organic and inorganic vapours and gases in selected trades*

| Trades | Chemical compounds emitted | Concentration detected, ppm | |
|-----------------|--------------------------------|-----------------------------|-------|
| Power station A | SO ₂ | 473 | |
| | H ₂ SO ₄ | 13 | |
| | NO _x | 37 | |
| | CO ₂ | 14.6% | |
| B | SO ₂ | 173 | |
| | H ₂ SO ₄ | 9 | |
| | NO _x | 192 | |
| | CO ₂ | 10.2% | |
| C | SO ₂ | 166 | |
| | H ₂ SO ₄ | 20 | |
| | NO _x | — | |
| | CO ₂ | 14.7% | |
| Incinerator A | NO ₂ | 65 | |
| | HCl | 33 | |
| | Cl ₂ | 0.043 | |
| | B | NO ₂ | 5 |
| | | HCl | 19.5 |
| | | Cl ₂ | 0.012 |

Table 3 (continued)

| Trades | Chemical compounds ⁺ emitted | Concentration ⁺ detected, ppm |
|--------------------------|---|--|
| Metal pickling plant | H ₂ SO ₄ | 5.1 |
| | HCl | 27 |
| | NO _x | 220 |
| | SO ₂ | 311 |
| Metal etching plant | NH ₃ | 277 |
| Metal recycling plant | Toluene | 131 |
| | Benzene | 21 |
| | Total aldehyde & ketone | 9.8 |
| Paint coating factory | Toluene | 39 |
| | Methyl ethyl ketone | 9.4 |
| | Xylene | 6.4 |
| Magnetic tap manufacture | Toluene | 200 |
| | Methyl ethyl ketone | 180 |
| Plastic recycling plant | Toluene | 150 |
| | Methyl ethyl ketone | 14 |
| Gas work | n-Hexane | 23 ppb |
| | Propylene | 0.26 ppb |

The samplings were taken during the summer over a three years period.

The number of visit ranges from 2 to 12, depending on different trades.

The concentrations are normally given in ppm, unless specify other concentrations.

For the assessment of the pollution problem due to mobile sources, the relative contribution of the mobile and the stationary sources are estimated using the World Health Organisation (1983) rapid assessment method. The method is based on the statistical interrelationship of source inventory and the pollutant emitted. Working tables are compiled to provide a link between all major pollution-causing and waste producing activities to the corresponding pollution and waste load factors. The reliability of the method depends on the accuracy of the inventory data and the refinements of sources to reflect local conditions more accurately. In general, reliable source of compiled statistic data should be used as far as possible so as to obtain a better

Table 4 The levels of emission of particulate matters from selected trades*

| | | Particulate concentration at 15 °C and 1 atm . pressure, mg . m ⁻³ | Particulate emission ⁺ rate, g.s ⁻¹ |
|--------------------------------------|---|--|---|
| Power stations | A | 50.5 | 32.4 |
| | B | 33.8 | 8.4 |
| | C | 43.5 | 15.6 |
| Incinerator | A | 482.4 | 6.1 |
| | B | 3030 | 10.7 |
| | C | 93.6 | 1.7 |
| Cement factory | | 37.9 | 7.3 |
| Asphalt plant | | 2300 | 4.9 |
| Clay factory | | 377 | 2.04 |
| Aluminium smelting plant | | 568 | 0.632 |
| Ceramic plant | | 59.1 | 0.585 |
| Dyeing factory | | 258 | 0.107 |
| Total particulate emission rate=90.5 | | | |

* The samplings were taken over a four years' period

+ The number of visits ranges from 3 to 11, depending on different trades

estimate of the emission data. The traffic data from the Transport Department (1986) was used for the compilation, which indicated 258, 396 registered vehicles and 61.8km were covered every day per vehicle. The results are shown in Table 5. Compared

Table 5 Air pollutants from mobile and major stationary sources

| | | Particulate | SO ₂ | NO _x | Hydrocarbon | CO | H ₂ SO ₄ | Cl ₂ | HCl |
|---|---|-------------|-----------------|-----------------|-------------|------|--------------------------------|-----------------|------|
| Vehicle emission* | | 66.5 | 22.2 | 610 | 1330 | 8870 | | | |
| Stationary sources* (Power stations) | A | 32.4 | 868 | 48.8 | | | 35.8 | | |
| | B | 8.4 | 123 | 97.9 | | | 9.9 | | |
| | C | 15.6 | 170 | - | | | 31.9 | | |
| Incinerators* | A | 6.1 | | 1.69 | | | | 1.72 | 0.68 |
| | B | 10.7 | | 0.036 | | | | 0.13 | 0.11 |

* All emission are expressed as g . s⁻¹ except Cl₂

The concentration of Cl₂ is expressed as mg . s⁻¹

All NO_x concentrations are calculated as NO₂

to the two major pollutants sources in Hong Kong, the power stations and the incinerators, automobiles are also major contributors of particulate matter, NO_x , CO and hydrocarbon, while the sulphur oxides come mainly from the stationary sources. A major air pollution problem from automobiles in Hong Kong is the poor lateral and vertical air dispersion in areas with large concentration of high rise buildings (Fung, 1986c; 1987a).

