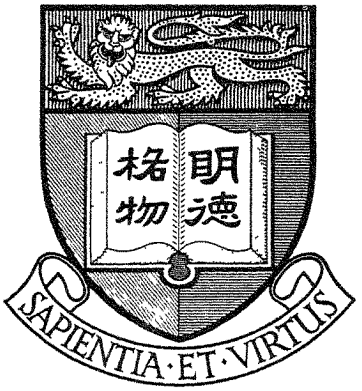

ASIAN
Journal of Environmental Management

Vol 3 No 1 May 1995

Contents

Hong Kong University Press
香港大學出版社

Hong Kong University Press
139 Pokfulam Road, Hong Kong

ISSN 1021–6634

Publication of this journal has been supported in part by a grant from the Caltex Green Fund, Hong Kong.

Printed on 40% recycled paper by Prosperous Printing Co., Ltd.

ASIAN
Journal of Environmental Management

Vol 3 No 2 November 1995

Contents

Hong Kong University Press
香港大學出版社

Hong Kong University Press
139 Pokfulam Road, Hong Kong

ISSN 1021–6634

Publication of this journal has been supported in part by a grant from the Caltex Green Fund, Hong Kong.

Printed on 40% recycled paper by Prosperous Printing Co., Ltd.

INVITED COMMENTARY

The Essential Role of Renewable Energy for Rural Development in the Lao PDR

Phouvong Sayalath

ABSTRACT

The Lao People's Democratic Republic (Lao PDR) has two major renewable energy resources which it must look to in order to improve the material well-being of its people: wood energy and hydroelectric power. Both of these resources are relatively abundant and widely distributed. Centralized and non-renewable energy resources are likely to play less of a role in meeting the country's own energy needs because of the relatively low present level of income and the largely rural and mountainous character of the country: per capita GDP is about US$250, the population is 90% rural, and the land is 80% mountainous.

The challenge is for the nation to develop these wood and small and micro hydroelectric resources in a manner consistent with sustainable development. In order to successfully meet this challenge greater attention needs to be placed on institution-building, including human resource and database development.

Keywords: *rural development, rural energy, environment, environment and energy, Laos, Southeast Asia*

INTRODUCTION

Like all countries seeking to raise the living standards of its people, the Lao PDR is seeking to provide more and higher quality energy supplies, including electricity, to its people. For reasons outlined below the most attractive near- and mid-term sources for such expansion of energy are renewable resources, particularly small hydro plants and the more rational use of forest resources. Yet, even renewable energy resources, while typically creating less serious air pollution than fossil fuels, nonetheless present environmental risks. The purpose of this commentary is to outline the major issues and options with regard to the efforts of the Lao PDR to provide much expanded access to energy in a manner which does not cause unacceptable environmental damage.

The Lao PDR is a relatively poor, landlocked, mountainous country of some 236 800 km^2. As reported by the World Bank, the 1992 per capita Gross Domestic Product (GDP) was only about US$250, the fourteenth lowest in the world. Of the estimated 1993 population of 4.5 million people, only about half a million live in urban areas, with roughly 90% of the population being classified as rural.

Mountains cover about 80% of the total land area, which tends to concentrate the population in

Phouvong Sayalath, Deputy Director, Department of Environment, Science Technology and Environment Organization, Prime Minister's Office, The Lao People's Democratic Republic, Tel (Vientiane, Lao PDR) 21–3470, Fax 21–3472.

those areas where the terrain allows for agriculture or urban development. However, on the positive side, the mountainous landscape together with abundant rainfall, provides a high potential for hydropower development on the order of roughly 18 gigawatts (GW). While international attention has tended to focus on development of larger sites which may be developed to serve the export market for electricity to neighbouring countries, considerable hydroelectric potential also exists in widely scattered sites suitable for small or micro hydro power plants to meet the needs of localized areas. Forests also represent a major economic development resource. Despite ongoing deforestation, the forest cover is still roughly 47% of the land area, amounting to about 11.2 million ha in all. Deforestation appears to be mainly due to unsustainable logging practices and inappropriate practices in shifting agriculture. For the most part, present practices of wood collection for fuelwood in rural areas appear to be environmentally acceptable. It is likely that wood will continue to play an important, though gradually diminishing, role in meeting the energy needs of the urban and rural population.

With a largely subsistence agrarian population of often limited formal education living in scattered mountain villages, the nation's remaining forests and widespread potential hydroelectric sites offer attractive resources for meeting both near-term energy needs and objectives of overall economic development. Indeed, it is essential that these resources be developed rationally and more fully, since present energy needs are met largely from the forests which are already under growing pressure from present unsustainable practices in shifting agriculture and logging. Over the longer term other, more environmentally benign, renewable energy resources such as solar and wind power, will hopefully come to play a major role in meeting the energy needs of the rural people. However, the near- and mid-term success or failure to rationally develop wood and hydroelectric energy sources will significantly affect not only the material well-being of the present generation but also the sustainability of rural development in the country.

Although the average population density in the Lao PDR is relatively low at about 18 persons per km^2, most of the population lives along the Mekong River and its major tributaries. Thus, while the population is mostly rural, the rural population tends to be concentrated in relatively narrow ribbon-like patterns following the major rivers, rather than being more evenly spread out across the land. With such localized concentrations of population and the high annual population growth rate of about 2.6% per year, pressures on the land will certainly continue to increase.

Within this context the government has moved to address issues in rural energy and rural environmental planning. These moves are outlined below following a review of the present situation with regard to rural electricification, since expansion of electricity supplies to rural areas is expected to be a major part of the country's development process in coming years.

RURAL ENERGY DEVELOPMENT

Although the existing data are not fully adequate, it is clear that fuel wood accounts for the overwhelming share of energy consumed. It is estimated that fuel wood (which is widely used in industry and agriculture as well as the residential and commercial sectors) accounts for about 90% of total national energy consumption. As in most poor countries, energy for cooking is by far the greatest energy need in the residential sector. In the Lao PDR for both urban and rural people, this need is met largely through wood. An estimated 4.5 million m^3 of fuelwood is used each year.[1] Except in certain areas, the collection of fuel wood is done in a selective manner and its environmental impact is generally considered to be minimal.

The other major energy need for people is lighting. While fuel wood is used for cooking, kerosene and electricity are mainly used for lighting in the rural areas. Although the ultimate potential of hydropower is quite high (as noted in the Introduction), existing installed capacity is only about 220 megawatts (MW), and most of the electricity produced (70 to 80%) is exported to Thailand. Indeed, much of the planned development in this sector is for further exports.[2]

Domestic electricity consumption in 1993 was 265 gigawatthours (GWH). This amounts to only to 55 kWH/capita, one of the lowest in Southeast Asia. In the rural areas only about 16% of households are electrified and rural areas account for only 10% to 15% of total electricity consumption.

Presently, there are four grid systems operating within the country (see Figs. 1 and 2). The largest is

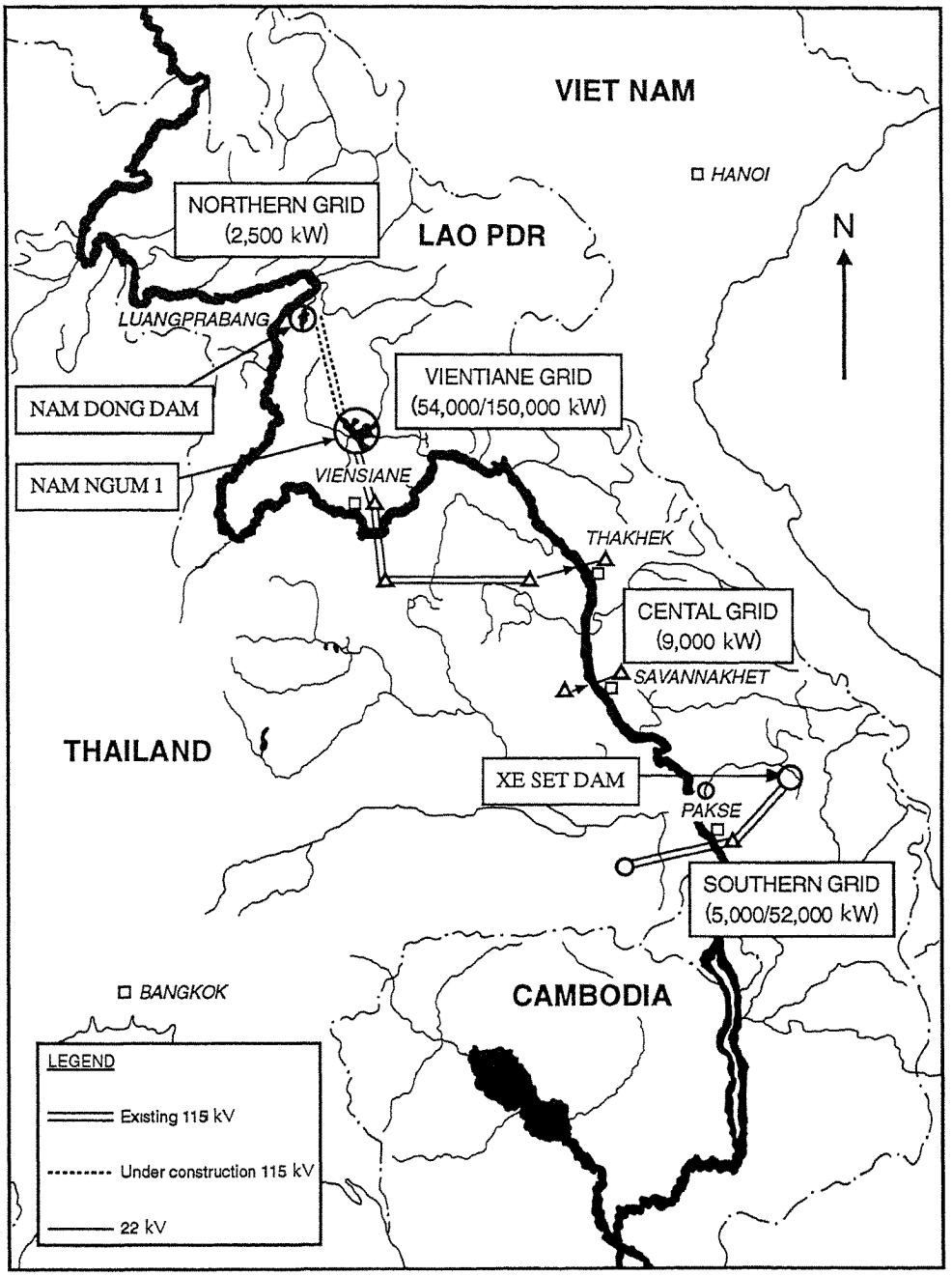

Fig. 1 Existing power grids.

for Vientiane and is based on the Nam Ngum power station with a capacity of 150 MW. This grid is now being interconnected with the Louang Phrabang grid by a 115 kW transmission line. The Louang Phrabang grid is based on the Nam Dong 1 MW hydropower plant and a 0.9 MW diesel plant. In the south, the townships of Savannakhet and Thakhek separately import electricity from Thailand. Further south, the Xeset (45 MW) and Selabam (5 MW) hydropower stations, serve parts of Champasack, Saravane and Xekong Provinces.

Electrification could be extended to some rural

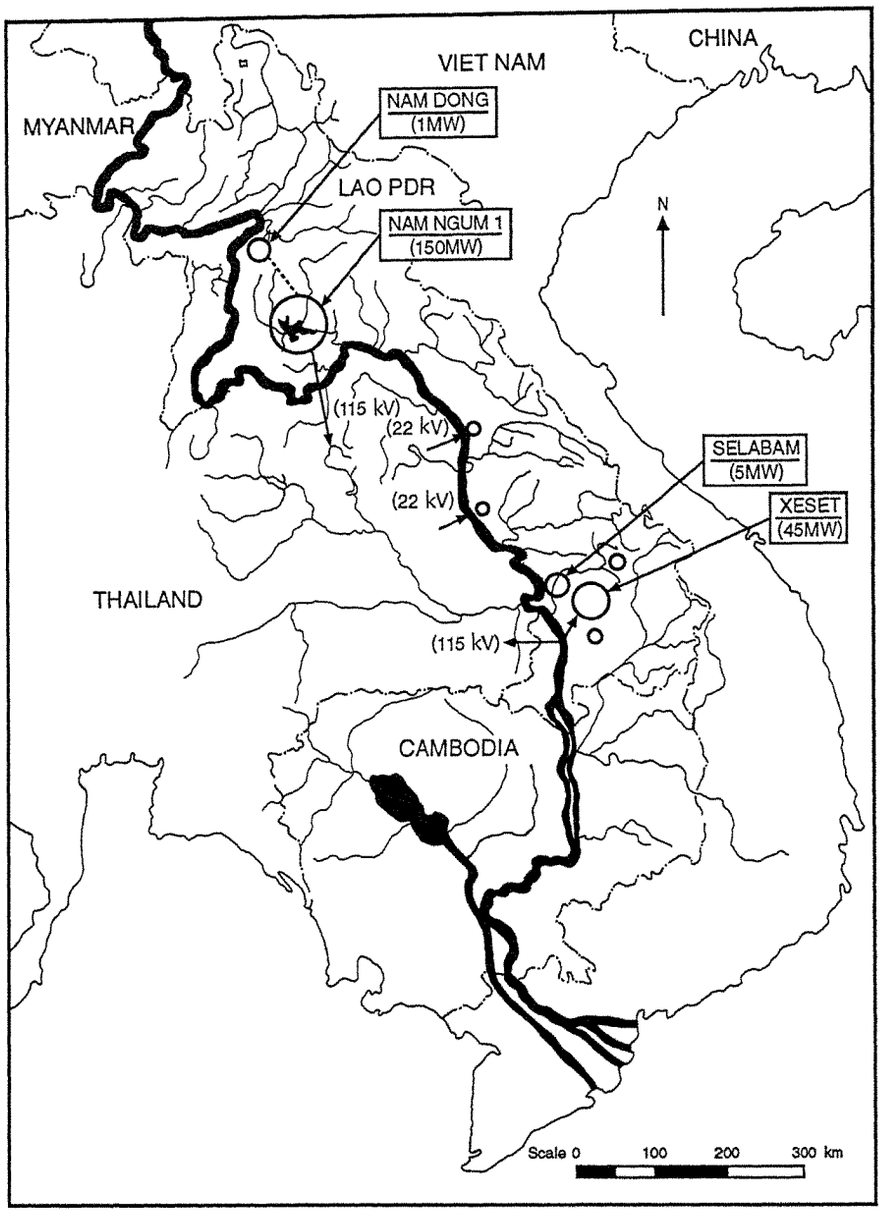

Fig. 2 Existing hydropower stations.

areas from the two main grids where the hydropower plants exist or by expansion of the township grids. However, it will be a long time before expansion of the existing electric grids could reach a major part of the rural population. Therefore, isolated small diesel and hydroelectric plants are likely to play an important role in rural electrification in the Lao PDR. About 50 sites suitable for small or micro hydroelectric in the northern and eastern parts of the country have been identified. Among those which have been implemented or are presently under construction are: Namphao (1.6 MW) (under construction) in Laksao, Borikhamsay Province; Houay Champi (80 kW) in Pakson district, Champasack Province; and Nam Ham (100 kW) in Boten district, Sayabory Province. In addition, two small micro hydropower plants for rice mills have been installed, the first with a capacity of 15 kW at

Nadeuay Luang in Prabang Province and the second with a capacity of 10 kW at Houay Tomo in Champasack Province.

In some remote areas, the local people have constructed micro hydro plants with outputs of 0.1 to 0.5 kW, primarily for village lighting. Already, where conditions permit, micro hydro plants are a popular means of providing village electricity. Where this is not possible or has not yet been done, people continue to rely on kerosene and wood. Studies are underway to assess alternative energy sources for rural areas such as solar and wind power systems.

RURAL ENERGY AND ENVIRONMENTAL PLANNING

A rural development committee has been recently established to coordinate and integrate rural development within the nation's overall socio-economic development. In the energy sector, the Ministry of Industry and Handicraft has the major responsibility for the country's rural electrification programme. The Ministry of Agriculture and Forestry is responsible for the development of mini or micro hydropower up to 1 MW capacity which is mostly related to irrigation systems. The Science, Technology and Environment Organization (STEO) was recently established within the Prime Minister's Office. STEO is responsible for the coordination and inter-ministry facilitation of environmental affairs.

The Lao government considers the rural development issue to be an important component of the national socio-economic development programme, especially as farmers represent the overwhelming majority of Lao society. The components of the comprehensive national programme are:

- to build awareness in local communities with regard to promoting participation of all people, particularly women, in the rural development programme;
- to promote agricultural goods production; and
- to develop infrastructure, such as roads, irrigation systems and rural electrification.

Under this programme, it is expected that energy intensity will increase. This increase would be met by tapping more fully the abundant renewable energy potential of the nation.

It is evident that fuel wood will continue to be the principal source of energy in the Lao PDR as forest covers a large part of the country and can meet the increasing demands of the population. Therefore the environmental issues related to rural energy development is directly linked to forestry protection. The present government policy has the following major components:

- to improve the management of logging operations and to undertake a major reforestation effort of about 100 000 ha by the year 2000;
- to involve local communities in resource management by granting explicit access rights to forest areas traditionally controlled by a given community in exchange for their adherence to resource use and management regulations;
- to implement national biodiversity conservation programmes in the 18 protected areas which cover about 10% of the total national land area;
- to undertake programmes to limit deforestation resulting from unsustainable shifting cultivation practices; and
- to establish a comprehensive legal and regulatory framework for sustainable forest management.

If these policy measures are successfully implemented, it is expected that the environmental issues related to the energy supplied from fuel wood will be acceptable.

With regard to rural electrification, the greatest environmental impacts of concern are those associated with the construction of large dams (see Note 2). However, the government has envisaged the implementation of an environmental impact assessment process with mitigation plans incorporated into project design. With regard to small and micro hydro, the needs are primarily in terms of careful site selection and sound construction so that the facilities are cost-effective and have minimal environmental impacts.

Unfortunately, at present, the ability of the nation to deal with these potential environmental issues is limited.[3] Therefore, various activities are needed for institution-building to strengthen rural energy/environment assessment capability in the Lao PDR. One vital need is in regard to developing better mechanisms for coordinating various economic sectors, and among environment and rural development, and project development. Pilot projects in the areas of small and micro hydro feasibility assessments and sustainable development of wood energy resources would be particularly useful.

NOTES

1. This figure is relatively high in comparison to the annual logging quota (under 0.3 m^3/year).
2. This expansion would be from a capacity of roughly 150 MW to 1200 MW providing approximately US$250 million per year in revenue (i.e. roughly US$50/person/year). Clearly, such exports of power from large hydroelectric projects, while raising issues of environmental impacts, represent an important source of earnings for the nation.
3. For large hydroelectric projects, training needs for environmental impact assessment, environmental impact mitigation techniques and for database development are especially crucial; these are important areas for foreign assistance to the Lao PDR.

Environmental Problems and Policies in China's Industrialization

Xia Guang

ABSTRACT

In March 1994 an earlier version of this paper was presented at the 'International Symposium on Economic Development and Environmental Problems in Eastern Asia' held at The International Centre for the Study of East Asian Development, in Kitakyushu, Japan. The paper presented here builds on this earlier one and seeks to explain to a wider audience some of the basic developments with regard to China's industrialization and environmental policies. China is fully committed to continuing on the path to industrialization as a means of providing a better life for its people. Yet, as the new environmental awareness and policies take hold, China's further industrialization will be much less damaging to the environment than has been the case in the past. This paper outlines the major policies and a number of the specific aspects of this more environmentally sensitive path to industrialization in China.

Keywords: *China, industrialization, environmental policy*

INTRODUCTION

Industrialization is the core of economic development as most countries have experienced it. Indeed, the term 'industrialized country' is often synonymous with higher income and economic strength. Many developing countries have also taken the road of industrialization 'in an attempt' to build up a rich and powerful country.

While it is true that industrialization has changed people's lives enormously and increased social welfare, the industrialization process has caused problems including environmental degradation. Today, people still value and seek industrialization but they are trying to find ways to reduce the unwanted side-effects of this process.

China initiated its industrializing process in the early 1950s. At that time, China had just recovered from long wars and its population of 540 million relied on a largely underdeveloped and run down economic system. Agriculture made up 70% of the economy with industry being a relatively small contributor. The then newly established People's Republic of China was determined to turn the economy from agriculture to industry as quickly as possible. Priority was given to industry, especially heavy industry.

For the past 40 years, the industrialization process in China has achieved much. In 1952, the total value of industrial output was 34 900 million yuan and this reached 2 894 100 million yuan in 1992 — 82 times what it was in 1952. Between 1987 and

Xia Guang, Deputy Director, Division of Environmental Economics, Policy Research Center of the National Environmental Protection Agency, No. 115 Xizhimennei Nanxiaojie, Beijing, 100035, China, Tel 86-01–601–2106, Fax 86-01–601–1182.

1992, the total value of industrial output increased on average 15% per annum. China has now established an independent and integrated industrial system and equipped large mines and power stations functioning on their own technology. Many of China's industrial products are ranked as excellent by world standards. The country has also advanced greatly in recent years in terms of the quality and quantity of its transport, communication and building industries. The impact of these achievements are evident in the rising standard of living.

Yet, the gains have been offset to some degree through declines in the quality of essential environmental services. These problems mainly can be divided into two kinds. First, environmental pollution that resulted from the industrialization process directly. Second, industrial development caused large-scale exploitation of resources and this damaged the natural environment. With respect to the first kind of problem, industry accounted for over 70% of total pollution. Excluding county industries, in 1992, the amount of industrial sewage discharge was 23 400 million tons; industrial gas waste amounted to 9 030 800 million m^3 (not including SO_2); and the amount of industrial solid wastes was 620 million tons.

Since many industrial enterprises are located in urban areas, local pollution pressure by industries is relatively great. Almost all the cities in the country have air pollution problems, especially northern cities in winter. In 1992, the total volume of suspended particulates in the atmosphere averaged 403 $\mu g/m^3$/day (very heavily polluted by any standard), and roughly 80% of urban rivers are heavily polluted. In rural areas, county industries have also caused widespread pollution.

Environmental problems caused by the industrialization process in China have the following features. First, cities and industrial areas are under severe strain from existing pollution. In these areas, the quality of the environmental services has dropped well below the 'comfortable level'. Second, the total volume of industrial pollutants is great, straining or exceeding the absorptive capacity of the natural environment to clean pollutants from the air, water and land. Third, heavily polluting industries dominate the nation's industrial structure (e.g. the power sector and heavy industry). Fourth, there has been a phenomenal growth in small industries which consume great amounts of resources and cause serious pollution per unit of output.

CHINA'S ENVIRONMENTAL POLICIES

Pollution Control

During the past two decades China has devoted increasing attention to environmental problems. This has been synchronized with the progress of international society in terms of environmental awareness. In 1972, China participated in the UN conference on Human Environment in Stockholm and set up its first government institute on environmental protection soon afterwards. Since then, China has gradually adopted policies to control environmental problems. After 20 years of experience, China has now formed a relatively complete environmental policy system. The major elements of this system are:

1. A priority for the environment in national policy. Strategically, China has established the position of 'environmental protection is an essential national policy', and in the early 1980s posed the principle of 'synchronized development of economy, urban and rural constructions and environmental constructions'.
2. Adoption of three principal policies to control pollution: the policy of prevention, the polluter pays principle, and the policy of intensified environmental management.
3. Implementation of a comprehensive control on the urban environment, mainly by bringing environmental protection into the plan of overall urban development.
4. Implementing three simultaneous steps in environmental management, i.e. installations for preventing pollution and the main part of the project has to be designed, implemented and operated simultaneously.

Priority for the Environment

The measure adopted to achieve this principle is the responsibility system, i.e. government at all levels have to be responsible for local environmental quality in order to improve the situation. Governors of all cities have to sign a responsibility guarantee during their tenure of office. This policy has played an important role in promoting the link between environmental protection and economic development.

Three Fundamental Policies of Pollution Control

The first policy is the 'prevention principle' in which policies used to eliminate pollution and to protect

the environment must be implemented before or during the early stages of economic development so that the cost of clean-up afterwards is substantially reduced. Since 1981, environmental protection has been brought into the plan of national economic and social development which now includes goals and measures such as preventing industrial pollution, controlling the key indicators of environmental quality, protecting the water quality of rivers and rural ecological environment, etc. This has ensured that some funds are available for environmental protection.

The second basic policy is the 'polluter pays' policy, which means that all enterprises have the responsibilities to bring pollution under control and to protect the environment. Those operating with processes that could potentially pollute the environment should bear the cost of preventing this. This policy has made the responsibilities clear and found the source of funds. More specifically, this measure involves levying of a pollutant emission discharge tax. All enterprises in China have to pay the tax if their pollutant discharge volume is over the national standard. The tax is put into a special fund for preventing pollution. In 1992, the tax collected was 2360 million yuan. Industrial pollution must be cleaned up within a specified time. Governments or environmental protection departments give orders of reducing pollution levels within a definite time to the enterprises which cause serious pollution. Since 1987, the state has arranged 120 000 projects to clean up the pollution.

The third policy is implementing the pollutants discharge permission system. Up to 1992, there were 370 cities and 5295 enterprises which were under the water pollutants registry. This policy not only controlled the volume of pollutants but also helped to enhance production efficiency. Where appropriate, this includes centralized pollution control. This is a technical policy to overcome the scattered pollution control, which is not economical, and to improve the efficiency of environmental protection investment. The measures adopted for this policy are large-scale sewage treatment plants, smoke and dust controlled areas in cities, noise controlled areas in cities and centralized heating systems.

Intensified environmental management policies reflect the fact that the main barrier to solving China's environmental problems is not necessarily technical, but rather the often loose management of pollution. Intensified management, therefore, is the core of these environmental policies. The conditions to ensure this are as follows:

1. Enhancing the legislation on environmental protection and its execution. China has always emphasized environmental legislation. For example, the Environmental Protection Law, the Prevention of Air Pollution Law, the Prevention of Water Pollution Law and the Ocean Environmental Protection Law have now been promulgated. Environmental protection has also been emphasized in eight resource laws, e.g. the Forest Law and the Grassland Law. The country has already set up 310 environmental standards (including environmental quality, pollutants discharge and pollution monitoring methods, etc.). Relatively integrated environmental laws, regulations and standards have been formed preliminarily. A large number of new environmental protection laws are now being examined and approved and will be implemented in future.
2. Establishing a network of environmental protection organizations in the country. Governments at all levels (state, province, county and city) have environmental protection departments with supporting departments, e.g. propaganda, education, scientific research, monitoring and management. Staff members involved in environmental protection now number more than 200 000 throughout the country (including members of all professions and enterprises). In general, large and medium-sized cities and enterprises have a relatively strong capability of environmental management.
3. Enhancing propaganda and education on environmental protection and encouraging public involvement in environmental protection. Environmental education has been widely introduced in all universities and secondary and primary schools. A large number of specialists on environmental science have been trained in the universities. The public has the right to recommend and complain and also has the right to take actions which may benefit the environment. In 1992, there were 40 000 complaints (including both letters and visits) from the public.
4. Promoting science and technology in environmental protection. Scientific research institutes on environmental science have been established at all levels, i.e. state, province and city. China has now set up more than 2100 environmental monitoring stations.

Controlling the Urban Environment

Another important step in China's increasingly urban society has been to implement a comprehensive control on the urban environment, mainly by bringing environmental protection into the plan of overall urban development. This is accomplished through various means including regulation of the structure of urban estates, the distribution of industries, the building-up of the regional 'industrial-biological chain', re-reusing resources, improving the structure of urban energy resources where possible, and reducing the volume of pollutant generation and discharge. Through the formulation and implementation of the urban plan, the state has basically addressed the earlier problems of the uncontrolled siting of factories by some large and medium-sized industries. In order to attain overall management of the urban environment, in 1991 China began an annual assessment. In this assessment exercise, 37 large cities are evaluated by the state directly. Dalian and Haikou are two major examples.

In addition to the above measures, China has implemented a system of environmental impact assessment for construction projects. Under this system, since the early 1980s, all proposed projects which may affect the environment must be approved by the relevant Environmental Protection Department. In 1992, the execution rate of this policy was about 60%. This produced results in the control of new sources of pollution.

Incorporation of Pollution Control into Project Design, Construction and Operation

Prevention in pollution control, like prevention in health care, typically is much cheaper than trying to cure the problems later. To ensure that such opportunities are not lost, the policy 'mandates' the simultaneous consideration of pollution control during each of the major stages of a project (i.e. its design, its construction and its operation). If this is not done, the project would not be permitted to operate even though the construction might already be completed. The execution rate for this measure was about 86% in 1992.

In the last 20 years, China's environmental problems have been improved through the implementation of environmental policies. In the 1980s, environmental quality did not drop in correspondence to the development of the economy (annual increase rate of the economy was 10%), contrarily, it improved in a few places. Although the absolute standard of environmental quality in the 1980s and at the present were and are not satisfied, it would have been worse without the implementation of these environmental policies. International society, especially developing countries and the UN Environmental Programme, highly praised China's environmental policies.

A NEW PATH FOR CHINA'S INDUSTRIALIZATION

China will continue its industrialization process and attempts to reach a higher living standard for its people in the twenty-first century. Already the pace of the process has outstripped expectations. For example, it seems likely that by 1997 China will achieve the economic goals originally set for the year 2000, i.e. gross national product (GNP) will be two times what it was in 1980, steel output will reach 94 million tons, raw coal output will be 1300 million tons and other industrial indicators will also have great increases. All these will no doubt increase pressure on the environment.

Facing such challenges, China's environmental policies have to be changed and developed accordingly. Separating the progress of industrialization from the management of the environment, will simply not work. The only way is to bring environmental policies into the industrialization process itself. The direction and goal of industrialization are not the issues in China. However, the means adopted for industrialization must be changed if the country is to avoid needless waste and long-term damages to the health of its people and the productivity of the natural resource base. Now is the time to make such changes. The new road of industrialization around the world is characterized by high product value and low cost. In China this includes the following elements:

1. Full consideration of the long-term potential of local environmental capacity and also rational distribution of industry.
2. Full utilization of non-polluting and low-pollution technology and technological processes.
3. Collection and reuse of wastes which have to be produced.
4. Environmentally sensitive products should be

produced and used under the conditions of an environmental risk assessment and a guarantee of acceptable levels of safety.

5. Building of a new industrial civilization and professional consciousness which regards environmental protection as one's duty.
6. Increase of public involvement with regard to the process of industrial development.
7. Establishment of a balanced relationship which will ensure that agriculture and other sectors provide a stable foundation of resources for industrialization.
8. Full development of environmental protection industries which will provide the means of material and technical support for preventing industrial pollution.
9. Increase of the involvement of all participants in environmental protection.

In brief, the core of this new path for industrial development is to regard environmental protection as one's duty and to bring it into the process of development rather than leaving the problems for society or environmental protection organizations to solve. This is significantly different from the traditional model.

China has no other option than to stay on the path to industrialization, but to do so by taking this new path. In fact, China has already begun to do so. At the end of 1993, China decided to implement the policy of 'cleaner production' in the development of industry. This is an important change for the nation. There may be many alternative ways in which China might go down this new road, but keeping to the broad terms outlined above is essential.

At present, there are still many barriers to China's industrialization. To overcome these barriers China has to rely primarily on the strength of itself, but effective international cooperation will no doubt help speed up this process. From this point of view, China has a bright future.

REFERENCES

Environmental State Report. 1992. *Environmental Yearbook of China.* China Environmental Science Press.

Li Peng, Government Report. *Beijing Daily* 2 April 1993.

National Report on Environmental and Development of the People's Republic of China. 1992. China Environmental Science Press.

Qu Geping and Li Jinchang. 1992. *Population and Environment of China.* China Environmental Science Press.

Statistical Yearbook of China. 1990. China Statistics Press.

Statistical Summary of China. 1993. China Statistics Press.

Xia Guang. 1992. *Environmental Pollution and Economic Mechanism.* China Environmental Science Press.

Xia Guang. 1993. A Review of Ecologically Sustainable Development of Industry. *Management World* Vol. 4.

Fish Ponds in the Ecology of the Inner Deep Bay Wetlands of Hong Kong

Wing Hing Chu

ABSTRACT

Since fish ponds are man-made, relatively homogenous, and intensively managed, environmental impact assessment (EIA) studies for development projects in the Inner Deep Bay area in the Northwest New Territories of Hong Kong have usually concluded that they have low value to wildlife. From this a further conclusion is drawn: that development projects which alter these ponds will have insignificant impact on the Mai Po Marshes and Deep Bay, which comprise a wetland of international importance. However, this conclusion may not be valid since each EIA was done for a small area over a short time period. Cumulative impacts were not assessed. This paper uses the baseline ecological data included in five EIA studies for development projects in Inner Deep Bay and other information to review the ecological value of fish ponds to the Mai Po Marshes Nature Reserve.

The results of this evaluation show that the number of species recorded in the fish pond areas of Inner Deep Bay is overall not much different from that in the Mai Po Marshes Nature Reserve. The fish pond areas support a number of protected species, notably medium-sized mammals, and are an important habitat for resident egrets and herons, as well as migrant birds. Fish ponds are now an integral part of the Inner Deep Bay wetland system and also serve as water storage facilities and hence reduce flooding. In terms of landscape, ecology and hydrological management, the Deep Bay fish ponds are of very considerable importance and should be retained as far as possible.

Keywords: *Hong Kong, wetlands, managed wetlands, mangroves, nature reserves, China*

INTRODUCTION

Inner Deep Bay, including the nature reserves of Mai Po (Mai Po Nature Reserve [MPNR]) and the Futien National Nature Reserve in The People's Republic of China together with the adjacent fish pond areas shown in Figure 1, is a wetland of international importance in accordance with the criteria established under the Ramsar Convention (Melville 1989, 1991). Although five Sites of Special Scientific Interest (SSSI) have been designated since 1976 (see Fig. 2), the Inner Deep Bay wetland continues to be threatened by development. Apart from the development of Fairview Park (a low-density housing estate next to MPNR) in the 1970s, about 450 ha of fish ponds were 'reclaimed' to form Tin Shui Wai New Town. More recently, there has been a large-scale, low-density residential development at Wo Shang Wai (also near MPNR). New development is expected which will result in further wetland loss. In addition, there is extensive unauthorized filling in of fish ponds for open container storage throughout the Northwest

Wing Hing Chu, World Wide Fund For Nature, Hong Kong, G.P.O. Box 12721, Hong Kong, Tel (852) 2526–1011, Fax (852) 2845–2734.

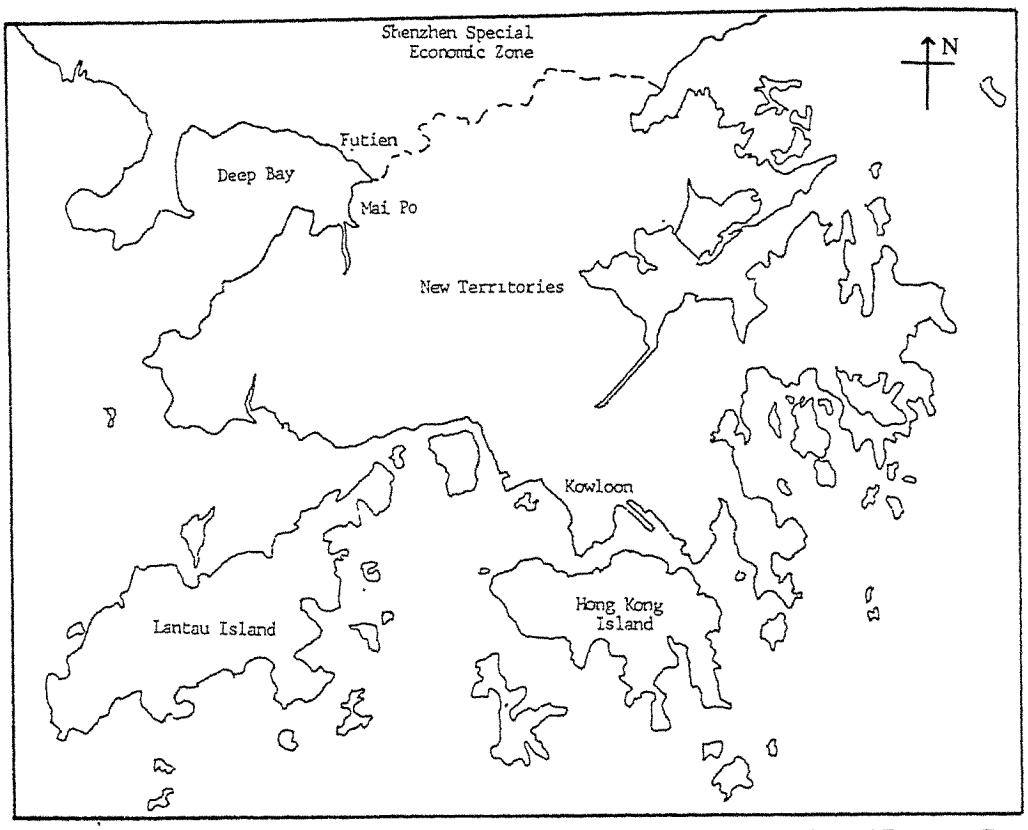

Fig. 1 Map of Hong Kong and locations of Deep Bay, Mai Po, Futien and Shenzhen Special Economic Zone.

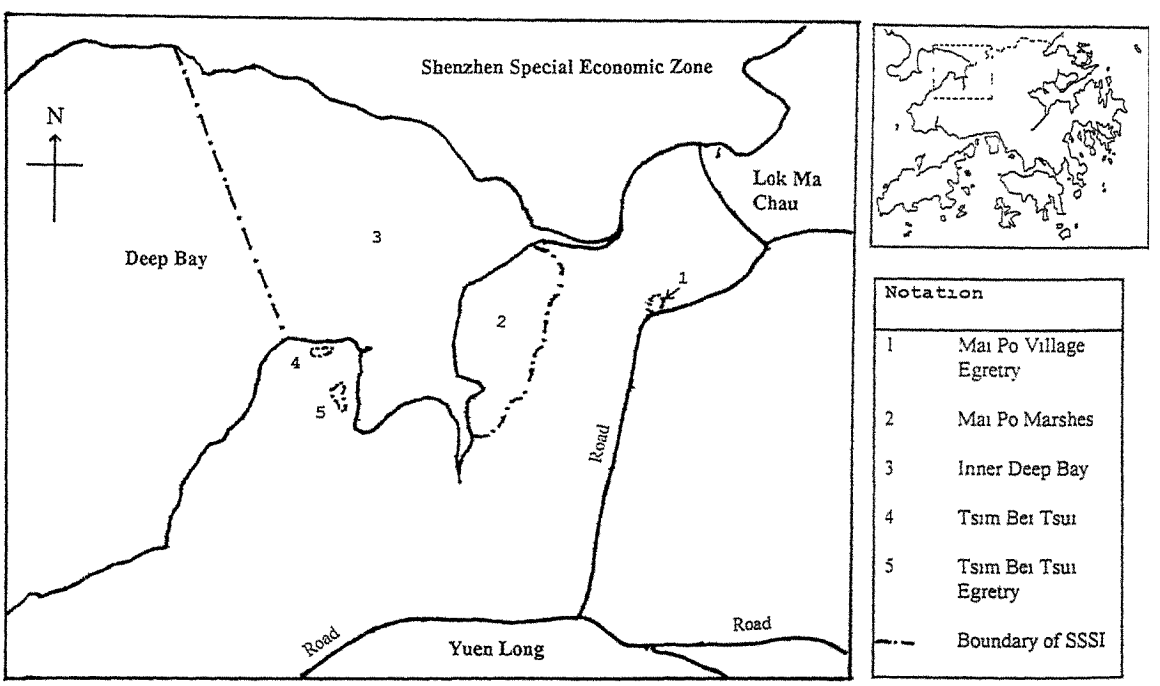

Fig. 2 Sites of Special Scientific Interest in the Inner Deep Bay area.

New Territories (NWNT) which has taken place in recent years in connection with the increasing cross-border trade between Hong Kong and the Shenzhen Special Economic Zone in China.

In response to the recommendations of the Deep Bay Integrated Environmental Management Study (ERL 1988), land-use planning Buffer Zones around Deep Bay were endorsed by the Hong Kong Government, and have been implemented through administrative controls to ensure sympathetic land use (TPB 1993). The area in the vicinity of Inner Deep Bay, including MPNR is classified as the Deep Bay Buffer Zone 1 consisting of 948 ha. In this area, new development will not be allowed unless it is 'required to support the conservation of the area's natural features and scenic qualities'. Deep Bay Buffer Zone 2 (1027 ha) is further away from the reserve inland and in this area only development with 'insignificant impact on Deep Bay' will be considered (TPB 1993). The Deep Bay Buffer Zones occupy a total area of about 1975 ha, the majority of which are freshwater fish ponds, brackish *gei wai* (intertidal shrimp ponds), low density residential areas, with scattered village houses, and open containerized cargo storage sites which were developed on reclaimed fish ponds.

With the enactment of the Town Planning (Amendment) Ordinance in 1991, development in the area around the MPNR came under planning control. The area was then covered by four statutory Development Permission Area (DPA) plans, namely, San Tin DPA plan (DPA/YL-ST/1), Mai Po and Fairview Park DPA plan (DPA/YL-MP/1), Nam Sang Wai DPA plan (DPA/YL-NSW/1), and Lau Fau Shan and Tsim Bei Tsui DPA plan (DPA/YL/-LFS/1), which came into effect in 1991. They were replaced by the four relevant Outline Zoning Plans (OZPs) in mid 1994. Any development within an area covered by a DPA plan or OZP has to comply with the land-use zoning which appeared on the plan and the planning intentions set out in the Notes (which form part of the plan) attached to the plan.

Before mid 1994 when planning control was governed by the DPA plans in Deep Bay Buffer Zone 2, about 74% of the area was zoned as 'Unspecified Use' Area (U-zone) in the aforesaid DPA Plans where new development is subject to approval, with or without conditions, from the Town Planning Board. There was a total of 13 planning applications for residential and/or recreational developments in these U-zones between August 1990 and March 1993. One of the requirements for new developments in Deep Bay Buffer Zone 2, as specified in the Explanatory Statement attached to the DPA plans, is that an environmental impact assessment (EIA) should be submitted to the Town Planning Board for consideration. Baseline ecological surveys have been included in some of the EIAs for these development proposals.

However, these ecological surveys were done individually, and the cumulative impacts on wildlife, particularly the effects of extensive loss of fish ponds outside the immediate area of study were not assessed. A few studies have been conducted in the fish pond areas in recent years, focusing on the use of these fish ponds by birds, particularly herons and egrets (Britton 1993; Wong 1991; Young 1992, 1994), and the importance of fish ponds as a feeding ground for nesting egrets and herons has been confirmed. However the EIA reports of the development projects consistently refer to fish pond areas as 'a heavily disturbed, man-made habitat with minimal value to wildlife'. Only recently has a study on the ecology and importance of fishponds to wildlife been started (G. Walthew, in prep.).

This paper evaluates the data contained in the baseline ecological surveys which were conducted for five planning applications in the Inner Deep Bay area. It is hoped that this paper can generate a clearer picture of the ecological implications of the continual loss of fish ponds to urban development on the ecology of Inner Deep Bay.

The baseline ecological surveys contained in the planning statements, environmental assessments (EAs) or environmental impact assessments (EIAs) of the following planning applications were reviewed. (See Fig. 3 for their locations):

- Residential Development at Lin Barn Tsuen;
- Comprehensive Residential Development at Tam Kon Chau;
- Sunnyville Estate — Development at Nam Sang Wai;
- Residential Development with Nature Garden at Fung Lok Wai;
- Residential Development at Pak Hok Chau.

The flora and fauna recorded in the application sites are summarized in four appendices, namely, 'vegetation', 'amphibians and reptiles',' mammals' and 'birds'. Species recorded in MPNR are also listed. Any protected species found there are noted. In addition, as the number of species recorded is

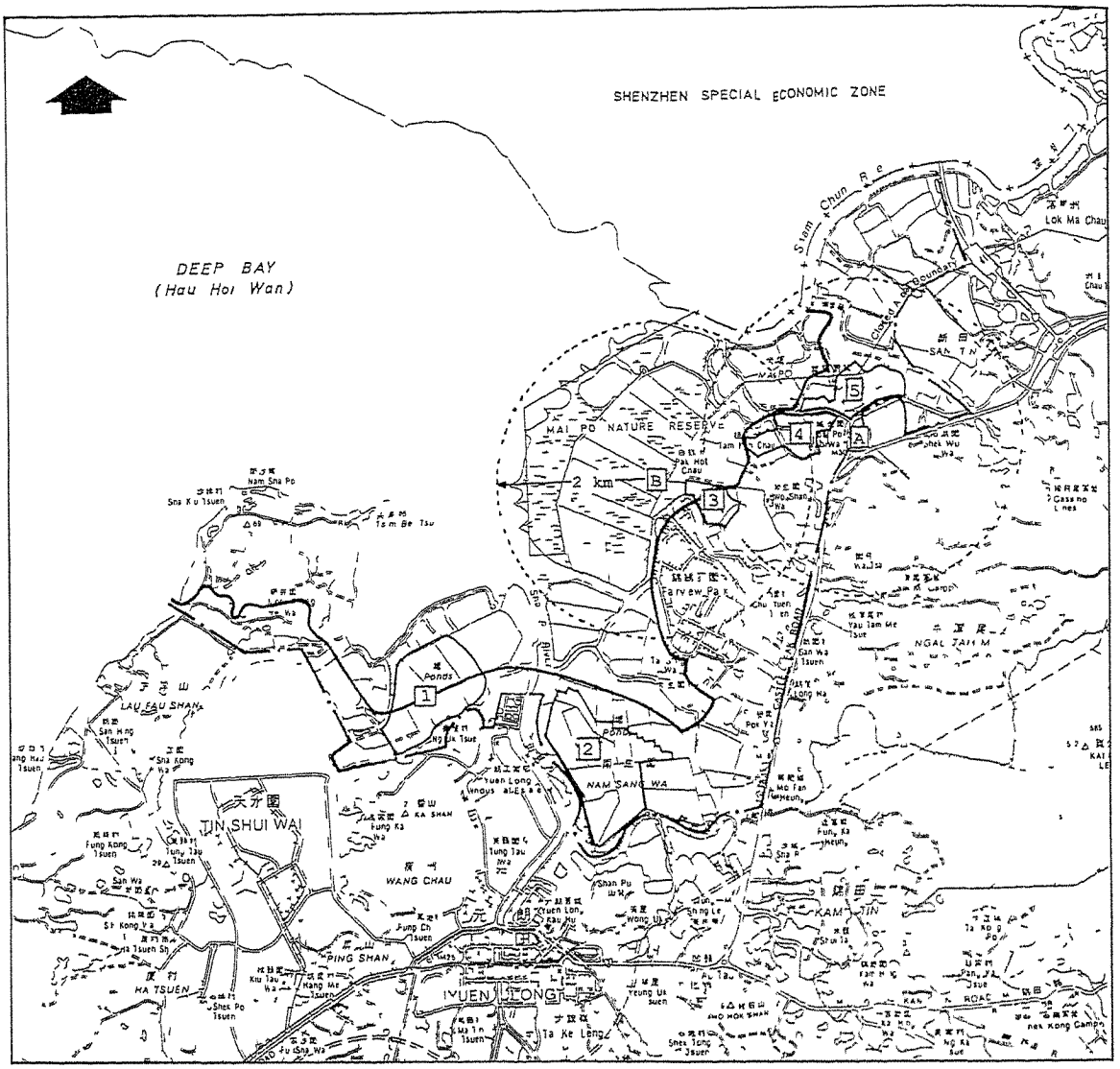

Fig. 3 Location of Planning Applications and Egretries within the Deep Bay Area and boundaries of Deep Bay Buffer Zones Notation 1, Fung Lok Wai, 2, Nam Sang Wai, 3,Pak Hok Chau, 4, Tam Kon Chau, 5, Lin Barn Tsuen, A, Mai Po Village Egretry SSSI, B, New Egretry at the *gei wai* no 12, ———, boundary of Deep Bay Buffer Zone 1, — —, boundary of Deep Bay Buffer Zone 2, - - - - , 2 km flight from egretaries

related to the level of effort devoted to each survey, a brief background on each study is also presented Since the data were not collected systematically, only subjective interpretation and conclusions can be drawn here Nonetheless, the likely importance of these areas is clear

GENERAL HABITAT DESCRIPTION

As shown in Table 1, except for the Lin Barn Tsuen site, the application sites are covered by either abandoned or operational fish ponds or both Only a few fish ponds remain at the Lin Barn Tsuen site Others have been filled in and replaced by a riding school, a construction equipment storage site and a vehicle repairing yard There was a factory and a warehouse on site, but they were abandoned recently Also, one of the reclaimed fish ponds which is abandoned has, through neglect, turned into a seasonally flooded grassland This site is close to the Mai Po Village Egretry SSSI.

Table 1
Summary of Sites and Development Proposals

Development	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Site Area	34 ha	31 56 ha	approx 107 ha	80 ha	15.37 ha
Deep Bay Buffer Zones	2	1	2	1 & 2	1 & 2
Existing land use	Fish ponds, marsh and grassland comprise 17 ha The rest consists of a riding school, a 'go-kart' track, a vehicle repairing area, and some temporary housing	Covered largely by fish ponds with one or two also for rearing ducks Some scattered village houses and structures for fish food storage also exist on the bunds	Over 90% of the site is covered by fish ponds Scattered structures on the bunds cover the remaining area	Covered largely by fish ponds To the south (outside the site) is a small hill (61 7m) covered with scrub vegetation	Covered by fish ponds with scattered huts on the bunds
Features of Development	Low density residential development with 876 units and 16 25% coverage at a 0 4 plot ratio Fish ponds on the northern and western parts will be retained	1119 2-storey houses at a 0 4 plot ratio, site coverage is 20% 3 77 ha of the western part of the site will be set aside for a conservation area	Residential development with an 18-hole golf course The former ranges from 2-storey houses to 8-storey apartments at a plot ratio of 0 31 An area of 21 8 ha at Lut Chau is proposed to be surrendered to the government in exchange for Crown Land adjoining Nam Sang Wai to be managed as a nature reserve	The residential development ranges from 3-storey houses to 12-storey towers, producing totally 4108 units with a plot ratio of 0 87 A 'Nature Garden' of 43 4 ha situated at the northern half of the site is proposed	302 houses with a plot ratio of 0 26 and 12 7% site coverage 5 63 ha of land in Buffer Zone 1 will be retained for conservation
Design Population	3232	3981	9129	12 320	1114
Area Designed for conservation	approx 11ha (32%) N B by rough estimation	3 77 ha (12%)	29 9 ha (21.8 %)	43 4 ha (54 3%)	5 62 ha (36 6%)
Period of Study	Three weeks between Feb & March, 1992	1–4 Oct. 1992	Aug & Sept , 1991	Early Feb , 1991	Phase I Jan 1992 Phase II Jul – Nov 1992 Phase III Mar – Jun 1992

(Source CES 1992a, 1992b, 1993, Townland 1992, 1993)

The Tam Kon Chau site is also close to the Mai Po Village Egretry. The Pak Hok Chau site is immediately adjacent to the WWF Hong Kong Mai Po Marshes Wildlife Education Centre and Nature Reserve. The largest site is at Nam Sang Wai, south of the MPNR. Fung Lok Wai is close to the coast of Deep Bay and the latter two have the most extensive areas of fish ponds among the five sites (see Table 1). Table 2 summarizes the numbers of species recorded in the study sites, while Table 3 gives a comparison of the biodiversity between survey sites and Mai Po Nature Reserve.

Flora

The floristic composition of the sites is relatively simple and similar to each other, with low species diversity. No protected species were found. Most of the trees are exotic species. Vegetation abundance was low and no sizable wooded areas were found on the survey sites. However, some trees found on the sites provide fruit for birds (see Appendix). The mature Eucalyptus at Nam Sang Wai are an important landscape feature but their value to wildlife is minimal. Mai Po Nature Reserve is richer in vegetation in terms of both amount of cover and species richness. Unlike the MPNR, no significant areas of mangrove or reed occur on the application sites. However, those fish pond bunds that are covered by grass and shrubs provide important refuges for some species of birds and larger mammals.

Fauna

Except for the study at Pak Hok Chau, most of the ecological surveys were conducted over only a few days. Species recorded, and those expected to occur in the study sites are independently marked in the Appendices (except for birds). Those species expected to occur were also listed in the ecological surveys because the survey periods were so short that some species recorded in the same sites on previous occasions may be missed during the surveys (see Appendix).

Table 2
Summary of Numbers of Species Recorded or Expected in the Five Survey Sites

Flora and Fauna	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Plants	83	48	41	29	39
Amphibians and reptiles	20	15	8	3	13
Mammals	6	3	7	7	7
Birds	31	40	52	129	81
Number of protected species*	4	2	5	8	5

* Except for birds, all species listed in the Wild Animals Protection Ordinance (Cap. 170) are counted in this category. However, since in Hong Kong, all wild birds are protected by the Wild Animals Protection Ordinance, only those birds listed in Appendix 1 of the Bonn Convention are counted in this category.

Table 3
Comparison of Biodiversity between Survey Sites and Mai Po Nature Reserve

	Number of Species Recorded in	
	Survey sites in Buffer Zones	*Mai Po Nature Reserve*
Plants	128	132
Amphibians and reptiles	23	26
Mammals	16	11
Birds	150	approx. 320

Amphibians and Reptiles

Species diversity of amphibians is not rich in either MPNR (three species recorded and two others expected) or the study sites (six species recorded in total) due to the saline/brackish nature and eutrophic conditions of many water bodies (see Appendix 2). However, the locally rare Narrow-mouthed frog *Kalophrynus pleurostigma* was recorded at the Lin Barn Tsuen site. The amphibian fauna in this particular site is relatively richer, which could be due to the seasonally flooded marshes there. None of the amphibians recorded are protected locally or internationally.

The MPNR is only slightly richer in reptiles than some of the study sites. Five species that could be found in the study sites are protected locally and/or internationally. The Chinese soft-shelled turtle *Trionyx sinensis* has been recorded at the Lin Barn Tsuen and Tam Kon Chau sites but was not found during the survey. It is a locally protected species which is also found in MPNR.

Mammals

In all, 10 species of mammals were recorded, while a further five species were expected to occur in the study sites. When considering the limited vegetation cover and general lack of other hiding sites in the area, the mammal diversity of the area is surprisingly high. Among these, eight species are protected by the Wild Animals Protection Ordinance. The mammal fauna in the study sites is similar to that in the MPNR where 12 species were recorded (see Appendix 3).

Birds

A total of 150 species of birds were recorded in the study sites and 98% of these species were also recorded in the MPNR (over 320 species have been recorded in the MPNR). A comparison of species numbers of some selected bird groups in the study sites and MPNR is shown in Appendix 4. In comparison with the MPNR, the diversity of waders (shorebirds) (excluding Fung Lok Wai), ducks, gulls and terns in the study sites is much lower. But the diversity of warblers, starlings and mynahs, egrets and herons, and buntings is similar. Since the baseline ecological surveys were not done systematically and quantitatively, it is not possible to assess the relative abundance of those birds that occur in the fish pond areas and the MPNR.

DISCUSSION

In recent years fish farming has been in decline in Hong Kong. In 1992, there were about 1620 ha of fish ponds remaining, of which 270 ha were abandoned (AFD 1994). Those in the Deep Bay Buffer Zones accounted for about 71% (i.e. 1165 ha) of the total fish ponds in Hong Kong in 1991. In fact, there were more fish ponds in the Deep Bay area in the past. The in-filling of fish ponds around Deep Bay for the development of Fairview Park, Tin Shui Wai New Town, Wo Shang Wai and Yuen Long Industrial Estate has reduced the fish pond area by over 600 ha. Added to this will be the fish pond loss due to the construction of the main drainage channels for Yuen Long and Kam Tin (over 140 ha), and Ngau Tam Mei main drainage (20 ha) (ERL 1988). There is also continued unauthorized in-filling of fish ponds for use as open container storage and car dumps. In addition, over 90% (about 300 ha) of the *gei wai* and fish ponds at Futien, Shenzhen, have been reclaimed for urban development since 1988 (ERL 1988). The fish pond area in Deep Bay continues to decline due to both authorized and unauthorized development. If all five study sites are approved for development, it will lead to a further loss of 282 ha of fish ponds which is about one quarter of the existing fish pond area in the Deep Bay Buffer Zones. On top of the impacts to wildlife, such a substantial loss may also pose a significant flood hazard to the northwest New Territories (ERL 1988).

Birds are the best represented and most prominent wildlife group in the Inner Deep Bay area. A total of 150 species of birds were recorded from the five study sites (Table 3). In comparison with the MPNR (the latest record for the MPNR is about 320 species), about 60% of the birds in the MPNR are also recorded in the fish pond areas. However, when considering the relatively short study period of these baseline ecological surveys and the fact that these study sites are smaller than Mai Po (Table 1), it is reasonable to assume that the fish pond areas in Inner Deep Bay are important habitats for birds and this has been recognized previously in the study on Deep Bay Integrated Environmental Management (ERL 1988).

Available records indicate that MPNR has many more species of some waterfowl groups (i.e. ducks, gulls and terns) than the surrounding fish ponds. Waders also are more diverse in the MPNR than the

study sites except the Fung Lok Wai site. This is attributed to the fact that the Fung Lok Wai site is immediately adjacent to the Inner Deep Bay coast. The simple reason for the more diverse bird fauna in the MPNR is the greater habitat diversity there in comparison to the rather uniform fish pond areas. However, some bird groups are equally represented in the fish pond areas and the MPNR. These include warblers, herons and egrets. The five baseline ecological surveys have only recorded species occurrence in the study sites, with no information regarding abundance, and it is difficult to determine from these survey data the significance of fish ponds to these birds.

Previous research on this aspect has been concentrated on the use of fish ponds by birds, particularly herons and egrets (Britton 1993; Wong 1991; Young 1992, 1993). The importance of fish ponds for herons and egrets is related to their management. Although artificially stocked with Mullet *Mugil cephalus* and carps (Cyprinidae), the ponds also support a variety of non-commercial fish (e.g. Mosquito fish *Gambusia affinis* and Tilapia *Oreochromis mossambicus*) and shrimps (e.g. *Macrobrachium nipponense*). It is these species which birds, particularly the herons and egrets, feed on most (Wong 1991; Young 1993).

Fish ponds provide predictable feeding grounds in the sense of daily behavioral variation in prey activity (Britton 1993) and annual operation practice of fish ponds (Young 1992). Little egrets *Egretta garzetta* were observed to hunt in the fish ponds early in the morning to take advantage of the Mosquito fish and freshwater shrimps which concentrate in the shallow water to undertake aquatic surface respiration (Kersten *et al.* 1991; Young 1993).

Fish harvesting usually occurs from autumn through to spring, and is done by slowly draining the ponds and then catching the fish in the shallow water using nets. Since fish ponds are drained at different times, it results in a mosaic of drained and un-drained fish ponds in the Deep Bay area from autumn to spring. Herons and egrets take advantage of the shallow water to feed on the non-commercial fish and shrimps that are trapped in the small pools. Several hundred herons and egrets (mainly Little egrets), may gather to feed in these ponds as they are progressively drained because of the ease with which food can be obtained. In addition, the non-commercial Tilapia are harvested and thrown onto the fish pond bunds where they rot, and the flies, which are attracted, and their maggots provide food for many birds. Up to 14 species have been seen around such piles of fish (Melville 1987;Young, pers. comm.).

There used to be three egretries in Inner Deep Bay but the two at Tsim Bei Tsui were abandoned soon after the fish ponds at Tin Shui Wai were reclaimed to form the Tin Shui Wai New Town. In addition to the still existing egretry at the Mai Po Village SSSI, about 40 pairs of Night heron *Nycticorax nycticorax* and Little egret *Egretta garzetta* nested at the eastern end of *gei wai* number 12 of the MPNR in 1992.

