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Environmental Health as a Determinant of Socioeconomic Development: The Need to Modify Contemporary Malaysian Strategies

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ABSTRACT

While Malaysia has made significant advances in improving the quality of life of its citizens through socioeconomic development, which has included control of major tropical diseases and provision of modern health and medical services, recent episodes of air, water, and soil pollution caused by domestic, industrial and transportation activities indicate an increasing cost in environmental health. Industrial diversification has also led to an increased variety of occupational exposures that are hazardous to health. Contemporary environmental protection policies in Malaysia, and worldwide, are only partially successful and greater effort must be given to prevention, reduction, or recycling of wastes, and to protection of workers from occupational hazards. The need for scientific evidence to justify changing behaviours that are damaging to environments and the communities they support is reviewed. Examples of epidemiological studies, new analytical protocols and biological monitoring methods are given. Eight strategic areas that need to be modified in order to better address behavioural-environmental problems as systems, and to lead towards a sustainable economy with optimal adaptation to the environment are suggested.

ABSTRAK

Sementara Malaysia telah banyak mencapai kemajuan dalam mempertingkatkan kualiti hidup penduduknya melalui pembangunan sosioekonomi termasuk pengawalan penyakit tropika utama dan peruntukan perkhidmatan kesihatan dan perubatan moden, episod-episod pencemaran udara, air dan tanah yang dihasilkan oleh kegiatan domestik, industri dan pengangkutan di hari-hari kebelakangan ini menunjukkan pertambahan kos kesihatan sekitaran. Pempelbagaian industri telah juga menambahkan variasi pendedahan kerja yang berbahaya terhadap kesihatan. Polisi perlindungan alam sekitar masa kini di Malaysia, dan di seluruh dunia, agak terhad kejayaannya dan usaha yang lebih gigih diperlukan bagi menghalang, mengurang atau menggunakan semula sisa buangan serta melindungi para pekerja daripada mala petaka kerja. Keperluan bukti saintifik bagi menjustifikasikan perubahan tingkah laku yang membahayakan alam sekitar

dan masyarakat yang ditanggungnya diulas. Contoh-contoh kajian epidemiologi, tata cara analisis yang baru serta metod permonitoran biologi diberikan. Lapan bidang strategik yang perlu diubahsuai bagi menghadapi dengan lebih berkesan masalah tingkah laku-alam sekitar sebagai sistem serta memandu ke arah satu bentuk ekonomi yang berterusan dengan pengubahsuaian yang optimum terhadap alam sekitar dicadangkan.

INTRODUCTION

Environmental health is the subfield of public health that is concerned with assessing and managing the impacts of human populations on their environment and the impacts of the environment on populations (Moeller 1992). The basis for assessment is epidemiological, that is, identification of the agents of ill-health, the populations affected, and the environments of exposure (Figure 1). While the current scope of environmental health gives emphasis to the physico-chemical and biological spheres of the environment, the cultural sphere is seen to be increasingly important.

The impacts of human populations on the environment, and vice versa, have accelerated in the last 100 years because of increased numbers and densities of people, increased per capita consumption of environmental resources, and increased per capita production of energy, goods and services (Figure 2). These activities have led to degradation of ecosystems, depletion of resources, and deterioration of environmental quality through pollution.

