Akademika 36 (Januari 1990) 33 - 49

Post Merdeka Development and Air Quality Degradation in Malaysia

SHAM SANI
JAMALUDDIN JAHI

ABSTRACT

Following rapid development particularly in the urban-industrial sector during the 1970–80 decade, the number of air pollution sources and emissions in Malaysia has correspondingly increased. Although the Clean Air Regulations under the Environmental Quality Act 1974 were gazetted in 1978, there have been some obvious problems relating to their effective implementation. This paper presents an appraisal of air quality situation in Malaysia with particular reference to air pollution potential, city-industrial effects, hazardous point sources and air quality management strategies. Illustrations from specific local examples are also presented.

ABSTRAK

Berikutan pembangunan pesat yang dialami terutamanya di sektor perbandaran-perindustrian dalam dekad 1970–80, jumlah punca dan keluaran pencemaran di Malaysia telah juga meningkat. Walaupun Peraturan Udara Bersih di bawah Akta Kualiti Alam Sekeling 1974 telah diwartakan pada 1978, terdapat berbagai masalah dalam mengimplementasikannya. Kertas ini mengutarakan suatu tinjauan mengenai keadaan kualiti udara di Malaysia dengan tumpuan khas kepada keupayaan pencemaran udara, akibat bandar-perindustrian, keluaran pencemaran daripada punca-punca bahaya dan strategi pengurusan kualiti udara. Gambaran daripada contoh-contoh tertentu juga diberikan.

INTRODUCTION

For a long time several observers have expressed the view that air pollution is never likely to be an important problem in Malaysia simply because the latter is generally well-endowed with ranfall in the order of 2 200 mm or more a year which can presumably do the cleaning up. Recent reports on the state of air quality in Malaysia and other tropical areas, however, have cast a considerable doubt on this assumption particularly in and around urban centres. This paper provides an overview of the state of air quality in Malaysia following the post-Merdeka development with particular reference to emissions and levels of pollution, air pollution potential, city-industrial effects, hazardous point sources and air quality management.

POST-MERDEKA DEVELOPMENT

The country's approach to planned development in the early years after Merdeka in 1957 followed closely the thinking of the growth-oriented economists. The five-year plans were very much oriented towards infrastructural and economic development with emphasis being placed on sectoral development, especially that of agriculture, mining and the primary industries with the main objective of promoting economic growth (Mohd Nor Abdul Ghani 1981). Meanwhile, infrastructural improvements were directed at facilitating the transportation of economic goods for marketing.

The introduction of the New Economic Policy (NEP) in 1970 brought about changes in the strategy for development. The NEP proceeded to focus attention on a two-pronged national goal, i.e. the eradication of poverty irrespective of race, and the restructuring of society so that economic vocation would no longer be identified with any one racial group. The economy was further diversified and in a way also decentralised with more and more land developed for agriculture and resettlement, new industrial estates being set-up outside the Klang Valley Region, and the provision of better and more modern infrastructure and transportation facilities.

Increased logging activities and an aggressive national land development programmes since Merdeka have resulted in large areas of forest being cleared. A survey in 1966 shows that in Peninsular Malaysia, about 9.1 million hectares of the total land area were under primary forest accounting for some 69 percent of the land (Lee 1973). Today, the land area under primary forest has decreased to around 6 million hectares. A large part of the cleared land had been used for agriculture, urban and industries. At present rubber occupies a total of 1.9 millon hectares; oil palm 1.5 million hectares; padi about 0.6 million hectares; cocoa about 0.3 million hectares; and coconut about 0.3 million hectares. The transformation of forest areas into agriculture is evident through land development by the Federal Land Development Authority (FELDA) and the various state land development authorities. FELDA alone, which in 1960 had opened up about 4,200 hectares, had developed about 600,000 hectares of former forest land by 1985, into agriculture. The agriculture development also saw the establishment of processing factories such as rubber factories and oil palm mills which are potential air pollution sources close to high population concentration areas.

Alongside agricultural development, urbanization process had also been rapid, fuelled by industrial growth and the provision of infrastructure and transport facilities. The rapid growth of urban areas, especially within the Klang Valley Region, had led to the problem of solid waste disposal and further problem of air pollution through open burning of solid wastes to add to the pollutants produced by domestic fuel burning. In fact more than 55 percent of the 210 refuse disposal sites in Peninsular Malaysia have been found to be practising open burning (Department of Environment 1986).

Various supportive industries were also opened up to cater for the rapid expansion of urban areas, housing, manufacturing and other industries, infrastructure and transport. Other industries such as quarries, cement works and steel mills whose operations are located either within or in the vicinity of urban areas for minimizing cost are also posing problems insofar as air pollution is concerned.