Due to the small size of most factories in Hong Kong (59.5% of the factories employed less than 100 persons in 1986, Table 6) and the limitation of space, most are located in multi-storey industrial buildings. The discharge of air pollutants would only be possible via chimneys put at the top of the high-rise industrial buildings. As a result of the intermixing of residential and industrial areas due to the prior city planning criteria of minimizing the volume of traffic between working and living places, it is often found that the pollution source and the residential areas are separated by < 100m among blocks of high-rise buildings. The generally available meteorological information is the prevailing wind data and no local wind data are available for the assessment. However, the air pollution controlling authority needs a rough estimate of the impact of the pollution source on the nearby residents before approving the selection of a chimney height at the top of the factory buildings. Thus, the simple dispersion formula developed by Warren Spring Laboratory which was adopted by the Department of the Environment of the Scottish Development Department and the Air Pollution Division in Hong Kong was tested for its applicability in Hong Kong. The reason for selecting this model is that it only requires the input of a minimum amount of data. Two parameters are calculated, the consideration distance

Table 6 The number of manufacturing establishments and person engaged analyzed by employment size as at September 1986 (Department of Labour and Mine. 1987)

| Size of establishments, persons | Percentage, ¹ % |
|---------------------------------|----------------------------|
| 1-9 | 14.2 |
| 10-19 | 10.8 |
| 20-49 | 18.0 |
| 50-99 | 16.5 |
| 100-199 | 13.8 |
| 200-499 | 13.9 |
| 500-999 | 7.4 |
| > 1000 | 5.4 |

¹ Total number of establishment: 48065

and the SO_2 concentration at a given site. The consideration distance refers to the horizontal distance from the source at which the SO_2 concentration attained the regulated level. It is calculated as:

$$\text{For } R_A < 74, \quad D = 16.5 R_A^{0.5} \quad (1)$$

$$\text{For } R_A > 74, \quad D = 5U, \quad (2)$$

where D = consideration distance, m

R_A = adjusted sulfur dioxide emission rate, $\text{kg} \cdot \text{h}^{-1}$

U = uncorrected chimney height, m

The following equation can be obtained for the calculation of the concentration of SO_2 at the nearby building:

$$C = 3 R_s / UL^2 \times 10^7, \quad (3)$$

where C – concentration of sulphur dioxide detected in $\mu\text{g}/\text{m}^3$; R_s – rate of emission of sulphur dioxide in lb/h ; U – mean wind speed in ft/s ; L – Length of the path of the plume in ft.

A given site was selected for testing the validity of the above formula. The site was selected because there was only one major air pollution source near the stack investigated, and it was well away from major traffic and other high rise buildings.

Two sampling stations, A and B , were set up with Station A closer to the chimney than station B (100 m and 140 m, respectively). No other structures near the sampling stations interfere with the normal dispersion of the plume. Also, the sampling stations are within the cone of a total 24 degree angle as required by the mathematical model.

The results are shown in Table 7. Due to the lack of comprehensive wind data at most of the sites, a yearly average wind speed of $4 \text{ m} \cdot \text{s}^{-1}$ is used to calculate the

Table 7 The test of the validity of the impaction formula

| | n | Mean | Standard deviation |
|--|-----|------|--------------------|
| A. SO_2 , $\mu\text{g} \cdot \text{m}^{-3}$ | | | |
| Calculated | 17 | 140 | 94 |
| Experimental | | | |
| Site A | 13 | 11 | 11 |
| Site B | 15 | 21 | 16 |
| B. Consideration distance, m | | | |
| Calculated | – | 61 | – |
| Experimental | 17 | 71 | 21 |

consideration distance with 40 ppm SO₂ as the ambient level. From the results obtained in Table 7, it can be seen that the difference between the calculated and the experimental consideration distance is within the statistical variation given the large standard deviation of the field data. As a result, a safety factor must be built in to reduce the frequency of exceeding the expected SO₂ levels during the year with adverse wind speed and directions.