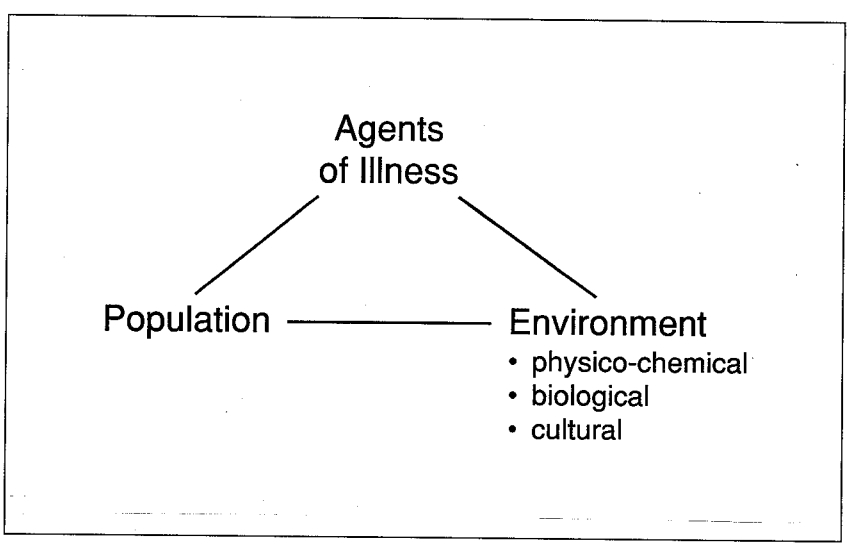

FIGURE 1. The epidemiological triangle

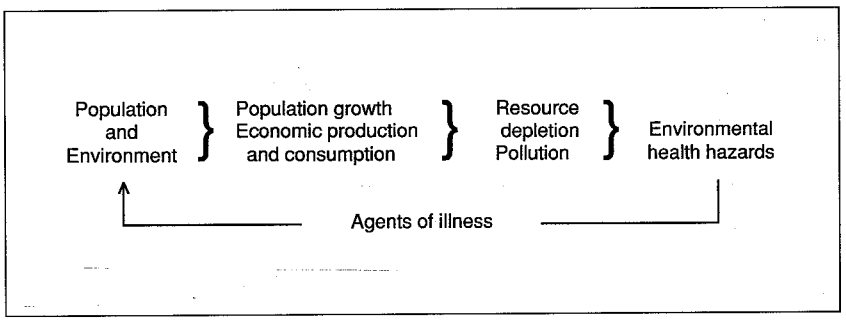

FIGURE 2. Cycle of major environmental health concerns

One severe example of a pollution impact is the depletion of ozone in the upper atmosphere with consequent increase in ultra-violet radiation at the earth's surface and a rising incidence of skin cancers and other ill-effects in human populations.

While the impacts of human populations on the environment were clearly recognised at the 1992 international conference on the environment in Rio De Janiero, the impacts of the environment on humans, and particularly the health effects, did not receive the same attention. Emphasis was given to the effects of human activities on natural ecosystems. In future, this needs to be balanced with concern for the effects of overpopulation on limited environmental resources, and the effects of a polluted environment on human health.

Environmental health seeks to define and manage those qualities of the environment that support optimal human health, which essentially means conservation of the environment to which human beings became adapted through evolution. These optimal environmental qualities for human health and continued evolution are changing under the impact of current forms of socioeconomic development, and because high rates of population growth multiply this impact (Doll 1992). Consequently, the quality of life and improved health and other social conditions that some of the world's nations have attained, and others strive to attain, is now threatened by a polluted environment and by overdemand on resources. Environmental health disasters can only be avoided by changing present human behaviors primarily in the economy and in rate of reproduction. In this sense, environmental health is a determinant of the nature and rate of socioeconomic development.

ENVIRONMENTAL HEALTH IN MALAYSIA

While many environmental health problems are international, the responsibility for change rests primarily at national levels. Malaysia is an important

example in the tropics of the emergence of environmental health issues that relate to development and of efforts at assessment and control. This paper reviews the present situation in Malaysia and suggests that future economic development will have to be more closely linked to population and health if the present quality of environmental health is to be maintained.

In the last 30 years, Malaysia has made significant advances in the improvement of its quality of life. Population has grown from 8 million in 1960 to 18 million in 1990, and moved during that time from 15 percent urban to 35 percent urban. Infant mortality rates have declined from 84 per 1,000 live births to 13, and life expectancy at birth has risen from 56 to 71 years. Industry has rapidly expanded with a pronounced shift towards manufacturing, especially in chemicals and electronics. Since 1970, electrical energy consumption has grown eight-fold from 3 to 25 billion kilowatt hours. Housing, transportation, education, health services, the arts, and other indicators of the quality of life have all been greatly advanced. In common with most other nations, Malaysia has used socioeconomic development as the path to national unity, population stability, and social well-being.