POLLUTION SOURCES AND EMISSIONS

Following rapid development, urbanization and industrial expansion over the last 15 years, the number of pollution sources in Malaysia has correspondingly increased. In 1957, the country had only two plywood factories, about 100 sawmills and 20 quarries (Tan 1982). According to the Department of Environment, in 1987 these have increased to over 8,000 including some 14 thermal power plants, 2,254 other fuel combustion sources, five cement plants, 305 quarries, 1,624 wood-based industries, 320 industrial process industries and 684 other mineral product industries, 57 petroleum industries, 1,258 rice mills and 346 metal industries. In addition, there were 4,005,172 registered vehicles in Peninsular Malaysia at the end of 1986 with 3,720,866 using petrol and 260,423 using diesel. In the larger urban centres, vehicular concentration is even more glaring particularly during peak periods. In the Klang Valley, latest estimates show that the annual air pollution load due to motor vehicles is as much as 78 percent (Department of Environment 1986). The latest traffic count by the Kuala Lumpur City Hall in 1986 at the Federal Territory Kuala Lumpur – Selangor border along the Kuala Lumpur – Klang Highway shows that the daily flow was in the region of 318,000.

The Department of Environment estimated that in 1987 some 1.9 million tonnes of air pollutants were released into the atmosphere as a result of fuel combustion in Peninsular Malaysia assuming no pollution control equipment was installed (for comparison the 1980 percentage is given in brackets). Of this, 63.5 percent (69.9 percent) were carbon monoxide, 14.1 percent (9.6 percent) sulphur oxides, 5.0 percent (8.1 percent) oxides of nitrogen, 16.2 percent (10.6 percent) hydrocarbons and 1.2 percent (1.8 percent) dust. Transportation (mainly motor vehicles) accounted for about 82.7 percent (82.1 percent) of the pollution load, the rest were contributed by burning of liquid fuel in boilders and power plants at 17.1 percent (11.4 percent) and the burning of solid wastes and agricultural wastes at 0.2 percent (6.5 percent). The estimates also show that petrol-powered vehicles accounted for about 97.8 percent (90 percent) of the 1.2 million tonnes of carbon monoxide and some 98.4 percent (86 percent) of the 307,691 tonnes of hydrocarbons. In 1980 industrial boilers and thermal power plants contributed more than 90 percent of the 223,000 tonnes of sulphur oxides besides an estimated 20,000 tonnes of particulates and 190,000 tonnes of carbon monoxide generated from six iron and steel works assuming no control equipment was used.

Meanwhile air monitoring results indicate that:

1. ambient air quality over 80 percent of the areas monitored in 1983 failed 50 or more percent of the time to comply with the proposed Malaysian standard for total suspended particulate matter of 75 $\mu g/m^3$. In Kuala Lumpur near Pudu, the standard was not met 99 percent of the time. In fact not a single area monitored was free from dust pollution at all times. According to the Department of Environment, in 1987 the air quality for most urban centres (69 percent) remain unsatisfactory. The large urban centres of Pulau Pinang, Petaling Jaya, Kuala Lumpur and Johor Bahru recorded annual mean value that ranged from 110.0 to 182.6 $\mu g/m^3$, far exceeding the acceptable proposed standard. Only Kuala Terengganu, Kuching, Shah Alam and Kota Kinabalu recorded annual mean values which were below the acceptable proposed standard.

2. The standard for sulphur dioxide (SO_2) was satisfactorily met in most areas monitored in 1983, except for two industrial areas in Johor Bahru and Prai (Department of Environment 1986).

3. Lead (Pb) level in the atmosphere remained high especially in the commercial areas of major cities, namely Kuala Lumpur and Georgetown. In 1982, the ambient standard for lead of 1.5 $\mu g/m^3$ was not met 75 percent of the time in Kuala Lumpur near Pudu, and 42 percent of the time in Bangsar and Georgetown (Department of Environment 1986). Following the reduction of Pb content in petrol to 0.4 mg/1 by July 1985 the ambient lead was somewhat lower than the pre-1985 levels in some parts of the Kuala Lumpur commercial areas but were still in excess of the WHO long-term goals. One of the main reasons for this was the continued increase of road traffic and the non-existence of gaseous emission standards (other than black smoke) to facilitate exhaust emission control.

4. Although carbon dioxide, oxides of nitrogen and ozone have not been wide spread, they are fast becoming serious problems in localised areas. The 8-hour average for carbon monoxide for some of the major roads in the Kuala Lumpur commercial area ranges from 5–16 p.p.m.

Levels as high as 50 p.p.m. or more have been recorded at some of these sites. Diurnal variations of oxides of nitrogen measured at the City Hall building persisted beyond the recommended level of 60 p.p.b. from 0630 to 1130 hours and from 1500 to 0130 hours. Likewise an increased ozone levels especially after noon was also observed indicating a significant photochemical reaction process during the period.

These figures, although somewhat sketchy and fragmented, illustrate the present state of air pollution in the country. It will be observed that especially in urban areas the levels for certain types of pollutants have already exceeded the long-term goals recommended by the W.H.O. However, studying these figures in isolation is not sufficient to fully appreciate the extent to which air quality will deteriorate in the future. The atmospheric component has to be taken into account simultaneously.

AIR POLLUTION POTENTIAL

Once air pollutants are released from their respective sources, what happens to them next will depend largely on the behaviour of the atmosphere especially the latter's ability to dilute and disperse pollutants.

