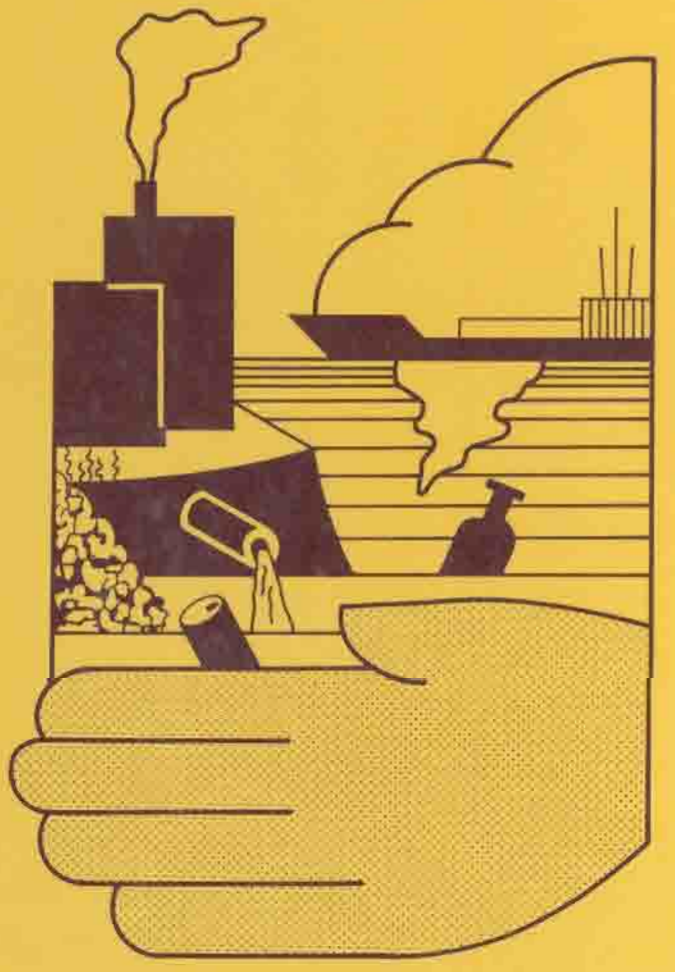
Waste Management in the Coastal Areas of the ASEAN Region

Roles of Governments, Banking Institutions, Donor Agencies, Private Sector and Communities



Edited by
Chua Thia-Eng
Len R. Garces

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Waste Management in the Coastal Areas of the ASEAN Region: Roles of Governments, Banking Institutions, Donor Agencies, Private Sector and Communities

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CHUA THIA-ENG
AND
LEN R. GARCES

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Contents

Preface

Every year, the world produces millions of tons of household garbage, industrial waste and sewage, the disposal of which has now become a major environmental problem. In industrialized nations, each consumer throws out an estimated 1.6 kg of garbage every day. As a result, sanitary landfills are filling up at an alarming rate. New disposal sites are scarce.

In developing nations, the average consumer produces a relatively lesser amount of garbage, i.e., about 0.45-0.90 kg daily, but these countries have great financial difficulty in collecting all of it properly. In Manila, for example, only 70% of the garbage is being collected.

Furthermore, because environmental regulations are not as stringent or as well enforced as those in the developed nations, most garbage is dumped directly into the sea, typically in nearshore waters. The refuse, however, is eventually deposited in wetlands, coral reefs and seagrass beds. In some cases, these ecologically fragile habitats are used as disposal sites. The refuse clogs up water conveyance structures and litters tourist beaches causing aesthetic losses.

In some nations, sewage undergoes primary treatment before its release into the sea. Yet, organic pollution has been obvious in many nations in Asia, especially those with dense populations along their coasts. Eutrophication in coastal waters due to nutrient enrichment has led to increased blooms of toxic phytoplankton and altered benthic communities, posing serious risks to ecosystems and public health.

Current trade and investment policies in many developing nations favor accelerated industrial development, which has led to the increasing discharge of untreated industrial waste into the coastal waters. Toxic chemicals such as cadmium, arsenic, mercury, lead, zinc, polychlorinated biphenyls, acids, alkalis and oily waste enter the coastal systems through the waterways. The inexorable buildup of poisons, if unchecked, will soon become a serious environmental and public health crisis. In Hong Kong alone, close to 101,000 t of chemical waste are discharged directly into the sea by over 10,000 factories.

Industrial waste management has always been a serious technical problem even in industrialized nations. The main issue in developing nations is the lack of financial resources to deal with it. Most decisionmakers are aware of the need to protect the environment, but consider it a low priority compared to the pressing need for food production, employment generation and foreign exchange earning. Political leaders usually do not want to take the risk of losing votes by imposing taxes for services such as sewage treatment and garbage disposal; neither is there a strong political will to implement environmental regulations and invoke the "polluter pays" principle. As a result, the problem of environment and human health loss resulting from improper waste disposal is quite high in many developing nations.

While many Asian countries are facing critical environmental problems, newly industrialized nations are prepared to spend a considerable amount of their national budget in cleaning their waters. This is partly due to increased public pressure for a healthier environment and mainly because waste management presents a newly emerging industry which provides opportunity for economic growth and sustainability. Hong Kong already has a thriving export trade in waste materials; in 1988, it exported HK$2.17 billion worth of waste metals and papers. Taiwan, Hong Kong and South Korea are expected to spend US$5 billion in the next five years for waste management. This will provide more opportunities for Western and Japanese companies to sell

their technologies and equipment. In other developing nations, public pressure for clean environment and an awakening to current environmental crises have made policymakers aware of their responsibility to address these issues seriously. Waste disposal has become a serious environmental issue that national governments can no longer avoid or ignore.

Waste management was one of the issues raised at the Conference on Managing ASEAN's Coastal Resources for Sustainable Development in Baguio, Philippines, on 4-7 March 1990, which led to the Conference on Waste Management in the Coastal Areas of the ASEAN Region held in Singapore on 28-30 June 1991.

This conference aimed to assess the severity of environmental threats of waste disposal to the region's coastal zone; demonstrate technologies in waste management; explore ways in which international banking institutions and donor agencies could assist in waste management; and solicit the commitment of ASEAN political leadership in the effective enforcement of waste management schemes.

The highlights of the conference were the adoption of the Singapore Resolution on Waste Management in the Coastal Areas of the ASEAN Region, the stronger commitment from policymakers, and the participation of private sectors in present and future waste management activities.

Organized under the auspices of the ASEAN/US Coastal Resources Management Project (CRMP) of the International Center for Living Aquatic Resources Management (ICLARM), the conference was co-organized by the Singapore Ministry of the Environment (ENV). It was sponsored by the United States Agency for International Development, Asian Development Bank and the Canada-ASEAN Centre. We appreciate the full cooperation of the session chairmen and coordinators, resource speakers and discussants, and the Secretariat, namely, Mr. Lim Chuan Poh and Mr. Eng Tiang Seng and their staff at ENVI. Our special thanks to Maylene Loo and Beverly Goh of the National University of Singapore, and Cory Guerrero, Len Garces and Rachel Josue of ICLARM. We acknowledge the ICLARM editorial staff who provided support in the preparation of these proceedings: Marie Sol M. Sadorra, Pamela P. del Rosario and Katherine I. Chua assisted in the editing; Rachel Josue and Teresa Cruz typed the manuscript; Rachel Atanacio and Reynaldo Silvestre prepared the figures and layout.

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Foreword

Concerns about the environment have emerged as a global preoccupation. They coexist with the continuing, huge requirement for development through the concept of sustainable development.

Nowhere in the world does the confluence of environment and development occur more dramatically than in the ASEAN region. Its rapid economic growth is the envy of the world, but the people and governments of ASEAN know that these advances can only be maintained and continued if the development takes place in an environmentally sustainable manner.

With its thousands of kilometers of shoreline, ASEAN is directly concerned with the question of waste management in coastal areas. Canada is concerned with the same issues; we too have a huge coastline and archipelago.

We are therefore pleased to be co-sponsors of this conference. Its findings are important not only to the ASEAN region itself, but also to Canada and all other countries which share a commitment to sustainable development.

Ian B. Robertson
Executive Director
Canada-ASEAN Centre

Foreword

The rapid economic and demographic growth taking place in the coastal areas of many Asian countries has been accompanied in recent years by heightened awareness of its environmental repercussions. Overfishing, destructive fishing and indiscriminate conversion of mangroves to aquaculture have lowered the productivity of rural coastal environments. In urban coastal areas, household and industrial waste disposal demand has typically outstripped the ability of municipal systems to prevent environmental deterioration and increased public health risk.

These problems have been recognized by the Asian Development Bank (ADB) for some time. The design of ADB projects has come to pay greater attention also to the growing interdependence of economic activities within coastal zones as well as the links between the environmental condition of coastal areas and economic activities taking place at some distance from the coast.

The ADB's interest in this complex subject is a reflection of the concerns of its member-countries, many of which have long coastlines or are island nations. Among ADB's developing member-countries, those of the ASEAN have been active in their search for best responses to the conflict between rapid economic growth and coastal environmental degradation.

We are pleased to have been associated with the preparation of the Conference on Waste Management in the Coastal Areas of the ASEAN Region and to have provided funding support and some of the technical inputs for the conference.

We wish to express our appreciation to the Ministry of the Environment of the Republic of Singapore for the generous support it extended to the conference organizers and to our co-sponsors, the United States Agency for International Development and the Canada-ASEAN Centre.

K.F. Jalal
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Opening Ceremonies

Waste Management in the ASEAN Region: Challenges and Directions*

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CHUA, T.-E. 1992. Waste management in the ASEAN region: challenges and directions, p. 1-3. *In* T.-E. Chua and L.R. Garces (eds.) Waste management in the coastal areas of the ASEAN region: roles of governments, banking institutions, donor agencies, private sector and communities. ICLARM Conference Proceedings 33, 218 p. Ministry of the Environment, and Canada-ASEAN Centre, Singapore; Asian Development Bank, and International Center for Living Aquatic Resources Management, Philippines.

ABSTRACT

Waste and pollution problems not only pose ecological risks but also have far-reaching socioeconomic implications which governments in the ASEAN region should consider seriously. Efforts in waste management require political will, public support and multilateral cooperation. In addition, low-cost technologies need to be explored, and reuse and recycling promoted as viable waste management methods.

It gives me great pleasure to welcome all of you on behalf of the conference organizers, the Ministry of the Environment of the Republic of Singapore and the ASEAN/US Coastal Resources Management Project of the International Center for Living Aquatic Resources Management. I am glad to see among us ministers, governors, parliamentarians and senior government officials of the ASEAN region and representatives of multilateral banking institutions, donor agencies, nongovernmental organizations and the private sector.

This conference, which also has the financial support of the Asian Development Bank and the Canada-ASEAN Centre, aims for an interchange of information and ideas on the pressing issue of waste management. Specifically, this gathering has a fourfold objective, namely:

- assess the severity of the environmental threats posed by waste disposal, especially to the coastal zone in the ASEAN region;
- explore and demonstrate the availability of technologies (especially low-cost ones) and methods in waste management that are appropriate for developing nations;
- explore ways in which international banking institutions and donor agencies could assist the region in developing and implementing waste management schemes; and

*Welcome Address delivered during the Opening Ceremonies of the Conference on Waste Management in the Coastal Areas of the ASEAN Region on 28 June 1991 at the Marina Mandarin, Singapore. ICLARM Contribution No. 823.

- solicit the commitment of ASEAN political leadership in the effective implementation of environmental regulations and waste management schemes.

Incidentally, this conference is the offshoot of the successful ASEAN/US Policy Conference on Managing ASEAN's Coastal Resources for Sustainable Development held last year in Baguio, Philippines.

Waste management in the coastal zone is imperative because this zone is the most vulnerable and most heavily utilized among the major resource systems. This is a result of the ever-increasing coastal population and the attendant economic pressures. Roughly 70% of the region's population lives in and depends on the coastal areas for their livelihood.

The current rates of population growth and industrialization, consumption level and inadequate waste disposal methods all conspire to make garbage mountains a common spectacle in some coastal areas in the region. A typical resident of the region disposes of on average, approximately 0.5 to 1 kg of solid waste every day.

Wastes can be classified according to origin. The domestic front produces solid and liquid waste which are disposed of in landfills and in the seas. The high concentration of industries along the coast gives rise to serious pollution problems which heavily degrade the environment. Because the rivers, streams and seas are being used as the cheapest and easiest disposal sites, many of them are either dying or dead.

Experts recognize a solid waste management hierarchy that has source reduction at the top of the list. They believe that one of the best and the most difficult of solutions to the garbage problem is avoiding garbage generation in the first place. Next is direct reuse of products and then recycling which is simply the recovery and conversion of waste materials into new products. The fourth option is incineration or the burning of waste. And the last resort is supposed to be landfilling, ironically the most popular in the world.

Waste and pollution are not just national or regional problems. Wastewater pollution, for example, does not recognize national boundaries. It also affects waters of neighboring nations. Clearly, the issues are transnational in scope as we live in one world, a world that will give up on us unless we have an agenda for change particularly in the field of waste management.

The waste problem is not only an ecological risk. It has also far-reaching socioeconomic implications that governments today should consider seriously. Degrading environmental quality threatens public health. The cost of mitigating measures are prohibitive. One of the major problems encountered in many developing nations is the large cost needed to implement effective waste management programs. A developing country with 60 million people may need as much as US$1 billion a year to clean both solid and liquid wastes and to maintain their infrastructure. This will have a far-reaching political implication if public funds are used. The problem of unpopular government measures to levy taxes often compels lawmakers to make waste management a low priority in the hierarchy of national concerns.

As we examine the country situations and issues during this conference, measures to curb the problems will be discussed and applied, if feasible.

The agenda for waste management requires strong political will, public support and multilateral cooperation. Governments can build a framework of initiatives to reduce the amount of waste requiring disposal. They can promote source reduction, reuse and recycling as viable management strategies that cut waste and foster more resilient, diverse, self-reliant and sustainable economies. National recycling plans should be adopted, with convenient facilities for collection and exchange of used goods. Decentralized collection and processing of secondary materials can create new industries and jobs. Markets for "recyclables" should be consistently available for the success of recycling programs. The public and private sectors should support recycling by buying materials recovered from waste. The concept of "polluter pays" must be examined more carefully regarding its implementation in the developing nations.

Low-cost technologies have to be explored and adopted. Some technologies may even turn waste management into a profitable enterprise. Other potential benefits include reduction in pollution and imports, employ-

ment generation, and the conservation of raw materials and energy. In other words, we should now look at the issue of waste management not only from the standpoint of social obligation but also as an economic opportunity. On this note, the private sector can play a significant role.

The government cannot handle waste management by itself. Its efforts should be complemented by the joint forces of the media and the nongovernmental organizations to educate the public on limiting waste generation and disposal and effective recycling as an added source of income. The public awareness campaign should be geared toward the mobilization of mass commitment to sound waste management.

International cooperation is also important. The invaluable support of multilateral banking institutions and donor agencies is therefore sought especially in financing innovative solutions to waste management problems. Adequate funding and attention can help develop alternatives to traditional landfills and dumpsites as well as upgrade waste storage, collection and disposal for environmental safety in the developing countries.

I welcome you once again to what promises to be a fruitful conference.

Thank you.

Singapore's Efforts in Toxic Waste Management*

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MATTAR, A. 1992. Singapore's efforts in toxic waste management, p. 5-7. *In* T.-E. Chua and L.R. Garces (eds.) Waste management in the coastal areas of the ASEAN region: roles of governments, banking institutions, donor agencies, private sector and communities. ICLARM Conference Proceedings 33, 218 p. Ministry of the Environment, and Canada-ASEAN Centre, Singapore; Asian Development Bank, and International Center for Living Aquatic Resources Management, Philippines.

ABSTRACT

Because of the growing concern for environmental degradation, the need for international cooperation in protecting the environment has become more urgent. However, efforts to safeguard the environment must begin in each nation. In Singapore, for example, current efforts are towards managing toxic wastes. By June 1992, the sale of zinc carbon and alkaline batteries with more than 0.001% and 0.025% mercury by weight per cell, respectively, will be prohibited. In addition, importation of batteries containing mercuric oxide will be banned by January 1992.

Let me first extend a warm welcome to all participants to this conference jointly organized by my ministry and the International Center for Living Aquatic Resources Management (ICLARM). For any coastal country, successful waste management is an important step toward safeguarding coastal resources. I am glad that in cooperation with ICLARM, we are able to bring together many experienced policymakers, experts and members of financial institutions here today to exchange views on this important subject.

The world's first conference on the environment was held in Stockholm, Sweden, in 1972. It was then that the issues of global environmental degradation were first brought to the attention of the international community. Unfortunately, the follow-up warnings by scientists and environmentalists went unheeded for more than a decade. It was not until the 1980s that the world community began to show its concern for the future of our planet earth.

The publication of *Our Common Future* in 1987 by the World Commission on Environment and Development acted as a catalyst for a concerned worldwide effort to preserve the environment. It is indeed encouraging that 20 years after Stockholm, the world community will meet in Rio de Janeiro, Brazil, to deal with the threat of environmental degradation.

Preparations for the Brazil conference continues to produce many interesting ideas in response to the various environmental concerns. Whether or not mankind can effectively implement these ideas will depend on

*Opening Remarks delivered during the Opening Ceremonies of the Conference on Waste Management in the Coastal Areas of the ASEAN Region on 28 June 1991 at the Marina Mandarin, Singapore.

whether a consensus can be forged among nations. This is indeed not an easy task.

Till today, there remains a general lack of agreement at the international level on how countries should cooperate. The differences in perception between the North and the South on issues such as accountability, financial responsibility and technology transfer continue to plague negotiations for global solutions.

The solutions will inevitably require a global partnership of the developed and developing countries. This partnership can only be effective if the developed countries which have the technical expertise and financial capability assist developing countries in participating in programs to halt global environmental threats.

Growth and development in any country cannot be sustained if the environment is not properly managed and protected. Developed countries must to this end see that it is also in their interest to help the developing world achieve sustainable growth if they wish to count on them as long-term trading partners. In this regard, developing countries must cooperate between and among themselves, sharing experiences, expertise and technologies in dealing with environment and development.

The need for international cooperation in protecting the environment is critical. Yet efforts to safeguard the environment must begin at home.

Many countries today face problems of urban drift. People are attracted to the cities which promise better-paying jobs and exciting lifestyles. As a result, cities have often grown at a pace unmatched by the slow development of facilities and systems needed to protect the environment, e.g., systems for wastewater collection and treatment and solid waste management. Without these, urban pollution finds its way into rivers and subsequently into the sea, threatening marine and coastal habitats as well as resources.

We are fortunate in Singapore to have developed systems for comprehensive sewerage and solid waste management which have helped prevent pollution. These have cleaned up Singapore and Kallang Rivers, once major conveyors of pollution to the sea.

According to the report of the Co-ordinating Body on the Seas of East Asia-United Nations Environment Programme Seminar on the Assessment and Environmental Impact of Pollution from Land-based Sources in ASEAN held in Singapore on 25-27 January 1989, land-based sources of pollution indeed contribute greatly to pollution in the sea. This conference is therefore timely.

Waste management has become more complicated as our society becomes more dependent on modern technology. A greater variety of materials and products is produced in this consumer age and many inevitably end up as waste. Unfortunately, some pose environmental problems.

Take the example of batteries. Seemingly harmless, batteries in all shapes and sizes are widely used today. If not properly disposed of, batteries can pose a threat to the environment because of their toxic chemicals. Recycling used batteries is the best way, provided suitable facilities and technologies are available. The only other alternative is disposal by controlled landfill.

Toxic chemicals commonly found in batteries are mercury and cadmium. The mercury content of batteries, however, is being considerably reduced by advances in technology and the establishment of standards in Japan, the European Community and Nordic countries. Cadmium in rechargeable batteries will soon be reduced and recycled with the broad support of the public.

In this respect, Singapore has these developments. Starting 1 June 1992, the sale of the following will be prohibited: zinc carbon batteries with more than 0.001% mercury by weight per cell and alkaline batteries (except those in button form) with more than 0.025% mercury by weight per cell.

Imported mercuric oxide batteries will not be allowed in Singapore after 1 January 1992 and existing stocks will have to be sold before 1 June 1992. Their use, however, for special medical equipment such as hearing aids shall be allowed until alternatives are found.

The Ministry of the Environment will work closely with local dealers and distributors on a scheme to recover nickel cadmium batteries for recycling. We hope the scheme could be in place by January 1992.

Singapore is committed to the protection of the environment at the local, regional and

international levels. We see economic development and good quality environment as the means to a better quality of life. It has now become clear that we must now add to this the need for a safe global environment if we are to leave behind a heritage of value to our future generations.

This conference is important as it brings into focus a key problem in the region. We are blessed with a very rich natural environment on land and at sea. We must ensure these are preserved for our children and our children's children.

I wish you all a fruitful and productive round of discussions over the next three days. I look forward to your forthcoming recommendations.

On this note, it is my pleasure to declare open the Conference on Waste Management in the Coastal Areas of the ASEAN Region.

Waste Management in Coastal Zones: The Role of Multilateral Development Banks*

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CHUNG, I.Y. 1992. Waste management in coastal zones: the role of multilateral development banks, p. 9-12. *In* T.-E. Chua and L.R. Garces (eds.) Waste management in the coastal areas of the ASEAN region: roles of governments, banking institutions, donor agencies, private sector and communities. ICLARM Conference Proceedings 33, 218 p. Ministry of the Environment, and Canada-ASEAN Centre, Singapore; Asian Development Bank, and International Center for Living Aquatic Resources Management, Philippines.

ABSTRACT

This paper discusses the role of multilateral banks such as the Asian Development Bank (ADB) in promoting economic and social development in the ASEAN region. The ADB looks into technological solutions as well as legislative and policy approaches that can deal effectively with urban and industrial waste in coastal areas. It helps the environmental cause through investment support and policy agenda.

It is a pleasure for me to address this important and timely conference.

Growing populations and rapidly changing economies are having severe effects on coastal and marine resources of the Asia-Pacific region. In many countries, fisheries resources are being rapidly depleted. In others, estuaries and mangroves are being seriously threatened. Damage to coral reefs, meanwhile, has become a matter of grave concern. Many of these problems are related to existing practices of natural resources management along the coasts.

Of the ADB's 51 member-countries, only five are landlocked. All the rest have direct access to the sea and several are island nations with coastlines that are second to none. Among ADB's developing members, the countries of ASEAN stand out. Proximity to the sea and a long history of using similar marine and coastal resources are features that unite ASEAN member-nations.

It is no surprise, therefore, that a sense of "shared resource endowments" has developed. Or, that the growing threat to coastal areas has begun to raise deep concern. ASEAN's interest in the future of its coastline is common to all its members. This conference is good proof of this. The productivity and value of these resources, with and without proper coastal management, will depend on the course of action governments take now. Your discussions during this conference can affect the outcome when decisions reached at this meeting find their way home.

*Keynote Address delivered during the Opening Ceremonies of the Conference on Waste Management in the Coastal Areas of the ASEAN Region on 28 June 1991 at the Marina Mandarin, Singapore.

Headquartered in one of ASEAN's capital cities, ADB has had ample opportunity to witness changes in the coastal environments. Moreover, its strategic location allows for a better understanding of existing environmental conditions.

ASEAN member-countries have been among ADB's largest borrowers. Most ADB assistance has little to do with coastal areas and their management. However, many loans are related directly or indirectly to coastal and marine resources on the one hand, and to waste disposal on the other.

The ADB helps to promote economic and social development in the region. We rely on our developed member-countries for capital, technologies and experience. For example, coastal resources management (CRM) in Japan and Holland, where population densities are high and economic activity is concentrated along the coast, is highly relevant for several ASEAN coasts. The need for sound management of the northern coast of Java, Thailand's eastern seaboard and Manila Bay comes to mind.

In drawing lessons from these and other developed countries, ADB looks for technological solutions and legislative and policy approaches that can deal effectively with urban and industrial waste in coastal areas, two of the most pressing problems in the region.

ASEAN member-nations, like most of our developing member-countries, face a host of other problems which damage coastal resources. The ADB is trying hard to respond to these problems.

When ADB first opened its doors for business 25 years ago, the main development tasks in most ASEAN member-countries were to increase agricultural productivity and to use the region's underutilized resources better, especially its labor force. Agro-processing and industrial activities were promoted.

Rapid population growth brought heavy concentrations of people along the coast. The strains and pressures of these increases were felt acutely in coastal zones, even though their impact on the resources were less visible than the impact of population growth on forests, for example.

Early environmental concerns in coastal areas centered on declining fisheries productivity and on destructive fishing practices. During the 1970s and 1980s, environmental pressure on coastal resources increased alongside the rapid growth of coastal aquaculture, especially within ASEAN. It soon reached a point at which the benefits of greater use of coastal resources were outweighed by indirect losses caused by the large-scale disappearance of mangrove and other original habitats. Associated problems quickly emerged, reminding policymakers and development banks of the fragile interdependence between natural habitats and resources.

Environmental inquiry increased in range and intensity. Institutions like ADB began to examine more closely the effects of economic activities on coastal environments. Contributing factors, both in and outside coastal zones, came to be better understood.

In studying the destruction of coral reefs, it would be normal for ADB today to consider both destructive fishing methods and siltation caused by rapid deforestation in nearby watersheds.

Similarly, threats to coastal environments can no longer be discussed without referring to toxic effluents that originate long distances from the coast.

Nowadays, it is also more readily accepted that substantially changed river hydrology, linked as it is to increasing irrigation, land reclamation and inland hydroelectric projects can have unintended consequences for coastal areas.

Recognizing this crucial interdependence, policymakers are forced to reassess both the methodology behind their approach to environmental problems in coastal areas and the policies designed to keep these areas productive and safe.

Today, the concept of CRM has become widely accepted among the developing countries of the region which now evaluate the adequacy of existing institutions that resolve the problems affecting coastal areas.

Unfortunately, the environmental problems of urban coastal areas are too often either ignored or treated separately from pressing inner-city problems. The assumption, perhaps, is that coastal populations near urban areas are somehow immune to the consequences of environmental degradation. This kind of thinking is wrong.

Poor air quality and pollution of urban stretches of rivers, both more "visible," then tend to be much higher on the list of concerns than the effects of the combined urban and industrial pollution load on coastal areas. In the absence of sound industrial waste disposal legislation and its enforcement, the disposal of untreated waste into the sea usually emerges as the most acceptable interim solution. This problem is common to many ASEAN urban-industrial centers.

Up until now, plans to develop urban public health infrastructure in coastal areas have largely ignored the link between various waste disposal alternatives and the deteriorating coastal environment. The tendency to treat the sea as a bottomless dumping ground may, in the short term, make up for weak waste disposal policies. But, in the long run, this thinking is short-sighted and must be reversed. It has already created public health problems and has detracted from the search for promising new alternatives which would treat coastal areas as an integral part of the broader urban landscape.