Over 50% of the herons and egrets breeding at the Mai Po Village SSSI feed around fish ponds, the average foraging distance being 1.5–2 km from the egretry (Wong 1991; Young 1993). Though no studies have yet been undertaken in the new egretry at the MPNR, it is expected that the nesting egrets and herons will also forage in the fish pond areas, particularly during high tides (Young, pers. comm.). Over recent years, as the area of fish ponds has decreased around Mai Po, the number of herons and egrets breeding at the Mai Po Village SSSI has also decreased, although disturbance may also be partly responsible (Young 1992). There is no doubt that the Inner Deep Bay fish ponds are important to the nesting egrets and herons. If further areas of fish ponds are filled in for urban development, then the egretries will be threatened and may be abandoned altogether. It should be noted that there are no alternative breeding sites surrounded by suitable feeding habitats on either side of Deep Bay for the displaced birds to resettle.

Warblers are the other diverse group of birds in the fish pond areas, but no systematic study on the use of fish pond and bunds by warblers has yet been undertaken. However, fish ponds are the breeding site for chironomid midges, Chironomidae, which swarm in large numbers on hatching. They are an important food source for aerial insectivores such as the swallow *Hirundo rustica* and swifts. Vast numbers of chironomids move from the freshwater fish ponds to the reed beds and *gei wai* at the MPNR and also provide a very important food source for the warblers there. This is particularly significant to migratory species such as the Great reed warbler *Acrocephalus arundinaceus* which depends on such a food source to enable it to deposit fat so that it will have sufficient energy reserves to complete its migratory flight (birds may gain in excess of 1 g of fat per day in spring) (Melville, unpub.).

The study at the Pak Hok Chau site (Townland 1993) also shows that fish ponds are important breeding grounds for insects in the families Diptera (e.g. chironomids), Lepidoptera (e.g. butterflies and moths) and Hymenoptera (e.g. wasps, bees and ants) which are preferred food for insectivorous bats and birds. It should be noted that the study at this site is the most comprehensive to date and is the only study which has covered a whole year (Table 1). A Malise trap study at different times of the year revealed that the peaks in insect numbers and species during spring and autumn was finely matched with the movement of the passage migrant birds through the Mai Po area (Townland 1993). It is reasonable to assume that these insect peaks also occur similarly in the other study sites due to the presence of similar habitats. This highlights the fact that fish ponds may be important as a food supply for some passage migrants, notably warblers such as the Great reed warbler and Black-browed reed warbler *Acrocephalus bistrigiceps*.

Apart from birds, reptiles such as the Chinese soft-shelled turtle *Trionyx sinensis* have also been recorded in the fish pond areas, which is protected by the Wild Animals Protection Ordinance Cap. 170. Moreover, the occurrence of locally protected mammals, such as the Leopard cat *Felis bengalensis*, the otter *Lutra lutra* (not recorded during the surveys), the Seven-banded civet *Vierricula indica* and the Javan mongoose *Herpestes javanicus* in the fish pond areas, deserve special concern (see Appendix). Otters presumably take fish from the ponds, but the exact dependence on fish ponds by these species still needs to be determined.

CONCLUSION

The baseline surveys have shown that the species diversity in the fish pond areas of Inner Deep Bay (i.e. the study sites) is not much different from that in the MPNR (Table 3). Taking into account the short study periods (i.e. low sampling effort) and the relatively small areas covered by these five studies, it is reasonable to assume that the biodiversity in the Inner Deep Bay fish pond areas could be broadly comparable to the MPNR. Like the MPNR, the fish pond areas support a number of protected species, notably the larger mammals, and are an important habitat for passage migrant birds, egrets and herons. One fact that is becoming clear, is that the more that is revealed about the use of fish ponds by wildlife, the more important they are considered to be to wildlife. Fish ponds are an integral part of the Inner Deep Bay wetland system and therefore should be conserved as far as possible. Further destruction and fragmentation of the fish pond areas will very likely threaten this wetland system.

Apart from the need to undertake more scientific research in the Inner Deep Bay wetland so as to accurately assess the value of different habitats in the area to wildlife, opportunities to actively manage some of the wetland areas should be explored so as to increase the carrying capacity of the area to compensate for the wetland loss in recent years. It is suggested that the Hong Kong government seriously investigate the value of this compensatory measure as fish ponds are often lost due to certain types of important developments.

ACKNOWLEDGEMENTS

Special thanks are given to David S. Melville, Llewellyn Young and Billy C.H. Hau for their comments and suggestions on the draft manuscript of this paper. Valuable advice was also given by Michael W.L. Lau, John Fellows, Gary Ades and Graham Reels of The University of Hong Kong.

REFERENCES

AFD. 1978. *Check List of Hong Kong Plants*. Agricultural and Fisheries Department, Hong Kong Government, Hong Kong.

AFD. 1991. Agriculture and Fisheries Annual Departmental Report 1989–1990, Hong Kong Government, Hong Kong.

AFD. 1994. Agriculture and Fisheries Annual Departmental Report 1992–1993, Hong Kong Government, Hong Kong.

Britton, A.R.C. 1993. Feeding Behaviour of the Little Egret at Mai Po, Hong Kong. *Hong Kong Bird Report* 1992:176–84.

CES. 1992a. Preliminary Ecological Impact Assessment for a Comprehensive Residential Development at DD 301, Tam Kon Chau, Yuen Long. Consultants in Environmental Sciences (Asia) Ltd., Hong Kong.

CES. 1992b. Environmental Assessment Study, Nam Sang Wai Development Company Ltd. & Kleener Investment Ltd., Hong Kong

CES. 1993. Environmental Impact Initial Assessment Report. In Technical Appendix Volume II for Proposed Residential Development with Nature Garden at Fung Lok Wai, Yuen Long. Mutual Luck Investment Ltd., Hong Kong.

Corlett, R.T. 1992 Plants Attractive to Frugiverous Birds in Hong Kong. *Memories of the Hong Kong Natural History Society*, No. 14.

ERL. 1988. Deep Bay Integrated Environmental Management. Environmental Protection Department, Hong Kong Government, Hong Kong.

Kersten, M., Britton, R.H. and Dugan, P.J. 1991. Flock Feeding and Food Intake in Little Egrets: The Effects of Prey Distribution and Behaviour. *Journal of Animal Ecology* 60:241–52.

Melville, D.S. 1987. Chinese Pond Herons *Ardeda bacchur* Eating Flies. *Hong Kong Bird Report* 1986:104–6.

Melville, D.S. 1989. Hong Kong. In *A Directory of Asian Wetlands* (ed. D.A. Scott), 283–94. Gland: The World Conservation Union.

Melville, D.S. 1991. Potential Impacts of Development on Waterfowl Using the Internationally Important Inner Deep Bay Wetland, Hong Kong. In *Polmet'91: Pollution in the Metropolitan Environment* (ed. J. Boxall), 869–83. Hong Kong: Hong Kong Institute of Engineers.

Townland, 1992. Planning Statement and Master Plan of Residential Development at Lin Barn Tsuen, Yuen Long. Townland Consultants Ltd., Hong Kong.

Townland, 1993. Supplementary Planning Statement: Pak Hok Chau, NWNT, Townland Consultants Ltd., Hong Kong.

TPB 1993. Town Planning Board Guidelines for Application for Developments within Deep Bay Buffer Zones under Section 16 of the Town Planning Ordinance. Town Planning Board, Hong Kong

Wong, F.K.O. 1991. Habitat Utilization by Little Egrets Breeding at Mai Po. *Hong Kong Bird Report* 1990:185–90.

WWF HK, n.d.a. Checklist of Plants, Mai Po Nature Reserve. World Wildlife Fund Hong Kong.

WWF HK, n.d.b. Reptiles and Amphibian, Mai Po Nature Reserve. World Wildlife Fund Hong Kong.

WWF HK, n.d.c. Mammals, Mai Po Nature Reserve. World Wildlife Fund Hong Kong.

WWF HK, n.d.d. Checklist of Birds, Mai Po Nature Reserve. World Wildlife Fund Hong Kong.

Young, L. 1992. Conservation of Wildlife in the Deep Bay Area: with Particular Reference to Heron Species. In *Polmet'91: Pollution in the Metropolitan Environment* (ed. J. Boxall), 813–22. Hong Kong: Hong Kong Institute of Engineers.

Young, L. 1993. The Ecology of Hong Kong Areidae (Aves) with Special Reference to the Chinese Pond Heron at the Mai Po Marshes Nature Reserve. Ph. D. Thesis, University of Hong Kong.

APPENDIX I: VEGETATION RECORDED IN THE SURVEYS

	Remarks	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*	*Mai Po*
Trees							
Acasia confusa	E	*		*		*	*
Albizia lebbek		*	*				*
Aleurites moluccana	E	*					
Aporusa dioica	B	*					
Bauhinia purpurea							*
Bridelia monoica							*
Bridelia tomentosa	B	*	*	*		*	
Carica papaya	E	*		*	*	*	*
Cassuariana equisetifolia	E			*	*		*
Celtis sinensis	B	*	*	*		*	*
Cleistocalyx operculata	B		*				*
Crateava religiosa	E		*				
Croton crassifolius							*
Delonix regia	E	*					*
Euphora longan	E	*	*				
Eucalyptus tereticornis	E			*			
Excoecaria agallocha							*
Ficus elastica	E				*		
Ficus microcarpa	B	*			*		*
Ficus superba	B			*		*	*
Glyptostrobus pensilis							*
Litsea glutinosa							*
Macaranga tanarius	B	*	*	*	*	*	*
Melia azedarach	E, B	*	*	*	*	*	*
Morus alba	B	*	*				*
Musa sp.	B	*	*	*		*	*
Musa paradisiaca	E				*		
Paliurus ramosissimus							*
Pinus elliotti	E	*					
Plumeria rubra	E	*					
Podocarpus neriifolia	E	*					
Prunus sp.	E			*			
Psidium guajava	E, B		*	*	*	*	
Salix babylonica	E						*
Sapium sebiferum	B	*	*		*	*	*
Sterculia lanceolata							*
Syzgium orientalis	E			*			
Trema orientalis	B	*					
sub-total no. of species		19	12	13	9	10	23

Key: * Recorded E Exotic B Bird Food

	Remarks	Lin Barn Tsuen	Tam Kon Chau	Nam Sang Wai	Fung Lok Wai	Pak Hok Chau	Mai Po
Shrubs							
Breynia fruticosa							*
Clerodendrum inerme			*	*	*	*	*
Codiaeum variegatum	E						*
Corchorus acutangulus			*				*
Crotalaria muctonata		*					*
Desmos chinensis						*	
Hibiscus rosa-sinensis	E			*			*
Lantana camara	E, B	*	*	*	*	*	*
Ligustrum sinensis		*				*	
Malvaviscus arboreus	E	*					
Melastoma sp.							*
Phyllanthus reticulatus			*				
Rhus chinensis							*
Sageratia theezans				*			
Scolopia chinensis							*
Sesbania cochinchinensis							*
Sesbania sp.		*	*				
Sida rhombifolia			*				
Urena lobata			*				
Wikstroemia indica							*
sub-total no. of species		5	7	4	2	3	13
Grasses/Sedges							
Apluda mutica		*	*			*	*
Arundinella setosa		*					
Bothriochloa intermedia		*					
Brachiaria intermedia		*					
Brachiaria mutica	E	*				*	
Carex sp.		*					
Coix lachryma-jobi		*				*	
Cuscuta chinensis			*				
Cynodon dactylon		*	*			*	*
Cyperus alternifolius	E	*	*				
Cyperus malaccenis							*
Cyperus polystachyus							*
Cyperus rotundus							*
Dichanthium annulatum							*
Digitaria sp.				*			
Digitaria radicosa		*				*	
Digitaria sanquinalis		*					*
Echinochloa colonum			*	*			*
Echinochloa crus-galli		*					
Eleusine indica		*	*			*	*
Eragrostis uniloides		*					
Eragrostis zeylanica							*
Eragostis sp.		*					

	Remarks	Lin Barn Tsuen	Tam Kon Chau	Nam Sang Wai	Fung Lok Wai	Pak Hok Chau	Mai Po
Ischaemum aristatum							*
Ischaemum indicum							*
Juncus effusus						*	
Leptochloa chinensis							*
Merremia sp.			*				
Neyraudia reynaudiana		*					*
Panicum maximum	E	*	*	*		*	*
Panicum repens		*	*				
Paspalum conjugatum							*
Paspalum distichum		*	*		*		*
Paspalum scrobiculatum							*
Paspalum sp.							*
Pennisetum polystachyum		*					*
Pennisetum purpureum	E				*	*	
Phragmites communis		*	*	*	*	*	*
Pogonatherum crinitum							*
Rhynchelytrum repens		*					*
Rhynchospora sp.					*		
Saccharum sp.		*					*
Sporobolus fertilis		*	*				*
Sporobolus virginicus							*
Zoysia sinica							*
sub-total no. of species		24	12	4	4	10	27
Herbs							
Achyranthes sp.				*	*		
Achyranthes aspera		*	*			*	*
Ageratum conyzoides		*					
Allium fistulosum	E	*					
Alocasia macrorrhiza		*	*				
Alternanthera philoxeroides	E		*	*		*	
Alternanthera sessilis		*	*				*
Amaranthus viridis		*	*	*			*
Bidens sp.				*	*		
Bidens pilosa		*	*		*	*	*
Blumea lacera							*
Canna indica	E						*
Cassia tora							*
Centella asiatica							*
Chenopodium album							*
Commelina nudiflora							*
Commelina communis		*	*			*	
Conyza bonariensis		*					
Crassocepalum crepidiodes		*					
Desmodium heterocarpon		*					
Dianella ensifolia							*
Eclipta prostrata							*

	Remarks	Lin Barn Tsuen	Tam Kon Chau	Nam Sang Wai	Fung Lok Wai	Pak Hok Chau	Mai Po
Eichhorinia crassipes	E	*	*		*	*	
Emilia sonchifolia		*				*	*
Erigeron bonariensis							*
Eupatorium odoratum		*					
Euphorbia heteropphylla	E						*
Gnaphalium purpurenum		*					
Gynura sp.				*	*		*
Gynura bicolor							*
Gynura divaricata							*
Lactuca sp.			*				
Lemna minor							*
Lindemia crustacea							*
Melochia corchorifolia							*
Mimosa pudica							*
Phyllanthus urinaria							*
Phytolacca acinosa	E						*
Plantago major		*					
Pluchea indica		*				*	*
Polygonum chinense		*	*				*
Polygonum perfoliatum						*	*
Portulaca oleracea							*
Rumex dentatus	E						*
Senecio scandens							*
Sida rhombifolia		*					
Solanum surattense		*					
Solanum torvum		*					*
Solanum nigrum		*	*	*		*	*
Sonchus arvensis	*						
Sonchus oleraceus						*	*
Sonchus sp.					*		
Suaeda sp.							*
Synedrella nodiflora		*		*			
Urena lobata		*				*	
Urena procumbens							*
Vernonica cinerea							*
Wedelia sp.				*			
Wedelia trilobata	E		*			*	
Zeuxine strateumatica							*
sub-total no. of species		25	12	8	6	12	37
Vines							
Basella alba	E	*					*
Benincasa hispidavar							*
Canavalia maritima		*		*			*
Cardiospemum halicacabum							*
Cocculus trilobus		*					*
Ipomoea aquatica	E						*

	Remarks	Lin Barn Tsuen	Tam Kon Chau	Nam Sang Wai	Fung Lok Wai	Pak Hok Chau	Mai Po
Ipomaea babatas	E						*
Ipomoea brasiliensis							*
Ipomoea cairica	E	*	*				*
Ipomoea purpurea			*				
Ipomoea triloba	E						*
Mikania micrantha	E	*	*		*	*	*
Morinda umbelllata							*
Paederia scandens		*	*	*		*	*
Passiflora foetida		*	*	*	*	*	*
Strophanthus divaricatus							*
sub-total no. of species		7	5	3	2	3	15
Bamboos							
Bambusa sp.							*
Bambusa ventricosa	E	*					
Bambusa vulgaris	E	*					
sub-total no. of species		2	0	0	0	0	1
Ferns							
Achrostichium aureum				*	*		*
Blechnum orientale							*
Ceratopteris siliquosa							*
Cyclosorus interruptus						*	
Dicranopteris linearis							*
Lycopodium cemuum							*
Lygodium dichotomum		*					
Lygodium japonicum							*
Nephrolepis sp.							*
Nephrolepis hirsutata							*
Pityrogramma tartarea							*
Pteris longifolia							*
sub-total no. of species		1	0	1	1	1	10
Mangroves and Associates							
Acanthus ilicifolius				*	*		*
Aegiceras corniculatum				*	*		*
Bruguiera gymnorrhiza				*	*		
Cerbera manghas							*
Derris alborubra							*
Derris trifoliata				*	*		
Excoecaria agallocha				*			
Hibiscus tiliaceous				*			*
Kandelia candel				*	*		*
Pandanus sp.				*			
sub-total no. of species		0	0	8	5	0	6
Total no. of species recorded in the site		**83**	**48**	**41**	**29**	**39**	**132**

Source: AFD 1978; CES 1992a, 1992b, 1993; Corlett 1992; Townland 1992, 1993; WWF HK n.d.a.

APPENDIX II: AMPHIBIANS AND REPTILES RECORDED/EXPECTED IN THE SURVEY SITES

	Remarks (see note)	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*	*Mai Po*
Amphibians							
Bufo melanostictus (Asiatic common toad)		*	*	#		*	*
Kalophrynus pleurostigma (Narrow-mouthed frog)		*					
Kaloula pulchra (Asiatic painted frog)		*					
Microhyla ornata (Ornate pigmy frog)		*	#				
Polypedates leucomystax (Brown tree frog)							*
Rana guentheri (Gunther's frog)		#	*			*	*
Rana limnocharis (Paddy frog)							#
Rana tigrina (Chinese bullfrog)		#	*				#
sub-total no. of species		6	4	2	0	2	5
Reptiles							
Amphiesma stolata (Buff-striped keelback)							*
Bungarus fasciatus (Banded krait)							#
Bungarus multicinctus (Many-banded krait)		#	*	#		*	
Calotes versicolor (Crested tree lizard)							*
Chinemys reevesi (Reeves' terrapin)							*
Cuora trifasciata (Gold-headed terrapin)							*
Elaphe radiata (Copperhead racer)		#	*				
Enhydris bennetti (Mangrove water snake)					#		*
Enhydris chinensis (Chinese water snake)		#	#	#		*	*
Enhydris plumbea (Plumbeous water snake)							*

Key: * recorded # expected

	Remarks (see note)	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*	*Mai Po*
Eumeces chinensis (Chinese skink)		#	#			*	*
Gehyra mutilata (Four-clawed gecko)							*
Gekko chinensis (Chinese gecko)							*
Hemidactylus bowringi (Bowring's gecko)		#	#	*		*	*
Leiolopisma reevesi (Reeves' smooth skink)		#		*		*	*
Naja naja (Chinese cobra)		#	#	#		*	*
Oligodon formosanus (Taiwan kukri snake)		#	#			*	
Ophiophagus hannah (King cobra)							*
Pseudemys scripta (Red-eared terrapin)	E						*
Ptyas korros (Indo-Chinese rat snake)		#					
Ptyas mucosus (Oriental rat snake)		#	#			*	*
Python molurus (Python)	WAPO				#		
Ramphotyphlops braminus (Common blind snake)		#	#	*		*	#
Rhabdophis subminiatus (Red-necked keelback)							*
Takydromus sexlineatus (Six-lined grass lizard)		#					
Trachemys scripta elegans (Red-eared terrapin)	E				#	*	
Trionyx sinensis (Chinese soft-shelled turtle)	WAPO	#	#				
Trionyx steindachneri (Steindachner's turtle)							#
Xenochrophis piscator (Checkered keelback)		#	#			*	*
sub-total no. of species		14	11	6	3	11	21
Total no. of species		**20**	**15**	**8**	**3**	**13**	**26**

Source: CES 1992a, 1992b, 1993; Townland 1992, 1993; WWF HK n.d.b.
Note: WAPO, species protected under the Wild Animals Protection Ordinance (Cap. 170); E, exotic species.

APPENDIX III: MAMMALS RECORDED/EXPECTED IN THE SURVEY SITES

	Remarks (see note)	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*	*Mai Po*
Bandicota indica (Large bandicoot rat)							*
Cynopterus sphinx (Greater short-nosed fruit bat)	WAPO	*			#	*	*
Felis bengalensis (Leopard cat)	WAPO			#			*
Herpestes javanicus (Javan mongoose)	WAPO			#			*
Herpestes urva (Crab-eating mongoose)	WAPO			#	#		
Nyctalus noctula (Noctule bat)	WAPO	*					
Mus caroli (Ryuku mouse)		*				*	
Mus musculus (House mouse)					#		*
Pipistrellus abramus (Japanese pipistrelle)	WAPO	*		*	#	*	*
Rattus sp.			*				
Rattus losea (Lesser ricefield rat)		*	*				
Rattus norvegicus (Brown rat)				#	#		*
Rattus rattus (Wild sub. sp. of the Black rat)						*	*
Scotophilus khuli (Lesser yellow bat)	WAPO				#		*
Suncus murinus (Brown musk shrew)		#	*	#	#	*	*
Vierricula indica (Seven-banded civet)	WAPO			#		*	*
Total no. of species		**6**	**3**	**7**	**7**	**7**	**11**

Key: * recorded # expected
Source: CES 1992a, 1992b, 1993; Townland 1992, 1993; WWF HK n.d.c.
Note: WAPO, species protected under the Wild Animals Protection Ordinance (Cap.170).

APPENDIX IV: BIRDS RECORDED IN THE SURVEY SITES

Common name	*Scientific name*	*Remarks*	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Grebes							
Comorant	*Phalacrocorax carbo*	WV	*		*	*	*
Little grebe	*Tachybaptus ruficollis*	R			*	*	*
Bittens, Herons and Egrets							
Grey heron	*Ardea cinerea*	WV	*	*	*	*	*
Purple heron	*Ardea purpurea*	R					*
Chinese pond heron	*Ardeola bacchus*	R	*	*	*	*	*
Cattle egret	*Bubulcus ibis*	R	*	*		*	
Little green heron	*Butorides striatus*	R		*			*
Great egret	*Egretta alba*	R		*		*	*
Little egret	*Egretta garzetta*	R	*	*	*	*	*
Chestnut bittern	*Ixobrychus cinnamomeus*	SV					*
Yellow bittern	*Ixobrychus sinensis*	SV			*	*	*
Night heron	*Nycticorax nycticorax*	R		*	*	*	*
Storks							
Oriental white stork	*Ciconia boyciana*	WV,B,I,IUCN(E)				*	*
Ducks and Geese							
Pintail	*Anas acuta*	WV				*	
Shoveler	*Anas clyptea*	WV					*
Teal	*Anas crecca*	WV			*	*	*
Yellow-nib duck	*Anas poecilorhyncha*	R				*	*
Garganey	*Anas querquedula*	PM				*	*
Birds of Prey							
Japanese sparrowhawk	*Accipiter gularis*	PM				*	
Horsfield's goshawk	*Accipiter soloensis*	PM				*	
Spotted eagle	*Aquila clanga*	NBV				*	*
Imperial eagle	*Aquila heliaca*	WV,I,IUCN(R)			*	*	
Buzzard	*Buteo buteo*	WV				*	*
Marsh harrier	*Circus aeruginosus*	WV			*	*	
Saker falcon	*Falco cherrug*	V				*	
Peregrine falcon	*Falco peregrinus*	R				*	*
Hobby	*Falco subbuteo*	PM					*
Kestrel	*Falco tinnunculus*	WV	*		*		
Black kite	*Milvus migrans*	R	*		*	*	*
Osprey	*Pandion haliaetus*	NBV,B		*		*	
Crested serpent eagle^	*Spilornis cheela*	NBV					*

Key: * recorded ^ species not recorded in Mai Po

Common name	*Scientific name*	*Remarks*	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Rails and Crakes							
White-breasted Waterhen	*Amaurornis phoenicurus*	R		*	*	*	*
Coot	*Fulica atra*	WV	*		*	*	*
Moorhen	*Gallinula chloropus*	R	*		*	*	*
Waders							
Common sandpiper	*Actitis hypoleucos*	PM/WV		*	*	*	*
Turnstone	*Arenaria interpres*	PM				*	
Sharp-tailed sandpiper	*Calidris acuminata*	PM				*	
Sanderling	*Calidris alba*	PM				*	
Dunlin	*Calidris alpina*	WV				*	
Red knot	*Calidris canutus*	PM				*	
Curlew sandpiper	*Calidris ferruginea*	PM				*	
Red-necked stint	*Calidris ruficollis*	PM				*	
Long-toed stint	*Calidris subminutus*	PM/WV				*	
Temminck's stint	*Calidris temminckii*	PM/WV				*	
Great knot	*Calidris tenuirostris*	PM				*	
Kentish plover	*Charadrius alexandrinus*	PM/WV				*	
Little ringed plover	*Charadrius dubius*	R		*	*	*	*
Greater sand plover	*Charadrius leschenaultii*	PM				*	*
Lesser sand plover	*Charadrius mongolus*	PM				*	
Spoon-billed sandpiper	*Eurynorhynchus pygmaeus*	PM,I,IUCN(I)				*	
Snipe sp.	*Gallinago* sp.						
Fantail snipe	*Gallinago gallinago*	PM/WV					
Oriental pratincole	*Glareola maldivarum*	NBV				*	
Grey-rumped sandpiper	*Heteroscelus brevipes*	PM				*	
Black-winged stilt	*Himantopus himantopus*	WV/PM				*	*
Broad-billed sandpiper	*Limicola falcinellus*	PM				*	
Asiatic dowitcher	*Limnodromus semipalmatus*	PM,I, IUCN(R)				*	*
Bar-tailed godwit	*Limosa lapponica*	PM				*	
Black-tailed godwit	*Limosa limosa*	PM				*	
Little whimbrel	*Numenius minutus*	PM				*	
Whimbrel	*Numenius phaeopus*	PM				*	
Ruff	*Philomachus pugnax*	PM/WV				*	
Asiatic golden plover	*Pluvialis fulva*	PM/WV				*	
Grey plover	*Pluvialis squatarola*	PM/WV				*	
Spotted redshank	*Tringa erythropus*	PM/WV				*	
Wood sandpiper	*Tringa glareola*	PM	*		*	*	*
Spotted greenshank	*Tringa guttifer*	PM,I,B				*	
Greenshank	*Tringa nebularia*	WV				*	
Green sandpiper	*Tringa ochropus*	PM/WV		*		*	*
Marsh sandpiper	*Tringa stagnatilis*	PM/WV				*	
Redshank	*Tringa totanus*	PM				*	*
Grey-headed lapwing	*Vanellus cinereus*	PM/WV				*	
Terek sandpiper	*Xenus cinereus*	PM				*	

Common name	*Scientific name*	*Remarks*	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Phalaropes							
Red-necked phalarope	*Phalaropus lobatus*	PM				*	
Gulls and Terns							
Whiskered tern	*Chlidonias hybrida*	PM				*	
White-winged black tern	*Chlidonias leucoptera*	PM			*	*	
Gull-billed tern	*Geochelidon nilotica*	PM				*	
Black-headed gull	*Larus ridibundus*	WV			*	*	*
Caspian tern	*Sterna caspia*	NBV				*	
Doves							
Spotted dove	*Streptopelia chinensis*	R	*	*	*	*	*
Rufous turtle Dove	*Streptopelia orientalis*	WV		*		*	*
Red turtle dove	*Streptopelia tranquebarica*	PM				*	
Parakeets							
Rose-ringed parakeet	*Psittacula krameri*	R				*	*
Cuckoos							
Greater coucal	*Centropus sinensis*	R			*	*	*
Swifts							
House swift	*Apus affinis*	R	*	*	*	*	*
Large white-rumped swift	*Apus pacificus*	PM,SV			*	*	
White-throated needletail	*Hirundapus caudacutaus*	PM				*	
White-vented needletail	*Hirundapus cochinchinensis*	PM				*	
Kingfishers							
Common kingfisher	*Alcedo atthis*	R	*	*	*	*	*
Pied kingfisher	*Ceryle rudis*	R		*	*	*	*
Black-capped kingfisher	*Halcyon pileata*	R				*	
White-breasted kingfisher	*Halcyon smyrensis*	R	*	*	*	*	*
Woodpeckers							
Wryneck	*Jynx torquilla*	WV				*	
Larks							
Skylark sp.	*Alauda gulgula/arvensis*	R				*	
Swallows & Martins							
Asian house martin	*Delichon dasypus*	OV				*	
Red-rumped swallow	*Hirundo daurica*	WV				*	
Swallow	*Hirundo rustica*	SV	*	*	*	*	*
Sand martin	*Riparia riparia*	PM				*	
Pipits							
Red-throated pipit	*Anthus cervinus*	WV				*	*

Common name	*Scientific name*	*Remarks*	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Olive-backed pipit	*Anthus hodgsoni*	WV					*
Richard's pipit	*Anthus novaeseelandiae*	PM/WV					
Thrushes							
Grey-backed thrush	*Turdus hortulorum*	WV					*
Wagtails							
White wagtail	*Motacilla alba*	WV					*
Grey wagtail	*Motacilla cinerea*	WV					*
Citrine wagtail	*Motacilla citreola*	V					
Yellow wagtail	*Motacilla flava*	WV					*
Bulbuls							
Crested bulbul	*Pycnonotus jocosus*	R					*
Chinese bulbul	*Pycnonotus sinensis*	R					*
Robins and Chats							
Magpie robin	*Copsychus saularis*	R					*
Daurian redstart	*Phoenicurus auroreus*	WV					*
Stonechat	*Saxicola torquata*	WV					*
Warblers							
Great reed-warbler	*Acrocephalus arundinaceous*	PM					*
Black-browed reed warbler	*Acrocephalus bistrigiceps*	PM					
Chinese bush warbler	*Cettia diphone*	WV					*
Fantail warbler	*Cisticola juncidis*	R					*
Pallas's grasshopper warbler	*Locustella certhiola*	PM					*
Long-tailed tailor bird	*Orthotomus sutorius*	R					*
Arctic warbler	*Phylloscopus borealis*	PM				*	
Dusky warbler	*Phylloscopus fuscatus*	WV				*	*
Yellow-browed warbler	*Phylloscopus inorantus*	WV				*	
Yellow-bellied wren-warbler	*Prinia flaviventris*	R	*	*	*	*	*
Brown wren-warbler	*Prinia subflava*	R	*	*	*	*	*
Orioles							
Black-naped oriole	*Oriolus chinensis*	WV			*		
Babblers							
Black-faced laughing thrush	*Garrulax perspicillatus*	R			*		*
Flycatchers							
Brown flycatcher	*Muscicapa latirostris*	WV/PM			*		*

Common name	*Scientific name*	*Remarks*	*Lin Barn Tsuen*	*Tam Kon Chau*	*Nam Sang Wai*	*Fung Lok Wai*	*Pak Hok Chau*
Tits							
Penduline tit	*Remiz pendulinus*	PM				*	
White-eye	*Zosterops japonica*	R		*	*	*	*
Shrikes							
Rufous-backed shrike	*Lanius schach*	R	*	*	*	*	*
Drongos							
Black drongo	*Dicrurus macrocercus*	SV		*	*	*	*
Koel	*Eudynamis scolopacea*	R			*		*
Crows							
Daurian jackdaw^	*Corvus dauuricus*	V				*	
Jungle crow	*Corvus macrorhynchus*	R			*	*	
Collared crow	*Corvus torquatus*	R	*	*	*	*	*
Magpie	*Pica pica*	R	*	*	*	*	*
Starlings and Mynahs							
Crested mynah	*Acriodotheres cristatellus*	R	*	*	*	*	*
White-vented mynah	*Acridotheres javanicus*	E					*
Grey starling	*Sturnus cineraceus*	WV				*	
Black-necked starling	*Sturnus nigricollis*	WV		*	*	*	*
Silky starling	*Sturnus sericeus*	WV	*	*		*	*
Chinese starling	*Sturnus sinensis*	WV				*	*
Daurian starling	*Sturnus sturninus*	PM				*	
European starling	*Sturnus vulgaris*	WV					*
Sparrows							
Tree sparrow	*Passer montanus*	R	*	*	*	*	*
Munias							
Spotted munia	*Lonchura punctulata*	R			*	*	*
Buntings							
Yellow-breasted bunting	*Emberiza aureola*	PM				*	
Grey-headed bunting	*Emberiza fucata*	WV				*	
Little bunting	*Emberiza pusilla*	WV	*			*	*
Masked bunting	*Emberiza spodocephala*	WV			*	*	*
Siebold's bunting (Yellow bunting)	*Emberiza sulphurata*	V,IUCN(R)				*	
Others							
Japanese quail	*Coturnix japonica*	PM/WV	*				
	Total no. of species	31	40	52	129	81	

(Source: CES 1992a, 1992b, 1993; Townland 1992, 1993, WWF HK n.d.d)

Note:

R	Resident
WV	Winter Visitor
SV	Summer Visitor
PM	Passage Migrant
NBV	Non-breeding Visitor
E	Escapee
OV	Occasional Visitor
V	Vagrant
I	Species listed in the ICBP (International Council for Bird Preservation) World Checklist of Threatened Birds.
B	Species listed in Appendix I of the 'Bonn' Convention (Convention on the Conservation of Migratory Species of Wild Animals).
IUCN(E)	Species classified as 'Endangered' according to the 1994 IUCN Red List of Threatened Animals. (i.e 'Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.')
IUCN(R)	Species classified as 'Rare' according to the 1994 IUCN Red List of Threatened Animals. (i.e. 'Taxa with small world populations that are not at present "Endangered" or "Vulnerable", but are at risk.')
IUCN(I)	Species classified as 'Indeterminate" according to the 1994 IUCN Red List of Threatened Animals. (i.e 'Taxa known to be "Endangered", "Vulnerable" or "Rare" but where there is not enough information to say which of the three categories is appropriate.')

Totally 150 species of birds were recorded in the five survey sites whereas the number recorded in Mai Po is about 320. It should be noted that the number of waders recorded in Fung Lok Wai stands out among the rest of the sites and many of them were not found in the other sites. Again, the difference in sampling effort should be noted.

Sustainable Development and Rural Energy Planning in Asia

Peter Hills

ABSTRACT

This paper focuses on the emerging debate concerning the relationship between sustainable development and the planning and management of rural energy systems in Asia. It examines changing perspectives on rural energy systems and their linkages with rural development and evaluates recent rural energy planning experiences in Asia, emphasizing the environmental dimension. It then focuses on various conceptual and methodological issues that must be resolved if environmental factors and the pursuit of sustainable development are to be more influential in shaping rural energy systems in the decades ahead.

Keywords: *Asia, sustainable development, rural energy, environmental management*

INTRODUCTION: THE RURAL ENERGY PROBLEM

The characteristics of the rural energy problem in developing countries have been extensively reviewed in the literature and require little elaboration here (see, for example, ElMahgary and Biswas 1985; Islam *et al.* 1984; Ramani *et al.* 1993). Energy is fundamental to the pursuit of rural development policies. Rural energy systems are linked with and impact on rural development processes in various ways, including:

1. the high levels of dependence on traditional energy sources such as fuelwood, crop residues and animal wastes, a number of which are now becoming increasingly scarce in many developing countries;
2. reduced soil fertility and agricultural output resulting from the diversion of potential fertilizers to energy uses;
3. the diversion of potentially productive human labour to the task of fuel collection, a burden which usually falls on women, who must also allocate a great deal of time to using these low efficiency fuels for cooking and are exposed to the adverse health impacts of indoor biomass combustion;
4. the high costs of modern fuels such as kerosene and electricity and the often punitive 'entry costs' associated with the need to purchase appliances that can utilize these energy sources;
5. the vulnerability of many rural areas to the economic, social and political shocks associated with the shift to marketed modern fuels, especially when the latter's prices show considerable volatility;
6. energy constraints imposed on economic restructuring and development (e.g. inadequate and unreliable supplies of modern fuels such as electricity and petroleum products) and on the provision of infrastructure and social facilities (e.g. water supplies, health and education facilities).

Peter Hills, Professor and Director, The Centre of Urban Planning and Environmental Management, The University of Hong Kong, Pokfulam Road, Hong Kong, Tel. (852) 2859–2720, Fax (852) 2559–0468.

The realities of the rural energy situation and its implications for the development process went largely unnoticed until the early 1980s (Bajracharya 1983; Barnett *et al.* 1982), for various reasons. In many developing countries, power and resources remain concentrated in the cities, and the needs of the marginalized rural population are even now inadequately reflected in the policy making and resource allocation processes. In many countries national energy policy has been preoccupied with meeting the growing energy needs of the urban-industrial sector, primarily through the development of conventional large-scale supply systems based on electricity and petroleum products. Energy has failed to achieve a high position on the rural development agenda, and has received only limited attention in the literature on the theory and practice of rural development (Ramani 1992; Hurst and Barnett 1990).

Discussion of rural energy problems has generally focused on supply side considerations, prompted largely, but not exclusively, by the growing recognition that prevailing levels of fuelwood use in many parts of the developing world are unsustainable (Agarwal 1986). This has stimulated much discussion about the limits of sustainable fuelwood exploitation, as well as the potential contribution of new and renewable sources of energy (NRSE) such as biogas, micro-hydro and solar photovoltaics, and demand side measures, including more efficient wood burning stoves (Foley 1981; Islam 1990; Leach 1992; Meyers and Leach 1989; Perlack *et al.* 1991).

The role of energy in rural development has recently entered a period of reappraisal resulting from the new environmental imperative which demands that both development specialists and energy planners evaluate their plans and investment programmes in relation to sustainable development objectives. This shift away from a purely energy-orientated response has been brought about by a number of factors. The problem of deforestation has itself been reinterpreted in a manner which places the exploitation of wood as an energy source in a much broader analytical framework (Poore *et al.* 1989; Repetto and Gillis 1988; Soussan *et al.* 1992). Within this framework, wood fuel use is seen as only one of a number of exploitative modes contributing to the deforestation problem (FAO 1993). Deforestation has also received far greater attention recently because of its links with biodiversity (Ryan 1992) and the role that forests play in the global CO_2 balance (Bhadra 1990; Hurst 1990; Rosillo-Calle and Hall 1992). Thus, forestry management and afforestation initiatives are now often justified on the basis of environmental rather than energy considerations, although clearly they may have significant implications for the longer term availability of adequate supplies of biomass fuels (UNDP/World Bank 1988). In addition, it is now widely recognized that policy initiatives intended to diffuse modern energy systems, particularly electricity, into rural areas have often enjoyed only limited success (Ramani 1992).

Paradigm shifts in rural development planning itself have also helped to create a context in which some of the guiding principles of sustainable development are being inculcated into development institutions and policies. In particular, the increased emphasis on participation of the rural population and local community groups to generate a bottom up as opposed to a top down mode of decision making (Ramani 1992) is intended to match peoples' needs more closely with their own cultural aspirations and their ability for self help. The close affinity between the rural population and the environment in which they live is, therefore, far more likely to be recognized as a key component of the decision making and planning processes.

RURAL ENERGY SYSTEMS AND SUSTAINABLE DEVELOPMENT

Sustainable development is, to quote Soussan (1993:29): '. . . . a call for policies which maximize growth without jeopardizing the position of vulnerable people or depleting the future viability of the resource base.' As Soussan also argues, sustainable development policies have certain distinguishing characteristics. These include a concern with long-term planning horizons; appropriate valuation of natural capital assets, particularly environmental resources; the reduction of existing inequalities within society and the pursuit of policies that seek to meet the needs of all, even at the expense of short-term production goals and economic growth; and, the devolution of control over resources and decision making, and the empowerment of local communities.

Rural energy systems, however, pose particular problems for environmental analysts and for the task of integrating environmental and sustainable development concerns into the energy planning process (Hills 1988, in press; Ramani *et al.* 1992). These include:

1. the decentralized nature of the systems involved, which greatly extends the geographical scale and complexity of the environmental assessments required;
2. data limitations which make it difficult to characterize the type of physical environment on which energy production and use may impact, rendering baseline studies very difficult;
3. the uncommodified nature of various rural energy resources which gives rise to uncontrolled use and an inability to enforce control over resource exploitation even where this is known to be environmentally damaging;
4. the absence of clearly defined energy developers who possess the necessary expertise or resources and might be made responsible for preparing environmental assessments;
5. the linkages between energy, food supply and rural development which mean that the implications of energy resource exploitation cannot simply be seen in environmental terms (as is typically the case with large-scale modern energy projects) but must be firmly located in a developmental and basic needs frame of reference;
6. the importance of the rural environment in the overall context of national well-being and quality of life given the high proportion of the population still found in rural areas and the consequent need for environmental assessment to be located in this broader setting;
7. the growing need to relate rural energy system development to environmental problems at the global level, particularly issues surrounding deforestation and the benefits and disbenefits of substituting modern fuels for traditional biomass sources of energy;
8. the problems of allocating institutional responsibility for managing the rural environment.

How might these problems be tackled with a view to integrating sustainable development principles into rural energy planning? We can commence by restating the guiding policy principles for sustainable development as a series of questions:

1. are policies and programmes directed to the pursuit of long term goals and objectives for energy and the environment in rural areas?
2. is there continuity in terms of policy objectives and implementation mechanisms and has an adequate framework been adopted to ensure continuity?
3. are the real costs of different energy-environment options effectively determined with respect to both technology choices and the environmental trade offs associated with them?
4. is the environment itself appropriately valued such that policy objectives can achieve long term sustainability without degrading the quality of environmental resources?
5. are options that involve resource exploitation (e.g. fuelwood use) set within a framework which allows for determination of what constitutes sustainable yields of the relevant environmental resources?
6. do the energy-environment options under consideration achieve redistribution of incomes and opportunities such that differentials between different groups within society (especially between rural and non-rural communities) are effectively reduced?
7. do these options take account of the potential trade offs between redistribution of incomes and opportunities and overall rates of economic growth and how are these handled within the political/policy making context?
8. do the energy-environment options pursued promote devolution of resource control and decision making on development issues and enhance the prospects for greater community inputs to the planning of the development process?

These questions represent a starting point for analysis and a preliminary assessment framework. Such a framework places rural energy system development in a very different context from the one that has dominated the planning of such systems over the past 20 years. Here, the problem is being approached from a sustainable development perspective and not from an energy perspective *per se*. This has important implications for the way in which such policy and planning assessments are carried out, not least with regard to the ability of energy specialists themselves to answer all the types of questions listed above. In many cases this will simply not be possible. Energy and environment planning programmes framed in the context of sustainable development strategies must be both developed and evaluated on an interdisciplinary basis and must give due recognition to the multiple objectives embodied in the rural development process. This suggests that a reconfiguration of many rural energy planning institutions around the region will be required if they are

to be able to cope effectively with the demands imposed by this type of analysis.

EXISTING APPROACHES TO RURAL ENERGY PLANNING IN ASIA

A recently published survey of rural energy planning and management approaches in Asia (Ramani *et al.* 1993) indicates that a number of fundamental issues must be resolved if progress is to be made towards the design and implementation of sustainable rural energy development policies.

Table 1 provides a summary assessment of the status of rural energy planning in a number of Asian countries in relation to linkages with the guiding principles of sustainable development. Of the countries included in the table, it is clear that only China appears to have made any significant progress towards meeting at least some of the criteria concerned.

Firstly, it is clear that in most of the countries of the region few, if any, serious attempts have been made to link energy and environmental planning in rural areas. While there exists widespread awareness of the existence of environmental problems associated with rural energy systems, this awareness has not been translated into firm policy and planning responses. In part, this is due to the inherent weaknesses in existing environmental databases which preclude detailed analysis of the scale and causes of such problems and, in the context of sustainable development, prevent appropriate valuation of environmental resources. While most countries in Asia have a national policy framework for environmental concerns and, in most cases, various pieces of legislation dealing with such matters as air or water pollution and environmental impact assessment, the policy and institutional infrastructure that has developed appears to be primarily directed towards dealing with urban-based environmental problems. Thus, integrated rural energy and environmental planning has yet to be applied in practice (see Table 1).

Secondly, while references to sustainability and sustainable development are to be found in an increasing amount of the literature concerned with rural energy planning and, indeed, in the objectives apparently pursued by government agencies in various countries around the region, thus far it appears that few attempts have been made to articulate policies and specific programmes from the starting point of sustainable development *per se*. In many cases it seems that the concept (or the generalized objectives) of sustainable development is simply being grafted on to existing policy structures. Given the inertia inherent in these structures such an approach is unlikely to produce substantial benefits because sustainable development requires a fundamental reappraisal of the development process itself within which energy is simply one element. Furthermore, while there is increasing recognition of the need for what are often termed 'sustainable forestry practices', it is important to remember that woodfuel is itself only a part, albeit an important part, of the rural energy system in most countries of the region. Achieving sustainable management practices for forests does not of itself mean that sustainable development has been achieved, although clearly it can make a significant contribution. Thus, there is little to indicate that sustainable development has yet taken hold as the guiding principle for rural energy system development across the region. In some senses, of course, it may still be premature to expect such a shift in emphasis. The full implications of the Rio Earth Summit and *Agenda 21* have yet to be integrated into national development policies and practices but it is nonetheless clear that this will be no easy task given the prevailing situation.

Thirdly, the picture regarding the integration of rural energy planning with rural development planning is itself complex and confusing. The role of energy in rural development seems well-recognized in some countries but far less so in others. Interactions between agencies responsible for these different but crucially related areas of planning activity are often not fostered by existing institutional structures and it appears that the process of integration is hampered by fundamental misunderstandings regarding the relationship between energy and development in rural areas.

RURAL ENERGY PLANNING IN ASIA: NATIONAL EXPERIENCES

The following discussion briefly reviews the status of rural energy planing in nine Asian countries. Summary data are presented in Table 2.

India

In India the rural energy crisis was identified as a major issue in the formulation of the Sixth Five-Year

Table 1
Rural Energy-Environment Planning and Sustainable Development:
An Assessment of Current Approaches in Selected Asian Countries

Criteria	*India*	*Sri Lanka*	*Indonesia*	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*	*China*
Long-term goals for energy and environment in rural areas	Partial	No	No	No	No	Developing	Developing	No	Yes
Policy continuity	Limited	No	No	Limited	No	Limited	Limited	No	Yes
Determination of real costs of energy-environment options	No	No	No	No	No	No	No	No	No
Appropriate valuation of the environment	No	No	No	No	No	No	No	No	No
Determination of sustainable yields	Limited	Limited	Limited	Limited	Limited	Limited	Limited	Limited	Limited
Redistributive effects	No	No	No	No	No	No	No	No	No
Trade offs between redistributive effects and economic growth	No	No	No	No	No	No	No	No	No
Devolution of resource control and decision making	Limited	No	No	Limited	Limited	Limited	Limited	Limited	Considerable

Table 2
Key Rural Energy Planning Indicators

Country	*Rural Population (%)*	*Traditional Fuels as Percentage of Total Rural Energy Consumption*	*Major Reported Environmenta Impacts of Rural Energy Systems*	*Rural Emphasis in National Energy Planning*	*Integration of Rural Energy System Planning Sustainable Development*	*Linkages between Rural Energy Planning and Development*
India	72%	65.9%	Deforestation, loss of soil quality due to use of dung and crop residues as fuel rather than fertilizer, health impacts from cookstoves, socio-economic impacts	High	Quite high	Weak
Sri Lanka	78.6%	77.9%	Soil erosion and loss of soil quality due to deforestation, health impacts of traditional stoves and open air burning of surplus paddy husk, socio-economic impacts	Moderate	Limited	Weak
Indonesia	71.2%	42%	Loss of soil quality from fuel/manure trade offs; health impacts from woodburning stoves; socio-economic impacts	Generally low (except for centralized rural electrification)	Low	Low
Malaysia	57.7%	17%	Some deforestation effects; impacts of of high fossil fuel use in rural households; socio-economic impacts	Low (except rural electrification and LPG)	Low	Low (but aware of importance of sustainable development)
Myanmar	75.7%	83.7%	Loss of soil quality from fuel/manure trade-offs; soil erosion and silting extraction; health impacts of stove emissions; socio-economic impacts	Low (except rural electrification)	Low	Low
Philippines	57.7%	32%	Loss of soil quality from fuel/manure trade offs; health impacts from stove emissions; socio-economic impacts	High	High (with newly introduced integrated approach)	Low
Thailand	77.5%	20%	Loss of soil quality from fuel/manure trade offs; health impacts of stove emissions; socio-economic impacts	High	Moderate	Weak
Vietnam	89.9%	51.2%	Loss of soil quality from fuel/manure trade offs; soil erosion and siltation from deforestation; health impacts from stove emissions; socio-economic impacts	Moderate	Low	Weak
China	43.5%	36.7%	Loss of soil quality from fuel/manure trade offs; acid precipitation; health impacts from stove emissions; socio-economic impacts	High	High	Moderate

Notes: 1. The data and comments included in this table are drawn primarily from the APDC volume edited by Ramani *et al.* (1993).
2. The comments regarding the integration of rural energy system planning with rural development programmes and those concerning linkages between rural energy planning and sustainable development represent the authors' own assessments based upon the materials in the APDC volume, supplemented by other materials.

Plan document (1980–85) (Shah *et al.* 1993). Continuing low levels of energy use in rural areas and the failure of large-scale investment in the energy sector to generate significant 'trickle down' benefits in such areas were seen to represent a serious constraint on rural economic development. While India possesses an elaborate framework for rural energy planning and that a variety of agencies operating at the national, state and local levels are responsible for the implementation of decentralized energy technologies and related development programmes, it is not apparent however, whether there is any significant involvement of environmental agencies in these activities. Furthermore, with the exception of established concerns about the sustainability of the nation's sources of woodfuel, there is little to indicate that the basic premises of sustainable are explicitly integrated into the rural energy planning process (Shah *et al.* 1993).

The environmental impacts of rural energy systems in India reflect the mix of conventional, traditional and non-conventional sources of energy available in such areas. The impacts of conventional energy sources which essentially provide electricity through the grid, are relatively well-known and documented.

Rural energy planning in India is characterized by a relatively strong emphasis on public participation in the planning process. The importance of this participation was, for example, recognized by the state of Gujurat during the Sixth Five-Year Plan period (1980–85) when it allocated 20 per cent of the plan budget to decentralized planning and implementation at the district level and below. This approach was extended to other states in the following plan period. In Gujurat, public participation in decentralized rural energy programmes played a prominent role in helping to ensure the success of the Methan Energy Village, Asia's largest community biogas programme (Shah *et al.* 1993).

Sri Lanka

In Sri Lanka, the major environmental concern relating to rural energy systems is the declining supply of fuelwood and its implications for deforestation and resulting problems such as soil erosion. Given this situation, Fernando and Siyambalapitiya (1993) suggest that an environmentally sensitive strategy for rural energy would be to disseminate as rapidly as possible efficient cookstoves to reduce fuelwood consumption. They also see the possibility of an expanded role for paddy husk as fuelwood supplies in rural areas dwindle and urban fuelwood prices increase.

Sri Lanka has no committed policy for the development of non-conventional energy systems and promotional programmes have therefore tended to be *ad hoc* in nature. Similarly, there appears to be no consistent pattern in the institutional structure relating to the implementation and maintenance of rural energy development projects.

Public participation in the planning and implementation of rural energy projects is, according to Fernando and Siyambalapitiya, extremely limited in Sri Lanka. Even though there is recognition of the importance of community participation, planning is still dominated by a top-down approach. At the same time, it appears that community awareness of alternative rural energy systems is limited.

Thus, it appears that Sri Lanka lacks a rural energy planning framework at the national level. There is little to suggest that any serious attempts have been made to integrate energy and environmental planning in rural areas and sustainable development *per se* is not a guiding principle for the development of the rural energy system.

Indonesia

In Indonesia, the energy policy component in the Five-Year Plan (REPELITA V) for the period 1989–90 to 1993–94, has been considerably strengthened and recognizes, *inter alia*, the need to manage energy with a view to maintaining the long term sustainability of energy resources, the need to encourage lifestyles that prevent the wasteful use of energy, the importance of promoting local (decentralized) energy resources in a sustainable manner to conserve important fossil fuel resources (especially petroleum) and to avoid adverse environmental impacts (Siagian 1993).

With regard to rural energy systems, the most significant environmental concern is deforestation resulting from overexploitation of forests for fuelwood. Other rural energy systems do not appear to present major problems and as conventional, commercial energy sources are not widely available in rural areas, these have not given rise to any major environmental impacts. However, some conventional power generating facilities such as hydropower plants do impinge on the rural areas and may result in some negative impacts on the resource base and lo-

cal populations. Siagian (1993) suggests that the environmental impacts of rural energy systems may increase significantly in the future as conventional, commercial fuels make greater inroads into rural areas and as a growing rural population imposes even greater pressure on the biomass resource base.

There is presently no specific planning for rural energy development in Indonesia and no arrangement to promote intra-agency cooperation in rural energy development initiatives. Such rural energy planning activities as do take place relate primarily to rural electrification and these are carried out through regional development planning exercises. Public participation in rural energy planning is limited and confined for the most part to the initiation of proposals relating to rural electrification programmes.

Indonesia represents a case where there is some recognition of the need to relate energy resource development to environmental considerations although such an awareness has yet to be effectively integrated into the rural energy planning system. It is not clear that Indonesia has yet made much progress in integrated rural energy and environment planning as a means of pursuing a sustainable development strategy at the national level.

Malaysia

In Malaysia, there are clear national environmental policy objectives which bear directly on rural energy systems and which are themselves directly related to a growing emphasis on sustainable development (Zamzam 1993). Malaysia is rapidly moving towards a modern (i.e. conventional, commercial) fuel-dominated rural economy based upon widespread availability of electricity and petroleum products.

Regarding rural energy planning, electricity is viewed as infrastructure and a basic amenity rather than an energy source in its own right. Renewable energy projects are implemented in two ways: either as small-scale pilot projects by research institutions, or as commercial projects by major plantation companies who are usually responding to environmental regulations and must find appropriate ways of disposing of potentially polluting waste streams.

Public participation in rural energy planning in Malaysia is typically limited to requests for the supply of electricity although consultations do apparently take place during the implementation of specific projects. The public are also drawn into reviews of major projects through public fora and a mandatory environmental impact assessment system.

The types of rural energy planning concerns that predominate elsewhere in Asia do not exist on anything like the same scale in Malaysia. While Malaysia appears aware of the importance of sustainable development, it is not clear how exactly this is articulated through national energy policy and rural energy development programmes.

Myanmar

Although there is no formal structure for rural energy planning in the country, the fact that Myanmar is essentially a rural society means that in practice, national energy planning in the country is largely an exercise in meeting the energy needs of the rural population (San 1993). Virtually all energy planning is centralized and this applies to the supply of petroleum products, rural electrification and fuelwood planning and management. Decentralized planning for commercial energy systems in rural areas is largely confined to small-scale hydropower projects.

Given that the existing rural energy system in the country is almost entirely dependent on woodfuel, as is a significant proportion of the urban energy system, it is not surprising that the major environmental impacts associated with energy are those stemming from the problem of deforestation. Although concern about deforestation has arisen in relation to certain regions of the country, San (1993) indicates that the total volume of wood extracted in recent years falls well below the sustainable yield.

The Philippines

In the Philippines, in 1991 the government designed a new national framework for an integrated approach to energy planning for sustainable rural development and also framed an action plan to assist in its implementation. It is noteworthy that within this framework, particular recognition has been given to the role of non-governmental organizations (NGOs), which have a good track record for interfacing between government agencies and rural communities.

Since the beginning of the 1990s, Affiliated Non-conventional Energy Centres based in provincial universities and agricultural colleges have also been drawn into the planning and implementation process, initially through data collection exercises and subsequently through expected output in the form of local rural energy plans.

As regards environmental impacts associated with rural energy systems, these again tend to be dominated by concerns surrounding the overexploitation of forest resources, partly for energy use, and the health effects of woodfuel combustion. In general, however, it appears that rural energy systems *per se* are not a major source of environmental problems.

Public participation in rural energy system development is, according to Heruela (1993) most highly developed in the rural electrification programme, where planning, implementation and management is carried out by rural electric cooperatives.

The Philippines shows clear evidence of awareness of the need to integrate rural energy planning and environmental planning and a sensitivity to the longer term sustainability of at least some of the natural systems upon which certain types of rural energy development are based. The introduction of the integrated planning approach referred to above is a recent development and it is not yet clear how effective it will be in creating a more positive context for the pursuit of sustainable development strategies.

Thailand

In Thailand, rural energy planning is directly linked to rural development planning only through programmes relating to rural electrification (under each Provincial Electricity Authority) and fuelwood supply (by the Royal Forestry Department). However, these are not treated in an inter-related manner within the planning framework (Sompongse 1993). Rural development represents a key focus in Thai policy making and is one of the major objectives in the Sixth Five-Year Plan of the National Social and Economic Development Board. As Sompongse (1993:528) notes: 'Most rural energy programmes/ projects in Thailand have been developed around a particular technology.'

Thailand's rural energy supply system is based upon both conventional and traditional sources. Some conventional system projects located in rural areas have given rise to significant environmental impacts on the rural population (e.g. hydro-projects) and have become very controversial. As regards traditional fuels, the major impacts experienced relate to fuelwood supply and use and to crop residues. The exploitation of fuelwood supplies has contributed to the country's serious deforestation problem which recently prompted the government to introduce a ban on logging activities and measures against the illegal exploitation of forests for other uses, including fuelwood. Reforestation and plantation projects have also been launched. The public can participate in various ways in rural energy development programmes, most notably through helping government agencies to identify energy needs and resources at the local level and then through the formation of cooperatives to assist in project implementation.

Thailand appears to be at the stage where there are some serious attempts to link rural energy systems and rural development but not within an explicit framework for sustainable development. Integration of energy and environmental planning concerns thus far appears to be relatively undeveloped.

Vietnam

In Vietnam, rural development planning itself is an important activity and is structured around responding to the differing needs and characteristics of the seven agro-ecological zones into which the country is divided.

The major national energy-related programme for rural areas relates to grid-based rural electrification. As regards the planning and management of NRSE, these activities focus on either specific programmes (e.g. afforestation) or individual projects (e.g. small-scale hydro).

As far as environmental factors in rural energy development are concerned, the Institute of Energy (1993:551) comments that:

> Environmental concerns in energy development have emerged in Vietnam only since 1990. As such, no reliable data are available on the magnitude of the environmental impacts of prevailing rural energy systems . . . the most significant impact has occurred in the form of rapid deforestation due to the excessive harvesting of forests for fuelwood. . . . In addition . . . the burning of fuelwood and crop residue in low efficiency trivet cookstoves has led to widespread indoor air pollution in rural households.

The involvement of rural communities in the rural energy development process is limited and confined largely to the maintenance of equipment and plant, but this may change as the country's economic reform programme takes hold and development pressures intensify in rural areas.

Vietnam is presently experiencing a major shift

in macro-economic policy and consequent economic restructuring. Awareness of existing and future potential environmental problems certainly exists but has yet to be effectively translated into policies and programmes, not just in the energy sector but across the economy as a whole.

China

In China, rural energy development is an important component of national development as reflected in the country's five-year plans and is also seen as a key element in national energy planning and management. There exists an elaborate and sophisticated institutional structure for rural energy development, which falls primarily within the purview of the Ministry of Agriculture (MOA). This ministry deals with both traditional and new energy technologies for rural development.

One of the key features of the Chinese system has been the identification of a large number of demonstration areas within which rural energy systems are planned on a comprehensive basis and is closely related to environmental concerns and economic development. This programme was initiated during the Sixth Five-Year Plan (1981–85) and is now manifest in the '100 Counties Programme'.