The capability of the atmosphere to disperse pollutants is called the *air pollution potential,* a quantity independent of source distributions or strength. It is a function of two key meteorological factors, the *mixing depth* and the average wind speed through the mixing layer. The former is defined as the height above the earth's surface through which relatively vigorous vertical mixing occurs (Holzworth 1969 & 1974). The *ventilation volume* which is derived by multiplying the mixing depth and the average wind speed through the mixing layer gives an indication of air pollution potential in the area. The greater the ventilation the more pollutants are dispersed and diluted, and the smaller is the pollution hazard. On the other hand, the smaller the ventilation the less pollutants are dispersed, and the greater is the pollution hazards.

Observations based on data from Subang indicate that about 90 percent of the morning ventilation volumes fall within or below 2,000 m^3s^{-1} and 97 percent of the afternoon values belong to the category 6,000 m^3s^{-1} and less (Sham 1976 & 1980). Indeed, 85 percent of the morning values come within the category of 1,000 m^3s^{-1} or less and 84 percent of those in the afternoon fall in the category 2,500 m^3s^{-1} and less. The critical values used by the U.S. National Air Pollution Potential Forecasting Program (NAPPFP) to classify hazardous conditions are respectively 2,000 m^3s^{-1} for the morning and 6,000 m^3s^{-1} for the afternoon. Thus, if we use these as the basis of assessment, it becomes obvious that the situation of air pollution potential in the Klang Valley can be more serious than those observed in some mid-latitude locations like Los Angeles or New York (Figure 1).

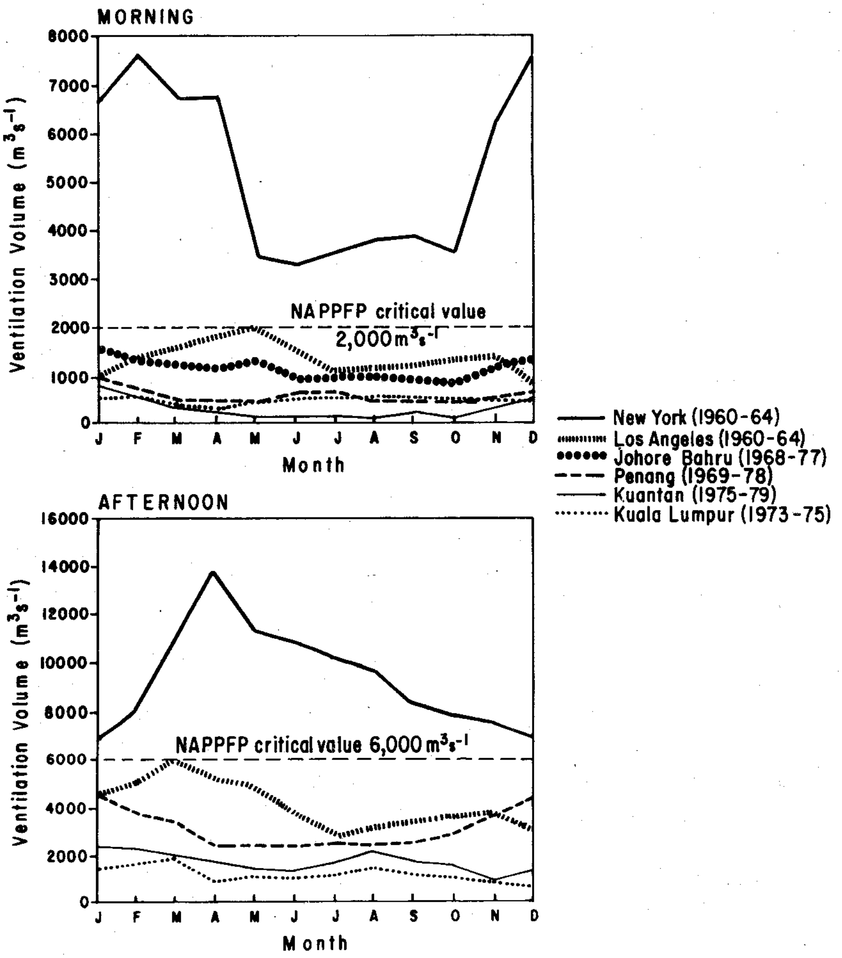

FIGURE 1. Monthly mean ventilation volume at Los Angeles and New York and some selected Malaysian cities

Similar assessments of air pollution potential for Pulau Pinang, Johor Bahru and Kuantan show that the atmospheric capability in those places was also restrictive (see Lim 1980; Zainab Siraj 1980; Kiftiah Razak 1981) in as much it was for the entire low latitude areas of Southeast Asia (Sham 1984a).

THE CITY EFFECT

The situation obviously becomes more complex in city areas. Here, following the modification of the atmosphere by urbanization, pollution dispersion takes place in a manner different from those observed in rural areas.