The links that exist among different types of ADB-financed activities and their impact on coastal environments are, admittedly, somewhat complex. This is particularly true for urban/industrial coastal zones.

The ADB activities are designed to promote sustainable income growth through projects that improve social infrastructure and provide irrigation, power generation and transmission, etc. Our standard practice is to subject all projects particularly those that might harm the environment to a rigorous environmental impact assessment to establish clearly a balance between project benefits and potential environmental costs, though many environmental impacts remain imprecisely quantified or even unquantified.

A growing proportion of ADB lending has been earmarked to "directly" improve the state of the environment where deterioration is most serious. We do this through investment support, e.g., to control industrial pollution and through policy agenda. The policy agenda aims to help our developing member-governments modify the economic behavior of environmental polluters so that environmental targets can be reached at the lowest possible resource cost to society. This assistance may include an enforcement or legislative component.

The ADB experience points to at least three important conclusions.

First, whether in an urban/industrial or rural development context, coastal areas can no longer be treated in isolation from inland economic activities.

Second, eliminating altogether waste disposal in the sea is probably not a realistic option. It is urgent to eliminate "unmanaged" waste disposal. The choice of the quantity or the kind of disposal is ours. This will depend not only on a better understanding of the physical interdependence between coastal resources and inland economic activities, but also on a more complete quantification of the economic consequences of continued coastal zone deterioration. This enlarged understanding would make policy choices easier.

Third, the standards applied to the practice of waste disposal in the sea cannot be discussed independently of environmental legislation and each country's environmental policy emphasis. Certain types of waste disposal in the sea might be socially or even globally superior to forms of disposal on land or vice versa. I hasten to add that waste minimization may be the best option of all. The important principle to defend is that of objective inquiry based on a balanced evaluation of all the alternatives.

While the extent of waste disposal into the sea must be considered a policy variable of changing economic parameters, the practice of coastal zoning for conservation or specific uses must remain an important part of the overall policy approach. Various coastal landfill options also deserve our attention. These become particularly interesting once the questions of financing and cost recovery are introduced.

The success in managing wastes along ASEAN coastlines will also depend a great deal on the policies and institutional support directed at small-scale industries which tend to be no less polluting than the large-scale industrial units. The small-scale industrial sector is, perhaps, the most difficult to monitor and regulate.

Indeed, for most ASEAN cities, more satisfactory solutions to the problem of coastal pollution will be possible once coherent

industrial strategies for small- and medium-sized industries are put into place.

Coastal and marine resources provide crucial economic support along ASEAN coasts and in the hinterland. Degradation of ASEAN coastal environments can no longer be ignored. The severity of the threat is known to all of us. That's why we are here. The ADB, for its part, is prepared to do more to help ASEAN member-nations develop schemes to preserve coastal ecosystems and to ensure that coastal areas realize their development potential and be productive for generations to come.

I wish you success in this important conference and look forward to the results of your deliberations.

Session 1: Waste Management in the ASEAN Region: Status, Trends and Problems

Waste Management in the Coastal Area of Brunei Darussalam

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Bandar Seri Begawan 1921
Brunei Darussalam

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ABSTRACT

Waste management problems in the coastal area of Brunei Darussalam are considered minimal. Special concerns include the dumping of solid waste into Sungai (Sg., which means river) Brunei in Kampong (Kg., which means village) Ayer and the indiscriminate disposal of abandoned vehicles. The solid waste generation rate is estimated at 1 kg/capita/day. Waste collection and disposal is done by municipal boards (MBs) and district offices (DOs). The Public Works Department (PWD) is

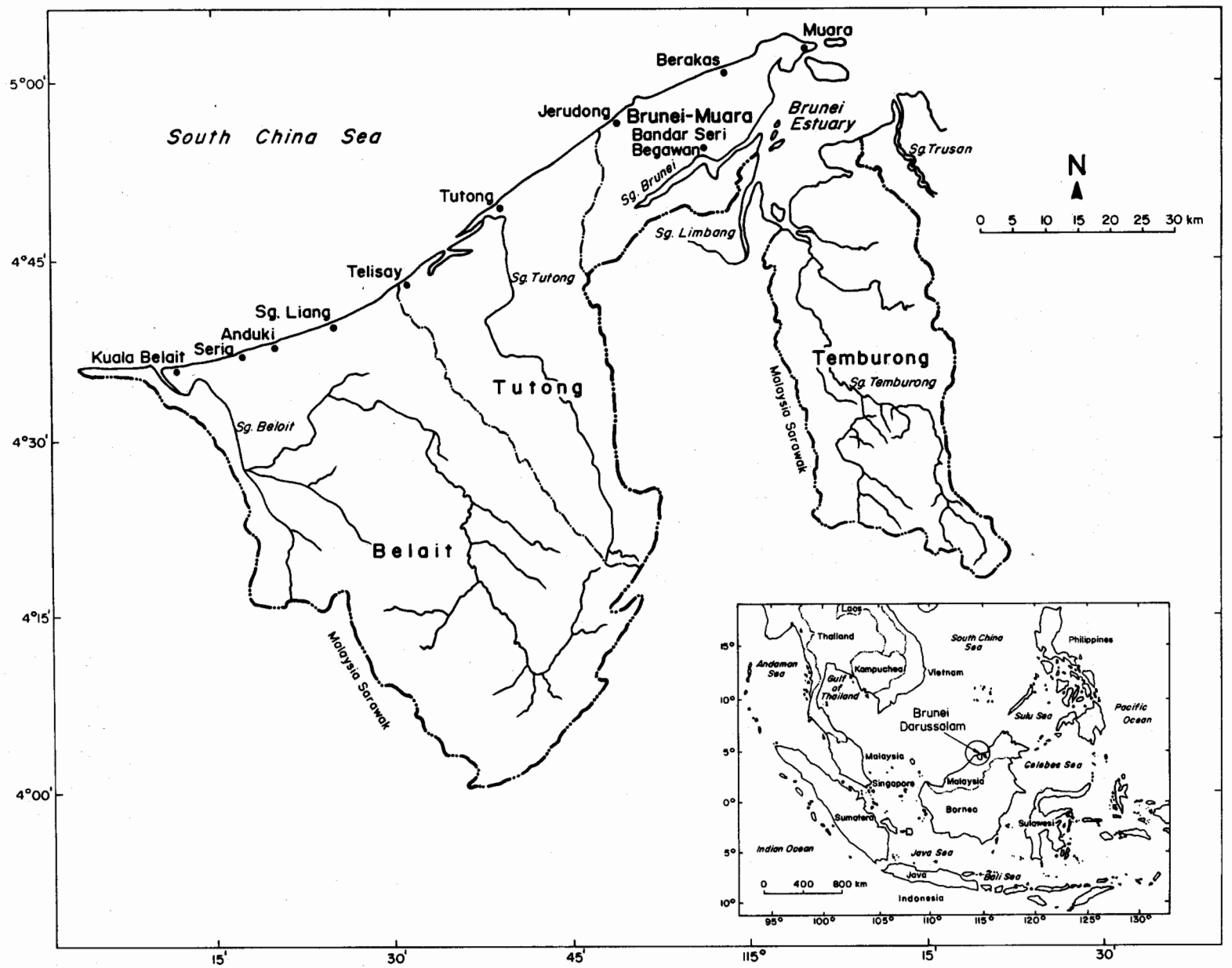

Fig. 1. Negara Brunei Darussalam and its districts (Chou and Halidi 1987).

responsible for road cleanliness. The common waste disposal systems are open burning dumpsites and sanitary landfills. Main sewerage is provided only in urban areas, which have 13 sewage treatment works (STWs). Outside the sewered catchments, septic tanks are used. Recommendations include the zonation of industries for toxic waste and pollution control, new sewage treatment plants (STPs) and sewer lines for sewerage efficiency. Plans for Kg. Ayer include an extensive communal bin system and transfer stations for solid waste management (SWM) and a vacuum sewer system.

BACKGROUND

Brunei Darussalam is situated on the northwestern coast of the island of Borneo, between east longitudes 114° 23' and 115° 23' and between north latitudes 4° and 5° 5'. It shares a common border with the eastern Malaysian state of Sarawak, which cuts across Brunei (Fig. 1).

The country's high per capita income estimated at US$17,000, the favorable balance of payment and the relatively small population has enabled the country to enjoy a high standard of living. Since the discovery of oil in 1929, the country has gradually moved towards an economy based on petroleum exploitation which reached its zenith in the late 1970s. With the government's conservation policy on petroleum extraction and the interest in diversifying the economy, attention has begun to focus on the industrial development of other resources. Rapid industrialization, urbanization and population increases are bound to make additional demands on all services, including those of waste management. In anticipation of the country's future needs, the government has taken several steps to alleviate the waste management problems. The recommendations of several commissioned studies on solid and liquid waste management have been implemented or are being studied for implementation.

Geology, drainage, soils, climate, demography, activity patterns in the coastal area and other factors need to be considered because they directly or indirectly affect waste management in the coastal area.

In this paper, the term coastal area is defined as "1 km landward from shore extending out seawards to the 20-fathom isobath" (Chou and Halidi 1987). In addition, the estuaries of important rivers--Sg. Temburong, Brunei, Tutong and Belait--and areas reached by tides are considered part of the coastal area (Fig. 2). Coastal area management is vital for the protection and conservation of the coastal environment.

The significance of the Brunei Darussalam coastal area

Brunei Darussalam is a relatively small coastal state in Southeast Asia with a 130-km coastline bordering the South China Sea (DOTCP 1987a). Its urban centers are coastal and more than 85% of its population lives in the coastal zone. Much of the economic activities, including the country's most important economic activity, oil and gas exploitation, occurs in this zone.

Economic and Social Benefits of the Coastal Area. Many social and economic benefits are derived from the coastal area which includes the urban towns of Bandar Seri Begawan (the capital city), Seria-Belait, Muara and Tutong.

Gross domestic product (GDP). In 1988, economic contributions from the coastal area constituted more than 90% of the total GDP (at 1974 constant prices). The highest contribution (59.5%) came from the oil and gas industry. Other contributions came from fisheries, mangrove harvesting, water transportation, beach sand mining, agriculture, other industries and services.

Employment. Employment generated by economic activities in the coastal area is approximately 81% of the total private sector employment. But, the government remains the most important source of employment in the country.

Food. Approximately one-half of the fresh fish and shrimp consumed in Brunei Darussalam come from the local fisheries industry. Vegetables, fruits, poultry and eggs (where self-sufficiency has been attained) are produced in the coastal area.

Foreign exchange. In 1986, oil and gas contributed 97.18% of the total exports with a total value of B$3.877 billion (EPU 1988).[1] This has exceeded the import of food, goods and services.

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[1] 1986: B$2.15 = US$1.00.

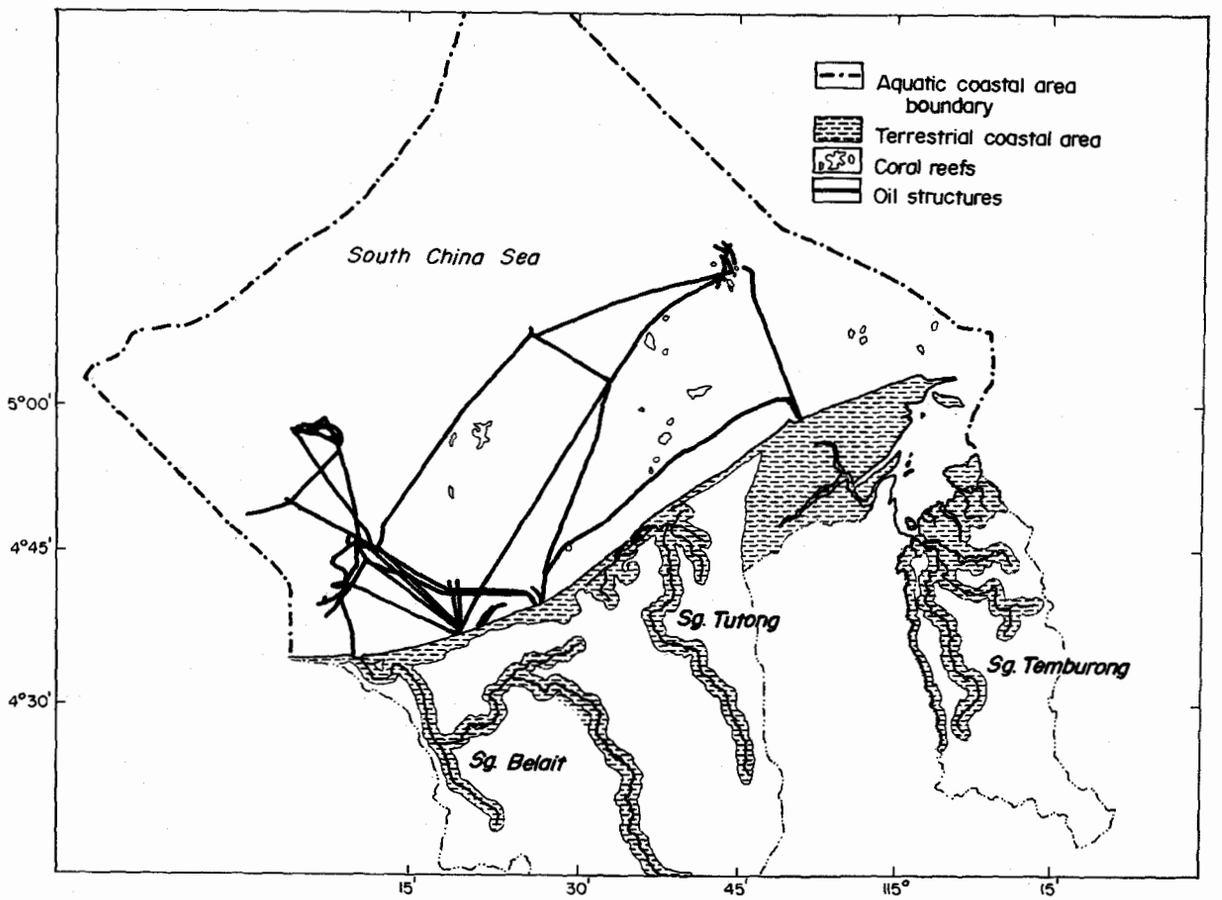

Fig. 2. The coastal area of Brunei Darussalam.

Industrial development sites (IDS). All the IDS are located within the coastal area (Fig. 3). De Silva et al. (1990) proposed that industries be categorized into light (nonpollutive), general (pollutive) and special (highly pollutive) industries based on the degree of pollution which they can cause prior to any treatment or control. Other recommendations include (1) prohibiting pollutive industries within the catchment areas of Sg. Brunei, Inner Brunei Bay and other estuarine environments; (2) assessing all pollutive industries for environmental impacts and pollutant treatment facilities; and (3) siting these industries in IDS which are in less sensitive environments.

Physical environment

Geology. The coastal lowlands encompass most of Brunei-Muara District. The interiors of Belait and Tutong Districts are underlaid by synclinal basins. The rims of the basins gradually rise from groups of low hills, surrounded by swamps, to distinctive hill ridges of considerable heights.

Most of the coastal areas, particularly in Temburong, are occupied by flat swampy alluvium, which extends as broad belts up the valleys of Belait and Tutong Rivers. Almost all the alluvial plains are covered by peat except near the riverbanks and in the vicinity of hills. Thin clay or sandy alluvium is usually located in these areas. Terraces, usually of unconsolidated sand and gravel, are found in the main river valleys and also along the coastal land between Tutong and Muara (Loo et al. 1987).

Drainage and basin areas. The four main river systems in Brunei Darussalam are Belait, Tutong, Brunei and Temburong. These are tidal for long distances inland, especially

during low flow and drought periods. Salinity could be high, up to 90 km inland.

Temburong Basin, which drains nearly the whole of Temburong District, is the smallest, with an area of some 1,100 km². Sg. Temburong has two tributaries flowing into its estuary, Sg. Batu Apoi which has a mountainous catchment and Sg. Labu, which is a coastal swamp river. Both divide the basin into two, with Sg. Temburong flowing into the head of Brunei Bay.

Belait Basin is the largest, having an area of some 2,700 km². The lower catchment comprises an extensive area of peat swamp forest.

Tutong Basin covers around 1,300 km², and the river is contiguous with that of Sg. Belait on the west. Sg. Tutong discharges to the sea between two sand spits which form an elaborate estuarine system. Two branches extend parallel to the coast and cover a distance of about 15 km. The western end of the basin is drained by Sg. Telisai. From the head of the estuary and over its full length, the river channel is extremely sinuous, and like Sg. Belait, is tidal to a distance upstream.

The watershed of Sg. Brunei is low-lying and swampy. The catchment is characterized by broken high ground with deeply incised valleys forming the three major subcatchments, Sg. Kedayan, Sg. Damuan and Sg. Imang. Each of the subcatchment rivers enters Sg. Brunei at different points. Sg. Kedayan includes a high proportion of urban development and enters Sg. Brunei at Bandar Seri Begawan. Sg. Damuan enters about 3

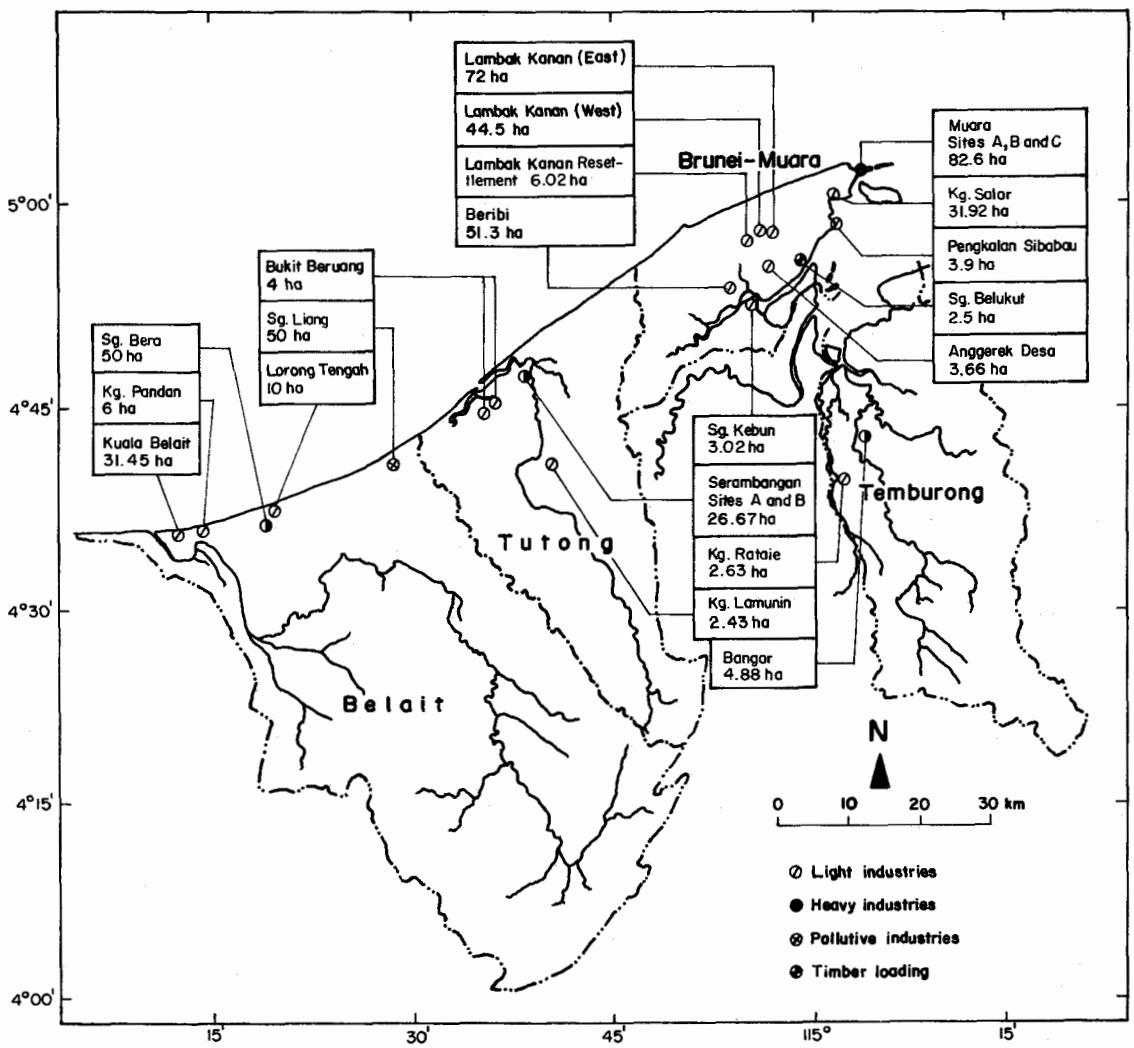

Fig. 3. The IDS in Brunei Darussalam (De Silva et al. 1990).

km upstream from that of Sg. Kedayan. The headwaters of Sg. Brunei are Sg. Imang and its tributaries. The main catchment adjoins that of Sg. Tutong on the western side, and to the north, is defined by an irregular ridge parallel to the coast. The watershed boundary moves southeastwards and continues along the ridge parallel to Brunei Estuary back to Bandar Seri Begawan (Loo et al. 1987).

Soils. In some low-lying coastal areas formerly occupied by brackish, organic-rich mangrove swamps, potential acid sulfate soils are present. Oxidation by aeration or leaching with oxygen-charged water of these soils converts iron sulfides into sulfates and sulfuric acid. The soils will, thus, have very low pH, releasing large amounts of aluminum which are toxic to plants.

In most of the estuarine areas of the major rivers, alluvio-marine soils predominate. These soils are gleysols which are usually poorly drained and which have potential acid sulfate layers beneath (Loo et al. 1987).

Climate. The country has an equatorial climate characterized by uniformly high temperature and rainfall throughout the year. There is no distinct seasonality, but the climate is governed by two monsoon winds generated by a low pressure trough called Inter-Tropical Convergence Zone (ITCZ) and the trade winds. The northeast monsoon blows from November to March and the southwest monsoon, from April to October. The two stations with the longest weather records are the Agricultural Research Station at Kilanas and the Brunei Shell Petroleum (BSP) Co. Head Office at Seria.

Rainfall. The annual rainfall is generally high, with an average of over 280 cm. It exceeds 230 cm throughout Brunei Darussalam and can be as high as over 400 cm further inland in many parts of Temburong (Fig. 4). The higher rainfall toward the interior is due to the geographic effect of an increased amount of precipitation with altitude.

Air Temperature. The air temperature is uniform throughout the year, with little vari-

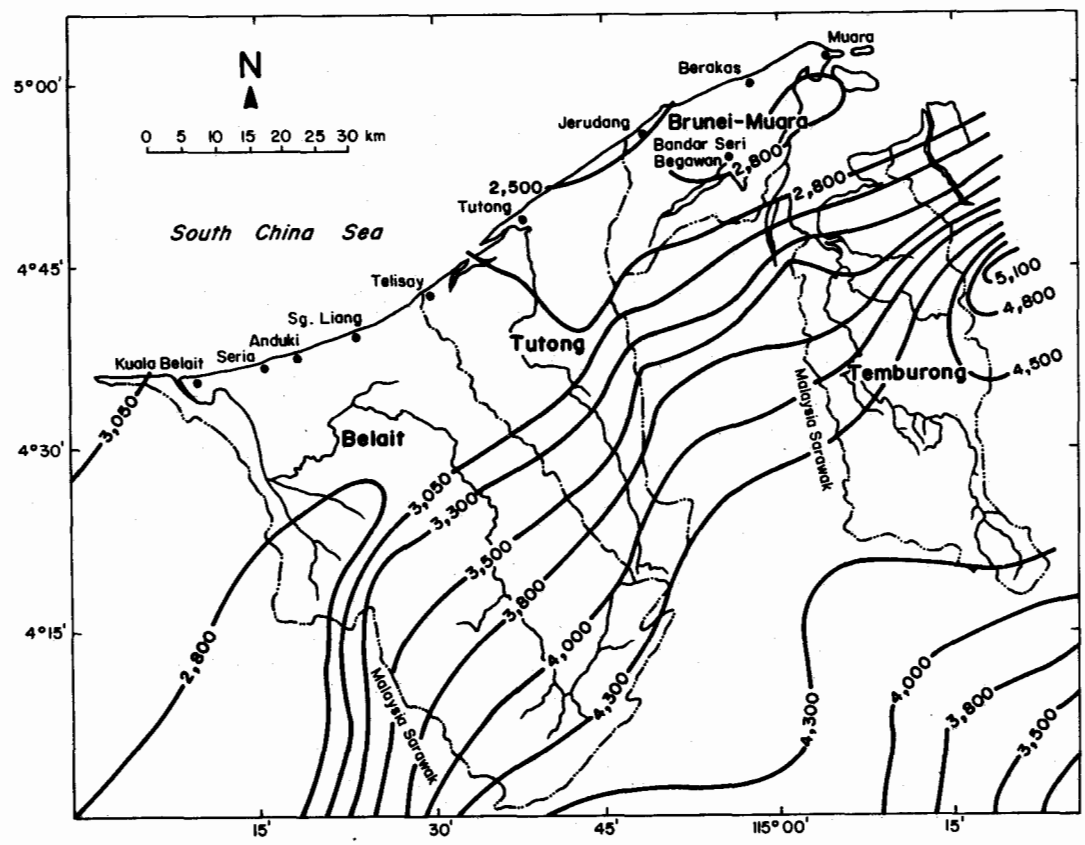

Fig. 4. Annual rainfall (in mm) distribution in Brunei Darussalam (Loo et al. 1987).

ation in seasonality and in different parts of Brunei Darussalam (Fig. 5). The annual mean temperature is 27.5°C occasionally (DOTCP 1986b).

Relative Humidity and Evaporation. Relative humidity is high throughout the year because of high temperatures and rainfall. The annual mean is 92.6% with a range of 89.3-95.6% (Fig. 6).

The rate of evaporation depends on the air temperature, relative humidity and wind velocity. Evaporation is higher during the hot dry months, March to May (Fig. 7).

Population

Demography. The population of Brunei Darussalam in 1981 was 192,832 (EPU 1983). By mid-1985, the population was estimated to have reached 221,900. Table 1 shows the distribution of 1981 and mid-1985 population by administrative districts. The latter did not change much compared to the former.

The mid-1985 estimates indicate that Brunei-Muara was the most populous coastal district, comprising 60% of the country's population. Kuala Belait District was next with 26%. Tutong and Temburong Districts together comprised under 15% of the total population.

Majority of the population was concentrated in the urban areas around the capital city of Bandar Seri Begawan in the Brunei-Muara District and Kuala Belait/Seria in the Belait District.

The population density variations throughout the country (Fig. 8) reflect these observations. The density in most of the inland rural areas was below 10 persons/km^2. The coastal area between Seria and Sg. Liang in the Belait District also showed a low population density.