On the other hand, a large difference is observed between the calculated and experimental SO₂ concentration which can not be explained by the statistical variation of the data due to the comparatively small relative standard deviation of the data for both stations *A* and *B*. The particularly low values of SO₂ detected at both sites indicates that dispersion at the sampling stations are good and the variability of the wind is high. Moreover, although air was sampled for 24 h, only the time when the chimney is on (17 h daily) was used in the calculation of the resulting average SO₂ level. Thus, the average SO₂ level would even be lower if the background SO₂ is also taken into account. The situation of the sampling stations at the top of a hill away from any high buildings and the local variability of the wind direction may be the factors that reduced the SO₂ concentration.

As a result of the difficulties encountered in using the dispersion model for predicting the pollutant concentrations under local conditions with lack of required meteorological data and the occurrence of rather complicated topography around most receptor sites, an alternative approach using the receptor model method was tested for its applicability for source apportionment use. The location of the sampling site and nearby major air pollution sources is shown in Fig.1. The sampling site was set at the roof top of a two-storey building with no high rise buildings in the near vicinity in Tuen Mum, a major residential area in the NW region of Hong Kong. The immediate surroundings of the site include a main road in a rural setting with no major air pollution sources nearby. As shown by our previous survey on the particulate inventory (Table 4), the major sources of air particulate matter are the power stations and incinerators. Two power stations are within 10 km of the sampling site, one at the SE and the other at the SW. The two nearby incinerators are situated at the ESE and SE of the sampling site. The major industrial area, Tsuen Wan, is situated towards the E of the sampling site. The sampling was done in a year and in all, 14 elements in the particulate matter collected were analyzed, and 50 data sets were taken at the Tuen Mum site.

The results obtained were analyzed by means of PCA and TTFA methods using principal component analysis with eigenvalue above 1. Six factors were successfully identified using the SAS statistical package. The results are shown in Table 8. Six similar factors were also isolated using Target Transformed Factor Analysis. The first

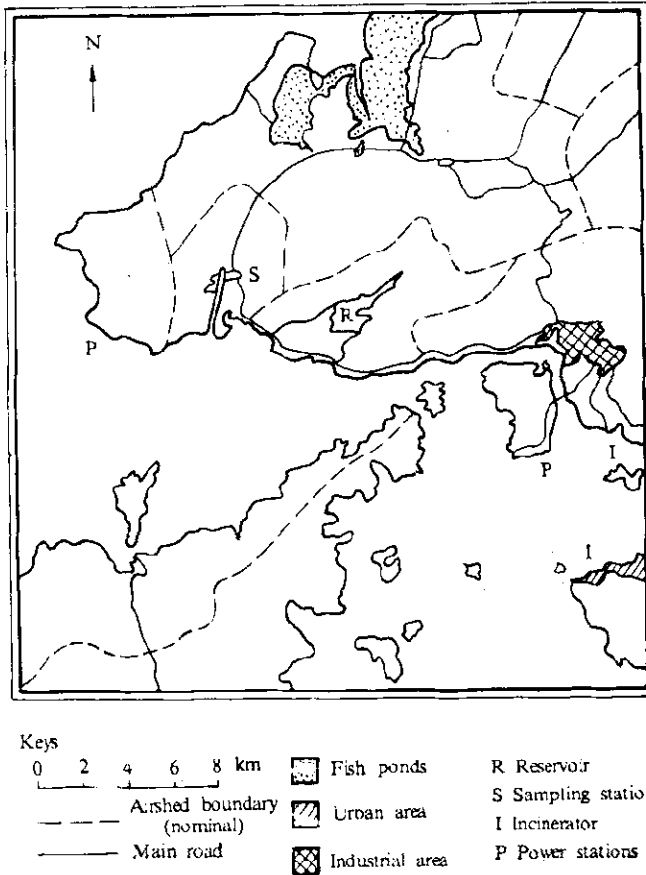


Fig. 1 Sketch map of north-western region of Hong Kong showing sampling site and nearby major air pollution sources

factor is related to the sea aerosol. The second factor which has a high loading on Fe, Mn and Ba would be related to wind blown dust. The third factor is the Ca source, which is attributed to nearby construction work, the fourth factor automobile and incineration, the fifth factor the oil combustion sources and the final factor the coal fired power plant. Regression analysis was performed on the data set to obtain the scaling coefficients. But after regression, the sea aerosol source gives a negative loading. This is probably due to the large variation of the source. The elements with large factor loading in the six sources identified are given in Table 9 together with the mass contribution of each of the sources. The mass contribution refers to the statistical average concentration of the factor identified as present in the particulate

matter collected during the sampling period. On the whole, the mass contribution for each of the sources resembles those reported in other urban areas in Hong Kong (Bower, 1986) except the oil combustion source which is larger than expected. The exceptionally large value of the oil combustion source would most likely be caused by the negative value generated by the sea aerosol factor. Work is under progress at present to solve the negative scaling factor problem.