Until 1960, infectious diseases were the main health concern in Malaysia. Since then there has been a decline in the rates of infectious diseases and the emergence of rates of noninfectious diseases as being important. The infectious diseases of childhood including measles, pertussis, diarrheal diseases and poliomyelitis have been substantially reduced. Diarrheal diseases continue to be a serious cause of illness and death among children under 12 in rural Malaysia in those villages where poor sanitation and poor water quality continue to exist (Lye 1984). Cholera, leprosy, and typhoid fever are minor and diminishing concerns. Malaria and tuberculosis remain troublesome, with malaria still a major problem in Sabah, East Malaysia. But the leading causes of death, as indicated by the 37 percent of deaths that are medically certified in Peninsular Malaysia, are now heart disease, cancers, stroke, and injuries (Malaysian Department of Statistics 1991). A large proportion of the uncertified deaths in those 65 years and older are due to heart disease and cancer. Incidence of heart disease and cancer of the lung are both rapidly increasing and these are, respectively, associated with a rising consumption of higher fat diets and cigarette smoking, and with other behaviours that accompany contemporary affluent lifestyles.

Much of the recent reduction in incidence and severity of infectious diseases in Malaysia is due to socioeconomic development that has improved incomes, education, diets, housing, electrification, public health and medical services, water supplies, and sanitary disposal of human wastes. In 1989, 74 percent of the population had safe water supplies and 81 percent sanitary latrines, a marked improvement since 1970 when less than half had such status (Malaysian Ministry of Health 1991). Public health education and vaccination programs have been especially effective against childhood diseases,

and mosquito control has greatly reduced the risk of malaria and filariasis for most of the population. A well-developed public medical services system, a growing private hospital system, and traditional medical practitioners, provide treatment services notable for their ease of access and affordability for the entire population. High rates of injury and death from motor vehicle crashes are of particular concern and, although being vigorously addressed, continue to rise in incidence. Rates of occupational injuries and deaths are less extreme but nevertheless of concern. In 1989, 107,479 industrial accidents were reported, a rate of 16 per 1,000 workers in a workforce of 6.8 million (Malaysian Ministry of Health 1991).

Health and medical care are well supported by the national budget. In 1990, RM$1.8 billion, or 5.5 percent of the total budget, was spent on health and medical care (Malaysian Ministry of Health 1991). But in common with most countries, Malaysian costs of medical care are rising and there is growing governmental concern that it will come to comprise an unacceptable proportion of the national budget. Policies to encourage greater privatisation of hospital services are being considered. Total expenditures on health and medical care, public and private, are emerging as major cost considerations for all sectors of Malaysian society, and drawing attention to the need for added emphasis on prevention.

ENVIRONMENTAL POLLUTION

Since 1970, there have been signs of environmental degradation in Malaysia with adverse health effects which are likely to undermine the long-term potential of economic development and improved quality of life (World Resources Institute 1990). Several episodes of air, water, and ocean pollution have occurred with local damage to plant and aquatic ecosystems, and occupational illnesses associated with new exposures in industries have been reported (Nicholas & Wangel 1991). Urban noise pollution, and rapid expansion of cities beyond their capacities to provide adequate sewerage and waste disposal systems are also concerns. During the past five years there have been hundreds of articles in Malaysian daily newspapers on environmental health issues.

Sources of toxic air pollution have grown from about 120 industrial sites and a quarter-of-a-million motor vehicles in 1960, to 7,791 industrial sites and over 5.2 million motor vehicles in 1991 (Malaysian Department of Environment 1992). The major sources identified by the Department of Environment are shown in Table 1. Air pollutants from combustion sources were estimated at 961,000 tonnes in 1991, in a pattern typical of modern cities with carbon monoxide the principal component (Table 2). The main source is motor vehicles (Table 2). In 1988, the heavily urbanized Klang

TABLE 1. Potential air pollution sources, Malaysia, 1991

Source	Number
Stationary	
Chemical Industries	325
Food and Agriculture	1,674
Metal Industries	320
Mineral Products	956
Petroleum Industries	62
Wood Products	1,555
Boilers, Furnaces, Incinerators	2,819
Solid Waste Disposal Sites	80
Total Stationary	7,791
Mobile	
Motor Vehicles (Peninsular Malaysia only)	5,211,922

Source: Malaysia. Department of Environment, 1992.