The total population in Brunei Darussalam increased 42% (about 57,000) from 1971 (136,256) to 1981 (192,832) implying an annual growth rate (AGR) of 3.5%. From 1981 to mid-1985, the population was estimated to be about 221,900; an increase of 28,068 from 1981. Projections based on available information indicate a population of 367,300 by the year 2005. Table 2 summarizes the population distribution by district from 1985 to 2005.

Health. The National Health Policy of Brunei Darussalam emphasizes health-oriented, preventive and promotive care for the whole community rather than disease-oriented, curative services for the sick. The

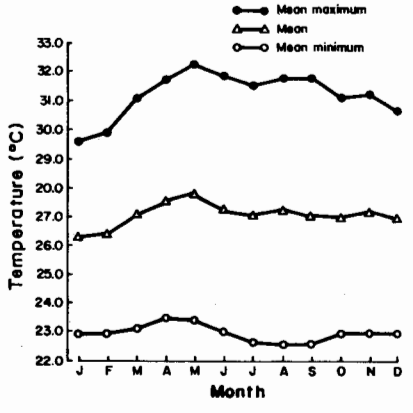

Fig. 5. Monthly mean temperature based on data from Kilanas, 1976-1982 (Loo et al. 1987).

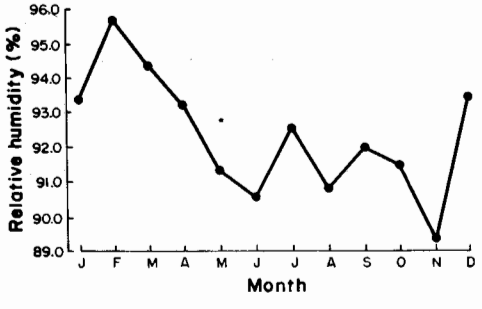

Fig. 6. Relative humidity from data recorded at Kilanas (Loo et al. 1987).

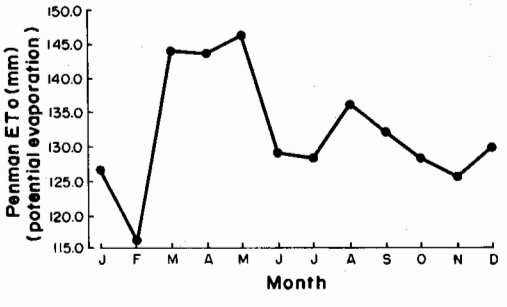

Fig. 7. Potential evaporation from data recorded at Kilanas (Loo et al. 1987).

Table 1. Population by district in 1981 and mid-1985.

District	1981[a]	%	Mid-1985[b]	%
Bandar Seri Begawan	49,902	25.9	133,600	60.2
Brunei-Muara	64,329	33.4		
Belait	50,768	26.3	58,400	26.3
Tutong	21,615	11.2	22,900	10.3
Temburong	6,218	3.2	7,000	3.2
Brunei Darussalam	192,832	100.0	221,900	100.0

[a]Unpublished 1981 Census.
[b]EPU estimates.
Source: Kuntjoro (1987).

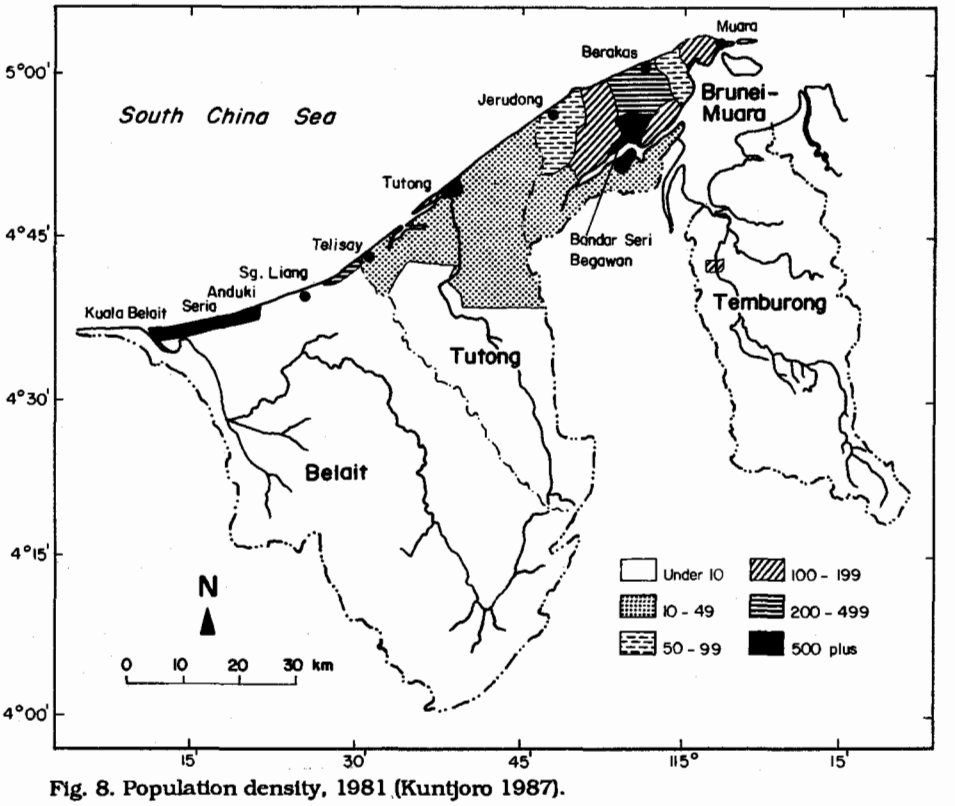

Fig. 8. Population density, 1981 (Kuntjoro 1987).

Table 2. Urban and rural population by district, 1985-2005.

District	1985 Urban	1985 Rural	1985 Total	2005 Urban	2005 Rural	2005 Total	1985-2005 Urban population growth (% p.a.)
Brunei-Muara	136,000	-	136,000	241,000	-	241,000	2.9
Belait	51,350	3,150	54,500	71,470	3,830	75,300	1.7
Tutong	9,500[a]	14,400	23,900	23,090[a]	19,710	42,800	4.5
Temburong	1,650	4,950	6,600	2,760	5,440	8,200	2.6
Total	198,500	22,500	221,000	338,320	28,980	367,300	2.7

[a]Including military personnel.
Source: DOTCP (1986a).

target is the avoidance of disease and disability by the year 2000. Primary health care is stressed. Identified requirements include a sound, physical infrastructure, basic utilities, health information, logistic support, adequate supplies to remote areas, better communication facilities and training of community nursing staff. The improvement of sanitation and epidemiological surveillance to eliminate major health hazards is also important. This plan of action involves the community and is intersectoral (Kuntjoro 1987).

Water- and seafood-related communicable diseases were reported mostly in Kuala Belait but these were not serious. The general health condition of the coastal population is very good. There is no report of malnutrition among coastal communities. In 1990, the number of people afflicted with common water- and food-related communicable diseases as recorded by the Medical and Health Department was:

Cholera	16
Typhoid	17
Dysentery	18
Hepatitis	1,163
Gastroenteritis	7,155

WASTE MANAGEMENT IN THE COASTAL AREA OF BRUNEI DARUSSALAM

The waste management problems of Brunei Darussalam are relatively minor at present. The pressures of urbanization, industrial growth and population increase, however, demand that existing systems and services be improved. Thus, the government has commissioned several studies and implemented some of the recommendations (DOTCP 1986e, 1986g; DOTCP 1987 and PWD 1987a/c, 1989).

Some areas of concern are: (1) solid waste, which includes abandoned vehicles; (2) sewage; and (3) industrial and toxic wastes. A special concern is the waste management in Kg. Ayer, a unique residential development built over the shallower areas of the Sg. Brunei Estuary, near Bandar Seri Begawan.

Solid waste

Except for the dumping of solid waste into Sg. Brunei in Kg. Ayer and the indiscriminate disposal of abandoned vehicles, the solid waste problem in Brunei Darussalam is relatively minor.

Waste Generation and Composition. The solid waste sampling at various disposal sites throughout the country indicated that the typical waste generation rate was 1.0 kg/capita/day (PWD 1987b). It is well within the range of 0.7-1.8 kg/capita/day, which the World Bank reports for industrialized countries. The typical domestic solid waste composition (%) in Brunei Darussalam was:

Food waste	37
Paper/cardboard	26
Rubber/leather	1
Cloth	2
Wood	2
Plastic	13
Metal	11
Glass	6
Others	2
	100

The average heat value of the waste (11,000 kJ/kg or 4,800 BTU/lb) is adequate to sustain combustion. The waste can be composted but moisture and nitrogen will have to be added to optimize the reaction.

Waste Collection. At present, solid waste collection and disposal is done by MBs and DOs, except for Seria in the Belait District, the population of which is served largely by BSP. The army camps have their own collection system, but they use the disposal sites operated by MBs and DOs. The PWD Road Section is responsible for roadside cleanliness and has recently established an extensive communal bin system.

The MBs collect the refuse generated within their jurisdiction while DOs are responsible for areas outside municipal boundaries. The MBs, which have extensive collection manpower and equipment as in the Brunei-Muara District, often serve both the municipal and district service areas. This practice, however, should be discontinued and routes reorganized for the maximal use of available resources (PWD 1987b).

For municipal service areas, revenue comes from house assessments. Monthly rates of B$15.00 and B$45.00 are charged per residential and commercial unit, respectively.[2] The same rates apply for district areas served

[2] 18 September 1991: B$1.70 = US$1.00.

by MBs. These rates, however, should be reviewed for possible adjustment so all members of the community are served (PWD 1987b). Free collection service is provided to all government premises and staff quarters.

Government premises have standard galvanized steel or rubber refuse containers while most of the private premises use containers of their choice, e.g., bulky 200-l drums which require at least two laborers to empty into the collection vehicle. Large, commercial-sized containers are recommended for communal bin systems as well as commercial zones, parks and recreation areas. Suitable collection vehicles equipped to handle these containers should also be used (PWD 1987b).

In most residences, the containers are located near the road curb so the refuse is loaded directly into the collection vehicle. Rattan baskets are used to transfer refuse from containers that are located some distance from the road.

Most of the high-rise apartments have refuse chutes with inlets on each floor. The chutes discharge to a vault at ground level where there are wheeled steel containers. For smaller apartments, the refuse is usually deposited by individual households to a designated storage area located near the road. Door-to-door collection, however, should be made available to those who are willing to pay for it (PWD 1987b).

The communal bin system, which is used in Brunei-Muara and Belait Districts, is recommended for Tutong District. It should also be the minimum requirement for squatter areas (PWD 1987b). In addition, transfer stations should be constructed in Brunei-Muara District to lessen transportation costs and traffic congestion (PWD 1987b).

A collection system should be designed for the rural and outlying areas as many private residences do not enjoy solid waste collection services (PWD 1989).

Clearly, the overall collection system for Brunei Darussalam can be made more efficient. The privatization of collection services should be considered (PWD 1987b).

Waste Disposal. The common waste disposal practice in the country is the open burning dump. The dumpsites come in different sizes, with large dumps posing greater problems. Fig. 9 shows the solid waste disposal sites in Brunei Darussalam. Those in Kuala Belait in the Belait District and Muara in the Brunei-Muara District are now closed.

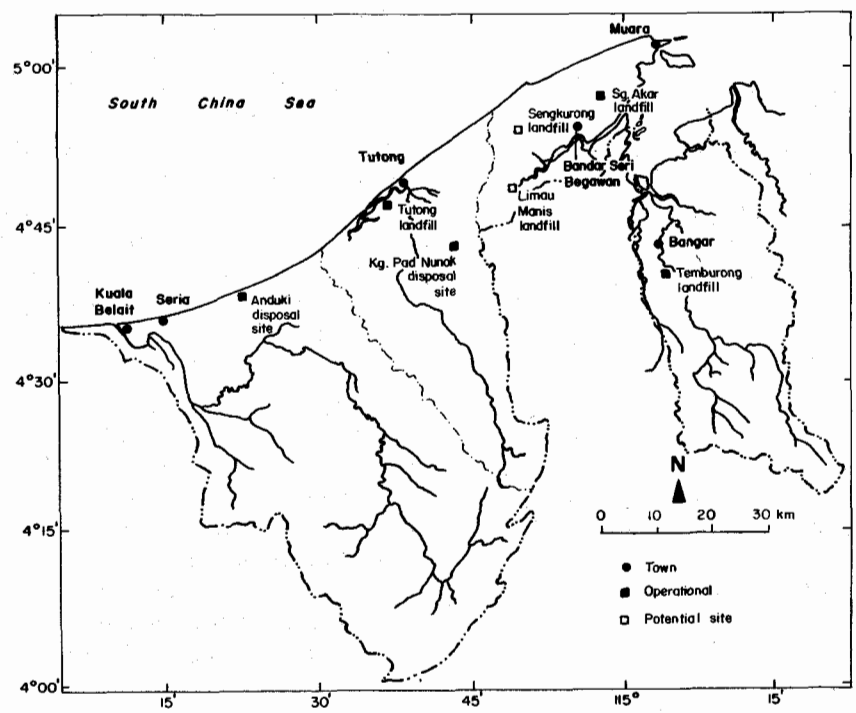

Fig. 9. Present and potential landfill sites in Brunei Darussalam (modified from PWD 1987b).

The Belait District uses a disposal site in Anduki. The high groundwater in the district, however, dictates landfilling in a specially constructed borrow pit (PWD 1987b).

Because of the lack of soil cover on site, the Muara disposal site was closed. It is also near the Sg. Akar Sanitary Landfill which is now in use. While this Sg. Akar site and the adjacent Sengkurong clay pits can provide for the district's disposal needs through the year 2005, the clay pits should be conserved in case of changes in land use patterns or environmental conditions. An alternate disposal system is thus recommended: an area method sanitary landfill in the jungle for which a site-specific environmental assessment is needed (PWD 1987b).

The Tutong and Temburong Districts have small disposal sites which resemble sanitary landfills in that the burned refuse is periodically covered with soil. To make these disposal sites environmentally acceptable, burning should be stopped and soil cover applied more frequently. Specifically, the Tutong landfill should be covered daily while that of Temburong should be covered weekly with fly and rodent controls (PWD 1987b).

Sanitary landfills are recommended for all districts. Another waste management option is incineration which is technically feasible but more costly than landfilling. It also requires more sophisticated operational procedures.

In addition, solid waste disposal in the rural and outlying areas needs upgrading (PWD 1989).

Abandoned vehicles. An effective disposal program for abandoned vehicles will include the following: (1) a vehicle collection program implemented by government or private contractors; (2) a car flattener or crusher; (3) a privately operated used parts salvage yard; and (4) scrap metal exportation.

Toxic waste disposal. At present, toxic waste in Brunei Darussalam primarily consists of small quantities of pesticides, solvents and waste produced by BSP. The country's industrialization and diversification program, however, will certainly increase toxic waste quantity. Hence, these recommendations.

Both old and existing toxic waste disposal sites need to be investigated. Records will have to be searched and interviews conducted to determine the type and quantity of waste disposed of at the sites. Ground- and surface water sampling may be necessary to check for adverse environmental impacts.

A spill response program that trains personnel for chemical emergencies has to be developed. Private waste management companies can be considered for toxic waste disposal and technical assistance.

Facilities for toxic waste management include: (1) small-scale disposal pits; (2) treatment, incinerating and/or recycling facilities; and (3) a secure landfill for sludge, ash and stabilized waste disposal (PWD 1987b).

Legislation. The Minor Offenses Act, Chapter 30 of the Laws of Brunei Darussalam is a comprehensive legislation for litter and indiscriminate dumping. The violation of the act carries a penalty of B$1,000 for the first offense and B$3,000 thereafter. It also includes a section on abandoned vehicles in public lands. This act, however, should be strengthened: (1) it should provide for the control of abandoned vehicles on private property and for toxic waste disposal; and (2) DOs should be given specific authority to enforce this act (PWD 1987b).

Administration. No single government department, however, has sole responsibility over SWM. Although it monitors public health, the Medical and Health Department only advises MBs and DOs as it has no administrative role in SWM. While the PWD conducts studies, implements projects and sets up SWM facilities such as disposal sites, it is not involved in day-to-day collection and management except for the communal bin system and cleanliness along major roads. A single authority with full operational responsibility is therefore necessary (PWD 1987b). Its tasks should include refuse collection; operation of transfer stations and landfills as well as administration of the abandoned vehicle program.

Sewage

Main sewerage is provided in urban areas only. In 1987, it accounted for more than 50% of the total sanitation in Kuala Belait-Seria, 35% in Tutong and 13% in Bandar Seri Begawan, including Berakas and Kg. Ayer

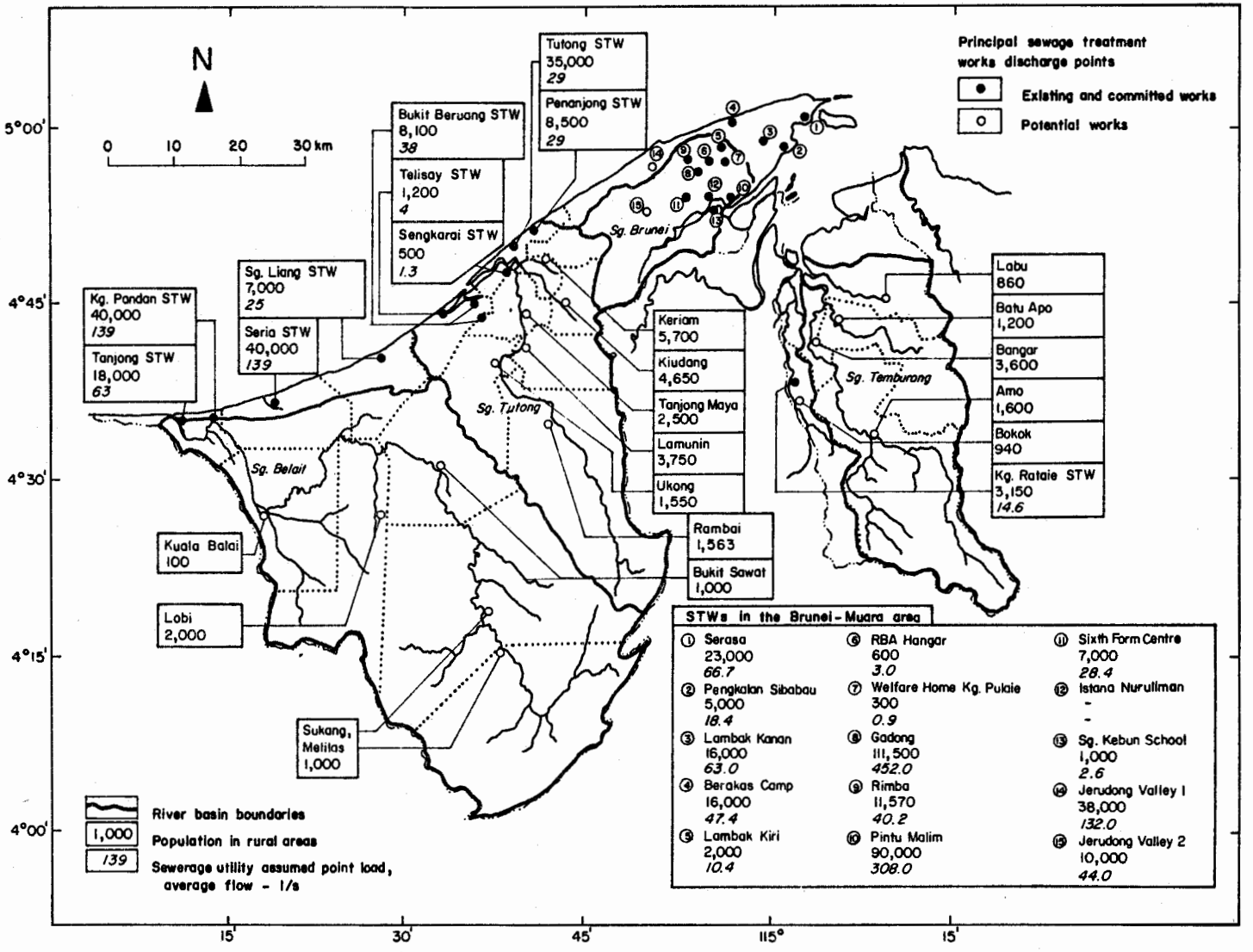

Fig. 10. Existing, committed and potential STWs in Brunei Darussalam (PWD 1987a).

(DOTCP 1987a). A new STP in Muara was completed in 1990 with an initial capacity of 10,000 equivalent population. Other STPs completed in 1990 in the Brunei-Muara District were Pengkalan Sibabau, Lambak Kiri, Mata Mata, Bukit Beruang and Rataie, all of which are land-for-the-landless projects.

A new STP in Gadong near Bandar Seri Begawan is expected to be completed by December 1991. It is designed to relieve the existing load at the Pintu Malim Treatment Plant from the two principal catchments within Gadong including the area to the northwest of the airport which encompasses the proposed New University Campus and Rimba Resettlement site. Its initial capacity is 25,000 equivalent population with an ultimate capacity of 75,000 equivalent population. The STP at Kg. Pandan, Kuala Belait in the Belait District will be operational by September 1991 with an initial capacity of 18,000 equivalent population.

Under the current Five-Year National Development Plan (1991-1995), two new STPs, each with an initial capacity of 18,000 equivalent population, will be constructed in Kuala Belait and Seria in the Belait District.

The completion of the new STPs and sewer lines is expected to increase sewerage efficiency in Kuala Belait-Seria to 70%; Tutong, 50%; and Brunei-Muara, 60% by 1995.

Sewered Areas. The PWD Sewerage Section has 13 STWs under its jurisdiction and management. Fig. 10 shows the locations of the existing, committed and potential STWs. The largest is the Pintu Malim Treatment Plant which only had primary treatment until sludge digesters were installed for a capacity of 72,000 equivalent population.

But, the quality of sewage effluent from Pintu Malim is generally lower than those discharged by the other STWs (Table 3) (PWD 1987a). Also, the *Escherichia coli* levels are quite high in Kg. Ayer and the confluence of Sg. Kedayan and Sg. Kianggeh near the open market (Lim 1990a).

Nonsewered Areas. In areas outside the sewered catchments, different flush and nonflush sanitation systems are used. Most of the urban fringe areas of the districts use the flush system (mainly septic tank) while rural areas have nonflush latrines or other less hygienic systems.

Septic tanks are common where piped water is available, i.e., in the urban fringe areas of Bandar Seri Begawan, Muara, Tutong, Kuala Belait and Seria as well as in the high standard housing in the rural areas. Generally designed as "all-purpose" tanks, these are capable of accepting all household wastes including water closet (WC) and sullage wastes.

Table 3. Annual average laboratory analysis of effluents, 1989.

TW	BOD (mg/l)	TSS (mg/l)	VSS (mg/l)	pH	DO (mg/l)	TC (C/100 ml)	FC (C/100 ml)
Pintu Malim PS	78.5	65.14	39.5	6.69	0.73	2.17E+08	7.14E+07
Sixth Form Centre EA	16.6	37.2	23.3	6.16	5.61	7.33E+07	1.77E+06
Istana Nurul Iman EA	8.3	23.6	14.3	6.60	5.01	2.26E+06	1.60E+05
Lambak Kanan EA	18.1	40.5	26.5	6.49	2.17	7.45E+07	9.80E+05
RBA Hangar PEA	11.9	24.0	13.58	6.91	4.62	1.64E+07	5.98E+06
Welfare Home PEA	5.5	46.2	27.2	7.27	6.16	7.96E+06	3.61E+05
Sungai Kebun PEA	13.5	36.3	26.9	7.05	4.49	2.14E+07	1.00E+06
Sengkarai PEA	9.3	21.6	12.4	6.68	3.55	8.43E+06	3.12E+05
Tutong Camp FSP	19.1	73.8	53.1	8.35	6.09	9.91E+06	2.50E+04
Penanjong Camp FSP	22.1	54.0	35.9	7.03	4.42	1.50E+07	6.40E+04
Berakas Camp FSP	22.2	56.8	37.1	6.77	2.94	2.24E+08	5.21E+06
Mulaut Abattoir FSP	17.9	66.2	33.2	7.47	3.72	7.20+06	2.98E+06
Lambak Kiri FSP	2.64	13.6	7.14	4.23	6.42	102000	nil

Source: PWD Sewerage Section (1989).

TW - treatment works.
DO - dissolved oxygen.
TSS - total suspended solids.
VSS - volatile suspended solids.
TC - total coliform.
FC - fecal coliform.
E+03 - 1 x 1,000.
PS - primary settling TW.
EA - extended aeration TW.
PEA - package EATW.
FSP - facultative stabilization pond.

Septic tanks accounted for 71% of sanitation in Muara, 42% in Bandar Seri Begawan, including Berakas and Kg. Ayer, 40% in Tutong, and 20% in Kuala Belait-Seria (DOTCP 1987a). Septic tank desludging services are available on request.

New dwellings and buildings in areas without a piped sewerage system are required to have a septic tank system. The government exercises control over septic tank usage and design through DOTCP in development control areas (DCAs) inside and outside urban centers. In municipal areas, the PWD Sewerage Section checks: (1) tank design against UK-based standard designs (e.g., concrete construction with dual compartments); (2) plumbing stack designs; and (3) proposed construction materials, on behalf of DOTCP. Outside these areas, no follow-up inspection or construction quality control is undertaken. Septic tank design and construction in areas not covered by the Development Control Legislation are not monitored nor controlled.

The principal problems with septic tank effluent disposal are:

- difficulties in the enforcement of design, construction and operation controls which results in poor tank performance and high effluent biological oxygen demand (BOD), suspended solids (SS), grease and bacterial concentrations;
- lack of soil absorption systems which leads to organic and bacterial pollution of the watercourses and monsoon drains;
- absence of an administrative system for the regular desludging of tanks; and
- installation of tanks in inappropriate areas, i.e., frequently flooded areas or those with high groundwater or river levels, like Kuala Belait-Seria.

INDUSTRIAL WASTE

At present, the major producer of industrial waste in the country is the petroleum industry. Nonetheless, industrial waste management is a necessity, considering the country's projected non-oil industrial development and diversification.

Available information does not indicate any adverse environmental impacts on the coastal zone of Brunei Darussalam due to waste disposal from already established industries other than perhaps BSP's activities in Seria (Leong et al. 1987; PWD 1987a; De las Alas and Bentillo 1992; Lai et al. 1992; Lim 1990 and Juliano et al. 1991).

Environmental baseline studies of the macrobenthos in the vicinity of the BSP crude oil terminal in Seria (Leong et al. 1987 and 1990) indicate some hydrocarbon contamination in Sg. Bera and Sg. Seria by the operations of BSP oil facilities. The BSP oily waste treatment plant was then installed after the first study of Leong et al. in 1987. While it has improved the water quality of the rivers concerned, it has yet to reach acceptable levels. The BSP has set a self-imposed limit of 35 ppm of hydrocarbon for its effluents in the near future. Further, it has developed an Environmental Management Plan (BSP 1989) which covers all aspects of in-house waste management, including the improvement of the quality of the waterways into which BSP discharges its wastewater.