There is a high level of awareness of the environmental dimensions of rural energy development in terms of such problems as deforestation, soil erosion, acid precipitation, airborne emissions and the effects of rapid and substantial rural industrialization. Various policy measures have been adopted to respond to some of these problems, including the development of ecological agriculture and tree plantations and afforestation programmes. The former, to quote Zhang *et al.* (1993:583) involves:

> ... comprehensive utilizing of solar and biomass energy, the rational rotation of crops, and the combining of agriculture with fish breeding, poultry raising and agro-based industries. The objective is to ensure that natural resources, including energy, are recycled to augment agricultural productivity, and that the overall utilization and transformation of these resources yield the maximum benefits.

There remains concern, however, over the mechanisms by which environmental considerations *per se* can be effectively integrated into the overall rural energy planning process and the means by which appropriate databases can be constructed. The participation of local people in rural energy development programmes is actively fostered by the government. As Zhang *et al.* (1993:598) comment:

> The extent of success achieved by certain decentralized energy technologies, such as small-scale hydropower, biogas and efficient cookstoves, owes largely to the high level of local community participating in planning and implementing the related programmes.

China has clearly enjoyed considerable success in the implementation of its rural energy development programmes and has established planning and implementation structures and institutions that are among the most effective in the region. However, it is perhaps the scale of the Chinese rural energy system and its environmental implications that present the most daunting challenges. Progress has certainly been achieved but more work is required to enhance the integration of rural energy and environmental planning within a sustainable development framework.

FUTURE DEVELOPMENTS AND CONCLUSIONS

How, then, might these existing weaknesses in rural energy planning approaches be overcome? A number of important pointers are provided in *Agenda 21* and in the recent work of the Food and Agricultural Organization of the United Nations.

Agenda 21

This document sets out a programme of action for global sustainable development. Chapter 14 of the document deals with the promotion of sustainable agriculture and rural development (SARD), arguing in Section 14.2 (UN 1993) that:

> Major adjustments are needed in agricultural, environmental and macroeconomic policy, at both national and international levels, in developed as well as developing countries, to create the conditions for sustainable agriculture and rural development (SARD). The major objective of SARD is to increase food production in a sustainable way and enhance food security. This will involve education initiatives, utilization of economic incentives and the development of appropriate and new technologies, thus ensuring stable supplies of nutritionally adequate food, access to those supplies by vulner-

able groups, and production for markets; employment and income generation to alleviate poverty; and natural resource management and environmental protection.

To achieve these objectives, 12 programme areas are identified as a basis for action. These include the enhancement of public participation and promotion of human resource development for sustainable agriculture, land resource planning information and education for agriculture, land conservation and rehabilitation, and, rural energy transition to enhance productivity. Insofar as the programme area relating to energy considerations is concerned, *Agenda 21* (Sub-section 14.93) argues that:

> . . . energy supplies in many countries are not commensurate with their development needs and are highly priced and unstable . . . More intensive energy inputs are required for increased productivity of human labour and for income generation. To this end, rural energy policies and technologies should promote a mix of cost-effective fossil and renewable energy sources that is itself sustainable and ensures sustainable agricultural development. Rural areas provide energy supplies in the form of wood. The full potential of agriculture and agroforestry, as well as common property resources, as sources of renewable energy, is far from being realized. The attainment of sustainable rural development is intimately linked with energy demand and supply patterns.

The objectives of the energy programme area are, firstly, to initiate and encourage by the year 2000 a process of what is termed 'environmentally sound energy transition' in rural communities. This transition would involve a shift from unsustainable energy sources to a more diversified energy supply system based on new and renewable energy sources. The second objective is to increase the energy inputs available both for rural households and agro-industry, and the third, to implement self-reliant rural programmes emphasizing sustainable development of renewable energy sources and improved energy efficiency.

To achieve these objectives, *Agenda 21* calls for the promotion of pilot plans and projects involving various types of energy systems (e.g. gasifiers, biomass, solar driers, wind pumps and combustion systems) that are appropriate and maintainable, the initiation and promotion of rural energy programmes supported by technical training, banking and related infrastructure, and, the intensification of research and the development, diversification and conservation of energy, taking into account the need for efficient use and environmentally sound technology (Sub-section 14.95). Emphasis is also placed on the need to collect and disseminate data on rural energy supply and demand patterns and the analysis of sectoral energy and production data to identify rural energy requirements. The document also advocates international and regional cooperation and coordination with a view to exchanging country and regional experience on rural energy planning methodologies to promote efficient planning and select cost-effective technologies.

On implementation strategies, the document argues for an intensification of research by both the private and public sectors in developed and developing countries on renewable sources of energy for agriculture, and research on and the transfer of biomass and solar energy technologies to agricultural and post-harvest activities (Sub-section 14.99). In addition, governments are encouraged to enhance public awareness of rural energy problems, placing particular emphasis on the economic and environmental advantages of renewable energy sources (Sub-section 14.100). Furthermore, they are also encouraged to set up national institutional mechanisms for rural energy planning and management that would improve efficiency in agricultural productivity and reach the village and household level, and strengthen extension services and local organizations to implement plans and programmes for new and renewable sources of energy at the village level (Sub-section 14.101).

The FAO's Approach: Area-based Decentralized Energy Plans

The FAO's recent contributions to this area are of a more focused nature (FAO 1992, 1993, 1994). Environmental concerns figure prominently in the organization's work, as do sustainability issues, particularly with regard to sustainable forestry policies. More importantly, FAO has attempted to establish an approach to rural energy assessment and planning for sustainable development (Best 1993). As Best (1993:155–6) comments:

> The provision of appropriate energy services, with its direct impact on rural living standards and the environment, and its contribution towards the generation of economic activities, is a vital requisite for sustainable rural development . . . (which) is de-

> fined as that which: (i) permits the full satisfaction of the present and future needs of all rural inhabitants — beginning with the poorest and taking into account their broad socio-cultural differences; (ii) is environment-friendly; (iii) favours regional and national self-determination ... Current integrated or comprehensive rural development programmes fail to, or barely, consider the concept of energy for development.

The FAO approach is based on the preparation and implementation of area-based decentralized energy plans that explicitly link both planning and management functions. These plans are intended to meet the energy needs of the rural population for subsistence and for development, at least cost to the economy and to the environment. These micro-level plans should also be linked to national economic planning and development activities, particularly those relating to energy, agriculture and rural development.

Although most countries around the region have now established institutional structures and related approaches for national energy planning, these often fail to respond specifically to the energy requirements of rural areas for sustainable agriculture and rural development except perhaps in the broadest national terms (Best 1993). Few countries have mechanisms for energy planning that are directed specifically at the rural sector. The situation in rural areas is further compounded by the fact that the high level of dependence on non-commercial energy forms, particularly for domestic energy needs, makes it very difficult to use economic or fiscal measures or regulatory systems to control the damage to the environment that results from frequent overexploitation of the resource base.

The approach advocated by FAO is also designed to take account of socio-cultural and economic variables, and their relationship with energy consumption patterns (both existing and desired), environmental constraints and the needs and priorities of rural people. The approach has to adopt an integrated perspective on energy sources, including not only NRSE but also conventional, commercial energy systems and their applications in rural areas. Because the latter energy systems are typically planned at the national or regional level, it is clear that the micro-based approach must itself be linked to energy and economic development planning at these levels, the overall objective being to reduce disparities between urban and rural areas in terms of access to energy supplies.

There are seven major stages involved in the preparation of the area-based integrated rural energy plans that form the basis of the new approach:

1. **Selection of the area.** The most suitable unit is likely to be a group of villages which coincides with a local administrative unit and, ideally, with certain ecological characteristics.
2. **Energy surveys.** These are required to characterize and understand existing supply-demand relationships and the nature of the energy resource base.
3. **Energy demand projections.** These must be made to establish energy needs in relation to subsistence and economic development requirements. The latter is especially complex, requiring as it does, linkages with existing and planned rural development initiatives.
4. **Energy supply assessment.** The availability of all types of energy must be assessed for the plan period.
5. **Energy conversion technologies.** Detailed technology assessments are required for all commercially available options. These assessments should also include factors which affect the viability of options (e.g. financing, marketing, maintenance and support services).
6. **Energy costs and prices including environmental impacts.** Each option must be evaluated in terms of the delivered cost of energy. Environmental costs should be included where possible and in cases where quantification is not feasible, options should be classified with respect to their environmental implications by evaluating trade offs between the option and the local, regional and global environments.
7. **Energy plan.** The stages summarized above lead to the preparation of an integrated rural energy plan. This plan should provide the energy resources and relevant technologies required to meet both subsistence and development needs in the micro-area at least cost to the national economy and the environment.

The initial implementation of this new approach was pursued in the early 1990s as part of the Asian Regional Energy Development Programme (REDP), funded by the United Nations Development Programme. In a pilot effort, a number of Asian countries received assistance from FAO in the adaptation of the comprehensive, integrated approach to their own national situations. This was implemented

through a series of national consultations in the Philippines, Indonesia, Sri Lanka, Laos and Vietnam, the overall objective being to prepare a National Energy Strategy for Rural Areas in each country. Further work on the application of the methodology was in progress in 1994.

The FAO approach has much to commend it. It seeks explicitly to draw together the disparate threads of energy planning, rural development planning and environmental management. Clearly, and as Best (1993) recognizes, it is crucially dependent on the nature and effectiveness of the networks that are established to foster these linkages and it remains vulnerable to the vagaries of political commitment. Nonetheless, it provides an important approach for advancing efforts to integrate energy and environmental planning in rural areas.

Energy will continue to be a topic of major concern in the rural areas of Asia for many decades to come. The dimensions of the rural energy problem itself are now much better understood but policy responses tend to remain partial and fragmented. The emergence of sustainable development as a basic concept driving policy formulation will pose many difficulties for existing institutions and their current approaches to rural energy planning. This paper has drawn attention to certain difficulties associated with existing planning approaches and has focused on recent developments that might potentially overcome some of these problems. Nonetheless, there remains considerable inertia in the policy making systems concerned and effective sustainable strategies for rural energy system development are likely to emerge only slowly in the years ahead.

REFERENCES

Agarwal, B. 1986. *Cold Hearths and Barren Slopes: The Woodfuel Crisis in the Third World.* Delhi: Allied Publishers Ltd.

Bajracharya, D. 1983. Rural Energy Planning in the Developing Countries of Asia. Background Paper for ESCAP Seminar on Rural Energy Planning, Beijing, China, 9–29 April 1983.

Barnett, A. *et al.* 1982. *Rural Energy and the Third World.* Oxford: Pergamon Press.

Best, G. 1993. An Approach to Energy Assessment and Planning for Sustainable Development — Status of Implementation in Asia. In FAO, *Wood Energy Development: Planning, Policies and Strategies*, Vol. II,155–6. Bangkok: Regional Wood Energy Development Programme.

Bhadra, B. 1990. Forest Resources: Nepal. In *Energy Systems and the Environment: Approaches to Impact Assessment in Asian Developing Countries* (ed. P. Hills and K.V. Ramani), 315–42. Kuala Lumpur: Asian and Pacific Development Centre.

ElMahgary, Y. and Biswas, A.K. (Eds.). 1985. *Integrated Rural Energy Planning.* Guildford: Butterworths.

Fernando, S. and Siyambalapitiya, T. 1993. Sri Lanka. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 297–332. Kuala Lumpur: Asian and Pacific Development.

Foley, G. 1981. The Future of Renewable Energy in Developing Countries. *Ambio* 10(5):200–5.

Food and Agriculture Organization (UN). 1992. *Sustainable Development and the Environment:* FAO Policies and Actions Stockholm 1972–Rio 1992. Rome: FAO.

Food and Agriculture Organization (UN). 1993. *Wood Energy Development: Planning, Policies and Strategies*, Bangkok, FAO, 3 Vols.

Food and Agriculture Organization (UN). 1994. *Policy Management Systems and Methods of Analysis for Sustainable Agriculture and Rural Development*, report prepared by M.Carley, International Institute for Environment and Development (London). Rome: FAO.

Heruela, C.S. 1993. Philippines. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 451–506. Kuala Lumpur: Asian and Pacific Development.

Hills, P. 1988. Overview of Environmental Impacts and General Approach to Assessment. In *Rural Energy Planning: Asian and Pacific Experiences* (ed. K.V. Ramani), 379–94. Kuala Lumpur: Asian and Pacific Development Centre.

Hills, P. 1994. Environmental Aspects of Rural Energy Planning Implementation: Synthesis Paper. Report prepared for the United Nations Economic and Social Commission for Asia and the Pacific for presentation at a Regional Workshop on Rural Energy Planning, Beijing, China, September 1994, 40 pp.

Hills, P. In press. Rural Energy Systems and the Environment. In *Rural Energy Systems in Asia and the Pacific* (ed. K.V. Ramani, N. Islam, and A. Reddy), Vol. II. Kuala Lumpur: Asian and Pacific Development Centre.

Hurst, C. and Barnett, A. 1990. *The Energy Dimension: A Practical Guide to Energy in Rural Development Programmes.* London: Intermediate Technology Publications.

Hurst, P. 1990. *Rainforest Politics: Ecological Destruction in South-East Asia*, London: Zed Books.

Institute of Energy (Vietnam). 1993. Vietnam. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status,*

Planning and Management (ed. K.V. Ramani, N. Islam and A. Reddy), 539–66. Kuala Lumpur: Asian and Pacific Development.

Islam, N. 1990. Biomass Resources: Bangladesh. In *Energy Systems and the Environment: Approaches to Impact Assessment in Asian Developing Countries* (ed. P. Hills and K.V. Ramani), 343–84. Kuala Lumpur: Asian and Pacific Development Centre.

Islam, N., Morse, R. and Hadi Soesastro, M. (Eds.). 1984. *Rural Energy to Meet Development Needs: Asian Village Approaches*. Boulder: Westview Press.

Leach, G. 1992. The Energy Transition. *Energy Policy* 20(2):116–23.

Meyers, S. and Leach, G. 1989. *Biomass Fuels in the Developing Countries: An Overview*, LBL-27222, Lawrence Berkeley Laboratory, Berkeley, CA.

Perlack, R.D. *et al.* 1991. *Biomass Energy Development in Yunnan Province, China: Preliminary Evaluation*, ORNL/TM-11791.

Poore, D. *et al.* 1989. *No Timber Without Trees: Sustainability in the Tropical Forest*. London: Earthscan Publications.

Ramani, K.V. 1992. *Rural Electrification and Rural Development*. Kuala Lumpur: Asian and Pacific Development Centre.

Ramani, K.V., Hills, P. and George, G. (Eds.). 1992. *Burning Questions: Environmental Limits to Energy Growth in Asian-Pacific Countries During the 1990s*. Kuala Lumpur: Asian and Pacific Development Centre.

Ramani, K.V., Islam, N. and Reddy, A. (Eds.). 1993. *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management*. Kuala Lumpur: Asian and Pacific Development Centre.

Repetto, R. and Gillis, M. 1988. *Public Policies and the Misuse of Forest Resources*. Cambridge: Cambridge University Press.

Rosillo-Calle, F. and Hall, D.O. 1992. Biomass Energy, Forests and Global Warming. *Energy Policy* 20(2):124–36.

Ryan, J.C. 1992. Conserving Biological Diversity. In *State of the World 1992* (ed. L.R. Brown *et al.*), 9–26. London: Earthscan Publications Ltd.

San, M.T. 1993. Myanmar. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 407–50. Kuala Lumpur: Asian and Pacific Development.

Shah, K.S. *et al.* 1993. India. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 159–232. Kuala Lumpur: Asian and Pacific Development.

Siagian, U.W.R. 1993. Indonesia. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 333–76. Kuala Lumpur: Asian and Pacific Development.

Sompongse, C. 1993. Thailand. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 507–38. Kuala Lumpur: Asian and Pacific Development.

Soussan, J. 1993. Relating Macro-economic and Sectoral Policies to Wood Energy Supply and Use. In *Wood Energy Development: Planning, Policies and Strategies* (FAO), 85–96. Bangkok.

Soussan, J. *et al.* 1992. Fuelwood Policies for the 1990s. *Energy Policy* 20(2):137–52.

United Nations. 1993. *Agenda 21*. New York: United Nations.

UNDP/World Bank. 1988. *Thailand: Northeast Region Village Forestry and Woodfuel Preinvestment Study*, Activity Completion Report, Joint UNDP/World Bank Energy Sector Management Assistance Program, New York, United Nations.

Zamzam, Mohd bin Jaafar. 1993. Malaysia. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 377–406. Kuala Lumpur: Asian and Pacific Development Centre.

Zhang, Z.M. *et al.* 1993. China. In *Rural Energy Systems in the Asia-Pacific: A Survey of their Status, Planning and Management* (ed. K.V. Ramani, N. Islam and A. Reddy), 567–602. Kuala Lumpur: Asian and Pacific Development Centre.

Forest Management Through People's Participation: Practices and Problems in India and Nepal

Niaz Ahmed Khan and Samiul Hasan

ABSTRACT

The 1970s saw a major shift in forest management in south Asian countries. The shift was in the form of greater involvement of the common populace in the management and regeneration of forests. The core philosophy behind this approach, more commonly coined as 'participatory forestry' (PF), was people's participation. This paper examines the performance of participatory forestry in India and Nepal against the lofty philosophy with which the programme was initiated. It also analyses the socio-political and institutional factors affecting the rise, functioning and performance of PF as a forest management approach. The causes of limited participation and the effects of PF on different 'interests' of the society are also dealt with in the paper.

Keywords: *Nepal, India, forest management, participatory forestry, environment*

INTRODUCTION

Increased realization of the need for protecting the forest resource and involving people in its management forced the governments in south Asian countries to take resort to a major shift in forest management in the 1970s. The shift was made in the form of 'participatory approaches' to forest management. This paper looks into the process and performances of participatory forestry in India and Nepal. It examines the factors contributing to the emergence, influencing the implementation process, and responsible for the failure of participatory forestry in south Asia. It also evaluates the effects of participatory forestry on different interests in society.

PARTICIPATORY FORESTRY IN SOUTH ASIA

In the 1970s and 1980s forest depletion became a great concern for the governments in most of the south Asian countries. In early 1970s 20% of land in Bangladesh was under forest cover. Since then the forest area has been reducing at a rate of 8000 ha every year (ADAB 1992). In India during the 1970s and 1980s an estimated 1.5 million ha of forest area was depleted annually (Nadkarni *et al.* 1989). Among all the countries in south Asia Nepal has the highest percentage of forest cover. Nepal, however, lost almost 10% of its forest cover between 1964 and 1985. The process of deforestation in Pakistan during the same period brought the forest cover down to only 5% of total land, and Sri Lanka lost about 16% of its tree cover between 1960 and 1980 (Bhattarai 1990; Stevens 1990). The rate of deforestation in some of the south Asian countries was much worse than government estimates. For example, in India, the government estimated 40% forest cover in Orissa. But satellite images show actual forest cover in Orissa is only 20% (Jayaraman 1987).

Niaz Ahmed Khan, Centre for Development Studies, University of Wales, Swansea, UK SA2 8 PP.
Samiul Hasan, Department of Public Administration, University of Chittagong, Bangladesh.

In any event in all these south Asian countries governments became keen to do something very discerning to arrest the rate of drastic forest depletion. In all of these countries participatory forestry was seen as an alternative approach of forest management to reduce the pace of forest depletion.

The central idea of this new approach of forest management is popular participation in the regeneration and management of forest. The approaches followed in different countries are similar in context and philosophy. There are, however, very small geographic and micro-contextual differences. Different countries use different approaches and processes of involving people in forest management. In Bangladesh the participatory approach of forest management is named 'community forestry'. The major components of community forestry in Bangladesh are: farm forestry, woodlot plantation, strip plantation, re-afforestation on degraded and marginal lands, and rehabilitation of farmers on degraded government forest lands for community forestry (Task Force 1987). Participatory forestry (PF) in India is referred to as social forestry. Social forestry programmes in India have three major components: farm forestry, woodlot forestry and community woodlot forestry.

In Nepal participatory forestry is known as 'community forestry' and is defined as a process which enables communities or forest user groups to direct the establishment and sustained management of local forests for their own benefits (Gronow and Shrestha 1991). It includes village woodlot, fallow revenue lands, with forest department (FD) officials performing most of the managerial and supervisory functions. In Pakistan the major focus of participatory forestry is farm forestry, because the FD views farm forestry as a very effective way to meet rising demands for basic forest products. Plantations on degraded forest land and marginal land are other components of participatory forestry in Pakistan (Bhattarai 1990). Communal, state or private marginal lands are all used for tree plantation in Pakistan. The FD by offering free or subsidized seeds, saplings, other necessary supplies, and technical support encourages the marginal growers to raise forest production for personal or community consumption or for selling in the market.

In sum, in all the south Asian countries participatory forestry is referred to as 'social forestry', 'farm' or 'community forestry'. In all these cases, except in Nepal, farm forestry has predominance due to involvement of big farm owners and the forest department officials in the planning stage of the programmes. Woodlot plantation, community woodlot plantation, plantation on degraded community and government lands are other common components of participatory forestry in south Asian countries. In Bangladesh participatory forestry focuses more on re-afforestation of degraded and marginal lands. The FD officials in all these countries control the planning and implementation aspects of participatory forestry. The government initiatives for participatory forestry in all the south Asian countries are readily complemented by easily available external funding.

PARTICIPATORY FORESTRY IN THE CONTEXT OF INDIA AND NEPAL

Social forestry is the main type of participatory forestry programme in India. The three important components of social forestry programmes in India are: farm forestry, encouraging farmers to plant trees on their own farms by distributing free or subsidized seedlings and offering technical support, woodlot forestry, strip plantation along roadside, canal banks and other such public lands, and reforestation of degraded forest and community lands by the FDs for the needs of the community; and community woodlot forestry, plantation by the communities themselves on village community lands, fallow revenue lands and state forest lands to be shared equally by them (Agarwal and Narain 1985, Arnold and Stewart 1988; Arnold 1989).

In India participatory forestry is practised in almost all the states. The major concentration and efforts are, however, identified in the states of Bihar, Gujrat, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal. Although India is a vast country, the participatory forestry programmes introduced in different parts of the country are almost uniform. In almost all the places local government councils, in one form or another, are involved in participatory forestry programmes. In terms of trees, eucalyptus and babul (*Acacia nilotica*) are used widely for participatory forestry in all the states in India.

The main thrust of community forestry in Nepal is handing over of control and responsibility for the management of forests to local people (Adhikari 1990). During late 1970s and 1980s, forests used to be handed over to the user groups through the Panchayats (local government councils) as

'Panchayat Forest' and 'Panchayat Protected Forest'. After the abolition of Panchayat system, by a new government regulation issued in 1990, community forest is now handed over directly to the forest user groups instead of the Panchayats (Bartlett and Malla 1992).

The whole of Nepal is under participatory forestry programmes. Different parts of different selected districts have been focused more to the programmes than the others. In Nepal the local government councils have been involved in the participatory programmes for a long period of time. After the recent changes in the system, the forest user groups are now directly responsible for participatory forestry programmes. In early periods of participatory forestry in Nepal, Chir pine (*Pinus roxburghii*) trees were planted predominantly. The local people, however, prefer a tree which provides fodder, fuel and fruit. They thus showed less interest in species like Chir pine. The local common people prefer species like soft shelled walnuts and mango trees to any other species for plantation (Shepherd 1981). These species along with Chir pine are used most in participatory forestry projects in Nepal.

The main objectives of participatory forestry are to meet the needs of people for food, fuel-wood, and fodder from grown forestry rather than from natural forest. It is assumed that if people are involved in producing forest resources, they would help protect and be cautious in using them. The governments initiating participatory forestry thus assumed the responsibility of generating resources to provide: (1) free seeds and saplings; (2) cooperative works with the community; (3) field expertise; (3) supervision and monitoring; and (4) the willingness to tolerate encroachment on public property (Khator 1991).

Factors Leading to the Emergence of PF in India and Nepal

Political

India, with about 304 million ha of land, is inhabited by more than 866 million people (World Bank 1993). Every hectare of this land in addition has to support 0.76 cattle (Bowonder *et al.* 1987). Further, the country is still largely dependent on fuel-wood for household and some informal commercial energy needs. In India participatory forestry was thus seen as an effective answer to these three dimensional needs for food, fodder and fuel-wood (Nadkarni *et al.* 1989).

The agricultural output under the Integrated Area Development Programme (IADP), introduced in India in 1960, was impressive, but the effects of the 'green revolution' failed to reduce rural poverty. The government thus undertook the Small Farmers Development Agency (SFDA) programme to minimize adverse effects of the previous programme. The SFDA being an exclusively land-based programme automatically excluded landless labourers — the poorest of the poor. Recognizing the fact that no single strategy can be applicable everywhere and can benefit all the groups in society the Integrated Rural Development Programme (IRDP) was undertaken in 1980 (Nickson 1986). The IRDP was aimed, among other things, at land distribution, agricultural subsidies, small-scale industries, cottage and household production. The participatory forestry programme was seen as compatible with the IRDP. The National Commission on Agriculture, in 1976, thus, suggested growing trees on land accessible to village people in order to reduce pressure on forest earmarked for production forestry (Arnold 1989).

In Nepal, the indigenous system of forest management, did not always have a fair and equitable distribution of forest benefits or a mechanism for sharing the responsibilities. The Talukdari (1769–1951) and the Kipat (1846–1951) systems were conservative allowing access only to a few products, and grazing which may be inimical to development of seedling regeneration (Bartlett and Malla 1992). Some initiatives to tackle these problems and to make sure that the poor and weaker people get a fair share of forest product became a necessity.

In Nepal, forests were nationalized through the Private Forest Nationalization Act, 1959. The legislation was intended to prevent destruction of forest wealth, and to ensure adequate protection, maintenance and utilization of privately owned forests (Bartlett and Malla 1992). Forest land was thus brought under the control of the FD performing a policing and licensing role. In 1961 the Forest Act was introduced to transfer some government forest land to the Panchayats for use by the community and development of community forests with the help of a decentralized local political system. The Act clearly indicated government's reluctance to share either the ownership of forest land or the overriding

authority over it (Mahat *et al.* 1986) and was seen by people as a means of destroying traditional forest management systems and increasing exploitation (Adhikari 1990). The Forest Act, 1993, is the latest legislation relating to forest lands of Nepal. It is expected to expedite the process of handing over parts of national forests as community forests to be managed and utilized by user groups.

Prior to this legislation, as noted by one study, the community forestry programmes have been 'neither effective in handing over (national forest to the people) nor efficient in input utilization' (Kanel 1993). Participatory forestry in Nepal thus emerged to offset the failure of previous forest policies, to reorient people, who looked on nationalization of forests as a means of deprivation of their traditional rights on forests. It was seen as an useful response to the growing mistrust among the rural communities about authoritative (and sometimes autocratic) state intervention. The participatory forestry was devised as a means of involving the rural poor in growing and gaining benefits from plants and trees, previously exclusively reserved for landowners.

Economic

In comparison to the cost involved in other programmes of land distribution and social welfare, and rural development, the participatory forestry was seen by these governments as very cost-effective. The programme did not require any change in the existing structure of forest management and was expected to generate only a little controversy. Further, the participatory programme required a greater presence of the FD officials at the field level thereby increasing government's credibility with the people.

The increased need for food and fuel-wood of urban areas caused rapid disappearance of forest land in these countries (Shepherd 1990). Due to comparatively higher prices, rural wood went to urban centres (Bowonder *et al.* 1986). Participatory forestry in the peripheral rural areas were seen by the policy makers as an important means of sustaining the supply of urban demand for fuel-wood. Further, the programme had an intrinsic mechanism to offer new opportunities to expand power, thus it attracted local elites and received support from even the rich rural farmers (Khator 1991).

Easily available external funding earmarked exclusively for this purpose helped the concerned government undertake programmes in participatory forestry. The major funding agencies were: CIDA, SIDA, ODA-UK, USAID and the World Bank. In addition, in the case of Nepal, funding came also from the governments of Australia and Germany (Foley and Barnard 1984). In fact, more than 75% of the public sector development expenditure in Nepal comes from external sources, as such bilateral and multilateral aid agencies have a strong influence on the internal policy. According to their advise the large-scale commercial plantation projects in Nepal were shifted to small-scale, community-based programmes (Gilmour *et al.* 1989).

THE PROCESS AND NATURE OF PEOPLE'S PARTICIPATION

Two common sets of tasks in participatory forestry are: 'management task' and 'operative task'. Type A, 'Management Task', includes: selection of land, planning and deciding what to raise, organizing planting operations, managing plantation, distributing the produce after exploitation, and marketing. Type B, 'Operative task', involves: nursery-raising, land protection, watering, weeding, fertilization, protection and exploitation (Sen and Das 1987). 'Management tasks' (Type A) are idealistic and concerned with building up a participatory environment whereby people play major roles in participatory forestry and the FD serves as the facilitator and technical experts. Whereas the second set, operative tasks (Type B), implies a rather restricted meaning of popular participation in participatory forestry, mainly in the form of wage labour contribution.

The description of Type A and Type B activities in participatory forestry relates to active and passive participation, respectively (Oakley and Marsden 1984). In India as well as in Nepal the FD personnel take on the responsibility of choosing and planting trees. The engagement of the local community in the implementation of this programme is largely passive and is normally restricted to the provision of hired labour for planting, and an agreement to cooperate in protecting the plantation (Foley and Barnard 1984). These activities fall in Type B thereby are passive form of participation.

There are regional differences, but the village is the basic unit of participation in participatory forestry. The commonly used organization to ensure popular participation, in both the countries, is the 'forest committee', which is supposed to work in

collaboration with the Panchayats. The Village Forest Workers (VFW) in each village are responsible for undertaking all the functions of social forestry. All the decisions regarding social forestry are made at the highest levels and the VFWs employ labourers from the community for planting and protecting trees. Even a minor decision made at any level of hierarchy in the FD must have approval of the highest authority.

At the beginning in Nepal the Panchayats in general and 'forest committees', in particular, were to ensure popular participation. The committee generally consisted of representatives from Panchayats, forest officials and beneficiaries of the projects. There was a major idealistic policy shift in favour of the local community involvement but it seemed to have little impact on the field. In some places it did not necessarily represent the real users of an individual forest. The forest committees were created by external suggestions as an 'efficient' way of managing forests, thus these committees were ineffective, unrepresentative and had no authority or responsibility (Hobley 1991). The people rarely participated in the planning of establishment of nurseries, and plantations or management of the forest (Gronow and Shrestha 1991:3).

In the recent past, especially since the abolition of Panchayat system in 1990, definite progress in the establishment of community forests has been made in Nepal. The new system recognized existing forest user groups comprised of people sharing mutually recognized claims to use specified forest resources (Bartlett and Malla 1992). These groups thus can make operational plans based on the indigenous forest management system for regeneration, management, and utilization of forest land. The effectiveness of this programme is, however, yet to be seen.

The poor people in general either in India or in Nepal were not a part of the overall management and implementation process of participatory forestry. The women irrespective of their income and status in society, were barred from even the minimal participation available for the males (Nesmith 1991). The women's participation was limited to weeding and transplanting tasks, and the collection and transportation of fuel-wood. They were not an active member of the overall implementation work (FAO 1989). Women in south Asia in general naturally have more attachment to trees and forest than men, but in India and Nepal they are excluded from participatory forestry. Thus the forestry programmes undertaken in India and Nepal abandoned the values of the people and the society in general.

Factors Responsible for Limited Participation

Institutional

Participatory forestry demands special types of skills, knowledge and aptitude, which are significantly different from classical forest management in terms of value orientation and management practices. These factors are still absent in the forest management system in India and Nepal. Forest departments (FD) in these two countries thus have not been successful in performing their designated roles of forest conservation, and regeneration with community involvement for public welfare.

Local bureaucrats in India for their own benefits preferred to implement a policy for their procedural obligations, rather than for its policy intent. The implementation network provided by the programme guidelines was easily alterable to favour the local elite against the masses (Khator 1985:149). In fact, no programme in India has been diverted away so much from its objectives than the social forestry programme. The FD officials failed to build up good relationships with the village people, though it was essential for the success of participatory forestry. The FD officials in India did not relish the new role forced upon them of accepting the rural poor as partners in forest management. In some areas the villagers were also sceptical of this partnership. For example, in some places they did not let the forest officials afforest their common lands, because they were afraid the FD may later claim ownership of the afforested land.

In Nepal the FD has continued to follow their 'policing role' and has been 'tree-oriented and not 'people-oriented' (Agarwal and Hobley 1991). Institutional incapability was in fact the root cause of the failure of the nationalization of forest programme and still remains equally threatening to community forestry (Gronow and Shrestha 1991). In spite of the prevalent bureaucratic character of the state FDs, however, most of the forest officials in these countries are said to be reluctant to be involved in social forestry programmes to give up 'power, influence, and the chances of making extra money' (Jayaraman 1987:14). The bureaucratic mentality of the FD offi-

cials and the lack of reorientation training in the new approach of forest management away from traditional forest bureaucracy were responsible for this failure.

Procedural

The plethora of rules and procedural formalities which guide the operation of the forestry groups are normally beyond the capacity and understanding of the common villagers. As a result, the general people were not involved in the identification of needs and project design, so they did not have any interest in implementing any project.

The participatory forestry groups tend to represent and maintain local patterns of power and interests and the 'wealthier members of the village usually have the dominant voice in decisions . . .' (Foley and Barnard 1984:120). At the policy level, there have been some gross misconceptions, as regards the 'community' and 'committees'. The policies assumed that:

- community is an undifferentiated entity and united for common action;
- has undifferentiated access to natural resources in a given territory;
- all the individuals would benefit equally from tree-planting programmes;
- committees would be able to determine and execute their rules independently (Cernea 1991).

In reality, proper representation of different classes and factions rarely occurs in these committees. The committees are semi-functional or even dysfunctional. Sometimes their formation is 'simply a bureaucratic requirement' and majority of villagers remain 'unaware of its existence or of its members' (Arnold *et al.* 1990:40).

In India almost 96% of forests are owned by the government. The FD has a tendency to emphasize revenue generation for the department. This aspect results in less participation by the people and thus poor replantation (Bowonder *et al.* 1987). At least 69 species were listed for planting but only two, babul (*Acacia nilotica*) and Eucalyptus, dominate. The FD, however, persisted with eucalyptus even when the villagers demanded casuarina, because of its suitability as fuel-wood (Agarwal and Narain 1985:56). The small growers did not like eucalyptus because, they have to wait for at least four to five years to harvest. Further, it competes for water and other nutrients with crops in its vicinity The forest officials saw it as a good source of cash income and irrespective of regions and soil conditions advocated eucalyptus plantations. The farmers had to find out themselves that eucalyptus is not suitable for dry land and land without irrigation facilities (FAO 1989:47). Local people in different communities not only were apprehensive of the new approach, in some places they tried even to block the activities of 'user groups'. The community was unable to trust the government bureaucracy. The local people also did not see any real benefit that may derive out of their involvement in the government or external sponsored community forestry programme. The government policy and operational guidelines alone failed to provide enough incentive or reason for a community to participate in the government's community forestry programmes.

Economic

In India the FD's structure, system, training of work force, procedures, and planning pivots around the 'major forestry produces', i.e. timber (Chambers 1983; Sarin 1981). The management and development of 'minor forestry produce', i.e. non-timber products like leaves, seed, gum, honey and the associated people become secondary to the FD. These small growers thus kept themselves aloof from participatory forestry programmes.

Heterogeneous village communities with different economic interests is one of the main reasons for the poor performance of participatory forestry in India. Different economic interests led to disputes amongst the farmers concerning the availability of village common land for the establishment of village woodlot. For example, everybody, except the cattle-owning landless households, are in favour of woodlots on village common lands. The cattle-owning landless people fear that the woodlots may reduce further the availability of grazing lands, block ancient rights of passage for carts, and reduce the supply of brushwood (Agarwal and Narain 1985:56).

In West Bengal India, the landless do not get the title to the land, but they are given full right to the usufruct of the trees they plant. The FD officials also show little interest in these schemes and tribal families are reluctant to take advantage of them for fear of getting into trouble in the long run. The participatory forestry programme, without going for any fundamental institutional change, expected an unre-

alistic degree of collaboration between villagers who use forests and the FD personnel who police them (Agarwal and Narain 1985:59).

Most of the tanks in India besides which trees are to be planted are under the legal possession of the Panchayats. In many instances the village Panchayats refused to offer their lands for forestry programme (Foley and Barnard 1984:111). At the primary stage all the plantation schemes were planned and managed by the FD. The FD also had complete control over the proceeds from the tree plantation. Thus the Panchayats did not want to take the risk of losing the possession of these land, without at least some economic benefit. Realizing this fact, the FD later on introduced 50% profit sharing with the Panchayats. The Panchayats thereby got involved in the implementation and management of strip plantations on the side of these tanks.

The FD in India introduced the community forestry or the 'Village Self-Help Scheme', which allowed all the responsibilities of tree planting on the community with the FD responsible only for providing with free seedlings and technical assistance. This programme also failed to achieve its targets, because of the shortage of required funds for labour payment and protection of the plants.

Political

In some places, e.g. in Gujrat and Tamil Nadu (India), the initiative of the forest officials in transferring additional responsibilities for plantations was opposed by the members of the local communities in favour of the existing system. The community argued that if the FD keeps the responsibility of plantation it saves the community from (1) getting into disputes in the distribution of works related to planting; (2) identifying the person responsible for any mishaps; and (3) keeping an eye on the members of their own groups engaged any pilferage (Foley and Barnard 1984:121).

The community forestry in its true form has been existent in Nepal for a long time. The problem associated with the present governmental efforts is that it is being imposed from outside and it is not in sympathy with the existing systems of indigenous common property resource management system. At the early stage the concept involved a partnership between the FD and the community. In the system the management and protection of these forests would be sustained by the local communities and any profit derived from the forests could be used for the welfare of the community concerned. The introduction of a new system giving the FD excessive authority to become a law and policy enforcing agency created definite mistrust among the local people about the 'true' motives of 'community forestry'.

Attitudinal (FD Officials)

Bureaucratic connivance and corruption, harassment of local people by petty officials, collaboration with commercial traders and/or contractors with ulterior ends are identified as some of the characteristic features of FD in south Asian countries (Chambers *et al.* 1989; Fernandes *et al.* 1988:323). Many studies show the major institutional and attitudinal drawbacks of the FDs. The principal shortcomings of these forest departments are: (1) a purely bureaucratic attitude to the forests; (2) alienation from the people; (3) treating deforestation as a technical problem; and (4) conservation orientation towards forest resources (Nadkarni 1989). All these factors affected the implementation programme of participatory forestry.

EFFECTS OF PF ON DIFFERENT INTERESTS IN SOCIETY

In the context of participatory forestry projects there are three groups of stakeholders (Table 1). The need, importance and implications of participatory forestry is different for different stakeholders based on their perspectives and interests.

There are significant differences between the attitudes of local elites and those of general people towards forests, because the major beneficiaries of forest resources are the richer class (Nadkarni 1989:164). For common rural people the village plantations 'represent too expensive and too luxurious a resource in themselves and indeed remove rather than create a valued local resource' (Arnold *et al.* 1990:5). There are a number of cases where alienation of the local poor from the forest is evident. Traditional forest dwellers in Nepal used to treat forests as 'life support system', to which they claimed open access. Being superseded and defeated by commercial interests, they changed their attitudes and tried to maximize exploitation and 'from a culture of a mutually supportive community (they) began to go more and more towards individualism' (Fernandes *et al.* 1988:323).

Table 1
Different Stakeholders in Social Forestry

Stakeholder	*Characteristics/Nature*	*Interests*
Local	Sees forest as a source of shelter, food, and fuel-wood	Use forest beyond formal economy Get marginal benefits based on the volume of resource under control
Government	'Regulator', balancing	Welfare and motivation between 'protection' and 'conservation'.
Industrial/Commercial	Sees forest as a source of raw material	Profit-motivated actions

Based on Nadkarni (1989:160).

In some states in India the interest of the state government deprives local people of adequate benefits. For example, in Orissa, the state government provides 51% of the funds for social forestry, the rest comes from external sources (i.e. SIDA) through the central government as loan. The social forestry agency of the state government then give part of the produce to the village, market the rest and use the profits to pay off the loan. The government do not see any thing wrong in combining social objectives of social forestry with commercial motives (Jayaraman 1987:15).

In many cases commercial interests override all other parties involved in Indian forestry. These interests may take different forms or magnitude, e.g. a local elite controlling market dynamics almost in a monopolistic manner or an urban-based sawmill owner, furniture and timber trader, a local tout in close 'understanding' with and proximity to the local forest offices.

Among these competing local, governmental, and commercial interests, obviously, the powerful forces supersede and manoeuvre the process towards their ends. The needs of the people and of the environment contradict with those of the industry and revenue. The interests of the more powerful groups, mainly industry and state predominate and the general people suffer (Fernandes *et al.* 1988:344).

Chambers *et al.* (1989) illustrates the main gainers and losers of social forestry. Economic and political elites are the main gainers of the participatory forestry programmes. Whereas, weaker sections, e.g. grazers sustain maximum losses. Grazing lands are taken away by the government and planted with non-browsable species. Due to lack of participation, in most of the Indian states, the survival rate of plants in programmes like 'strip plantation' on railway/road/embankment sides are 40–60%. Local people are generally indifferent to these programmes; sometimes they are even hostile to the plantation (Shah 1988:3). To tackle this problem the West Bengal government has handed over the 'strip plantation' to Gram (Village) Panchayats (councils) to nurture, protect, harvest, and replant trees. The Panchayats are allowed to keep the entire revenue as well.

The FD places a high priority on the meaningful use of common property resources (CPR), like village lands, uncultivated communal lands, grazing lands, for the maximum benefit to the community. In reality, however, the structure of most plantations on CPRs reflects FD's rather than local preferences and priorities (Arnold *et al.* 1990).

It is women in the rural households who are responsible for collecting fuel and fodder for everyday use. The male orientation of participatory forestry, ignoring the contribution of the women in society has turned it to cash generating rather than basic needs generating exercises (Agarwal and Narain 1985:57). Non-cash benefits and ecological gains of farm forestry became secondary for the forest officials and thus to the farmers (FAO 1989).

The mechanisms of the informal wood market like other crops were not favourable to small, unorganized growers. It favoured large growers. In some places, however, there were organized cooperatives for selling and ensuring a fair price for other products. The community forestry programmes failed to establish such a marketing mechanism. The benefits from forestry thus goes mainly to the larger growers, middlemen, or the dealers of wood and wood products.

The selection of plants and trees to be raised aroused some problems for participatory forestry in

south Asia. The FD officials through exaggeration of facts about benefits of Eucalyptus pushed the expectation of the individuals so high that at the beginning saplings of plants other than Eucalyptus were wasted in the government nurseries (Khator 1991:146). Finally, the yield, being much less than they had expected, brought them great disappointment.

From the policy stand point eucalyptus farming was a blow to the primary objectives of the programme. Eucalyptus was unable to meet food, fuel and fodder needs of the local people — its leaves were not palatable to animals and branches were too few to provide a substantial fuel base. Further, since the plant required minimal maintenance, it did not create new job opportunities for the local people. On the contrary, rather it helped shrink the labour market, through the inclusion of irrigated crop land under its production. Shifting of every hectare of cropland to Eucalyptus reduced the labour market by 150 person-days per year (Jain 1985). This shift affected the pattern of farming and supply of essential or basic survival commodities — cereal or cotton. In addition, eucalyptus had an adverse effect on the physical environment. These trees weakened the long term capacity of soil. Due to its heavy planting and root structure it extracts a large quantity of nutrients in a relatively short period of time and damages the soil permanently (Khator 1991:146–7).

CONCLUSIONS

Participatory forestry, as a distinct forest management practice, has great potential in the face of present state of crisis in the forest sector in India and Nepal. Its contribution and performance so far, however, has not been very encouraging, because of (1) the inability of the policy makers and the practitioners to appreciate the specific contextual realities of the society; (2) the introduction of participatory forestry through existing local government institutions when these institutions already had failed in supporting participatory development practices; (3) the absence of an overall policy guidance and political commitment at the macro and micro level; and (4) the institutional and attitudinal incompetence of the FDs.

In the long run, in highly class differentiated societies like India or Nepal, some degree of corresponding change in the socio-economic-cultural fabric is also necessary for the sustainability of any participatory programme and for ensuring involvement of the hitherto excluded weaker sections. Popular participation in forestry can only be realized through the creation of truly representative local organizations. A fair representation of women in these local organizations will also have to be achieved. Mere representation of women in the community organizations itself, however, will not bring about desired changes in the participatory procedures. Male members of the groups have to be committed and sincere to affect a fruitful 'participation'.

With the relative advantage of power, legitimacy, and discretion, the FD has to take the initial responsibility to facilitate and motivate the process of creating a 'participatory environment' which is vital to the success of participatory forestry. In the face of the obvious failure of the classical mode of forest management, a reorientation of the FD and a commitment towards its role in gradual 'empowerment' of local units, is the need of the time. This process of reorientation must be supported by corresponding changes in other government agencies which are intimately related with forest management (like the magistracy, police, land and Revenue administration).

NOTE

1. The collective works by the people concerned to pull their efforts and resources to achieve the objectives set by themselves are defined as 'active participation'. 'Passive participation' is involvement of people in actions thought out and designed by others.

REFERENCES

Association of Development Agencies in Bangladesh (ADAB). 1992 Environment and Development: Bangladesh NGOs Perspective on Policy and Action, A Position Paper for UNCED (RIO, June 1992).

Adhikari, J. 1990. Is Community Forestry a New Concept? An Analysis of the Past and Present Policies Affecting Forest Management in Nepal. *Society and Natural Resources* 3:257–66.

Agarwal, A. and Narain, S. 1985. *The State of India's Environment 1984–85: The Second Citizen's Report.* New Delhi: Center for Science and Environment.
Agarwal, D. 1991. *Cold Hearths and Barren Slopes: The Woodfuel Crisis in the Third World.* London: Zed Books.
Arnold, J.E.M. 1989. Beyond Community Woodlot: Programmes With Participation. Social Forestry Network Paper No. 11e. London: Overseas Development Institute.
Arnold, J.E.M and Stewart, W.C. 1988. *CPR Management in India: Report to the Agriculture Division.* Washington, D.C.: World Bank.
Arnold, J.E.M. *et al.* 1990. *Evaluation of the SIDA Supported Bihar Social Forestry Project for Chotanagpur and Santhal Parganas, India.* Stockholm: Swedish International Development Agency.
Bartlett, A.G. and Malla, Y.B. 1992. Local Forest Management and Forest Policy in Nepal. *Journal of World Forest Resource Management* 6:99–116.
Bhattarai, T.N. 1990. Community Forestry and Research Initiatives in the South Asia Sub-Region. *Research Policy for Community Forestry in Asia Pacific Region Seminar Proceedings.* Bangkok: RECOFTC.
Bowonder, B., Prasad, S.R.R and Unni, N.V.M. 1986. Fuelwood Prices in India: Policy Implications. *Natural Resources Forum* 10(1):5–16.
Bowonder, B., Prasad, S.R.R. and Unni, N.V.M. 1987. Afforestation in India: Policy and Strategy Reforms. *Land Use Policy* 4(2):133–46.
Cernea, M.M. 1985. *Putting People First: Sociological Variables in Rural Development.* New York: Oxford University Press for the World Bank.
Chambers, R. 1983. *Rural Development: Putting the Last First.* New York: Longman Scientific and Technical.
Chambers, R., Saxena, N.C. and Tushaar Shah. 1989. *To The Hands of the Poor: Water and Trees.* New Delhi: Oxford and IBH.
FAO. 1989. *Case Studies of Farm Forestry and Wasteland Development in Gujrat, India.* Bangkok: FAO Regional Office for Asia and the Pacific.
Fernandes, W. *et al.* 1988. *Forest, Environment, Tribal Economy: Deforestation, Impoverishment, and Marginalization in Orissa.* New Delhi: Indian Social Science Institute.
Foley, G. and Barnard, G. 1984. *Farm and Community Forestry.* London: Earthscan and International Institute for Environment and Development.
Gilmour, D.A., King, G.C. and Hobley, M. 1989. Management of Forest for Local Use in the Hills of Nepal: Changing Forest Managing Paradigms. *Journal of World Forest Resource Management* 4:93–110.
Gronow, J. and Shrestha, N.K. 1991. From Mistrust to Participation: The Creation of a Participatory Environment for Community Forestry in Nepal. *Social Forestry Network Paper No. 12b.* London: ODI.
Hobley, M. 1991. From Passive to Active Participatory Forestry: Nepal. In *Projects with People: The Practice of Participation in Rural Development* (ed P. Oakley), 112–4. Geneva: ILO.
Jain, L.C. 1985. *Grass Without Roots: Rural Development Under Government Auspices.* Sage: New Delhi.
Jayaraman, K.S. 1987. *Trees for the Poor.* London: The Panos Institute.
Kanel, K. 1993. Community Forestry and the 1993 Legislation: Implications for Policy and Implementation. *Banko Janakari* 4(1):2–5.
Khator, R. 1991. *Environment, Development and Politics in India.* Lanham: University Press of America.
Mahat, T.B.S., Griffin, D.M. and Shepherd, K.R. 1986. Human Impact on Some Forests of the Middle Hills of Nepal. 1: Forestry in the Context of the Traditional Resources of the State. *Mountain Research and Development* 6(3):223–32.
Nadkarni, M.V. *et al.* 1989. *The Political Economy of Forest Use and Management.* New Delhi: Sage.
Nesmith, C. 1991. Gender, Trees, and Fuel: Social Forestry in West Bengal, India. *Human Organization* 50:337–48.
Nickson, R.A. 1986. The Integrated Rural Development Programme of India. Papers in the Administration of Development. DAG, University of Birmingham.
Oakley, P. and Marsden, D. 1984. Approaches to Participation in Rural Development. Geneva: ILO.
Sharad Sarin. 1981. Management of Minor Forestry Produce: Perspective and Alternative Frameworks for Research and Analysis. *Indian Forester* 107:397–411.
Sen, D. and Das, P.K. 1987. *The Management of People's Participation in Community Forestry: Some Issues.* Social Forestry Network Paper 4d. London: Overseas Development Institute.
Shah, T. 1988. Gains from Social Forestry: Lessons from West Bengal. *Discussion Paper No. 243.* Brighton: IDS. University of Sussex.
Shepherd, G. 1990. Forestry, Social Forestry, Fuelwood and the Environment: A Tour of the Horizon. *Social Forestry Network Paper No. 11a.* London: Overseas Development Institute.
Shepherd, K.R. 1981. The Nepal-Australia Forestry Project. *Australian Forester* 44:210–21.
Stevens, M. *et al.* (Eds.). 1990. *Research Policy for Community Forestry in Asia Pacific Region, Seminar Proceedings.* Bangkok: RECOFTC.
Task Force. 1987. Participatory Forestry in Bangladesh: Concept, Experiences, and Recommendations. A Task Force Report to the Ministry of Agriculture, Government of Bangladesh.
World Bank. 1993. *World Development Report, 1993.* New York: Oxford University Press for the World Bank.

Air Pollution Control in Hong Kong

Edward J. Epstein

ABSTRACT

In 1983, Hong Kong replaced the Clean Air Ordinance with what was supposed to be a more progressive law on air pollution control. Ten years later, however, it was clear that the Air Pollution Control Ordinance (APCO) had achieved little and this was the result of a number of legislative deficiencies in the legislation which had been apparent from the very beginning. Air pollution and air quality were too narrowly defined. APCO was too generous in exempting from regulation certain obnoxious air polluters and was limited to atmospheric air pollution from stationary sources and did not address health and safety in the workplace. Finally, maximum fines for air pollution were too low and actual fines imposed were often laughable.

The Air Pollution Control (Amendment) Ordinance was thus enacted in 1993 and attempts to address most of the deficiencies in the existing law. In particular, the new law creates a regime for the control and abatement of asbestos. It also redefines air pollution and introduces technical memoranda for discharges. The generous exemptions to existing polluters have been withdrawn and the maximum fines have been increased. Imprisonment has also been introduced as a penalty for some offences and corporate officers and managers can now also be penalised for air pollution discharged by their companies. The new law is thus an important technical improvement but enforcing the law and imposing deterrent sentences is a problem of prevailing attitudes to environmental pollution in Hong Kong which cannot be changed by the stroke of a pen.

Keywords: *environmental legislation, environmental law, air pollution, Hong Kong*

INTRODUCTION

In 1983, Hong Kong enacted the Air Pollution Control Ordinance (APCO) which was the third part of a package of environmental legislation designed to deal systematically with the territory's declining environment.[1] APCO was supposed to be a 'modern' law designed to replace the 'old' Clean Air Ordinance which was based on Britain's Clean Air Acts and considered to be too 'old fashioned' to deal with Hong Kong's growing air pollution problems. In fact, despite its pretensions to modernity, APCO was in itself little, if any, improvement on the existing law (Epstein 1983). Despite three sets of mostly minor amendments in the ten intervening years,[2] the efficacy of APCO has been dependent on a body of subsidiary legislation dealing with, literally, the nitty gritty of Hong Kong's air pollution problems from the construction of furnaces and ovens to the quality of smoke which they produce and, most recently and importantly, the type of fuel which they may use.[3]

In 1993, out of 231 convictions for air pollution offenses, more than half (141) were for excessive dark smoke emissions under the Air Pollution Control (Smoke) Regulations the requirements of which

Edward Epstein, Practising Solicitor, Hong Kong, and the Department of Law, The University of Hong Kong, Pokfulam Road, Hong Kong, Tel (852) 2859–2966, Fax (852) 2559–3543.

are little different from the obsolete Clean Air Ordinance. The average fine was HK$6337 and ranged from HK$1500 to the maximum of HK$20 000. About 20% (52) were for the unauthorized installation or alteration of furnaces, ovens and chimneys under the Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations which were first enacted under the Clean Air Ordinance in 1972. The average fine was HK$2565 and ranged from as little as HK$500 to HK$7000. The maximum fine, increased in 1990, is HK$50 000. Overall, the average fine for air pollution offences in 1993 was only HK$5261. As this figure includes fines for repeat offences, the average for first offences is even lower.

Even Government in Hong Kong has recognized that it has not been able to achieve its often modest air quality objectives through APCO. In its 1994 report, the Environmental Protection Department (EPD) revealed that average concentrations of Total Suspended Particulates exceeded the yearly Air Quality Objectives at five out of seven monitoring stations in 1993 (EPD 1993:123–4) Objectives for Respirable Suspended Particulates were exceeded at three monitoring stations. However, nitrogen dioxide levels were slightly improved in 1993 although daily Air Quality Objectives were still exceeded in Mongkok (EPD 1993:123–4). For the first time in several years, however, sulphur dioxide levels were within daily and yearly objectives throughout the territory.

The purpose of this article is to outline the deficiencies in the existing law and how far the recent changes go to remedy them. It will be shown that there have been sound technical improvements to the legislation, such as redefining 'air pollutant nuisance', as well as making a long overdue expansion to its scope, such as extending the law to motor vehicle emissions and certain previously exempt obnoxious polluters, and to the control and abatement of asbestos. Notwithstanding improvements to the legislation, however, effective enforcement continues to be hampered by the light penalties imposed on polluters. This is partly a problem of the criminal law's traditional use of fines which do not deter commercial polluters who write them off as a cost of doing business. Primarily, however, it is a problem of Hong Kong's prevailing fatalistic attitude to the environment which is only reflected in the general body of the judiciary but which is beginning to show signs of change.

PROBLEMS WITH THE EXISTING LAW

At the time APCO was first enacted, as well as in the course of its enforcement, several deficiencies in the law became evident. First, for the purposes of abating air pollution APCO's narrow definition of 'air pollutant nuisance' was little, if any, improvement on the 'smoke nuisance' regulated by the Clean Air Ordinance (Epstein 1983:368–72). It was not wide enough to address the extensive problem of dust emanating from construction sites. It did not directly address the problem of odours. And it did not clearly deal with the problem of micro-scale air pollution, that is, where air pollution affects people in the workplace or persons in the vicinity who do not constitute 'inhabitants of the neighbourhood'.

Secondly, the implementation of APCO was frustrated by a lack of emission standards by which vague air quality planning objectives were to be achieved. Air quality objectives have been set and it is the authority's duty to achieve them but, as with the Water Pollution Control Ordinance before it, APCO provided no means to lay down detailed and objective emission standards which dischargers should observe. Instead, emissions were regulated on the basis of outdated 'dark smoke' provisions, 'air pollutant nuisance' or the famously capricious formula of 'a greater quantity of air pollutant than need be' which any authority would obviously be reluctant to enforce.

Thirdly, APCO was unduly generous in 'grandfathering' existing emissions from 23 types of industrial polluters called 'specified processes' (Air Pollution Control Ordinance First Schedule). These 'specified processes' were required to take measures to limit emissions and were subject to licensing but existing polluters were granted exemptions. This has meant that provided their emissions did not change existing specified processes continued to enjoy their exemption.

Fourthly, APCO was limited to stationary sources of air pollution. Vehicular emissions were for a long time only regulated by the Road Traffic (Construction and Maintenance of Vehicles) Regulations (1983 ed.). In fact, these Regulations were still relied on in 1992 to test the 44,426 vehicles with smokey exhaust, of which about 2500 had their licences cancelled for non-attendance or multiple failure of the test. More recently, the introduction of unleaded motor vehicle fuel, the regulation of its use and regulation of motor vehicle emission stand-

ards has been assisted by the making of the Air Pollution Control (Motor Vehicle Fuel) Regulation (1994) and the Air Pollution Control (Vehicle Design Standards) (Emission) Regulations (1992). Emissions from ships are regulated by the Shipping and Port Control Ordinance. It was, therefore, impossible to take a comprehensive approach to achieving air quality objectives but this problem has been partially alleviated by the centralization of air control policy, although not enforcement, in the EPD.

Fifthly, and related to the above deficiency, APCO was limited to atmospheric pollution. The air pollutant nuisance included emissions 'prejudicial to public health'.[5] But this provision was not designed to be a mandate to the authority to regulate health and safety in the workplace or protect public health from indoor air pollutants.

Finally, experience in enforcing APCO's criminal provisions has shown that the penalties have been set too low and that Hong Kong's magistrates have been too lenient in penalizing air polluters. In 1993, the average fine for a failure to comply with an air pollution abatement notice or otherwise failing to take reasonable steps to prevent an unnecessary air pollutant nuisance was only HK$3728 which is low even by 1983 standards and has by the course of inflation become ridiculously low today. In one aggregious case in September the fine imposed was only HK$5000 for a seventh offence. In 1993, the average fine imposed for air pollution offenses generally was only HK$5261. Such small fines are easily absorbed by most polluters as part of their operating costs but recover little of the public cost of prosecuting these cases let alone the cost to the environment as a whole. Of course, this is merely one illustration of a more general problem in the enforcement of Hong Kong's pollution laws.[6]

THE AIR POLLUTION CONTROL (AMENDMENT) ORDINANCE 1993

In the light of these six major deficiencies, an overhaul of APCO was conducted and in February 1993 the Air Pollution Control (Amendment) Ordinance 1993 was enacted.[7] The Amendment Ordinance effects the first major amendments to APCO in ten years and attempts to address most of the deficiencies discussed above.

Control of Asbestos

The most important change to APCO is the addition of Parts 8 and 9 (ss. 51 to 80) which create a regime for the control and abatement of asbetos in premises throughout Hong Kong. Part 8 may be described as administrative. It establishes the machinery for administering a register of asbestos consultants, contractors, supervisors and laboratories whose functions will become clearer from the discussion of asbestos control below. This is more than a ministerial function because it gives an administration committee the authority to advise the authority who qualifies for registration, to make recommendations on the discipline registered persons and ultimately their removal from the register after a disciplinary hearing. No appeal from disciplinary proceedings is provided for but neither is there any attempt to exclude the right to judicial review.