TABLE 2. Air pollution from combustion sources, Malaysia, 1991

Total: 961,000 tonnes/year	
Pollutants	
Carbon Monoxide	66.2%
Nitrogen Oxides	12.4%
Sulphur Oxides	7.8%
Hydrocarbons	7.2%
Particulates	6.4%
Sources	
Transport	70.9%
Open Burning	10.5%
Industries	9.9%
Power Stations	8.0%
Domestic	0.7%

Source: Malaysia. Department of Environment, 1992.

Valley, which includes the cities of Kuala Lumpur, Petaling Jaya, Shah Alam and Klang, accounted for 46 percent of the nation's air pollutants, 79 percent of which came from motor vehicles (Sham Sani et al. 1991). Heavy metals from air pollution accumulate in soils and plant ecosystems. Concentrations

TABLE 3. Heavy metals in urban roadside dusts

City	Year	Lead	Cadmium	Zinc	Copper
		Micrograms per cubic gram			
London	1984	1,045-2,346	2.2-3.1	401-527	174-237
Lancaster	1981	660-2,540	2.7-4.9	260-539	71-312
New Jersey	1979	8,300	—	110	500
Kuala Lumpur	1985	545-7,227	2.2-3.6	210-1,013	15-114

Source: Noor Ramlan and Badri, 1988, 162.

of lead, cadmium, zinc, and copper in roadside soils and dusts in Kuala Lumpur are high, and comparable to the levels measured in older industrial cities of the United Kingdom and United States (Table 3) (Noor & Badri 1988).

The August 1990 haze incident, which affected much of western Peninsular Malaysia, was an air pollution episode of the photochemical type where a period of low atmospheric ventilation and dry conditions allowed the accumulation of pollutants to record levels. Especially severe were the levels of suspended particulate matter. The highest recorded peak of 787 ug/m^3 in the Klang Valley was nine times in excess of the Malaysian guideline level, and 16 times in excess of the W.H.O. recommended level (Table 4) (Sham Sani et al. 1991). Malaysian factory workers reported problems with their eyes, while hospitals in and around Kuala Lumpur reported treating hundreds of patients with respiratory complaints (Tsuruoka 1990). As epidemiological studies in London, New York, Osaka and other cities have shown, high concentrations of particulate and sulphur oxide air pollution will

TABLE 4. Total suspended particulates, Klang Valley, Malaysia

Zone	1989 Mean ug/m^3	Peak August 1990 ug/m^3
Industrial/Traffic areas	90-107	516
Commercial/Residential	60-76	787
Rural	49	268

Malaysian Guideline = 90 ug/m^3
World Health Organization = 40-60 ug/m^3

Source: Malaysia. Department of Environment, and Universiti Pertanian Malaysia. Cited in Sham Sani et al. 1991.

cause excess death. Recent studies based on long-term observations show a significant illness effect of particulates at concentrations below the US national standard of 75 ug/m^3 (Schwartz & Marcus 1990; Schwartz & Dockery 1992).

Malaysia's population is expected to almost double between 1992 and 2020, and combined with that there could be at least a doubling in the numbers of motor vehicles and industrial sites if present trends continue. Current levels of carbon monoxide in Kuala Lumpur range between 2 and 4 parts per million (8-hour period) (Malaysian Department of Environment, 1992), but are projected to reach 10 parts per million by 1998, a level considered dangerous.

Air pollution in Malaysia is generated in rural populations as well as urban. In 1992, air and dust pollution from open burning of padi husk was associated with respiratory and eye ailments in some rural districts of Peninsular Malaysia. Indoor air pollution from smoke from cooking fires needs investigation. Given the open nature of rural house construction in Malaysia, this is less likely to be a problem than in higher latitudes where houses are closed for heating in winter and for cooling in summer. However, the advent of commercial buildings and apartment dwellings in major cities of Malaysia which are closed for air conditioning raises the possibility that indoor air pollution may become a health concern.

Water pollution occurs in most parts of populated Malaysia but especially in the industrial urban areas of Kuala Lumpur, Selangor, Perak, Malacca, Johor, and Penang. Sewage, animal wastes, silt and heavy metals (such as mercury and lead), are the main contaminants (Malaysian Department of Environment 1992). Contamination of rivers by sewage from latrines is a problem in all parts of Malaysia, rural and urban. A high priority development program must be for the expansion and modernizing of existing sewerage systems and treatment facilities, and the construction of systems in towns as yet without them. Safer disposal of sewage in rural areas that will reduce the risk of contamination of rivers, especially during times of flood, needs to be vigorously pursued.