To minimize the degradation of the coastal water quality, the zonation of new industries on the basis of their pollutive nature is proposed (De Silva et al. 1990). This calls for the exclusion of pollutive industries, wherever practical, from IDS located in the catchment areas of the major river systems that feed the Inner Brunei Bay and other estuarine environments. The recommendations for National Water Quality Standards (PWD 1987a and Lim 1990a) are being studied for implementation.

The disposal of oily wastes from vehicle service stations and households remains an area of concern that requires further attention.

Waste management in Kampong Ayer

Built over the shallower areas of the Sg. Brunei Estuary, Kampong Ayer (literally "Water Village") is a unique residential development of several smaller component *kampongs*. Located close to the center of Bandar Seri Begawan, access to much of the village is only by water transport.

Its 300-year history has seen its substantial growth and decline. The 1981 census recorded 27,125 persons in 2,826 dwellings. The current population is estimated at 25,000.

Except for an experimental pilot project for solid waste disposal, there is no waste disposal service in Kg. Ayer. The traditional method involves dumping all refuse, into the surrounding waters of Sg. Brunei and Sg. Kedayan. In the absence of a sewerage system, raw sewage (toilet waste and sullage) is discharged directly into the rivers. This waste discharge is a major pollutant load on the receiving waters and a potential health hazard, human excreta being a principal vehicle for the transmission of communicable diseases.

Solid Waste Disposal and Management. Solid waste in Kg. Ayer is composed of household or domestic refuse (food waste, plastic containers, etc.); household junk (discarded furniture, appliances, etc.) and builder's waste (old timber piles, etc.).

The annual total waste generation of Kg. Ayer is estimated at 3.77 million kg (Goh 1991). Table 4 shows the average waste generation (by component) per household (Goh 1991).

Table 4. Mean garbage production (by component) per household per week.

Type	Weight (kg)	%
Organic	17.28	71.3
Cloth	2.80	11.5
Metal	0.46	1.9
Paper	0.69	2.8
Plastics	0.23	1.0
Wood	0.31	1.3
Rubber	0.59	2.4
Glass	1.87	7.7
Total	24.23	100.0

Source: Goh (1991).

Solid waste disposal into its waterways has aggravated environmental problems. Although much of the floating refuse is removed by tidal currents, a considerable quantity is stranded, creating aesthetic and some odor problems in many parts of Kg. Ayer. The lower reaches of the rivers are also adversely affected. A government-commissioned study indicated that it would be practical to provide a regular solid waste collection service comparable with the land-based service (PWD 1986).

A pilot project for solid waste disposal was undertaken in three component *kampongs* of Kg. Ayer which had a total of 377 houses (approximately 10% of the total number of houses in Kg. Ayer). The ongoing project commenced on 31 March 1989.

The project objectives are to:

a. establish a demonstration project;
b. effect a regular solid waste service in the three selected *kampongs*;
c. cleanup the selected *kampongs*; and
d. provide a basis for the extension of the solid waste disposal service to the rest of Kg. Ayer.

The two options considered for solid waste disposal in Kg. Ayer are shown in Figs. 11 and 12.

System 1 involves boat transporters with large containers, jetty crane and roll-on/roll-off truck. System 2 uses boat transporters with small wheelable containers, jetty ramp and compactor truck.

The ongoing project uses System 1 with encouraging results: the *kampongs* appear to be cleaner. The cleanup of waste accumulated over a long period would require more time, as much of the work needs to be done manually, particularly under residences.

The total solid waste collected from March 1989 to January 1990 is summarized below:

Household waste	3761 m^3 or 88 m^3/week
Household junk/ builder's waste/cleanup	4736 m^3 or 110 m^3/week
Total	7349 m^3 or 198 m^3/week

A recent survey of the residences in the collection area indicated that the residents are very positive about the project and an overwhelming majority want it continued and expanded to the whole of Kg. Ayer (PWD 1990).

The extension of the pilot project, which will cover the entire Kg. Ayer, will be implemented under the current Five-Year National Development Plan (1991-1995).

Sewage Disposal. Raw sewage from Kg. Ayer is basically composed of toilet waste

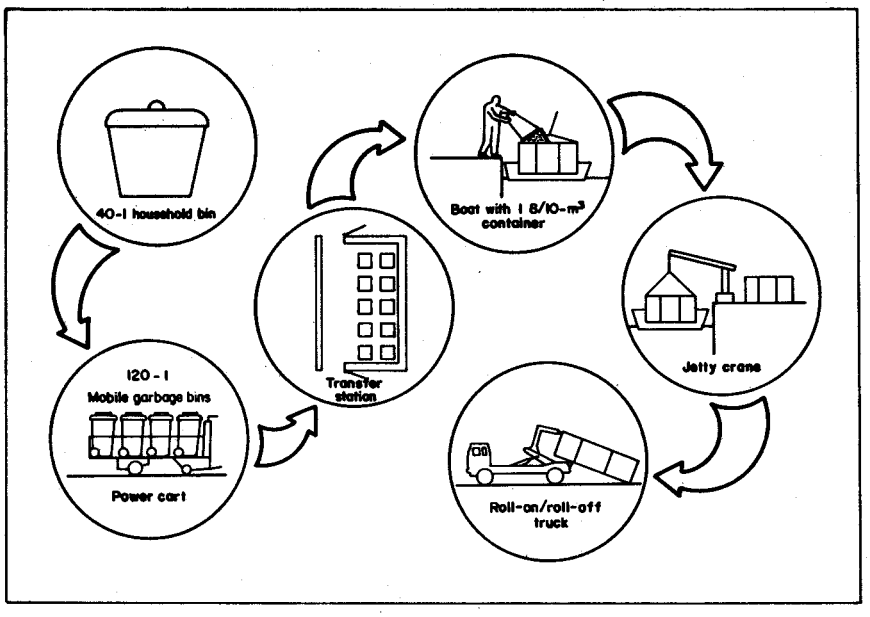

Fig. 11. Waste collection system using 40-l bins, jetty crane and roll-on/roll-off truck.

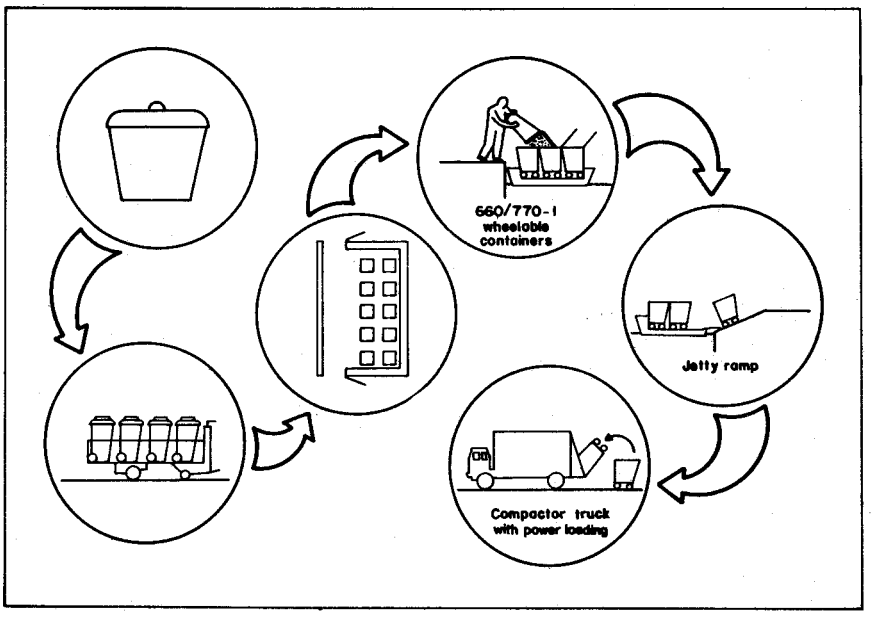

Fig. 12. Waste collection system using 660- or 770-l wheelable containers, jetty ramp and compactor truck.

(essentially human feces and urine) and sullage (wastewater from nontoilet sources such as washing, bathing and kitchen activities). Toilet waste contributes more than half of the sewage pollution load and 90% of the sewage solids.

Kg. Ayer contributes an estimated 10% of the total BOD load discharged into the waterways of Brunei Darussalam (Lim 1990). Thus, it is imperative to treat its domestic waste which is discharged untreated at the moment.

A sewerage system for Kg. Ayer would require an estimated total capital expenditure of B$23.7 million (PWD 1986). The estimated annual cost of administration, operation and maintenance would be about B$1.5 million, excluding interest and redemption of capital.

The government is very keen on initiating a sewage disposal program for Kg. Ayer and is looking into several options. One of these is a vacuum sewer system which consists of:

- a 100-mm diameter gravity sewer between house toilet and vacuum

chamber laid at a gradient of 1 in 40 and with a maximum length of 70 m;
- collection chambers with vacuum valves servicing 2-5 houses and situated close to the vacuum sewer so long as the gravity sewer run is able to be commanded;
- vacuum sewer mains laid along the alignment of the walkways connected to collection chambers;
- a shore-based vacuum pumping station and a conventional lowhead sewage pumping station;
- a short rising main up to the low ridge; and
- a gravity sewer connected to the town systems near the Abdul Razak Building (Fig. 13).

A pilot sewerage project, which will involve the use of this system will be implemented initially in five component *kampongs* of Kg. Ayer, namely Kg. Bendahara, Kg. Pg. Kerma Indra, Kg. Pg. Tajuddin Hitam, Kg. Tamoi Tengah and Kg. Tamoi Ujong. An efficient sewerage system in Kg. Ayer will halt the discharge of untreated toilet waste into Sg. Brunei and Sg. Kedayan. This will: (1) improve the water quality of the rivers concerned; (2) reduce the potential health problems associated with water-based activities such as boating, bathing and swimming; and (3) have a positive impact on the tourist trade and fishing activities in the area.

CONCLUSION

At present, waste management problems in the coastal area of Brunei Darussalam can be considered relatively minor. The waste disposal problem of Kg. Ayer is being addressed by the government. The solid waste collection techniques used in the component *kampongs* will be extended to cover all of Kg. Ayer. A sewerage system pilot project for Kg. Ayer will also commence.

Brunei Darussalam aspires to have "a clean and healthy environment." The government plans to initiate the enforcement of the anti-litter law which will carry a fine of up to B$1,000 for the first offense and B$3,000 for the second offense under the Minor Offenses Act. Its enforcement has been delayed until a nationwide cleanliness education campaign is completed. Several cleanup projects involving towns, villages, office compounds and streets were carried out during the campaign.

Commissioned studies and projects focusing on existing and anticipated problems as well as the recent upgrading of systems and

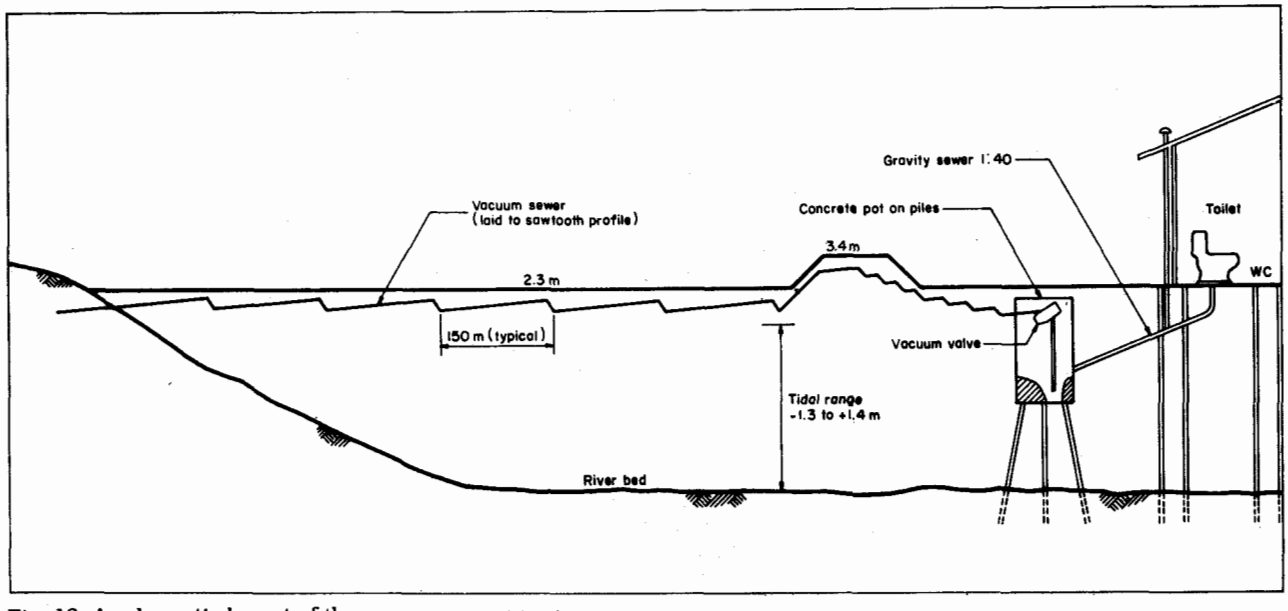

Fig. 13. A schematic layout of the vacuum sewer system.

facilities for waste collection, treatment and disposal attest to the government's commitment to waste management.

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Environmental Impact Management in Indonesia

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ABSTRACT

This paper presents Indonesia's experience in environmental management, including structure and strategy transformations like the formation of the Agency for the Management of Environmental Impacts (BAPEDAL). The BAPEDAL has 14 strategic management units (SMUs) in seven priority programs which tackle sea, coastal, surface- and groundwater pollution; air pollution from stationary and nonstationary sources; environmental damage from mining and quarrying; small-scale industry pollution; environmental impact assessment (EIA) and emergency response system management; noise pollution; and management of sewage, solid and hazardous waste.

Program success factors include a committed and credible leadership; institutional control and regional cooperation; an adequate budget and well-developed support services; specific objectives that can be achieved within a short time-frame; and public awareness of and participation in efforts to relieve environmental stress.

INTRODUCTION

The multidimensional nature of development brings about socioeconomic progress and negative environmental impacts. To control these impacts, governments create institutions which often are not very effective. The foremost cause is the inherent conflict between resource use (development) and resource management (specifically, environmental and natural resource management) which makes for a halfhearted leadership and inadequate institutional support.

Another is the management approach. Textbooks and examples from more advanced countries offer attractive concepts, such as "one river, one management" for water resource management and "bubble concept" for air pollution control. While these concepts are undoubtedly good, they require a certain degree of sophistication in institutional support. Adopting such approaches in the early stages of management development presages failure.

The purpose of this paper is to share Indonesia's experience in environmental impact management, especially the structure and strategy transformations that came with the adoption of a pragmatic approach in 1989.

ENVIRONMENTAL MANAGEMENT APPROACH

In 1978, the State Ministry of Population and Environment (KLH) was created for the national coordination of environmental management. Its functions are to protect, develop,

and manage the living, natural, socioeconomic and human environment of Indonesia. Provincial coordination is the responsibility of the Bureau of Population and Environment (BKLH). Operations are managed by sectoral ministers and governors at the central government and provincial levels, respectively. In the 1970s, tasks were performed by ad hoc interinstitution teams which were replaced later by permanent teams.

As expected, this system was relatively ineffective since the institutions and their personnel were not related directly to management. While it was tolerable in the first ten years when the emphasis was on increasing public awareness, it became inadequate when the management strategy increasingly involved law enforcement.

In 1990, BAPEDAL was created at the central government level to assist the President of Indonesia in formulating policies for the implementation of environmental pollution control; implement hazardous waste management; monitor and control activities which have important environmental impacts; develop a reference laboratory and handle information on pollution control; increase public participation in impact control; and implement other tasks assigned by the President.

The BAPEDAL head reports directly to the President and is assisted by two deputies. The Deputy for Pollution Control is responsible for pollution control, domestic and hazardous waste management, and the control of environmental degradation due to mining and quarrying activities. The Deputy for Development implements EIAs and develops support systems, i.e., for information, training and reference laboratory management. Institutions related to BAPEDAL were formed immediately at provincial and municipal levels.

In the first months of operation, BAPEDAL's immediate tasks were to recruit staff, decide on the right management strategy and create a working environment. The first batch of staff was from KLH, later supplemented by personnel from other ministries (e.g., Industry, Public Works, etc.). Strategic planning and management (SPM) was adapted from private corporations for use in the public sector.

To determine the BAPEDAL strategies, internal and external environmental assessments were done in conjunction with the mission of BAPEDAL and the national policy for environmental management. The strategies are:

1. strengthen the commitment of decisionmakers and community leaders;
2. increase public participation through:
   - training and education of target groups like the press and nongovernmental organizations (NGOs);
   - information availability; and
   - increasing newsworthiness of environmental impact management.
3. develop the internal management of BAPEDAL, provincial and municipal institutions, and trainings, and information systems; and
4. win public confidence as a short-term gain in selected areas.

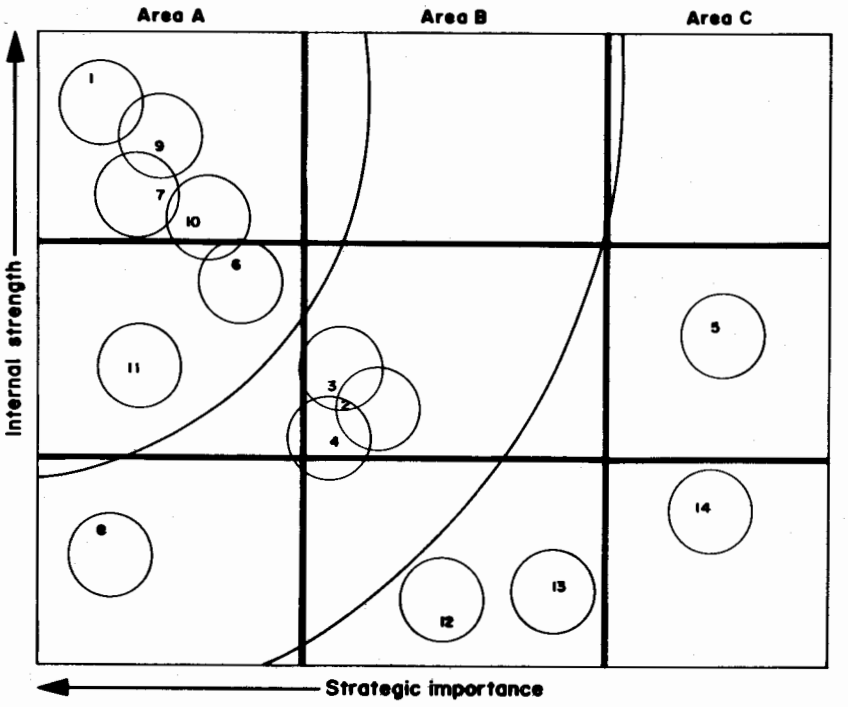
Due to limited resources, the choice of priority areas was critical. The programs focused on: (1) surface water pollution; (2) air pollution from mobile sources; (3) urban area sanitation; (4) control of environmental damage; (5) environmental impact analysis; (6) hazardous waste management; and (7) small-scale activities. These were divided into 14 areas called SMUs (Fig. 1). These units have separate systems for input, management and output headed by a responsible manager.

Next, SMUs were plotted in a modified "industry attractiveness-business strength matrix" or General Electric (GE) matrix (Fig. 1). Priority decisions were then made. In Area A, priority SMUs must "produce", i.e., win public confidence as a short-term gain. Regulations and support systems for operation have to be prepared for Area B. In Area C, concept papers need to be developed first.

In addition to SPM application, the organizational culture was developed in the staff. The values are: responsibility and teamwork; the ability to deliver at the right time with the right quality; personal development; and open management.

Long-term approach

The ten-year plan of BAPEDAL includes the development of an effective and efficient



SMUs in BAPEDAL

1. Surface water pollution control
2. Groundwater pollution control
3. Coastal water pollution control
4. Sea pollution control
5. Air pollution control: stationary sources
6. Air pollution control: nonstationary sources
7. Environmental damage control (mining and quarrying)
8. Small-scale industry pollution control
9. Solid waste management
10. Environmental impact assessment
11. Hazardous waste management
12. Emergency response system management
13. Sewage management
14. Noise pollution control

Fig. 1. The GE matrix for BAPEDAL's SMUs.

working system by the year 2000. These are the four channels:

- Institution-building. Consists of BAPEDAL internal management; training and education; and the development of (1) institutions operating at provincial and municipal levels, (2) an information system, (3) a reference laboratory, and (4) regulation and economic incentives, among others.
- Program development. Includes the implementation of focused programs with short-term gains. Using a bottom-up development approach, these will be extended and refined to achieve the desired management system by the year 2000.
- Market mechanism development. An emphasis of program development which proceeds from a feasibility study.
- Public participation. Consists of the development of the tripartite system and emphasis on the external control function which includes strategy-sharing with NGOs.

A BOTTOM-UP DEVELOPMENT APPROACH: PROKASIH

One of the seven BAPEDAL programs, PROKASIH aims to achieve clean water quality by eliminating pollution sources. Its goal: unpolluted rivers by the year 2000. This ten-year goal is divided into short-term subgoals and expansion stages.

Some of the features which PROKASIH shares with the other programs are:

1. The program must be focused on a particular area, and then expanded. In its first year, PROKASIH controlled the discharge of industrial waste to 20 rivers in 8 provinces by requiring target factories to sign agreements to achieve effluent standards in 6-10 months. By the second year, the program was expanded to 11 provinces and followed by implementing sanctions.
2. It must have a simple but strong name like PROKASIH.
3. The manager must be the highest ranking official in the province. The

overall management of PROKASIH is the responsibility of the provincial governor and the daily activities are managed by vice governors.

4. It must provide institutional support, like PROKASIH teams which will lay the groundwork. These will be superseded by provincial and municipal institutions which will function as BAPEDAL extensions.
5. It must maintain a high profile: PROKASIH has an attractive packaging with a high recall value. A marketing (not a public relations) manager is essential, at least at the central level.
6. Quality control is important. In the provinces, PROKASIH gives guidelines and does performance checks regularly. The BAPEDAL staff hold consultation meetings and make routine visits to the provinces.
7. A competitive spirit must be instilled in the program participants. Thus, every September, the province with the best achievements is recognized by the President of Indonesia. Creating a sense of togetherness is also important. Last year, the vice governors of PROKASIH provinces were sent to Canada for a six-week training that also helped create camaraderie among them.
8. Enforcement, either legal or administrative, must be a program function. (The PROKASIH is prosecuting three violators soon.)
9. Trainings for technical managers and engineering consultants must also be conducted.

Program success factors

One of the key factors that contributes to the success of a program is a committed and credible leadership with excellent management skills. Institutional control and regional cooperation are also necessary. Some of the program objectives must be specific so as to show results within a short period, e.g., to reduce pollution load or take pollution cases to court. Budgets at the central and regional levels must be raised to cope with the work demands. Support services have to be developed as well. More importantly, public awareness and participation must be harnessed to help improve the general environmental quality.

Wastewater Management in Malaysia

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ABSTRACT

Water pollution sources in Malaysia are agro-based and manufacturing industries, animal husbandry and sewage. Through regulations and enforcement mechanisms such as licensing, the Environmental Quality Act of 1974 (EQA) sets water pollution control. The significant investment in research and development (R & D) of waste treatment technology and the compliance with effluent standards by industries have led to considerable success in water pollution control. But cumulative loads of various polluting sources may eventually exceed the assimilative capacity of rivers and other water bodies. Thus, the development of water quality criteria and standards, river classification, and the establishment of appropriate effluent standards are recommended.

INTRODUCTION

In Malaysia, the management of water resources involves essentially a number of agencies and three major functions, i.e., assessment, protection and development. Its underlying basis are the state and federal lists of the Constitution. The State List includes rivers, canals, water supplies, riparian reserves and silt control. Waterworks, power supply and matters relating to factories, machinery and health are in the Federal List. Although wastewater in particular and pollution in general are not listed, they are covered under EQA of 1974. The purpose of EQA is twofold: pollution prevention, abatement and control as well as environment enhancement.

SOURCES OF WATER POLLUTION

The four water pollution sources in the country are agro-based industries, manufacturing industries, animal husbandry and sewage. The implementation of EQA regulations has made substantial progress in controlling both agro-based and manufacturing industries. In terms of organic pollution load, both these sectors contributed only 7% (32 t/day) of biological oxygen demand (BOD) in 1989 in contrast to 13% (60 t/day) and 80% (366 t/day) of BOD loads from animal husbandry and sewage, respectively (Table 1). The success of industrial pollution control is evident in the case of palm oil mills--100% of

Table 1. Organic pollution load by sector in Malaysia, 1986-1989.

Sector	1986 BOD load[a]	1986 %	1986 Population equivalent[b]	1987 BOD load	1987 %	1987 Population equivalent
Agro-based industries (palm oil and rubber)	11	2.7	0.22	11	2.5	0.22
Manufacturing industries	30	7.3	0.60	20	4.6	0.40
Agriculture (animal husbandry)	55	13.4	1.10	55	12.7	1.10
Population (sewage)	314	76.7	6.28	348	80.2	7.16
Total	410		8.20	434		8.68

Sector	1988 BOD load	1988 %	1988 Population equivalent	1989 BOD load	1989 %	1989 Population equivalent
Agro-based industries (palm oil and rubber)	11	2.5	0.22	11	2.4	0.22
Manufacturing industries	19	4.3	0.38	21	4.6	0.42
Agriculture (animal husbandry)	55	12.4	1.10	60	13.1	1.20
Population (sewage)	358	80.8	7.16	366	79.9	7.32
Total	443		8.86	458		9.16

[a]In t/day.
[b]In million, using a BOD load of 0.05 g/capita/day.
Source: Department of Environment, Malaysia.

those discharging onto land and 83% of those discharging into watercourses comply with effluent standards.

Partially treated or untreated waste, both human and animal, is a national problem. Notwithstanding the National Agriculture Policy of 1983, the available technology and adequate financial resources, organic waste from animal husbandry is still a problem. This is because of land tenure issues, lack of political support and society's low regard for animal husbandry as a backyard activity rather than a modern industry. The difficulty in overcoming the sewage problem is probably due to the lack of political will and poor siting of good sewage projects.

Water pollution also arises due to intensive land clearance, uncontrolled earthworks, and mining and logging activities in water catchment areas. Soil erosion causes suspended solids as well as river siltation and sedimentation. There are no specific regulations to control erosion and siltation and the existing laws are not enforced strictly by relevant authorities.