Observations carried out over the last 15 years in the Klang Valley indicate that the commercial centres are usually several degrees warmer than the surrounding country-side (Sham 1973, 1979, 1980). On the average, the mean annual temperature difference between the city and the airport was approximately 1–2°C but under calm nights, the urban-rural temperature differential could go up to 8°C (Sham 1984b). The maximum intensity of the heat island for some selected urban centres in Malaysia is shown in Table 1.

TABLE 1. Intensity of heat island for selected urban centres in Malaysia

Centre	Maximum heat island (°C)	Source
Kuala Lumpur–	6	Sham (1973, 1979)
Petaling Jaya	8	Sham (1984b)
Georgetown	4	Lim (1980)
Johor Bahru	3	Zainab Siraj (1980)
Kota Kinabalu	3	Sham (1983)

Recent study on the effects of the merging Klang Valley conurbation on temperatures (Sham 1986) indicate the following major points:

1. Maximum temperatures roughly coincide with built-up areas. Generally this is true during both day and night although the day-time temperature distribution patterns appear to be more irregular than those at night. During the day, maximum temperatures can also occur outside the commercial centres.

2. In the Klang Valley, relatively steep temperature gradients were observed at the periphery of each settlement area or city.

3. In each of the urban settlements within the conurbation, there can occur several heat islands and a number of cool islands indicating the sensitivity of temperatures to land use types.

4 Maximum afternoon temperatures occur most frequently in the relatively newer settlements. In the more established areas where mature trees have grown to provide shades, the maximum temperatures were lower.

5. It was also noted that the heat island intensity for Kuala Lumpur in the survey was smaller ranging from 2°–4°C compared to a similar survey earlier (Sham 1984b). This could be attributed partly to the possible influence of the tree-planting programme of the City Hall or the rapidity with which the surface features of the surrounding area has been modified over the last few years or both.

6. Proximity to the sea does not necessarily ensure cooler afternoon condition and lower temperatures. In the survey, Port Klang recorded one

of the highest afternoon temperatures in the Klang Valley area despite its close proximity to the sea. Obstruction of the sea breeze by buildings standing close together may have caused a 'shadow' effect resulting in higher afternoon temperatures. A similar situation was also observed in Kota Kinabalu and Georgetown, Pulau Pinang (Sham 1983 & 1981).

7. Data from the longer meteorological records show that during the period 1971–83, the mean annual minimum temperature from urban Petaling Jaya 0.6°C higher than that of the airport. There was also an overall increase of mean annual minimum temperatures by 0.7°C for Petaling Jaya and 0.9°C for Subang Airport for the period 1969–83.

8. The five-month running means of minimum temperatures for Petaling Jaya for 1971 to 1983 indicates that there has been an overall increase of about 1.2°C with a marked upward swing round about 1976–77. A similar pattern was also observed at Subang Airport. In this case the overall increase of mean minimum temperatures was smaller, in the region of 0.5°C with a marked upward swing round about 1977–78.

9. An analysis of the number of months in a year having minimum temperatures greater than the period average (1969–83) indicates that there is an increase of nearly 80 percent when the first and second half of the period are compared. A similar pattern was also observed for Petaling Jaya; the corresponding increase was nearly 100 percent.

10. An analysis of the number of days, with temperatures less than 22.8°C (the average minimum temperature for Subang) at Subang Airport and Petaling Jaya shows that for the period 1971–83, the average number of cooler day at Subang Airport was in excess of that in Petaling Jaya by 61 days or 164 percent. For individual years, the figure ranges from 20 days (1980) to 124 days (1978).

11. Similarly an analysis of the number of days with temperature greater than 23.4°C (the average minimum temperature for Petaling Jaya) at Subang Airport and Petaling Jaya indicates that for the period as a whole, the average excess of Petaling Jaya over Subang Airport was 113 days or 113.3 percent. For individual years, the figure ranges from 64 days (29.0 percent) in 1983 to 265 days (464.9 percent) in 1977.

The effect of urbanization is not only confined to horizontal distribution of temperatures but also to those in the vertical direction with far-reaching consequence. Overseas studies (Oke 1974 & 1979) have shown that the thermal influence of a large city commonly extends up to 200–300 m and even to 500 m and more. When the warm air is advected by the wind, an urban 'plume' in the downwind region is formed; in calm condition, an urban 'dome' may be created (Figure 2). Under the latter condition at night, the city can even create its own circulation with wind blowing from the cooler surrounding area into the warm city centre bringing with it plume from the outskirts into the city area. In both cases, however, these modified