Industrial pollution of land and ocean waters is also of concern. In 1991, 62 percent of industrial pollution came from the food and beverage, palm oil, and raw rubber industries. Acute episodes have been serious. In 1992, ammonia pollution from rubber processing mills located in the catchment area, forced a shut-down of the water supply in Melaka. This demonstrates the need in some areas to relocate industry away from water catchment areas and to enforce the separation of water supplies and pollution sources in the future. In the industrial region around Kuala Lumpur, river water is often polluted by waste from chemical industries, sawmills, paint factories, and electroplating and printing shops. These rivers are also used by households for washing clothes and as playing areas for children.

Malaysian industries generate each year at least 380,000 cubic meters of toxic and hazardous waste from some 1,000 sources (Malaysian Government 1991). The main types of wastes are acids (22 percent), sludge with heavy metals (15 percent), and sludge with minerals (13 percent) (Malaysian Department of Environment 1990). While some toxic waste is handled by approved operators and disposed of in designated sites, much of it is dumped indiscriminately in places that can pollute ground and surface waters. Plans are underway for a centralised comprehensive treatment and disposal facility for toxic and hazardous wastes in Negri Sembilan, Peninsular Malaysia, and for transfer stations to serve it in Penang, Johor, and Terengganu (Malaysian Department of Environment 1992).

In Malaysia occupational environments include a wide range of potential exposures to toxic substances (Nicholas & Wangel 1991). Industries such as steel milling, metal fabrication, cement and chemicals manufacture, motor vehicle assembly, rubber processing and tyre manufacture, computer chips and other electronics, electroplating, plastics, shoemaking, clothing, palm oil refining, and wood products are all represented. Safety varies from the extremes of back-yard operations with minimal worker safety, to modern plants with excellent safety conditions. Many older established industries, such as metal foundries and wood products, continue to use outmoded processing techniques with minimal environmental protection that has high risk of worker exposure to particulates and gases. In contrast are new industries with modern plant design that have adopted the most stringent requirements for worker safety.

Food contamination with pesticides and with chemical residues in soils has been reported since 1985 in Malaysia. One well-publicized event involved excessive levels of pesticides in vegetables from Cameron Highlands, a major source of fresh produce in Malaysia (Hanidza 1988). Malaysian fruits and vegetables imported into Singapore have been found on occasion to carry high pesticide residues.

The comparative recency of the Malaysian experience with pollution from industrial, transport, and domestic sources means that primarily acute forms of health effects (such as respiratory distress), rather than chronic forms (such as lung disease), have so far been observed. The chronic effects of current trends in pollution will not be apparent in the population for a decade or more. But there is ample evidence from the experience of older industrialized countries that if the kinds and levels of pollution now occurring in Malaysia continue, an increased incidence of disease will result from this source.

EPIDEMIOLOGICAL SURVEILLANCE

The epidemiological surveillance that has been conducted in several countries has documented the acute health effects of environmental exposures. Toxic chemicals in the environment are important, widespread, proven causes of human disease (Landrigan 1992). Such disasters as Minamata Bay, Elizabeth—New Jersey, Seveso, Chernoble, and Bhopal offer clear evidence of immediate effects. Long-term exposure to low dosages of toxic chemicals is more common, but the evidence for health effects has taken time to gather because there is a long latent period between exposure to chemicals in both community and occupational settings, and the techniques for long-term surveillance of environmental health effects have been slow to develop. The complex relationships between specific pollutants and specific diseases have also taken time to describe (Bates 1992). The most extreme examples of health effects in relation to long-term pollution come from the former Soviet Union where rising rates of disease and falling life expectancies have been linked in part to pollution of air, water, and food by industrial wastes (Feshbach & Friendly 1992).