Part 9 contains the central provisions on asbestos regulation. Section 69 establishes duties on the owners of certain premises which contain or may reasonably be suspected of containing asbestos to engage a registered asbestos consultant to carry out an investigation, to report on the existence of asbestos and, if any is found, to plan its management and/or abatement. Premises will be regulated according to three situations. Sub-section 69(1) imposes on the owners of all premises the blanket duty, discussed above, to report and, if necessary, abate asbestos. However, this is qualified by subsequent provisions so as to permit the gradual implementation of asbestos abatement, starting with those premises which are used by the most vulnerable sections of the public. It is EPD policy to commence enforcement in hospitals and schools. Some premises will be exempt, where the Secretary of Planning Environment and Lands ('the Secretary') so classifies them by notice in the Gazette. These are likely to include the owners of most residential and commercial premises for the time being. The duty of owners of other specified premises will be limited, initially, to engaging a consultant to investigate the existence of asbestos and then, if any is found, to report and plan its management or abatement.

Sections 70 and 71 stipulate the content of the abestos investigation report and the management plan respectively. The investigation report is essentially a statement of the methods used to investigate the premises, what was discovered, an assessment of the hazards and the impact on people and their ac-

tivities in the immediate vicinity. The management plan consists of an 'operation and maintenance plan' and an 'abatement plan'. The former explains why the asbestos material should not be removed and how it will be maintained so as to mitigate its impact. The latter sets out a programme for the safe removal and disposal of the asbestos material.

There is a drafting anomaly between section 69 and sections 70 and 71. Although the last two sections clearly intend for reports and plans to be made on premises located on land and ships, section 69, in imposing the duties on owners to report and plan on asbestos only refers to owners of 'premises'. Further, the definition of 'premises' in the amended section 2 does not expressly include ships but only refers to 'a place, building or relevant plant'. Are shipowners under a duty to engage a consultant to investigate and report on asbestos materials used in ships in Hong Kong waters? It would seem not, if 'premises' are to be construed narrowly. This seems inconsistent with the intention expressed in section 70 and 71 and seems to be the unfortunate result of poor drafting.

Asbestos investigation must be carried out by a registered asbestos consultant and samples must be tested at a registered asbestos laboratory. Abatement must similarly be carried out by registered asbestos contractors under the supervision of a consultant. The EPD must be notified of proposed asbestos abatement work at least 28 days before it is to commence and may require additional measures or impose additional conditions considered necessary to the abatement plan. The owner of premises may, however, appeal against the imposition of such measures or conditions.

Apart from the systematic control of asbestos, Part 9 also contains provisions for the issue of asbestos abatement notices in other cases where asbestos may pose a threat to public health (s. 79). Further, it imposes a ban on the import into Hong Kong of any asbestos known as amosite and crocidolite, except where it is in transit or for transshipment (s. 80).

Penalties for offences in Part 9 are quite heavy, ranging from a maximum fine of HK$200 000 plus a daily fine of HK$5000 for owners who fail to fulfill their investigation, reporting and abatement duties to a hefty maximum fine of HK$500 000 and 12 months' imprisonment for owners or contractors who ignore an asbestos abatement notice. These penalties must be read in conjunction with the new provision for personal liability of corporate officers which is discussed below. In the first prosection under this part . . .

Air Pollution Redefined

While APCO failed to confront air pollution caused by odour and dust as well as the micro-scale air pollution problem, the Amendment Ordinance has tackled these issues by redefining air pollution and setting out the factors which the authority may take into account in determining what is air pollution. First, the definition of 'air pollutant' is expanded to include 'objectionable odour'. Secondly, 'air pollutant nuisance' has been redefined into 'air pollution' and 'nuisance' respectively. The old definition did not extend liability to abate a micro-scale air pollution problem because it was limited to a 'nuisance *to the inhabitants of the neighbourhood*' [emphasis supplied]. The italicised words have been deleted by the Amendment Ordinance so that even where the air pollution is merely a nuisance between neighbours the discharger will be liable to abate it. 'Nuisance' has been given a legislative definition in addition to the rather old-fashioned and arbitrary meaning given by the courts. It is defined as including 'an event which is obnoxious and results in any of the effects set out in section 10(2)(h)' which is discussed below.

Further, the definition of 'air pollution' has been expanded to include an emission which 'is determined to be air pollution under a technical memorandum', that is, a set of standards established by law which restrict emissions with reference to objective criteria. The importance of the introduction of technical memoranda into air pollution control is discussed below.

In tandem with the redefinition of air pollution and nuisance, section 10 has been replaced with a new provision on the abatement of air pollution which clearly enumerates the information or effects the enforcement officer may take into account in deciding whether an emission constitutes air pollution. The officer's discretion is defined so broadly, in fact, it is hard to conceive of a situation where an unsafe or reasonably objectionable emission cannot be called air pollution. In particular, the officer may take into account 'research material results or publications which indicate that the type of emission may have adverse health effects', the advice of a medical practitioner', and, in section 10(2)(h) 'any of the following effects . . .

(i) the deposit of dust, grit or particles of any kind;
(ii) an objectionable odour;
(iii) the staining of, corrosion or damage to, a building, plant, equipment or other material;
(iv) the irritation of the eye, nose or skin or any other sensory discomfort;
(v) the disturbance of normal activities by the colour or opacity of the emission;
(vi) an effect which in the opinion of the Authority or an authorised person may affect public safety; or
(vii) any other effect which in the opinion of the Authority or an authorized officer is unreasonable for a member of the public to suffer.'

It will be recalled that these effects are also elements of the definition of 'nuisance' arising from air pollution. In this way, the meaning of air pollution which invites an abatement notice must be found in the statutory definition of air pollution, nuisance and the information and effects enumerated in subsections 10(1) and (2). These efforts to redefine air pollution may not make easy reading but will hopefully prove to be more a more accurate and effective basis to order the abatement of emissions.

Technical Memoranda

Technical memoranda are detailed standards for effluents or emissions prepared by the EPD and issued by the Secretary for Planning, Environment and Lands with the approval of the Legislative Council. They are designed to provide a set of technical standards through which to achieve the environmental quality objectives set by Hong Kong's various environmental laws. They fill an important gap left by the currently vague or simply non-existent standards for emissions and discharges.

In Hong Kong, the use of technical memoranda was first established by the Water Pollution Control (Amendment) Ordinance (No. 67 of 1990 Cap. 358) and the first technical memorandum was issued in January 1991 (EPD 1991). It prescribes in elaborate scientific detail what substances are prohibited in effluent, the maximum levels of those substances which are permitted in effluent and various other characteristics of the effluent such as its acidity, temperature and colour. It also sets out the analytical methods to be used to test for these substances and characteristics.

In a similar way, technical memoranda for emissions into the air should assist the authority in achieving the Air Quality Objectives long established under APCO which have in many cases proved all too elusive (EPD 1993:123–4). As has been mentioned, under the Amendment Ordinance the definition of air pollution has been expanded to include emissions which exceed the limits prescribed by a technical memorandum. Of course, section 10 also permits an enforcement officer to take the technical memorandum into account in determining whether an emission constitutes air pollution.

Removal of Exemptions for Specified Processes

It is characteristic of all Hong Kong environmental legislation enacted in the 1980s that the status quo be upheld and existing polluters be granted generous exemptions or licences to continue to pollute the environment with little or no abatement. In APCO, this phenomenon manifested itself in the exemptions from licensing, and thus effectively from regulation, granted by section 20 to existing 'specified processes', that is, 23 types of industrial polluters which produce noxious or offensive emissions and were already in operation or being developed for operation at the time this part of APCO took effect in 1987. 'Specified processes' are listed in the First Schedule.

In contrast, environmental amending legislation in the 1990s is gradually undoing these generous exemptions and replacing them with licences by which discharges may be strictly monitored and standards enforced. The Air Pollution Control (Amendment) Ordinance has added section 20AA which empowers the Secretary to remove an exemption (s. 20AA(1)) from the owner of a specified process without compensation (s. 20AA(4)) and require the owner to apply for a licence (s. 20AA(2)). In 1991, of a total of 146 factories operating specified processes only 42 were licensed (EPD 1993:50–1). Having gained the legal authority, it remains to be seen whether the administration will have the political will to take on these remaining 104 industrial polluters.

Tougher Penalties

Finally, but most importantly, the penalties for offenses under APCO have been increased. It has long been argued that by penalizing air pollution offences with fines which are on average only about HK$5000 and as low as HK$500 (EPD 1993:123–

4), the law is allowing air polluters to absorb fines into their operating costs. The first step has therefore been to increase fines as, for example, under sub-section 10(7) the maximum fine for failing to cease the polluting operation specified in an air pollution abatement notice has been increased ten times from HK$50 000 to HK$500 000. This may appear to be a hefty increase. In fact, it barely keeps up with inflation since APCO was first enacted in 1983. There is a further fine of up to HK$100 000 (increased from HK$9600) per day for each day the polluting operation continues. Maximum fines in other provisions have been similarly increased. Of course, whether the increased fines will act as a financial deterrent will depend on how rigorously the courts are prepared to impose fines on Hong Kong's industrial polluters who, in the minds of many in Hong Kong today, are still economic heroes rather than the environmental villains.

The EPD once attempted to raise environmental consciousness among Hong Kong's judiciary by giving them a talk on the importance of rigorously enforcing environmental law, but this backfired when a High Court judge criticized a magistrate for heeding the EPD's calls for deterrent sentences when sentencing an individual offender. The need for deterrent sentences 'is a matter for the courts and for the courts alone' chided Keith, J. and the magistrate was therefore not entitled 'to respond to what she was told by those [EPD] officers about the need for deterrent sentences in this area' (*Chan Chi-kuen v. R.* Magistracy Criminal Appeal No. 915 of 1993, 28 January 1994 unreported).

Secondly, penalties for air pollution offences have in some cases been expanded to include a term of imprisonment. For example, sub-section 10(7), discussed above, includes a penalty of imprisonment for a maximum of 12 months. It should be noted under this and other sections, imprisonment is technically possible even for a first offence, although it would be fair to say this would be rare save in exceptionally egregious circumstances.

Unlike other environmental legislation in Hong Kong,[8] APCO has not attempted expressly to exclude the mental ingredient usually required for a criminal offence. Instead, it has been taken for granted that *mens rea* is not required for an offence relating to the emission of an air pollutant and this position is supported by good authority.[9] However, does the substantial increase in fines and the introduction of imprisonment alter the strict liability character of air pollution offences? This question is now particularly relevant in the light of the guarantees of substantive and procedural justice provided by articles 11(1) and 5(1) of the Bill of Rights Ordinance.[10]

It is beyond the scope of this commentary to provide a detailed analysis of the impact of the Bill of Rights on strict liability offences in Hong Kong (Byrnes 1992:194–202), but it should be noted that there is scope to argue that the requirements of justice imported by these provisions assume that there is a mental element in an offence which carries the threat of heavy fines and imprisonment. It may be that the requirements of justice will be satisfied where a strict liability offence incorporates, to use the Canadian expression, a 'due diligence' defence, that is, a provision which allows the accused to negative liability on the grounds that he/she was not at fault because all reasonable steps had been taken to avoid the commission of the offence.[11] Section 48 of APCO provides defences of this nature but limited to the failure of furnaces, chimneys or other relevant plant. Of course, this limitation reflects the narrow focus of APCO when it was first enacted. The legislature's failure to widen the defences to reflect the expanded definition of air pollution in the Amendment Ordinance will no doubt provide fertile ground for legal challenge under the Bill of Rights.

The third and final step taken by the Amendment Ordinance is to create personal liability for corporate officers. As most prosecutions are taken against corporate polluters where a sentence of imprisonment is impossible and a fine may be absorbed into operating costs, the Amendment Ordinance has added Section 47A(1) which provides that:

> Where a person is convicted of an offence under this ordinance is a body corporate and it is proved that the offence was committed with the consent or connivance of, or was attributable to any neglect or omission on the part of, a director, manager, secretary or other person concerned in the management of the body corporate, the director, manager, secretary or other person also commits the offence.

Three matters should be noted in relation to this provision for personal liability. First, the offence under section 47A(1) creating personal liability is dependent on a conviction for the principal offence by a body corporate. In other words, the company's officers can only be convicted if the company has first itself been convicted. Secondly, while the prin-

cipal pollution offenses are presumably based on strict liability,[12] an offence under section 47A(1) incorporates a clear mental element, that is, 'consent or connivance . . . or . . . neglect or omission'. There has been no attempt to remove or shift the prosecution's onerous burden to prove such a mental element and this will surely mean that offences creating personal liability will rarely be prosecuted, and rarely with success. A better alternative would have been to take the Canadian approach where personal liability is also strict but an ample defence of due diligence is available to the accused.[13]

Thirdly, there seems to be nothing to prevent a company from indemnifying one of its officers in respect of a fine imposed under section 47A(1). This practice would, of course, completely subvert the intention of the legislation to impose personal liability. In Ontario, Canada, a court has ordered that a convicted company officer not be indemnified by his company but it seems unlikely Hong Kong's courts could make such an order without legislative authority.[14]

CONCLUSION

There can be no question that the Amendment Ordinance makes important changes to air pollution regulation in Hong Kong but they are, frankly, long overdue. Even so, problems remain. Although expanded in scope, APCO still applies to stationary sources of air pollution.

However, pollution from motor vehicles remains a serious problem. The EPD admits that nitrogen levels remained high in some areas in 1993. Nitrogen, TSP and RSP problems will not go away until motor vehicle pollution, especially the use of diesel fuel, is further tackled. It is anomalous that the power in the Air Pollution Control Ordinance (s. 43(ra)) to regulate emissions from pre-1992 motor vehicles has not been used and the EPD continues to rely on ambiguous and lax provisions concerning 'excessive emissions' in the Road Traffic (Construction and Maintenance of Vehicles) Regulations.

The success of any environmental law ultimately depends on the rigour and integrity of its enforcement. Hong Kong is fortunate to have EPD personnel who are well-trained, diligent and above all committed to solving Hong Kong's pollution problems. The environment would be even better served if the drafting of legislation more accurately reflected the needs of regulation and was more comprehensible to the regulated. The increased penalties for air pollution and other environmental offences should help to deter offenders providing they are rigorously applied.

These recent statements by members of Hong Kong's judiciary may indicate a growing level of environmental consciousness:

> People who are prepared for their own commercial reasons to allow such poisonous concoctions of metals to be released into the water courses are committing graver offences than most criminals I have to deal with. This kind of offence cannot be tolerated in any society nowadays.[15]
>
> The courts must ensure that the penalties imposed adequately reflect the community's determination to protect its own environment . . . and they must ensure that these penalties are a real deterrent against those who list profit above our ecological well-being.[16]

However, the currently low fines, even for repeat offenders, suggest that most Hong Kong magistrates are not too concerned about pollution but it is to be hoped that these words will soon reflect the views of a much wider selection of the judiciary and the general public in Hong Kong.

NOTES

1. Ordinance No. 17 of 1983. The first two ordinances were the Waste Disposal Ordinance (no. 8 of 1980 now Chapter 354 of the Laws of Hong Kong, as amended) and the Water Pollution Control Ordinance (no. 41 of 1980, now Chapter 358, as amended). In 1988, the Noise Control Ordinance (no. 75 of 198, now cap 400 as amended) became Hong Kong's fourth major piece of environmental legislation. Environmental impact legislation, the fifth and final part of the package, is proposed but has never been made. There are, of course, other laws which were not part of the original package but play an important role in regulating pollution in Hong Kong. One example is the Ozone Layer Protection Ordinance which implements Hong Kong's international obligations under the Montreal Protocol concerning the production and regulation of CFCs.
2. Legal Notice 165 of 1984, no. 23 of 1987 and Legal Notice 244 of 1989.
3. See subsidiary legislation, e.g. Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations, Air Pollution Control (Smoke) Regulations and Air Pollution Control (Fuel Restriction) Regulations.

4. For example, Air Control Zones (Consolidation) Statement of Air Quality Objectives LN 1 of 1987 and Legal Notice 389 of 1989.
5. I have argued (Epstein 1983) that this is a species of public nuisance and could not be invoked to regulate micro-scale air pollution which did not affect inhabitants of a neighbourhood. In fact, the EPD has successfully applied this provision to deal with micro-scale air pollution, such as volatile vapours which have escaped into public areas from paint spraying operations. This does not, however, detract from my main argument that APCO was not designed to regulate health and safety in the workplace or public health in general.
6. In 1992, the average fine for water pollution offences was $12 911 and for noise pollution offences it was $9103. See *supra* note 5.
7. Ordinance No. 13 of 1993. To come into operation on a date or dates to be appointed by the Secretary for Planning, Environment and Lands.
8. Compare the Water Pollution Control Ordinance Chapter 358 of the Laws of Hong Kong s. 10 and the Waste Disposal Ordinance Chapter 354 s. 31.
9. See *Alphacell Ltd v Woodward* [1972] AC 824 where the House of Lords stressed the public importance of preventing pollution. On strict liability offences and statutory interpretation generally see *Sweet v Parsley* (HL) [1970] AC 132; *R v City of Sault Ste Marie* (SC) [1978] 85 DLR 161 the approach of which has been followed in Hong Kong, see *Attorney General v Gammon Hong Kong Ltd. and Others* (HKCA) [1983] HKLR 93; (PC) [1985] AC 1.
10. No. 59 of 1991. Art 11(1) Everyone charged with a criminal offence shall have the right to be presumed innocent until proven guilty according to law. Art 5(1) Everyone has the right ot liberty and security of the person. No one shall be subjected to arbitrary arrest or detention. No one shall be deprived of his liberty except on such grounds and in accordance with such procedure as are established by law.
11. *R v Wholesale Travel Group Inc.* (1991) 84 DLR (4th) 161.
12. *Supra* note 10.
13. See, e.g., *R v Bata Industries Ltd, Bata, Marchant & Weston* 9 OR (3d) 329 (Ontario Court Provincial Division).
14. Id. This order does not appear in the reported judgment of Ormston, J. and I am relying on a report in the Smith, Lyons, Torrance, Stevenson and Mayer (Canadian Solicitors), *Environmental Newsletter* April/May 1992.
15. Per Mr. J. Acton-Bond S.M. in sentencing a factory director to a $80 000 fine for water pollution, *South China Morning Post* 20 April 1993.
16. Per Juffy, J., in persuading two defendants to abandon their appeal against fines totalling $560 000 for convictions under the Ozone Layer Protection Ordinance, reported in *South China Morning Post* 16 December 1994.

REFERENCES

Byrnes, A. 1992. *The Impact of the Bill of Rights on Litigation in Law Lectures for Practitioners 1992* (Sihombig ed.) Hong Kong: Hong Kong Law Journal Ltd.

Environmental Protection Department. 1991. *Standards of Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*. Hong Kong: Government Printer.

Environmental Protection Department. 1993. *Environment Hong Kong: 1994* Hong Kong: Government Printer.

Epstein, E. 1983. Air Pollution Control in Hong Kong: Back to Square One? *Hong Kong Law Journal* 13:365.

Environmental Impacts of Increased Sediment Loads Caused by Channelization: A Case Study of Biomonitoring in a Small River in Hong Kong

David Dudgeon

ABSTRACT

The effects of clearance of riparian (riverbank) vegetation on a Hong Kong stream were investigated by comparing streambed (benthic) invertebrate animals at sites up- and downstream of the impact. Samples from the downstream site prior to impact (1990), and from both sites when vegetation clearance began, showed similar, diverse species composition. After vegetation clearance, the downstream site had higher suspended-sediment loads and a greater proportion of fine particles in stream bed sediments. The abundance and diversity of animals at the impacted downstream site in summer 1991 was lower than they had been prior to the impact (summer 1990) or at the upstream control site (summer 1991). In addition, a transfer experiment (summer 1991) in which animals were moved from the control to the impacted site indicated that higher mortality or drift (i.e. emigration) rates were associated with elevated sediment loads.

Because 'structural' data on biological communities (e.g. population densities, species richness, diversity) may not directly indicate fully how the ecosystem is affected by a disturbance such as increased sedimentation due to removal of riparian vegetation, it is useful to consider 'functional' data as well (e.g. productivity, energy flow, nutrient cycling). To this end, this study also compared the rates at which leaves (of *Bauhinia variegata*) were broken down at the impacted and the control sites (summer 1991). Breakdown was significantly slower at the impacted site, and densities and diversity of invertebrates associated with the leaf packs was lower.

In this case study, alteration of community structure caused by increased suspended-sediment loads was associated with a change in ecosystem functioning. Studies of functional parameters may be of particular value for environmental biomonitoring in Asian streams, because availabiltity of the types of taxonomic information (i.e. species identities) that is essential to determine community structural changes often are inadequate.

Keywords: *Hong Kong, biomonitoring, stream ecology, benthos, riparian vegetation, community structure, leaf litter breakdown, ecosystem functioning*

INTRODUCTION

Asian rivers are under threat from a variety of sources, including pollution and flow regulation due to dams and other factors (Dudgeon 1992a). The degradation of drainage basins, particularly through deforestation and overgrazing, leads to increased suspended sediment loads and in certain cases to

David Dudgeon, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong, Tel (852) 2859–7091, Fax (852) 2517–6082, E-mail DDUDGEON@HKUCC.HKU.HK.

extensive flooding (Douglas *et al.* 1992; Dudgeon 1992a). Effective enviornmental managment of streams requires that we be able to predict the impacts of human activities in drainage basins, and to take steps to ameliorate or mitigate them. Even if we cannot fully predict such impacts, the early detection of impacts is important so that assessments of possible mitigation measures may be undertaken.

Two general problems arise in detecting human-caused (anthropogenic) impacts on ecosystem communities. Firstly, how can we clearly distinguish alterations caused by human activities from changes in communities resulting from natural variation in environmental conditions (environmental 'noise'; Underwood 1991)? Secondly, should structural data (e.g. population densities, species richness, diversity, etc.) or functional parameters (e.g. productivity, energy flow, nutrient cycling) be used to measure impact? Both structure and function are sensitive to environmental impacts. Whiles *et al.* (1993) report that changes in the taxonomic composition of stream macroinvertebrate communities due to disturbances (e.g. insecticide treatment) can have significant effects on ecosystem processes for at least two years after the termination of disturbance.

Whether structural or functional data will be most appropriate, and which will provide the most sensitive 'early warning' of environmental degradation, depends upon the relationship between community structure and function (Cairns and Pratt 1986). This relationship can take three forms. Firstly, community structure and function may be interlinked intimately (i.e. change one and the other changes too). Alternatively, there may be functional redundancy among species (periphytic algae, for instance), so that a change in community structure (species complement or diversity) may not affect functional parameters (such as primary productivity). A third possibility is that community function is altered (i.e. by 'stress') before species are lost from the environment, so that function changes before structure alters.

This paper documents the effects of increased suspended sediment loads resulting from river area (riparian-zone) clearance along a Hong Kong stream. The impacts on animal (zoobenthos) community structure and the breakdown of terrestrial (allochthonous) leaf litter by large (macro) invertebrates were assessed by comparing an impacted and an unimpacted stream section. The breakdown of leaf litter by macroinvertebrates is an important functional parameter in stream ecosystems (Cuffney *et al.* 1990; Whiles *et al.* 1993) and is relatively easy to measure. That assessment was supplemented by an inter-site transfer experiment designed to indicate whether conditions at the impacted site caused rapid changes in zoobenthos communities. If macroinvertebrates transferred from upstream to the impacted downstream site showed high drift rates and/or mortality (compared to invertebrates transferred to an unimpacted site), then the attribution of changes in community structure downstream to unfavourable conditions at that site can be made with some confidence.

THE STUDY SITE

Research was undertaken in a tributary of the Lam Tsuen River near Pak Ngau Shek, New Territories, Hong Kong (see Fig. 1). Dudgeon (1984, 1991, 1992b and references therein) has described the hydrobiology of the river, including a site adjacent to Pak Ngau Shek. Two sites 690 m apart were investigated during this study. The upstream site drained secondary growth forest; riparian vegetation around the downstream site also included trees, but immediately upstream the vegetation was cleared and the banks cut during river channelization associated with road construction. As a result, soil and earth entered the river and suspended-solid (SS) loads increased at the downstream site. Preliminary channelization work began in late January 1991, and extensive vegetation clearance and bank cutting commenced in April 1991. Pre-impact data on zoobenthos were available from the downstream site only, but post-impact data (February 1991 to February 1994) on zoobenthos, stream sediments and SS loads have been obtained for both sites. For brevity, this paper will consider only pre-impact data and observations made between February and July 1991. Water chemistry did not appear to vary between the two sites during 1991, and thus the results will not be reported in any detail here; waters were circumneutral to slightly acidic, and conductivity was 76 (range 46–112) micromhos cm^{-1} at the upstream site and 83 (range 62–118) micromhos cm^{-1} downstream.

Study Materials and Methods

Total SS loads were monitored by filtering known volumes of stream water (four replicates at each site; 15 site visits) through pre-ashed Whatman GF/F fil-

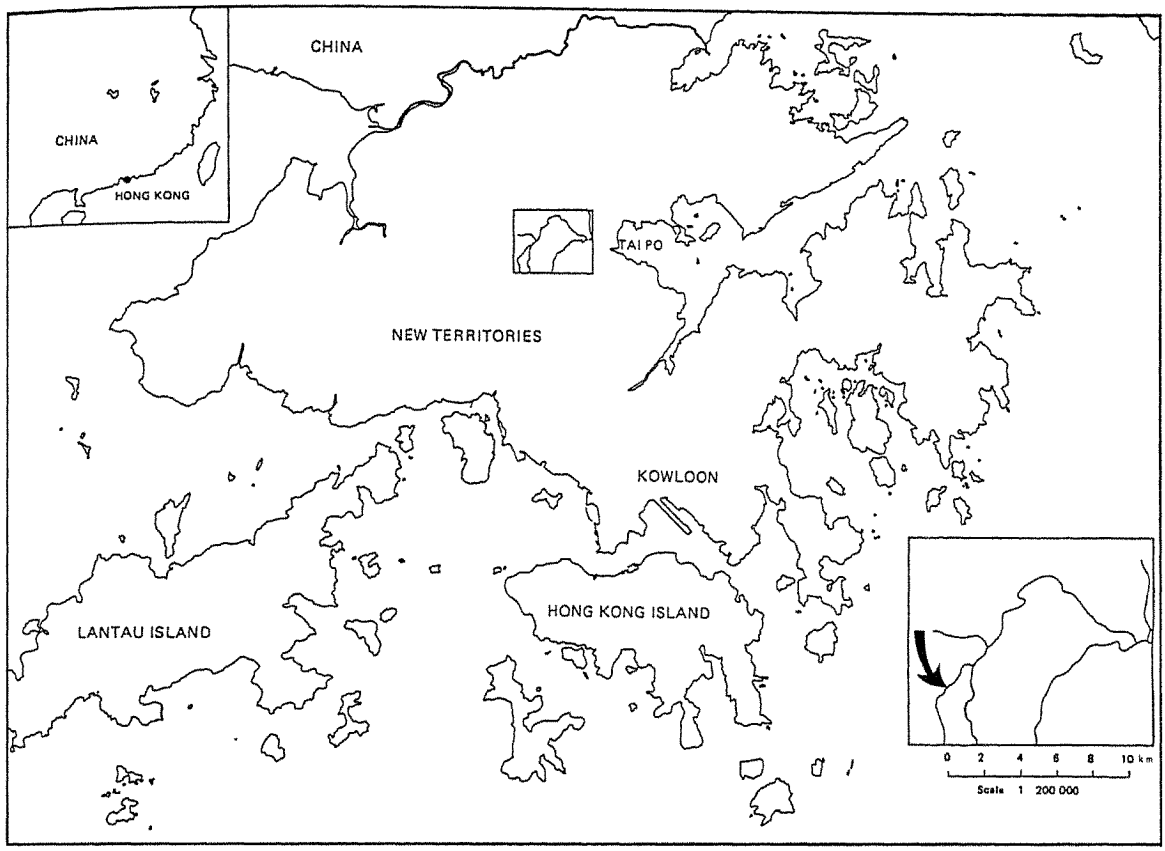

Fig. 1 A map of Hong Kong showing the Lam Tsuen River and (inset, arrowed) Pak Ngau Shek where the two study sites were located approximately 690 m apart.

ters. Suspended organic matter (SOM) load was calculated from weight loss after ignition at 450°C for two hours in a muffle furnace. Interstitial sediments were sampled using 300 mL cores (5 replicates at each site) on 20 May 1991. Samples were oven dried to constant weight at 70°C, sieved into three fractions (> 2 mm, 250 μm — 2 mm and < 250 μm), and weighed. The organic-matter content of the < 250 μm fraction was obtained from weight loss after ignition in a muffle furnace. Zoobenthos composition and abundance were estimated in July 1990 and 1991 using Hester-Dendy multiplate samplers (MPS; surface area 0.13 m^2). Six replicates were taken at each site, and the colonization period was six weeks. Before being taken out of the stream, each MPS was enclosed in a fine-meshed (250 μm) net to avoid loss of animals, and then transferred to individual plastic bags containing 5% formalin as a preservative for transportation to the laboratory. MPSs have been applied widely in studies of anthropogenic impacts on streams (e.g. Meier *et al.* 1979; Richards *et al.* 1993).

A restricted sampling programme based upon the use of Surber samples was also undertaken as part of the present study; although these samples contained more species that were taken from MPS, the pattern of community change uncovered by both methods was similar (Dudgeon, unpublished observations). Moreover, laboratory processing of Surber samples is extremely labour intensive, and thus MPS were used for routine monitoring of benthic macroinvertebrate communities. Indeed, a recent comparative study (Modde and Drewes 1990) has indicated that MPS provide information for environmental assessment that is at least as good or better than that derived from sampling natural substrates.

In order to investigate the effects of elevated SS loads on a functional parameter (leaf-litter breakdown), 30 *Bauhinia variegata* (Caesalpiniaceae) leaf packs were placed in the stream at each site on 20

July 1991. Each pack comprised a known dry weight (approximately 5 g) of leaves. Packs were tagged and tethered to steel stakes driven into the stream bed. At each site, 8 packs were retrieved after 7 days, 10 after 11 days, and 8 after 16 days (total n = 52 packs recovered). Each pack was removed from the stream after being enclosed in a fine-meshed (250 µm mesh net), placed in a plastic bag and preserved using 5% neutral formalin. In the laboratory, invertebrates were washed from the litter, preserved in 70% ethanol, prior to identification and enumeration. Invertebrates from MPSs were treated in the same way. After the animals had been removed, the *Bauhinia* litter was dried to constant weight at 70°C, and ignited in a muffle furnace to obtain ash-free dry weight (AFDW). An sample of leaves which had not been placed in the streams were also ashed, in order to obtain an estimate of initial AFDW for a leaf pack of known dry weight. Litter breakdown was estimated from rates of AFDW loss; invertebrate densities were expressed as numbers per g dry weight of litter, and species richness as taxa per leaf pack.

To determine whether conditions at the impacted site caused rapid changes in zoobenthos densities, 20 MPSs were placed at the upstream site for a four-week colonization period. On 12 March 1991, each MPS was enclosed in a 250 µm mesh net and removed from the stream. MPSs and associated animals were transported in steam water to the impacted site where 10 were placed on the stream bed. The whole process took approximately 40 minutes, so that stress or disturbance to the animals during the transfer process was short-lived. The remaining 10 MPSs (a procedural control) were returned to the upstream site and replaced on the stream bed. All 20 MPSs were recovered 24 hours later (using the procedure described above) and taken to the laboratory where the fauna were identified and counted. All statistical analyses of data follow methods given by Zar (1984).

RESULTS

SS loads differed greatly at the two sites following impact, and mean (± SEM) values were almost 20 times greater downstream: 5.3 ± 0.8 versus 102.6 ± 35.9 mg L^{-1}. SOM loads showed a similar trend (2.8 ± 0.5 versus 16.3 ± 6.2 mg L^{-1}). These differences influenced interstitial sediment characteristics (Table 1), with more fine inorganic particles, and a lower proportion of organic matter in the < 250 µm fraction, at the impacted site.

Fifty-two benthic macroinvertebrate taxa colonized MPSs at the downstream site in July 1990 (before impact) compared with only 24 taxa after impact in July 1991. The general pattern of macroinvertebrate colonization of MPSs at the upstream site (1991) and the lower site before impact (1990) was similar with respect to total taxa and total individuals after six weeks in the stream (see Fig. 2); 51 taxa were recorded from MPSs at the upstream (unimpacted) site where community structure resembled that downstream in 1990. However, MPS colonizers at the lower site were less abundant and represented by fewer taxa (see Fig. 2). Of the total of 65 taxa colonizing MPSs (all samples and dates combined), 16 were Ephemeroptera. ANOVA revealed significant differences between sites with respect to the abundance of mayfly families, total taxa, and total numbers of colonizers (see Table 2). In all but one instance, densities were lowest at the impacted site (i.e. downstream, July 1991). The exception was Caenidae which were most numerous at the impacted site.

Litter weight decreased the longer the leaves remained in the stream (2-way ANOVA on arcsine-transformed data, $P < 0.001$) regardless of site (Table 3), but breakdown was significantly slower downstream ($P < 0.001$); the ANOVA interaction term (site x time) was insignificant. More macroinvertebrate individuals and taxa colonized leaf

Table 1
Comparison of interstitial sediments (percent by weight) at two sites on Lam Tsuen River. ANOVA undertaken on arcsine-transformed data ($P < 0.01$; *** $P < 0.001$).**

	Unimpacted site	*Impacted site*	*ANOVA*
> 2 mm	93.5 ± 2.1	82.2 ± 1.6	**
250 µm – 2 mm	6.2 ± 2.1	16.6 ± 1.7	**
< 250 µm	0.3 ± 0.1	1.2 ± 0.3	**
% organic matter	11.4 ± 0.9	6.6 ± 0.6	***

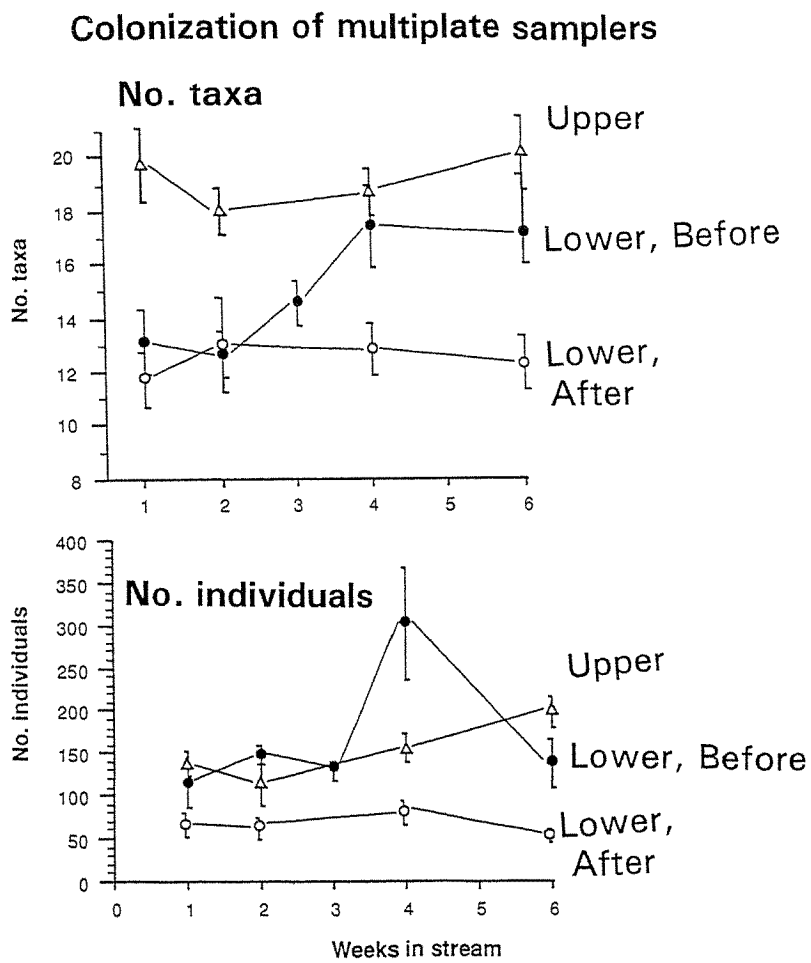

Fig. 2 Colonization of multiplate samplers placed in the stream over a six-week period. Changes in the numbers of macroinvertebrate taxa and total individuals are shown for the upper site, and the downstream site before (1990) and after (1991) impact.

Table 2
Inter-site Differences in Zoobenthos Colonization of Multiplate Samplers

	ANOVA	*Site contrasts*
Total individuals	***	U = B > L
Total taxa	***	U > B > L
Baetidae	**	B > U > L
Heptageniidae	***	U = B > L
Ephemerellidae	***	U > B > L
Leptophlebiidae	***	B > U > L
Caenidae	***	L > B > U

U, upstream unimpacted; B, downstream pre-impact; L, downstream post-impact. ANOVA undertaken on log-transformed data (n 0.13m^{-2}); site contrasts based on Student-Newman-Kuels tests where $P < 0.05$ (*** $P < 0.001$).

Table 3
Inter-site Comparison of *Bauhinia variegata* Litter Breakdown: % AFDW lost (mean ± SEM)

	7 days	11 days	16 days
Upstream	69.9 ± 5.9	92.2 ± 5.6	96.7 ± 1.7
Downstream	56.0 ± 9.0	78.1 ± 5.2	95.0 ± 1.9

packs at the unimpacted site where shredders — mainly the atyid shrimp *Neocaridina serrata* and the thiarid snail *Brotia hainanensis* — were relatively abundant (Table 4). The importance of invertebrates in litter breakdown is underscored by significant regressions of log densities/g litter against

Table 4
Inter-site Comparison of Invertebrates Colonizing Leaf Packs

	Site	*Time*	*S x T*	*Site contrasts*
Total taxa (per leaf pack)	***	***	***	U > L
Total individuals (per g litter)	***	n.s.	n.s.	U > L
Brotia hainanensis	***	*	n.s.	U > L
Neocaridina serrata	**	*	n.s.	U > L
Total shredders	***	*	n.s.	U > L

U, unimpacted site; L, impacted site. Two-way ANOVA undertaken on log-transformed data (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$)

% AFDW lost (arcsine-transformed prior to analysis) for total individuals ($r = 0.42$, $P < 0.05$), *Brotia hainanensis* ($r = 0.55$, $P < 0.05$), *Neocaridina serrata* ($r = 0.61$, $P < 0.01$), and total shredders ($r = 0.41$, $P < 0.05$). However, such regressions were significant at the unimpacted site only.

MPSs transferred to the impacted site yielded fewer taxa (mean ± SEM = 9.9 ± 0.5 versus 17.5 ± 1.4 0.13 m^{-2}) and fewer individuals (49.5 ± 4.2 versus 108.0 ± 10.6 0.13 m^{-2}) than MPSs in the procedural control group upstream ($P < 0.001$; ANOVA on log-transformed data).

DISCUSSION

Before-and-after comparisons at the impacted site, and post-impact comparisons of impacted and unimpacted sites, showed that reductions in zoobenthos densities and species richness were associated with changes in stream sediments (i.e. an increased proportion of fine particles in the substratum) and elevated SS loads. This is in general agreement with the results of similar studies elsewhere (e.g. Burns 1972; Lloyd *et al.* 1987; Campbell and Doeg 1989; Ryan 1991; Richards *et al.* 1993), and reflects clogging of coarse substrates by fine sediment runoff from cleared land (Douglas *et al.* 1992; Schalchi 1992) resulting in reduced bed permeability and interstitial dissolved oxygen (Quinn *et al.* 1992).

The addition of fine sediments to substrates composed of large materials causes reductions in macroinvertebrate diversity (e.g. Cordone and Kelly 1961; Williams and Mundie 1978; Hogg and Norris 1991; Quinn *et al.* 1992), and the rapid reductions in both density and diversity which occurred when macroinvertebrates were transferred to the impacted site, provide strong support for the detrimental effects of high SS loads. Immediate reductions in density of this type have been attributed to catastrophic drift caused by saltating sediments (Culp *et al.* 1986), and Doeg and Milledge (1991). Present evidence is that there is a threshold critical level of suspended sediment that initiates macroinvertebrate drift. Interestingly, densities of most but not all taxa were reduced by increases in fine sediments, and caenid mayflies — which are considered to be adapted to silty conditions (Hynes 1970:178) — increased in abundance at the impacted site (see Table 2). This point has been noted also by other investigators, and habitat for a minority of stream macrobenthic species may be enhanced by the addition of fine sediment (Chutter 1969; Lenat *et al.* 1981).

A possible limitation of the present study which might reduce the power of some conclusions drawn from it, is that it is only pseudoreplicated (*sensu* Hurlbert 1984) in the sense that the upstream and downstream site are not independent of each other — clearly they are linked in space so that the 'treatments' are not independent. A more appropriate survey design would be to select an unimpacted control site on a separate tributary from the impacted site such that the tributaries joined downstream of both study sites. Unfortunately, no such directly comparable tributary stream was available for study.

A second problem arises from the fact that only one control site was used, and differences between the impacted and control site could have arisen because of changes at the control site (Underwood 1991). Fortunately, pre-impact data from the downstream site (July 1990) indicate that declines in benthic diversity and biomass were associated with riparian zone clearance, although the study design employed here falls far short of that which Underwood (1991) considers is required to detect an environmental impact.

Thirdly, it is worth pointing out that the association of the increased sediment loads downstream with reduced benthic diversity and abundance, and slower litter breakdown, is correlative and not causal;

the correlation, but not the causality, is strengthened by the transfer experiment. Nevertheless, with the limitations noted, it does seem that the circumstantial evidence that increased suspended sediment loads caused the biological changes is convincing.

In addition to changes in suspended load and sediment composition, other consequences of riparian zone clearance include increased stream temperatures, reduced litter input (and hence shredder habitat), and increased nutrient loads (Stout and Colburn 1989; Garman and Moring 1991; Ahtiainen 1992; Holopainen and Huttunen 1992). The synergistic effects of such changes may be especially deleterious when (as in the present case) they are combined with channelization which tends to simplify and degrade habitat suitability for aquatic animals, especially fish (e.g. Swales 1982; Wilcock and Essery 1991).

Retention of protective riparian strips (buffer strips) of at least 10 m width along each stream bank clearly reduces the effects of clear-cutting and soil erosion (Burns 1972; Newbold *et al.* 1980; Ahtiainen 1992; Holopainen and Huttunen 1992). However, it is not yet clear what the necessary width of these strips should be in order to maintain the structural and functional integrity of stream communities. This is an important management question for streams in Asia, since there are not even the most basic data pertaining to the question of what buffer strip widths are both necessary and sufficient to ensure stream protection. Moreover, we do not know whether the findings of the few studies undertaken on buffer strips in temperate Europe and North America can be applied to Asian streams.

CONCLUSIONS

The results of the present study suggest that there is a close link between structural and functional attributes of stream communities (see also Whiles *et al.* 1993). Functional changes such as productivity, energy flow, nutrient cycling are likely to be coupled with alterations in community structure, because litter breakdown rates were correlated with macroinvertebrate abundance — especially those animals which shred the leaves — and were slower at the impacted site where zoobenthos densities were low. Stout and Colburn (1989) recorded similar findings in a north-temperate (Tennessee, USA) stream affected by highway construction, and Tuchman and King (1993) have recorded differences in litter-processing rates at two agriculturally — perturbed sites compared to an undisturbed woodland stream in Michigan, USA; only in the latter were shredders were the primary mediators of weight loss.

Litter breakdown rates can be measured conveniently and, in the present study, results were obtained after less than three weeks. Horton and Brown (1991) report comparable breakdown rates in a North American stream. Leaf-pack samples take less laboratory and field time to process than conventional zoobenthos samples, and thus provide a cost-effective means of monitoring environmental change (Bruns *et al.* 1992). Indeed, Merritt *et al.* (1979) and Webster and Benfield (1986) have suggested that litter breakdown can be used as a bioassay of human impacts on streams, and Newman and Perry (1989) have employed this functional parameter in an analysis of the effects of pollution loads in experimental streams.

Although functional measurements are used less often than structural attributes to detect differences between sites experiencing stress or pollution (Cairns and Pratt 1986), they have the advantage that time-consuming taxonomic penetration of poorly known groups of aquatic organisms is not required. This is a particularly important consideration in Asian streams where species identification of many macroinvertebrate taxa is not possible, and there is a critical lack of identification guides for even the commonest groups. Functional data may therefore complement — or even replace — community structural data as a means of assessing anthropogenic impacts, because measurement of structure provides an instantaneous 'snapshot' assessment upon every visit to the stream. In contrast, function is cumulative over the same period and therefore permits continuous monitoring of ecosystem parameters (Dudgeon 1991). It is the cumulative nature of functional measures make them especially valuable for environmental impact assessment.

ACKNOWLEDGEMENTS

I am grateful to Professor Mike Dickman for his constructive comments on a draft manuscript.

REFERENCES

Ahtiainen, M. 1992. The Effects of Forest Clear-cutting and Scarification on the Water Quality of Small Brooks. *Hydrobiologia* 243/244:457–64.

Bruns, D.A., Wiersma, G.B. and Minshall, G.W. 1992. Evaluation of Community and Ecosystem Monitoring Parameters at a High-elevation Rocky Mountain Study Site. *Environmental Toxicoloy and Chemistry* 11:459–72.

Burns, J.W. 1972. Some Effects of Logging and Associated Road Construction on Northern California Streams. *Transactions of the American Fisheries Society* 10:1–17.

Cairns, J., Jr and Pratt, J.R. 1986. Developing a Sampling Strategy. In *Rationale for Sampling and Interpretation of Ecological Data in Assessment of Freshwater Ecosystems* (ed. B.G. Isom), 168–86. Philadelphia: American Society for Testing and Materials.

Campbell, I.C. and Doeg, T. 1989. Impact of Timber Harvesting and Production on Streams: A Review. *Australian Journal of Marine and Freshwater Research* 40:519–31.

Chutter, F.M. 1969. The Effects of Silt and Sand on the Invertebrate Fauna of Streams and Rivers. *Hydrobiologia* 34:57–76.

Cordone, A.J. and Kelly, D.E. 1961. The Influence of Inorganic Sediment on the Aquatic Life of Streams. *California Fish and Game* 47:189–228.

Cuffney, T.F., Wallace, J.B. and Lugthart, G.J. 1990. Experimental Evidence Quantifying the Role of Benthic Invertebrates in Organic Matter Dynamics of Headwater Streams. *Freshwater Biology* 23:281–99.

Culp, J.M., Wrona, F.J. and Davies, R.W. 1986. Response of Stream Benthos and Drift to Fine Sediment Deposition Versus Transport. *Canadian Journal of Zoology* 64:1345–51.

Doeg, T.J. and Milledge, G.A. 1991. Effect of Experimentally Increasing Concentrations of Suspended Sediment on Macroinvertebrate Drift. *Australian Journal of Marine and Freshwater Research* 42:519–26.

Douglas, I., Spencer, T., Greer, T., Bidin, K., Sinun, W. and Wong, W.M. 1992. The Impact of Selective Commercial Logging on Stream Hydrology, Chemistry and Sediment Loads in the Ulu Segama Rainforest, Sabah, Malaysia. *Philosophical Transactions of the Royal Society of London* B335:397–406.

Dudgeon, D. 1984. Seasonal and Long-term Changes in the Hydrobiology of the Lam Tsuen River, New Territories, Hong Kong, With Special Reference to Benthic Macroinvertebrate Distribution and Abundance. *Archiv für Hydrobiologie, Supplement* 69:55–129.

Dudgeon, D. 1991. An Experimental Study of Abiotic Disturbance Effects on Community Structure and Function in a Tropical Stream. *Archiv für Hydrobiologie* 122:403–20.

Dudgeon, D. 1992a. Endangered Ecosystems: A Review of the Conservation Status of Tropical Asian rivers. *Hydrobiologia* 248:167–91.

Dudgeon, D. 1992b. *Patterns and Processes in Stream Ecology*. Stuttgart: Schweizerbart'sche Verlagsbuchhandlung.

Garman, G.C. and Moring, J.R. 1991. Initial Effects of Deforestation on Physical Characteristics of a Boreal River. *Hydrobiologia* 209:29–37.

Hogg, I.D. and Norris, R.H. 1991. Effects of Runoff from Land Clearing and Urban Development on the Distribution and Abundance of Macroinvertebrates in Pool Areas of a River. *Australian Journal of Marine and Freshwater Research* 42:507–18.

Holopainen, A-L. and Huttunen, P. 1992. Effects of Forest Clear-cutting and Soil Disturbance on the Biology of Small Forest Brooks. *Hydrobiologia* 243/244:457–64.

Horton, R.T. and Brown, A.V. 1991. Processing of Green American Elm Leaves in First, Third and Fifth Order Reaches of an Ozark Stream. *Journal of Freshwater Ecology* 6:115–9.

Hurlbert, S.J. 1984. Pseudoreplication and the Design of Ecological Field Experiments. *Ecological Monographs* 54:187–211.

Hynes, H.B.N. 1970. *The Ecology of Running Waters*. Liverpool: Liverpool University Press.

Lenat, D.R., Penrose, D.L. and Eagleson, K.W. 1981. Variable Effects of Sediment Addition on Stream Benthos. *Hydrobiologia* 79:187–94.

Lloyd, D.S., Koenings, J.P. and LaPierre, J.D. 1987. Effects of Turbidity in Fresh Waters of Alaska. *North American Journal of Fisheries Management* 7:18–33.

Meier, P.G., Penrose, D.L. and Polak, L. 1979. The Rate of Colonization by Macro-invertebrates on Artificial Substrate Samplers. *Freshwater Biology* 9:381–91.

Merritt, R.W., Cummins, K.W. and Barnes, J.R. 1979. Demonstration of Stream Watershed Community Processes with Some Simple Bioassay Techniques. In *Innovative Teaching in Aquatic Entomology* (ed. V.H. Resh and D.M. Rosenberg), 93–105. Ottawa: Department of Fisheries and Oceans.

Modde, T. and Drewes, H.G. 1990. Comparison of Biotic Index Values for Invertebrate Collections from Natural and Artificial Substrates. *Freshwater Biology* 23:171–80.

Newman, R.A. and Perry, J.A. 1989. The Combined Effects of Chlorine and Ammonia on Litter Breakdown in Outdoor Experimental Streams. *Hydrobiologia* 174:89–97.

Newbold, J.D., Erman, D.C. and Roby, K.B. 1980. Effects of Logging on Macroinvertebrates in Streams With and Without Buffer Strips. *Canadian Journal of Fisheries and Aquatic Science* 37:1076–85.

Quinn, J.M., Davies-Colley, R.J., Hickey, C.W. Vickers, M.L. and Ryan, P.A. 1992. Effects of Clay Discharges on Streams 2. Benthic Invertebrates. *Hydrobiologia* 248:235–47.

Richards, C., Host, G.E. and Arthur, J.W. 1993. Identification of Predominant Environmental Factors Structuring Stream Macroinvertebrate Communities within a Large Agricultural Catchment. *Freshwater Biology* 29:285–94.

Ryan, P.A. 1991. Environmental Effects of Sediment in New Zealand Streams: A Review. *New Zealand Journal of Marine and Freshwater Research* 25:207–21.

Schalchli, U. 1992. The Clogging of Coarse Gravel Beds by Fine Sediment. *Hydrobiologia* 235:189–97.

Swales, S. 1982. Environmental Effects of River Channel Works Used in Land Drainage Improvements. *Journal of Environmental Management* 14:103–26.

Stout, B.M. and Colburn, C.B. 1989. Impact of Highway Construction on Leaf Processing in Aquatic Habitats of Eastern Tennessee. *Hydrobiologia* 178:233–42.

Tuchman, N.C. and King, R.H. 1993. Changes in Mechanisms of Summer Detritus Processing between Wooded and Agricultural Sites in a Michigan Headwater Stream. *Hydrobiologia* 268:115–27.

Underwood, A.J. 1991. Beyond BACI: Experimental Designs for Detecting Human Environmental Impacts on Temporal Variations in Natural Populations. *Australian Journal of Marine and Freshwater Research* 42:569–87.

Webster, J.R. and Benfield, E.F. 1986. Vascular Plant Breakdown in Freshwater Systems. *Annual Review of Ecology and Systematics* 17:567–94.

Whiles, M.R., Wallace, J.B. and Chung, K. 1993. The Influence of *Lepidostoma* (Trichoptera: Lepodostomatidae) on Recovery of Leaf-litter Processing in Disturbed Headwater Streams. *American Midland Naturalist* 130:356–63.

Wilcock, D.N. and Essery, C.I. 1991. Environmental Impacts of Channelization on the River Main, County Antrim, Northern Ireland. *Journal of Environmental Management* 32:127–143.

Williams, D.D. and Mundie, J.H. 1978. Substrate Size Selection by Stream Invertebrates and the Influence of Sand. *Limnology and Oceanography* 23:1030–13.

Zar, J.H. 1984. *Biostatistical Analysis (Second Edition)*. New Jersey: Prentice Hall International Inc.

The Center for International Environmental Law

PURPOSES AND GOALS

The Center for International Environmental Law (CIEL) was founded in 1989 to help strengthen and develop international and comparative environmental law, policy and management throughout the world. CIEL's goals are: (1) to incorporate fundamental principles of ecology and transparency into international environmental law; (2) to strengthen national environmental systems and public interest movements throughout the world; (3) to educate and train public-interest-minded environmental lawyers; and (4) to solve environmental problems and promote sustainable societies through the use of law.

CIEL provides a wide range of assistance in international and comparative environmental law through research and publication, advice and advocacy, and education and training. CIEL works with nongovernmental organizations (NGOs), international institutions, countries and territories (particularly those with economies in transition), multinational corporations, and academics and professionals working on environmental issues.

In addition, CIEL has a Joint Research Programme with The American University's Washington College of Law. The Joint Research Programme is part of the law school's International Studies Programme that trains 150 foreign lawyers from over fifty countries each year. CIEL attorneys teach international and comparative environmental law courses in the International Studies Programme and supervise practical training at CIEL. CIEL has thirteen full-time attorneys in Washington, D.C. and one in Moscow, as well as *of counsel* attorneys in Berkeley, California, Portland, Oregon, and Washington, D.C.

PROGRAMMES

CIEL organizes its work into various geographic programmes, substantive programme areas, a State of Environmental Law programme and an educational programme. The major elements of these programmes are briefly outlined below.

Geographic Programmes

These include the Asia-Pacific Programme, the Central and Eastern Europe and the Newly Independent States Programme, and the Americas and Caribbean Programme.

Under the Asia-Pacific Programme, CIEL's initial project in the region was the ASEAN Workshop on Scientific, Policy and Legal Aspects of Global Climate Change, held in Bangkok, Thailand in 1990. Currently, CIEL is conducting research and working with local public-interest minded lawyers and scholars, in conjunction with its State of Environmental Law Programme. The ultimate goal is the publication of updated national reports describing and analysing the environmental regulatory systems of Bangladesh, Cambodia, China (P.R.C.), Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Mongolia, Myanmar, Nepal, Papua New Guinea, the Philippines, Singapore, Sri Lanka, Taiwan (R.O.C.), Thailand and Vietnam. In Thailand, CIEL worked with the Ministry of Justice to develop a training course on environmental law enforcement for Thai judges. CIEL also assisted the Ministries of Justice and Public Health plan a series of jointly sponsored seminars on enforcement of the Thai Public Health Act of 1992. In Cambodia, CIEL assisted the Cambodian Ministry of Environment with drafting a framework environmental law and an environmental impact assessment (EIA) law. Drafting of the EIA law is ongoing. CIEL is also involved in work on Trade and Environment issues related to Japan, and is in the process of creating a compilation of works examining legal and other issues related to trade and environment in the Asia region.

Under the Central and Eastern Europe and the Newly Independent States Programme, CIEL is monitoring the European Bank on Reconstruction and Development (EBRD). As a result of the work by CIEL and other NGOs, the Bank's charter re-

quires it to promote 'environmentally sound and sustainable' development in all of its activities. In addition, CIEL staff give legal assistance and advice on such diverse issues as privatization, the regulation of oil development in Bulgaria's Black Sea, and the international issues surrounding the continued construction of the Gabcikovo-Nagymaros Dam. Additionally, through a subgrant from the World Resources Institute, CIEL coordinated a review of Kazakhstan's environmental law, which was furnished to the Kazakhstan Ministry of Environment. CIEL also participated in a review of the Republic of Georgia's environmental law, organized by the American Bar Association. During 1994 CIEL also extended its assistance to public-interest-minded professionals and NGOs in CEE and the NIS. In August 1994 CIEL opened its Moscow office and now has a senior attorney stationed full-time in Moscow.

Under the Americas and Caribbean Programme, CIEL has provided scholarly and practical training for public interest environmental attorneys in Latin America. CIEL supports and assists the Centro Mexican de Derecho Ambiental (CEMDA), Mexico's first public-interest environmental law firm. CEMDA was founded in 1993 by former students from the CIEL/American University Joint Research Programme with assistance from CIEL. CIEL held parallel conferences in Washington and Santiago relating to trade and environment in Chile. CIEL is working with the NAFTA secretariat in Montreal to develop a comparative environmental law database, and with other NGOs and IGOs to develop its State Environmental Law Latin America programme. CIEL also recently held a conference entitled 'Haiti and Environmental Restoration: Toward an Environmentally Sustainable Society', in 1994 at The American University in Washington, D.C.

Substantive Programme Areas

CIEL's substantive activities are grouped into a number of programmes. Present programmes are: Trade and Environment, Global Commons, Multilateral Development Bank Accountability, Biodiversity and Wildlife, Environmental Information Alliance, and the State of Environmental Law. Illustrative examples of activities under each substantive programme follow.

Under the Trade and Environment Programme, CIEL continues its work on competitive sustainability — a mechanism for realizing sustainable development through the upward harmonization of domestic and international environmental standards, using competitive forces to create a level playing field for commerce at consistently higher levels of environmental and social protection that reward the cleanest and most efficient economic actors.

CIEL has continued its work on the interrelationship between trade rules and the environment, in particular the implementation of NAFTA and the new GATT rules. CIEL remains committed to promoting public oversight of and participation in trade policy making as a means of attaining competitive sustainability. CIEL's *Trade and Environment: Law, Economics and Policy* (Island Press 1993), is in its second printing and has been translated into Spanish. Additionally, the book has been accepted by a literary agency in Taiwan for possible future translation into Chinese and distribution throughout Chinese-speaking Asia. Among CIEL's major projects in this area is the creation of an Environmental Advisory Panel to the OECD, which would parallel existing advisory bodies, such as the Business and Industry Advisory Committee; participation in the NAFTA National Advisory Committee; and the development of proposed text for the GATT post-Uruguay Round trade and environment process.

Under the Global Commons Programme, CIEL has analysed the trade implications of the Climate Change Convention, including implications of the Uruguay Round Final Agreement of the GATT and the new World Trade Organization. This analysis will be included in CIEL's new trade and environment book to be published in mid 1995. CIEL has also continued its work on the Global Environment Facility (GEF) — the funding mechanism for the Climate Change and Biodiversity Conventions. CIEL testified before the US House Banking Committee on behalf of a number of environmental groups regarding US involvement with the GEF. Additionally, CIEL was the fiscal sponsor for Ozone Action, a new NGO aimed at stimulating and coordinating a broader response to the threats of ozone depletion. CIEL organized a roundtable involving leading scientists and attorneys to discuss other factual and legal requirements for holding manufacturers of ozone destroying substances responsible for ozone loss. In the area of oceans conservation, CIEL published *Freedom for the Seas in the 21st Century: Ocean Governance and Environmental Harmony* (Island Press 1993). This work was co-winner of the

Sprout Award for the best environmental publication, 1994.