POLICY ON WATER POLLUTION CONTROL

Policies relating to wastewater treatment and disposal are found in various laws, regulations and enactments, at least ten of which provide statutory powers to control pollution (Tables 2 and 3). The most comprehensive legislation is EQA. To date, it has six sets of regulations which include Environmental Quality Regulations (EQRs):

- EQR (Prescribed Premises [PP]) 1977: Crude palm oil;
- EQR (PP) 1978: Raw natural rubber;
- EQR 1979: Sewage and industrial effluents;
- Environmental Quality Order (PP) 1989: Scheduled wastes treatment and disposal facilities;
- EQR 1979: Scheduled wastes; and
- EQR (PP) 1989: Scheduled wastes treatment and disposal facilities.

Similar sets of extensive regulations have yet to be widely introduced and enforced under other laws.

Table 2. Federal legislation on water pollution control in Malaysia.

Legislation	Provision
1. Fisheries Act (1963)	Protection of any fishery and fish cultivation in maritime and estuarine waters.
2. Environmental Quality Act (1974)	Control of water pollution largely from industrial sources.
3. National Forestry Act (1984)	Prohibition of water pollution in permanent forest reserves.
4. Atomic Energy Licensing Act (1984)	Prohibition of unauthorized radioactive waste disposal.
5. Exclusive Economic Zone Act (1984)	Prohibition of oil or pollutant discharge into the marine environment.

Table 3. State legislation on water pollution control in Malaysia.

Legislation	Provision
Waters Enactment (1920)	Prohibition of water pollution.
Mining Enactment (1929)	Control of effluent water from any mining area.
Province Wellesley Piggery By-Laws (1956)	Control of pig rearing.
Land Conservation Act (1960)	Control of silt and erosion from land use activity.
Street, Drainage and Building Act (1974)	Regulation of waste disposition, sewerage works, drainage and watercourses, cleansing and emptying sewers, and discharge of sewage or wastewater; control of earthworks.
Local Government Act (1974)	Prohibition of stream pollution and provision of sanitary services.
Rearing of Pigs Enactments Johore (1975) Trengganu (1976) Malacca and Negeri Sembilan (1980) Selangor (1984)	Control of pig rearing.

The underlying principles adopted in the formulation of EQA are:

- pollution should be controlled at source;
- polluters must pay or bear the costs of their waste or wastewater treatment or disposal;
- discharge standards should be uniform for a particular source, type of industry or activity;
- uniform discharge standards should be contravened for polluters whose discharge does not adversely affect receiving waters, i.e., waters still have the required "carrying capacity"; so-called "polluters" must bear the costs of investigative studies required by the relevant authorities; and
- variable discharge standards ought to be introduced by the Minister of the Environment should the uniform standards imposed on every discharge point and all polluting sources within a water body be inadequate to maintain the conditions necessary to support the intended use of the water body.

The principles of equity, cost-effectiveness, efficiency and maintenance of uniform quality within a water body have yet to be adopted. Any policy taking these into account would entail a formal declaration of water body or river classification according to various beneficial uses. Its implementation would require technical support and trained manpower of the highest order.

PRESENT STRATEGY

The Department of Environment (DOE), which implements EQA, has adopted licensing as one of its enforcement mechanisms. Its purpose is to provide "incentives" for polluters to comply with imposed discharge standards as quickly as possible and to allow polluters to "buy" the necessary time for further R & D or for proper design and installation of wastewater treatment or disposal facilities.

Significant investment in R & D of waste treatment technology resulted in pollution control from agro-based industries. Palm oil industries, for example, have developed several systems, the most common and efficient of which are those for ponding, open tank digester and extended aeration as well as closed tank digester with biogas recovery and land application.

Types of licenses

The DOE issues two kinds of licenses: the annual license for prescribed premises and the contravention license. Under EQA Section 18(1), the annual license requires both palm oil and rubber processing mills to comply with discharge standards specified under EQR (PP) 1977: (amended 1982) and EQR (PP) 1978: (amended 1980), respectively.

Issued under EQA Section 25(1), the contravention license for other manufacturing industries contravenes discharge standards specified in EQR 1979.

FUTURE STRATEGY AND CONCLUSION

Regulatory control has its limitations in water quality protection and enhancement. Despite compliance with discharge standards, the pollution sources' cumulative loads may eventually exceed the assimilative capacity of rivers and other water bodies. River water quality criteria and standards need to be developed. Rivers and other water bodies should be classified for the review of existing effluent discharge standards. Appropriate effluent standards can then be established. These strategies will certainly accord better protection for the country's water resources.

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Solid and Hazardous Waste Management in the Philippines

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ABSTRACT

This paper presents available information on solid waste and hazardous waste management in the Philippines. About 3,673 t of refuse is generated daily, only 85% of which is collected. The rest is indiscriminately burned, thrown in estuaries and canals, or dumped into sewers. Each year, industrial and manufacturing plants discharge about 80-100 million l of hazardous waste. These are disposed of by direct discharge to watercourses; on-site storage or burial; collection by tanker and discharge to domestic waste dumpsites or sewer; recycling; and incineration. Hospital waste, i.e., general, infectious and pathological waste, is thrown in open dumps or incinerated.

Present government efforts include the formation of the Presidential Task Force on Waste Management, strict pollution monitoring and management, and implementation of the rivers revival programs and those on solid and industrial wastes.

BACKGROUND

Demographic and socioeconomic concerns

The population of the Philippines in 1990 is estimated at well over 60 million with an annual growth rate (AGR) of 2.4%. This means that about 1.4 million people are added to the country's population every year, or that the population doubles in just one generation. The Philippines is the 14th most populated country in the world and 8th in Asia. The population density is about 196 persons/km^2, which is higher than the population densities of Indonesia and Malaysia combined.

About 43% of the total population is considered urban and is expected to increase to 48% by the year 2000. With an AGR of 3.6%, Metropolitan Manila has the highest population with about 8 million residents and 2 million commuters.

In the rural areas, upland population is of great concern. It is estimated at 18 million with an AGR of 2.6%. The increase of upland population has caused rapid forest clearing for farming and has thus led to serious siltation of lakes, rivers and coastal areas. Projections imply an upland population of about 24-26 million and densities of 160-175 persons/km^2 by the year 2000.

Labor statistics show rates of unemployment and underemployment at 9.2% and 32%, respectively. Other estimates, however, put unemployment at 20%.

In 1988, poverty incidence in the National Capital Region (Metro Manila mostly) was pegged at 31.8%, and that of the national population, at 60%. Rural poverty has caused a rapid growth in squatters in Metro Manila, estimated in 1990 at more than 400,000 people. Other data, however, show that more

than a million people, some nonsquatters, live in slum areas.

From 1986 to 1989, the gross national product (GNP) in real terms had an AGR of 5%. In 1989, however, inflation grew to 10.9% so that by 1990, the real GNP went down to 3.4%. This is due to drought, power outages and political instability caused by the 1989 coup d'état. The country has a US$29.7-billion foreign debt and an expected trade deficit of US$3.46 billion.

Existing and planned land and water use in the coastal zone

The Philippines is an archipelago of 7,107 islands with a total coastline of 17,460 km. Thus, 80% of the country's provinces and 66% of all municipalities are along the coast.

The coastal zone is the residence of 70% of the population. There are some 10,000 coastal *barangay* (villages). The ten most highly populated urban centers along the coast are Metro Manila, Metro Cebu, Davao, Zamboanga, Bacolod, Iloilo, Cagayan de Oro, Angeles, Butuan and Iligan. Only 12% of Metro Manila is properly sewered. The coastal zone is the end repository of urban sewage and garbage. In these cities, riverbanks and shorelines have very dense squatter colonies.

Agriculture

Agriculture is a major activity along the flatlands adjacent to coasts. One of the largest contributors to the national economy, it generates 36% of the country's export earnings and 28% of GNP. It is the livelihood of about $^3/_4$ of the country's population and $^1/_2$ of the labor force. Of the country's 30 million ha, about 43% or more than 13 million ha are croplands. About 7.086 million ha are planted to rice and corn; 4.721 million ha to other food crops, i.e., coconut, sugarcane, coffee, cacao, fruits, nuts and vegetables; and 1.235 million ha to nonfood crops.

Forestry

The two types of forestry activities that have an impact on the coastal zone are mangrove cutting for fuelwood, housing materials and conversion to fishponds as well as logging of the more inland dipterocarp forests. The latter, however, has started to decline with the dwindling of the timber resources. From estimates of more than 12 million ha of forest in 1981, there are only about 6 million left with less than 900,000 ha of old growth forest. Thus, while logging represented 2.2% of gross domestic product (GDP) in 1984, it slumped to 1.6% especially with restrictive government policies in 1986. In real terms, forest-based outputs contracted from ₱3.170 billion in 1970 to ₱1.998 billion in 1988.[1] While log exports earned more than US$200-300 million annually in the 1960s and 1970s, these have been banned by the government.

The contribution of forestry is still substantial. Forestry-related industries still provide jobs to about 274,000 people. Farming in forest lands is done by about 1.2 million households. About 64% of the country's households use wood from forest lands. It has been estimated that in 1990, 31 million m^3 of fuelwood will have been consumed by households, and 7.7 million m^3 by industries.

Industry

Industrial development in the Philippines has been generally sited along the coastal zone. The industrial sector ranges from the petroleum industry which is virtually monopolistic and large-scale but has a low employment contribution to the food industry which involves considerable numbers of small to big establishments and accounts for the largest manufacturing employment.

As of January 1990, the major groups providing the largest employment are: agriculture, fishing and forestry (44.62%); services (39.56%); community, social and personal services (18.23%); industry (15.98%); and wholesale and retail trade (14.59%).

The economic growth of the industry sector was 8.97% in 1988 which dipped to 6.91% in 1989 and about 2.10% in 1990.

There are 15,000 industrial firms in the country with 69% situated in Metro Manila. Industrial estate development, however, is

[1] 1970: ₱6.02 = US$1.00; 1988: ₱21.34 = US$1.00.

being aggressively pursued outside Metro Manila. Four export processing zones and 17 industrial estates operate in the country. Rapid developments are occurring in CALABARZON (Cavite, Laguna, Batangas and Rizal) with three more large developments in the advanced planning stage: the Samar Island Development Project (US$9.9 million), the Panay-Negros Agro-industrial Project (US$400 million) and the General Santos Agro-industrial Project (US$55.04 million). Industrial development is expected to increase with the passage of laws and policies providing greater incentives to local and foreign investors.

A major industry affecting the coastal zone is mining. The total mineral ore reserves was estimated at 31.27 billion metric tons (BMT), with 6.11 and 25.6 BMT, respectively for metallic and nonmetallic ores. An important nonmetallic mining activity is silica sand mining.

Of special consideration is small-scale mining. The disorganized, opportunistic and gold-rush nature of small-scale mining results in landslides, erosion, mercury pollution and overcrowding, which are environmentally destructive.

There are 37 major mining companies/operations for gold, silver, copper, chromite and nickel all over the country. From 1980 to 1988, the mining industry's GDP contribution averaged ₱1,852.22 million annually.[2] It also employed an average of 121,750 people.

Tourism

Small islands are being developed for tourism, particularly the relatively remote El Nido and Calamianes Islands of northern Palawan. Designed to be exclusive resorts, these tend to be high priced. The relatively small Ten Knots Resort in El Nido, for example, has an estimated ₱40-million annual gross revenue. Resort development also provides a more lucrative livelihood to traditional fishermen who ferry and guide tourists or supply seafood to the resort. Resort developers tend to recruit community members as part of their staff to generate community support for the resort.

In 1990, private investment in tourism development amounted to ₱9.516 billion.[2] The projected manpower involved in the industry is more than 11,000 over 1,218 licensed and accredited establishments.

Fisheries

Fisheries is a major industry in the Philippines. From 1973 to 1986, overall fisheries production increased from 1.205 to 2.089 million t/year. About half of the annual take comes from municipal fisheries. The 1990 figures put fisheries production at 2.1 million t/year. Municipal fisheries and aquaculture account for increased production. Commercial fisheries has remained relatively constant at 0.5 million t/year. Fisheries contribute 5.1% of GNP and ₱4.47 billion in annual foreign exchange earnings.

Fisheries employs an estimated 1 million people or 3-4% of the national labor force, not including secondary fisheries activities. Municipal fisheries accounts for 75% of the employment, followed by aquaculture and commercial fishing with 21% and 4%, respectively.

The number of fisherfolk has increased by 50% over the last ten years. The catch per fisherman, however, has declined by 42% over the same period in Regions 5, 7, 8 and 11. Except for Regions 4, 6, 9 and 10, the average catch per fisherman in the other eight regions cannot raise the economic level of fishermen. About 80% of the municipal fishing families live below the official poverty line.

Apart from dynamite and cyanide fishing, one of the most serious negative impacts of fisheries on the coastal zone is the conversion of mangrove areas into fish- and shrimp-ponds. The average annual conversion rate is about 5,000 ha until the early 1980s to about 3,500 ha thereafter. Ninety-five percent of the more than 288,000 ha of fishponds can be ascribed to mangrove conversion.

Infrastructure

New ports and roads are being planned and constructed for increases in population and

[2] 1990: ₱28.00 = US$1.00.

demand for development. Many of the proposed industrial estates, as in General Santos City, South Cotabato, include ports. As cities expand, new ports will be built or old ones expanded.

The building of coastal roads has substantial impacts. Business establishments or squatter colonies displace fishermen. Some new roads will inadvertently provide access to hitherto isolated resources, e.g., a proposed road along the western side of Palawan is adjacent to the few remaining thousand hectares of virgin mangrove forests. Roads built more inland eventually impact on the coastal zone as they cause inmigration into unsettled areas which result in erosion and eventual siltation of rivers and bays.

The three large fish processing zones also have negative impacts on the coastal zone. The Iloilo Fishport has been issued a cease-and-desist order by the Pollution Adjudication Board (PAB) prompting the Philippine Fisheries Development Authority to commit to the establishment of wastewater treatment systems for that facility as well as the ones in Navotas, Metro Manila and in Zamboanga in the island of Mindanao.

Of special concern, too, are planned hydroelectric dams and mine tailings dams of mining companies. The latter helps control pollution but causes changes in river hydrology and eventually, on the ecology of bays.

ENVIRONMENTAL INVENTORY

Climate

The climate of the Philippines varies according to location and time. Topography also affects climate. The terrain varies a great deal with extensive mountain chains across Luzon and Mindanao to the land-sea mix of the Visayas. The country's proximity to the Asiatic continent and the surrounding large bodies of water gives rise to seasonal variation of the wind system.

The first semester rainfall covers the main summer period from April to September. Rainfall greater than 2,000 mm is found in the western sections of Luzon and Panay islands while Cagayan Valley, the interior portions of the Visayas and southern part of Mindanao have rainfall less than 1,000 mm. The second semester rainfall covers the main winter monsoon months from October to March. Rainfall greater than 2,000 mm is found in eastern Philippines which is more exposed to the prevailing northeasterlies.

The northern tip of Luzon, Southern Luzon, Bicol Region and Samar-Leyte are prone to typhoons. The country is also known to experience droughts associated with the El Niño phenomenon.

Topography

The Philippines is an archipelago of hilly and mountainous islands. Of the 30 million ha of land, some 16.8 million ha or 56% have a slope of above 18%. The watershed areas, especially in the smaller islands (only about 450 of the 7,107 islands have areas larger than 2.6 km^2), are very susceptible to flash floods and drought, once denuded.

Water quality

The quality of the country's coastal waters along growth centers has deteriorated due to sewage, garbage, industrial effluents, mine tailings, oil from shipping operations and agricultural runoff. Coastal areas adjacent to denuded watersheds are also silted. More than half of the area of at least 21 provinces has been eroded.

In Manila Bay, bacterial counts have exceeded acceptable standards, rendering its eastern beaches unfit for bathing, fisheries and aquaculture. Calancan Bay and Tañon Strait are major waterbodies seriously affected by mine tailings. About 113 million t have been discharged into Calancan Bay from 1975 to 1986.

The country's inland waters of 421 rivers, 58 natural lakes and more than 100,000 ha of freshwater swamps have also suffered environmental degradation brought about by developments and the destruction of adjacent ecosystems. All five rivers in Metro Manila are biologically dead. In highly urbanized Cebu, rivers have registered high coliform bacteria counts of 5,000-170,000 MPN/100 ml. The 90,000-ha lake, Laguna de Bay, is already considered hypereutrophic.

Deforestation and mine tailings have silted many rivers. The lead content of Pantalan, Dagupan and Agno Rivers range from 1.0 to 5.4 mg/l, exceeding the 0.05-mg/l standard for Class C waters. Rivers along small-scale gold mining areas have mercury levels higher than the 0.002-mg/l standard.

As far back as 1984, saltwater intrusion has affected approximately 480,082 ha of waters outside of Metro Manila whose affected areas cover 19,611 ha.

Biodiversity

The archipelagic nature of the country creates considerable richness in flora and fauna. Recent short-term botanical surveys are still discovering plant species new to science. Plant endemism is about 27%. For birds, 39% of residents are endemic. The diversity of marine organisms in the coral reef ecosystems is also high, considering the 34,000 km^2 of reefs within the country.

The rare and endangered species that must be protected include the Philippine eagle, tamaraw, Calamian deer, tarsier, Palawan peacock pheasant, dugong, various marine turtles, and freshwater and estuarine crocodiles.

ENVIRONMENTAL CHALLENGES IN THE COASTAL ZONE

Use conflicts in the coastal zone are expected to heighten over the years. Fishermen, competing with their own highly increased population for limited resources, have become active in pollution control efforts to increase the productivity of fishing grounds. The growth of the shrimp- and fishpond industry, which is sensitive to pollution stresses, has created a counterpoint to the traditional use of the rivers as industrial disposal systems. There is a stronger demand for a steady domestic water supply in growth centers. In Metro Manila, the adjacent Laguna de Bay can be tapped, but this will mean stopping more than 900 industrial firms from disposing of their effluents into the lake or forcing them to treat their waste within water quality standards appropriate for drinking water supply.

In the rural areas, there is greater vigilance among farmers against the siltation and pollution of their irrigation waters from mine tailings. Farming, however, also creates coastal pollution problems in its heavy use of chemical fertilizers and pesticides. The hypereutrophic state of Laguna de Bay is partly due to this.

Because rivers are traditional sources of water for drinking and washing in the rural areas, housewives are the first on many occasions to complain against pollution. At present, pollution complaints filed by rural communities are mostly related to piggery and sugar mill waste.

Rivers are also used for navigation. Residents of Metro Manila at first were not too concerned about the pollution problem and navigation. Now, however, that a Metro ferry service plies the Pasig River to help solve the city's serious public transport problem, people have taken notice. No one wishes to ride on a ferry that moves along a garbage-strewn and malodorous river.

Solid waste pollution of the rivers causes serious flooding in the streets. Polluted floodwaters at knee- or waist-level are health hazards as have been proven by increased gastrointestinal cases during the rainy season.

Tourism resort owners and developers have recently joined efforts to control river and coastal pollution. No tourist would want to go to a beach where the coliform bacteria count is high nor to a place where polluted water can be seen. Tourist resorts that cater to specialized activities such as scuba diving have been particularly concerned about coastal pollution.

Tourism, however, can be the source of coastal pollution especially in areas of too much development. Improper garbage and sewage systems have resulted in plastic bags lodged between corals and high coliform counts in bathing areas. More specialized tourism development of the remote small islands is expected to have negative impacts on ecologically sensitive species such as marine turtles.

Oil spills and oily waste from passing ships are of special concern because these damage water resources. Fortunately, the oil spills in

the Philippines, although many, are relatively small. Ports development, however, is being intensified. Oily wastes from docked and passing ships will, in time, render shellfish culture inadvisable.

Energy development also bears watching. A geothermal plant in Tiwi, Albay disposes of its waste steamwater into a bay, against which there have been protests. Future geothermal development should develop designs for reinjection or closed systems of effluent management. Coal-fired power plants are also being checked for both air and water pollution.

Should population trends continue, there could be more coastal zone reclamation with serious negative environmental impacts, i.e., the flooding in the Navotas-Malabon area. Seagrass communities along Manila Bay disappeared because of the construction of the Cultural Center of the Philippines Complex on reclaimed land.

CURRENT WASTE MANAGEMENT ISSUES

Metro Manila is the center of education, industrialization and commercial growth in the Philippines. In effect, the influx of people to the region is continuous. The current population, estimated at about 8 million, is expected to reach 10 million by the end of the century.

Consequently, environmental degradation has been one of the major problems of the region. Air pollution is caused mainly by transport and industry, contributing approximately 60 and 40% of the total pollution load, respectively.

Water pollution in Metro Manila is caused by increased domestic and industrial discharges. Today, most major rivers are considered biologically dead. All urban areas in the Philippines have no efficient sewage collection and treatment system although some affluent residential communities have sewage treatment facilities. Only about 12% of Metro Manila's population is served by a sewerage system. The rest contributes about 70% of all biodegradable organic pollutants in the river systems. Industrial activities contribute majority of the toxic pollutants with some biodegradable pollutants.

Estimates of the biological oxygen demand (BOD) generated by an average Filipino are 35-70 g/person/day as sewage and 640-1,600 g/person/day as solid waste. For Metro Manila, estimates of BOD loading (t/year) to the rivers and estuaries in the mid-1980s were:

Sewage	25,550
Food processing industry	1,849
Textile industry	313
Piggeries	298
Others	204

Solid waste management

A number of feasibility studies have been conducted regarding solid waste management in Metro Manila. The findings of the most recent study (DPWH 1990) were:

1. Solid waste generation varies from one city or municipality to another, depending on income levels and the predominance of commercial and industrial activities. In terms of per capita generation, the municipality of Makati is the highest at 0.623 kg/capita/day while the municipality of Taguig is the lowest at 0.320 kg/capita/day.
2. Of the estimated 3,673 t/day of garbage generated in Metro Manila, government operators collect about 71% and private haulers, 14%. About 300 t/day or 8% is recycled and the remaining 7% is believed to be indiscriminately burned, thrown in estuaries and canals or dumped into sewers.
3. Waste collection is undertaken by a combination of 43 private contractors with a total of 432 open dump trucks and government operators with 139 vehicles. The contractors' fleet is subject to frequent breakdowns mainly because most of these trucks are about 20 years old; this results in inadequate refuse collection. The two-year old government vehicles are more reliable.
4. The seven open dumpsites in Metro Manila are not used simultaneously because of these basic problems: (a) health and safety of scavengers; (b) leachate runoff, blowing debris, odor, vermin and rodent infestation; (c) air pollution; and (d) poor access road, especially during the rainy season.

5. Residential and market value characterization showed that yard and field wastes constitute 30.4% of the waste stream, wood, 10.8% and food waste, 9.9% (Table 1). A physicochemical waste analysis, which confirms the results of a 1982 study, observes the presence of mercury, cadmium and lead in the waste at 1.9, 3.9 and 23.0 ppm, respectively (Table 2).

Another study (EMB 1990a) focused on leachate pollution in three open dumping sites in Metro Manila, i.e., Pasig, Payatas (Quezon City) and San Mateo. In Pasig, shallow wells and the upper part of the deep aquifer are saline, which is attributed to saltwater intrusion and tidal effects of nearby rivers. A clay layer protects the deep aquifer from leachate contamination.

Some shallow wells are already affected by leachate in Payatas, the dumpsite of which is to be decommissioned. The extent of groundwater pollution is yet to be determined. The nature of the San Mateo site is most favorable for a sanitary landfill. A number of measures and additional studies, however, need to be undertaken for its optimal use with the least environmental risks.

Table 1. Composition of domestic waste (% by weight) in Metro Manila, 1988.

Composition	Arithmetic average
Paper	7.62
Cardboard	3.09
Food waste	9.96
Plastic	9.32
Textile	4.79
Rubber and leather	2.02
Petroleum products	1.25
Yard and field waste	30.43
Wood	10.84
Fines	10.30
Metals	3.63
Glass	2.32
Inerts	4.35
Total	99.92

Source: DPWH (1990).

Table 2. Physical and chemical parameters of Metro Manila's solid waste.

Parameter	Results
Dry matter	57.70%
Moisture	42.30%
Ash	26.40%
Carbon	40.29%
Oxygen	29.16%
Hydrogen	5.22
Nitrogen	1.11
Chlorine	0.82%
Sulfur	-
Phosphorus	-
C:N ratio	36:1
Heat value	3,907.0 Kcal/kg 7,032.0 BTU/lb
Average density	233 kg/m^3 393 lb/y^3

BTU - British thermal unit.
Source: DPWH (1990).

Hazardous waste management

The few studies on hazardous waste management do not give actual data on the extent of toxic and hazardous substances (THS) generated nationwide, but these recognize that hazardous waste needs priority attention. Rough estimates put toxic and hazardous waste generation at 20-40 million and 80-150 million l/year, respectively.

The primary sources of hazardous waste are industrial and manufacturing plants. Although a number of these have wastewater treatment facilities, there are no facilities for the disposal of concentrates and sludges which are generally more toxic and hazardous than wastewater.

The buildup of these hazardous waste poses environmental problems:

1. heavy metal sludge from semiconductor industries and other industrial wastewater systems;
2. geothermal plant waste with very high heavy metal concentration;
3. oil residue and volatile organic carbon from petroleum refineries, bulk depots and storage tanks in industrial plants and complexes;
4. arsenic and oxide of sulfur and other heavy metals from copper roasting or smelting processes;
5. used polyethylene bags impregnated with pesticides from banana plantations;
6. mercury from small-scale gold mining in Mindanao;
7. chromium from leather tanning and finishing industries;

8. waste from agricultural chemical industries;
9. heavy metals such as cadmium, chromium, zinc, nickel and copper from metal plating and finishing plants; and
10. hospital and laboratory waste containing radioisotopes, pathologic and infectious agents, and other toxic chemicals.

Because of the lack of a centralized facility for treatment and disposal, industries used these disposal methods:

1. direct discharge of dilute washwaters from drains into watercourses;
2. on-site storage and/or burial or on other lands owned or leased by the industry;
3. collection by tanker and discharge to domestic waste dumpsites, open lands and sewer or drain;
4. recycling; and
5. incineration.

Most of these are inadequate. Thus, industries (especially the multinationals), which are becoming aware of the hazards of their waste, conduct research and pilot studies. A recent study of hazardous waste was conducted in Laguna Lake for estimates of selected chemical constituent pollutant loads from 51 industry and land-use category types (LLDA 1989). Table 3 shows the industrial and land-use categories while Table 4 is a list of THS considered as well as the total loads and estimates for the next 20 years. In addition, there were estimates of these nonpoint sources: deforestation; agricultural runoff; urbanized-area runoff; leachate from solid waste dumps; and runoff from mines and quarries.

The findings were:

1. Of the 908 registered industries in the Laguna Lake area, 65% contributed significantly to the lake's pollution load with varied and increasing pollutive and/or hazardous waste.
2. The 41 industry types discharged an increasing number of THS which exceeds the chronic criteria for the protection of aquatic life. More than 90% generated waste contaminated with varying concentrations of trace metallic elements like chromium, cadmium, lead and zinc. Less than half of the types had nonmetallic pollutants like cyanide, phenol, toluene and dichlorobenzene (Table 5).