Long-term surveillance studies combined with improved monitoring technologies have now compiled reliable data on the significance of exposure to low dosages of industrial pollutants (Mossman 1992). Important examples include: the on-going epidemiological studies of population radiation exposure from the atomic bombings in Hiroshima and Nagasaki (Shimizu et al. 1989); the studies in London, Los Angeles, Osaka, and other cities of daily mortality in relation to urban air pollution (Kinney & Ozkaynak 1991; Schwartz & Dockery 1992); the studies now underway in east Germany, the Czech Republic, Poland and Ukraine using the centralized medical records of those countries to link illness to industrial pollution exposures (Nowak 1992); and the cohort studies of workers exposed to asbestos, lead, polyvinyl chloride, formaldehyde, and other occupational hazards in American and European industries (Checkoway et al. 1989). Comprehensive occupational and exposure linkage systems have been developed for the study of a wide range of illnesses in a variety of industries (Hoar et al. 1980; Gerin et al. 1985). Occupational diseases and injuries, and exposure limits to substances, continue to be documented as new substances and exposures appear (Weeks et al. 1991).

Biological monitoring methods are being expanded to measure the absorbed dose of a chemical in tissue following an exposure. Most promising are immunoassays that use such biomarkers as adducts for benzo(a)pyrene, polycyclic aromatic hydrocarbons, N-nitrosamine-DNA, and aflatoxin to detect exposure to industrial and dietary toxins (Compton et al. 1991; Rosner et al. 1991). The environmental health concerns of local communities, especially their perceived health risks, have stimulated improved methods for analyzing

clusters of cases of disease (Szklo 1990), and prompted the development of a wider range of end points besides cancer and birth defects, including the prevalence of illness symptoms (Lipscomb et al. 1991; Shusterman et al. 1991).

Monitoring of environmental quality of air and water has been improved with the expansion of computer controlled networks of instruments that can continuously measure several pollutants simultaneously. Animal sentinels are also proving to be useful monitors of ill-health from air and water pollutants (US National Research Council 1991). And satellite remote sensing of air pollution is becoming increasingly useful as ground control data permit interpretation of different aerosols from multispectral images (Chwastek & Dworak 1990).

The policy assumption that pollution caused by current activities can be reduced to acceptable levels, and that it is technically feasible to clean up pollution damage and restore the environment to former public health standards is not always true. No one questions that high-level radioactive waste is a very long-term pollutant and that it has to be contained without practical prospect of elimination. But only recently has it been realised that many industrial chemicals are the same (British Medical Association 1991). Intensive efforts in the United States to clean up hazardous waste sites in association with groundwater have shown that it is not always technically feasible to restore these sites to a condition where drinking water is safe. Pumping contaminated acquifers reduces pollution levels by a factor of 2 - 10, but little more can be achieved because residual chemicals are irreversibly bound to the soil (Travis 1992). Health-based clean up goals for many hazardous waste sites are therefore unrealistic and we should aim for more effective containment of existing waste sites.

MALAYSIAN RESPONSES

In common with many other countries, Malaysia has three governmental agencies primarily responsible for environmental health: one for environmental protection, one for public health, and one for occupational safety and health (Figure 3). Secondary responsibility for environmental and occupational health does rest with a few other agencies, for example the Department of Agriculture. Direct authority and responsibility for environmental health rests with the federal government with state governments having only an indirect and intermittent role. The Department of Environment is a branch of the Ministry of Science, Technology, and the Environment, and is the equivalent, in the United States, of the Environmental Protection Agency. The Malaysian Ministry of Health has not established a division for environmental health. Instead there are programs for sanitation and food