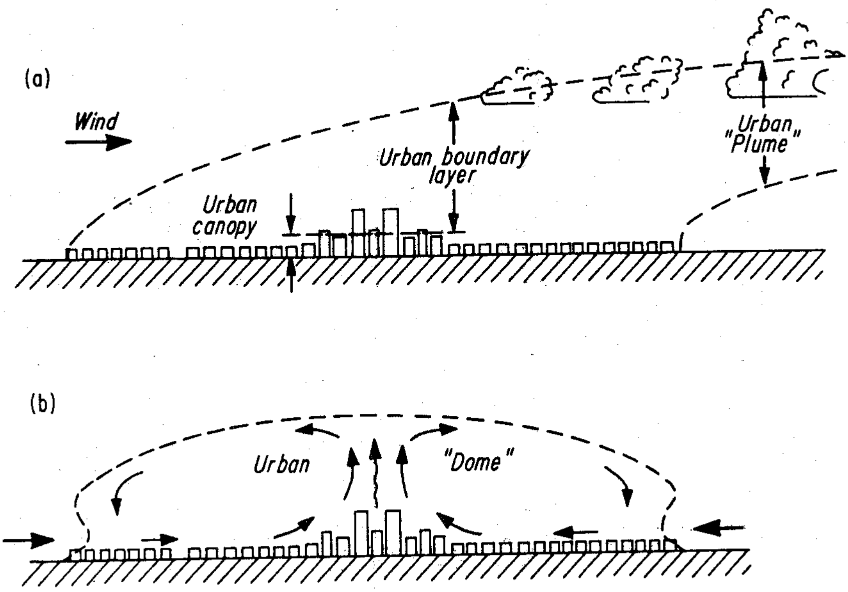

FIGURE 2. Schematic representation of the form of the air layer modified by a city
(a) with steady regional airflow,
(b) in calm conditions (after Oke 1976)

urban air layers are invariably being capped by an elevated inversion inhibiting upward dispersion of pollutants.

Buildings and structures in the urban area further complicate the airflow pattern in the city and hence air pollution dispersion (Figure 3). For some areas, the situation is made more complex by the proximity to the sea and the detailed topography in which they are located. The Klang Valley Region is a good example. Here there is a reversal of windflow during day and night (Sham 1981). At night, the windflow is from the easterly quarter, blowing from Kuala Lumpur–Petaling Jaya towards Shah Alam, Klang and Port Klang. During the day, the flow pattern is reversed, the wind blows from the sea inland. Such flow patterns are likely to cause much of the pollutants produced within the valley to remain very much where they are. Under the circumstances and in view of the rapid development of the valley itself, one wonders if it is not bad planning to concentrate too much of industrial activities within the Klang Valley conurbation. Already, the Klang Valley had more than 90 percent of all industrial development in Selangor and the Federal Territory taken together.

AIR QUALITY AROUND HAZARDOUS POINT SOURCES

Besides deteriorating air quality in the large urban centres, air quality degradation is also experienced around 'hazardous' point sources such as

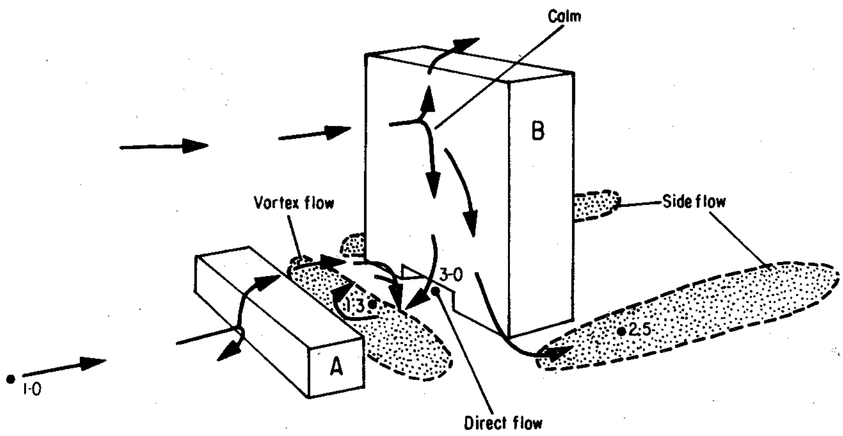

FIGURE 3. Airflow in the vicinity of a tall building (B) behind a lower building (A). Shaded areas denote increase in airflow (Penwarden & Wise 1975)

cement factories, quarries and steel mills. Measurements by the Department of Environment show that the boiler used by Malayawata Steelmill in Prai produced SO_x load of 13.1 kg/year in 1983; Tasek Cement in Ipoh emitted on average about 57.7mg/Nm^3 of dust in 1986 and; the quarries in Batu Caves emitted particulate matters to a total of 2.64×10^3tonnes/year in 1985.

Table 2 shows the state of air quality based on certain selected parameters at locations in the vicinity of selected hazardous point sources in Peninsular Malaysia. The high concentration of ash and solid particles emitted by the rice mill, steel works and cement plants is a hazard to health as they are located near residential areas. In fact the data were measured not at the sources of emission, but in the residential areas nearby. The SO_2 emission at Prai Industries exceeds the proposed standard of 50 microgram/m^3.