Under the Multilateral Development Bank Accountability Programme, CIEL has launched a multiyear effort to promote monitoring and using the new inspection panels being created to increase accountability at multilateral development banks. In addition, CIEL continues to monitor the European Bank for Reconstruction and Development. CIEL was also instrumental in pushing for the creation of the World Bank's precedent-setting Inspection Panel. The Panel began operations 1 August 1994 and marked the first time any international financial institution has made itself directly accountable to citizens in borrowing countries. The World Bank's Inspection Panel is serving as a model for the regional development banks. CIEL is actively monitoring the development of similar 'inspection' functions at the Inter-American Development Bank and the African Development Bank. The Asian Development Bank is also expected to create a panel in the near future.

Under the Biodiversity and Wildlife Programme, CIEL continues to provide legal services, including advice and advocacy, to NGOs, government agencies, and intergovernmental organizations, on biodiversity issues. These issues include ratification and implementation of the Biodiversity Convention in the United States and elsewhere around the globe. CIEL also continued to analyse issues that link law, economics and conservation, such as the relationship between the Biodiversity Convention and trade law, the legal principles governing the commercial use of biodiversity, and the impact of economic policies on biodiversity conservation and loss. CIEL participated as an NGO observer at the second meeting of the Inter-Governmental Committee on the Convention on Biological Diversity (ICCBD), and also as an NGO representative in the official US delegation at the First Conference of the Parties to the Biodiversity Convention. CIEL provided other advice to the US government on various aspects of US international policy and obligations regarding biodiversity, including comments to the National Security Council on proposed US international biodiversity policy. In other examples, CIEL advised the US National Institute of Health on legal aspects of commercial use of biodiversity, and advised the Department of the Interior on the US report to the Commission on Sustainable Development on implementation of the biodiversity chapter of *Agenda 21*. CIEL participated in the ninth Conference of the Parties of CITES as an NGO observer and played a significant role in establishing science-based, pro-conservation criteria for listing species on Appendices, as well as other issues. CIEL continues to play an active role in guiding the Biodiversity Action Network (BIONET), a coalition project CIEL initiated with the Sierra Club in 1993. BIONET supports broader and more effective NGO participation in biodiversity law and policy.

The Environmental Information Alliance Programme (Alliance), established by CIEL in 1994, is designed to increase electronic access to environmental information. The Alliance is a partnership between CIEL, the Institute for Global Communication, EcoNet, the World Resources Institute (WRI), and Island Press. 'EcoNet Plus', and Internet demonstration project mounted by the Environmental Information Alliance for Earth Day, can be found on the World Wide Web at: http://www.econet.apc.org.ciel/index.html.

CIEL's State of Environmental Law Programme is an effort to monitor development, implementation, and enforcement of environmental law at all levels of government. The programme includes two series of reports written by a global network of public interest-minded lawyers and edited and distributed worldwide by CIEL; the periodic *State of Environmental Law* country reports, and the *CIEL Briefs* that focus on specific environmental issues such as environmental assessment, technology transfer, the environmental accountability of development banks, regional environmental protection trends, and global warming.

For further information contact:

CIEL
1621 Connecticut Avenue, Suite 200
Washington, D.C. 20009-1052
Tel.: (202) 332-4840
Fax: (202) 3324865
E-mail: CIELUS@IGC.APC.ORG

INSTITUTIONAL PROFILE

The Conservancy Association (Hong Kong)

BACKGROUND

The Conservancy Association (CA) is the oldest non-governmental voluntary organization for environmental protection in Hong Kong. Founded in 1968 by a group of concerned citizens who wished to provide a better life for Hong Kong people by improving environmental quality, it has continued to play an active role in promoting the concept of environmental protection and nature conservation. CA is strongly community-based and emphasizes outreach activities to local people from all income and educational levels on issues of environmental health and the conservation of nature, and related matters such as energy efficiency and consumer product information. In addition, CA member experts assess governmental policy (or the need for policy) for the broad spectrum of issues related to the environment as part of the quality of life for people living in Hong Kong. These assessments are presented to government, to other concerned groups and to the community at large.

STRUCTURE

The association's members come from all walks of life, including professionals, civil servants, teachers, social workers, priests, District Board members, executives, industrialists, journalists, homemakers and students, etc. In 1993, more than 2000 people participated in activities organized by CA.

The work of the association is supervised by a 10-member Executive Committee elected from the membership. The Executive Committee is the governing body of CA, mangeing and conducting the affairs of the association. The work of the Exective Committe is supported by five full-time and two part-time staff.

CA's sources of funding include donations from the public (both from annual membership/donation drives and from special events) as well as from programmes such as the Asia Partnership for Human Development, the Caltex Green Fund (Hong Kong), and the Environmental Conservation Fund. The annual budget is about US$130 000.

ACTIVITIES

CA's major activities may be summarized as follows:

1. Working as a Constructive Pressure Group. CA monitors Hong Kong government policies on environmental protection and, when feasible, participates actively in their formulation (e.g. through advisory or consultative groups).

2. By Being a Supporting Community Organization. CA is a supporter and facilitator to other community groups in the planning and organization of activities to promote environmental protection.

3. Through the activities of CA's Environmental Education Centre. In 1988, CA set up the Hong Kong Environment Centre to promote environmental education. The centre provides information resources and educational activities for the general public in Hong Kong. Since 1992 the centre has also acted as the Environmental Education Facilitator of the Asia South Pacific Bureau of Adult Education in the East Asia Subregion. As part of this facilitator role, CA participated in environmental education workshops in Japan, Macau, Thailand, Australian and the Philippines which were organized for environmental educators. The main objectives of these workshops were to provide opportunities for experience sharing, the development of strategies for networking and the organization of common environmental education programmes on a regional basis.

Among its Hong Kong programmes the centre ran the Environmental Pioneer Scheme (EPS) (1993–94), a 10-month programme involving 120

participants and 30 voluntary organizing committee members. The training session included a three-day training camp and guided visits to several environment-related facilities such as sewage treatment plants, paper recycling factories and nature reserves. In the service session, the participants carried out a minimum of 20 hours of volunteer work in the environmental field or designed their own environmental projects in order to fulfill the service requirements.

4. Through various special and annual activities. Some of those in recent years were:

International Cooperation

i. United Nations Conferences on the Human Environment. CA attended both the June 1972, United Nations Conference on the Human Environment held in Stockholm, and the June 1992, by the Earth Summit held in Rio de Janeiro, which mapped out an agenda for the sustainable development of the world into the twenty-first century.
ii. The Earth Day 1994 International Congress in Japan. CA participated along with other NGOs from China, Japan, USA, Canada, Australia, the Philippines, Korea and Hong Kong. Among the ideas endorsed by all the participants were to strengthen international connections by establishing a fax network and joint editing of the Asian Earth Day newsletter, and to organize Earth Day activities on 22 April 1995 (Earth Day) in order to promote environmental protection and bring about the spirit of cooperation among different countries.

Hong Kong Community Environment Action Activities included

i. Walk for the Environment. CA has been organizing this since 1974. It is not only a fund raising activity, but also an environmental education programme.
ii. The Greening of Hong Kong — Tree Planting Programme is an annual CA event which has involved more than 500 participants.
iii. Bicycle Parade on the Promotion of Clean and Safe Energy. The objective of this campaign was to promote the development of safe and clean energy such as solar energy, and to stop using dangerous, polluting and non-renewable fuel. More than 50 bicycles decorated with colourful posters and slogans showing the advantages of safe and clean energy were ridden around Hong Kong. This activity has received a wide media coverage.
iv. Seminar on Land Use and Environmental Quality in Hong Kong. Some of the wetlands around Hong Kong (e.g. those near Deep Bay and the Mai Po Marshes) are known internationally for their importance to migratory birds and are significant for their resident populations of local wildlife and biodiversity. However, recent developments around these precious wetlands has been vigorous and threaten to undermine the fragile ecology. CA organized a seminar on Land Use and Environmental Quality in Hong Kong in the Hong Kong Convention and Exhibition Centre in order to raise public awareness on the importance of well-planned development of rural areas. More than 100 representatives from government, academia, the private sector and environmental advocacy groups attended.
v. Waste Paper Recycling Scheme in Schools. In the academic year of 1994–95, CA (together with four other organizations) organized a Waste Paper Recycling Scheme for more than 300 schools in Hong Kong. The main objectives of this scheme are to educate students on the importance of conserving resources, reducing the use of one-time use items and to provide a channel for the constructive use of paper waste in Hong Kong.

FURTHER INFORMATION

For further information on the Conservancy Association (Hong Kong) or the Hong Kong Environment Centre, please contact:

The Executive Secretary
The Conservancy Association (Hong Kong)
Shop 301 Lai Mei House
Lai Kok Estate
Cheung Sha Wan, Kowloon, Hong Kong
Tel (852) 2728-6781
Fax (852) 2728-5538

The Swire Institute of Marine Science, The University of Hong Kong

BACKGROUND

The Swire Institute of Marine Science is located at the tip of the Cape d'Aguilar Peninsula on the remotest south-eastern corner of Hong Kong Island. Opened on the 3 November 1990 with a donation of HK$12 million (US$1.5 million) from The Swire Group of Companies, The Swire Marine Laboratory, as it was called initially, attracted local and international attention quickly. So much, in fact, that by 1992 its facilities were over-subscribed and a further donation of HK$6 million from The Swire Group allowed expansion. In 1994, following the expansion, the laboratory was renamed The Swire Institute of Marine Science. In addition to its external support from The Swire Group of Companies, the Institute benefits from excellent technical and secretarial support and its various activities are coordinated by a Committee of Management reporting to the University of Hong Kong's Senate.

RESEARCH ACTIVITIES

Four senior university staff work at the Institute and, at present, supervise, in cooperation with 18 Research and Institute Fellows, 26 higher degree (M.Phil. and Ph.D.) students. There are also two resident post-doctoral fellows. As the institute and staff have grown, so its research programme has become more focused and can be divided into four broad categories.

1. Rocky intertidal ecology, with a strong emphasis on field experimentation and community manipulation.
2. Wetland ecology with particular emphasis on mangroves, sea grasses and routes of production.
3. Shallow sub-tidal ecology with particular emphasis on coral ecology, growth and reproduction. This research group has recently established an experimental artificial reef at Hoi Ha Wan, site of Hong Kong's first proposed marine park.
4. Fish ecology with particular reference to reproductive strategies.

Researchers also work on other topics, such as dolphin ecology, plankton dynamics and marine pollution. Studies of marine pollution find their way into most research undertaken at the Institute and there is also a growing trend for the researchers to take management issues into their purview. This particular aspect of marine science was recently stimulated by the award of a Swire Scholarship in Wetland Ecology to a local arts student to establish a Hong Kong GIS coastal database with the ultimate aim of creating conservation maps and a coastal zone management strategy. This Ph.D. project is influencing the research of other workers and the database is also being linked to the infant Reference Collection of Hong Kong's Marine Flora and Fauna now being developed at the Institute. To summarize, the research strategy of the Institute can be defined broadly as a group approach focused within the overall aims of studying Hong Kong's coastal ecology, pollution impacts, and the conservation and management of marine resources.

AFFILIATED ACTIVITIES

To assist the Institute in meeting its research aims, the staff and postgraduate student body organize undergraduate project work at Cape d'Aguilar. There is also an active local Institute Fellow body and cooperation with other marine institutions is encouraged. For example, formal exchange agreements exist with the School of Ocean Sciences, University of Wales, Bangor, UK, the South China Sea Institute of Oceanology, Guangzhou, China, and the Third Institute of Oceanography, Xiamen, China. On av-

erage, the Institute receives about 20 research visitors each year. Various seminars and research group coordination meetings are held at the Institute.

PUBLICATIONS

The Director produces an annual report which details the facilities, activities and research opportunities of the Institute. Copies of the report are available from the Director. The Institute is also the home of The Marine Biological Association of Hong Kong, which publishes the periodical journal *Asian Marine Biology* through Hong Kong University Press.

FACILITIES

The Swire Institute of Marine Science complex at Cape d'Aguilar includes research laboratories, offices and residential areas. The academic block has a research laboratory with capacity to accommodate 20 higher degree students and a smaller laboratory for staff and visitors. There are outdoor seawater tanks and an indoor research aquarium, all fed with raw seawater from adjoining Lobster Bay. There are specialist equipment rooms, including an SEM and image analysis laboratory, an ICP trace metal laboratory and a microbiology laboratory/balance room. The remainder of this building includes offices for senior staff, visitors and technical support staff and various equipment, chemical, boat and field equipment stores. There is also a fully equipped diving room. The institute is served by two vehicles, two Zodiac inflatables and a Boston Whaler. The Institute has two residential blocks with 18 rooms, some occupied by students on either a shared or single basis, and with others for visitors.

FURTHER INFORMATION

For further information on The Swire Institute of Marine Science and its activities, please contact:

The Director
The Swire Institute of Marine Science
The University of Hong Kong
Cape d'Aguilar, Shek O, Hong Kong
Tel (852) 28092179
Fax (852) 28092197
E-mail: SWIREML@HKUCC.BITNET

Industrial Pollution Control Policies in Asia: How Successful Are the Strategies?

A. Markandya and A. Shibli

INTRODUCTION

Background

The fastest growing region in the world, Asia has witnessed a remarkable increase in the level of economic activity over the last quarter of a century. Inevitably this has been accompanied by increases in emissions of pollutants, with the industrial sector being responsible for both the largest increases in output as well as environmental pollution. In the early years of this economic take off, policy makers paid little attention to the environment. Economic growth was *the* priority and imposing any restraints on that growth was seen as erroneous. Of course, some controls on emissions were in place, and some new ones were introduced, but the level of effort that went into environmental regulation remained very low. The same applied to investments in infrastructure to collect and treat industrial wastes. The public sector simply did not treat this as a priority category and the incentives or pressures on the private sector to undertake such investments remained weak or non-existent.

As the large economies in Asia have increased industrial output by orders of magnitude since the late 1960s, the realization that environmental protection is not a luxury but a necessity has become clear to policy makers. As this survey shows, health concerns about industrial wastes in air, water and soil have increased substantially in recent years. As a result, governments have introduced a number of measures to control pollution and to treat industrial wastes. The underlying philosophy behind the measures has been a 'command-and-control' one; polluters are required to adopt certain cleaner technologies, or to meet specified standards for emissions. But, as this survey shows, these measures have been much less successful than expected. Weak enforcement (few inspectors, small fines, and corruptible officials) and widespread exemptions are responsible for this state of affairs. Furthermore, the polluter pay principle, under which the party responsible for generating the pollution should pay for any measures to reduce or eliminate it, has not been generally observed. In many instances polluters asked for and received subsidies to install cleaner technologies and to control and treat wastes. In following these policies, it is important to note that the Asian countries are only doing what has been the standard practice in many OECD countries. The latter were more successful in their strategy for a number of reasons, among which better enforcement and monitoring were the main ones.

More recently, policy makers in the OECD countries have turned increasingly to 'market-based instruments' for pollution control. These are measures that use fiscal incentives to obtain the desired reduction in emissions, rather than imposing rigid technological and physical constraints on the polluters. The main reason for this shift in the advanced economies has been the realization that the command-and-control solutions were very costly in terms of resources. Making all polluters face the same regulations allowed for little flexibility in meeting a target level of environmental quality. In the US and elsewhere, this became apparent as the environmental standards that had to be met rose, and as the cost of

A. Markandya and A. Shibli, Harvard Institute for International Development (HIID), 1 Eliot Street, Cambridge, MA 02138, USA, Tel (617) 495–9173, Fax (617) 496–3956; A. Markandya, HIID Moscow Office, 34 Bolshaya Cheryomushkin Kaya 117259 Moscow, Russia, Tel (095)128–9385, Fax (095)124–9553.

meeting those standards, in terms of less industrial activity and more unemployment, became evident.

Initially the prevalent view was that market-based instruments were too sophisticated to be used in less developed economies. After all, it was argued, they had not proved themselves in developed economies; how could they be expected to work in circumstances where markets were less well developed? While there is some truth in the view that market-based instruments for environmental regulation are still evolving everywhere, there is no justification in the view that this evolution should not take place in developing countries at the same time as it takes place in developed countries. In some respects the imperative for using such instruments is even greater in the former. These countries can ill afford the higher costs of command-and-control strategies, and they have even less capacity for the larger enforcement infrastructure that command-and-control policies require. As this survey shows, many Asian societies are simply not accustomed to using litigation and court procedures to enforce pollution standards. As this survey also shows, there are some initial attempts to use and develop market based instruments for environmental regulation in Asia.

Structure of This Review

This paper reviews the development of industrial pollution control policies in Asia over the last 25 years. In collecting the material for this survey, the authors have drawn on material collected in the countries themselves, particularly in India, the Philippines, and Thailand, and from USAID's own programmes and studies carried out in Asia. The survey evaluates the effectiveness of different instruments used for environmental regulation, and analyses the factors that have influenced their effectiveness. In particular, it examines the use of market-based instruments and comments on their role in the country's industrial pollution control strategy in this region. Finally it offers some suggestions for ways of making pollution control more effective and more efficient.

Five countries have been selected for a detailed analysis of their policies. These are: China, India, Malaysia, the Philippines, and Thailand. Each of them is dealt with in detail below. After these five countries there are some general comments on the other countries in the region, including some comparisons with the five countries. Finally this paper offers some conclusions and recommendations for policy reform in this area of environmental regulation.

It should be noted that the pollution control framework is in a state of flux in this part of the world, and that changes in policies are being made all the time. Hence it cannot be guaranteed that the measures reported here will still be in place over the mid to long term, or that new policies will not have replaced existing ones. However, where changes are being actively considered, and where this is known, it has been pointed out.

CHINA

Background

Manufacturing growth in China has been very high in the last 25 years. Between 1965 and 1990 total industrial production increased from US$21 billion to $155 billion, a factor of 7.4. This surge has been even greater than the overall growth in national income and has brought about heightened concern regarding the environmental effects of this structural change in the economy.

In terms of water pollution, the amount of both industrial and household wastewater discharged into the environment is 30 to 40 million tons in 1980. Almost 2% of the wastewater, about 0.7 million tons, are treated in wastewater treatment facilities of which there are between 35 and 40 in the nation. The rest of the wastewater is discharged into rivers, lakes or sea without any treatment.

Air pollution is also serious. The main source of energy in China is coal; it accounts for about 70% of total energy production. In 1988, coal consumption in China required the disposal of approximately 100 million tons of ash, fly ash, and sludge. Around 80% of total energy is consumed by industry. The efficiency rate in the use of energy is about 28% and is quite low compared with Japan (around 50%) and Europe (around 42%). More than half of the factories which use coal have neither a dust collector nor sulphur emission control equipment. Total sulfur dioxide emissions from China are approximately 18 million tons, with around 7 million tons produced from the power industry.

Example: Beijing's Industrial Pollution

There are some 5,700 industrial enterprises (excluding township and village enterprises) in Beijing,

employing 1.7 million people. They produce about 1 million cubic metres per day of wastewater, contributing approximately 45% of the volume and 60% of the total water pollution load in the municipality. In addition, they produce 24% of the soot and dust emissions of the city, and 4 million tons of industrial solid wastes each year, of which 267,000 tons are toxic and hazardous. Half of these enterprises, producing 70% of the output, are in the most densely populated 5% of the land in the municipality. Most polluting industries are being moved out of these densely populated areas, and occasionally the moving costs are financed by the sale of the land. Others are simply being shut down.

The most common industrial approach to pollution control in Beijing has been through end-of-pipe (EOP) technologies. By 1988 a total of 692 wastewater treatment plants had been installed in factories in Beijing. However, a survey showed that many of the EOP treatment systems were not being operated because of the high electricity demands and high operating costs. As a result, the municipality now favors a cost-effectiveness approach to the solution of individual industrial pollution problems. In many cases, this leads to pollution prevention at source through technical transformation, rather than EOP treatment.

Environmental Policy in China

Chinese environmental policy received a great boost from the Stockholm Conference on the Human Environment in 1972. Following that conference, the 1978 Constitution of China made a firm commitment to environmental protection. Subsection 3 of Section XI of that constitution states that 'the state protects environment and natural resources and it also prevents and eliminates pollution and other public nuisances'. The Environmental Protection Law (Trial Enforcement), based on this constitution was promulgated in 1979. Subsequently other laws were enacted, for air (1985), water (1985), and toxic wastes (1989).

These legislations have been accompanied by a reorganization of the administrative structure of environmental protection. The National Environmental Protection Agency has been established and charged with overall responsibility for environmental protection and coordination.

Chinese environmental policy has been fashioned basically on a 'command-and-control' approach. The policy toward individual firms consists mainly of urging them to adopt pollution control equipment at the time when they improve their equipment. The result is that existing policy applies only to firms that improve their technology. This implies that firms that delay technological improvements can continue to discharge pollutants into the environment. In this framework, effective pollution control can be achieved only when a large proportion of firms upgrade their equipment. Furthermore, in spite of the campaign for promotion of both economic development and environmental protection, it is considered acceptable not to install pollution control equipment before technological upgrading.

China's municipal and provincial governments have pursued detailed specialized strategies for small industrial enterprises called Wuxiao Gongye. In southern Jiangsu Province, these enterprises are growing by 15 to 20% per year, and they account for 45% of industrial output. They produce cement, iron and steel, chemical fertilizer, coal, and machinery. These small factories have contributed significantly to the environmental problem since they rely mainly on indigenous technology. The local governments have attempted to regulate these enterprises through relocations, closures, changes in the production line, changes in raw materials, pretreatment and common treatment facilities, and, in some cases, financial incentives.

Application of the Command-and-Control System

There is no overall evaluation of how effective the command-and-control policies for pollution control have been in China, although there are a number of studies that refer to continuing serious pollution problems, especially in the small scale industries. However, one case of a relatively successful control strategy has been the Pollution Discharge Permit System in Beijing. This has addressed water pollution problems from industrial enterprises in the city and achieved a reduction in COD discharges at a time when overall output from the enterprises was growing (see Case Study 1 below). However, what has not been assessed is the cost of the strategy, either in absolute terms or relative to other approaches that could have been pursued.

The Role of Economic Incentives in Pollution Control in China

Although the strategy for industrial pollution regu-

lation in China is mainly a 'command-and-control' one, there is some use of market-based and fiscal incentives. The Environment Protection Law (EPL) adopted the principle of economic incentives in the form of carrots for the accomplishment of and sticks for failure in pollution control. Positive incentives, such as tax reductions or tax elimination for a certain period on the products of a firm that sets up systems to reuse wastes, are designed to encourage factories to take measures to conserve resources and protect the environment.

China has introduced effluent charges for discharges from industrial plants in a nationwide scheme. The Provisional Law on Effluent Charge was put into force in July 1982. The scheme defines norms for the discharge of many pollutants on a nationwide basis. Enterprises are then required to pay a fee for discharges up to the norm, with the fee varying according to the pollutant. The system's original purpose was to induce individual firms to reduce the amount of pollutants discharged at source through economic incentives.

Effectiveness of Market-Based Incentives in China

Results from this system have been mixed. Even after a 40% increase in the fee level in 1991, it remained only about 0.1% of most enterprises' production cost. Clearly such a charge level is not enough to deter pollution.

CASE STUDY 1

The Pollution Discharge Permit System in Beijing

In recent years, Beijing has introduced a range of environmental management systems for reducing industrial pollution, including the pollution discharge permit and fee system. Other systems address environmental impact assessment and quantitative reporting; the design, construction and operation of pollution abatement facilities in coordination with production units; deadline control; and annual 'pragmatic' performance systems. Beijing has shown success in its development of strong regulatory (command and control) framework and environmental institutions, but has not widely incorporated market–based instruments in its efforts to reduce industrial pollution.

The pollutant discharge permit system is an approach that addresses phased pollution-loading reduction based on the results of environmental audits and pollution prevention — that is, clean technologies, reduced consumption of raw materials, energy efficiency, waste minimization, and EOP treatment only as needed. The Beijing Environmental Protection Bureau began by making an analysis of current pollution levels, goals, and required reductions. It then initiated detailed discussions with industrial enterprises to agree on reduction plans, involving a wide range of technical and managerial changes. Since Beijing focused on the control of heavy metals and major poisonous substances during the 1980's (and shows a 90% reduction in ambient levels of mercury, phenol, cyanogen, chromium, and arsenic), the pollutant discharge permit system was targeted on COD discharges (including organic BOD substances).

Investments are ranked using a ratio of COD reduction (measured in terms of COD discharge per unit of output) to 10,000 yuan investment, and the most cost effective approaches have consistently been new 'clean' or 'whole process control' technologies, as opposed to EOP treatment. On average, for every 10,000 yuan investment, whole-process control technologies (which are often imported) eliminated as much as 5.9 tons per year of COD discharge, as opposed to 1.8 tons for EOP investments — a three-fold difference. Projected production increases are also part of the analysis, with the condition that pollution increases due to increased output must be offset by further reductions either by the same enterprise, or those discharging pollutants into the same water area, or by other enterprises in the same subsector in the Beijing area.

The results between 1988 and 1990 for three of Beijing's largest chemical polluters were a 5% increase in output and a 6% (1,000 tons per year) decrease in COD discharges. It is projected that by 1995, total output will have risen by 50%, and COD discharges reduced by 16%. Comparable results are expected in other subsectors.

Source: Carter and Ramankutty, 1993.

Although the system uses charges and sets norms, it is weak in the way these charges and norms are determined. To be effective, charges have to be set at levels that are high enough to make installation of pollution control equipment or other methods of reducing emissions cost effective. In China this is not generally the case (Ueta 1988). Charges tend to be even lower than the operating costs associated with industrial pretreatment. Finally, charge schemes are only effective to the extent that the enterprises are cost conscious and concerned to be profitable. In China, where most enterprises are state owned, sensitivity to policies that use such economic incentives is low because the firms are not accountable for their high costs.

There are a number of other difficulties that have been identified with the system. Firms are allowed to dilute pollutants into large amounts of water to reduce the concentration levels of pollutants below the standards. Some cities, such as Shenyang, are considering the use of charge schemes based on total discharges rather than concentrations but these are not in place yet. The charge scheme is also rather crude in its treatment of different pollutants. If there is more than one pollutant from the same overflow or stack, the amount of the charge is based only on the most poisonous material. Finally the use of norms that are uniform nationwide ignores the differences in environmental damage and assimilative capacity in different parts of the country.

The main benefit that the charge scheme has had is to provide revenue for pollution prevention and control, although even in this area there have been problems. In Beijing, for example, 8% of all enterprises were charged fees in 1988, raising a total of 30.5 million yuan. This money is used partly to defray the administrative costs of the authority responsible for pollution control, partly to subsidize pollution control investment in individual firms and partly to support general research on development of appropriate pollution control technologies. The amounts going to administration can be quite high: in Shanghai 43% went to cover administrative costs but in Canton it was less than 20%.

The use of funds for pollution prevention investments has been based on criteria that are not always clear. Some enterprises have discovered that they can benefit from the subsidies if they make nominal charge payments and have pursued this strategy. Others have obtained funds from this source, not for pollution prevention investments but investments of a more general nature. The government is particularly concerned about this issue and is reviewing the kinds of investments supported by the environmental funds.

Conclusions on Industrial Pollution Control Strategies in China

There is no careful study of the effectiveness of China's pollution control strategy at this time. It would be a useful task to carry out such a study, which would show us where the major failures and successes have been and what reforms are needed. From the very partial picture available so far, it appears that some of the 'command-and-control' policies have been successful but others have not. Zhou (1982) pointed out that China's environmental problems are the result of poor implementation of the environmental protection plans, which are part of the five-year plans, and which detail targets that should be met in terms of pollution control. However, this begs the question of why the implementation was poor. Other sources suggest that it was due in part to the shortage of financial resources in the state enterprises that were supposed to carry out the investments, in part to the poor enforcement of pollution control regulations, and in part to the inadequate formulation of those regulations.[1] Nevertheless, there have been some successes, as has been shown in this review.

As far as market-based incentives are concerned, the system has yet to prove itself. The levels of charges are too low, the incentives they offer to enterprises too weak, and the use made of the revenues collected is too poorly directed to have had a major positive impact on pollution levels in the country. For enterprises that are in the state sector, which still hold for most of the large ones, financial incentives do not work in the same way as they do for private firms.

The theory of economic incentives is based on the assumption of a market economy. If a firm, faced with pollution charges, does not invest in pollution control equipment, the price of the commodity produced by the firm would increase making it less competitive in the market. However, China is not a market economy. For most goods there is excess demand. Therefore, even if the price of commodities produced by individual firms increase because of the pollution charge, the demand for these commodities will be in excess of current production level. As a result, firms have no incentive to adopt pollu-

tion control measures to cut costs and stay competitive. 'The charge system in China cannot be effective as a policy of encouraging individual firms' environmental protection activity unless some supplementary measure is carried out to modify the planned economy and allow a more flexible price system' (Ueta 1988).

INDIA

Background

Like many other developing countries at similar stages of development, India is only recently awakening to the problems of industrial pollution. While Indian industrial growth dates back to the nineteenth century, the industrial landscape changed substantially after Independence in 1947. The government of India, under the stewardship of Prime Minister Nehru and the Planning Commission chaired by Professor Moholanobis, embarked upon industrialization as a vehicle for self-reliance under the auspices of the Five Year Plans. Basic industries, including heavy industries, were set up by state-owned corporations, and private industrialists were given incentives in the non-reserved sectors. The policy of import-substitution along with tariff protection quickly led to rapid industrial growth. Industrial production quadrupled between 1965 to 1990, from US $22.21 billion to $85.77 billion — a growth rate of 3.9%.

Industrial and urban pollution in India has been increasing over the last few decades, and it has become very acute in recent years. The deaths of over 2,800 people in Bhopal from the methyl isocyanide gas leak at a Union Carbide pesticide plant in 1984 and the gas leak at the Sriram Food and Fertilizer plant in Delhi are only the most recent and egregious instances of the magnitude of the problem. The apparent laxity in enforcement of environmental laws has led to a strong citizen's movement, and citizens groups are frequently using the judicial system to force compliance with the environmental laws. In a very widely publicized case, a Supreme Court ruling in 1993 forced 212 industrial plants in and around Agra to close down due to the damage caused by them to human health and the Taj Mahal.

Status of Industrial Pollution

Provincial industrial output data shows that industrial activities are relatively concentrated in India, although less so than in Indonesia and China. Of the 25 states, Gujarat, Tamil Nadu, West Bengal, Uttar Pradesh and Maharashtra are most industrialized. About half of the industrial value added in India comes from industries located in the largest urban centres. Bombay, India's leading financial and business center, has just over 1% of the country's population, but it generates 10% of India's industrial jobs and handles more than a quarter of foreign trade (Carter and Ramankutty 1993). It is often difficult to distinguish between observed environmental degradation caused by industrialization and by urbanization. Bombay, Calcutta and Delhi are some of the most polluted cities in Asia — air pollutant levels exceed WHO guidelines most of the time. WHO data shows that of the 12 cities worldwide that received the worst ranking for air pollution in 1988, two were in India: Calcutta and Delhi. (Three other Asian cities in this category are: Beijing, Jakarta, and Shenyang.) Bombay, Calcutta and Delhi are among fifteen cities worldwide with the highest levels of particulate matter (Carter and Ramankutty 1993).

Pollution is also a serious problem in other industrial cities such as Ahmedabad, Bangalore, Dhanbad, Durgapur and Howrah. The Union (Federal) government compiled a list of 22 environmentally sensitive (i.e. problem) areas and this includes Dhanbad (in Bihar), Durgapur and Howrah (both in West Bengal). According to data complied by the Central Pollution Control Board (CPCB), Bihar is the most polluted state, followed by West Bengal and Orissa.

Problem Areas

The Policy Statement for Abatement of Pollution, issued by the government of India in 1992, identified the following problem areas in water and air pollution and noise nuisance.

Water Pollution

Water pollution was seen to be caused by four kinds of substances:

- waste generated from industrial processes
- chemical agents for fertilizers and pesticides
- traditional organic wastes
- silt from degraded catchments

The Policy Statement noted that while three-fourths by volume of the wastewater generated was

from municipal sources, industrial wastes, though small in volume, contributed over one half of the total pollutant load. The major portion of industrial wastes came from medium and large industries.

CPCB data shows that Damodar, the most polluted river, carries discharges from 43 major industries and scores of small scale units. It is estimated that in Delhi, 19,000 cubic metres of water containing DDT wastes are dumped into the Jamuna River daily. As many as 68 industrial units dump 1000 cubic metres of untreated water in the river Ganges (Ganga) every day. Industrial and municipal waste discharges have made segments of the Ganges, a sacred river whose water is used for drinking and bathing, unsuitable for bathing. The Ganges river carries industrial waste and untreated sewage of 114 cities, each with 50,000 or more inhabitants. It may be mentioned that of India's 3,119 towns and cities, only eight have full sewage collection and treatment facilities and 209 have partial facilities (Brandon and Ramankutty 1993).

Air Pollution

The Policy Statement noted that ambient air quality trends in major cities were showing levels of suspended particulate matter (SPM) much higher than the prescribed standards or limits, especially in the summer months. Levels of nitrogen oxide were also seen to be on the rise in urban centres due to increased vehicular emissions. As Table 1 shows, SPM levels exceed WHO standards on many days of the year in Calcutta and Delhi. By contrast, sulfur dioxide standards are still relatively less frequently exceeded.

In Indian cities, use of leaded gasoline in motor vehicles has resulted in high levels of lead in the environment in Ahmedabad, Bangalore and Calcutta. In terms of suspended particulate matter, Delhi is one of the two most polluted cities in Asia (the other being Bangkok) with Calcutta following very closely. Industrial pollution has contributed to high air pollution levels in many Indian cities and are comparable to air pollution in Chinese cities. These levels are generally higher than those of large cities of more industrialized countries, such as Tokyo, Osaka, New York, London, and Sao Paolo.

Noise Nuisance

Data on noise pollution (which is generated by vehicular traffic and aircraft, industry, construction activities, etc.) is hard to get and is incomplete. The average level of noise pollution in Bombay, Calcutta, and Delhi is 90 dB. This is higher than the noise levels in Manila and Bangkok (Shin *et al.*).

Strategy for Industrial Pollution Control in India

Indian industrial pollution control policy has, until recently, been based almost exclusively on a 'command-and-control' approach. Standards,

Table 1
Air Pollution in Selected Cities in India

	Sulfur Dioxide				*Gravimetrically Determined SPM*			
	Number of days over 150 µg/cubic metre				*Number of days over 230 µg/cubic metre*			
	Site Years	*Minimum*	*Average*	*Maximum*	*Site Years*	*Minimum*	*Average*	*Maximum*
Bombay	13	0	3	32	12	23	100	207
Calcutta	8	0	25	85	8	189	268	330
Delhi	12	0	6	49	12	212	294	338

Note: Air quality in selected cities is given for the number of site years of observations (number of sites multiplied by the number of years of operation) for sulfur dioxide (SO_2) and suspended particulate matter (SPM). These data are presented for the minimum, the average, and the maximum number of days that the pollutant exceeded WHO guidelines for all years of observation (site year). WHO recommends that SO_2 exposure should not exceed 150 micrograms (µg) per cubic metre on more than seven days a year. Many reporting cities exceed this level on an average basis. This is of particular concern for young children and people at risk of respiratory illness. The health effects of SPM are in part dependent on the biological and chemical makeup and acitivity of the particles. Heavy metal particles can be especially toxic. In this table gravimetrically determined suspended particulate matter measurements are shown and compared with the WHO guideline of 230 micrograms (µg) per cubic metre.

Source: World Resources Institute, *World Resources 1990–91* (cited in Panayotou, 1991).

licences, fines, and cease and desist orders have been used with moderate degrees of success to regulate emissions. A few market-based instruments, mostly in the form of rebates and depreciation allowances, have also been used, but on a much smaller scale. In recent years, however, use of market-based incentives is getting greater attention, mainly in response to poor compliance with 'command-and-control' measures.

Industrial pollution control legislation goes back as far as the Indian Penal Code of 1860, which has some sections relating to the environment (Pachauri 1994). The modern era of pollution control may be considered to have begun in 1972, after the Conference on the Human Environment held in that year in Stockholm. The first piece of legislation explicitly directed at protecting the environment was the Water (Prevention and Control of Pollution) Act, enacted in 1974. This and other acts are discussed briefly below.

The Water (Prevention and Control of Pollution) Act

The main features of this act are:

- The Central Pollution Control Board and the State Pollution Control Boards are to be set up.
- The State Boards are empowered to demand information from any person in order to ensure compliance with the act.
- The boards are authorized to close down certain activities which cause pollution.
- The 1988 amendment to the act requires that there should be no new discharge of trade effluent or sewage without permission of the State Boards.
- Non-compliance and some other acts of commission and omission are punishable by imprisonment and fines.

The Air (Prevention and Control of Pollution) Act of 1981

The Central and State Pollution Boards established under the Water Act were empowered by the Air Act also to prevent, control, and abate air pollution. The main features of this act are:

- The Central Board is to advise the central government on matters of air pollution, coordinate activities of the State Boards, and it specifies desirable air quality standards. The State Boards have a similar role within their respective states.
- State governments are empowered to declare any area within the state an air pollution control area after consulting the State Boards. In such areas, the government can regulate or prohibit the use of certain fuels, material, or appliances which may cause air pollution. The operation of any industrial plant in that area also requires prior permission of the government.
- A board may issue directions including closure, prohibition, or regulation of any industry, operation or process, stopping or control of water and power supply, and/or other services.

Environment Protection Act of 1986

A more comprehensive law providing for stringent penalties in the case of non-adoption of pollution control measures. Main features are:

- The government or an authority designated is expected to lay down standards, regulations, and rules for enforcement of comprehensive measures for the prevention and control of all types of pollution, including air and noise pollution.
- The rule-making powers broadly cover screening, testing, classification, standardization, powers of entry, inspection, examination, control, direction, closure or prosecution.
- A private citizen can also make a complaint to a court under the law for any violation of the act.

All these acts stipulate that non-compliance and other acts of commission and omission are punishable by imprisonment and fines.

Environmental Quality Standards and Environmental Protection Act (EPA) of 1986

The Ministry of Environment and Forests, under the EPA, 1986, has been empowered to impose standards for air and water quality. It frames minimum national standards which are binding for all industrial units throughout the country. These standards refer to the maximum limit of concentration of pollutants in the effluent and emission discharges. These standards cannot be relaxed, but they can be made more stringent by the SPCBs. The present standards are based on concentration of pollutants in the effluent and emissions discharges. However, mass-based standards have recently been laid down to set specific limits to encourage the minimization of waste and promote recycling and reuse of materials as well as conservation of natural resources, particularly water.

Apart from the minimum national standards specified for industry specific emissions, the government through various legislation has also specified National Ambient Air Quality Standards, emission regulations, and emission limits for vehicles.

What Has Been Achieved Under the Pollution Control Strategy

The Central Pollution Control Board (CPCB), constituted in September 1974 under the Water Act, is the apex board under the Ministry of Environment and Forests, and coordinates and guides all State Pollution Control Boards (SPCBs). The standards and regulations for pollution control are framed by CPCB and the Ministry of Forests. Also, all 25 states of the Union have SPCBs and are responsible for enforcing the regulations in their respective states.

The achievements under the various acts described above can be divided into those relating to the monitoring of environmental quality, enforcement of the legislative measures and overall effectiveness of the strategy.

Monitoring

As a result of the increased level of interest in environmental issues, and the strategy described above, India now has a fairly extensive monitoring system for air and water quality.

Air Quality Monitoring

The National Ambient Air Quality Monitoring Program (NAAQ) was started in 1984 with 28 stations spread over 7 cities. It now covers 290 stations in 99 major cities. Air quality monitoring at these stations is conducted by the respective State Boards with financial assistance from CPCB. Three basic parameters, namely, sulphur dioxide (SO_2), nitrogen oxide (NO_x), and suspended particulate matter (SPM), are monitored for 24 hours on alternate days.

Water Quality Monitoring

Inland Water Quality Monitoring (WQM) is currently being done under three major programmes:

- Global Environmental Monitoring Systems (GEMS)
- Monitoring of Indian National Aquatic Resources (MINARS)
- Ganga Action Plan (GAP)

There are now 480 WQM stations in the country, of which 51 are under the GEMS programme, 402 under the MINARS programme, and 27 under the GAP. In addition, recently nine Automatic Water Quality Monitoring Systems (AWQMS) were installed along the Ganga river and two along the Jamuna river to monitor water quality continuously.

Coastal Water Quality Monitoring

A monitoring network of 173 stations along the entire coast line of the country was established during the Seventh Five Year Plan.

Enforcement

Enforcement has been hampered by a lack of resources at the union and state levels. The number of industrial units are too numerous to be monitored by the administrative levels. However, in recent years, both government and the public (including NGOs) have taken a number of steps to improve the level of enforcement.

The government has constituted National Zonal Task Forces for the implementation of standards in industries like fertilizer, iron and steel, thermal power plants, cement, paper and pulp, and oil refineries. These Task Forces create a forum for industries and SPCBs to interact, disseminate the latest pollution control technologies to industries, and also inspect the pollution control systems and monitor the progress of implementation of standards.

The central government, in consultation with the states, has also evolved an action plan for controlling pollution from heavily polluting industries and critical areas. Nineteen such problem areas have been identified, surveyed and time targeted action plans have been framed out in consultation with the respective SPCBs. The heavily polluting industries that have been identified in the action plan are:

- *For Air Pollution Control:* cement, thermal power plants, iron and steel, fertilizer, zinc smelter, copper smelter, aluminum smelter and oil refineries.
- *For Water Pollution Control:* distilleries, fertilizer, paper and pulp, basic drugs, dyes and dye intermediaries, pesticides, oil refineries, petrochemicals, tanneries, sugar and pharmaceuticals.

Finally, the judicial system has been stepping in, taking over the role of the government and control authorities in an attempt to regulate pollution.

The Supreme Court of India has taken a number of landmark decisions, particularly shutting down hundreds of industrial plants, to enforce environmental compliance. The last few years have also seen an increase in the number of NGOs and other action groups fighting to close down polluting industries.

Effectiveness

There have not been many studies, thus far, to assess the effectiveness of the pollution control measures laid down by the government. Nonetheless, some aspects of effectiveness can be gleaned from two different sources:

- study by the National Institute of Public Finance and Policy (1993)
- data from the Central Pollution Control Board (1991–92 and 1992–93)

Study by National Institute of Public Finance and Policy

With regards to *air quality*:

- ambient levels of SPM, SO_2 and NOx were monitored in four cities (Delhi, Bombay, Calcutta and Madras);
- regulations were found to be most effective in Madras, followed by Calcutta, Delhi and Bombay in that order.

The study, however, cautions against drawing any inferences about the effectiveness of legislation. They point out that although ambient air quality standards have been laid down by the CPCB under the Air Act of 1981, the actual enforcement measures, penalties, etc. authorized by this piece of legislation all relate to source specific emission standards and not ambient air quality. They therefore feel that it is quite possible that there is no violation of source specific standards at all and yet the ambient standards are violated, simply because the source specific standards have not been made consistent with the ambient standards in terms of the pollution causing activities.

With regards to *water quality*, the study focused on the parameters in terms of BOD and coliform count and found that:

- contrary to popular belief, the extent of standard violation fell distinctly for the country as a whole in the post-regulation period;
- the acts have reduced BOD standard violations, but were ineffective in reducing coliform standard violations.

Data from CPCB

The data shows that:

- out of 1641 large and medium scale units in 18 polluting industries, only 117 comply with the norms;
- about 70% of the 174 distilleries are not complying with the standards;
- cement and pharmaceutical industries have the best record of compliance, about 70% and 78% respectively;
- industry is responsible for about 40% of the total pollution, including one-half of the total pollutant load in water;
- currently industry spends Rs. 800 crores ($266 million) annually on pollution control.

An overall assessment of effectiveness, based on these two studies, concluded that implementation and enforcement of the various legislative acts have not been totally successful. 'When looking at actual air and water quality standards over the post-regulation period, it becomes evident that there has been no real improvement, and in some cases there has been a definite deterioration' (Pachauri 1994). This might, in part, be because the actual enforcement provisions of the control authorities relate to source pollution rather than ambient levels. This again points to the fact that there is a gap in the control regime, as it fails to link ambient and source standards in terms of the volume of polluting activities.

Finally it is important to note that very little attention has been paid to the *efficiency* of abatement, either in terms of minimizing the cost of achieving certain ambient standards, or comparing the social costs and benefits of abatement.

Use of Market-Based Instruments

In addition to the framework presented above, the government has also provided a few fiscal incentives to industrial enterprises to meet pollution norms. Mostly these have taken the form of investment tax credits, accelerated depreciation allowances for pollution control equipment and rebates from excise and import duties for such equipment. Particular measures that have been introduced include:[2]

Accelerated Depreciation for Corporate Tax Computation

The Income Tax Act of 1961 allows deduction of a certain percentage of the written down actual cost of capital assets, net of any subsidies and concessions, from gross profit in computing the base for levy of corporation tax. In 1983, for the first time, a higher rate of depreciation of 30% for pollution control equipment was allowed. This was finally raised to 100% in the 1993–94 budget.

Direct Tax Incentives

A provision introduced in the 1982 Income Tax Act allows deduction of contributions made by tax payers to any institution dedicated to conservation of natural resources. Another provision exempts from tax any capital gains arising from transfer of building, land, machinery, etc., for establishing business in a new place and thereby reducing industrial congestion.

Rebate on Customs or Excise Duties and Sales Tax

In March 1989, the basic custom duty for some specified pollution equipment was reduced to a concessional rate of 35%. The countervailing duty was also eliminated for such items. In March 1992, the auxiliary duty was also reduced to 5%.

Since March 1992, a rebate has been allowed on excise duty over 5% for specified pollution control equipment. In addition to the rebates on customs and excise duties levied by the central government, rebates on sales taxes have also been introduced by a number of states for specified pollution control equipment.

Pollution assessing equipment worth a maximum of Rs. 30 million per annum and consumables worth Rs. 10 million can be imported without paying customs duty with ceiling on individual items being Rs. 1 million and Rs. 0.1 million respectively.

Import duty has also been reduced for equipment used in solar energy and wind-operated power generation from 40% to 20%. Tariffs on selected energy-efficient products has also been reduced.[3]

Excise duty on bagasse and jute based products has been abolished.

Recently the government has begun to look more closely into the use of market-based instruments in other spheres. One area where there has been some success is the tanning industry. Traditionally a heavy polluter, the industry used to be controlled through effluent standards and specifications of technology (see Case Study 2 below). However, weak enforcement of existing firms (especially small ones) meant that pollution problems remained very severe in the areas where tanning is a major activity. The state authorities have attempted to tackle the problem with

CASE STUDY 2

Tanning Industry in India

The leather industry is the fourth largest foreign exchange earner in India. Tanning operations, due to a heavy concentration of organic constituents in their wastewater, contribute to the pollution of inland waterways. Considerable technical development has occurred in recent years in leather tanning, and cleaner processes are available. However, many obstacles remain to their widespread adoption.

Government policy is based on command-and-control type regulations. The effluent standards are: BOD: 30 mg/litre (max), suspended solids: 200 mg/litre. For new tanneries, provision for effluent treatment has been made mandatory before issuing licences. Environmental management of leather industries went into a fast track as a result of a Supreme Court verdict in 1987 (M.C. Mehta vs. Union of India) where polluting tanneries were asked to install adequate treatment units or close down.

In Kanpur, the Upflow Anaerobic Sludge Blanket (UASB) bioreactor project treats composite wastes from tanneries which are mixed with domestic sewage to reduce BOD load. In Tamil Nadu, the State Pollution Control Board, Tamil Nadu Leather Development Corporation Limited (TALCO), UNIDO, and other organizations are setting up a number of Common Effluent Treatment plants throughout the state to process wastewater on a 'fee for service' basis.

a mix of policies including demonstration of the cost effectiveness of primary treatment systems and the financing of collective treatment facilities through a mixture of grants and loans. These facilities would recover the cost of operations through charges on the tanneries that are obliged to deliver their waste to them. Systems of fair charges and cost sharing have been worked out and it is hoped that the arrangement can be extended to other areas with the operations being run by a private firm or by a cooperative.

Conclusions

India has recognized its environmental problems as serious over the last 20 years and has implemented a framework of laws to deal with them. The 'command-and-control' framework has been evaluated to some extent and, although there are some successes, there are also many areas where the measures have not been effective. Data from the Central Pollution Control Board shows widespread failures in compliance. At the same time resources in monitoring have been increased and more data becomes available, which should help. The government is also stepping up its efforts to improve enforcement.

There is a real difficulty is assessing the effectiveness of measures from ambient quality data because the controls are on emissions, and there is no link between the emissions levels and ambient measures. Nevertheless, the fact that several environmental quality measures have deteriorated in recent years implies the need for a more effective framework of pollution control.

The government is interested in introducing more market-based instruments and is studying the options at the present time. In February 1992 it issued a Policy Statement for Abatement of Pollution. In this statement it was noted that the state of the environment had continued to deteriorate. In view of this assessment of the current trend, the Policy Statement asserted that henceforth the emphasis of policy would shift from defining objectives to more practical concerns of implementation. To achieve the objectives, it was stated that maximum use would be made of a mix of instruments in the form of legislation and regulation, fiscal incentives, voluntary agreements, educational programmes, and informational campaigns.

The reorientation in the choice of policy instruments for pollution control reflects a number of important developments both inside and outside India. Internally, the failures of the 'command-and-control' approach to development have become more and more visible over the years. The economic philosophy of the current Indian government is based upon greater reliance on market forces and less on government regulation. Externally, the government has taken its lessons from the collapse of the command economies in Eastern Europe, the economic success of the market-based Asian economies, and the ever increasing use of market-based instruments for pollution control in other countries of the world.

The reformist government of Prime Minister Narasimha Rao has realized that a control oriented approach to environmental policy, as has been adopted by India thus far, is not very effective in achieving set standards, nor very efficient in terms of pollution control costs, nor easy to implement. What seems necessary is to introduce a set of economic instruments to supplement the regulatory mechanism, which would enable the development and adoption of cost-effective technologies to reduce pollution and generate revenues to finance monitoring and enforcement.

MALAYSIA

Background

Malaysia's manufacturing output increased eightfold between 1970 and 1992. In 1992 it accounted for 29.3%of the country's GDP, 44.1% of exports and 20.3%of employment. In the wake of this rapid industrial growth has come a series of pollution problems, the main among them being:

- suspended particulate discharges that cause air pollution;
- biological oxygen demand (BOD) discharges that cause water pollution; and
- toxicity discharges that affect all media.

Trends in manufacturing output and in the intensity of discharges show that particulate discharges increased in the initial phase of industrial growth but are now declining. BOD has declined consistently while toxic waste discharges have increased in recent years. A World Bank study has identified hazardous waste, reflecting the changing structure of the economy, as the principal industrial pollution problem in the coming years.

Industrial Pollution Control Strategy

The overall legal umbrella for pollution control in Malaysia is provided by an array of legislation. The Environmental Quality Act (EQA), 1974, contains the provisions regarding air pollution, noise pollution, degradation of land, pollution of inland waters and oil pollution. Fifteen regulations have been promulgated under the EQA, the latest of which are aimed at checking the increasing problem of hazardous waste.

The 1974 act also created the Department of Environment (DOE) in the Ministry of Science and Technology with the responsibility of monitoring compliance to the legislation and taking steps to enforce it. The DOE carries out this responsibility with a staff of 490 (1991 figures), of which 290 have professional or sub-professional qualifications. Owing to increasing demand, DOE staff is now fully stretched. The command-and-control approach to control pursued by the government has placed great pressure on the DOE staff and has heightened the search for alternative approaches.

The strategy for industrial pollution control in Malaysia has been a reliance on command-and-control type intervention, including ambient standards for air and water pollution, and effluent/emissions standards. In recent years, however, the country has relied a little more on market-based incentives, including fees, tax incentives, and deposit-refund systems, as well as on Environment Impact Assessment (EIA) requirement in an attempt to tackle pollution problems at an early stage.

Effluent Standards

The DOE has set a large number of ambient standards for air and water pollution, which do not appear to be excessively stringent and are similar to those in many East Asian economies. In practice, policy makers work with emissions standards measured as pollution load. For air pollution, emissions standards are measured in tons of pollution load while water pollution standards in Malaysia are given as concentration ratios of effluents. The effluent concentration standards for water in Malaysia are within international guidelines in general. For rubber and palm oil industry (which was the main source of water pollution in the past) the effluent standards, although adequate, are not as tough as those in Indonesia.

Standards have to be monitored. Monitoring is expensive and is done selectively in Malaysia. Palm oil and rubber sectors have good coverage with 42 and 33% respectively, of the firms being covered. Monitoring is focused on the larger polluters, which takes care of the bulk of emissions in these two sectors. Over 80% of the two sectors are in compliance. The rest of the industry is largely self-monitored. A public complaint system exists (811 such complaints were received in 1991, an increase of 24% over 1990), which triggers off investigations to determine whether standards are violated. This resulted in 45 prosecutions in 1991.

Effluent standards specified as concentration ratios require considerable resources for monitoring, since concentration standards can be met through dilution particularly if water is under-priced. Monitoring is effective in industries where polluters are clearly identified and point sources are few (as in the palm oil and rubber industry). However, for the industry as a whole, concentration standards are a very blunt instrument since monitoring on this scale would be prohibitively expensive.

An illustration of the difficulties in monitoring can be seen in the case of the industrial estate of Pasir Gudang. This rapidly growing estate is located in the state of Johor Bahru. The estate has only one officer in charge of monitoring pollution, who is not always able to determine whether standards are actually violated. He counts on additional support of the DOE representative in Johor Bahru who also has many demands on his time.

Use of Environmental Impact Assessment (EIA) in Malaysia

Malaysia has 39 prescribed activities requiring EIAs (mainly large-scale energy, transportation, infrastructure, agro-industries, waste treatment and disposal projects) for which EIA is mandatory. The number of EIA reports reviewed by the DOE have increased from 11 in 1988 to 174 in 1991. Of the 334 reports received so far only 30% were rejected because of their potential environmental damage. The review procedure has become more efficient over time — there was a decline in the review time from 6.6 months in 1988 to 4.3 months in 1991.

EIAs are a useful planning tool in addressing potentially serious problems at an early stage. Examples are locating industry away from centres of incompatible development (e.g., urban areas, tourist centres) and incorporating abatement technology in

plant design rather than retrofitting, which is very costly. Malaysia has used EIA judiciously, having made them mandatory in only carefully selected sectors and keeping the clearance time to a minimum.[4] A World Bank study comments that the 'judicious use of EIA has helped to avoid serious conflicts between the country's development and environmental objectives' (World Bank 1993).

Market-Based Incentives in Malaysia

Malaysia has introduced a system whereby polluters who exceed emissions limits can obtain a 'contravention licence' and pay an associated fee in the form of an abatement charge. In 1992 a total of 81 contravention licences were issued for air pollution and 72 for water pollution. Forty percent of these went to the food processing industry. Water effluent fees amounted to RM138,000 ($50,100). Such a system is a mixture of a command system (involving licences) and a market-based system (involving fees for pollution levels in excess of the limit). The amounts involved in the charges, however, appear to be quite small and there is no assessment of the overall effectiveness of the whole programme.

One programme that Malaysia has implemented and that has been studied in some depth is that of palm oil effluent. That the programme has been a success in pollution terms is not in doubt; pollution loads have fallen from a level of 81,000 tons of BOD in 1978 to around 1,800 tons in the mid-1980s. Given its novel features, it is worth looking at this programme in some detail.

Control of Palm Oil Effluent

1. *Environmental issues.* Crude Palm Oil (CPO) mills in the early 1970s disposed of their waste by dumping it, untreated, into the nearest body of water. The environmental impact of the palm oil effluent (POME) was to cause serious water pollution in almost every major river basin in peninsular Malaysia. Untreated POME discharge depletes the oxygen concentration in freshwater as it decomposes. This in turn depletes the populations of fish, prawns, and other aquatic animals that provided a significant share of the protein in the diets of riverine Malay villages in the 1960s and 1970s. Other negative effects of the effluent discharges were: increase in toxicity and malodorous compounds in water, reduction in fish and crop harvests, contamination of sources of drinking water in rural areas and sites of intakes for municipal water supplies for most cities and towns, and creation of breeding grounds for disease-bearing mosquitos.
2. *Strategy for regulation.* The Department for the Environment (DOE) announced the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations on 7 July 1977. The regulations required CPO mills to obtain a license and pay a license fee before they could operate. In their applications, mills needed to describe their system for treating and discharging POME. The regulations also imposed standards on eight parameters of POME, the key parameter being BOD (biological oxygen demand, a measure of oxygen-depleting potential). The license fee consisted of two parts — a flat processing fee and a variable effluent-related fee. The latter gave the DOE latitude to make the license fee equivalent to an effluent charge.
3. *Implementation.* In the first year (1978) of implementation of the system, the standard was set at 5,000 mg/L of BOD and was not mandatory, in recognition of the initial difficulties that would be faced by the industry. The effluent related license fee was set at US $3 per ton of BOD discharged up to the standard. In the following year, the BOD standard was made stricter (2,000 mg/L) and mandatory and progressive effluent charges were imposed to provide an incentive for establishment of waste treatment facilities. If the BOD concentration exceeded the prescribed standard, a surcharge was imposed equal to $100 per ton above the standard. The rates were set such that the annual fees for untreated discharge exceed at least the capital costs for building treatment facilities.
4. *Evaluation.* Despite a 50% increase in the number of palm oil mills between 1978 and 1982 and a steady increase in CPO production, the total BOD load released in public water bodies dropped steadily from 222 tons per day in 1978 to 58 tons in 1980, 19 tons in 1982, and 5 tons in 1984. Studies also show that these changes did not result in loss of competitiveness for the palm oil industry or production. During the period 1982–86, Malaysia's palm oil export sector lost only 5% of the value of output as a result of environmental regulations

that reduced allowable BOD discharges by 90%. The CPO sector lost even less — only about 1% of the value of production.

There were some efficiency losses. First, the charge was not set on the basis of marginal environmental damage costs, but based on the cost of capital investment in waste treatment facilities. Another source of inefficiency was the imposition of the charge on BOD load rather than volume of discharge. This might provide an incentive for intermedia substitution, from disposal in land to water, since the surcharge for land disposal was based on concentration. In terms of distributional effects, one study found large losses among primary input producers, the oil palm plantation sector, which bore over two-thirds of the total welfare losses of the industry.

5. *Comments.* A similar system is being implemented in Malaysia's rubber industry. The system for palm oil is still in effect, but has now lost part of its original rationale. Treatment facilities have become a licensing requirement and standard feature of palm oil mills. The surcharge for effluents above the standard is still enforced but is so low (having lost much of its real value to inflation) that it no longer acts as a compliance incentive and in any event is no longer necessary.

A study undertaken by the Palm Oil Research Institute of Malaysia (PORIM) concludes that palm oil effluent treatment costs are 3 to 6% of total mill processing cost, and about 0.7 and 1.4% of total cost of palm oil production. Given this low cost, it is not surprising that the majority of palm oil mills have installed treatment systems to reduce or avoid the payment of effluent charges. It is also important to note that the effluent charges levied in the palm oil sector allow for cost variation in abatement and thus are effective.

Conclusions

The overall system of pollution control in Malaysia has not been evaluated. Although there are several indicators that even the command-and-control framework is having difficulties in terms of inspection and monitoring, the evidence is patchy and the government is increasing its budgetary allocations in this area. The Sixth Plan (1990–95) has made a firm commitment to safeguarding the environment.

In terms of fiscal incentives, the country has made a number of moves that are still being implemented and that will need some time before they can be evaluated. These include the contravention licences, a deposit refund system (under review) and a tax relief system for those who install or implement pollution measures (MIDA).[5] The palm oil effluent case, however, demonstrates very well what can be achieved with a charge system linked to a pollution standard and a technology guideline. This should provide some hope for similar attempts in other areas.