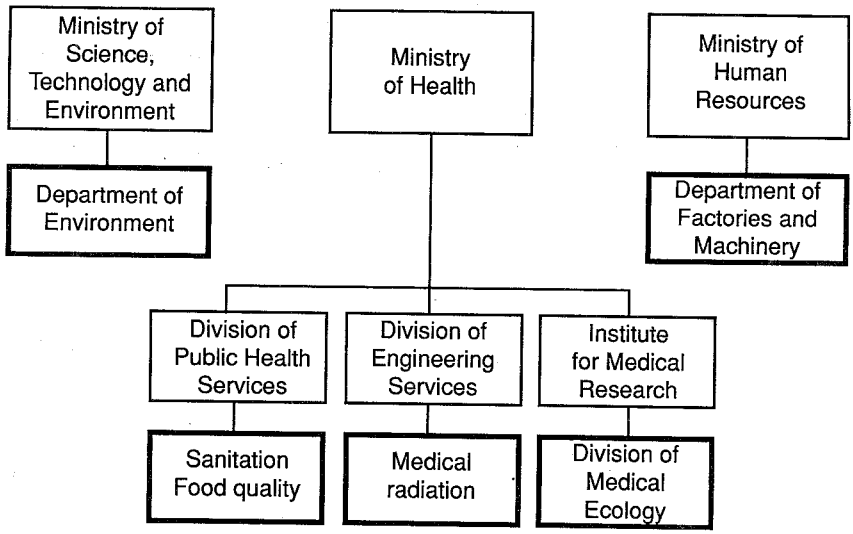

FIGURE 3. Malaysian Federal Government agencies with major concern for environmental health

quality in the Public Health Services Division, for medical radiation monitoring in the Engineering Services Division, and for environmental health-related research in divisions of the Institute for Medical Research. Training of environmental health specialists is carried out by the Public Health Institute and an institute for occupational health is being established. The Department of Factories and Machinery under the Ministry of Human Resources is responsible for industrial safety and health in factories. All three agencies have declared themselves to be understaffed and comparatively low on the governmental hierarchy of ministries. In early 1992, the government approved the appointment of 110 more officers for the Department of Environment bringing it up to 480. But the Minister for Science, Technology and Environment has stated that at least 1,000 officers are needed to carry out the Department's mission (*New Straits Times* 14 January 1992).

Compared to most countries in the tropics, Malaysia has a longer history of environmental concern, and more legislation aimed at environmental quality control. The Town and Country Planning Act and the Land Conservation Act date from the colonial period and the Environmental Quality Act from 1974. Today, there are more than 40 pieces of legislation to regulate management of the Malaysian environment (Sham Sani 1991). However, there is no Public Health Act which could conceivably address the human health implications of environmental quality.

While the laws are comparatively adequate, their enforcement leaves much to be desired. For example, enforcement of the Land Conservation Act and Environmental Quality Act is hampered by the relationship between federal authorities and state governments. Most matters of land development are under state government control, whereas environmental legislation is primarily federal. State governments can ignore environmental legislation, and the federal government can claim the law cannot be implemented without state government cooperation (Vatikiotis 1992). Penalties and fines for industrial pollution with a maximum of M$5,000 (US$2,000) are too small to be effective. Corruption of the system is also known to occur at all levels, from the taxi and truck drivers who pay the assessment officers to certify their polluting vehicles as "clean", to the developers who arrange for variances on industrial processes. Despite these difficulties, Malaysia continues to adopt legislation that has either immediate impact on environmental health, or which opens the way for control in the future. The mandatory reduction of lead content of gasoline from 0.4 to 0.15 g/liter, and introduction of unleaded motor vehicle gasolines during 1991-92, have had immediate health effect. Other legislation introduced in 1992 relating to motor vehicle exhaust emission controls will begin to reduce the rate of emissions of carbon monoxide and hydrocarbons.

STRATEGIES

In Malaysia, as in most countries, there has been a concern for environmental quality for the past 15 years that has led to strategies for pollution control and prevention, including enforcement, monitoring, and education. The chief responsibility for this effort has been with the Department of Environment, with the Ministry of Health, and Department of Factories and Machinery, maintaining traditional roles, respectively, in sanitation and food quality, and occupational safety and health. Within the capacities of its mandate and resources, the Department of Environment has vigorously and effectively pursued the national environmental policy objectives that were first laid out in the third national plan, 1976-80 (Malaysian Government 1976). These objectives recognise the need to balance the goals for socioeconomic development, population growth, and environmental quality. However, the Department of Environment's strategies for environmental quality relate to the environment essentially as a non-social system focussing on physico-chemical and biological spheres. Human populations and their behaviors in relation to environment and health are not at present directly addressed by any of the agencies. Present strategies will have to change if Malaysia is to maintain environmental health at existing levels by the year 2020. Some suggestions for change are:

1. ***National Policy*** As in all industrial nations, the ultimate objective should be redevelopment of the economy in ways that will prevent pollution. This will have to be coordinated with population growth and change over the redevelopment period to sustain desired quality of life. Revised national economic and population policies will be desireable for the *Seventh Malaysia Plan* in 1996. Economic development should be linked to population and health as well as to environment, which would force the adoption of strategies to prevent pollution. Population policies should aim to stabilize growth so as to reduce the rate of environmental demand, especially in the younger and older age groups who are not in the labour force.