THE ENVIRONMENTAL QUALITY ACT 1974 AND AIR QUALITY MANAGEMENT

The most significant and comprehensive piece of legislation concerning environmental management in Malaysia is the Environmental Quality Act (EQA) which was passed by Parliament in 1974. Among other things, the Act provides for the appointment of a Director General of Environment whose duties and functions include the issuing of licences for waste discharge and emission, the formulation of standards, the coordination of pollution research, and the dissemination of information and educational

TABLE 2. Air quality in the vicinity of selected hazardous point sources in Peninsular Malaysia

Location	Parameters		
	Ash	Total solid	SO_2
Chemor (near APMC), Perak (1985)	–	574	–
Ipoh (near Tasek Cement) (1985)	–	477	–
Teluk Kechai (near LPN rice mill), Kedah (1985)	500	620	–
Prai (near Oriental Steel) (1984)	66	210	–
Batu Caves (near quarries) (1985)	99	248	–
Prai Industries (1985)	–	–	54.9

Source: Department of Environment
Note: Ash and total solid units are in mg/sq.m/day and SO_2 in microgram/m^3

materials to the public. To assist the Director General, a Division (now Department) of Environment (DOE) was established in 1975. In order to administer the Act, the DOE developed a three-pronged strategy as follows:

1. short-term measures (statutory) to control pollution and take remedial actions;
2. medium-term measures (non-statutory) to provide guidelines for planners and developers so that environmental considerations may be incorporated into developmental activities; and
3. long-term measures through the Environmental Impact Assessment (EIA) procedures so that adverse environmental impacts of projects may be minimized if not prevented altogether.

The first two of these strategies have been effected almost immediately. The third could only be made mandatory after the amendment to the EQA was passed in 1985 and gazetted on 9 January 1986 (Department of Environment 1988). Prior to that, 'EIA reports' for certain specific projects were prepared only as part of the normal process of getting approval from the DOE.

For air pollution control measures, two sets of regulations were gazetted: Motor Vehicle (Control of Smoke and Gas Emission) Rules, 1977 and Environmental Quality (Clean Air) Regulations, 1978. In addition to these regulations, the recent Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations 1985 is also of relevance to air pollution control management. These regulations restrict the import or manufacture of any motor gasoline which contains lead or lead compounds expressed as lead in excess of 0.40 gramme per litre including the sale of motor gasoline at petrol stations. The Regulations also prohibit the import, manufacture and sale of motor gasoline containing lead or lead compounds in excess of 0.15 gramme per litre on and after 1st. January 1990.

Under the Motor Vehicle Rules 1977, it is an offence for motor vehicles to emit dark smoke in excess of 50 Hartridge units. This is especially relevant with respect to diesel-powered vehicles such as buses, lorries and taxis which operate in concentrated numbers in urban centres. The DOE is still working on standards for exhaust gas emissions appropriate for Malaysia. Environmental Quality (Clean Air) Regulations 1978 provide for detailed specifications on waste burning, dark smoke emissions by factory chimneys, and the emissions of air impurities. With effect from October 1978, it was mandatory for new industrial and trade premises to ensure that smoke emissions are not darker than shade no. 1 on the Ringelmann Chart for burning equipments using liquid fuel and shade no. 2 for those using solid fuel. For trade premises which were in operation before October 1978, the smoke emissions should not be darker than shade no. 2 of the Ringelmann Chart with effect from March 1979.

As for air impurities, three sets of emission standards (A, B and C) were prescribed. All new industries established after October 1978 had to comply with standard C which is the most stringent. Existing industries, on the other hand, were given a maximum of two years to comply with standard A which is the most relaxed, and a further year to meet standard B. In cases where technological and economic considerations do not permit the installation of pollution control measures, the operators are allowed to apply to the Director General of Environment for a licence to contravene specified acceptable conditions.

Controls of air pollution through legislation such as those described above are mostly short-term and remedial in nature. As a complementary strategy to minimize pollution, *Guidelines for the Siting and Zoning of Industries* were introduced (Division of Environment 1982). The main feature of this strategy is the incorporation of the environmental component as an integral element in the medium term development planning process with a view of bringing about an ecologically balanced relationship between development and environment. Under these guidelines, the use of 'buffer zones' is encouraged between industries and residential areas or even between different industrial areas. The guidelines also allow for light industries to be located near housing or in built-up areas provided that the distance between them meet the stipulated requirements of the Department of Environment.

While the main objective of the short and medium-term strategies described so far is basically to ensure that the existing industries and other pollution sources are subject to direct controls or 'add-on' technologies and that land use planning be employed fully as an effective tool to minimize adverse environmental effects, such remedial controls alone, however, without the support of some form of preventive measures were thought to be inadequate. In view of this, an Environmental Impact Assessment (EIA) as an integral part of an overall project planning was proposed (Goh 1977). Unlike pollution control legislations, EIA is essentially a preventive measure and an aid to the environmental planning of new project or to the expansion of existing ones. It is designed basically to identify and predict the magnitude of environmental impacts of proposed projects so that adverse environmental effects may be avoided. Early identification of likely impacts also enable the environmental experts to study in depth a limited number of impact areas which are most likely to be of major significance. With the recent amendment to the EQA, environmental impact assessment is now mandatory for activities prescribed by the Minister in consultation with the Environmental Quality Council.

In addition to the three-pronged strategy adopted by the Department of Environment, the other major thrusts in the management of the environment which are relevant to air quality include:

1. Presiting evaluation of new industrial sources;
2. Monitoring and surveillance;
3. Investigation of and action on complaints;
4. Cooperative research into effluent treatment technology; and
5. Education.