THE PHILIPPINES

Background

The government of the Philippines has promoted industrialization ever since the 1950s, first by pursuing an import substitution strategy and later (from the 1980s) by emphasizing export-oriented production. In 1981 the government embarked on a structural adjustment programme which has shaped its current approach to industrialization — regional dispersion and rural-based industrialization.

The industrial sector exhibits a wide range of diversity both in terms of the size of business establishments and in the activities undertaken. The latter range from the virtually monopolistic petroleum industry, characterized by large-scale operations and low unemployment, to the food industry, which contributes the largest amount to manufacturing employment and where the enterprises range from the very large to the very small. Most industries, however, are dominated by a few large companies, many of which are concentrated in Metro Manila. At the same time there are a large number of small, diverse, often unregistered establishments that make up the informal industrial subsector.

Industrial Pollution

The National Environmental Protection Council (NEPC) classifies industry according to the extent of pollution they generate and the degree of hazard associated with their waste. The chemical and the petroleum industries are considered highly polluting and extremely hazardous. The cement, iron and steel, and non-ferrous basic metals industries are also classified as highly polluting, hazardous, as are sugar milling and refining, wine and spirits, textile spin-

ning, weaving and finishing, leather processing, pulp and paper, and soaps, cleansing preparation and toiletries. Somewhat less polluting, but extremely hazardous, industries include fertilizer and pesticides, synthetic resins, plastic materials, paints, varnishes and lacquer, tires and tubes, and rubber products.

Industrial activity in the Philippines has a number of direct environmental impacts:

- Water pollution arises from the discharge of wastes that are high in BOD and total suspended solids. The few major water polluting industrial outfits are scattered about the country.
- Air pollution arises from emissions of gases and particulates.
- Toxic and hazardous waste arises from the discharge of wastewater containing heavy metals, solvents, and acid/alkali wastes, primarily from the growing electronic and metal finishing industries.
- Non-toxic solid waste arises from disposal of materials such as packaging.

In almost all cases, pollution levels have been increasing in the past 25 years (where monitoring data is available). Particular concern is being expressed about lead and particulate levels in air (see Table 2) and several toxic elements in the water.

The high level of industrial pollution in the country is attributable to several factors, including:

Table 2
Ambient Air Quality in the Philippines, 1990
(Actual as a percentage of the standards)

Pollutant	*Philippines standard*	*WHO guideline*
Particulates (PM10)	170%	110%–170%
Sulfur Dioxide	2%–53%	2%–27%
Carbon Monoxide	140%	46%
Nitrogen Dioxide	42%–250%	20%–120%
Ozone	<1%	<1%
Lead	17%–260%	26%–780%

Note: The table shows 1990 levels of major pollutants in the Metro Manila Area. The levels are shown as a percentage of the Philippines proposed ambient quality standards, as well as the WHO guidelines. Lead level and particulate levels are of key concern, where as sulfur dioxide levels are within acceptable bounds. Although ozone levels are also apparently within acceptable bounds, sample sizes have often been inadequate to draw definitive conclusions.
Source: World Bank, 1993.

- *Old plant and equipment.* Technologies and processes employed in some industries are inefficient and outdated.
- *Lack of know-how.* The understanding of proper waste management and pollution reduction options is low.
- *Weak enforcement of environmental standards and permits.* Low rates of detection and enforcement result in low rates of compliance.
- *Nascent community awareness and influence.* In most regions of the country, public pressure is now just beginning to affect industry decision making, as evidenced by the increasing number of NGOs active in the urban/industrial environmental area.

Strategy for Industrial Pollution Control Strategy in the Philippines

Broadly speaking, the regulatory framework for environmental management in the Philippines has three aspects.[6]

1. Environmental Impact Statement (EIS) and Environmental Compliance Certificate (ECC)
2. Standards and rules (Command-and-control)
3. Market-based incentives (MBI)

EIS and ECC

The Environmental Impact Assessment (EIS) system currently serves both regulatory and planning functions. As a planning tool, its goal is to identify changes in project design that will reduce unacceptable environmental impacts by implementing the most cost-effective mitigation measures. But the EIS process also involves monitoring and evaluation following project implementation. In this sense, the Environmental Compliance Certificate (ECC), which certifies that the requirements of the EIS system have been met, is a regulatory tool used by the Department of Environmental and Natural Resources (DENR) to ensure that firms continue to comply with anti-pollution laws.

Quantitative and Regulatory Standards

The second aspect of the regulatory framework is the set of quantitative and regulatory standards that apply to industries and to energy and transport sources with respect to their inputs and waste discharges. Other instruments used in this so-called 'command-and-control' (CAC) approach are prohi-

bitions, limits and other controls, and permits and licenses. Under this approach, the environmental protection agency is responsible for standard setting, prescribing and recommending specific control technologies, and monitoring and enforcing individual firms' compliance with the standards and prescribed controls. In the Philippines, these standards are often source specific and apply to a variety of pollutants and quality criteria.

These standards are comprised of the following components:

1. Quantitative Ambient Standards — comprising the specific numerical ambient water and air quality targets for a given region at a given point in time (e.g., PM10 (24 hr.):150 $\mu g/m^3$);
2. Quantitative Effluent Standards — comprising the specific numerical standards for emissions to air, land or water for any given emission source (e.g., SO_2 emission from power plants (existing): 1.5 g/Ncm (grams per normal cubic metre); and,
3. Quantitative Input Standards — comprising the specific numerical standards for production inputs (such as fuel quality) or industrial processes (such as technology standards) (e.g., sulphur content in diesel: 1%).

Market-Based Instruments

The third aspect involves the economic policy environment, which comprises the specific price signals (or policies that influence price signals) that may influence the selection of technologies and the levels of emissions. While current environment policy in the Philippines is dominated by a command-and-control (CAC) regulatory framework, market-based incentives (MBI) are becoming more popular. The country's experience with such instruments is derived from: financial incentives (tax credits and income tax holidays), pollution charges (fees on mine wastes and tailings), industrial waste exchanges, a deposit refund system (soft drink bottles and containers), and a risk liability system.

Experience With the Pollution Control Strategy

Command-and-control Framework

The command-and-control framework is achieving patchy success in the Philippines. DENR has certainly made a number of attempts to improve effective implementation (see below), but there is a lack of resources. Visits to DENR offices revealed problems of lack of equipment, trained personnel and facilities. DENR is making an effort to decentralize monitoring and enforcement functions at the regional level and is introducing a few innovative schemes, One such scheme was the initiated in 1991 and is known as the 'dirty dozen scheme'. By targeting the most polluting industrial units in each region, it aims to improve the enforcement of pollution control. During the period it has been in place, the program has had some notable successes in forcing firms to install control equipment under the threat of closure ('cease and desist') by the regional offices.

The current penalty system is based on points with various infringements having different weights. The following factors with their corresponding weights determine the penalty (TR&D 1993):

- the duration of the violation — days (6.5)
- the present resource condition (5.5)
- capacity of source of pollution (4.5)
- average deviation from effluent or emissions standards (3.5)[7]

Industries are given three months to correct their violations before the fines are actually imposed. While the fines increase with the severity of the violation, the marginal rate of increase is constant. This feature tends to be regressive, in that increasingly polluting firms pay relatively low increments in fines. It has been found, for example, that the larger firms in the tanning industry find it economical to pay the fine rather than comply with the standard.

In controlling pollution from industry, the regulations have achieved greater success in securing compliance from large firms in pollution intensive subsectors. But even for these firms. DENR's attention (and its compliance statistics) has been mainly on getting them to install waste treatment systems or pollution control facilities rather than on ensuring that this equipment is operated properly.

The review of CAC environmental regulations in the Philippines is summarized in four general features of the system (World Bank 1993).

1. The implicit policy goals are ambitious and they attempt comprehensive coverage across sources. The water and air quality standards apply to all industrial establishments and power generation facilities regardless of size or pollution inten-

sity. Also, air and water quality regulations prescribe standards for a large number of parameters. For water quality, for instance, the effluent regulations prescribe effluent standards for 8 toxic substances and standards on 12 other parameters including BOD, COD, pH and colour. In addition, firms producing strong industrial wastes (defined as the BOD concentrations exceeding 3,000 mg/L) are subject to separate uniform standards regarding the BOD concentrations of their discharges. Similarly, although the EIS system applies to environmentally-critical projects or projects in environmentally-critical areas, the manner in which the latter is defined means that in practice every investment project could be required to obtain an environmental compliance certificate.

2. The regulatory framework relies on standards formulated in terms of discharges from individual sources, and these are typically uniform across different sources. For instance, the water quality regulations specify effluent standards (defined typically in terms of percentage reductions in pollutant concentrations) that apply to the discharges of each facility. For some parameters, the standards are more stringent for new plants than for existing facilities, but within each category the same limit applies to all sources irrespective of type of industry or process. The same is true of the air quality standards that apply to stationary as well as transport sources.
3. The policies currently in place to control pollution are all regulatory or command-and-control in nature. The air and water quality regulations as well as the EIS process specify emissions limits or mandate the use of specific control technologies. So, none of these regulations actually prices environmental damage (either through charges or the use of tradeable permits) or forces polluting firms and households to take account of those costs in their decision making. Rather, the attempt to alter their behaviour is made by regulators determining how stringent the limits on dischargers should be.
4. Some of the regulations to control pollution which are currently in place are faced with conflicting signals from other aspects of the sectoral policy regime. The most significant instance arises with regard to the pricing of fuels. The present system favors the use of diesel, fuel oil and domestic coal. This worsens the problems of PM10 emissions from trucks and jeepneys as well as from the use of high-sulphur fuel and more-polluting domestic coal in industries that generate their own power.

A recent World Bank study has pointed out that the Philippine regulatory structure currently in place has no clear set of policy priorities underlying it. Most forms of industrial pollution are subjected to a very broad set of regulations, while concurrently a large number of conflicting policy signals effectively renders these regulations ineffective in addressing the problems of greatest environmental significance. Also, given some of the economic costs and benefits associated with reducing pollution, the flaws of the existing system becomes clearer: the problems addressed by the existing regulations simply are not tackling the highest policy priorities.

Market-Based Instruments

So far the MBIs have been implemented on a small scale and their impacts are under review. However, a USAID funded study looked at these instruments recently (RCG/Hagler Bailly 1993). Its main findings, as well as those from a personal visit to the country, and meetings with DENR and other officials are summarized below.

Tax Incentives

Section 56 of the Environmental Code of the Philippines (PD 1152) provided tax incentives to encourage industry to install anti-pollution devices over a five-year period. These incentives, which expired in 1984, provided for:

- exemption of up to 50% of the tariff duties for the importation of pollution control devices;
- tax credits equivalent to 50% of the value of the tax and tariff duties that would have been paid had the pollution control equipment been imported.

Although this policy has not been formally assessed, some DENR officials feel that it was not successful because of implementation problems. Many companies used the incentives system as a loophole for securing tax exemptions and credits, even on equipment that was not used for pollution control.

Pollution Charge

The fee on mine wastes and tailings is the closest example of a pollution tax based on the 'polluter-pays' principle in the Philippines. Under DAO 85, DENR imposes a fee of P0.05 per ton (26 Peso = US$1) on mine wastes from metallic mines; P0.10 per ton on mine tailing from metallic mines for those using approved impoundments and those discharging to the sea by pipelines, launders, and tunnel; and P1.00 per ton on mine tailings discharged on impoundments not duly approved. Mines wastes and tailings puts to beneficial use (usually as filling materials for civil structures) are exempted from fines. This encourages recycling, and it diminishes damage to the environment.

However, current mining fees do not fully reflect the polluter- pays principle. First, the-compensation that the Mine Wastes and Tailings Damages Evaluation Committee awards to claimants is drawn from the reserve fund (representing accrued mine wastes and tailing fees collected for compensation, etc.) without identifying which company caused the damage. As a result, cross subsidization is created. Second, the current fees do not take into account the need to maintain the long-term integrity of the impoundments. Third, the compensation is only rewarded to private owners of damaged infrastructure, owners of private land, agri-cultural lessors and lessees, and share tenants; it excludes parties affected by pollution damage to common property.

Waste Exchange

The Industrial Waste Exchange Program (IWEP) was begun in 1987. It was implemented for four years in the National Capital Region, Cebu, Cagayan de Oro, Albay, Batangas, Laguna, Benguet, Cavite, Davao, Iloilo, and Zamboanga del Sur. The Environmental Management Bureau (EMB) assumed the role of an information centre and an in-formation broker on this project.

Companies listed themselves as suppliers or buyers of waste in the Listing Form, which became the basis of an annual, publicly available bulletin that contained a list of materials available for exchange. Interested buyers and suppliers sent letters of inquiry using the bulletin as a reference. IWEP then forwarded these letters to concerned companies. IWEP also offered such services as arranging for meetings, providing laboratory analysis, and disseminating technical information.

Unfortunately, IWEP was not sustained after its funding ran out. During discussions with industry, most participants claimed that they has not even heard of IWEP. A major reason why the project was not self-sustaining was that it was government-led, and industry was wary of submitting information to DENR. Of the country's 15,000 industrial firms listed in the last bulletin (December 1990), only 593 listed themselves under 'Materials Available' and 127 firms listed themselves under 'Materials Wanted.'

Deposit-Refund Systems

To date, the deposit-refund system has been used only for soft drink glass and plastic bottles in the Philippines. Initiatives have also been tried based on a system whereby a portion of the fee collected was channelled back into investments aimed at environmental preservation. These systems established a precedent for fees charged and brought back to the environment.

Risk-Liability Systems

To date, the only experience with risk-liability systems in the Philippines is through the Environmental Guarantee Fund (EGF) as part of the implementation of the country's Environmental Impact Statement System. The EGF is a financial arrangement placed on the project proponent and allocated specifically for environmental activities (i.e., rehabilitation, monitoring and payment of damages). It is managed by a multisectoral group whose primary concern is to address impacts and issues pertaining to the operation of the project. The EGF is established in three parts:

1. Multisectoral Monitoring Fund — provides periodic cash payments to cover all the expenses incurred by the monitoring team in conducting its monitoring activities.
2. Trust Fund — provides a trust account or performance bond that will be used to compensate aggrieved parties for any damages to life and property, and to finance environmental restoration and the rehabilitation of environmental quality caused by the project's operation, including its abandonment.
3. Cash Fund — is a joint account, managed by the EGF committee, used to implement companies' environmental management and rehabilitation programmes (these may include environmental maintenance and safety, ecosystems rehabilitation, environmental research,

community-based environmental programmes, environmental information campaigns and training, and the funding of periodic pollution management appraisals.)

There has been only limited application of the EGF. DENR/EMB reports that it has encountered two major contentious issues in attempting to negotiate EGF arrangements: the basis for computing EGF amounts and the company's opportunity cost for the funds that are put in trust.

Conclusions

This survey has shown that the Philippines has many issues that need to be addressed before its pollution control strategy can be considered effective and efficient. First, resources in monitoring and enforcing regulations need to be increased substantially. Related to this penalty levels have to raised as well. Second, environmental regulations need to be integrated with other aspects of economic policy. Controlling pollution and devoting resources to cleaning up emissions that have actually been encouraged by the fuel pricing policy makes little sense. Third, the system of regulation needs to give market-based instruments more of a role. Uniform standards are difficult to implement and, if successfully implemented, there are costly in terms of real resources.[8] The experience to date with MBIs has not been all that positive but that is partly because it was implemented in a very limited way and with many constraints and obstacles. In future a more comprehensive framework for MBIs in selected areas is needed, with strong political legal support and adequate financial resources to implement it successfully.

THAILAND

Background

Industrialization in Thailand, which began in the late 1950s, progressed rapidly in the last three decades. At the end of 1969 there were approximately 600 factories registered with the Department of Industrial Work (DIW) in the whole kingdom. This number jumped to 19,691 by the end of 1979 and to 51,500 by the end of 1989 (TDRI 1990). The number of polluting industries were only 211 in 1969, but had increased to 7,030 by 1979, and had reached 26,235 by 1989. This growth has been concentrated in the Bangkok Metropolitan Region (BMR) which accounts for 76% of the countries manufacturing value added.

Parallel to this rapid rate of industrial and urban growth, environmental quality has severely deteriorated. Several commentators have suggested that environmental degradation in BMR is not so much a consequence of urban and industrial growth as it is the result of the failure to supply urban and environmental infrastructure consistent with the pressures on the resource base resulting from economic growth. For example, during the 1980s, while industrial output of the BMR doubled, public infrastructure capacity — particularly sewage treatment, water supply, solid waste collection, and industrial waste treatment — to protect the environment remained almost unchanged.

The rapid growth of industrial pollution in Thailand in recent years is also a reflection of the structural change of industry away, from traditional food-processing industries, which generate biodegradable waste, toward large-scale, heavy industries, such as petrochemicals, which generate heavy metals and other hazardous wastes. It is projected that hazardous waste will grow from the current level of 1.9 to 5.8 million tonnes by 2001 (TDRI 1990). None of the 23 industrial estates currently have hazardous waste treatment facilities. There is only one industrial hazardous waste treatment centre (at Bang Khuntien, discussed below) and the bulk of hazardous waste is dumped freely into rivers and landfills or stored in drums. It is estimated that in Thailand, 600,000 tons of hazardous waste annually find their way into Thailand's rivers and canals where they mix with much larger quantities of untreated sewage to make several canals and sections of Tachin and Chao Phrya rivers anaerobic for part of the year and a potential health hazard (Panayotou 1991).

Given Thailand's relatively large size and the considerable assimilative capacity of its environment, the current level of industrialization and implied pollution load would not present a serious problem if it were evenly distributed throughout the country. While hazardous wastes would still be a problem, most other pollutants — especially biodegradable wastes — could be assimilated if widely distributed.

Unfortunately in Thailand (unlike Taiwan, for example), industry is highly concentrated in the BMR and its surrounding provinces, whose landscape, air and water bodies are receiving pollution levels far in excess of their assimilative capacity. Fifty-two percent

of industries (76% in terms of the GDP) are located in the BMR. This area also embraces 12 industrial estates out of 23 in 1989. Analysis of five heavily hazardous-waste producing industries (including basic metal, fabricated product, transport equipment, electrical machinery and chemicals) showed that 10,152 out of 15,126 factories are located in the BMR area and employ about 88% of the total number of workers occupied in these five industries.

In terms of air pollution, about 30% of total emitted sulfur dioxide (SO_2) is attributed to industrial activities and approximately 54% of industrial emissions of SO_2 are released within the BMR. Suspended particulate matter (SPM) levels are the highest in Asia. Industry emits about 21% of SPM, which is slightly less than that from power plants, which emit 33%. Vehicle generated gases (lead, carbon monoxide, hydrocarbons, nitrogen oxides and particulates) are expected to double by the year 2000. Currently the levels of CO, SPM and lead exceed the WHO guidelines. It is also anticipated that in the near future acid rain might pose a serious environmental problem. Power and industrial sectors are converting to the use of coal, particularly lignite, and by the year 2006, 32% of electricity generating capacity will be fired by lignite.

Case Study 3 below shows the increasing severity of health-related damages resulting from industrial pollution. Environmentally related health cases from 2 per 100,000 people in 1978 to nearly 9 in 1987. As Table 3 demonstrates, the levels of emissions will continue to rise over the next 16 years, unless significant pollution controls are undertaken. Therefore, we will witness a mass deterioration in environmental damage, particularly to health.

Table 3
Emissions Projection

Pollutant	*Level in 2011 (million tonne)*	*Increase (in percentage)*
SO_2	3	400
CO_2	389	450
HC	1.7	100
NO_x	2	400
CO	8.4	300
Lead	0.02	100*
SPM	1.6	200

* Thai government announced its decision to reduce lead in gasoline to 0.15 grams per litre.
Source: Thailand Development Research Institute, 1993.

A study by the Thailand Development Research Institute (TDRI 1990) shows some other features of the Thai industrial pollution scenario:

- Overall industrial pollution is expected to quadruple within the next 15 to 20 years and to have an increasing impact on human health, property, and the quality of life.
- Industrial pollution is currently concentrated in the BMR and will continue to be in the foreseeable future. There are indications, however, that some of the worse polluters are moving outside Bangkok and into the satellite provinces of the BMR.
- The 1980s were characterized by an increase in output from textiles, leather, chemicals, basic metals, and petrochemicals. The economic forecast for these industries in the 1990s shows high growth potential.
- The structural changes in industry and in production materials are leading to the emergence of new types of pollution problems in Thailand. A shift is occurring from traditional pollutants such as wastewater pollution in the form of BOD to more complex toxic pollutants including heavy metals, toxic air and water pollutants, and hazardous wastes.
- The Board of Investment (BOI) has provided investors with privileges and incentive packages in order to draw foreign investment, but has not used environmental impact assessments (EIAs) or pollution intensity per unit of the GDP among its selection criteria for these target industries. By neglecting this, it has accelerated the production of hazardous industrial waste. An analysis of BOI promoted industries indicated that the proportion of investment approved for hazardous-waste-generating industries increased from 25% in 1987 to 55% in 1989.

Strategy for Industrial Pollution Control Strategy in Thailand

Industrial pollution control in Thailand is based mainly on CAC instruments such as standards, screening (through EIAs), licenses, land use zoning, and fees backed by threat of fines and imprisonment in case of non-compliance. The government lays down effluent and ambient standards and waste treatment requirements. A potentially powerful tool is the environmental impact assessment (EIA) which is mandatory for new licenses.

CASE STUDY 3

Industrial Pollution and Health in Thailand

Industrial activity in Thailand has resulted in increasing occupational exposure of workers to toxic chemicals. As a result, Thai workers have experienced significant occupationally linked health problems. A survey of five regional hospitals in 1983 found that over 7% of total poisoning cases were occupationally related. In 1984, an investigation into occupational disease showed that the average lead levels in the blood of workers in various tasks at a Thai battery plant was in the range of 12 to 48 milligrams per 100 millilitres — implying that lead exposure in workers were 480 times greater than health standards. Since the study included less exposed workers, such as administrative staff, in its sample group, the health risk may be even more extreme than indicated in the study.

Another study performed by the Ministry of Public Health showed that the incidence of environmentally related health cases increased from 2.00 cases per 100,000 people in 1978 to 8.88 per 100,000 in 1987. These results are summarized below.

Two caveats are in order. First the studies do not indicate that adequate control groups were used to properly attribute all the impacts in the workplace. Lead ingestion, for example, is widespread, due to water pipes, paint, and particulates from leaded gasoline. Second, improved diagnosis and reporting will appear as higher incidence. Therefore, these data are perhaps better used to illustrate the seriousness of the problems than to show detailed trends.

Incidence of Occupational Disease per 100,000 Workers, 1978–1987

	1978	*1983*	*1987*	*Annual increase (%)*
Insecticide poisoning	1.97	4.76	8.64	17.9
Lead poisoning	0.01	0.02	0.1	29.2
Manganese, mercury and arsenic poisoning	0.01	0.01	0.04	16.7
Petroleum products poisoning	n.a.	n.a.	0.02	n.a.

Source: Ministry of Public Health, Thailand.

Source: Brandon and Ramakutty, 1993.

It is generally believed that the current policy is ineffective and its lack of enforcement has contributed to serious environmental degradations.[9] There have been some instances of using economic instruments, and there have been calls for greater use of these instruments in recent policy debates (see below).

A change in government policy was initiated in 1971 when it set up the Environmental Quality Committee after the public outcry over the pollution of Mae Klong river from sugar mill wastes. The concept of industrial pollution control was formulated under the Third Plan (1972–76) . In the Fourth Plan (1977–81), areas with high population density and heavy industrial concentration, such as BMR, were given priority in pollution control policy. The Fourth Plan also focused on deterioration of water quality, pollution from industrial plants, and noise pollution.

Legislative Framework

The Thai government has over time enacted several laws and regulations introducing effluent and emissions standards as well as ambient standards for various industrial pollutants. The key features of the legislation affecting industrial pollution are discussed below :

1. The Improvement and Conservation of National Environmental Quality Act of 1975 (NEQA) — The act, which was amended in 1978, created the National Environmental Board (NEB) and the Office of National Environment Board (ONEB) as its secretariat. The act introduced the concept of environmental quality standards, the requirement for EIAs in industrial permitting, and the use of 'emergency powers'. It established two sets of policy guidelines on water pollution: one for inland waters and the other

for marine coastal waters. EIA is considered to be the most powerful tool for environmental protection efforts of NEB.

2. The Public Health Act of 1941 (PHA) — While this legislation was enacted for prevention of diseases and provision of national health care, some sections provide legal authority for the prevention and abatement of water pollution. Under the act, environmental public nuisances embrace all sources of water, air, and noise pollution. The chief enforcement mechanisms are: abatement orders, judicial injunction, and criminal prosecution. Abatement orders, prohibition orders, or closing orders can be made by court injunctions. PHA currently offers the most effective legal controls for general pollution.
3. The Factory Act of 1969 (FAC) — The FAC provides the legal basis for establishment and control of industrial plants, and the Ministry of Industry (MOI) is vested with the power to administer FAC through ministerial regulations and notifications. The FAC was amended in 1975 to strengthen the environmental dimension of the original act. It is now the principal legislative mechanism for industrial wastewater pollution control, and allows the MOI to exercise the power to issue notifications for treatment of waste water and legal sanctions against violators. Monitoring and enforcement of this act is done by the Department of Industrial Works (DIW).
4. Investment Promotion Act of 1977 — Section 19 of this act has environmental protection measures. The act requires all new factories to install wastewater treatment facilities.
5. Industrial Estates Act of 1979 — This act allows Industrial Estate Authority of Thailand (IEAT) sole responsibility for overseeing environmental control of registered industries within estates.

Institutional Framework

Policy formulation and planning at the central level is done by the Office of the National Economic and Social Development Board (ONESDB) in the Prime Minister's Office, and the Office of National Environment Board (ONEB) in the Ministry of Science, Technology, and Energy (MOSTE). ONEB coordinates governmental environmental management, while the standards are set by National Environmental Board (NEB).

The execution of laws and regulations is done by ONEB, DOH (part of the Ministry of Public Health), and the DIW (part of the Ministry of Industry). The enforcement of industrial pollution rests with DIW's Industrial Environment Division (IED). IED is responsible for EIA report approval, and for pollution control measures proposed in factory license applications.

The Role of Economic Incentives

As is clear from the above, the basic structure of environmental regulation in Thailand is a command-and-control one. There are, however, some areas where economic incentives have been used as an instrument. One is the area of wastewater, where, as in India, collective treatment facilities have been set up, with firms being charged for using of the facilities, which is compulsory. The second area is solid waste collection and recycling, where there is a growing private sector involvement in solid waste collection. Finally, in the area of hazardous waste, collection and treatment are to be financed from levies on polluters. Some details of these applications are given below. Although they are important, and make a contribution to the control of pollution, they are still a small component of the total framework of regulation. Nevertheless, the ability of the public and private sectors to cooperate successfully in this way in tackling serious pollution problems is a positive indication of what can be achieved.

The government is considering extending economic incentives to other areas, such as air and water pollution emissions, but this remains to be implemented.

1. *Wastewater.* Usually wastewater treatment is funded by the government. However, Thailand experimented with the 'polluter pays principle' and charged the firms that pollute. The country's first central treatment facility for industrial wastewater treatment was set up in the 1970s at the Mae Klong river which had been polluted by effluent from sugar mills. It was financed by charges levied on industrial users. The basis for sharing operating and maintenance cost has evolved over the years from one that originally considered only the quantity of sugar cane processed, to one that gives increasing weight to the quantity and waste loading characteristics of the wastewater.

   In 1988, the Bang Khuntien Treatment

Center was set up by the Ministry of Industry to deal with heavy metal contaminated wastewater that was generated by 200 small- and medium-scale electroplating factories scattered around Bangkok. Between September 1988 and May 1990, 8,300 tons of hazardous waste from 46 electroplating and about 20 other factories was treated. A standard fee of 450 baht (25 baht = US$1) per ton is charged to the factory with adjustments for type of waste and distance from treatment site. A 'waste manifest system' is used to track the waste from the factory to the treatment facility to ensure no discharge along the way. A key element of the success of this operation is a contracting arrangement between the MOI and the factories involved to supply a given quantity of waste to the treatment center at an agreed upon cost which is sufficient to cover the facility's operating costs.

2. *Solid waste.* In Bangkok, solid waste recycling takes place not at government initiative, but due to the entrepreneurial instincts of the city's scavengers and collection workers. Each collection worker receives, on average, an extra 1,500 baht per month from recycling, which is a strong incentive for them to service their routes. Scavengers at disposal sites report that they earn 300 to 500 baht a week. Kitchen wastes from large restaurants and hotels are often given to farmers for pig feed.

   User charges in Thai urban areas are used to recover about 10% of costs of solid waste management. But a 1985 regulation enabled charges to be raised by 10 to 15 times. With these raised fees, the private sector is showing interest and the Bangkok Metropolitan Administration is already contracting private companies to collect solid waste (ADB 1993)

   Thailand is also considering a system of pollution taxes, but this remains to be implemented. However, the Industrial Finance Corporation of Thailand (IFCT) has a fund of $8 million per annum available for concessional financing for purchases of pollution abatement equipment. There is also an Environmental Fund, which was established for the same purpose in 1991, and it is financed by the government (US$20 million) and by a US$0.40 per litre tax on oil consumption.

3. *Hazardous wastes.* To control hazardous wastes from industrial sources, the Thai government has established an Industrial Environmental Fund in early 1991 with counterpart contributions from government and industry. In line with the 'polluter pays' principle, the fund is expected to be financed from waste charges that would be estimated for each industry and later verified by environmental auditing. The charge would be set at a level that covers the cost of transport, treatment, and disposal of hazardous wastes and provides a margin for running the programme. A charge of 1,000 baht per ton on the 600,000 tons of industrial hazardous wastes projected for 1991 would raise 600,000 million baht. This is only 0.3% of the GDP originating in the 17,000 industrial plants that generate hazardous wastes, or 1.5% of net profits. The proceeds would be used to establish and operate central treatment and disposal facilities for hazardous wastes collected from factories. Factories would deposit with the fund their waste charges for the entire year. Plants that attained lower waste per unit of output, as verified by accredited private environmental auditing firms, would then be eligible for rebates. The operation of the treatment and disposal facilities would be contracted out to private waste management firms through competitive bidding.

Effectiveness of the Pollution Control Strategy

Existing regulations and institutions, though appearing to be adequate on paper, have been largely ineffective in controlling industrial pollution. The factors contributing to this ineffectiveness range from diffusion of authority to lack of coordination and lax enforcement. Consider, for instance, the procedure for jointly implementing the Factory Act and the NEQA. The law requires that applications to the DIW for the establishment and operation of new factories above a certain size must be accompanied by an environmental impact assessment (EIA), which should be submitted for review to the NEB before licensing by the DIW. The NEB, in turn, conducts an internal review of the EIA, with no public participation (EIAs are treated as confidential) and recommends approval, modifications, or disapproval to the DIW. The NEB is not vested with the authority to prevent implementation of projects with an unsatisfactory EIA or to monitor and to enforce its recommendations or the agreed EIA provisions; it

can only recommend disapproval of a subsequent EIA submitted with a license renewal application. Even if the license is not renewed, the environmental damage caused by the failure to implement the earlier conditions remains.

Factory licensing often proves to be too blunt an instrument for industrial pollution control. The most notable application has been the case of a heavily polluting pineapple factory in Cha Am, whose license of operation was withdrawn after two years of ignoring warnings against wastewater dumping. However, this appears to be an exceptional case of applying the enclosure sanction. Violation of effluent standards by failing to treat waste does not carry fines but only warnings, even following repeated violations.

The same difficulties hold for BOI-promoted investments and industrial estate projects under the IEAT, which also require prior approval of an environmental impact assessment (EIA) by the ONEB. IEAT's overall organization does not indicate a real commitment to environmental responsibility, despite the existence of a site office for waste analysis. IEAT does not have an environmental unit, and of the 23 industrial estates in operation in 1989, none are known to have an operating hazardous waste treatment facility. While all industrial estates report having waste water treatment facilities, it is still not known how many actually operate, and at what level of treatment efficiency.

It is often argued that the problem is a lack of technical manpower and financial resources (e.g., White and Emani, quoted in TDRI, 1990). This is true to some extent. For example, the Industrial Environment Division of the DIW has only 43 staff for some 50,000 industrial plants (one staff for 350 factories) and a budget of only 1,900 baht per factory. These resources are grossly inadequate for implementation of regulations, monitoring, and enforcement. One also needs to mention that the instruments selected by the government, i.e., inflexible effluent standards or waste treatment requirements, are also responsible for the current state of industrial pollution, (TDRI, 1990).

Conclusions[10]

In Thailand, existing institutions and regulations for dealing with industrial pollution, designed under entirely different circumstances, are clearly inadequate for dealing with emerging industrial pollution problems. One problem is that existing institutions and regulations were put in place at a time when the country had less than 500 factories and was struggling to industrialize through generous incentives for import substitution. Thailand now has more than 50,000 factories and is one of the world's most rapid and successful export-oriented industrializing economies. In the 1960s, there were hardly any factories producing hazardous waste; today, 33% of all the factories in the country are hazardous-waste producers. Even in the 1970s there was hardly a river with a BOD load exceeding its assimilative capacity. Today, virtually every river in and around the BMR is at risk of becoming anaerobic.

The times have changed dramatically, but the institutions and regulations have changed only marginally. In addition, existing environmental regulations in Thailand, which are replicas of foreign regulations with a considerable time lag, have little grounding in Thai reality and culture and are, therefore, largely unenforceable. The fact that agencies responsible for their enforcement are not given the authority and the means for enforcement is symptomatic of this problem. Like many other developing countries that followed the environmental regulation example that developed countries set some 10 to 15 years ago, Thailand based its environmental regulations on command-and-control standard-setting instruments. These instruments set inflexible effluent standards or waste treatment requirements coupled with sanctions for non-compliance, rather than setting flexible, market-based mechanisms and incentives (such as proper pricing, pollution charges), which are now increasingly being used by the developed countries. While the conventional view is that market-based mechanisms are not as suitable for developing countries as command-and-control mechanisms, the reality is that, '. . . for cultural reasons, the Thai society is not given to litigation, and courts are used only when everything else fails. Each of the major environmental regulations nonetheless stipulates a term of imprisonment and/or fine for a violation of that regulation. . . .' (White and Emani, in TDRI, 1990). In Thailand, very few environmental violations reach the courts, and fines are negligible in comparison to the benefits gleaned from violations. On the other hand, the imperatives of the market are laws that one can only ignore to one's peril. Therefore, internalizing industrial pollution through proper pricing and other market-based incentives is even more necessary and suitable for

developing countries such as Thailand than for developed countries, especially if the objective is a measurable improvement of environmental quality.

There have been some tentative steps in Thailand with the use of economic incentives for pollution control. Financing collective treatment facilities through user fees appears to work. The enterprises are willing to cooperate in the arrangement and to share costs on an equitable basis. This instrument can and should be extended. However, it cannot solve all pollution control problems. In some cases collective treatment is not the appropriate method; what is required is a charge on the polluter to encourage treatment or use of different inputs at the plant level. In other cases the flexibility required for cost effective pollution control can be achieved most effectively through tradeable permits.

Thailand will have to spend a great deal of money on pollution control in the next decade or two. At present it spends only about 0.24% of GNP in investments in this area, compared to an average 1.2% in the OECD. Estimates indicate that expenditures will have to rise by 20 to 25 per cent annually to meet even modest environmental quality objectives. With such large levels of investment it is all the more important that an efficient solution be implemented, so that reductions in emissions and improvements in environmental quality are brought about at the least cost. This will require increasing use of market-based instruments.

USE OF MARKET-BASED INSTRUMENTS IN OTHER ASIAN COUNTRIES

The other countries in Asia, like the five discussed above, have relied mainly on command-and-control to regulate environmental pollution and manage natural resources. However, there are a number of applications of the use of market-based instruments in these countries. This section looks briefly at those applications that are relevant to the industrial pollution control.

Bangladesh

To discourage the use of ozone depleting substances (ODS), Bangladesh has imposed a tax on the importation of such substances, as well as equipment and machinery using ODS. No further details of this scheme were available.

Bangladesh has a deposit refund scheme for soda bottles. It is an informal scheme introduced by retailers and without government intervention. Soft drink consumers leave a deposit with the retailer on purchase and get the money back on return. The system appears to work well. As in most developing countries, improper disposal of bottles is not a problem.

Indonesia

There is an unusual deposit refund scheme in Indonesia, under which forest concessionaires pay a deposit that is returned when the logged area has been reforested. However, as the fee is only a small fraction of the cost of replanting, the logger simply treats it as an additional cost and does not bother with the replanting. Even an increase of more than 100% would not be sufficient for the fee to have an incentive effect.

Indonesia has several other market-based instruments that impact on the environment, such as national park fees. However, there do not appear to be any that relate directly to industrial pollution.

Korea

Korea has introduced a deposit refund scheme for a number of products which contribute to waste disposal problems. They include food and beverage containers, pesticide containers, batteries, tires, lubricant oils and plastics. As of mid-1992, the deposits totalled $16.9 million while refunds amounted to only $38,000. This suggests that the system provides a very weak incentive to recovery of waste products, the main reason being the low level at which the fees have been set.

Korea has also recently started a pollution charge scheme for major emissions. Details were not available for this survey, except that the revenues will be used to provide long-term, low-interest loans to stimulate pollution control investment in the private sector.

Singapore

A somewhat exceptional country in the Asian context, Singapore has introduced a sophisticated system of auctionable permits for the consumption of ozone depleting substances (ODS). In this it offers the one example of the use of tradeable permits in Asia.

Each quarter the national quota of ODS are allocated among importers and users, half on the basis of historic consumption and half through an auction. Importers and users must register to participate in a tender process conducted by sealed bid, in which each firm indicates the amount of ODS it would like to purchase and its offer price. Bids are then ranked by price and the lowest winning bid (i.e. the one that clears the market) serves as the quota price for the full allotment of ODS, including the 50% that was allotted on the basis of historic consumption. There is a sufficiently large number of bidders to establish competitive conditions, as indicated by the rapid increase in quota prices during the first few rounds of bidding (i.e. before firms had made a serious effort at conservation and substitution). The auction allows the government to capture a sizeable portion of the quota rents, which can then be used to subsidize recycling services and the diffusion of alternative technologies.

WHAT HAVE WE LEARNED: A COMPARATIVE ANALYSIS

Historically, the environmental management systems of all the countries reviewed in this study have relied heavily on command-and-control. Experimentation with the use of economic instruments has begun only recently and on a small scale. The countries differ widely in the length of their experience with regulatory approaches. While India, Korea, China and Indonesia continue to rely primarily on CAC, Taiwan, Thailand, and the Philippines appear to be inclined to experiment with the use of economic instruments. One partial explanation for the continued appeal of CAC in Korea could be its industrial structure, where a small number of very large firms (the chaebol) account for a sizeable share of industrial output and related industrial pollution. In that context, a targeted approach focusing on the worst offenders can be quite effective and monitoring costs are relatively low. A similar strategy was adopted by the Philippines in its 'dirty dozen' programme described before.

In Thailand and the Philippines, the industrial structure is markedly different, with many more small and medium-sized enterprises that tend to be geographically dispersed. A straight CAC approach would not be so effective under the circumstances, though both countries have basically put in place such a regulatory framework (defining environmental quality standards). Moreover, the greater reliance on market incentives in these two countries is consistent with what appears to be a smaller overall government role in economic management than is the case in Korea and China.

Taxes Versus Subsidies

Governments have tended to prefer the use of subsidies to taxes and charges as means of influencing polluters' behaviour. Ironically, the 'polluter pays' principle, simply stated, does not allow for public subsidies to polluters to encourage them to undertake investments and modifications that they should do anyway. However, more for political than economic reasons, many Asian countries rely on subsidies to meet their environmental policy objectives. These countries are India, Korea, the Philippines, Singapore, China and Taiwan.

In all cases, subsidies — if used — should focus on a finite period (such as five years) during which time the country's enforcement activities become binding (Brandon and Ramankutty 1993). Many Asian countries are now in such a period. However, after such a period has passed, the case for the continuation of subsidies weakens since industry has learned of tighter regulatory environment, public monitoring and enforcement have improved, and domestic environmental service industry has emerged to meet local needs. As illustrated in the case of China, subsidies are often misused to finance general investment and also builds a resistance to its withdrawal.

Taxes Too Low and Not Indexed

Where employed, taxes and charges have functioned principally as revenue sources rather than as incentives to behavioural change. For the most part, they have been set at levels which are too low to act as a major pollution deterrent. This has been the case in the Philippines, China and India. Also, if the pollution charge is fixed in nominal terms, inflation (which often runs into double-digit figures in many of these countries), drastically reduces the disincentive effect of these charges. Even if the charge rate is indexed to inflation, the timing of the rate adjustments and delays in announcing these charges diminish the pollution reduction impact of these charges. In some cases, the sheer magnitude of the

increase in tax or charge rates needed to achieve significant reductions in pollution could be expected to engender strong political resistance.

The reluctance and tentativeness with which economic incentives are being introduced does not create sufficient confidence in their durability to warrant behavioural changes and long-term investments. Moreover, when economic incentives begin to work, they lose their force (face value) due to inflation or political manipulation.

Marketable Permits

In none of the countries studied has there been a significant use of marketable permits as a policy instrument. This may reflect the unfamiliarity of the instrument as well as the limited capacities of environmental agencies in some countries to administer such a system effectively. Marketable permits require the creation of new institutional arrangements for monitoring the transactions in pollution permits. With little experience to date in the operation of pollution permits, even in developed countries, any country setting up such markets would effectively be a pioneer which would have to be willing to take risks and bear the costs of learning by doing. Singapore's system for ODS, discussed earlier, is one of the few examples of an operational tradeable permits.

Obstacles to Greater Adoption of MBIs

Whatever the merits of economic incentives and the experience in developing countries with their use, considerable obstacles prevent their wider adoption. First there is a lack of understanding of how these systems work, and of their impact on growth and income distribution. Often, they are dismissed as ways to appropriate poor people's resources or to reward polluters with a legal right to pollute. Some fear that economic incentives will raise the costs of production and make local industries less competitive in world markets. Because these systems raise the cost to the public, governments are concerned that they will be unpopular and government stability might be compromised. Command-and-control regulations appear safer, even if they are not cost effective.

These political concerns constrain not only the introduction of economic instruments, but also their effectiveness. Their limited acceptance has led to some charges and taxes being introduced with rates set at levels too low to change behaviour. While it is necessary for initial charges to be set low to elicit wide acceptance by industry and provide time for adjustment, a predictable schedule of escalation to meaningful levels must be provided to shape expectations, influence investment decisions, and stimulate innovations.

Soft Budget Problems

Economic instruments will be most effective when economic agents respond sensitively to changes in incentives, in the light of the pressures on them to minimize costs and maximize profits. We see from the experience of socialist countries such as China that complex and sophisticated systems of pollution charges may be highly ineffective in conditions where such charges have no influence on the aims that are actually pursued by managers, which may be only loosely connected to cost control and profit maximization. This problem will be most significant in countries where a substantial part, or even the majority, of major industrial enterprises is in parastatal control.

Cultural Factors

One other aspect of governance in some developing countries is worth noting, that casts a different light on the above argument. In highly industrialized societies, taxation of environmentally damaging behaviour is seen as an economic instrument, as opposed to the command-and-control instrument of legal regulation backed by fines. It is characteristic of many developing country situations that the decision to notice a breach of the law and to prosecute it, and with what degree of severity and what level, is distributed to very low levels. In other words, ordinary policemen, customs officers, and minor officials frequently extract informal payments for disregarding offences, or even for not inventing offenses. In these situations the distinction between regulations and fines on the one hand, and taxation on the other becomes blurred. The disadvantage of such informal taxation from the economic point of view remains, however, that the 'price' of environmental nuisance becomes highly variable between economic agents, and highly unpredictable. It therefore loses the advantages of taxation as an instrument.

Conditions for Success

Successful use of economic instruments in developing countries requires that a number of conditions be met. The important ones are:

1. The agency responsible for environmental policy must have technical knowledge to formulate and implement economic incentives, and polluters must have the knowledge to respond appropriately.
2. The legal structure must define property rights adequately and establish the authority to implement and enforce incentive systems.
3. Economic incentives are ineffective without reasonably competitive markets.
4. The responsible government agency must have the financial and administrative capacity to initiate, monitor, and enforce incentive programmes.
5. The application of economic incentives must be politically feasible.

Economic incentives that meet these five conditions reasonably well have a chance of success. Ideally, as well, success also requires that the incentives be effective, efficient, equitable, and flexible.

CONCLUSIONS AND RECOMMENDATIONS

An effective pollution control strategy needs a combination of command-and-control measures as well as market-based instruments. It also requires the different instruments to be coordinated, and pricing decisions in the economy in general to be integrated with the pollution control strategy. In reviewing the experience of these Asian countries, one must conclude that none of these conditions are met. The command-and-control measures are sometimes misdirected and often too weakly enforced to be effective. In many cases, the use of market-based instruments could do a better job. But there will always be a need for CAC measures, and it is the responsibility of the government to ensure that adequate resources are made available for the monitoring and enforcement of emissions, for these to work. Paradoxically, it may be through the use of market-based instruments such as charges and fees that enough resources will be mobilized for the CAC measures to be effectively implemented.

The few attempts at using MBIs in Asia cannot be said to present a picture of great success. While there have been a few cases of effective use of such measures, in many cases the applications have failed because the incentives were not strong enough (e.g. the taxes or charges were simply too low), and the commitment of the government to make the policy work was not really there. It would be useful for policy makers to study the successes and see how they can be replicated in other areas. In doing this they need not restrict themselves to neighboring countries, or even to Asia. Lessons are transferable from all parts of the world and we do not have that many good examples of MBIs. In particular, governments should look at ways in which (a) charges for emissions and (b) tradeable permit schemes can be introduced. Both these avoid the difficulties associated with subsidy schemes, where budgetary constraints and possible misuse of funds are real problems. If subsidies are justified they should come from revenues raised through charge and permit schemes. There is some evidence that this is happening, but there is much more potential for it to be extended.

If MBIs are to be adopted more widely, policy makers have to be convinced of their merits. This requires the kind of in-depth study referred to above, but it also requires key concerns of elected officials to be answered. These include

1. the distributional implications of the use of MBIs,
2. the implications on output and employment in the affected industries,
3. the costs of implementing such measures, and
4. the international trade implications of the measures.

All these can be addressed, but doing so implies a careful study of one or more instruments to meet clearly stated objectives. Presenting the results of the research simply and clearly is also important.

Although most of the discussion in this review has been of pollution control strategies as enacted by the departments or ministries of the environment, it is important to remember that market incentives which have environmental implications exist in other government departments as well. Governments can encourage or discourage pollution emissions through their pricing policies on energy inputs such as petroleum products and coal; on the pricing of electricity; on the delivery and collection of water; and on environmentally damaging inputs such as fertilizers and

pesticides. Although it is true to say that none of these countries price these resources and inputs to fully reflect their social costs, including environmental costs, they do vary considerably in the extent to which the prices deviate from the full social cost. As was pointed out in the review of the five countries, it is important to integrate such pricing decisions in the overall pollution control strategy. This appears generally not to be the case. There are even examples of governments subsidizing emissions through price subsidies while making the polluter pay through end-of-pipe cleanup (e.g. diesel subsidies). Integrated pollution control requires more inter-departmental cooperation than exists at present. One way in which this could be brought about is through an inter-ministerial council that would be responsible for the overall pollution control strategy and have the authority to make recommendations about taxation and pricing outside the narrow environmental domain.

NOTES

1. In fact it has been suggested that the state, in trying to ease it financial burden, has encouraged firms to limit their pollution control investments, thus deliberately failing to enforce some of its own environmental controls.
2. For details see Pachauri, 1994.
3. Warford *et al.*, 1993, p.110.
4. In contrast, EIA requirement in the Philippines is broad based, and it has been found that it can easily take over a year to get clearance.
5. MIDA gives incentives to encourage proper facilities for the storage, treatment, and disposal of hazardous wastes. 'Pioneer' status incentive for five years will be available to companies which are directly involved in the storage, treatment and disposal of toxic and hazardous wastes in an integrated manner. For these companies that are themselves waste generators and wish to establish facilities to store, treat or dispose of their wastes, either on-site or off-site, they would be eligible for a special allowance at an initial rate of 40% and an annual rate of 20% for all capital expenditure. As a further incentive to industry, MIDA will also extend the current import duty and sales tax exemption scheme for machinery, equipment, raw materials, and components to them for the storage, treatment and disposal of hazardous wastes.
6. Several voluntary schemes and corporate environmental programs initiated by Philippine businesses have also been implemented. See ARMDEV, 1993, for examples.
7. Overall points are calculated by multiplying the weights assigned to the factors by the categorical points which capture gradations in each of them. The over-all weighted scores correspond to particular levels of daily fines.
8. A feature of industrial pollution in the Philippines that has implications for the cost-effectiveness of alternative control policies is the heterogeneity of pollution sources in terms of costs of controlling discharges. These costs vary not only across subsectors, but even within the same industry across firms of different scales and with capital equipment of different vintages. For instance, within the textile and dyes industry, the average cost of installing secondary wastewater treatment varied from about P5/kg of BOD for the lowest-cost firm to almost P45/kg for the firm with the highest costs.

   The implications of the industrial structure in Philippines for industrial pollution control are twofold. First, because of the variation in control costs across firms, there would be sub- stantial savings in using market-based policies rather than regulatory instruments. The second implication, which follows from the great number of firms involved, is that measures to control pollution should economize on monitoring and enforcement requirement. This implies that policies should be based on more easily observable parameters such as output or input use (a second best option).
9. The Department of Industrial Work (DIW) is in charge of administering the factory Act and other acts relating to the operation of factories nationwide. However, it had a staff of 143 in 1989 and has difficulty performing its operations and enforcement functions nationwide.
10. The comments in the 'Conclusions' here draw on the discussions in TDRI, 1990.

REFERENCES

ARMDEV. 1993. 'Corporate Environmental Policies and Programs. Conference Proceedings,' prepared for Philippine Business for the Environment, Inc. Manila, March.

Brandon, Carter and R. Ramankutty. 1993. *Toward an Environmental Strategy for Asia.* World Bank Discussion Paper (224) Washington, D.C.: World Bank.

Pachauri, Shonali. 1994. *The Status of Industrial Pollution Control in India* , Mimeo. February.

Panayotou, Theo. 1991. *Environment and Development in Asia,* Cambridge.

RCG/Hagler Bailly. 1993 'Market-Based Instruments to Promote Pollution Reduction in the Philippines,' Draft Final Report to USAID, Washington, November.

Repetto, R. 1986. 'Appropriate Incentives in Public Irrigation Systems,' World Resources Institute, Washington, D.C., June.

Shin, Euisoon, et.al. (n.d.) *Valuing the Economic Impacts of Environmental Problems: Asian Cities*.

Thailand Development Research Institute. 1990. 'The Greening of Thai Industry: Producing More and Polluting Less,' Research Report, (5), Bangkok.

TR&D. 1993. 'Sustainable Urban and Industrial Environmental Management Review,' Report prepared for USAID Philippines.

Ueta, Kazuhiro. 1988. 'Dilemmas in Pollution Control Policy in Contemporary China,' The *Kyoto University Economic Review*, (LVIII) 2.

Warford, et. al. 1993. *Financing of Environmentally Sound Development*, Manila: Asia Development Bank.

World Bank. 1993. Malaysia. 'Managing Costs of Urban Pollution,' *Country Economic Report*, Washington, D.C., November.

World Bank. 1993. *Philippines Environmental Sector Study*. Washington, D.C., December.

Water Pollution Control and Sustainable Development in the Upper Nanpan River Basin in Yunnan Province, China

Wendong Tao

ABSTRACT

This paper examines water pollution and the associated disparity between supply and demand in the upper Nanpan river basin in Yunnan province, China. Countermeasures and improvement in environmental management instruments toward sustainable development are explored. Policy to prevent water-related environmental issues is emphasized so as to match the poor economic base with the needs to maintain rapid economic and social growth. During the accelerated transition of environmental management from control and minimization of end-of-pipe discharges to control of the whole production process, appropriate environmental management instruments are expected to be introduced.

Keywords: *Nanpan River, water pollution, water conservation, market-based instruments, sustainable development, environmental management*

INTRODUCTION

The Nanpan River runs for 677 km in Yunnan province of China. Owing to its heavy pollution, the Yunnan provincial government resolved to carry out water pollution control planning in the Nanpan River basin. Initial efforts were focused on the upper Nanpan River, which is 176 km in length with a drainage area of 3961 square kilometres.

The upper river basin covers parts of Qujing city, the second largest city in Yunnan province, and also parts of Luliang county. The most important urban centres are Qujing and Luliang with populations of 160,000 and 80,000 respectively. Industrial enterprises are mainly concentrated in five areas along the river: Huashan and Zhanyi towns, the northern and western parts of Qujing urban centre, Yuezhou town and Xiqiao industrial district of Luliang county. Industrial growth and urbanization have played an important role in poverty alleviation in the region. On the other hand, the river water quality and water supply deteriorated due to demographic growth and industrial development.

The monsoon climate brings to the region a mean annual rainfall of 811 mm in Qujing city and 736 mm in Luliang county, and 80% of the annual precipitation falls in the rainy season (May through October). The annual water resources per capita are 1642–1770 cubic metres, which is lower than that of Yunnan province as a whole (5490 m^3) and even the country as a whole (2545 m^3) (QWC 1991, LWC 1991). In order to meet the requirements of water resources for economic and social development, tens of waterlocks, 165 reservoirs and about a thousand pumping stations have been built on the upper river system to supply water for irrigation, industrial pro-

Wendong Tao, Yunnan Institute of Environmental Sciences, 23 Wang Jia Ba, Kunming 650034, China, Tel (0871) 415–4575, Fax (0871) 415–5472.

duction and urban daily life (QWC1991, LWC 1991). However, hydraulic projects have given rise to such a low river flow in the dry season (roughly 2 cubic metres/second) that the main stem of the river serves largely as a wastewater draining channel, and the reservoirs and waterlocks on the lower reaches end up storing the wastewater discharged upstream.

The combined water pollution and water resource shortage have reduced and will continue to hamper the long-term sustainable development of the local economy and society. It is urgent that water pollution be controlled comprehensively. In addition to treatment of industrial effluent and municipal sewage, the countermeasures emphasize economic instruments to prevent river water pollution and to mitigate water shortages. These countermeasures may be appropriate to other basins in China and also to other developing countries which are experiencing rapid economic growth and accelerated urbanization, while attempting to pay serious attention to environmental protection and resource conservation at the same time.

While this paper does not deal in depth with ecological issues, it is important to note a few points here as context for what follows. Forests cover 28.5% and 18.9% of the total areas of Qujing city and Luliang county respectively. With the exception of the past few years, the upper basin has been suffering a decrease in forested area, leading to enhanced water and soil erosion and accelerated sedimentation of reservoirs. Excessive amounts of chemical fertilizers and pesticides applied to cultivated land also contributed, to a certain degree, to the deterioration of the water environment in the basin.

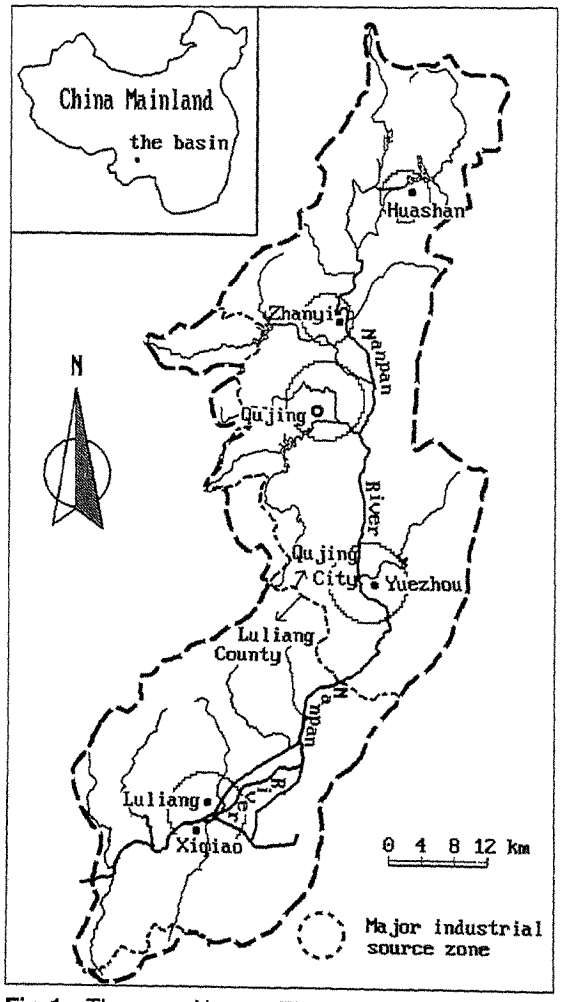

Fig. 1 The upper Nanpan River basin and distribution of the major industrial sources of water pollution.

SITUATION OF WATER QUALITY AND QUANTITY

Limited Water Resources Versus Inefficient Use

As mentioned above, limited water resources combined with vast seasonal and annual variations have resulted in a high level of water resources exploitation and subsequently, unsustainability of the water resources. The region is, at present, facing a water shortage. The water supply capacity and the annual water demand estimated as of 1993 is shown in Table 1. Substantial water shortfalls, especially in the downstream area in dry years and during most dry seasons, have generally presented a major challenge to the local social and economic development. Water distribution among the

Table 1
Estimation of Water Disparity Between Supply and Demand (in millions of cubic metres)

	Annual Assurance Rate		
	50%	*75%*	*95%*
Water supply capacity	483.84	433.82	352.82
Water demand	435.82	476.42	521.74
Disparity	+48.02	−42.60	−168.92

Source: Yunnan Institute of Environmental Sciences (Tao *et al.*), 1995.

Table 2
Water Consumption of the Top Six in Dustrial Water Users (1993)

User	*Freshwater consumption (1000s of tons)*	*(ton/1000 yuan* output value)*	*Recycling rate (%)*
Huashan town: Vinylon plant	9082.5	103.9	66.46
Zhanyi town: Fertilizer plant	7754.8	56.0	91.50
Qujing urban centre: Paper mill	940.0	104.6 (249 tons/ton paper)	7.39
Yuezhou town: Steelworks	1505.3	29.3 (18.4 tons/ton iron)	52.02
Luliang county town: Paper mill	1500.0	69.0 (244 tons/ton paper)	11.76
Luliang county town: Nitrogenous fertilizer plant	5894.4	246.9	31.03

Source: Tao, *et al.* (1995).
* 8.3 yuan = US$1

competing demands of agriculture, industry and urban residential use, has been a constant dilemma in the last decade. More importantly, further exploitation of water resources has not proved to be cost-effective because the total storage capacity of all the hydraulic engineering (292 million cubic metres) has amounted to only 24% of the total water resources deposit (1195 million cubic metres) and it has become difficult to locate feasible sites for additional large hydraulic projects.

Although the domestic water consumption per capita (121 litres/day in Qujing urban centre and 73 litres/day in Luliang county town) and the irrigating water quota (560–640 cubic metres per mu for paddy, where 15 mu = 1 ha) are at a low to medium level in Yunnan province, industrial freshwater consumption of 27 major water-polluting establishments is up to 25.5 tons for a thousand yuan (RMB) of gross output value (consumption and pollutant output of the top six industrial water users are presented in Table 2), which is considered a medium to high level in Yunnan province. To mitigate the conflict between supply and demand, emphasis should be given to: preventing construction of new projects with high water consumption and/or high wastewater discharge; saving water in the context of the whole production process; and reclaiming water for irrigation, industrial cooling and intermediate water supply system.