Table 3. Industrial and land-use categories in Laguna Lake Basin.

Adhesive and sealant
Battery manufacturing
Coal/oil petroleum products/refinery
Dye manufacturing and formulation
Electric generation plants/distribution
Electroplating/metal finishing
Equipment manufacturing and assembly
Unsecured sanitary landfills
Fertilizer manufacture
Food/food by-product processing
Industrial/commercial laundries
Ink manufacture and formulation
Inorganic chemical manufacture
Iron/steel manufacture/forming
Laboratories/hospitals
Leather tanning/finishing
Misc. chemical formulation
Motor vehicle services
Nonferrous metals forming
Nonferrous metals manufacturing
Organic chemical manufacturing
Paint manufacturing/formulation
Pesticides manufacture
Pharmaceuticals manufacture
Photo chemical and film manufacture
Plastics molding/forming
Plastics/resins/synthetic fibers
Porcelain enamel
Printing/publishing
Pulp/paper mills
Rubber manufacture/processing

Source: LLDA (1989).

A lot still has to be done about hazardous waste management. Some of the needed measures are standards development, research, inventories, a regulatory and monitoring system and technical staff training.

A special concern is the increasing number of countries which want to bring their industrial and hazardous wastes and scraps to the Philippines. The pretext is that the move will help improve the Philippine economy through no-dollar importation, technology transfer, increased employment and income. The import of toxic waste has to be guarded against, so the government has been rejecting these offers.

Hospital waste

A hospital solid waste management study, which was confined to those with bed capacities of 100-5,200, was undertaken by the

Table 4. Total THS loads (kg/day) in Laguna Lake Basin.

THS	1989	1995	2000	2010
Acrolein	36.2	61.3	95.2	229.6
Benzene	1.11	1.89	2.93	7.06
Carbon tetrachloride	2.55	4.32	6.71	16.18
Chlorobenzene	19.3	32.8	50.9	122.7
1,2,4-Trichlorobenzene	0.72	1.21	1.88	4.54
1,2-Dichloroethane	20.9	35.5	55.1	132.9
1,1,1-Trichloroethane	11.8	19.9	30.9	74.6
Hexachloroethane	0.008	0.013	0.020	0.048
1,1-Dichloroethane	2.29	3.88	6.02	14.52
1,1,2-Trichloroethane	0.14	0.24	0.37	0.89
1,1,2,2-Tetrachloroethane	0.32	0.54	0.83	2.01
Chloroethane	0.17	0.28	0.44	1.05
2,4,6-Trichlorophenol	0.63	1.07	1.66	4.00
Chloroform	1.40	2.37	3.68	8.87
1,2-Dichlorobenzene	1.59	2.70	4.20	10.12
1,3-Dichlorobenzene	3.70	6.28	9.75	23.51
1,4-Dichlorobenzene	3.36	5.70	8.85	21.35
1,1-Dichloroethylene	2.91	4.94	7.67	18.51
1,2-Trans-dichloroethylene	1.57	2.66	4.13	9.96
2,4-Dichlorophenol	0.35	0.60	0.93	2.25
1,2-Dichloropropane	0.070	0.119	0.184	0.444
2,4-Dimethylphenol	782.0	1,326.0	2,059.0	4,966.0
Ethylbenzene	42.9	72.8	113.0	272.5
Bis (2-chloroethoxy) methane	0.00	0.00	0.00	0.11
Methylene chloride	242.0	410.0	636.0	1,535.0
Methyl chloride	0.04	0.07	0.11	0.26
Naphthalene	10.73	18.20	28.26	68.14
Pentachlorophenol	2.83	4.79	7.45	17.95
Phenol	7,804.0	13,233.0	20,549.0	49,546.0
Bis (2-ethyhexyl) Phthlate	72.0	122.0	190.0	458.0
Butyl Benzyl Phthalate	5.34	9.06	14.07	33.92
Di-n-Butyl Phthalate	2.20	3.73	5.80	13.97
Di-n-octyl Phthalate	1.92	3.25	5.04	12.16
Diethyl Phthalate	7.76	13.16	20.44	49.28
Dimethyl Phthalate	1.37	2.33	3.62	8.73
Tetrachloroethylene	19.9	33.7	52.4	126.2
Toluene	167.0	282.0	439.0	1,057.0
Trichloroethylene	4.41	7.48	11.62	28.01
Vinyl chloride	0.002	0.003	0.005	0.011
PCB	0.19	0.33	0.51	1.22
Antimony	4.93	8.36	12.98	31.30
Arsenic	3.60	6.10	9.47	22.82
Cadmium	20.3	34.4	53.4	128.9
Chromium (hexavalent)	165.0	280.0	435.0	1,049.0
Copper	181.0	306.0	475.0	1,146.0
Cyanide	108.0	183.0	284.0	684.0
Lead	324.0	549.0	853.0	2,056.0
Mercury	19.0	32.0	49.0	118.0
Nickel	264.0	447.0	695.0	1,675.0
Selenium	0.82	1.39	2.16	5.21
Silver	110.0	187.0	291.0	701.0
Zinc	297.0	504.0	782.0	1,886.0
Acetone	108.0	184.0	285.0	687.0
Barium	12.5	21.2	32.9	79.4
Bromoform	0.21	0.35	0.55	1.34
Cresols	0.78	1.33	2.06	4.97
Cumene	0.50	0.84	1.31	3.16
Dichlorodifluoromethane	0.24	0.41	0.64	1.53
Ethyl acetate	1.51	2.56	3.98	9.59
Ethyl ether	1.06	1.79	2.78	6.70
Formaldehyde	9.29	15.74	24.45	58.95
Isobutyl alcohol	6.75	11.44	17.76	42.82

Continued

Table 4. (continued)

THS	1989	1995	2000	2010
Methyl alcohol	816.0	1,383.0	2,148.0	5,179.0
Methyl ethyl ketone	2.55	4.33	6.72	16.20
Methyl isobutyl ketone	1.21	2.05	3.18	7.68
N-Butyl alcohol	40.7	68.9	107.0	258.1
P-Chloro-M-Cresol	4.84	8.20	12.74	30.71
Tetrahydrofuran	16.1	28.2	43.7	105.4
Trichloromonofluoromethane	1.97	3.34	5.18	12.50
Xylene	43.4	73.6	114.3	275.7

Source: LLDA (1989).

Table 5. Percentage of industry types in Laguna Lake that exceeds the THS chronic criteria.

THS	Industries exceeding criterion (%)
Metallic	
Chromium	95
Lead	95
Copper	95
Cadmium	93
Zinc	93
Mercury	76
Silver	73
Nickel	68
Arsenic	24
Selenium	10
Antimony	3
Nonmetallic	
Cyanide	41
Phenol	22
Toluene	15
1,2 Dichlorobenzene	15
Tetrachloroethylene	12
2,4 Dichlorophenol	12
1,3 Dichlorobenzene	7
2,4,6 Trichlorophenol	7
1,2 Dichloroethane	5
1,4 Dichlorobenzene	5
Pentachlorophenol	5
Carbon Tetrachloride	5
1,1,1 Trichloroethane	5
2,4 Dimethyl Phenol	5
Chloroform	2
Acrolein	2
1,2,4 Trichlorobenzene	2

Source: LLDA (1989).

Department of Health (DOH) with the assistance of the Department of Environment and Natural Resources (DENR) (DOH 1988). Significant findings include:

1. Of the 64 government and private hospitals surveyed, 92% dispose of their general, i.e., domestic, noninfectious and packaging waste, in the open dumps. About 16 and 31% include their pathological and infectious waste, respectively. Only 27% disinfect their infectious waste before disposal with the general waste. Sharps are also usually disposed of in dumpsites.
2. Other methods include open burning and dumping, burying within hospital compounds and flushing through the hospital plumbing system.
3. Thirteen hospitals utilize incineration for their general, pathological and infectious waste. Only six of these, however, have incinerators that completely destroy the waste.

PRESENT GOVERNMENT EFFORTS AND PROGRAMS

Pollution control and management is vested upon DENR. The Environmental Management Bureau (EMB) is the unit tasked with environmental pollution concerns.

Pollution monitoring as well as implementation of orders and projects are the responsibility of regional offices under the function of the Regional Technical Directors for Environment. The adjudication of pollution cases, however, is still in a central PAB, composed of seven members with the DENR Secretary as Chairman. The PAB has *ex parte* powers to issue cease-and-desist orders to pollutive firms.

Pollution control and management, however, cannot be implemented properly by one agency alone. In fact, in the Metro Manila area, $^1/_2$ of the metropolis comprising the watersheds and water bodies of Laguna de

Bay falls under the jurisdiction of the Laguna Lake Development Authority (LLDA).

The DENR works with the Department of Trade and Industry on an Industrial Efficiency and Pollution Control Project, industrial pollution issues and environmental concerns related to industrial estate development. For public education, DENR works with the Department of Education, Culture and Sports on integrating environmental education in the school curricula. For the informal sector, DENR cooperates with the Public Information Agency, various non-governmental organizations (NGOs) and media.

The government follows a sustainable development approach regarding industry because industries are important to employment and the economy, and poverty causes environmental degradation. Thus, PAB has made it a policy to close polluting firms immediately, allowing temporary operations if they meet three requisites:

- submit a detailed pollution control and management program for the firm complete with computations, work schedules, engineering designs, proof of contracts and budget;
- file in favor of government a performance bond equivalent to 25% of the total cost of implementing the pollution control program; and
- commit to interim measures (i.e., production reduction, temporary lagoons, etc.) that will reduce pollution substantially until the pollution control facilities are finished.

The government also plans to improve zoning and land-use planning systems in the country. To evaluate the accomplishments of its regional offices, DENR made ecoprofiling a key result area.

Also, the government, through Cabinet Resolution No. 37, has passed a Philippine Strategy for Sustainable Development (PSSD) which lays out ten basic strategies (DENR 1990):

1. integrate environmental considerations in decisionmaking;
2. price natural resources properly;
3. reform property rights;
4. establish an Integrated Protected Areas System;
5. rehabilitate degraded ecosystems;
6. strengthen residuals management in industry;
7. integrate population concerns and social welfare in development planning;
8. induce growth in rural areas;
9. promote environmental education; and
10. strengthen citizens' participation and constituency building.

These strategies are general but they provide the comprehensive framework for environmental concerns like solid and hazardous waste management. There are ongoing efforts at translating these strategies into operational terms for the synchronized medium-term planning and budgeting exercise of all government agencies and for the 1992 Philippine Report to the United Nations Conference on Environment and Development.

Solid waste programs

Solid Waste Management Assistance and Development Program. Ongoing for 11 years, the Solid Waste Management and Subsidy Program aims to assist local government units in their solid waste management problems. As of the end of 1990, 124 local government units in the country have been given subsidies of ₱30,000.

Solid Waste Management Programs for Metro Manila. In 1987, solid waste management became a presidential concern through Memorandum Circular No. 30 which created the Presidential Task Force on Waste Management. Composed of government agencies such as the Department of Transportation and Communication, Metro Manila Authority, Department of Public Works and Highways (DPWH), DOH and DENR, the task force aims to find better solutions to the solid waste problems in Metro Manila.

Among its major decisions were the operation of two sanitary landfills (in Carmona, Cavite and San Mateo, Rizal) and five transfer stations; and the closure and rehabilitation of all open dumpsites.

Although this is a major government project in need of immediate operation, DENR ensures that all environmental protection measures are being done.

Hospital waste program

The government, through DOH, is preparing a Hospital Waste Management Program. Recommendations include the operation of centralized incinerators in regions where the majority of hospitals are located, establishment of written policies on waste handling and disposal, and legal accountability of the hospital management for their waste management practices.

In addition, Senate Bill No. 1581 requires all hospitals, medical centers and clinics to provide their own waste disposal system. The bill is entitled "An Act Regulating the Waste Disposal System of All Government and Private Hospitals, Medical Centers and Clinics, Prescribing Penalties for Violations thereof and for Other Purposes".

Toxic and hazardous waste programs

Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990. On 26 October 1990, Philippine President Corazon C. Aquino signed into law the act controlling THS and nuclear waste and providing penalties for violations thereof. Specifically, it covers "the importation, manufacture, processing, handling, storage, transportation, sale, distribution, use and disposal of all unregulated chemical substances and mixtures in the Philippines, including the entry, even in mere transit, as well as the keeping or storage and disposal of hazardous and nuclear wastes into the country for whatever purpose." Currently preparing the rules and regulations for its implementation is an interagency committee coordinated by EMB.

Philippine Inventory of Chemicals and Chemical Substances (PICCS). Initially conceptualized as the data bank system for information storage and retrieval of identified toxic chemicals, PICCS will also serve as the repository of information and notifications received by the EMB from international and national organizations like the United Nations Environment Programme (UNEP), World Health Organization (WHO), United States Environment Protection Agency, International Register of Potentially Toxic Chemicals and International Programme on Chemical Safety.

Containing around 4,000 chemicals manufactured in or imported into the country, PICCS is also an important document in preparing the regulations for the Toxic Substances and Hazardous and Nuclear Wastes Control Act.

Training Programs on Hazardous Waste Management. One of the constraints of both government and industrial sectors is the lack of technical know-how in hazardous waste management. The EMB, through the assistance of the US Agency for International Development (USAID), East-West Center, World Environment Center, Carl Duisberg Gesellschaft South East Asia Program Office, WHO and UNEP, has promulgated these training workshops for 1991:

1. overall safety and control of toxic chemicals and hazardous wastes (national level);
2. hazardous waste management for government engineers and industrial technical personnel;
3. pilot programs for the development of a national hazardous waste survey and inventory system;
4. reduction of waste and disposal of metal sludges for the electronics industry; and
5. reduction of waste and management of organic solvents for metal finishing and chemical industries.

Industrial waste program

Industrial Waste Exchange (Philippines) (IWEP). Started in 1987, the IWEP project is expected to reduce environmental impacts from industrial waste disposal through the promotion of waste transfer and utilization between and among firms as a practical alternate to waste management schemes. Also, it aims to generate economic returns on both waste generators and users through savings on disposal costs and raw materials, etc.

As the clearinghouse and link of participating industries, EMB has, thus far, issued four Waste Exchange Bulletins containing a directory of available and wanted waste materials. Around nine actual exchanges have been made, including waste recycling.

Regional Monitoring. The DENR regional offices also conduct regular monitoring of industrial firms and potentially pollutive

activities. Potentially pollutive industries are required under law to have their own pollution control officer to implement their monitoring programs. The regional office, however, validates the regular reports submitted by the company especially if there are pollution complaints.

Examples of special programs are the mercury pollution monitoring program in the gold rush areas of Mindanao and the water quality monitoring and ecological assessment of selected priority bays, which is being done by DENR as part of a major Fisheries Sector Program.

DENR Planned Investment Programs. To support residuals management in industry, DENR has drawn up these programs and projects:

- Toxic Chemicals and Hazardous Waste Management Program;
- Air and Water Quality Monitoring Network;
- Developing Air, Water and Soil Quality Standards;
- Economic Incentives for Pollution Control;
- Pollution Control Technologies and Industrial Efficiency;
- Reduction of Pollution from Toxic Materials Used in Small-Scale Mining; and
- Environmental Impact Assessment (EIA) of Major Mines.

The DENR is also discussing the possibility of a US$100-million environmental sector loan and a US$20-million "brown ecology" or a sustainable urban and industrial environmental management program with the Asian Development Bank and USAID, respectively.

River revival programs

There are two ongoing river revival programs in the country. The first involves the interorganizational Navotas-Malabon-Tullahan-Tenejeros Rivers project: government and nongovernment efforts include actual river cleanup, dredging, closure of pollutive factories and public education. Slum/squatter resettlement or improvement is still being planned.

The second is on the historic Pasig River, the planning and studies of which were supported by the Danish International Development Agency (DANIDA). Recommendations to be implemented include the formation of an interagency Secretariat; cleanup by flushing; slum/squatter management; control of factory pollution; and proper sewage and solid waste management.

The DENR regional offices have already been tasked to identify major rivers requiring rehabilitation in their areas of jurisdiction. The experience and expertise gained from the Navotas-Malabon-Tullahan-Tenejeros Rivers and Pasig River revival programs will be used.

Recent DENR initiatives

The DENR focus has shifted from regulatory to developmental. Conflict resolution processes allow development initiatives to proceed without sacrificing environmental protection. The DENR initiatives include:

- a "Dirty Dozen" program that targets the biggest twelve polluters in each region to maximize limited resources and send the message that DENR is serious in its efforts;
- rigorous implementation of the public hearing process in the EIA system and giving importance to the resolution of community concerns before any Environmental Compliance Certificate (ECC) is given;
- initiating multipartite monitoring, that includes NGOs and community leaders, to later on be set up in a nationwide citizens environmental monitoring network;
- agreements with the National Economic Development Authority (NEDA) as well as major funding institutions that no endorsement will be given to major projects without these going through the EIA system and receiving an ECC;
- setting up an Environmental Guarantee Fund or a sharing of royalties for environmental protection purposes from proceeds of the utilization of natural resources to finance multipartite monitoring, immediate compensation for damages, community environmental projects and later rehabilitation of utilized areas; and

- initiating the institutionalization of an Awareness and Preparedness for Emergencies at the Local Level (APELL) system for industries; a workshop with related government agencies and supporting industrial firms has been held, and piloting of the system with selected firms is ongoing.

NONGOVERNMENTAL INITIATIVES

Waste management is one of the concerns of the nongovernmental sector. Due to lack of funds and technical expertise, however, many NGOs have been content with issuing complaints or leading protests against polluters. Some NGOs, however, have joined the government's systematic monitoring of pollutive industries through multipartite programs which are being expanded. Monitoring is presently being done at the Marcopper mines in Marinduque, Leyte Industrial Development Estate, and Grand Antamok Mines in Benguet. The Nationwide Coalition of Fisherfolk for Aquatic Reforms has agreed to a training of their leaders on pollution monitoring in key fishing grounds all over the country.

With NGOs as part of the overall monitoring system, the Philippines can then easily move into direct community participation for monitoring and regulation in waste management. The actual implementation, however, has not gone beyond public information and recruitment of key leaders.

In the cities, NGOs have been quite active in the solid waste recycling campaigns. They have also naturally handled the public education campaign for proper garbage management. Enterprising NGOs have started "money from garbage" projects to help provide livelihood for the needy. Some are discussing joint efforts with plastic companies for easier recycling of waste plastics.

The IWEP is ongoing for the polluter industry group. Many polluter industries, however, still need to join this program. Some organized themselves into the Voluntary Organizations of Industries for a Cleaner Environment (VOICE) which focuses on environmental education of their own members; improves channels of communication between industries and regulatory agencies, especially DENR; and lobbies for greater incentives for industries that spend for pollution control systems.

Big companies have decided to do it on their own. Benguet Corporation, one of the biggest mining companies, has recently put up its own high-level environmental unit. San Miguel Corporation, another giant of Philippine industry, has invested substantial funds for pollution control of their activities and for environmental projects outside of the company's profit-making businesses. The country's "greening of business" is on its way as the Philippine Chamber of Commerce and Industry makes environment a concern in one of its major committees.

CONSTRAINTS, PROBLEMS AND CONSEQUENCES

Most Filipinos today realize the connection among health, the quality of life and the condition of their environment. There is a growing concern about the increasing environmental degradation and a call for more effective and efficient policies to cope with the problems.

The country, however, has to contend with these constraints:

1. lack of trained and expert government technical staff for hazardous waste;
2. unavailability of monitoring and analytical equipment;
3. polluter industries' lack of knowledge of their hazardous waste or deliberate noncompliance with government restrictions;
4. unavailability of approved treatment facility and disposal sites for hazardous waste;
5. conflict between economic development and environmental protection. The strict requirements of the environmental protection agency sometimes turns investors off. On the other hand, the importers of hazardous materials and waste believe that they are boosting the economy, notwithstanding the serious environmental consequences.

6. the growing "not-in-my-backyard" (NIMBY) syndrome among the people; and
7. lack of public information and the people's negative attitude towards waste management efforts.

The resources needed are enormous. For Metro Manila alone, environmental improvement in the next five years will cost at least US$710 million. An integrated solid waste management program and sewerage projects need US$134.22 and US$128.20 million, respectively over the next five years. For starters, at least US$100 million is needed to support efforts at industrial efficiency, pollution control and waste reduction improvements. Billions of dollars are needed for the proper waste management of all the growth centers in the country.

Delays in the establishment of waste management programs are believed to result in the degradation of the natural resources. Because majority of the people depend directly on these resources, the loss of livelihood spawns resentment that is being translated into violent action.

While there are no quantifying studies yet, many sectors believe that production losses due to illnesses and medical costs are higher due to the deteriorating environment. Other costs redound to activities dependent on the quality of the environment. Tourism, seen as a dollar-earning industry, will be lost unless the trend is reversed.

CONCLUSION

Planning for solid and hazardous waste management should be done in close liaison among the concerned government authorities, industries and communities. Cooperation that generates a very strong political will is needed to attain the objectives of a national waste management policy.

While developing countries like the Philippines may not have the financial resources for modern pollution control facilities, they can resort to solid and hazardous waste management options that focus on waste reduction and recycling processes or on non- and low-waste technologies.

Under present efforts, the situation is one of a close tug-of-war between complex problems and proper policies complemented by increasing concern and effort. Also, the country is rushing both its environmental protection and industrial development efforts. The balancing of these two traditionally conflicting directions requires not only technical expertise but also a restructuring of socio-economic structures, values and attitudes. This is the challenge of waste management in the Philippines.

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Status and Trends of Waste Management in Singapore

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ABSTRACT

Highly urbanized and industrialized Singapore has a relatively small land area that needs properly planned land use and pollution control.

The bulk of solid waste comes from domestic and trade sources. Collection of refuse is done by government and private contractors. Disposal is by sanitary landfill or incineration. Refuse incineration is the most cost-effective method for solid waste disposal in Singapore.

Around 90% of the wastewater is derived from domestic and industrial sources. To control discharges that pollute watercourses, the government has provided an extensive sewerage system. To date, it comprises 2,240 km of sewers, 132 sewage pumping stations and 6 central sewage treatment works (STW). These STW produce sludge which has been used as soil conditioner and topsoil for reclaimed land.

Proper legislation and law enforcement will result in more effective waste management. Future directions include the construction of another incineration plant, development of an offshore disposal site, extension of sewerage infrastructure and rehabilitation of existing sewerage facilities. A compact-cum-covered STW design will be also adopted.

BACKGROUND

Singapore consists of the island of Singapore and some 58 islets within its territorial waters. The main island is about 42 km long and 23 km wide, covering an area of 573.1 km^2. Its coastline is 137.7 km. The total land area, including the islets, is 625.6 km^2.

Singapore has a relatively uniform temperature, high humidity and abundant rainfall due to the marine exposure of the island and its proximity to the equator. The average daily temperature is 26.6 °C and the average daily relative humidity is 84.5%. The mean annual rainfall is 2,369 mm (MOCI 1989).

Population

Singapore's 1990 population is 3 million. Rising standards of living, health and hygiene have reduced the infant mortality rate from 82.2 per 1,000 live births in 1950, 34.9 in 1960, 20.5 in 1970, 11.7 in 1980, to 7 in 1988.

The national life expectancy has also increased from 62.5 years in 1957, 67.3 years in 1970 to 71.2 years in 1980. The population growth rate was 1.7 % in 1970, 1.2 % in 1978 and 1.5% in 1988.

Singapore's ultimate population is expected to reach 4 million (MOCI 1989).

Table 1. Employed persons by occupation.

Occupation	Employed persons (thousands)	%
Professional and technical workers	142.8	11.5
Administrative, managerial and executive workers	86.3	7.0
Clerical and related workers	190.7	15.4
Sales workers	152.2	12.3
Services workers	163.8	13.2
Production and related workers	446.1	36.0
Not classifiable	56.6	4.6
Total	1,238.5	100.0

Table 2. Employed persons by gross monthly income.

Gross monthly income (S$)	Employed persons (thousands)	%
Under 200	40.5	3.3
200-399	134.8	11.1
400-599	296.1	24.3
600-799	225.9	18.6
800-999	136.3	11.2
1,000-1,499	181.6	14.9
1,500 and over	201.6	16.6
Total	1,216.8[a]	100.0

[a]Excluding unpaid family workers.

Employment data

In June 1988, Singapore's population aged 15 and over totalled 2,037,200. Of this, 1,281,400 (62.9%) made up the total labor force. The unemployment rate was 3.3%.

Of the 1,238,500 employed, there were 1,057,400 employees, 61,000 employers, 98,400 own-account workers and 21,700 unpaid family workers. Majority worked in the manufacturing (352,600); commerce (283,600); community, social and personal services (271,600); and transport, storage and communications (120,200) sectors.

Tables 1 and 2 show the distribution of employed persons by occupation and gross monthly income, respectively.

The per capita indigenous Gross National Product in 1988 was S$15,999 (MOCI 1989).[1]

[1]1988: S$1.95 = US$1.00.

Land use

Land use in highly urbanized and industrialized Singapore is for housing, industrial, commercial, agricultural and recreational purposes as well as for water catchments (Table 3). Its relatively small land area makes proper management and pollution control necessary.

Housing and Industry. About 48.6% (304.2 km^2) of the land is taken up by housing and industry. The Housing and Development Board (HDB), the public housing authority, is the biggest housing developer in Singapore. By 1988, HDB had developed 95 new town and housing estates, and succeeded in housing 87% of the population in Singapore (Fig. 1). The remaining 13% live in private housing.

The largest industrial estate is the Jurong Industrial Estate at the western part of Singapore. Smaller industrial estates are scattered across the country (Fig. 2).

Table 3. Land use in Singapore.