STRATEGY IMPLEMENTATION: SOME OBSERVATIONS

It was noted earlier that several legislations pertaining to air quality had been gazetted and are at present fully enforced. However, while such legislations have obviously been useful, the seriousness with which these control measures has been implemented is still an open question. The effectiveness of the quantum of fines levied upon non-compliance is also questionable. Tables 3 and 4 show that although the maximum allowable fines are high, the actual amount paid for non-compliance is small. For court cases and with the exeption of 1981, all other cases on the average were fined less thanM$2,000 each. For compounded cases, the average compound ranges from M$300–$404 (Table 3). Vehicles issued with summoms on the average paid only between M$6–$62 each. As a deterrant such fines are meaningless. For many, it is cheaper to flout the regulations than comply with standards.

The provision of Guidelines as a medium-term measure is commendable. The effectiveness of these Guidelines as a tool in the management of environment, however, is still uncertain. No study has been made to assess the extent to which these Guidelines have been used effectively. For meaningful results, such Guidelines need to be made more binding.

TABLE 3. Number of factories taken to court and compounded under the Clean Air Regulations,1981–84

	1981	1982	1983	1984	Total
Fined:					
No. of factories taken to court	1	8	29	65	103
Amount (M$)	4 000	14 300	44 300	84 150	146 750
Average (M$)	4 000	1 787	1 528	1 295	1 425
Compounded:					
No. of factories compounded	38	175	135	87	435
Amount (M$)	12 250	52 450	54 450	35 150	154 300
Average (M$)	322	300	403	404	355

Source: Department of Environment, 1986

TABLE 4. Summons issued to motor vehicles for emitting dark smoke 1981–87

Year	Vehicles issued with summons	Amount collected (M$)	Average (M$)
1981	1 516	32 895	21.70
1982	1 406	87 609	62.31
1983	2 509	65 406	26.07
1984	2 620	106 930	40.81
1985	2 059	46 760	22.71
1986	3 971	23 615	5.95
1987	4 712	25 580	5.43
Total	18 793	388 795	20.69

Source: Department of Environment, 1988

It is still too early to pass any judgement on the effectiveness of the EIA Procedure in the Malaysian context. The Department of Environment records show that even before EIA became mandatory, some 29 projects (1981–84) were subjected to informal EIA through the normal procedure of project planning and approval of the Department of Environment. If this figure is anything to go by, there is no reason to be doubtful about the acceptance of the contribution of the EIA to environmental conservation by the industries, developers and project initiators. However, while EIA in itself is acceptable as a planning tool in resource conservation and environmental management, it is still uncertain if it does not serve purely as an administrative requirement and remains very much as an academic exercise. We are still unsure, for examples, as to how much of the recommendations especially those with respect to mitigating measures and monitoring is being strictly adhered to. Post-audit, for example, is only rarely considered if at all. In many cases, this part of the EIA Procedure is usually ignored.

Closely related to EIA and an important component of the pollution control programmes is a continuous assessment of the state of the environment generally and air quality particularly including baseline studies and monitoring. The latter is necessary in order to ensure that environmental standards and goals are met. Baseline studies, on the other hand, help to identify the status of existing condition and are useful in the preparation of EIA statements. Monitoring and research, however, require good support funds. Without meaningful allocations the effectiveness of monitoring and research will suffer. Within its limited allocation, the Department of Environment is hardly expected to undertake monitoring and research single handed. It is here that cooperation from federal, state, the non-governmental organisations (the NGOs), the universities and the press can come in handy.

While recognizing the importance of legislations and institutions in the administration of policies and programmes of environmental management, public support is essential in order to ensure success of such programmes.No conservation programme, however good it may be designed, can be completely successful without public support. The latter can only be expected from well-informed citizens who are aware of the problem, committed and willing enough to do something about it. Recent studies by the Department of Environment show that generally people are responsive to efforts to improve environmental quality and that the mass media play an important role as a disseminating agent.

At both the federal and state levels, efforts to educate the public and disseminate environmental information must be intensified. Since environmental education is basically aimed towards community action, efforts to reach the different target groups must be varied involving both governmental institutions and agencies and a wide variety of NGOs including private and commercial enterprises.

The role of NGOs in environmental education cannot be over-emphasized. Their activities transcend political and religious beliefs and are directed at effecting changes and shaping attitudes, and so, both directly and indirectly are involved in environmental education. Of great significance is the role of NGOs in providing a mechanism for feedback to the government and its regulatory agencies on negative side-effects from programme implementation. They provide the watchdog function on behalf of the public on the use and abuse of natural resources, conservation, professional practices and other activities of the government and private sectors which adversely impinge on the environment. The feedback from NGOs can take many forms including newsletters, magazines, exhibitions, talks, forums, seminars, training workshops and campaigns.