River Water Pollution

The local reservoirs, tributaries and ground water generally meet the water quality requirements (Class III) of the Surface Water Quality Standard of the People's Republic of China, for centralized drinking water sources. However, the main stem of the river is polluted seriously by domestic sewage and industrial effluent. In 1993, 33,400 tons of domestic sewage were discharged into the main stem per day without any treatment (Table 3). The 27 major industrial polluters, most of them built in the 1960s and 1970s, hold 56 sets of primary treatment facilities (the other 20 sit idle), but most of the industrial polluters still discharge effluents that could not meet the Integrated Wastewater Discharge Standard (IWDS) of China. It is necessary and technically possible to raise treatment efficiencies and to reinforce management of treatment facilities.

Interaction Between Quantity and Quality of River Water

From the long-term point of view, the magnitude of natural river flow played an important role in the water quality change, annually and seasonally. In particular, a network of reservoirs and waterlocks on the river system counteracted the dilution effect

Table 3
Distribution of Wastewater (1993)

Source	Volume (ton/year)	COD(ton/year)	5-day BOD (ton/year)	NH_3N (ton/year)
Zhanyi town	2,115,200	423.0	169.2	42.3
Qujing urban centre	8,880,000	1,760.0	704.0	176.0
Luliang town	1,276,000	226.7	102.2	27.1
Industry	17,786,800	12,326.8	5,313.9	1,480.5

Source: Tao *et al.* (1995).

of naturally recruited water on the river's polluted main stem. And, as most of the industrial water users were located near the main stem, serious water pollution made the construction of hydraulic projects ineffective. The main stem water quality could not meet the lowest requirement of the Surface Water Quality Standard (SWQS) of China. In other words, the river water is not suitable for any use. The degree of pollution is measured by the Chemical Oxygen Demand (COD), the Biochemical Oxygen Demand (BOD) and ammonia nitrogen (NH_3N) levels (ammonia nitrogen is the dominant form of nitrogen under conditions lacking dissolved oxygen in the river water). Some enterprises have no choice but to use the polluted river water and to suffer the consequential economic losses. Utilization of the heavily polluted river water resulted in several serious pollution episodes, such as a high incidence of fish death in ponds from 1991 to 1993 and the occurrence of a rice blight in 1993. The shallow wells in the vicinity of the river channel were also influenced by river water pollution. It is imperative that the utilization of water resources be coordinated with water quality management.

EVOLUTION OF WATER ENVIRONMENTAL ISSUES

The local governments have planned ambitious economic and social targets as shown in Table 4. More than 27 industrial projects have been proposed and all will discharge wastewater to some extent.

According to these targets it was estimated that the domestic and industrial wastewater would increase by 91% (to 57.38 million tons) by 2000 and by nearly three times (to 118.05 million tons) by 2010, and that the load growth of major pollutants would be 73% to 88% by 2000 and 183% to 286% by 2010 (Tao *et al.* 1995). Accordingly, river water pollution would be aggravated. It was expected the domestic and industrial fresh water demand would increase by 136% (to 170.36 million cubic metres) by 2000 and 323% (to 305.54 million cubic metres) by 2010 (1995). The local water conservancy agencies had tried to extend some of the existing reservoirs via caught runoff (LWC 1991, DIWCH 1993). However, the cost per unit of local water resources has become so high that they have to address the feasibility of water diversion from adjacent watersheds (LWC 1991, DIWCH 1993).

Table 4
Targets of Social and Economic Development

		Year 2000	Year 2010
Non-agricultural population	Huashan town	20,000	35,000
	Zhanyi town	25,000	35,000
	Qujing urban centre	255,000	402,000
	Yuezhou town	11,000	20,000
	Luliang county town	120,000	200,000
Industrial gross output value (billion yuan)	Qujing city (3.16 in 1993)	9.0	18.4
	Luliang county (0.33 in 1993)	1.5	3.9

Source: PCQC (1993), PCLC (1993).

COUNTERMEASURES TO ENVIRONMENTAL ISSUES

With respect to the awareness of the public and the governments to water environment issues, the provincial government requires comprehensive water pollution control planning to enable the sustainable development of the local society and economy. Local governments and relevant agencies have made substantial efforts to control water pollution and to provide fresh water for industry and urban daily life. However, environmental problems are still out of control. It must be recognized that the costs of controlling water pollution solely through wastewater treatment and the alleviation of water shortage via construction or extension of water supply projects, have become prohibitive in the basin. Comprehensive action should be adopted. Macro-economic instruments should be emphasized to match the poor economic base with the needs for rapid economic and social growth. Generally, incorporation of environmental protection and resource conservation into macro-economic policy is urgently needed to prevent the occurrence of environmental or resource-related problems. This approach costs much less than 'treatment after pollution'.

Adjustment of Industrial Structure

A diversified industrial system has been established in the upper Nanpan river basin. Key sectors include tobacco-processing, textile, chemical, metallurgy, paper-making, power and machinery industries. Unfortunately, textile, chemical and paper-making industries in this region use traditional technological processes, which consume a great deal of fresh water and produce vast amounts of pollutants. The existing industrial structure is irrational in the light of limited available water resources and the almost exhausted dilution capacity of the main stem in the dry season. So the governments must take macro-economic steps:

- limit construction projects for industries using traditional technological processes, especially in the textile, chemical and paper-making industries;
- encourage development of the high-tech industrial sector;
- stress development of printing, construction and building material manufacturing, machinery and light industries to serve as the key large-scale enterprises (eg. cigarette factories, power plants and automobile manufacturing) and urban construction.

Cleaner Production and Renovation

Because environmental impact assessments (EIAs) of new projects in China had adopted a concentration-control approach (i.e. pollutant concentrations at the discharge point must meet the IWDS of China), the design institutions preferred using cheaper fresh water to dilute effluents to meet the discharge standard. Less consideration to cleaner production slowed progress on water pollution prevention in the region. A shift of emphasis on effluent treatment and minimization of discharged wastewater to cleaner production will be a solution consistent with the reality of limited water resources and a poor local economic base.

Existing polluters need to update their production technologies to conserve water, since the potential for water-recycling is substantial. For example, the common fresh water consumption of the paper-manufacturing industry at the advanced international level in the 1980s was around 50 tons/ton paper (including pulping), but that of the two paper mills in the basin during that period, was 244 to 249 tons/ton paper. A successful project of the Ministry of Chemical Industry involved dissemination of a technological process with a closed-circuit water system throughout small-scale nitrogenous fertilizer plants in China. As a local example of what can be done, an Asian Development Bank loan supports the Yunnan Simao Pulp Mill's plan to phase out existing small-scale pulping processes in Yunnan province by supplying its own kraft bleach pulp beginning in 1997.

All proposed projects in the region should adopt cleaner technologies as much as possible. For example, the advanced international level of freshwater consumption of coal power plants in the 1980s was about 1 ton/million kW, but that of new projects in this region will still be more than 2 tons/million kW. The construction of the Qujing and Luliang development districts is under way. The two districts ought to provide for the whole region an impetus for promotion of cleaner production. In Yunnan's paper industry, there are preparations for the introduction of a state-of-the-art pulping process (alkaline hydrogen peroxide mechanical pulping), as well as the development of many other cleaner tech-

nologies. It is vital to expand these steps and this would be encouraged by the formulation of a local standard for cleaner production.

Development of Economies of Scale

Among the 21,000 industrial enterprises in Qujing city and Luliang county, there are only two large-scale and less than 20 medium-scale enterprises. Most rural industries in this region use old facilities, outmoded technologies and small scales of production. Development of rural industries in recent years has increased water consumption and water pollution. Environmental protection agencies tend to avoid the management of small-scale enterprises because of inadequate funding of the agencies and the large number of small enterprises. The most cost-effective countermeasures to prevent pollution from small-scale polluters may be macro-economic guides:

- avoiding duplicate construction, duplicate production and duplicate introduction of products;
- promoting regional cooperation, incorporation and specialization of production;
- formulating standards for economies of scale in major industrial sectors and for major industrial products, and especially avoiding smallscale production in the pulping, chemical and coking industries;
- encouraging townships and villages to develop agro-products processing, construction and building material manufacturing and waste reclamation industries;
- prohibiting the use of backward or outdated equipment and processes in rural enterprises;
- locating small-scale projects rationally with regards to water supply and pollution concerns.

Improvement of Industrial Distribution

The aforementioned five industrial regions discharge wasterwater as do the two major urban centres situated along the upper reaches of Nanpan River. This pattern of wastewater distribution makes centralized wastewater treatment difficult and river water utilization inconvenient. Huashan town is located near the source of the river and 36 km downstream is Zhanyi town. The two towns accommodate a few chemical plants, a paper mill and several textile factories which discharge about 60% of the total industrial effluent of the basin. The Qujing urban centre, about 17 km downstream from Zhanyi town, suffers heavy river water pollution due to wastewater discharge upstream. Yuezhou town, a metallurgical base, is located 47 km upstream of Luliang town and its discharge of wastewater affects the downstream agricultural water quality. Moreover, there are polluting plants in the source area of the river.

To summarize, the governments should adjust their macro-economic policies to eliminate heavy-polluting sources from the water source area, especially from the towns of Huashan, Zhanyi and Yuezhou, to mitigate conflicts between agriculture and industry and to improve water distribution among different river reaches.

Efficient Use of Water Resources

Considerable efforts have already been made in construction of water supply projects in the region. Capacity for further expansion is so cost-constrained that future emphasis should be on the beneficial and efficient use of available water resources (ie. on demand rather than supply). As examined above, the potential for water conservation is substantial and can be achieved by:

- upgrading the water storage capacity of existing and prospective reservoirs through sound management and maintenance of hydraulic projects, to supply water during the dry years and seasons;
- developing water-efficient agriculture and industry, and reinforcing sound management of water utilization throughout the whole production process;
- promoting application of highly efficient irrigation technologies (such as watering through low-pressure pipelines, spraying, trickling and microsprinkling along with leveling of land) and acceleration of anti-percolation treatment of irrigation ditches;
- encouraging water recycling and water reclamation by, for instance, development of intermediate water supply systems in the construction of high-tech economic development districts, and storage of domestic sewage for irrigation.

Domestic Sewage Treatment Versus Improvement of Drainage System

As shown in Table 3, the contribution of domestic sewage in the whole region to water pollution was

about 41% in volume and 16% in pollutant load (COD, BOD and ammonia nitrogen in the aggregate) in 1993 and is projected to be approximately 58% in volume and 59% in pollutant load in 2000 (Tao *et al.* 1995). Therefore, domestic sewage treatment will play an important role in water pollution control. It is recommended that urban wastewater treatment plants be set up with a total capacity of about 180,000 cubic metres/day in the Qujing urban area and 54,000 cubic metres/day in Luliang town, gradually during the next 15 years (Tao *et al.* 1995).

The two urban areas have combined sewage systems. To maintain an appropriate treatment efficiency, there is a need to improve the existing drainage system by: establishment of separate sewage systems; pretreatment of industrial effluents from individual polluters in the urban areas and; construction of main sewage collecting pipes (Tao *et al.* 1995).

Industrial Effluent Treatment and Water-saving

From the cost-benefit point of view, much work remains to be done to control industrial pollution throughout the whole production process, since the previous control approach primarily emphasized the control and minimization of end-pipe discharges. Process control will result not only in a decrease of pollutant loads, but will also be water-saving and can subsequently increase revenue. It was estimated that an investment of 29.45 million yuan in process control by the eight key industrial polluters would decrease wastewater production by about 11 million tons annually and generate a water-saving revenue of 545.5 million yuan annually (25 tons of fresh water consumption per thousand industrial gross output value) (Tao *et al.* 1995). At the same time, existing treatment facilities need to be operated properly and treatment efficiencies need to be raised.

ENVIRONMENTALLY SOUND MANAGEMENT

Nearly all the environmental management instruments approved by the National Environmental Protection Agency (NEPA) have been implemented in the region. Nevertheless, environmentally sound management should be reinforced and tailored in line with local realities.

New Trends of Industrial Environmental Management

Accelerated economic and population growth has produced more and more pollutant loads despite the fact that concentration control had been applied in the region in the last few years. Since 1992, the pollutant load control method (the total volume of a specific pollutant discharged by a polluter must meet or be below the permitted volume by a deadline) has been tested in Qujing city and has proved a success. Data collection on water polluters, strengthening of monitoring capacity and provision of national and local relevant laws and regulations, have made pollutant load control in the whole basin practical. Further examination to establish *load* control over major pollutants (COD, BOD and ammonia nitrogen) with *concentration* control over the less crucial pollutants (such as oil, volatile phenol, nitrite nitrogen, sulfide, lead, arsenic, elemental phosphorus and fluoride) and other pollutants, would be most appropriate (Tao *et al.* 1995). The major pollutants originate from a wide range of sources, but only a few sources contribute to the occurrence of the less crucial pollutants. It was estimated that the requirements for river water quality, in terms of the less crucial pollutants, could be met if concentration control is implemented smoothly to the year 2010. Concentrations of other pollutants (such as nitrate nitrogen, mercury, copper, zinc, cadmium and chromium) are within or already meet Class I or II of the SWQS of China, due to the relatively few number of sources. For the major pollutants of concern, the total permissible pollutant loads derived from the river water quality targets will be imposed upon the major polluters.

In line with the principles of equity and benefit, which are emphasized under the socialist economic market mechanism in China, there are two aspects of load control that need improving. Firstly, criteria for allocating the total permissible pollutant loads should be based on the discharge standards of pollutant loads instead of the existing pollutant quantities discharged by individual polluters. The latter encourages adoption of backward technologies and less consideration to pollution control; the former will facilitate the promotion of process control, economies of scale and cleaner production. With reference to China's Agenda 21, the discharge standard should be set at the advanced international level of the 1980s or 1990s. In preparation of the local discharge stand-

ard of pollutant loads, China's IWDS could be referred to temporarily. A national discharge standard for pollutant load will be promulgated in the near future.

Secondly, marketable permits offer a further market-based incentive system to meet pre-determined environmental quality targets at lower costs (Kalid 1994). More than 27 water polluters have been identified in the upper Nanpan River basin as capable of forming transferable discharge permit markets (Tao *et al.* 1995 and OTWPDPQC 1993). The region has a capacity for environmental monitoring to support transferable discharge permit markets. Interestingly, the aforementioned planning project found that the polluters themselves had a clear recognition of their water pollution control approaches and associated costs. The reason they did not put them into effect was due to poor financial support and weak environmental management policy. Nevertheless, it can be assumed that the basin holds a strong potential for the implementation of a transferable discharge permits programme.

Comprehensive Decision Making

Currently, the Environmental Protection Bureaus (EPBs) are subordinate to governments at all levels and are charged with the responsibility of supervision over and administration of water pollution prevention and control. The water conservancy agencies are subordinate to governments at or above county level and are responsible for the management of water resources. The planning commissions, subordinate to governments, have authority for formulating social and economic policy and approving construction projects. Under this kind of administrative system, extensive cooperation and consultation among administrative agencies becomes necessary. In particular, water conservancy agencies should consult with EPBs to determine an environmentally sound discharge standard when a hydraulic project is proposed; the urban construction departments should consult with the EPBs to coordinate the construction of sewer pipe networks with the building of sewage treatment plants; and the planning commissions should pay adequate attention to water environmental plans and water resource management plans, when formulating social and economic development plans and examining the proposed construction projects. Consultation and cooperation on water pollution control and water resource conservation among administrative regions within the whole basin are still poor. China's Agenda 21 pointed out that government agencies at all levels should conduct Sustainable Development Impact Assessments (SDIAs) when making major decisions on the proposition of key projects. It was recommended that an Environmental Protection Foundation of the Nanpan River Basin be established to pool funds from both abroad and the whole basin to support ad hoc programmes (Tao *et al.* 1995). Meanwhile, the foundation may be nominated as the executing institution for integrated decision making.

Improvement of Local Environmental and Resources Regulations

State laws and regulations for environmental protection and resource conservation will be improved gradually to support sustainable development. According to the characteristics of the water environment and resources in the region, enactment and enforcement of local environmental and resource regulations needs improvement. There should be formulation of local standards for water consumption per unit of industrial output and discharge standards of pollutant load per unit output to provide a basis for allocation of the total permissible pollutant loads and to promote cleaner production. Water resource charges and tap water charges should be adjusted. Existing water sources for industrial production in the basin include surface water, ground water and tap water. The industrial users pay 0.04 yuan per ton of natural water and 0.40 yuan for per ton of tap water. It was estimated that water consumption expenditure only made up about 1% of the total production cost and about 0.2% of the urban family's expenditure (Tao *et al.* 1995). Despite the severe water supply problems, water charges are so low that water reclamation and efficient use of water resources is not given proper attention in the basin.

CONCLUSION

Sustainable development is a concept of growing importance worldwide. Since China's Agenda 21 was adopted at the 16th Executive Meeting of the State Council of the People's Republic of China on 25 March 1994, local governments at all levels have attached great importance to the development of economy, society, resources and the environment in

a coordinated way. This paper gives some examples of local governments' efforts toward sustainable development. Like many other river basins in China, the Nanpan River basin has been suffering from water pollution and shortage, while its economy and society developed rapidly in the last few years. Environmental protection and water resource conservation has attracted the awareness of governments and the public toward the need for greater attention to long-term, sustainable development. Despite successful countermeasures to prevent and control water pollution and the increasingly efficient rationing of water resources in many river basins, much work remains to be done to disseminate and to apply the successful approaches to similar basins. This paper describes a system of countermeasures covering macro-economic instruments, treatment of wastewater, water conservation and reclamation, efficient use of water resources and environmentally sound management for the upper Nanpan river basin. However, technicalities governing the adjustment of water charges and coordination of water resource distribution and water quality management among administrative sections, remains a problem in the upper Nanpan basin.

ACKNOWLEDGMENTS

This paper presents the author's views expressed partly in the draft report of a planning project sponsored by local governments and the Yunnan EPB. The author wishes to thank all the researchers who participated in the project and all those who supported the research.

REFERENCES

Qujing Water Conservancy, QWC (1991). *Assessment Report on Water Resources Exploitation of Quijing City*. Qujing: Government printer.

Luliang Water Conservancy, LWC (1991). *Report on the Survey of Agricultural Natural Resources and Agricultural Regionisation of Luliang County* (Hydraulic Regionisation volume). Luliang: Government Printer.

Planning Commission of Luliang County, PCLC (1993). *The Ten Year Plan and Eighth Five Year Plan: Program for Development of the Economy and Society and the Adjustment of Industrial Structure of Luliang County*. Luliang: Government Printer.

Planning Commission of Qujing City, PCQC (1993). *The Eighth Five Year Plan and the Ten Year Plan for Scoio-economic Development of Qujing City*. Qujing: Government Printer.

Design Institute of Water Conservancy and Hydropower, DIWCH (1993). *Planning of Water Sources for Urban Water Supply of Qujing City*. Report Prepared for the Qujing City Government. Qujing: Government Printer.

Office of Tentative Water Pollutant Discharge Permits of Qujing City, OTWPDPQC (1993). *Study Of Pollutant Load Control in Qujing Catchment Area of Nanpan River*. Qujing: Government Printer.

Barron, W., (1994) *Market-based Versus Direct Control Environmental Policy Instruments: conceptual and practical considerations with selected examples from Hong Kong*. Hong Kong: Centre of Urban Planning and Environmental Management, the University of Hong Kong.

Kalid, Abdul Rahim (1994). 'Recent Developments in the Use of Economic Instruments in Environmental Policies,' *Asian Journal of Environmental Management* 2 (2): 129–34.

Tao, W., Zhou, B. Yan, Z., Wang, H., Li, S., Yang, W., Gong, Z., and Guo, H. (1995). *Water Pollution Prevention and Control Planning in the Qujing/Luliang Catchment Areas of the Nanpan River*. (Draft Report to the Supervisor Group for Water Pollution Control Planning in the Nanpan River Basin). Kunming: Yunnan Institute of Environmental Sciences.

China's Energy Conservation Potential: Longer-Term Environmental Implications

Binsheng Li, James P. Dorian and Kirk R. Smith

ABSTRACT

Since 1980, China has successfully implemented a broad-based energy conservation programme which has not only helped the country achieve rapid economic growth in a more environmentally benign manner, but may have also contributed to a reduction of global warming. Greater efforts are still required, however, to reduce energy waste and mismanagement and improve energy efficiencies in heavy industry. Energy conservation is achieved through a reduction of specific energy consumption, and a reduction of consumption of energy-intensive raw materials, in addition to overall economic structural changes. Over the long term, energy conservation will play an increasingly important role in China. This paper identifies areas for energy conservation in China specifically by examining opportunities in the nation's chemical, iron and steel, construction materials, electric-power, and residential sectors. Potential energy savings through structural changes in the huge Chinese economy are also analysed. On a national scale, the environmental implications of energy conservation in China are summarized in the paper.

Keywords: *energy conservation, industry, environmental implications*

INTRODUCTION AND BACKGROUND

Between 1980 and 1993, China's real GDP growth rate averaged 9.5% per year. If commercial energy consumption in China grew at the same speed as GDP, the country's additional energy consumption per year would have been about 850 million tonnes of coal equivalent (MTCE),[1] which in turn would have released about 530 million tonnes (Mt) more carbon into the atmosphere in 1993, in the form of CO_2 emissions (the main contributor to global warming). Remarkably, the growth of CO_2 emissions that did not materialize in China during this period would have been more than twice as large as the growth that actually took place in all the OECD countries combined between 1975 and 1987. The emissions in these countries were 194 Mt higher in 1987 than in 1975, although OECD energy-consumption growth was fairly small during this period (Kato *et al.* 1991).

Even at this moderate growth rate, the largest national fuel flow in the world today is Chinese coal.[2] This leads, in turn, to the largest emissions of carbon as CO_2. The growth of Chinese energy use, which is and will remain dominated by coal, is of keen interest to the entire world. This interest is evidenced by the number of recent studies directed toward understanding how much the inevitable growth in Chinese energy use could be tempered in coming decades (see, for example, Wu and Flynn 1995; Johnson *et al.* 1994; Siddiqi *et al.* 1994; Wang 1994; and Lu 1993).

Government projections indicate that China's

Binsheng Li, James P. Dorian and Kirk R. Smith, East-West Center, 1777 East-West Road, Honolulu, Hawaii, USA 96848; B. Li, Tel (808) 944–7356, Fax (808) 944–7559; J. Dorian, Tel (808) 944–7560, Fax (808)944–7559; K. Smith, Tel (808) 944–7519, Fax (808) 944–7298, Telex 989171, Cable EASWESCEN.

GDP growth rate will average 8.5% a year during the 1994–2000 period, and 6.5% during the 2001–2010 period (Wang 1994). If energy elasticity with respect to GDP remains at about 0.5, which is slightly below the level achieved in the 1980–1993 period, energy consumption would be 1,500 MTCE in 2000 and 2,060 MTCE by 2010. If elasticity should return to 1.0, however, the increase would be substantial: some 500 MTCE per year in 2000 and 1,640 MTCE per year in 2010.

Much of the decoupling of energy growth from economic growth in China achieved to date has been through economic and industry structural changes, including the switching to higher value-added products and services. Investments in these changes are generally made on the basis of a number of factors, most of which are more important than energy consumption. In contrast are investments in direct energy conservation, which give a return on capital due entirely or mainly to decreases in specific energy consumption.[3]

In this paper, the authors first define some basic energy conservation concepts, then review both historical and current attempts at energy conservation in China. The paper's primary intent is to estimate the potential of direct energy conservation in China's major energy consuming industries. The energy conservation potential identified in this paper is achievable through economically viable means and, thus, does not include the many technically feasible, but uneconomic, measures. The specific energy consumption levels and the associated technologies used in China's major energy consuming sectors are discussed. Potential improvements are estimated based on international comparisons, government targets, and financial restrictions.

To obtain a quantitative estimation of total energy conservation potential between 1994 and 2010, growth rates in output of major energy consuming products and services are projected based on official forecasts, historical growth rates, expectations of China's GDP growth rate, and correlations, if any, between output of these products and GDP. The authors realize that making projections of long-term output levels of products and services based on expected GDP growth rates is subject to error. However, the method was considered suitable, as the paper's main purpose is to provide a realistic assessment of the energy conservation potential of individual sectors, given reasonable growth rates in output of selected chemicals, iron and steel, construction materials and other products. The opportunities for reductions in energy intensity from indirect conservation and economic structural changes are also estimated.

A CONCEPTUAL REVIEW

In China, overall energy conservation is often defined as:

$$\begin{aligned} AEC_1 &= (EC_0 / GDP_1 - EC_1 / GDP_1) \times GDP_1 \\ &= EC_0 \times (GDP_1 / GDP_0) - EC_1 \end{aligned}$$

where AEC_1 is the amount of overall energy conservation in a reporting year relative to a base year, and EC_0, GDP_0, EC_1, and GDP_1 represent energy consumption and GDP (at constant values) in the base year and the reporting year, respectively (State Statistical Bureau 1991: 403). Both the denominator (overall energy use) and the numerator (GDP) used to calculate overall energy intensity[4] have been criticized, however, as misleading for measuring how efficiently individual nations utilize energy or how large their potential is for energy conservation:

1. *Denominator.* The overall commercial energy measure is imperfect because it often inappropriately weighs different kinds of energy for the purpose of aggregation, such as fossil, hydro, and nuclear power. It also leaves out entirely some important energy sources, primarily biomass fuels, which make up a substantial portion of energy use in developing countries (Smith 1987), including China where it accounts for about 20% of the total.[5]
2. *Numerator.* For some nations, GDP seems to be a poor indicator of true economic activity. Measures such as purchasing power parity (PPP) give quite different results, particularly for China and other nations with substantial state ownership of productive and consumptive assets (United Nations Development Program 1994). In terms of GDP, for example, China's economy is about one-third the size of the US economy, but in terms of PPP it is twice as big — an overall increase by a factor of about six. This makes a big difference in energy intensity comparisons (Siddiqi *et al.* 1994).

This is more than an argument for eschewing the use of national energy intensities in international comparisons, however. The GDP-PPP confusion also

introduces uncertainty in time-series economic data, because a considerable, but unknown, amount of the recent apparent growth in Chinese GDP is actually a shift from PPP to GDP, as the proportion of asset ownership by the state decreases. This shift would imply, for example, that overall Chinese energy elasticity in the 1980s has not been as impressive as it seems by just considering what might be called 'gross GDP growth'. 'Net economic growth,' which would take into account the shift in the PPP/GDP ratio, would be smaller.

It is for these reasons that this paper focuses on physical outputs rather than economic values in the analysis below. Although there are quality differences in a tonne of steel produced at different places at different times, the uncertainties that result are substantially smaller than comparisons by economic value. Thus, the authors neither make international comparisons of energy intensity nor infer China's overall energy conservation potential from energy intensity measures. This is because a relatively energy-intensive economy may or may not also be a relatively inefficient one (Smil 1994). Instead, the paper examines China's energy conservation potential sector by sector.

Overall energy conservation is actually achieved in three main ways:

1. reduction in specific energy consumption of goods and services, referred to as direct energy conservation in this paper;
2. reduction in specific consumption of energy-using raw materials, which is defined as indirect energy conservation in this paper;
3. energy conservation through economic and industry structural changes, and a move toward higher value-added production.

For purposes of this paper, the Chinese economy is divided into three basic industrial categories:[6]

1. agriculture, forestry, animal husbandry, household sideline production, and fisheries;
2. all heavy (primarily manufacturing) and light industrial sectors and construction;
3. services, transportation, commerce, the public sector, and all others.

Unit GDP energy consumption of all heavy (primarily manufacturing) and light industrial sectors as well as construction (also known as secondary industry) is much higher than in other industries. Therefore, a reduction in the share of the secondary industry in total GDP leads to reduced overall energy consumption. Within the secondary industry, unit GDP energy consumption varies widely between industries, with heavy industry having a much higher unit GDP energy consumption than light industry. Reforming the shares of GDP within the secondary industry is called industry structural adjustment in China.

HISTORICAL ASSESSMENT

Deliberate government measures to encourage energy conservation in China were formally begun in 1980, when conservation projects were included in national economic and social development plans. Between 1980 and 1993, the real GDP growth rate averaged 9.5% a year, in comparison with a growth rate averaging 4.9% a year for total primary commercial energy consumption (Table 1). The energy elasticity to GDP in China was only about 0.52 during this period,[7] compared with 1.6 during 1953–1980.[8] Relative to the elasticity in 1980, the imputed decrease in annual energy use in 1993 was 850 MTCE.

Changes in energy intensity of other Asia-Pacific Economic Cooperation (APEC) economies between 1980 and 1990 are listed in Table 2. China was second only to the United States among the APEC economies in overall energy reduction owing to changing energy intensities.

The bulk of the shift of energy intensity achieved in China has been by way of industrial structural changes and a switching to higher value-added products, although direct energy conservation also achieved great success.[9] Between 1980 and 1990, the government invested 17.2 billion yuan (US$1.98 billion)[10] in energy-conservation construction projects, which led to the installation of 35 MTCE of direct energy conservation capacity.[11] During the same period the government invested 10 billion yuan (US$1.15 billion) in energy conservation retrofitting projects, which added another 31 MTCE of energy conservation capacity (Table 3).

During this period the specific energy consumption for about two-thirds of China's total products was reduced. For example, the energy consumed to produce 1 tonne of steel was reduced by 21% from 2.04 tonnes of coal equivalent (TCE) to 1.61 TCE; the energy consumed to produce 1 tonne of synthetic ammonia in small factories was decreased by 22.5%, from 3.02 TCE to 2.34 TCE; and the energy consumed to produce 1 tonne of cement clinker was decreased by 10%, from 0.207 TCE to 0.185 TCE (Shen *et al.* 1992).

Table 1
GDP and Energy Consumption Growth Rates in China

Year	GDP Growth Index	Energy Consumption (MTCE)	Energy Conservation Relative to 1980 (MTCE)	Energy Conservation Relative to 1993 (MTCE)
1980	100	603		
1985	162	767	207	
1990	235	987	428	
1993	327	*1117*	*852*	
2000	*578*	*1495*		*491*
2010	*1086*	*2058*		*1666*
Growth Rate				
1980–1993	*9.5*	*4.9*		
1994–2000	*8.5*	*4.2*		
2001–2010	*6.5*	*3.3*		

Note: Numbers in italics are estimated by the Program on Resources: Energy and Minerals, East-West Center, and based on Chinese government projections and independent analyses of the Chinese national economy. For further information on key assumptions and methodologies used, readers are referred to Fesharaki, Clark, and Intarapravich 1995 and Johnson and Li 1994.
Source: State Statistical Bureau 1994.

Table 2
Energy Conservation in APEC Economies (1980–1990)

Economy	GDP in US$ Billion (Constant 1985) 1980	GDP in US$ Billion (Constant 1985) 1990	Primary Energy Consumption (MTCE) 1980	Primary Energy Consumption (MTCE) 1990	Energy Conservation[a] (MTCE) 1980–1990	Growth Rate 1980–1990 (%/Year) GDP	Growth Rate 1980–1990 (%/Year) Energy
United States	3442	4590	2573	2723	708	2.9	0.6
Japan	1118	1684	494	612	132	4.2	2.2
Canada	301	402	274	301	66	2.9	0.9
Australia	137	187	101	127	11	3.2	2.3
New Zealand	19	23	13	19	-4	1.9	4.3
China	148	344	614	1003	417	8.8	5.0
South Korea	62	151	60	128	17	9.3	7.9
Taiwan	45	94	41	71	14	7.7	5.8
Philippines	33	38	18	22	0	1.6	1.9
Hong Kong	26	49	7	14	-1	6.7	7.6
Malaysia	24	43	13	26	-2	5.9	7.0
Thailand	28	60	18	42	-4	7.7	8.8
Indonesia	64	119	39	77	-5	6.4	7.1
India	163	285	151	279	-14	5.8	6.3

[a] Energy conservation in 1990 relative to 1980.
Sources: (1) Asian Development Bank 1993 and 1992; and (2) OECD 1992.

Table 3
China's Investment in Energy Conservation Projects (1980–1990)

Type of Project	Investment (Billion Yuan)	Investment ($ Million[a])	EC capacity[b] (MTCE/Year)	Unit Capacity Investment (Yuan/TCE)	Unit Capacity Investment ($/TCE)
Total	27.2	3126	66.0	412	47
Total in Basic Construction	17.2	1977	35.0	491	56
Total in Retrofitting	10	1149	31.0	323	37
Cogeneration	9.5	1092	12.0	792	91
District Heating	1	115	2.3	442	51
Coal Gas Recovery			4.7		
Small Fertilizer			1.8		
Coal Washing and Mixing			2.8		

[a] Current exchange rate (US$1 = 8.7 yuan)
[b] Energy conservation capacity
Source: State Planning Commission 1992.

CHINA'S ENERGY CONSERVATION POTENTIAL

China's energy, unlike that of most developed countries, is consumed primarily by the industrial sectors (Table 4). The chemical, iron and steel, and construction-material industries are the three most important, together accounting for about one-third of China's total commercial energy consumption (Table 5). China's energy conservation efforts are therefore concentrated in these three industries as well as electric power generation, industrial boilers, and fans and pumps, which are commonly used throughout industry.

The Chemical Industry

There are five major energy-consuming products in China's chemical industry — chemical fertilizer, caustic soda, soda ash, calcium carbide, and yellow phosphorus — which, in 1990, accounted for more than 70% of energy consumption in the chemical industry. Chemical fertilizers alone accounted for about 58% of the total (Wang 1993). Thus, fertilizer production is the focal point of energy conservation measures in the chemical industry.

Between 1980 and 1993, chemical fertilizer production in China increased from 12.3 million tonnes (Mt) to 20.2 Mt[12] (State Statistical Bureau 1994: 80), and the growth rate of chemical fertilizer production averaged 4% a year. Even if it were assumed that the annual growth rate of chemical fertilizer production averaged 3.5% during the rest of the decade, and declined to 2.5% in the 2001–2010 period, production of chemical fertilizers in China would still reach 26 Mt by 2000 and 33 Mt by 2010.

In China, nitrogenous fertilizer accounts for around 77% of total chemical fertilizer production. Owing to the use of outdated and inefficient technology, specific energy consumption in China's nitrogenous fertilizer production is much higher than in advanced countries. More than three-quarters of nitrogenous fertilizer production capacity in China uses technologies of the 1950s and 1960s. Moreover, even the imported, large facilities are using technologies of the early 1970s, with specific energy consumption about 20% higher than in advanced countries (Wang 1993).

In 1990, it took 3.38 TCE per tonne of chemical fertilizer on average to produce 18.8 Mt (100% effective composition), while 49.6 MTCE of energy was consumed to produce 14.6 Mt of nitrogenous fertilizer. If energy intensity were to remain at the 1990 level, China's energy demand for fertilizer production would reach 88 MTCE by 2000 and 110 MTCE by 2010.

Specific energy consumption of synthetic ammonia in 1990 was 1.29 TCE, 2.18 TCE, and 2.27 TCE per tonne of ammonia, respectively, for the 15 large (using natural gas) facilities, 50 medium-size plants, and 1,000-plus small (using coal or coke) enterprises, compared with about 1 TCE for advanced countries. Ammonia production accounts for the largest portion of energy used in the manufacture of nitrogen fertilizer. By 2000, China plans to reduce

Table 4
China's Energy Consumption by Sector

Energy Source and Year	Percent of Total Consumption					Total Consumption
	Agriculture	Industry	Transportation	Residential	Others	
Total Energy						
1985	5.3	66.6	4.8	17.4	5.9	767 MTCE
1990	4.9	68.5	4.6	16.0	6.0	987 MTCE
1991	4.9	68.8	4.6	15.4	6.2	1038 MTCE
Coal						
1985	2.7	71.8	2.8	19.1	3.5	816 Mt
1990	2.0	76.8	2.0	15.8	3.3	1055 Mt
1991	1.9	78.2	1.8	14.9	3.2	1104 Mt
Fuel Oil						
1985	0.1	93.8	5.1	0.0	1.0	28 Mt
1990	0.1	91.8	6.2	0.0	1.9	34 Mt
1991	0.1	91.2	6.5	0.0	2.3	35 Mt
Gasoline						
1985	8.8	32.3	34.2	0.8	24.0	14 Mt
1990	7.7	31.0	32.6	0.9	27.7	19 Mt
1991	7.6	29.3	31.9	1.0	30.1	22 Mt
Diesel						
1985	32.4	33.2	23.4	0.1	10.8	19 Mt
1990	32.7	27.0	26.4	0.0	13.8	27 Mt
1991	30.9	26.7	26.2	0.0	16.2	29 Mt
Natural Gas						
1985	0.0	84.8	0.6	3.3	11.3	13 bcm
1990	0.0	78.8	1.2	12.2	7.8	15 bcm
1991	0.0	81.3	0.8	11.4	6.5	16 bcm
Electricity						
1985	7.7	79.7	1.5	5.4	5.6	412 Twh
1990	6.9	78.2	1.7	7.7	5.4	623 Twh
1991	7.1	77.3	1.7	8.0	5.9	680 Twh

Note: bcm = billion cubic metres
Twh = Tera watt hours
Source: State Statistical Bureau 1993.

the specific energy consumption of synthetic ammonia to 1 TCE for large, 1.79 TCE for medium, and 1.86 TCE for small plants, or about a 20% decline in average specific energy consumption (Wang 1993). It is estimated by the authors that China can reduce its specific energy consumption by at least another 20% by 2010. Therefore, the potential for energy conservation in chemical fertilizer production relative to 1990 is about 18 MTCE a year by 2000 and 40 MTCE by 2010.

Production of nitrogenous fertilizer by small enterprises accounts for about 55% of total production. Thus, if China can increase the relative share of fertilizers produced in large enterprises, energy consumption could be reduced further. Given this factor, the energy conservation potential (estimated above at a moderate level) would be 30 MTCE by 2000 and 65 MTCE by 2010, relative to 1990.

The Iron and Steel Industry

Between 1980 and 1993, China's steel production increased from 37.1 Mt to 88.7 Mt, with annual growth averaging 6.9%. During the same period net imports of steel and semi-finished steel products increased from 4.6 Mt to 34.5 Mt. If it is conservatively assumed that one tonne of steel products can be manufactured from one tonne of crude steel, then the total equivalent consumption of steel increased from around 42 Mt to 123 Mt, and the equivalent steel consumption growth rate averaged 8.6%. Even if China could reduce the growth rate of equivalent steel demand by half during the 1994–2000 period, and reduce it further to 2.5% a year during the 2001–2010 period, the equivalent steel demand would still reach about 165 Mt by 2000 and 210 Mt by 2010.

Since the beginning of the Seventh Five-Year

Table 5
Major Energy Consuming Industries in China

Energy Source and Year	Percent of Total Consumption						Total Consumption
	Chemical	Iron and Steel	Construction Material	Mining	Machinery	Power	
Energy[a]							
1985	10.6	10.0	10.5	7.5	5.4	3.3	767 MTCE
1990	11.1	10.7	9.8	7.9	4.6	3.9	987 MTCE
1991	11.1	10.7	9.8	8.1	4.5	4.1	1038 MTCE
Coal							
1985	6.4	8.0	10.6	7.7	3.4	20.4	816 Mt
1990	6.9	7.7	9.4	8.4	2.8	25.6	1055 Mt
1991	6.9	7.9	9.3	8.8	2.7	27.0	1104 Mt
Fuel Oil							
1985	14.2	10.9	8.8	2.2	3.4	33.6	28 Mt
1990	16.3	12.8	9.2	4.2	2.4	24.2	34 Mt
1991	16.1	12.4	9.7	4.8	2.4	22.5	35 Mt
Gasoline							
1985	3.4	1.3	3.2	7.0	6.6	0.6	14 Mt
1990	3.0	1.5	2.9	6.8	5.7	0.7	19 Mt
1991	3.0	1.4	2.7	5.9	5.3	0.8	22 Mt
Diesel							
1985	7.7	0.9	3.0	4.3	4.1	6.7	19 Mt
1990	2.6	1.2	3.1	5.5	3.1	5.0	27 Mt
1991	2.2	1.3	3.5	5.1	3.6	4.3	29 Mt
Natural Gas							
1985	32.0	4.0	1.4	28.7	4.6	4.5	13 bcm
1990	31.8	6.2	1.7	24.8	2.4	1.8	15 bcm
1991	34.9	5.0	1.9	26.2	3.3	0.8	16 bcm
Electricity							
1985	12.5	8.8	5.4	10.5	7.8	14.3	412 Twh
1990	11.8	8.9	5.3	10.8	5.9	14.2	623 Twh
1991	11.4	8.6	5.3	10.8	5.5	14.6	680 Twh

[a] Total energy consumption excludes energy converted into secondary energy.
Note: bcm = billion cubic metres
Twh = Tera watt hours
Source: State Statistical Bureau 1993.

Plan period (1986–90), China has made significant efforts to reduce iron and steel imports, which represent the most costly imported non-fuel mineral commodity into the country (Dorian 1994). In order to keep steel imports at the 1993 level, domestic steel production would have to increase to 130 Mt by 2000 and 175 Mt by 2010.

In 1980, 71 MTCE of energy was consumed by China's iron and steel industry, or 1.91 TCE per tonne. By 1991, average energy consumption had decreased to 1.57 TCE per tonne, marking a reduction in specific energy consumption by 1.8% a year. Nevertheless, the potential for energy conservation in the iron and steel industry is still large. In developed countries, for example, the specific energy consumption of steel is only about 0.7 TCE per tonne of steel, less than half of the Chinese average level (Guo 1992). If we assume that China's specific energy consumption of steel continues to decrease at 1.8% a year, the total energy conservation potential in the iron and steel industry would be 33 MTCE by 2000 and 82 MTCE by 2010, relative to 1990 (Table 6).

Energy conservation technologies used in China's iron and steel industry include:

1. a dry coke-extinguishing process,
2. blast-furnace electricity generation utilizing pressure differences,
3. coal-gas recovery,
4. continuous casting,
5. converters to replace open-hearth furnaces to converters, and

Table 6
Projection of Energy Conservation in China's Iron and Steel Industry

Year	*Steel Production (Mt)*	*Net Steel Imports (Mt)*	*Net Steel Demand (Mt)*	*Energy Consumption Total (MTCE)*	*Specific (TCE/t of Steel)*	*EC Potential[a] (MTCE)*
1980	37	5	42	71	1.91	
1985	47	19	66	76	1.63	
1990	66	2	69	106	1.59	*0*
1991	71	1	72	112	1.57	*1*
1992	81	5	86	*125*	*1.54*	*4*
1993	88	35	123	*133*	*1.52*	*7*
2000	*130*	*35*	*165*	*174*	*1.34*	*33*
2010	*175*	*35*	*211*	*196*	*1.12*	*82*
Growth Rate						
1980–1993	6.9		8.6	5.0	-1.8	
1994–2000	*5.7*		*4.3*	*3.9*	*-1.8*	
2001–2010	*3.0*		*2.5*	*1.2*	*-1.8*	

Note: Numbers in italics are estimated by the Program on Resources: Energy and Minerals, East-West Center, and based on Chinese government projections and independent analyses of the Chinese national economy. For information on energy consumption forecasts, see Fesharaki, Clark, and Intarapravich (1995) and Johnson and Li (1994). Other studies on long term energy use in the Chinese iron and steel industry include Xi and Levine (1993) and Zhang (1988).

[a] Energy conservation potential relative to 1990.

Sources: (1) State Statistical Bureau 1993; (2) Economic Information and Agency 1993; and (3) Ministry of Metallurgical Industry 1986.

Table 7
Comparison of Energy Conservation Technology Dissemination in the Iron and Steel Industry

Technology	*Energy Conservation (kgce/t)[a]*	*Percentage of Industry Covered Dissemination*	
		China 1990	*Japan 1989*
Dry Coke-Extinguishing	24	4	72
Blast Furnace Generation	16	16	92
Open-Hearth to Converter	156	12	100
Converter Gas Recovery	31	40	90
Continuous Casting	24	22	93

[a]Kilograms of coal equivalent saved per tonne of steel produced.

Source: Wang 1993.

6. blast-furnace pulverized-coal injection (PCI) (Wang 1993).

These technologies are, however, still used less frequently in China than in developed countries (Table 7), indicating a large potential for energy conservation in the future.

The Construction Materials Industry

China's construction materials industry has undergone tremendous growth in the past decade owing to a robust modernization drive in the country. Between 1980 and 1993, cement production increased from 80 Mt to 357 Mt, or at an average annual growth rate of 12.2%, while plate glass production increased from 24.7 million weight cases (MWC) to 109 MWC, at an average annual growth rate of 12.1%. Remarkably, cement production will reach 650 Mt in 2000 and 1,150 Mt in 2010, even if the average annual growth rate of cement production declines to 9% during the 1994–2000 period and 6% during the 2001–2010 period.

Total energy consumption in the construction

materials industry increased from 44.4 MTCE in 1980 to 102 MTCE in 1991 (or 7.9% per year). Cement and brick-tile are two of the most important energy-consuming products within the construction materials industry.[13] In 1991, cement production and brick-tile production accounted for 44% and 48%, respectively, of total energy consumption in the construction-materials industry.

China has about 65 large and medium-size state-owned cement plants, which account for only 17% of cement production. About 40% of these plants use dry processes. Most local and township cement plants use small vertical kilns. China's energy consumption of cement in 1992 averaged 178 kilograms of coal equivalent per tonne of cement (kgce/t), about 70% higher than developed countries (Energy of China 1993; Guo 1992). Using the 1992 energy efficiency level, to produce 650 Mt of cement in 2000 and 1,150 Mt in 2010, China's energy demand in cement production will reach 115 MTCE in 2000 and 200 MTCE in 2010. If China can continue to reduce its specific energy consumption by 2.36% a year as it did in 1992, specific energy consumption of cement would be reduced to 147 kgce/t in 2000 and 115 kgce/t in 2010, and the energy demand of cement production would be 95 MTCE by 2000 and 130 MTCE by 2010. The energy conservation potential is therefore about 20 MTCE by 2000 and 70 MTCE by 2010, relative to 1992.

China has about 90,000 TVP (township, village, and private) brickyards, which account for 90% of China's brick and tile production. The 2,000 large and medium-size state-owned brickyards account for only 10% of total production. In 1990 China's production of 356 billion bricks consumed about 47 MTCE of energy. The specific energy consumption of brick was 132 TCE per million bricks (Guo 1992). Since the specific energy consumption of new equivalent building materials is only 70 TCE per million pieces, replacing traditional bricks with new building materials will reduce energy consumption by 47%.

The growth rate of brick production in China is comparable with the cement production growth rate. Even if it is assumed that brick production would grow at a modest average annual rate of 7% during the 1990s and 5% during the 2001–2010 period, total brick production would still reach 700 billion by 2000 and 1,140 billion by 2010. At the 1990 average energy consumption level, the total energy demand of brick production would reach 92 MTCE by 2000 and 150 MTCE by 2010. If 40% of the bricks can be replaced by new building materials in 2000 and 80% by 2010, however, energy demand will be only 75 MTCE by 2000 and 94 MTCE by 2010. The use of new building materials will also reduce the energy demand in space heating, owing to improved insulation. Cement and brick manufacture, therefore, have similar conservation potentials.

Other major energy conservation measures adopted by the construction-materials industry include:

1. retrofitting cement plants;
2. changing from wet processes to dry processes in cement production;
3. encouraging utilization of bulk cement;
4. retrofitting glass-melting furnaces and limekilns; and
5. replacing coal with coal gas in pottery kilns (Wang 1993).

Industrial Boilers

China has more than 400,000 industrial boilers with a total capacity of around 800,000 tonnes of steam per hour (t/h). These boilers annually consume more than 230 MTCE of energy and emit about 150 Mt of carbon as CO_2, 6 Mt of SO_2, and 8 Mt of particulates (Shanghai Industrial Boiler Research Institute 1992). Most of these industrial boilers are small: about 40% are rated below 1 t/h, 52% are in the range of 1–4 t/h, and only 8% are above 4 t/h. The average thermal efficiency of these boilers is in the range of 55–60%, whereas the efficiencies of industrial boilers in developed countries are typically higher than 80% (Guo 1992).

Most of China's industrial boilers burn raw coal, and owing to unreliable supplies and their low quality, coals consumed in industrial boilers very often do not match the requirements of the boiler design, leading to low thermal efficiency. Poor operating skills among workers in industrial boiler plants also contribute to low thermal efficiencies (Energy Policy Research Communication 1992).

Two major energy conservation measures have been implemented in China to address the problems created by low coal quality: fluidized-bed combustion (FBC) boilers; and coal preparation. Through the use of FBC boilers, thermal efficiency can be increased to more than 80%, and pollution can be reduced substantially (Energy Policy Research Communication 1992). Currently, however, FBC boilers account for only 2.5% of the total capacity of indus-

trial boilers, and the annual FBC boiler manufacturing capacity is only 2,000 t/h (Energy Policy Research Communication 1992).

Other major energy conservation measures in this area include:

1. improving the design of boilers, which can increase efficiency by 10 percentage points (for example, from 50 to 60%);
2. developing cogeneration of heat and power;
3. encouraging utilization of boilers that burn coal briquettes, which can increase thermal efficiency by 3 percentage points and reduce sulfur emission by 40%;
4. introducing heat storage in the heat supply system, which can increase thermal efficiency of boilers by 5–10 percentage points through increased stability of operation; and
5. introducing automatic control and adjustment, which can increase efficiency by 3–5 percentage points.

Currently, China has about 500 industrial boiler manufacturing factories, with an annual manufacturing capacity of 56,000 t/h. If the demand for industrial boilers increases 4.5% a year in the 1990s and 3% a year during the 2001–2010 period, and average thermal efficiency remains at current levels, the total energy consumption of industrial boilers will reach 360 MTCE in 2000 and 480 MTCE in 2010. If thermal efficiency can increase by 10 percentage points by 2000 and 15 percentage points by 2010, the total energy consumption of industrial boilers can be reduced to 300 MTCE in 2000 and 380 MTCE in 2010. The energy conservation potential is therefore 60 MTCE by 2000 and 100 MTCE by 2010, relative to 1990. If we assume that 30% of the industrial boilers are in the chemical, iron and steel, and construction materials industries (because total coal consumption of the three industries accounts for about 30% of total industrial coal consumption),[14] then the energy conservation potential excluding the three industries will be 40 MTCE by 2000 and 70 MTCE by 2010.

Electricity Generation

In 1993, China used about 300 MTCE of energy for thermal generation of 670 billion kWh of electricity. Electricity generated by fossil energy is projected to reach 1,080 billion kWh in 2000 and 1,750 billion kWh in 2010 (Li and Johnson 1994). Reportedly, between 1980 and 1992, thermal efficiency of power generation increased only a total of 2%, from 27.4% to about 29.3% (State Statistical Bureau 1991: 333; Energy of China 1993: 22). This figure refers, however, to the average efficiency of the power plants that have installed capacities of 6 MW or more. The average efficiency of all of China's thermal power plants is estimated at about 27% in 1993, or 455 gce/kWh, while the efficiency of power generation in developed countries is typically 35–40% (350–370 gce/kWh).

The low thermal efficiencies in China are partly due to a pronounced lack of capital to upgrade the power generation equipment. In addition, as a means of combating severe power shortages, some of the world's oldest power plants are still in operation within the country. China currently has 30 GW small low-efficiency coal-fired generators in operation, and their average thermal efficiency is less than half of the higher-efficiency generators.

To curb energy consumption in power generation, China's Ministry of Electric Power Industry plans to increase the average thermal efficiency in the power sector (for units of 6 MW and above) to 33% by 2000, through the introduction of high-efficiency generators and the retrofitting of low-efficiency ones. The government's policy is to try to ensure that newly installed coal-fired generators in the interprovincial power networks have a thermal efficiency above 37% (Ministry of Energy 1992). Newly installed generators will be rated at mainly 300 MW and 600 MW for units that are manufactured domestically, and at 350 MW and 660 MW for imported generators. During the 1990s China plans to retrofit or eliminate 18.5 GW of capacity in the smaller, low-efficiency power plants.

Based on the projected growth rates of electricity generated by fossil energy (Li and Johnson 1994), the total energy consumption in China's thermal power generation may reach 490 MTCE in 2000 and 795 MTCE in 2010, assuming current thermal efficiency levels. If, however, average thermal efficiency (including all generating units) can be increased to 31% in 2000 and 33% in 2010, energy consumption will approach 430 MTCE in 2000 and 650 MTCE in 2010. The energy conservation potential is therefore 60 MTCE in 2000 and 145 MTCE in 2010, relative to 1993.

Industrial Fans and Pumps

China had about 7 million industrial fans and 30

million pumps in 1990, which are important because they accounted for about 30% of all electricity consumption in the country that year. The average efficiency of industrial fans is only 50%, although the designed efficiency is 70%; the respective efficiencies of pumps are 41% and 65%. The efficiencies of fans and pumps in developed countries are typically around 80%. The low efficiencies of fans and pumps in China are mainly caused by a mismatch of load, obsolete equipment, and poor maintenance (Wang 1993).

Today, China gives high priority to conserving electricity used to operate fans and pumps. Major energy conservation measures in this area include:

1. selecting the appropriate equipment that properly matches the load of the production system; and
2. encouraging the use of variable-speed technology.

These measures can reduce electricity consumption by an estimated 20–30% (Wang 1993). Energy savings in industrial fans and pumps may reach 110 billion kWh (40 MTCE) in 2000 and 270 billion kWh (95 MTCE) in 2010, relative to 1990. If it is assumed that 33% of the industrial fans and pumps are in the chemical, iron and steel, and construction-material industries (since the combined electricity consumption of these three industries accounts for about 33% of total industrial electricity consumption), then the energy conservation potential excluding these three industries will be 27 MTCE in 2000 and 65 MTCE in 2010, relative to 1990.

The Residential Sector

China's commercial household energy is consumed primarily by the nation's urban population. Economic reforms since 1978 have promoted China's urbanization process. Between 1978 and 1993, the urban population in China increased by 161 million, from 173 million to 334 million, and the urban share of the country's total population increased from 17.9% to 28.1% (State Statistical Bureau 1994).

The growth rate of energy consumption in the residential sector was slightly faster than urban population growth. While the residential share of total energy consumption decreased slightly from 15.9% in 1980 to 15.4% in 1991, residential consumers began to switch from lower to higher quality energy sources during the period. Between 1980 and 1990, the share of coal in total residential energy consumption decreased from 90% to 80%, while the share of electricity increased from 4.5% to 12%. Major energy conservation measures in the residential sector include:

1. developing central heating and district heating;
2. promoting the utilization of coal briquettes;
3. substituting natural gas, LPG, and coal gas in place of coal; and
4. improving the efficiency of appliances and lighting.

According to the government's definition, any part of the country where the daily average temperature remains below 5°C for more than 90 days per year is defined as a 'space heating area (SHA)' (Wang 1993). This definition applies to 60% of China's land area. In 1990, the total floor space in all buildings in SHAs was 3,070 million square metres, about one-third of which had central heating. The total amount of energy consumed for space heating was 94.6 MTCE in 1990, which was about 60% of all residential commercial energy consumption.

About 44.5 MTCE was consumed for central heating in 1990. Only 5.3% (164 million square metres) of the centrally heated floor space in SHAs had district heating (that is, used waste heat from power plants or industrial boilers). It is estimated that energy consumption in space heating can be reduced by 30–50% through

1. improved building insulation and
2. increased district heating (Wang 1993).

If it is assumed that the floor space in the SHAs will grow at annual rates of 5% in the 1990s and 3% in the 2001–2010 period, the energy conservation potential in space heating will be 45 MTCE (a 30% reduction) by 2000 and 85 MTCE (a 40% reduction) by 2010, relative to 1990.

In 1990, about 40 Mt of coal briquettes was sold for household cooking and heating in China's urban areas. The use of coal briquettes rather than raw coal can reduce the amount of coal used for these purposes by more than 15%.

Lighting accounts for about 9% of total electricity consumption in China. In 1990, around 1,747 million incandescent lamps and around 213 million fluorescent lamps were manufactured in China. Today, high-efficiency fluorescent lamps are being produced that can reduce electricity consumption by 80% compared with incandescent lamps (Wang

1993). If the share of high-efficiency fluorescent lamps can be increased to 30% of all installed lighting fixtures by 2000 and 70% by 2010, the savings on electricity for lighting alone could be 30 TWh (12 MTCE) per year by 2000 and 118 TWh (41 MTCE) per year by 2010.

The use of home appliances in China is still very low, although the growth rate of the acquisition of appliances is high (Table 8). In the future, room air-conditioners and shower heaters will become major consumer items for Chinese households. If energy-efficient appliances are promoted, a substantial amount of energy demand can be avoided.

Residential energy consumption in the rural areas of China was 332 MTCE in 1987, around 80% of which came from non-commercial energy sources. Crop residues and wood accounted for 39% and 40%, respectively, of rural residential needs, while coal accounted for 18%. Promoting improved cookstoves is the major energy conservation measure in the rural residential sector. Between 1982 and 1992, the Chinese National Improved Stove Program reported the installation of improved stoves in more than 100 million rural households (Smith *et al.* 1993). The thermal efficiency of improved stoves reportedly exceeds 25%, providing energy savings of between 30 and 50% relative to the old stoves (Deng 1994).

History has shown that households switch to higher quality fuels when they have the means and opportunity, and this has been termed moving up the 'energy ladder'. According to Smith *et al.* (1993), most of the Chinese rural population stand on the rungs from crop residues to coal. Chinese statistics show, however, that China's rural residential sector has been moving very slowly up the energy ladder. Between 1985 and 1987, China's rural residential coal consumption increased from 69 Mt to 84 Mt; however, it then declined to 78 Mt in 1990 (State Statistical Bureau 1991: 169). Between 1980 and 1992, China's rural commercial energy consumption increased by 130% from 145 MTCE to 333 MTCE, while non-commercial energy increased by only 24%, from 191 MTCE to 237 MTCE, making the total increase about 70%, i.e., 4.5% per year. Increases in rural commercial energy consumption are mainly caused by the rapid development of rural industry. It is also possible, however, that some commercial energy consumption in the rural residential sector may have been included in the rural industrial sector, owing to China's outmoded rural accounting system.

INDIRECT ENERGY CONSERVATION

Raw Materials

Many raw materials used in industrial processes have a high energy content. For example, in China the energy content is 1 TCE per tonne of pig iron, 1.34 TCE per tonne of steel products, 2 TCE per tonne of aluminum oxide, and 11 TCE per tonne of electrolyte aluminum. Reducing the use of these raw materials will indirectly save energy. The utilization rate of steel in the machinery industry is only 67% in China and typically in the range of 80–85% in developed countries. The average consumption of refractory materials and pig iron is several times higher in China than in advanced countries (Guo 1992). Consequently, there would seem to be much scope for indirect energy conservation.

Table 8
Possession of Home Appliances in China

Item	*Number of Home Appliances per Hundred Households*		*Annual Growth Rate (%/Year)*
	1985	*1992*	*1985–1992*
Fan	74	146	10.2
Washer	48	83	8.1
Refrigerator	7	54	35.0
Colour T.V.	18	75	22.2
Tape Recorder	41	78	9.5
Room A/C	nil	1	
Shower Heater	nil	13	

Sources: (1) State Statistical Bureau 1993; and (2) *Energy of China* 1993.

Structural Changes

The economic structures of China, the United States, Japan, and India are shown in Table 9. It can be seen that the share of secondary industry is higher in China than in the other countries, while the share of the tertiary industry is significantly lower. China's energy consumption per million yuan of GDP was quite different in each of these three industrial categories: 96 TCE, 799 TCE, and 172 TCE, respectively, in 1991 (State Statistical Bureau 1993).

As a general rule, unit GDP energy consumption in each industrial category is projected to decrease over the next several years, and the resulting proportions may not be similar to the 1991 level. For the purposes of this paper, however, it is assumed that unit GDP energy consumption in each industrial category will decrease proportionally 23% by 2000 and 35% by 2010 from its 1991 level. This assumption is based mainly on the expected availability of energy supplies during those years. Thus, relative to the 1993 economic structure of China, the potential for energy conservation through economic structural adjustments is estimated at 172 MTCE in 2000 and 564 MTCE in 2010 (Table 10).