2. ***Data*** The possible consequences of a plan to redevelop the economy include temporary economic recession, unemployment, and refinancing and re-education for new jobs. It is therefore essential that all parties—government, industry, and the public—be fully informed that environmental health has indeed become the determinant of future socioeconomic development. Assessment of environmental quality is by itself not enough. It should be an assessment of environmental health based on an epidemiological approach that relates the agents of environmental illness to local populations, the behaviours of populations that lead to environmental hazards and exposure to agents, and the nature of environmental exposures. Much of the scientific data and policy experience of other countries could be adapted to the Malaysian situation. For example, the epidemiological knowledge on surveillance and monitoring could be adapted to Malaysia by local epidemiologists with reference to Malaysian population demography and behaviour, and environmental settings. Malaysia is not presently well prepared to do this yet. Existing epidemiological expertise, surveillance, and data collection facilities that are now scattered in three ministries need to be strengthened and coordinated.

3. ***Organisation*** Government organization for environmental health would be strengthened by raising the Department of Environment to cabinet level and creating a division of environmental health in the Ministry of Health. The Institute for Medical Research could undertake research and evaluation of environmental health interventions. Formal mechanisms for improved communication and coordination should be introduced to link the units concerned with environmental health. The political status of these units ought to be elevated to the same level as the units concerned with economic, land, and resource development.

4. ***Transition*** Strategies for transition from the present polluting economy to a non-polluting economy by a definite date should be developed. These would stress reduction and recycling of polluting materials, development of alternatives (such as mass transit systems to reduce dependence on motor

vehicles), strict enforcement of regulations and severe penalties for infringements, taxation incentives for industry to adopt non-polluting technologies, effective collection, treatment, and containment of hazardous wastes, and education for individual and public responsibility for protecting environmental health. Education that points up health issues is more likely to attract public attention and gain a commitment to change than any other issue. All of these kinds of strategies are well documented (Hirschhorn & Oldenburg 1991).

5. ***Personnel*** A strategy is required that will provide the skilled personnel and technological services needed for government agencies to fulfill their objectives. Understaffed agencies cannot perform to expectations. The present inequities in government salaries as compared to the private sector must change if an adequate supply of well qualified personnel are to be attracted and retained. Corruption of the enforcement system will also decline when salaries are fair and honesty is rewarded.

6. ***Education and Research*** Education of the coming generation of politicians, industrialists, and scientists in environmental science and pollution prevention needs to receive priority in secondary schools and in universities. Existing programs and curricula need change and expansion. Research on environmental health problems in Malaysia has been important thus far in demonstrating the impact of pollution, and pointing up the differences between the Malaysian environment and elsewhere. Research into Malaysian problems needs to be expanded and evaluation research studies extended to measure the effects of interventions. There is opportunity here to more effectively involve Malaysian universities to do much of this work through an expanded program of research grants and contracts aimed specifically at environmental health and pollution prevention.

7. ***Finance*** The costs of achieving the desired standards of environmental health will require adjustments in taxation, pricing, and investments by public and private sectors. Environmental health costs should be accounted for, including for example, the costs to the nation of resource depletion, environmental degradation, maintenance of environmental quality, and provision of health and medical services for environmentally related concerns.

8. ***International*** Strategies for regional and international cooperation to achieve environmental health at all geographical scales are essential for Malaysia and for all other nations. The proposal for an East Asian and Pacific Center for Environmental Protection is an example (Moon 1990). International cooperation should include sharing the costs of achieving prosperity without pollution in all nations.

CONCLUSION

Malaysia is in a good position to implement strategies that would prevent exposures to chemical toxins and other pollutants from human activities and to begin the process of conversion from a polluting to a non-polluting economy. It has the resources to do so, and it has the time to do so, before more serious health effects occur. Malaysia has become an example to the rest of the tropical world of a successful newly industrialized country. It has the opportunity to set another example in environmental health, and thereby assist the rest of humanity towards the ultimate necessity of optimal adaptation to our environment.

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