Land use	Area (km²)	%
Built-up areas (housing and industrial)	304.2	48.6
Farmholding areas (of licensed farms, excluding pure rubber and coconut plantations)	20.4	3.3
Forest	28.6	4.6
Marsh and tidal waste	15.7	2.5
Others (inland waters, open spaces, public gardens, cemeteries, nonbuilt-up areas in military establishments, quarries, rubber and coconut plantations and unused land)	256.7	41.0
Total land area (main island and offshore islets)	625.6	100.0

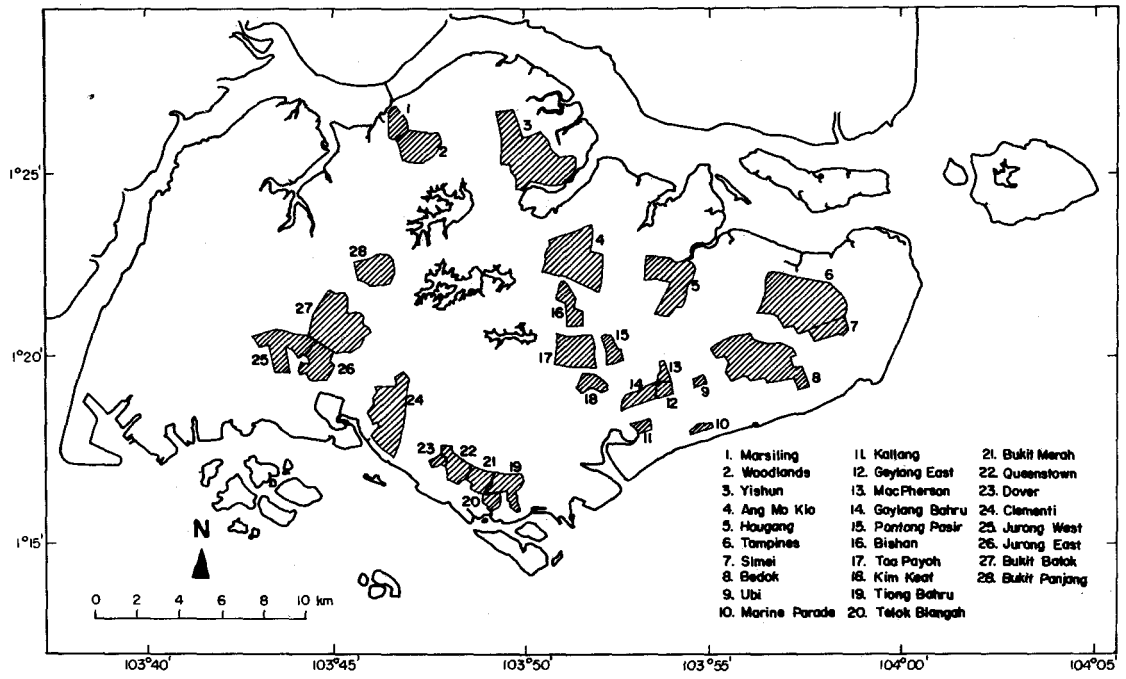

Fig. 1. Major housing estates in Singapore.

The major manufacturing industries in Singapore are: electronic, electrical, machinery and fabricated metal products, transport equipment, printing and publishing, wearing apparel, and petroleum industries.

The industrial estates have 3,900 factories employing 230,000 workers. Their gross fixed assets amount to S$18 billion.

Farmland and Other Uses. Farmland occupies only about 3% of the total land area. But the farming sector has been a steady and substantial source of essential fresh farm produce such as poultry, eggs, vegetables and fish. In 1988, 2,076 licensed farms, occupying 2,036 ha, produced an estimated S$361-million worth of farm produce.

Forest, marsh and tidal wasteland occupy about 7% of the land. Inland waters, open spaces, public gardens, cemeteries, quarries and unused land comprise the rest (41%) (MOCI 1989).

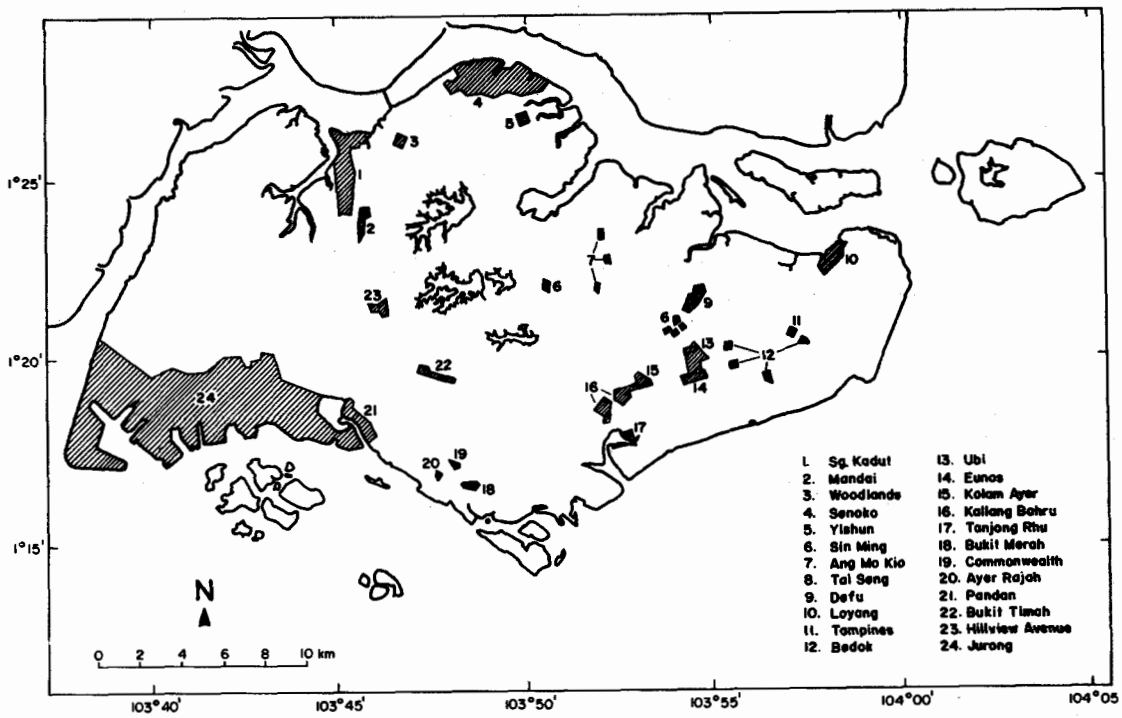

Fig. 2. Industrial estates in Singapore.

STATUS OF WASTE MANAGEMENT SYSTEMS

Solid waste

Sources of Refuse. In Singapore, refuse has three categories: (1) domestic and trade refuse; (2) industrial refuse; and (3) institutional refuse.

The bulk of refuse comes from domestic and trade sources, i.e., households, markets, food centers, hotels, restaurants, shops, etc. From 1980 to 1990, the average daily refuse volume increased 64%, from 1,721 t/day to 2,824 t/day with per capita volumes of 0.718 kg/capita/day and 1.023 kg/capita/day in 1980 and 1990, respectively.

Industrial refuse or solid waste generated by industries has increased about 4.7 times, from 546 t/day in 1980 to 2,554 t/day in 1990 (Low 1991).

Institutional refuse is generated by government and statutory board installations, hospitals, schools, recreational and other public development facilities. Its average volume was 305 t/day in 1980 and 318 t/day in 1990.

Quantity of Refuse. In 1970, the average total refuse generation was 1,278 t/day which increased to 2,572 t/day in 1980 and 5,696 t/day in 1990 (Fig. 3). The rapid population, industrial and economic growth as well as the rising standard of living have doubled the refuse volume over each decade (Low 1991).

By the year 2010, refuse volume is projected at 7,500 t/day as the high rate of economic growth cannot be expected to continue.

Quality of Refuse. About 85% of the refuse generated is combustible. However, its composition and calorific value varies substantially, depending on the source of generation and the period of the year (i.e., wet or dry season) (Table 4). The refuse comprises an assortment of furniture, scrap metals, plastic bags, food, packaging, tires, glassware, textile, etc. (Table 5). Some items such as rubber, paper, wood and plastics are highly combustible while iron, sand and glass are not.

Refuse Collection System. Refuse collection is carried out by government and private waste contractors. The government provides

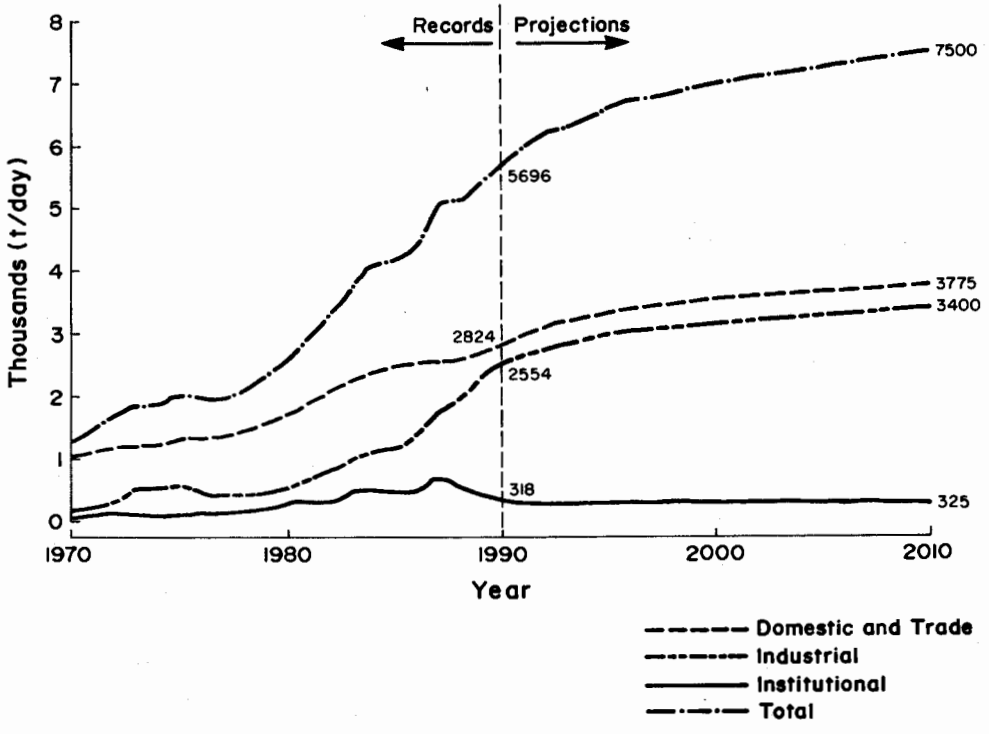

Fig. 3. Total daily refuse generation in Singapore, 1970-2010.

Table 4. Properties of refuse in Singapore.

Properties	Range
Net calorific value (kJ/kg)	4,000-9,000
Water content (% by weight)	40-65
Incombustible (% by weight)	7.5-22.5

Source: Low (1991).

Table 5. Refuse composition in Singapore.

Constituents	% by weight
Fruits, vegetables, garden and food waste	44.4
Paper, cardboard and wood	28.3
Plastics	11.8
Textile, leather and rubber	3.0
Metals	4.8
Glass	4.1
Ceramics	1.6
Residue	2.0

Source: Low (1991).

daily collection service to domestic households and trade premises while the private waste contractors collect refuse from mainly industrial premises, commercial and shopping complexes, and construction sites.

In private housing estates and shophouses, the refuse collection crew travels from premises to premises, emptying refuse from individual bins into the vehicles. Direct collection is unproductive because it is labor-intensive and time-consuming.

In high-rise apartment blocks, shopping and commercial complexes, markets, food centers, condominiums and flatted factories, refuse is collected, conveyed and stored in bin centers. The collection crew then removes the refuse from the bin centers to disposal sites. This indirect collection method is more efficient as refuse from many sources is collected from one location. Another set of workers, however, is needed to collect refuse from individual premises or blocks of premises to the bin centers, resulting in double-handling of refuse.

For refuse collection from domestic households and trade premises, the government operates a fleet of 209 collection vehicles fitted with compaction and hydraulically operated bin-lifting devices. Their capacity varies from 1.5 to 7 t. The fleet composition is:

Vehicle capacity	Number of collection vehicles
1.5 t	9
4.0 t	35
7.0 t	165
Total	209

The government provides both direct and indirect refuse collection services. Routes where both services are applied are known as mixed collection routes.

In 1990, private waste contractors removed and disposed of 2,554 t/day of refuse or 45% of the total refuse volume of 5,696 t/day (Low 1991).

Refuse Disposal Systems

Refuse incineration plants. The Ministry of the Environment (ENV) operates two incineration plants at Ulu Pandan and Tuas with a combined refuse capacity of 3,600 t/day (Fig. 4).

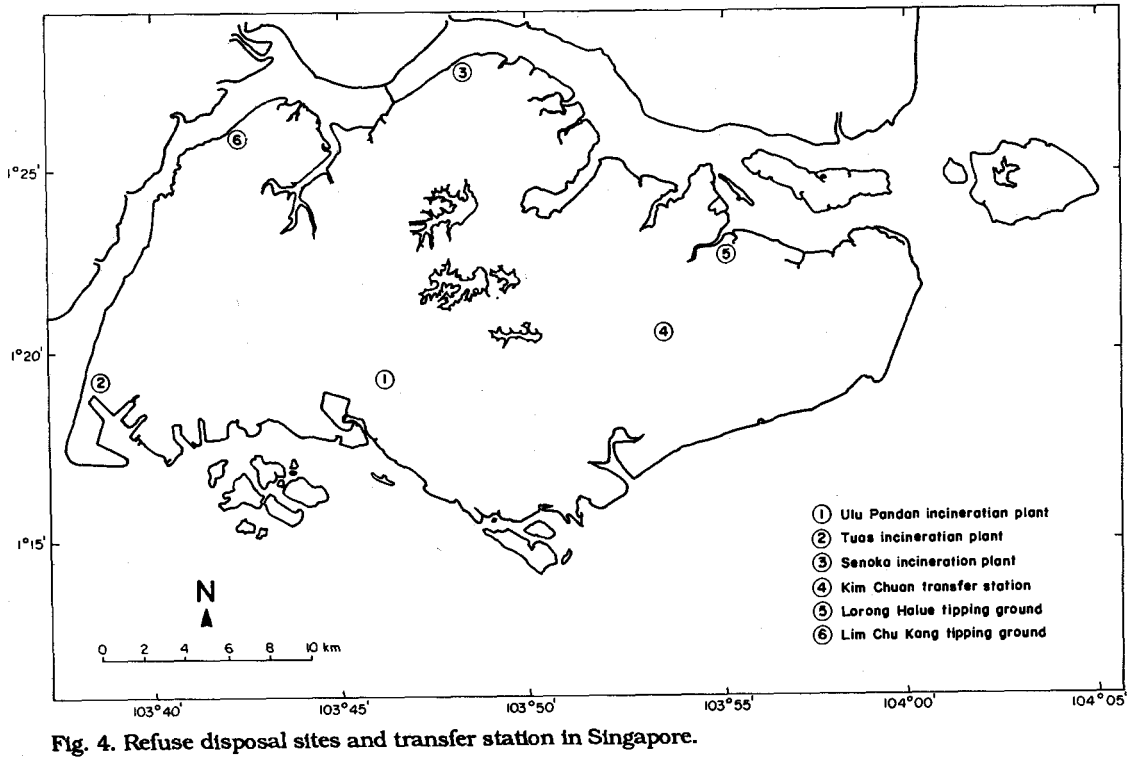

Fig. 4. Refuse disposal sites and transfer station in Singapore.

1. The Ulu Pandan Refuse Incineration Plant, which was built in 1979, has a rated capacity of 1,600 t/day. In 1990, it incinerated 488,742 t which amounted to 23% of the total refuse generated in Singapore.

   The plant also generated 85.4 million kwh of electricity in 1990, 20.7 million kwh of which were consumed by the plant. The surplus electricity of 64.7 million kwh were sold. Altogether, 6,237 t of scrap metal were recovered and sold.

   The average dust concentration in the flue gas disposed to the atmosphere via a 150-m high chimney was 24.3 mg/Nm^3, well within the limit of 200 mg/Nm^3 stipulated in the Clean Air Act. A total of 84,863 t of incineration ash was disposed of at the sanitary landfill at Lim Chu Kang.

2. The Tuas Incineration Plant (TIP), which was constructed in 1986, has a rated capacity of 2,000 t/day. In 1990, it incinerated 699,994 t which represented 34% of the total refuse generated in Singapore.

   The plant generated 230.6 million kwh of electricity, 54.4 million kwh of which were used for plant operation. The surplus of 176.2 million kwh were sold. About 12,112 t of scrap metal were recovered and sold.

   The average dust concentration in the flue gas was 28 mg/Nm^3, well within the Clean Air Act limits. Incineration ash amounting to 116,414 t was disposed of at the sanitary landfill site at Lim Chu Kang.

3. The Kim Chuan Transfer Station, which was built in 1986, has a capacity of 1,500 t/day (Fig. 4). The refuse unloaded at this station is brought by collection vehicles from the eastern half of Singapore. Refuse is then compacted into 20-t container-trailers, which travel across the island to TIP in the west for refuse disposal.

   This station improves the efficiency of collection vehicles servicing the eastern part of Singapore as well as the overall collection productivity. With the use of large container-trailers, there is no need for more collection vehicles or manpower.

   In 1990, the station handled a refuse average of 1,430 t/day. Its fleet of 40 prime movers and 60 container-trailers averaged 69 trips/day (Low 1991).

Sanitary landfill. In 1990, a total of 890,379 t of refuse was disposed of at the two sanitary landfills, Lorong Halus and Lim Chu Kang Tipping Grounds (Fig. 4). This represents about 43% of the total refuse generated in Singapore.

Refuse is weighed before being discharged at the landfills. A covering of approximately 150 mm of earth is placed over each day's layer of tipped refuse to prevent public health hazards like scavenging and fly breeding (Low 1991).

Costs and Revenue. The capital costs (S$ million) for the construction of the various refuse installations are (ESD-ENV 1990):

Ulu Pandan Incineration Plant	130
Tuas Incineration Plant	200
Kim Chuan Transfer Station	30
Lorong Halus Tipping Ground	32

Operation costs (including manpower, depreciation and other costs) per ton of refuse in 1989 are:[2]

Refuse collection	27.63
Disposal at landfills	3.43
Disposal by incineration	24.83

Solid waste revenue comes mainly from fees charged to households and trade premises, and sales of surplus electricity and scrap metal recovered from the refuse. For example, in 1989, the total revenue was S$84.17 million, the breakdown of which is:

Refuse collection fee	59.73
Disposal fee at landfills	8.74
Disposal fee at incineration plants	3.39
Sales of electricity	10.93
Sales of scrap metal	1.38
Total	84.17

[2] 1989: S$1.89 = US$1.00.

Liquid waste

Sources of Wastewater. The three main sources of wastewater in Singapore are domestic, industrial and farm waste.

Domestic wastewater comprises mainly sewage and sullage water generated by human activities such as cooking and washing. It comes from households, food centers and commercial premises such as hotels, restaurants, shops, etc. It consists mainly of organic matter in solution or suspension, and other substances including silt, grit, salts and microorganisms.

Industrial wastewater is effluent generated by the factories in their manufacturing processes. Effluent content depends on the raw materials and other chemicals used in the manufacturing processes. It may contain large amounts of organic matter as well as nonbiodegradable and toxic materials such as heavy metals, acids and other corrosive chemicals and synthetic organic compounds. It may also contain volatile and flammable chemicals which could be fire and explosion hazards.

In the past, the major sources of farm waste used to be pig and poultry farms. To minimize pollution in watercourses, cesspits for waste treatment were installed in pig farms. About 60% of the biological oxygen demand (BOD) and suspended solids (SS) were removed from the wastewater. The solids that accumulated in the cesspits were taken to STW at regular intervals for further treatment. Moreover, the government decided to phase out pig farming in 1985. In 1990, this was successfully completed.

To control waste from poultry farms, farmers were required to rear poultry in covered sheds and remove dung in solid form. Poultry rearing in batteries makes for simple and effective collection and disposal of pollution loads. The amount of waste that finds its way into the drain is insignificant.

Quantity of Wastewater. Population growth and rapid industrialization programs have increased wastewater quantity substantially over the years. In 1950, water consumption was 52 million m^3. In 1980 and 1989, this increased to 215 and 305 million m^3, respectively.

The approximate breakdown of water consumption in 1989 (PUB 1989) is:

Sector	Water consumption (million m^3)	%
Residential	160	52.5
Industrial/commercial, etc.	115	37.7
Others	30	9.8

Clearly, about 90% of the wastewater generated comes from domestic and industrial sources. To control wastewater discharge and prevent watercourse pollution, the government has provided an extensive sewerage system to ensure that all wastewater is collected and treated before final discharge into the sea. Table 6 shows the total volume of wastewater collected and treated yearly from 1985 to 1990. The total volume of wastewater to be collected and treated is expected to reach 620 million m^3 by the year 2025.

Table 6. Total volume (in million m^3) of treated wastewater, 1985-1990.

Year	Volume
1985	244
1986	258
1987	283
1988	301
1989	318
1990	320

Source: SD-ENV (1990).

Sewerage Infrastructure. Over the last two decades, the government has invested heavily in constructing and extending sewerage infrastructure. To date, the sewerage network comprises 2,240 km of sewers, 132 sewage pumping stations and 6 central STW.

These STW, which provide secondary wastewater treatment, have a total capacity of 955,000 m^3/day (Table 7 and Fig. 5). Using an activated sludge process, wastewater is treated to the Royal Commission Standard of 20:30 (BOD:SS) before it is discharged to the sea. The process removes 90-95% of BOD and SS. In 1990, these STW treated a total daily average flow of 877,000 m^3. The quality of wastewater received at the works is shown in Table 8.

All new developments in Singapore are required to have modern sanitation, i.e., these are to be connected to the public sewer

Table 7. Treatment capacity of STW.

STW	Year commissioned	Capacity (m^3/day)
Kim Chuan	1948	256,000
Ulu Pandan	1961	286,000
Bedok	1979	116,000
Kranji	1980	76,000
Seletar	1981	57,000
Jurong	1981	164,000
Total		955,000

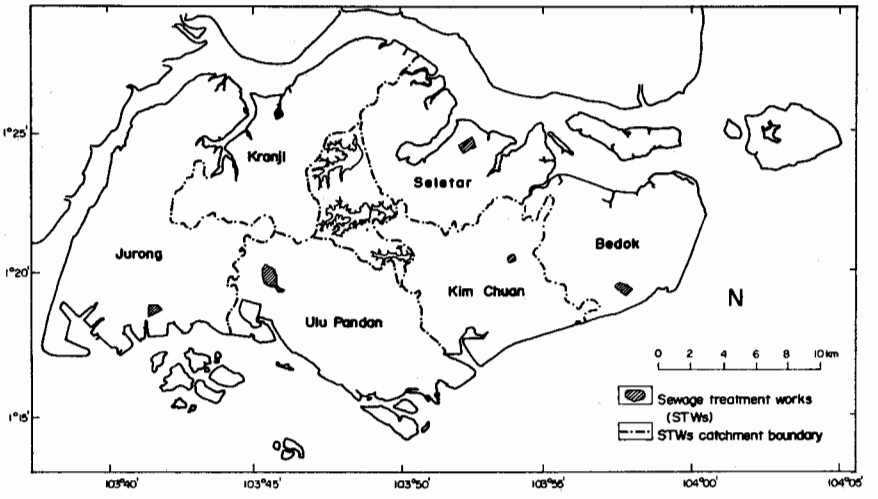

Fig. 5. The STWs and the catchments.

Table 8. Range of analytical results of wastewater before and after treatment in 1990.

Parameters	Crude sewage	Final effluent
Solids		
Total	580-2,180	350-1,000
Suspended	210-670	20-30
Oxygen demand		
BOD_5 (20°C)	250-560	16-20
COD	550-1,160	60-126
Nitrogen		
NH^3-N	18-54	15-31
TKN	25-82	16-42
Cl	76-450	71-450
pH	6.8-7.3	6.8-7.7
Total alkalinity (as $CaCo_3$)	170-300	130-210
Total PO^-_4 (as P)	3.1-9.7	1.3-3.3
Detergent (as LAS)	2.6-8.2	0.3-2.9
Oil and grease	32-66	3.5-6.6
Color (as HU)	-	20-70

Source: SD-ENV (1990).
All results are expressed in mg/l except pH and color.
COD - chemical oxygen demand.
TKN - total Kjeldahl nitrogen.
HU - Hazen unit.

where it is available or the developers themselves provide sewage treatment plants. Composed of a primary settling tank and a biological or trickling filter, a treatment plant has a capacity varying from 10 to 5,000 persons. In 1990, the government maintained 526 sewage treatment plants serving an estimated population of 85,000. These plants will be diverted to the public sewer when it becomes economical for the government to extend the public sewerage schemes to their areas.

Today, almost 100% of the population in Singapore enjoys modern sanitation compared with 75% in 1980 and 51% in 1970.

Industries that discharge their wastewater into the sewerage network are required to ensure that the quality of the industrial wastewater complies with the stipulated limits listed under the Trade Effluent Regulations of 1976. Otherwise, they have to install treatment plants at their factories to pretreat effluents before discharging them into the sewer.

Sludge Disposal. The STW produce sludge that is used as a soil conditioner for landscaping and tree planting. In the 1970s and early 1980s, the sludge demand was so high it exceeded production. Towards the mid-1980s, however, the demand dropped. At the same time, production climbed from 110,000 t in 1985 to 180,000 t in 1990. This resulted in a growing surplus.

In 1984, disposal options for the sludge surplus were reviewed. One solution was the use of sludge as the topsoil of reclaimed lands which were not yet marked for development. This was done by removing the top layer of the reclaimed land, then spreading a thin layer of sludge and finally covering the sludge with the excavated top layer. As many land reclamation projects were in progress then, this method was found to be the most economical and practical in the short term. Since 1985, 350,000 t of surplus sludge have been disposed of in this manner (Fig. 6).

Water Reclamation. In the 1960s, it was recognized that the increasing domestic and industrial demand for water would strain Singapore's limited water resources. The Jurong Industrial Water Works (JIWW) was therefore constructed in 1966 to reclaim water from sewage effluent. It supplied low-grade water to meet industry's demand for such purposes as washing and cooling.

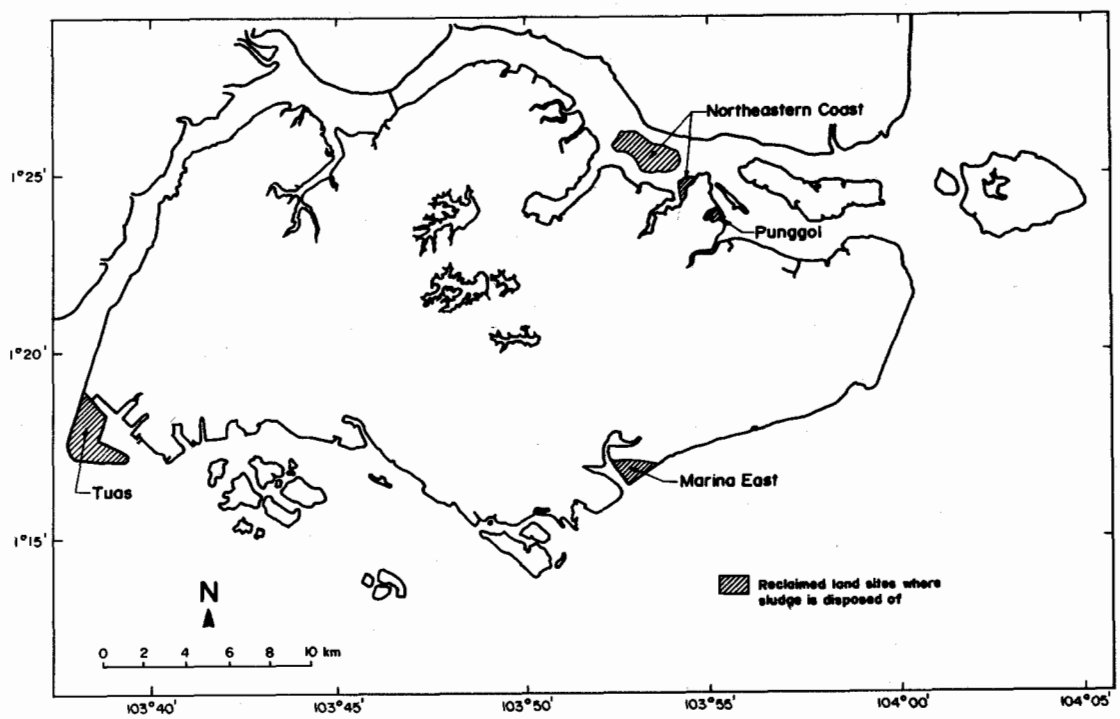

Fig. 6. Reclaimed land for sludge disposal in Singapore.