Table 9
Comparison of Economic Structures

	Share of GDP (%)						
	China				U.S.	Japan	India
Industry	*1980*	*1993*	*2000[a]*	*2010[b]*	*1987*	*1987*	*1986*
Primary	30	21	21	15	2	3	28
Secondary	49	52	44	35	29	41	26
Tertiary	21	27	35	50	69	57	46

[a] Chinese government expectations according to the Ten-Year Development Programme (1991–2000).
[b] Projected by the Program on Resources: Energy and Minerals, East-West Center and based on historical trends and an independent evaluation of the Chinese national economy. Forecasts assume a typical economic development growth scenario whereby the share of primary industry (for example, agriculture and fisheries) in a country's GDP declines over time while the share of tertiary industry (services) increases.
Sources: (1) State Statistical Bureau 1994 and 1993; and (2) Guo 1992.

Table 10
Projection of China's Energy Conservation Potential Resulting from Economic Structural Adjustment

	GDP with Structure Change (Billion 1991 Yuan)		Energy Demand (MTCE)	
Industry	2000	2010	2000	2010
Total	4606	8646	1532	2137
Primary	967	1297	72	81
Secondary	2027	3026	1246	1571
Tertiary	1612	4323	214	485
	GDP at 1993 Structure (Billion 1991 Yuan)		Energy Demand (MTCE)	
	2000	2010	2000	2010
Total	4606	8646	1704	2701
Primary	976	1832	72	115
Secondary	2385	4476	1466	2323
Tertiary	1244	2334	165	262
Energy Conservation Resulting from Structural Changes			172	564

Note: GDP and energy demand figures based on calculations by the Program on Resources: Energy and Minerals, East-West Center. For further information on key assumptions and methodologies used, readers are referred to Fesharaki, Clark, and Intarapravich (1995) and Johnson and Li (1994).

EFFECTIVENESS OF CONSERVATION MEASURES: PRICING POLICIES

Energy misuse and environmental pollution are, at least indirectly, related to a significant problem evident in China's basic industries — an irrational pricing system. China's commodity-pricing structure is considered one of the weakest aspects of its economy, a reason for the pricing reform now under way. Pricing is generally administered by the government at different levels. The price administration departments at province, autonomous region, and municipality levels can establish pricing principles, procedures, and standards within their assigned authorities. Prices have to be approved by the respective levels of government, and they can vary widely from one province or region to another (Dorian 1994).

China's economy is in disequilibrium today because of state-controlled prices and subsidies. In 1979 price reforms began in China in an effort to alleviate price imbalances, permit enterprises to earn profits at comparable rates, and allow prices to reflect supply and demand forces. With regard to resources, the prices of mineral products, raw materials, and energy are, in general, low, thus encouraging waste. To encourage industrial development, industrial fuel prices were set artificially low, while households and other users paid two to three times the industrial price. By the 1980s, this pricing scheme resulted in serious imbalances and widespread waste in energy use. Effective utilization of industrial energy declined to around 25%, nearly half the level in Japan (Dorian 1994).

Low prices for natural gas resulted in nearly one-third of the gas produced in some oil fields being flared. Low crude oil prices (in comparison with final-product prices) encouraged the overbuilding of small refineries, many in provinces or localities far removed from sources of supply. From 1972 to 1988 subsidized oil was distributed at 100 yuan a tonne, equivalent to an average price of US$6 a barrel at the exchange rate prevailing for most of that period (*Far Eastern Economic Review* 12 November 1992). By the beginning of 1992, it increased to 200 yuan a tonne, or slightly more than US$5 a barrel at the present exchange rate. In effect, therefore, the price of China's crude oil has been declining in real terms for more than two decades.

Additional price reforms were implemented in 1983 when a multitiered pricing system for energy and mineral products was adopted. This allowed above-quota output from mines, refineries, and power plants to be sold at prices two to three times higher than the fixed state price. Although this measure stimulated production of some energy and mineral commodities, problems with relative prices remain. Above-quota prices for gasoline, for example, are still 30% higher than diesel (on the international market, the gap is usually less than 10%), encouraging investment in gasoline-producing equipment at refineries to maximize profit.

Unless completely addressed, the presence of distorted energy and mineral prices in China will continue to lead to waste and imbalanced growth in output. Consequently, rational development of China's energy extraction and other mining industries in the future will be difficult. Indeed China's energy and mineral industries may have difficulty becoming competitive globally if domestic Chinese producers are unable to respond to the same prices as their competitors.

As for conservation, the adoption of market-oriented prices for oil, natural gas, and electricity will facilitate less waste and greater energy conservation. The success and extent of conservation will depend, in part, on the pace of price reform. The last price controls on coal, for example, were eliminated in 1994.

COMPARISON WITH OTHER STUDIES

Numerous other studies have examined China's prospects for energy conservation, including, for example, Wang (1994), Lu (1993), Polenske and Lin (1993), and Yang and Levine (1993). Table 11 lists energy consumption levels predicted for China in the years 2000 and 2010, as revealed in many of these studies. Comparison is difficult because each of the analyses uses slightly different assumptions and base years. In addition, the various industries and other energy-consuming parts of the economy are grouped differently. Nevertheless, as seen in the table, there is a rather remarkable degree of agreement among the different studies as to possible Chinese commercial energy demand in 2010, the final year of the period analysed in this study.

ENVIRONMENTAL IMPLICATIONS

Environmental repurcussions of energy consumption are dependent in large part on the specific type of

Table 11
Comparison of Estimated Future Energy Demand in China[a] (Unit: MTCE)

Source	*2000*	*2010*
East-West Center (this study)	1525	2100
Asian Development Bank[b] (Siddiqi et al. 1994)	1500/1460	2000/1850
Global Environment Facility (Johnson et al. 1994)	1560	2200[c]
International Energy Agency (in Wang 1994)	1413	2133
Institute of Nuclear Energy Technology, Tsinghua University (in Wang 1994)	1552	2179
Lu 1993	1500	2000
Wang 1994	1550	2139

[a] These figures all represent scenarios involving intensive energy conservation efforts. In some cases, the authors of this paper have made interpolations between estimates for 2000 and 2020 in the original reports.
[b] Low/high economic growth scenarios. Includes some contribution from alternative energy sources.
[c] An additional 200+ MTCE-equivalent CO_2 emissions reduction possible through alternative use of energy and afforestation.

energy chosen. Much of the concern over environmental matters in recent years has been emissions of CO_2, associated with fossil energy use. This focus has prompted many governments in developed countries to attempt to hold CO_2 emissions at their 1990 levels.

Energy savings through conservation in China can be substantial by 2000 and even greater by 2010 if appropriate measures are adopted and implemented today. The potential for direct and indirect energy conservation potential is forecasted at more than 400 MTCE by 2000, relative to 1993, and around 1200 MTCE one decade later. Given such reduction in energy use, the environmental implications of conservation in China are immense, and include a dramatic decline in air pollutants such as NO_x, SO_2, PM (particulate matter), and CO_2.

Most of China's air pollutants are by-products of coal combustion, as coal remains the primary energy contributor to the nation. Coal will continue to dominate the energy sector to the year 2010, but its share of primary energy consumption will decrease from 76.7% in 1993 to 72.8% in 2000 and 63.0% in 2010 (Fesharaki *et al.* April 1994). Given the energy savings possible through conservation in the individual sectors analyzed in this study, the following reductions in pollutants may be available to China:

1. by 2000 — 280 Mt of CO_2, 7 Mt of SO_2, and 4 Mt of NO_x; and
2. by 2010 — 840 Mt of CO_2, 20 Mt of SO_2, and 12 Mt of NO_x.

As is obvious, by adopting new technologies that can substantially reduce energy consumption, China's industry, as well as the country's residential sector, can help reduce air pollution by noticeable levels in the years ahead.

CONCLUSIONS

Since 1980, China has increasingly paid attention to energy conservation, which has not only helped alleviate continuing energy shortages, but also has local and global environmental advantages. Substantial additional potential to reduce energy consumption still exists, however, both through reductions in specific energy consumption and by way of economic structural changes.

China's potential for direct energy conservation is concentrated in the nation's industrial sector. The electric power, chemical, iron and steel, and construction materials industries are the focus of energy conservation efforts. Industrial boilers, fans and pumps, and space heating are also important areas where reductions in energy consumption can be achieved.

China's potential for direct energy conservation is projected at 235 MTCE in 2000 and 635 MTCE in 2010, relative to 1993 (Table 12). The actual direct energy conservation achieved may, however, be substantially below the potential. The total potential for energy conservation is projected to reach 500 MTCE by 2000 and 1,700 MTCE by 2010, relative to 1993. If this potential is fully realized, China will have about 250 Mt fewer carbon emissions in 2000 and 850 Mt fewer in 2010 than it would at 1993

Table 12
. Projection of China's Energy Conservation Potential (Unit: MTCE/Year)

Source of Conservation	*Energy Conservation*	*Potential Relative to 1993*
	2000	2010
Chemical Industry	20	55
Iron and Steel Industry	25	70
Construction Material Industry	30	120
Electricity Generation	60	145
Industrial Boilers[a]	30	60
Industrial Fans and Pumps[a]	20	60
Space Heating	30	70
Other Direct Conservation	20	55
Total Direct Conservation	**235**	**635**
Economic Structural Changes	172	564
Other Indirect Conservation	93	501
Total	**500**	**1700**

[a] Excluding the chemical, iron and steel, and construction material industries.

energy intensities. Without question, strong efforts from China's government, industry, and private sector will be needed to convert energy conservation potential into reality. Technical and economic assistance from foreign governments and companies will also be required. According to the World Energy Council, assisting China in achieving continued economic growth in a more environmentally friendly manner can be one of the single most beneficial actions mankind can take (Drucker 1994).

NOTES

1. One tonne of coal equivalent (TCE) equals 27.78 million Btu.
2. Largest in terms of overall mass, energy content, and amount of carbon (British Petroleum 1994).
3. Specific energy consumption is defined as the energy consumed to produce unit goods and services, such as the energy consumed to generate one kWh of electricity.
4. In its most general form, energy intensity is simply a ratio of the total primary energy use and GDP.
5. Biomass still dominates the Chinese rural household sector as it has from time immemorial. In 1987, for example, it supplied 80% of rural energy demand and about 65% of total residential demand in the country (Sinton *et al.* 1992).
6. In China, industries are commonly referred to as either heavy or light industry, both of which are included in the secondary industry along with construction.
7. The energy elasticity to GDP is defined as the ratio of average energy growth rate over average GDP growth rate during the same period of time.
8. China's GDP statistics before 1978 are not available. The average annual national income growth rate between 1953 and 1980 is used as the proxy of average annual GDP growth over the same period. Between 1980 and 1993, the average annual national income growth rate was 9.6%, very close to the 9.5% average GDP growth rate during the same period (State Statistical Bureau 1994: 6, 12).
9. At least one study, however, found, in contrast, that the structural change that took place during most of the 1980s would have actually increased overall Chinese energy intensity, if direct energy conservation had not taken place (Polenske and Lin 1993).
10. The exchange rate used in this paper is the current exchange rate of 8.7 yuan per U.S. dollar.
11. One MTCE of energy conservation capacity can save one MTCE of energy per year.
12. The amount of fertilizer production is converted to 100% effective composition. The effective composition of actual fertilizers is less than 100%.
13. For further analysis of energy efficiency within China's cement industry, readers are referred to Liu *et al.* 1995.
14. In fact, the share of industrial boilers in the three industries is likely below their share of coal consumption, because substantial coal consumption in these industries is not through boilers. The assumption is a very conservative one.

REFERENCES

Asian Development Bank. 1993. *Electric Utilities Data Book for the Asian and Pacific Region*. Energy and Industry Department, Manila.

Asian Development Bank. July 1992. *Energy Indicators of Developing Member Countries of ADB*. Manila.

British Petroleum. 1994. *BP Statistical Review of World Energy*, June, British Petroleum Company, Ltd., London.

Deng Keyun. 1994. *Energy Policy Research Communication*, No. 3, Beijing, pp. 8–15 (in Chinese).

Dorian, James P. 1994. *Minerals, Energy, and Economic Development in China*. Oxford: Oxford University Press.

Drucker, Harvey. 1994. 'Demand-Side Management: Long-Term Economic and Environmental Implications,' presented in APEC Inter-Utility DSM Liaison Group Organization Meeting, Honolulu, Hawaii, 7–9 March 1994.

Economic Information and Agency. December 1993. *China's Customs Statistics*. December, Hong Kong.

Energy of China. 1993. No. 9, Beijing, p. 19 (in Chinese).

Energy Policy Research Communication, No. 9, 1992. Beijing, International Publication (in Chinese).

Far Eastern Economic Review, 12 November 1992. 'China's Oil Shock,' Vol. 155, No. 45, Hong Kong, pp. 52–54.

Fesharaki, Fereidun, Clark, Allen L., and Duangjai Intarapravich. April 1995. 'Energy Outlook to 2010: Asia-Pacific Demand, Supply, and Climate Change Implications,' *Asia-Pacific Issues*, No. 19, East-West Center.

Guo, Tingjie. 1992. 'Reinforce of Energy Conservation to Raise Up Economic Development at New Level,' in *Market Economy and China Energy Development Strategy*. Atomic Power Publishing House, Beijing, p. 47 (in Chinese).

Johnson, Charles J. and Binsheng Li. October 1994. 'China Power: Challenging Opportunities,' in *World Coal*, Surrey, United Kingdom, pp. 18–31.

Johnson, Todd J., J. Li, Z. Jiang, and R. Taylor. 1994. *China: Issues and Options in Greenhouse Gas Controls*, Report to GEF by NEPA and SPC, Beijing; United Nations Development Program, New York; and IBRD, Washington, D.C.

Kato, Nobuo, *et al.* 1991. 'Analysis of the Structure of Energy Consumption and the Dynamics of Emissions of Atmospheric Species Related to the Global Environmental Change in Asia,' NISTEP Report No. 21, November 1991.

Li Binsheng and Charles J. Johnson. 1994. 'China's Booming Electricity Sector: The Opportunities and Challenges,' Proceedings of Power Generation in China Conference, 23–25 March 1994, Atlanta, Georgia.

Liu, Feng, Ross, Marc, and Shumao Wang. 1995. 'Energy Efficiency of China's Cement Industry,' *Energy*, Vol. 20, No. 7, Elsevier Science Ltd., London, pp. 669–681.

Lu Yingzhong. 1993. *Fueling One Billion: An Insider's Story of Chinese Energy Policy Development*. Washington, D.C.: Washington Institute Press.

Ministry of Energy. 1992. *Electric Power Industry in China* 1992, Beijing: Epoch Printing Co., Ltd.

Ministry of Metallurgical Industry. 1986. *Statistics of the Iron and Steel Industry of China*. Beijing (in Chinese).

OECD. 1992. *Coal Information 1992*. Paris.

Polenske, Karen R. and Xiannuan Lin. 1993. 'Conserving Energy to Reduce Carbon Dioxide Emissions in China,' in *Structural Change and Economic Dynamics*, Vol. 4, No. 2, Oxford University Press, pp. 249–65.

Shen Deshun, et al. 1992. 'The Strategic Position of Energy Conservation Planning in China,' in *Market Economy and China Energy Development Strategy*. Beijing: Atomic Power Publishing House (in Chinese).

Shanghai Industrial Boiler Research Institute. 1992. *Energy Policy Research Communication*, No. 9, Beijing, pp. 12–15 (in Chinese).

Siddiqi, Toufiq A., D.G. Streets, Z. Wu, and J. He. 1994. *National Response Strategy for Global Climate Change: PRC*. Asian Development Bank, Manila.

Sinton, Jonathan, *et al.*, eds. 1992. *China Energy Databook*. Lawrence Berkeley Lab, University of California, and State Planning Commission, Beijing.

Smil, Vaclav. 1994. 'Energy Intensities: Revealing or Misleading?' *OPEC Review*, Spring 1994, pp. 1–23, Vienna.

Smith, Kirk R. 1987. *Biomass Fuels, Air Pollution, and Health: A Global Review*. New York: Plenum Press.

Smith, Kirk R., *et al.* 1993. 'One Hundred Million Improved Cookstoves in China: How Was It Done?' *World Development*, Vol. 21, No. 6, pp. 941–61, 1993, Great Britain.

State Planning Commission, December 1992, Department of Resource Saving and Comprehensive Utilization, Beijing.

State Statistical Bureau of China. 1994. *A Statistical Survey of China* 1994, China Statistical Publishing House, Beijing (in Chinese).

State Statistical Bureau of China. 1993. *China Statistical Yearbook* 1993. Beijing: China Statistical Publishing House (in Chinese).

State Statistical Bureau of China. 1991. *China Energy Statistics*. Beijing (in Chinese).

United Nations Development Program. 1994. *Human Development Report*. New York: Oxford University Press.

Wang, Huijiong. 1994. 'China: Energy, Environment and Energy Trade,' Paper presented in the OECD Development Center Experts' Meeting on Trade, Environment, and Sustainable Development in the Pacific Basin, 7–8 December 1994, Honolulu, Hawaii.

Wang, Qingyi. 1993. *Energy of China*, No. 9, Beijing, p. 17 (in Chinese).

Wu, B. and A. Flynn. 1995. 'Sustainable Development in China: Seeking a Balance Between Economic Growth and Environmental Protection,' in *Sustainable Development*, Vol. 3, No. 1.

Yang, F. and M.D. Levine. 1993. 'Modeling China's Energy Demand, Supply, and CO_2 Emissions Futures: An Overview,' Energy Analysis Program, Lawrence Berkeley Laboratory, University of California Berkeley, Working Paper.
Zhang, Xiaoqin. July 1988. 'Forecasting Steel Demand in China in the Year 2000,' *Intertrade*, Vol. 7, No. 7, Hong Kong, pp. 15–19.

Designing Institutional Arrangements for Environmental Policy: Implications for ASEAN Countries of Recent New Zealand Reforms

P.A. Memon

ABSTRACT

This paper examines from an institutional perspective, the challenge of integrating environmental and development objectives in the decision-making process in market based economies. The key question posed is: within a plural societal context, how should one design institutional arrangements to promote a more balanced consideration of environmental and developmental objectives in public policy formulation and implementation ? The discussion is illustrated by the experience of comprehensive reforms in environmental administration and planning in New Zealand. Wide-ranging environmental reforms have been implemented in New Zealand recently, associated with a radical economic restructuring programme. The significance of the New Zealand experience is assessed from the perspective of the ASEAN states.

Keyboard: *environmental planning, institutional arrangement, New Zealand, Southeast Asia*

ENVIRONMENTAL CONCERNS IN THE ASEAN REGION

Environmental concerns have become a significant public issue in Southeast Asia. The broader Asian region is poised to become a major catalyst for global economic growth over the next decade. East and Southeast Asia's share of global output has been climbing steadily, and is projected to be the fastest growing region in the world for the rest of this decade. A feature of this trend is stronger reliance on the market through structural adjustment programmes. At the same time, and not unexpectedly, there are increasing concerns about environmental degradation and environmental quality in the ASEAN region. It could be argued that environmental and socio-economic development objectives are inextricably linked, as highlighted in the Brundtland report and the recent UNCED Conference in Rio. The concept of sustainable development encapsulates the twin imperatives of ecological rationality and social justice as part of the development planning process. Viewed from this stance, a major challenge for the ASEAN states is to develop effective institutional arrangements for environmental administration and planning at the national, regional and local levels.

There is considerable literature on the growing environmental problems in Southeast Asia. As documented in a recent publication on this subject, the causes of these problems have been attributed to growing pressures on regional resources from population growth and development, the continued use of air and water as a sink for wastes, the persistence of hard-core poverty in a region of

P.A. Memon, Department of Geography, University of Otago, P.O. Box 56, Dunedin, New Zealand, Tel (03) 479–1100, Fax (03) 479–9037

comparative affluence, and the continuing dependence on the exploitation of natural resources to nourish this affluence (Brookfield 1993: 30).

However, the relative effectiveness of institutions created to manage the environment in this region is constrained in important respects. As in many other parts of the world, the region's institutional frameworks for environmental and resource management have evolved incrementally over many years in an ad hoc manner:

> They include the traditional practices and institutions of the society which still operate at a local level, colonial legislation, land allocation and reservation, modern sectoral legislation and post-Stockholm environmental laws accompanied, or followed, by the creation of new bureaucracies. Especially in Indonesia, Malaysia and Thailand, and perhaps with most effect in Singapore, there are strong non-governmental organizations, well-supported among the middle classes, which are vocal on environmental issues. Moreover, these issues often get excellent coverage in the media. . . . However, several of the environmental agencies and ministries created in the 1970s are without line responsibility, and almost all have very limited professional staff . . . (Barber 1989 quoted in Brookfield 1993: 31).

Brookfield goes on to conclude that:

> Several governments, including those of Indonesia and Malaysia, have made firm statements of intent to strengthen environmental management in their development plans for the first half of the 1990s, but there is still a great deal to be done before such statements are translated into reality. Actual responsibility for environmental management is often widely dispersed among ministries and agencies, whose primary goals are not centrally concerned with the environment, and which are not legally or administratively obliged to accept directions from environmental ministries. Co-operation is difficult to achieve . . . (p. 31)

and that,

> . . . the situation in Southeast Asia is that of a political economy dominated by pride in the achievements of development and an impatience to see it advance further. Large state sectors still claim sovereign control over resources and their bureaucracies are subject to manipulation by socio-economic elites who have considerable power to distort outcomes in their favour (Barber 1989) . . . (p. 32).

Several countries in the region have adopted, during the last three decades, preventive and mitigating measures such as land-use planning, pollution control and EIA procedures to counter growing environmental concerns (Sani 1993). The situation found in many countries is fragmented and overlapping jurisdiction of a multiplicity of agencies responsible for implementing environmental statutes. The problem is compounded by constitutional division of power between federal and sub-national levels of government, characteristic of a number of countries. One suspects this is a common problem even in those countries with unitary systems of government.

In many countries, the problem is not lack of legislation but rather the effectiveness of enforcement of such laws in practice. Poor enforcement may be due to a number of considerations arising from lack of adequate institutional capability at different levels of government.

THE BROADER CONTEXT

To enable us to judge the wider significance of the environmental problems described above, it is useful to clarify a number of conceptual issues.

It is important at the outset to emphasize the broader socio-political context of environmental policy. Environmental issues have become an important priority for government in many countries. There is also an increasing awareness that environmental problems cannot be successfully addressed on the basis of a purely scientific or technical approach, that political, social and economic forces come into play too. Their relative significance should not be underestimated. It could be argued that an understanding of the bio-physical environmental processes provides an understanding only of the manifestation of environmental problems. The causes of these problems have to be understood in the socio-political context. The solutions to these problems have also to be formulated in socio-political terms.

Scope of Environmental Policy

The scope of environmental policy to address environmental problems is potentially wide-ranging. This is clear from the definition of environmental policy: governmental action to solve the problems of a society's relationship to its environment. Environmental policy is one aspect of public policy, that is, of the actions and positions taken by the

state as the overriding agency of authority in society. As with many societal issues, the solution to environmental problems must ultimately be endorsed by the state as a collective, public entity (Hill and Bramley 1986). However, even though the definition of the term 'policy' has attracted considerable interest, its interpretation has not yet been fully resolved. Recent reviews of the literature on this subject suggest that it is difficult to treat it as a specific and concrete phenomenon since it involves a course of action or a web of decisions rather than one decision. Thus, as suggested by O'Riordan (1982), policy may refer to a set of guidelines or principles against which possible courses of action can be evaluated, or it may relate to a declared statement of intent to do something, backed up by the provisions of an enabling statute or budget. Furthermore, it is difficult to identify particular occasions when policy is actually made. Policy will often continue to evolve during its implementation and not only in the policy-making phase of the process (Wildavsky 1979).

The above discussion has emphasized the process of formulating policy. From our perspective, it is equally important to clarify the substance or content of environmental policy. The term 'environment' also raises difficulties of defining the subject of analysis, because the concept has different connotations in different disciplines.

Environmental problems are complex, involving a wide variety of issues and subject areas. Thus, the term 'environment' needs to be defined comprehensively to include people, the natural conditions (such as climate, terrain, flora and fauna) and human artifacts (such as building structures and infrastructures) surrounding them, as well as the physical and cultural processes which interlink the above elements. As a generic concept, 'environment' provides an integrative view of society by looking at the way in which society interacts with its surroundings. Such a perspective gives an insight into the relationships between specific bio-physical, social and economic problems, and between the parts and the whole .

In view of the wide scope of the term 'environment', it is inevitable that government decisions regarding the environment affect many aspects of life in society. The reality of integrating environmental considerations into decision making thus constitutes a major challenge to governments (Portney 1990). It is imperative that environmental policies reflect the full range of diverse human needs that depend upon the environment. These include: psychological, economic, social, aesthetic and recreational needs.

Hitherto, governments have either ignored or only partly recognized the wide spectrum of values that people seek in the environment. This does not mean that governments should necessarily direct all uses of the environment. The task of environmental management is so vast and so complex that, to be accomplished, it must be broadly shared by central and sub-national government agencies, community groups, corporations and individuals (Caldwell 1970). Plural societies, in achieving acceptable environmental outcomes, need to agree on common goals and objectives and on the means for their implementation. A national policy for the environment is a framework which provides for these common criteria for independent but mutually consistent courses of action, while its implementation may be undertaken by sub-national levels of government.

It is in this context that the organization of responsibility for the management of the interaction between environment and society becomes a matter of major social importance. As pointed out earlier, while one should not underestimate the ability of adequate scientific and technological know-how to solve environmental problems, the major challenge is to develop appropriate institutional arrangements for environmental administration and planning, as Fernie and Pitkethly (1985) observe:

> all resource problems — over-population, hunger, poverty, fuel shortages, deforestation — are fundamentally institutional problems which warrant institutional solutions. The success or failure of resource management is intrinsically tied up with institutional structures — the pattern of agencies, laws and policies which pertain to resource issues. (p. vii).

Our concern in this paper is on two closely associated facets of environmental policy: administration and planning. The focus, with respect to administrative structures, is on the interrelated issues of the location of administrative authority and its jurisdiction. Important questions here relate to the role of the state in addressing environmental concerns, the organization and adequacy of administrative structures, their responsibilities and procedures and the relationship between central and sub-national levels of government.

Planning is a process of articulating needs, assessing alternative methods of responding to them, evaluating potential impacts, implementing such responses, and evaluating their success. Environmental planning is directed at promoting social and environmental well-being and attaining community goals and objectives in the course of using, modifying or protecting the environment. As a normative activity, it encompasses addressing causes of environmental problems as well as prescribing appropriate measures to mitigate the detrimental environmental impacts of human behaviour. Environmental planning provides a link between knowledge and action and is predicated on community consultation and participation. It has a strong sense of place and recognizes the interdependence between people and their habitats. The major issue here is the adequacy of the process of environmental planning and its effectiveness in achieving its objectives and reflecting aspirations of the community.

Causes of Environmental Problems

The emphasis in critical social science literature concerned with environmental issues, is on the underlying causes of the wide-ranging environmental problems facing societies in different parts of the world. These include issues such as pollution, resource depletion, urban malaise, rural poverty and famines. As noted earlier, in terms of designing appropriate institutional arrangements, it is important to understand the underlying causes of environmental problems even though the policy implications of this mode of analysis are not necessarily optimistic. The search for policies appropriate to address such problems seems nearly impossible at times.

The current focus in environmental studies in geography and other social science disciplines is on a political-economy approach, based on a critical conceptualization of society's relations with nature, with all the complexity and contradictions therein contained. The importance of this literature to environmental management lies in its emphasis on the actual social, political and economic factors that give rise to environmental problems, institutions, policies and outcomes. It stands in contrast to the neutrality of the dominant neo-classical economic approach, which assumes the objective of maximizing economic welfare from resource use in free markets, and also to the behaviourist theories, which stress the importance of individual perceptions, attitudes and values in motivating behaviour (Emel and Peet 1989).

Ultimately, all environmental problems boil down to a conflict between different social, economic and political interests over who should benefit from the use of the environment and the wealth or welfare derived from it. The problem is 'not just a question of reordering society to respond to the demands of the population, but of deciding which demands have priority over what timescale' (Rees 1985: 404). Both in developed and developing countries, there is a historically-based inertia deeply entrenched in our value systems and in our socio-economic and political structures. A state has numerous other important goals such as reducing unemployment, curbing inflation, or avoiding balance of payments deficits. Hence, it is not surprising that, contrary to public pronouncements, policies to address environmental problems are not given top priority and end up being only marginally effective (Dryzek 1990).

Recently, the Brundtland report has advocated the principle of sustainable development, defined as a strategy that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED 1987). Ideally, it means a development process which is equitable, conserves resources and which can be pursued indefinitely without environmental or social ill-effects. Pursued to its logical conclusion, the implementation of a sustainable development strategy entails comprehensive shifts in power relations and institutional alignments. Instead, sustainable development has been interpreted by many as a liberal, even conservative theme (Peet 1989). Even the Brundtland report shied away from examining these socio-political imperatives for promoting sustainability.

The radical changes to systems of production and to societal relations advocated by analysts of environmental issues are unlikely to happen while environmental problems continue to escalate. Nevertheless, incremental shifts in environmental values are apparent in societies in different parts of the world, providing a basis for reforms of institutional arrangements and decision-making processes (Emel and Peet 1989). Every society exhibits a complex and shifting structure of values and it is important to recognise these values as the basis of the environmental policy development process. The strength of the environmental movement is now acknowledged in many countries by the creation of institutional

structures designed to ensure that material goals are not pursued to the exclusion of environmental considerations.

Environmental Values

Societies demonstrate a plurality of environmental values. From a global perspective, the human impact on the environment during the course of the last two hundred years is a consequence of the utilitarian values shared by a majority of the population. In Western capitalist societies, such values are underpinned by a strong belief in the unfettered rights of the private property owner. In many Third World nations, strong development aspirations to respond to problems of poverty and under-development have prompted governments and international agencies to manipulate the environment in order to promote growth.

This is one end of the spectrum of environmental values. At the other end of the spectrum are the spiritual, existence (the worth of knowing that a resource exists) and bequest (the worth of endowing future generations with a natural resource) values. Resources such as forestry are increasingly being recognized as possessing scenic, wilderness and recreational attributes as well as a soil and water conservation function. Indigenous people have become increasingly vocal in asserting their values while more recently, there has been growing concern about the detrimental impact of deforestation on the global climate.

Some of these values are compatible; others are characterized by competition and conflict. The need for the wise use of these and other scarce resources highlights the importance of developing appropriate institutional arrangements at a national and sub-national level for decision making based on an integrated assessment of social and economic, as well as bio-physical, considerations.

It is instructive to reflect on the plurality of environmental values in the ASEAN region from a comparative stance. Table 1 is a description of the situation in Europe to-day (O'Riordan 1989). As shown in this outline, technocentrism is a manipulative mode of thinking as opposed to the nurturing mode of ecocentrism. Environmentalism seeks to embrace both worldviews as a constructive tension between, on the one hand, ' a conservative and nurturing view of society-nature relationships, where nature provides a metaphor for morality (how to

Table 1
Contemporary Trends in Environmentalism in Western Europe

Ecocentrism		*Technocentrism*	
Gaianism	*Communalism*	*Accommodation*	*Intervention*
Faith in the rights of nature and of the essential need for co-evolution of human and natual ethics	Faith in the co-operative capabilities of societies to establish self-reliant communities based on renewable resource use and appropriate technologies	Faith in the adaptability of institutions and approaches to assessment and evaluation to accommodate to environmental demands	Faith in the application of science, market forces, and managerial ingenuity
'Green' supporters; radical philosophers	Radical socialists; committed youth; radical-liberal politicians; intellectual environmentalists	Middle-ranking executives; environmental scientists; white-collar trade unions; liberal-socialist politicians	Business and finance managers; skilled workers; self-employed; right-wing politicians; career-focused youth
0.1–3% of various opinion surveys	5–10% of various opinion surveys	55–70% of various opinion surveys	10–35% of various opinion surveys
Demand for redistribution of power towards a decentralised, federated economy with more emphasis on informal economic and social transactions and the pursuit of participatory justice		Belief in the retention of the status quo in the existing structure of political power, but a demand for more responsiveness and accountability in political, regulatory, planning, and educational institutions	

Source: O'Riordan 1989: 85.

behave) and a guide to rules of conduct (why we must behave so)' and on the other hand, a 'manipulative perspective in which human ingenuity and the spirit of competition dictate the terms of morality and conduct. . .' (O'Riordan 1989: 82).

However, a coherent environmentalism is yet to emerge in Europe. The current situation is characterized by contradictions and tensions and by a failure to agree over cause and action. I believe the situation is little different in other parts of the world.

NEW ZEALAND EXPERIENCE

I would now like to discuss the wider significance of the recent environmental reforms in New Zealand. The environmental restructuring policies were implemented by the fourth Labour government between 1984 and 1990. The task of environmental restructuring was a very complex exercise with many facets, and the participants have had varying perspectives on it (Memon 1993).

At present, New Zealand offers a particularly interesting setting for examining issues of environmental policy. In comparison with other Western and Third World states, the recent reforms in New Zealand have been wide-ranging in nature; a concerted attempt has been made to develop an institutional framework for a national environmental policy and to establish integrated environmental planning as an important function of central and sub-national government. Indeed, New Zealand may be the first country to have incorporated the concept of sustainability into law. The New Zealand experience raises a number of generic issues which may be of relevance to other countries:

- An interesting question, from the perspective of other countries, is the nature of recent environmental reforms and their compatibility with free market policies.
- A related issue is why it has been possible to make such wide-ranging and radical reforms in New Zealand within such a limited time frame.

Before examining these issues, it is useful to highlight the main outcomes of the recent environmental reform process in New Zealand. The key points to emphasize are as follows:

1. The environmental reforms were part of the wider state sector restructuring process, based on a radical reassessment of the role of governmental intervention in New Zealand society. This process has been driven by a New Right ideology which recently has dominated public policy discourse in many Western and Third World countries. Under the fourth Labour government, a series of unprecedented changes were conceived and executed by a small, elite group of politicians, business people and governmental officials whose primary objective was to increase the competitiveness of the New Zealand economy in the global economic order. It is difficult to overstate the scope of the institutional reforms implemented during this short period. They included deregulating the production, financial and labour sectors of the economy; restructuring the state sector; corporatizing or privatizing many governmental functions; rationalizing government involvement in provision of social services such as health, housing and education and in environmental administration and planning.
2. The long-standing role of the state as a developer has been abandoned. The former state development bureaucracies had potentially conflicting developmental and environmental objectives, e.g. the Forest Service, and Department of Lands and Survey. The production functions of all of these agencies have been corporatized or privatized, while most environmental regulatory functions have been devolved to sub-national government agencies.
3. Three new central government environmental agencies have been established:
   (a) The Department of Conservation (DoC) is responsible for advocating conservation values in the government policy process and managing a very substantial national heritage estate.
   (b) The role of the Ministry for the Environment (MfE) is described as a 'ministry in the middle'. It advises the Cabinet on the environmental implications of significant policy issues and to administer the Resource Management Act (see No.5 below).
   (c) The Office of the Parliamentary Commissioner for the Environment is unique in the world. The Commissioner is an environmental ombudsman and public watch-dog. This office is outside the executive branch of the government, reporting directly to Parliament.

4. As part of the local government reform process, the number of territorial local authorities has been drastically reduced through amalgamation. The new framework comprises 14 regional councils and 74 district councils. The commercial functions of local government have been corporatized.
5. The Resource Management Act 1991 (RMA) has consolidated decades of fragmented sectoral environmental legislation. Its central purpose is to promote the sustainable management of natural and physical resources. It provides a framework for integrated management as it embraces all resources (land, air, water and geothermal) except mineral resources. The act defines a three-tier, hierarchical planning structure. Regional councils, whose boundaries are based on major watersheds, have a pivotal role in resource management within this framework.
6. The RMA is potentially much stronger in recognizing indigenous Maori interests than its predecessors. It directs attention to Maori concerns, promotes a closer dialogue on issues of mutual concern, and provides guidance on achieving consultation with Maori at local and regional levels.

The above environmental reforms have sought to address many of the concerns frequently expressed about integrating environmental values in the public policy process. In time, one may ask as to the extent to which these reforms marked a significant turning point from the pioneering mentality of promoting economic growth and resource exploitation, to one which accommodates a growing concern for environmental quality and sustainable development. One must also ask whether these environmental reforms will be as effective as anticipated. The answers to these two questions will continue to be debated in New Zealand for some considerable time.

A feature of the evolution of environmental administration since 1984, has been the restructuring of authoritarian agencies that previously carried out resource management functions to achieve a mix of commercial and environmental protection objectives. The old organizations were able to divert resources to special interest groups and ignore the external costs of resource exploitation.

New organizations have now been established to achieve single-purpose objectives, more explicitly defined. One could argue that the reorganization of the state sector has removed one of the major causes of environmental maladministration in the country.

Likewise, the resource management and local government reforms have rationalized the allocation of environmental planning functions between different levels of government, and the planning procedures are more clearly orchestrated and focused. The number of environmental quangos has been reduced and their functions more clearly defined.

Over all, these changes complement one another. Seen within the confines of a political economy based on the market, one may surmise that they provide an appropriate institutional framework for addressing environmental problems and concerns.

At the same time, the deregulation of the economy and the dismantling of the welfare state have potentially exacerbated the environmental crisis in New Zealand. The pressures on New Zealand to be competitive within the global arena will continue to be a major constraint on its ability to pursue environmental objectives in a free-market economy.

It would be foolhardy to hope that the recent environmental reforms provide the answers to the environmental dilemmas facing New Zealand. Indeed, this is far from the case. Fundamental issues and assumptions remain unquestioned, such as the merits of continuous growth and consumption in a predominantly individualistic society that continues to subscribe strongly to materialistic values. The recent environmental reforms are based on an optimistic worldview: that a secure and competitive economic niche for New Zealand in the global economic system will make the task of making choices between the different options for utilizing and managing resources easier, with minimal government intervention.

In hindsight, the environmental reforms in New Zealand have been innovative from an instrumental perspective. The reforms have been primarily concerned with organizational considerations and decision-making procedures for managing resources in market economies. The development of new environmental legislation has been guided by procedural concerns whose scope is limited to reducing the detrimental impacts of human activities on the environment. Because of the ideological premises on which the new environmental administration and planning legislation are based, there may be limitations in their ability to promote sustainable development objectives. Attempts to improve organi-

zational and statutory decision-making processes can go some way towards promoting appropriate resource utilization policies. But it can be argued that those preoccupied with such matters run the risk of ignoring the more fundamental questions relating to the causes of environmental problems: the socio-political context of decision making about resource allocation. The existing social structures and relationships, based on the tenets of private property ownership, have been perpetuated and reinforced through a continuing belief in the virtues of privatization; this process has led inexorably to a dismantling of the public estate. Public intervention is sanctioned, as in the past, only to minimize the undesirable downstream consequences of individual and corporate decision making (Memon 1993).

The fundamental issues relating to the causes of environmental problems and conflicts have been ignored or played down. From an environmental perspective, the gains that have been made are limited, and the dilemma of integrating conservation values with economic growth objectives is far from resolved. The extent to which the sustainable development ethic can be achieved within the paradigm that has guided the recent environmental reforms, will be limited primarily to functional considerations such as minimizing adverse impacts.

Achieving the sustainable development of resource-based activities such as agriculture, tourism, forestry and manufacturing, is a much bigger challenge. This demands a critical examination of the existing activities and practices from a bio-physical, as well as a social and economic perspective.

The environmental administration and planning reforms in New Zealand discussed in this paper have been ambitious in conception and achievement. It would be surprising if similar reforms could be achieved in Southeast Asian countries with comparable ease. This may be a reflection of a number of factors, including the relatively small size of New Zealand, the simplicity of its unitary political system, and the absence of strongly vested political and economic interests on a scale comparable to other developed and developing countries.

SIGNIFICANCE TO THE ASEAN REGION

The New Zealand experience with environmental administration reform raises a number of issues of relevance to those ASEAN countries which may wish to review their own decision-making procedures for integrating environment and development objectives.

Sustainable Development Strategy

The concept of sustainable development has become an important policy concern and a major challenge for many states is how to translate this global agenda into national and local strategies.

A number of ASEAN states have made headway towards developing sustainable development strategies (Sien 1987; Sani 1993). However, it should be stressed that a catalogue of environmental legislation and organizations does not amount to a sustainable development strategy. The tendency in a number of countries is to 'tack on' an environmental component to existing programmes under the guise of sustainable development, rather than to rethink policies to meet new objectives (Smith 1993). There is a need to reorient public policies to promote a sustainable society. The imperatives for achieving this objective are integrating ecological rationality and social justice as a consideration in all facets of government activities.

Devolution of Decision Making

The machinery for environmental policy formulation and implementation in ASEAN states tends to be highly centralized. This is a legacy of colonial administration as well as a reflection of pragmatic operational constraints such as availability of qualified staff and lack of financial resources.

There are powerful arguments for devolution and decentralization of environmental decision making to elected regional and district councils. Devolution is desirable from a social perspective because it can provide a platform for proactive and meaningful public participation in policy formulation and implementation as well as project planning. Decision making is thereby brought closer to those affected by decisions. Elected council members have to live with the consequences of their decisions and be held accountable for them.

The rationale for delegating environmental planning functions to sub-national tiers of government is also justified on the economic premise that environmental planning should be carried out at the point where the required information is available and where the incentives to get the right results are greatest. Public concerns related to resource devel-

opment, in terms of its environmental impact, vary according to locality. Territorial local government is thus the most appropriate spatial jurisdiction for environmental planning.

For addressing environmental issues of a regional nature, such as water and air pollution, it may be appropriate to also consider a role for regional and metropolitan government in environmental management. In the case of pollution, the receiving media of air, water and land have interrelated effects which extend beyond the jurisdiction of single territorial local authorities. In several instances in the ASEAN states, these effects correspond to river catchments.In these situations, it may be appropriate to define the jurisdiction of regional authorities on a river catchment basis. The Sarawak River in Malaysia is a good example. In more highly urbanized situations, such as that in Singapore, it may be best to do this on a metropolitan regional basis.

The constitutional division of power and functions between the federal and state governments should be recognized as a major constraint on the potential for devolution of environmental decision making in Indonesia, Malaysia and the Philippines. For example, in Malaysia, the apparent conflict between the sates and the federal authorities regarding resource development is a sensitive issue (Sani 1993). Thus, the Environmental Quality Act was enacted by the federal government and is administered by it. However, the management of land, water and forestry resources is the prerogative of the States. Cooperation between the two tiers of government becomes difficult especially when there is conflict of interest between the two parties.

Integrating EIA and Planning

A related issue to those discussed above is the need for integration of Environmental Impact Assessment (EIA) Procedures with the development planning process. A common characteristic in ASEAN states is the lack of coordination between these legislative requirements, even though they share common objectives. The statutes for environmental management have been enacted during the last few decades, in an ad hoc, incremental fashion as environmental and planning problems and issues became apparent. Thus, the current jurisdictional framework for environmental management in countries such as the Philippines, is characterized by fragmented and overlapping responsibilities.

This was also the situation in New Zealand until the recent environmental reforms, as discussed earlier. New Zealand now has a streamlined three-tier framework for environmental management. Under the Resource Management Act 1991, regional and district councils exercise major environmental planning responsibilities while EIA has been incorporated within the planning process.

Indigenous Peoples Issues

For the indigenous and tribal peoples in Southeast Asia, economic expansion has brought many new opportunities and new crises. The recent conflicts between them and transnational companies have been embedded in wider social tensions relating to sovereignty and claims to ownership of resources. As with the Maori people in New Zealand, disputes over the ownership and management of resources have been a source of long-standing grievances for tribal communities in Thailand, the Philippines, Malaysia and Indonesia. The needs of these peoples, including ownership rights to land and water resources, were in the past often overlooked or deliberately ignored in the growing apparatus of legislation and related instruments for resource allocation and management. More recently, resource and infrastructure development projects have imposed major changes on the lifestyle and development options of such groups.

New Zealand has recently made an attempt to recognize the concerns of its indigenous peoples in a number of ways. For example, public consultation with the Maori people is a mandatory requirement in the newly enacted Resource Management Act. From the perspective of the indigenous and tribal communities in the ASEAN states, public participation provisions in the formal district and regional development planning and impact assessment procedures could provide an opportunity to raise their concerns in an otherwise inaccessible decision-making process.

CONCLUSION

The Southeast Asian countries have achieved dramatic growth during the last few decades, described by some as an economic miracle. The region's economic success since the 1950s has placed very heavy demands on its natural resources and on the capacity of its environment to sustain continued

development. There is a growing concern that present forms of development are unsustainable. The major issues include deforestation, sustainability of food production, the deteriorating urban and marine environments, implications of climatic uncertainty and the institutional problems lying in the way of better environmental management. It has been argued that a fundamental change in the approach to development is necessary for it to be sustainable. The region needs to come to grips with the need not only for stronger and more effective institutions of environmental management, but also for a polity which places far higher emphasis than hitherto on the long-term common good (Brookfield 1993: 32).

Aspects of the New Zealand approach to environmental reforms and the outcomes of the reform exercise may be relevant to other countries but this would need closer assessment in each situation. Based on the review of New Zealand's experience, I would like to conclude the paper by listing a number of key generic issues that should be considered during a major environmental reform programme in market-based economies:

- Critically examine existing economic activities (agriculture, forestry, mining, manufacturing, tourism, etc.) from a bio-physical, technological and socio-economic perspective and the direction of development based on these productive sectors.
- Critically examine the role of the state as a national development agent and the scope of public intervention to promote economic growth and also achieve social and environmental objectives. To what extent is faith in the ability of government to combine these objectives justified?
- What are the appropriate institutional arrangements to integrate these objectives within the framework of a national strategy for sustainable development?
- Is it desirable to separate conservation functions of government agencies from their production functions through corporatisation and privatisation of the latter and by creating a central conservation department?
- Consider the role and effectiveness of a central government environmental agency to balance and integrate environment and development values in the public policy process and in formulating a sustainable development strategy; powers and resources of this agency within the central government bureaucracy; its relationship with other state agencies.
- Intergovernmental relations in environmental management and planning responsibilities, and the extent to which environmental responsibilities should be delegated to sub-national tiers of government in a hierarchical planning system in federal states and in unitary states.
- Design a comprehensive statute for integrated environmental planning; relative significance of regulatory and economic instruments in environmental regulation.
- Consider the role of EIA as part of the planning consent process; statutory provision for citizen participation and public accountability in the decision-making process.
- Consider the role and capability of sub-national government tiers in administering such a statute.

ACKNOWLEDGMENTS

An earlier draft of this paper was presented at the International Conference on the Geography of the ASEAN Region, Kuala Lumpur, 25–29 October 1994. I wish to thank the anonymous referees and Dr Michael Hilton for their comments on earlier drafts of this manuscript.

REFERENCES

Barber, C. 1989. 'Institutional Issues in Environmental and Natural Resources Management for the Asia/Near East Region.' Manuscript prepared for the Bureau for Asia and the Near East, USAID, World Resources Institute, Washington.

Brookfield, H. 1993. 'The Dimensions of Environmental Change and Management in the Southeast Asian Region' in Brookfield, H. and Byron, Y. (eds.) *Southeast Asia's Environmental Future: The Search for Sustainability.* Kuala Lumpur: Oxford University Press, pp. 5–32.

Caldwell, L.K. 1970. *Environment: A Challenge for Modern Society.* New York: Natural History Press.

Dryzek, J.S. 1990. 'Designs for Environmental Discourse: The Greening of the Administrative State ?' in Paehlke R and

Torgerson D (eds.) *Managing Leviathan: Environmental Politics and the Administrative State.* Peterborough, Ontario: Broadview Press.
Fernie, J. and Pitkethly, A.S. 1985. *Resources: Environment and Policy.* London: Harper and Harper.
Hill, M. and Bramley, G. 1986. *Analysing Social Policy.* Oxford: Basil Blackwell.
Memon, P.A. 1993. *Keeping New Zealand Green. Recent Environmental Reforms.* Dunedin: Otago University Press.
O'Riordan, T. 1982. 'Institutions Affecting Environmental Policy' in Flowerdew R.T.N. (ed.) *Institutions and Geographical Patterns.* London: Croom Helm, pp. 103–140.
O'Riordan, T. 1989. 'The Challenge of Environmentalism' in Peet, R. and Thrift, N. (eds.) *New Models in Geography,* Volume 1. London: Unwin Hyman, pp. 77–102.
Peet, R. and Thrift, N. (eds) 1989. *New Models in Geography*, Vol. 1, London: Unwin Hyman.
Portney, P.R. (ed.) 1990. *Public Policies for Environmental Protection.* Washington: Resources for the Future.
Rees, J. 1985. *Natural Resources: Allocation, Economics and Policy.* London: Methuen,
Sani, S. 1993. 'Urban Environmental Issues in Southeast Asian Cities: An Overview' in Brookfield and Byron, op. cit. pp. 341–360.
Sani, S. 1993. 'Economic Development and Environmental Management in Malaysia' *New Zealand Geographer*, Vol. 49(2), pp. 64–68.
Sien, C.L. (ed.) 1987. *Environmental Management in Southeast Asia.* Singapore, Faculty of Science, National University of Singapore.
Wildavsky, A. 1979. *Speaking Truth to Power. The Art and Craft of Policy Analysis.* Boston: Little Brown.

Joint Institute for Energy and Environment

BACKGROUND

Three institutions in the United States with major activities in the areas of energy, environment and economics formed the Joint Institute for Energy and Environment (JIEE) in 1992. Its work involves projects in the United States and in various parts of the world. The Institute functions as an umbrella under which the staff of Oak Ridge National Laboratory (the most interdisciplinary of the US national laboratories), the Tennessee Valley Authority (the largest US utility), and the University of Tennessee (with extensive ecological, economic and environmental capabilities) more freely collaborate among institutions. The core operating staff of JIEE number about 10. Staff housed at the parent institutions become JIEE operatives as they initiate collaborative projects under the JIEE umbrella. Outside organizations, nationally and internationally, frequently join in these collaborative efforts on a broad spectrum of projects concerning issues at the interface of energy, environment, and economics.

ACTIVITIES

JIEE initiates or facilitates collaborative research and development on difficult energy and environmental issues which have strong policy, technology and economic implications. The focus is on topics in which the parent institutions are collectively strong and are not otherwise pursuing independently. Additional collaborators may be anywhere in the world. Funding comes from non-government organizations (e.g. the Rockefeller Foundation, the National Bioenergy Industries Association), private companies (e.g. Lockheed, International Applied Engineering Inc.), US federal agencies (e.g. WEPA, National Science Foundation, USAID), non-US collaborators (e.g. the Yunnan Institute of Environmental Sciences in the PRC), international organizations (e.g. the UN Industrial Development Organization), and development banks.

MANAGEMENT STRUCTURE

The JIEE has a core scientific and operations staff whose responsibility is to support staff of the parent institutions in team formation, to facilitate the development of interesting R&D initiatives, and to streamline contracting. Its contracting office is the University of Tennessee. Staff from the parent institutions may either be loaned to JIEE or empowered to represent JIEE as a R&D (technical) team member while retaining identity with their home institution.

RESEARCH AND DEVELOPMENT

National Center for Environmental Decision-Making Research

JIEE is manager of the US National Science Foundation's new Center for Environmental Decision-Making Research. As such, efforts will be conducted with many collaborators around the country to address major regional and local environmental decision-making issues where uncertainty of diverse origins is making progress difficult. Activities fall into five interrelated areas: synthesis and distillation of decision-making knowledge; targeted case studies of environmental decision-making processes; development of a decision maker's 'toolkit'; initiation of a computer-based analysis infrastructure; and programmes to engage environmental decision makers as participants and research clients. The most important aspect of this Center is its US regional and local approach to environmental decision making.

Biomass Energy Commercialization

JIEE is involved in rural biomass energy projects which address system configurations in light of total system operation, profitability, and services to com-

munities and environmental sustainability. Rationally identifying niches for biomass energy, teams have developed special feasibility methodologies (such as cost-supply analyses), focused on private capital development requirements, investigated greenhouse gas monitoring issues, and conducted training. System feasibility has been assessed at all scales and levels of technological sophistication with specific attention to the interface between agriculture, energy, environment, and human well-being. Efforts in the Yunnan province of China have developed concepts to the investment stage and have demonstrated requirements to attain success. Other projects have been in India, Eastern/Central Europe, Latin America, and the United States.

Sustainable Development

This initiative addresses the sustainability of evolving human well-being and environmental conditions as affected by energy technologies, energy systems management, and conservation.

Training — Energy, Environment and Economics

Training in the areas of environmental economics, environmental policy, energy technology, and the business of energy management is conducted via study groups, visiting scholars, and students (primarily postgraduate). Most students and professional groups (decision makers, operators, investment representatives, and advanced postgraduate students) come from Asia and the US. For example, training activities have involved owners/operators of sugar mills in India and China, representatives of national and provincial ministries, as well as venture capital and insurance company executives. The typical objective of such training sessions is to enhance the skills of different types of participants (e.g. private companies, government or international organizations, venture capitalists) to facilitate project implementation. Training often involves the development of analytical tools and information important in negotiating policies, assessing profitability, and evaluating sustainability of various energy or environmental developments.

Environmental Clean-up

JIEE is involved in testing subsurface water (i.e. aquifers) clean-up of chemical contamination through biotechnology and microbiology. The Institute is also working with insurance companies and the US government on the cost-effective approaches to the clean-up of major contaminated sites (Superfund sites). Techniques assessing risk and cost are major components of these efforts.

Other Activities

Other efforts of JIEE involve water quality monitoring, biodiversity evaluations, climate change monitoring, development of biomass energy crops, and contaminant remediation (radionuclides and heavy metals). Collaborators have been utilities, investors, independent power producers, environmental protection agencies, energy departments, special interest groups, both private and state-owned businesses, university staff, business consultants, and national laboratories.

Further Information

For further information, please contact:

Dr. Milton Russell
Director
Joint Institute for Energy and Environment
(JIEE)
600 Henley Street, Suite 314
Knoxville, Tennessee
USA 37996–4138
Tel: (423) 974–3939
Fax: (423) 974–4609
E-mail: jranncy@utkvx.utk.edu
c/o Dr. Jack Ranney

COMMERCIAL ENVIRONMENTAL SERVICES AND INFORMATION*

Beveridge & Diamond, P.C., U.S.A.

Beveridge & Diamond, P.C. is a United States law firm of more than 70 attorneys providing environmental legal services and information to clients worldwide. Beveridge & Diamond is the largest United States law firm dedicated to the practice of environmental law, with offices in Washington, D.C., New York and San Francisco. The firm represents clients in all areas of United States environmental law and regulations and advises clients on matters arising under international environmental agreements, the environmental aspects of multilateral trade agreements, and matters arising under the laws of countries other than the United States, including many Asian countries. In addition, the firm updates clients and others regularly on recent developments in United States and international environmental law. The firm also publishes a bi-monthly newsletter *The Environmental Marketplace* that reports on environmental legal developments affecting the design and marketing of consumer products.

INTERNATIONAL ENVIRONMENTAL PRACTICE

Beveridge & Diamond has a diverse international environmental law practice. The firm advises clients on the impacts of proposed and existing international environmental accords and the environmental regulatory implications of existing and proposed international trade agreements. The firm has counselled clients on matters related to a number of global environmental agreements, such as the Montreal Protocol on Substances That Deplete the Ozone Layer, and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. The firm also monitors and counsels clients on legal developments within the European Union, the Organization for Economic Cooperation and Development (OECD), and various United Nations bodies such as the United Nations Environmental Programme (UNEP). The firm also monitors and advises clients on the environmental policies and guidelines of multilateral development banks, including the World Bank and Asian Development Bank, as well as United States financial institutions such as the Export-Import Bank and the Overseas Private Investment Corporation (OPIC). Principals at the firm have participated in the negotiation and implementation of international environmental conventions, including the Stockholm Convention on the Human Environment, the East/West Environmental Conference held in Vienna, and the Global Climate Change Convention in Rio de Janeiro. The firm has also assisted foreign governments in Europe and the Middle East in developing environmental regulatory programmes.

The firm is active in the 'trade and environment' arena as well and has counselled clients on the implementation of the North American Free Trade Agreement (NAFTA) and the GATT 1994 Agreement. The firm also works with foreign and United States multinational corporations in a wide variety of transactions, including worldwide licensing agreements, worldwide purchase and sale agreements, and worldwide environmental data development ventures.

Beveridge & Diamond also counsels clients on the requirements of US domestic environmental laws of other countries and territories. For example, the firm has counselled a number of clients on environmental issues in other countries related to facility acquisitions or sales, liability for the clean-

* Editor's note: *AJEM* welcomes brief, overview descriptions (up to 200 words) of commercial sources of environmental services and information. Inclusion of such description in this journal is provided as a service to our readers and does not constitute an endorsement by *AJEM*. (Descriptions are provided free-of-charge and without other contributions to *AJEM* by the organization concerned.)

up of contaminated property, the import and export of pesticides and hazardous wastes, environmental compliance assessments, air pollution control, and use and registration of both genetically-engineered and chemical pesticides. In addition, the firm has advised clients on issues related to the extraterritorial reach of United States environmental laws.

Beveridge & Diamond has also developed working relationships with a number of individual lawyers and law firms in Asia, Australia, Africa, the European Union, and North, Central and South America who specialize in environmental regulatory developments in their respective countries and territories.

The firm's environmental practice also encompasses representation in such matters as land development, wetlands permitting, and environmental compliance and transactional audits and assessments. The majority of the firm's resources are dedicated to representing numerous domestic and foreign, large and small corporations, commercial entities, and trade associations across a broad range of business and industry segments with respect to the full range of United States federal and state environmental requirements. The firm litigates extensively on behalf of foreign and multinational corporations on matters related to United States environmental law.

The firm tracks closely environmental legal developments in the United States and in Asia, particularly developments in the People's Republic of China. The firm routinely reports on these developments to clients and interested parties, providing original documents and summaries of the practical impact of various regulatory developments.

For more information, please contact:

Karl S. Bourdeau or Richard J. Ferris
Beveridge & Diamond, P.C.
Suite 700
1350 I Street, NW
Washington, D.C.
20005 U.S.A.
Phone: (202) 789–6000
Fax: (202) 789–6190
E-mail: 7540875 @ MCIMAIL.COM

PROGRAMME ANNOUNCEMENT

A Professional Certificate in *Pollution Prevention and Control*

A nine-week course leading to a *Professional Certificate in Pollution Prevention and Control* is being offered by the University of California Berkeley Extension from 11 March through 10 May 1996 in Berkeley, California, USA. The programme is intended for professionals from around the world from a variety of environmental backgrounds and professions including those persons involved in such activities as national energy policy analysis, institution-building for government environmental activities, environmental monitoring, and private sector waste reduction and compliance with environmental regulations.

The programme's courses include:

- Regulatory Framework for Environmental Management
- Environmental Behaviour of Pollutants
- Pollution Prevention, Waste Management and Minimization
- Toxicology and Risk Assessment
- Air, Water, and Land Pollution: Assessment, Control, Clean-up
- Auditing and Environmental Management (using ISO 1400 standards)

In addition to classroom training, the programme includes site visits to places such as a hazardous waste treatment facility, a landfill, an operating industrial facility and/or groundwater and soil remediation site.

Costs for the programme are US$4,500 *plus* books and living expenses.

For further information contact:

Elisabeth Lamoureaux
Environmental Management Department
University of California Berkeley Extension
2223 Fulton St. Berkeley, Ca 94720–7012 USA
Fax: 1–510–643–8290
e-mail: wel@unx.berkeley.edu