CONCLUSION

The paper has presented a brief overview of the state of air quality in Malaysia with special reference to pollution emissions, air pollution potential, city-induced effects and air quality management. The paper observes that while there has been some improvement, certain aspects of the atmospheric environment have been deteriorating particularly in the larger urban centres. It also notes that due to its geographical location, the dispersive capability of the atmosphere in this part of the world is restricted producing a high potential for pollution. This together with a rapid increase of pollution sources especially during the last 10 to 15 years has become a serious concern for the need to conserve air quality. The EQA 1974 and its subsequent amendments have gone a long way in our efforts to conserve and enhance air quality. There are, however, a great deal more to be done, upgraded and consolidated. These include improvements in certain aspects of the legislations, monitoring and assessment, implementation and enforcement of by-laws and other environment-related legislations by the state and local governments, public awareness and education and the cooperation of all concerned parties especially the mass media.

REFERENCES

Department of Environment. 1986. *Environmental Quality Report 1981–1984*. Kuala Lumpur: Ministry of Science, Technology and the Environment.

Department of Environment. 1988. *Environmental Quality Report 1985–1986*. Kuala Lumpur: Ministry of Science, Technology and the Environment.

Division of Environment. 1982. *Environmental Quality Report 1979*. Kuala Lumpur: Ministry of Science, Technology and the Environment.

Goh, K.S. 1977. Proposed Environmental Impact Assessment Procedure for Malaysia. Paper presented to the National Seminar on Environmental Impact Assessment, Kuala Lumpur, 26–28 September.

Holzworth, G.C. 1969. Large-scale weather influences on community air pollution potential in the United States. *Journal Air Pollution Control Association* 19: 248–254.

Holzworth, G.C. 1974. Estimates of mean maximum mixing depths in the contiguous United States. *Monthly Weather Review* 92: 235–242.

Kiftiah Razak. 1981. Pulau Haba dan Keupayaan Pencemaran Udara di Kuatan, Pahang. B.A. (Hons) thesis, Department of Geography, Universiti Kebangsaan Malaysia.

Lee, P.C. 1973. Multiuse management of West Malaysia's forest resources. In *Biological Resources and National Development*, Soepadmo, E. & Singh. K.G. (eds). Kuala Lumpur, p. 93–101.

Lim, G.E. 1980. Pulau Haba dan Aplikasinya Terhadap Kajian Pencemaran Udara Di Georgetown, Pulau Pinang. B.A. (Hons.) thesis, Department of Geography, Universiti Kebangsaan Malaysia.

Mohd Nor Abdul Ghani. 1981. Malaysia's development experience: Past strategies and alternatives. *Jurnal Ekonomi Malaysia* 3/4: 285–297.

Oke, T.R. 1974. *Review of Urban Climatology 1968–73.* WMO Technical Note No. 134.

Oke, T.R. 1979. *Review of Urban Climatology 1973–76.* WMO Technical Note No. 169.

Sham Sani. 1973. Observations on the effects of a city's form and functions on temperature patterns: a case of Kuala Lumpur. *Journal of Tropical Geography* 36: 60–65.

________________. 1976. Morning mixing depths, wind speeds and air pollution potential in the Kuala Lumpur area. *Sains Malaysiana* 5(1): 27–37.

________________. 1979. *Aspects of Air pollution Climotology in a Tropical City: A Case of Kuala Lumpur – Petaling Jaya.* Malaysia. UKM Press.

________________. 1980. *The Climate of Kuala Lumpur – Petaling Jaya Area. Malaysia: A Study of the Impact of Urbanization on Local Climate Within the Humid Tropics.* Bangi: Penerbit UKM.

________________. 1981. Inadvertent atmospheric modifications through urbanization and their implications on health. *Development Forum* 11(2): 1–22.

________________. 1983. Inadvertent atmospheric modification by urbanization with special reference to temperature: a case of Kota Kinabalu. In *Sabah: Traces of Change*, Dahlan, H.M. (ed). Bangi: UKM-Yayasan Sabah, p. 61–74.

________________. 1984a. Urbanization and the atmospheric environment in Southeast Asia. *Proceedings of the Symposium on Environment, Development and Natural Resources Crisis in Asia and the Pacific.* Penang: S.A.M., p 189–202.

________________. 1984b. Urban development and changing patterns of night-time temperatures in the Kuala Lumpur – Petaling Jaya area, Malaysia. *Jurnal Teknologi* 5: 27–36.

________________. 1986. Temperatures in Kuala Lumpur and the merging Kelang Valley conurbation, Malaysia. Report prepared for UNESCO under the Ecoville Project coordinated by the Institute of Advanced Studies, University of Malaya.

Tan, M.L. 1982. Air pollution in Malaysia: Problems, perspective and control. In *Development and the Environmental Crisis: A Malaysian Case.* Penang: C.A.P., p. 213–221.

Zainab Siraj. 1980. Pulau Haba dan Aplikasinya terhadap Keupayaan Pencemaran Udara di Kawasan Johor Bahru. B.A. (Hons.) thesis, Department of Geography, Universiti Kebangsaan Malaysia.

Jabatan Geografi
Universiti Kebangsaan Malaysia
43600 UKM Bangi,
Selangor D.E., Malaysia.