Table 8 Factors loading for the six sources affecting the Tuen Mum area

| Elements | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 |
|----------|----------|----------|----------|----------|----------|----------|
| Mg | 0.8995 | 0.1533 | 0.1710 | -0.0902 | 0.0060 | -0.2850 |
| Na | 0.8736 | -0.2029 | 0.0467 | -0.0810 | 0.2463 | -0.2150 |
| Fe | 0.1987 | 0.8579 | 0.2407 | 0.0483 | -0.2170 | 0.0610 |
| Mn | -0.1975 | 0.8129 | 0.1057 | 0.2136 | 0.0037 | 0.2171 |
| Ba | -0.0833 | 0.5113 | 0.3069 | -0.2572 | -0.0594 | 0.0773 |
| Sr | 0.1691 | 0.1419 | 0.9152 | -0.0744 | -0.1296 | 0.0122 |
| Ca | 0.0134 | 0.3153 | 0.8795 | 0.0166 | -0.0974 | 0.0785 |
| Zn | -0.1444 | 0.0466 | -0.0473 | 0.8620 | 0.1174 | 0.1621 |
| Pb | -0.0662 | 0.0543 | -0.0094 | 0.7873 | 0.3204 | 0.0053 |
| V | 0.2548 | -0.1565 | -0.0623 | 0.0890 | 0.7037 | -0.1102 |
| Ca | 0.1161 | -0.1014 | -0.0764 | 0.3807 | 0.5119 | 0.0118 |
| S | -0.0373 | -0.0020 | -0.0797 | 0.1182 | 0.5052 | -0.0949 |
| Se | -0.2054 | 0.1798 | 0.0334 | 0.0108 | -0.1035 | 0.7411 |
| As | -0.4088 | 0.1293 | 0.0973 | 0.2712 | -0.1987 | 0.6643 |

Table 9 Elements with large factor loading and mass contribution of sources identified

| Factors | Elements with large factor loading | Sources identified | Mass contribution, $\text{mg} \cdot \text{m}^{-3}$ |
|---------|------------------------------------|-------------------------|--|
| 1 | Mg, Na | Sea aerosol | - |
| 2 | Fe, Mn, Ba | Wind blown dust | 7.14 |
| 3 | Sr, Ca | Construction work | 6.48 |
| 4 | Zn, Pb | Automobile/incineration | 1.93 |
| 5 | S, V | Oil combustion sources | 8.15 |
| 6 | Se, As | Coal fired power plants | 4.92 |

CONCLUSIONS

Hong Kong was late in starting environmental protection as compared to most other major cities in the world and, at present, the main thrust for environmental pro-

tection is to prevent the air quality from further deterioration. An objective assessment of the existing air quality and pollution sources is important for setting up guidelines and standards for control purposes. The identification and apportionment of major air pollution sources at receptor sites with high population density is essential for settling disputes between the industrial sector and the residents in the adjacent housing estates. It will provide a better perspective for setting the priority for the protection measure taken to remedy the situation. A survey has been conducted for identifying the types of pollutants and determining their concentrations in the stacks or fugitive emission from the industries and trades under licence control at present in Hong Kong. Due to the lack of comprehensive meteorological data, a simple dispersion model developed by the Warren Spring Laboratory has been tested in one selected site in Hong Kong as it only requires the input data on the fuel consumption and the prevailing wind speed and direction. However, the results obtained are not accurate enough for predicting the pollutant levels dispersed in the rather complicated topology among high rise buildings. As the lack of local wind data for most sites in Hong Kong prevents the use of more advanced dispersion model for predicting pollutant dispersion in complex terrain, a programme has been started for using the receptor model approach to assess the input of major air pollution sources on nearby population centers. Six major pollution sources identified at the Tuen Mum site attributed to sea aerosol, wind blown dust, construction work, automobile/incineration, oil combustion sources and coal-fired power plants. The mass contribution of each of the sources are estimated using the target transform factor analysis method. On the whole, the results obtained are quite reasonable except for a larger than expected value of the oil combustion source and a negative sea aerosol factor. In conclusion, the receptor model approach as shown in the present investigation provides a satisfactory solution for apportioning pollution sources in highly urban areas in Hong Kong, given the constraint of lack of meteorological data and the variability of wind direction among high rise buildings with heavy traffic at street level.

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