The JIWW treats the effluent from the nearby Ulu Pandan STW by chemical coagulation and sand filtration before distributing the industrial water to factories in Jurong Industrial Estate. Industries using industrial water include paper, textile and steel mills; chemical plants, shipyards and a petroleum refinery. The quality of industrial water is given in Table 9.

The industrial water is currently supplied to industries at a charge of 28 cents/m^3, about one-fourth the charge for use of potable water at S$1.10/$m^3$.[3]

The JIWW is currently being expanded to increase its production capacity from 45,000 m^3/day to 65,000 m^3/day.

Capital and Recurrent Expenditure. The construction of sewerage infrastructure requires heavy capital investment. The government invested about S$1.8 billion to keep pace with the rapid housing and industrial developments over the past two decades. About S$72 million was spent in 1990, excluding the sewer construction costs of HDB for their housing estates.[4]

In 1990, the recurrent expenditure in liquid waste management amounted to S$76 million, including manpower and other operating costs, and depreciation of fixed assets.

The capital and recurrent expenditures incurred by the government for 1986-1990 is shown in Table 10.

In 1990, the operating costs (S$) per 1,000 m^3 of sewage are:

	Before depreciation	After depreciation
Sewage treatment	84	134
Collection and treatment	153	239

Revenue. The main sources of liquid waste revenue are the Sanitary Appliances Fee and the Waterborne Sewage Removal Fee. A fee of S$3.00 per sanitary fitting per month is charged to premises connected to the sewerage system. The Waterborne Fee is pegged against water consumption. A fee of 10 and 22 cents/m^3 of water consumed is charged on top of the water bills to domestic and industrial premises, respectively. Table 11 shows the revenue collected for 1986-1990.

[3]15 October 1991: S$1.70 = US$1.00.
[4]1990: S$1.75 = US$1.00.

Table 9. Quality of industrial water.

Color (HU)	7-11
Turbidity (NTU)	1-3
BOD^5 (20 °C)	less than 5
COD	21-41
Dissolved oxygen	3.9-6.5
Free ammonia (as N)	9-17
TKN	11-19
Nitrite nitrogen (as N)	0.1-0.4
Nitrate nitrogen (as N)	5-9
pH	6.5-7.1
SS	less than 5
Total solids	370-1,200
Chloride (as Cl)	170-430
Total hardness (as $CaCo_3$)	95-250
Sulfate (as SO_4^{2-})	60-180
Detergent (as LAS)	0.1-0.3
Phosphate (as P)	1-4
Alkalinity (as $CaCo_3$)	70-120

All values are expressed in mg/l except color, turbidity and pH.
NTU - Nephelometric turbidity unit.

Table 10. Capital and recurrent expenditures, 1986-1990.

Expenditure (S$ million)	Year 1986	1987	1988	1989	1990
Capital	94	79	74	60	72
Recurrent	68	67	69	74	76

Source: SD-ENV (1990).

Table 11. Revenue collection (S$ million), 1986-1990.

Year	Revenue
1986[a]	94
1987[b]	97
1988	103
1989	110
1990	112

Source: SD-ENV (1990).
[a]S$ 2.15 = US$1.00
[b]S$ 2.18 = US$1.00

The breakdown of the 1990 total revenue of about S$112 million is: Sanitary Appliances Fee, S$58.39 million; Waterborne Sewage Removal Fee, S$47.72 million; and others, S$6.38 million.

LEGISLATION AND CONTROL

Legislation

In the 1970s and 1980s, the legislation to protect and improve the environment included those for pollution control:

- Water Pollution Control and Drainage Act, Chapter 348;
- Trade Effluent Regulations (1976);
- Trade Effluent (Amendment) Regulations (1977);
- Poisons Act, Chapter 234;
- Poisons (Hazardous Substances) Rules (1986);
- Environmental Public Health Act (1987); and
- Prevention of Pollution of the Sea Act (1971).

The Water Pollution Control and Drainage Act, Chapter 348, empowers the director of Water Pollution Control and Drainage to control the wastewater discharge from domestic, industrial, agricultural and other premises. All wastewater is to be discharged into the public sewer where it is available. The act provides for severe penalty and punishment for offenses that result in serious water pollution. A subsequent offense of discharging a toxic substance into the inland water is punishable by a mandatory jail sentence of at least a month and a fine not exceeding S$20,000.

The Trade Effluent Regulations (1976) stipulate the discharge limits of trade effluents into the public sewer and watercourses. The Trade Effluent (Amendment) Regulations (1977) were passed to allow the discharge of trade effluents which exceed the stipulated limits of biodegradable pollutants as measured by BOD and SS. Industries can discharge into the public sewer on payment of a tariff or treat their biodegradable waste.

The Poisons (Hazardous Substances) Rules (1986) control the storage, transport and use of hazardous chemicals. The Poisons Act, Chapter 234, lists the hazardous chemicals which require a license for their importation.

The Environmental Public Health Act (1987) and subsidiary regulations provide for the control and disposal of toxic wastes.

The Prevention of Pollution of the Sea Act (1971) covers marine pollution from ships at sea.

Control and enforcement

The most effective pollution control measure is proper planning. Planning Control ensures that new developments and their activities are environmentally compatible with the surrounding land use. Specifically, it keeps out pollutive activities from sensitive areas such as water catchments.

Although the government encourages industrial developments in Singapore, activities which pose serious environmental hazards are not permitted. Also, wherever possible, all factories are sited in areas where public sewers are available so that the trade effluent, after pretreatment if necessary, is discharged to sewers to minimize pollution.

Nearly 50% of the land area in Singapore is used as water catchments for potable water supply as well as agricultural, residential and even industrial uses. Planning Control ensures that industries that use or store large quantities of chemicals or produce large amounts of toxic waste are not sited within these unprotected catchments. This will minimize the risk of contamination of the water resources during an accidental discharge of chemicals or toxic wastes.

Technical requirements on pollution control are incorporated into the planning and design of a building or plant when building plans are submitted for approval. Enforcement officers inspect the completed development to ensure that the requirements are complied with. Regular inspections of industrial and trade premises are also carried out to ensure that pollution control facilities are properly maintained and operated. Such inspections deter indiscriminate wastewater discharge into watercourses; violators are prosecuted.

In spite of the heavy penalty, littering is still a problem in Singapore. Further efforts in public education are being made to solve it. Engineering measures like the slabbing over of drains, installation of drain gratings, mechanical canal screening and deployment of float booms to trap and remove litter have also been implemented to prevent refuse from getting into the sea. Refuse that enter the estuary of the river would then have to be removed by workboats known as water witches.

FUTURE PLANS AND DIRECTIONS

Solid waste

Before 1979, solid waste was disposed of mainly by sanitary landfill, a relatively simple but land-intensive method. As land is scarce in Singapore, alternative methods such as composting, pulverization, high-density compaction and incineration were studied in the early 1970s. Refuse incineration, which reduces volume by as much as 90%, was found to be the most cost-effective. The government's solid waste management strategy is, therefore, to incinerate all incinerable wastes.

The first incineration plant at Ulu Pandan was constructed in 1979, followed by TIP in 1989. These plants are incinerating about 57% of the refuse generated each day. A third plant, with a capacity of 2,400 t/day, is being constructed at Senoko and is expected to be operational by 1992. Its completion will give Singapore a total incineration capacity of 6,000 t/day, which will enable the government to incinerate all incinerable refuse till the turn of the century. By 2025, a fourth plant may be necessary.

Phase IV of the Lorong Halus Tipping Ground has recently been constructed. To prevent leachate from polluting the coastal water, impermeable liners have been installed. A leachate treatment system will also be constructed.

The landfills at Lorong Halus and Lim Chu Kang will be able to cope with the nonincinerable refuse and incineration ash till 1997. Expected to be operational in 1997-1998 is a 350-ha offshore sanitary landfill being developed east of Pulau Semakau. Costing over S$600 million, it will be able to meet Singapore's disposal needs beyond 2025.

To reduce the demand for landfill space and incineration capacity, the government has exerted more effort to educate the public on reducing waste through resource recycling. A pilot waste recycling project covering three housing estates was recently introduced. Residents were encouraged to divert certain readily recyclable materials from the waste stream. Recycling will be extended to cover more households and workplaces. Reuse of materials which would otherwise be discarded will help to moderate the rise in waste disposal cost and conserve natural resources. The government will also encourage industries to minimize waste at source.

Liquid waste

In the 1970s and 1980s, the government embarked on an accelerated sewerage development program to provide basic sewerage infrastructure to the population and industries. Today, almost 100% of the population enjoys modern sanitation.

The provision of sewerage infrastructure in Singapore started in the 1910s. The old sewers will progressively require rehabilitation to cut down inflow and infiltration, prevent structural failure, and ensure the adequacy and reliability of the sewerage network. Also, the older sewage treatment works will require phased reconstruction when they reach the end of their economic lives. The sewerage network will continue to be extended to serve new public and private developments.

Sludge disposal on reclaimed land is an economical short-term solution, currently costing the government only about S$6 per ton. It is unlikely, however, that this method can be used beyond 1997. Thereafter, offshore disposal at the new sanitary landfill to be developed at Pulau Semakau will become necessary. Eventually, however, sludge incineration will have to be adopted.

The STW will also be expanded to cope with the projected flow increase from 320 million m^3 in 1990 to 620 million m^3 in 2025. The STW have a conventional design, i.e., open tanks sprawled over a large area. The government is now looking into the proposal to adopt the compact-cum-covered STW design. This requires less land since the treatment units are rectangular and are compactly laid out to facilitate covering up which would contain the foul air to be extracted for treatment.

These ongoing and long-term programs will cover the period beyond the year 2025. An estimated S$1.5 billion will be needed to implement these over the next ten years.

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Problems and Trends of Waste Management in Thailand

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ABSTRACT

Water pollution and solid waste disposal are the most serious environmental problems of Thailand. Many canals and rivers, especially those near large settlements, are heavily polluted because they serve as sinks of domestic and industrial wastewater. Only 4,200 t of the 5,000 t/day of solid waste in Bangkok are collected and disposed of. The rest is left in areas inaccessible to collection trucks or thrown into canals and rivers.

To solve existing problems and prevent new ones, water resources have to be protected. Measures include (1) laws on pollution control and development planning; (2) a pollution monitoring system; (3) reduced pollution loads; (4) government and private investment in pollution prevention and control; and (5) public awareness and participation. Also, water quality standards have been established, and duty fees reduced for antipollution equipment.

INTRODUCTION

One of the ASEAN member-countries, Thailand has a total land area of 513,115 km^2 and a population of nearly 60 million. Its unique geographical terrain is rich in natural resources, including a 2,614-km coastline and natural rivers and canals

Rapid population growth and industrialization, however, have brought about resource degradation and a declining environmental quality. Water pollution and solid waste disposal are the most serious environmental problems of the country. Many rivers are contaminated with untreated wastewater from factories and large settlements such as Bangkok, Chiang Mai and Khon Kaen as well as chemicals from fertilizers and pesticides used on commodity crops. In many regions of the country, both the surface- and groundwater are contaminated with toxic substances such as heavy metals.

The solid waste problem is becoming acute. In Bangkok, for example, more than 6 million people generate 5,000 t of refuse each day, only 4,200 t of which are collected. The rest is left in areas inaccessible to collection trucks or thrown into canals and rivers.

These problems will definitely pose a threat to the economy of Thailand unless adequate planning is done and appropriate technology and strict control measures are applied.

WATER POLLUTION AND SOLID WASTE PROBLEMS

Water pollution

In Thailand, surface waters include rivers, oceans, lakes, ponds and reservoirs. Four

major rivers, namely, Chao Phraya, Tha Chin, Mae Klong and Bangpakong, discharge into the Gulf of Thailand. The other rivers discharge into other bays (Table 1).

An extensive monitoring program undertaken by various agencies such as the Office of the National Environment Board (ONEB), Department of Public Health and Department of Public Works, concluded that many canals and rivers, especially those near large settlements, are heavily polluted.

Most of the natural waterways serve as sinks of domestic and industrial wastewater. A study of the Bangkok Metropolitan Area (BMA) estimated the quantity of domestic and industrial organic waste reaching the lower Chao Phraya River at 76% and 24%, respectively. Table 2 and Fig. 1 show the biological oxygen demand (BOD) load from the major coastal zones of Thailand: central basin, eastern seaboard, eastern south and western south. The central basin contributes the highest BOD load with 34,376 t/year, of which 29,033 t/year are from domestic sources and 5,343 t/year are industrial.

Table 1. The major rivers of Thailand and their sinks.

River	Sink
Chao Phraya	Gulf of Thailand
Tha Chin	Gulf of Thailand
Mae Klong	Gulf of Thailand
Bangpakong	Gulf of Thailand
Chi	Mae Kong River
Moon	Mae Kong River
Tapi-Phum Duang	Ban Don Bay
Phangnga	Phangnga Bay

Table 2. The BOD load from the major coastal zones of Thailand in 1986.

Zone	BOD load (t/year)		
	Industrial	Domestic	Total
Central basin	5,343	29,033	34,376
Eastern seaboard	-	1,207	1,207
Eastern south	208	451	659
Western south	-	1,384	1,384

Solid waste

According to an ONEB survey, the overall average waste generation rate is 0.66 kg/capita/day. Individual community rates range from 0.40 to 0.56 kg/capita/day for regional cities. Table 3 shows the estimated generation rates formulated by the Regional City Development Project.

The vegetable/putrescible waste and paper make up the largest and second largest portions of sample weight, respectively. Moisture content is about 55% of the total wet weight, with little difference observed between dry and wet seasons.

The most common waste disposal method in the cities is open dumping. Typically, waste is burned on-site during the dry season to reduce volume and control vectors. During the rainy season, insecticide is sprayed on-site. Three disposal facilities with a combined capacity of 5.7 million m^3 operate in Bangkok.

The solid waste collection system in Thailand is inefficient because it is inadequate. Uncollected garbage is an eyesore and a public health hazard. In addition, garbage dumped in natural waterways and leachate from open dumps cause water pollution.

POLLUTION CONTROL POLICY AND MEASURES

Water pollution policy and programs

There is no clear policy or programs to control water pollution in Thailand. The Sixth National Plan (1986-1990), however, recognized the need for the treatment of wastewater from communities and a master plan to control water pollution and maintain urban development.

For water pollution, 13 activities and 11 projects under 5 main categories, namely studies and research, improvement of laws and regulations, investment, administration, and monitoring, were identified. These cost 102 million baht.[1]

In October 1989, the Prime Minister appointed an ad hoc committee to prepare the policy and guidelines on water, air and noise pollution. The committee was chaired

[1] 1989: 25.70 baht = US$1.00.

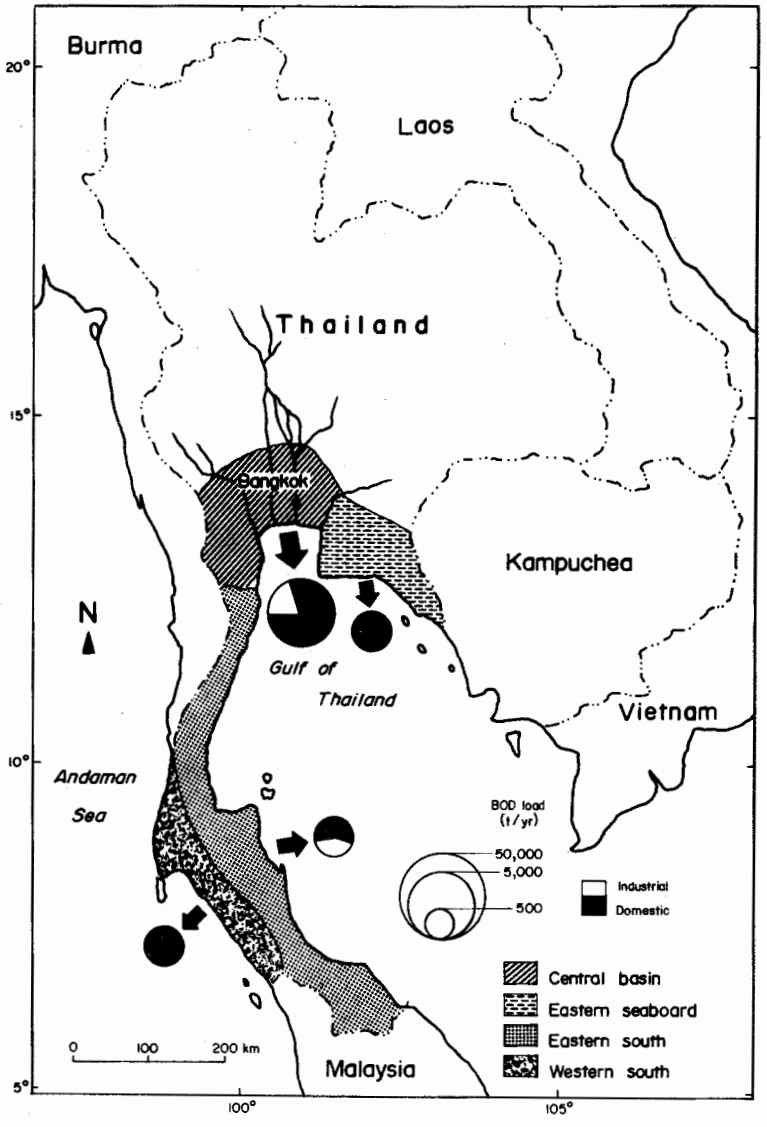

Fig. 1. The major coastal zones of Thailand and their BOD loads in 1986.

Table 3. The solid waste generation rates of major cities.

City	Area (km^2)	Population	Service coverage (%)	Daily waste quantity (t)	Generation rate (kg/capita/day)
Bangkok	1,568.74	5,559,600	83.8	5,003.6	0.89
Surat Thani	3.63	40,240	79.7	32.99	0.82
Hat Yai	15.96	140,250	86.6	168.3	1.20
Chonburi	4.57	45,024	91.5	50.88	1.13
Ratchaburi	7.97	45,959	66.36	56.10	1.22
Phitsanulok	17.39	70,502	65.80	84.15	1.19
Udon Thani	8.73	80,523	79.34	78.11	0.97
Phuket	11.66	47,438	90.56	69.26	1.46

Source: Thongkaimook (1990).

by the Permanent Secretary of the Ministry of Science, Technology and Energy with ONEB as its secretariat. The recommendations were approved by the government in early 1990. A working group, chaired by the Prime Minister was then formed to monitor the implementation of the activities.

To solve the existing problems and prevent new ones, the main objective is to protect and restore water resources so that water quality is suitable for human uses and corresponds to the social and economic development of the nation.

The guidelines to control water pollution are:

- Strictly apply existing laws on pollution control and development planning, including land use control.
- Establish an efficient monitoring system to enforce compliance with environmental quality standards and environmental impact assessment (EIA) procedures.
- Reduce pollution loads at source and treat them to meet effluent standards by developing management plans and investing in wastewater treatment systems.
- Encourage and support more government and private investment in pollution prevention and control.
- Motivate the public to understand the issues and participate in the fight against environmental pollution.

For the short term, 6 legal measures, 15 investment measures, 10 other measures, and a campaign and public relations measure were identified, with a total budget estimated at more than 6,000 million baht.[2] The measures related to solid and wastewater management in urban areas were estimated to cost 1,400 million baht. The year 1991 was declared the "Year for Wastewater Treatment".

Policies for solid waste have been established, namely: (1) the solid waste problem is the principal responsibility of the government and (2) manpower, budget and technology must be made available to the local government.

In addition, the following measures have been developed to control the problems associated with solid waste:

1. An effective waste management system that includes storage, collection, transportation, disposal, processing and recycling has to be developed for implementation by local authorities.
2. Recycling activities should be encouraged.
3. Local staff should be given technical training.
4. Laws and regulations must be enforced.
5. Public awareness and cooperation must be promoted.

Cabinet resolutions

At least six cabinet resolutions concern water pollution control in urban areas:

- Resolution on Restricted Zone for the Protection of Water as the Source of Water Supply for BMA (17 April 1979);
- Resolution on the Expansion of the Restricted Zone for the Protection of Water as the Source of Water Supply for the Bangkok Metropolitan Region (BMR) (12 January 1988);
- Resolution on the Action Plan for the Correction of Water Quality Degradation of the Chao Phraya River (29 August 1988);
- Resolution on the Guidelines for the Correction of Water Pollution in Pattaya Bay (22 November 1988);
- Resolution on Measures for the Correction of Water Pollution due to Domestic Wastes from BMA (2 January 1989). The four main measures are to: (a) construct a wastewater collection and treatment system for the Rattanakosin area; (b) develop a master plan for the treatment of wastewater from BMR; (c) require new hotels to have wastewater treatment; and (d) speed up the improvement of the water treatment system at the Sirirach Hospital;
- Resolution on the Urgent Measure for the Correction of Problems from Wastewater in BMR (19 September 1989) stipulates the investment in the

[2] 1990: 25.19 baht = US$1.00.

construction of a wastewater treatment system for BMR according to the master plan of the 2 January 1989 resolution.

Laws and regulations

At present, there are no laws and regulations on water pollution control. However, many existing laws and regulations relating to public health and safety as well as the environment have been indirectly applied.

Public Health Act (1941, 1984). Enacted by the Ministry of Public Health (MOPH), this law aims to protect public health. It authorizes local governments to issue ordinances to ensure proper collection and disposal of human and other solid wastes and to prevent adverse effects to public health. This act, however, does not require adequate treatment of sewage and wastewater generated by communities. Also, considering that this act was passed almost 50 years ago, the penalties and service fees specified are not enough to provide for adequate services and effective enforcement. The limited budget and manpower of the local governments and the lack of clear guidelines on enforcement make this act less effective. The MOPH is currently revising it to increase its effectiveness in water pollution control and other areas.

National Environment Quality Act (1975). This act aims to protect and conserve the quality of the nation's environment. It established ONEB, EIA requirements for specific projects, and standards of water quality and domestic effluents. But it does not provide for water pollution control and for financial and legal instruments to ensure enforcement. Clearly, these limitations do not help achieve the main objectives of the act and the national policy for water pollution control which is to preserve and enhance the quality of the nation's waters.

Factory Act (1969). Enacted by the Ministry of Industry (MOI), this act aims to control the waste discharges from industrial activities. Enforcement, however, is ineffective because the small and household industries in many urban areas are not monitored. Also, this act does not control the discharge from gas stations which are major contributors to water pollution in urban areas.

Building Code (1936, 1979). Enacted by the Ministry of Interior (MOInt), this code controls building construction in urban areas. Its main purpose is to ensure (1) structural safety; (2) protection of public health and environment; (3) accessibility to fire protection and traffic; and (4) conformity with town planning and architectural beauty. It requires the installation of a proper collection and treatment system for human waste, i.e., a leaching pit with soakway for houses and a septic tank with a cesspool for large buildings. The lack of monitoring to ensure proper construction of the treatment system reduces the effectiveness of this code. The MOInt is currently revising the code to effectively control wastewater discharges from buildings.

Navigation in Thai Waters Act (1913). This law aims to control construction along public watercourses and pollution that affects living resources as well as prevent sedimentation that obstructs navigation. It prohibits the dumping of rocks, gravel, silt, soil, mud, detritus, solid waste, sewage, oil and chemicals into public water and courses such as rivers, canals, swamps, reservoirs and lakes that are used for navigation or other purposes. The constraints are the lack of enforcement due to the limited personnel and budget, the low priority given by the Harbor Department, and other social and political complications.

Provincial Authority Act, Municipal Government Act, Sanitary District Act, City of Pattaya Act, Bangkok Metropolitan Act. Under these acts, local governments are assigned compulsory functions such as providing water supply and drainage as well as optional functions such as providing public utilities. These acts, however, lack specific authority or control over sewage and wastewater collection or treatment.

All these, however, are ineffective due to budget and staff limitations as well as the lack of enforcement.

Standards

Standards are established to control and maintain the levels of water quality to protect public health as well as to conserve national resources and environment.

The drinking water standards cover the quality of drinking water, bottled drinking water and groundwater for drinking purposes.

The effluent standards are for industrial effluents, water discharged into deep wells and effluents from buildings. There are regulations for industrial pollution control feasibilities and guidelines for domestic effluents.

Regulations also exist for water channelization in relation to waste dumping. There are water quality classification and objectives for coastal and surface water as well as water quality standards for Chao Phraya, Tha Chin, Bangpakong, Mae Klong Rivers and coastal waters.

As an incentive, the government has reduced duty fees on all imported pollution control equipment. A committee was formed to consider the machinery, materials and equipment for energy and environmental conservation.

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Session 2: Waste Management Options

Solid Waste Management in Developing Countries

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ABSTRACT

In developing countries, solid waste management needs to be recognized as being essential to proper public health and environmental control, particularly in urban areas. A key priority in the ASEAN region is efficient and effective refuse collection and disposal, the provision of which is both acceptable and affordable

Informal recycling systems which are generally well established in ASEAN member-countries should be reinforced. In addition, intermediate technologies should be developed and implemented instead of importing sophisticated western technology. Hazardous waste controls must also be developed alongside long-term programs for upgrading solid waste management.

INTRODUCTION

Solid waste management is an integral part of public health and environmental control, particularly in highly populated urban areas.

In the industrial cities of 19th-century Europe, epidemics of cholera and other infectious diseases led to the control of open sewers, sewage discharges to rivers that supply drinking water, and refuse accumulation in the streets (Wilson 1988). Specifically, in the United Kingdom (UK), the Public Health Act of 1875 empowered local authorities to remove house refuse; cleanse earth closets, privies, ash pits and cesspools; and cleanse streets. In addition, it gave the Local Government Board the power to require a local authority to carry out these services, if necessary.

From the 19th century through the 1950s, the primary focus in solid waste management (or public cleansing as it was then known) in Europe and North America was on improving the standards of street cleaning, refuse collection and storage. This became an accepted municipal service in all industrialized countries, the financial support of which was provided as a matter of course.

Waste disposal standards tend to lag behind waste collection, on the principle of "out of sight, out of mind". It was not until the 1950s and 1960s that open dumping was gradually replaced by modern landfilling (originally known as "controlled tipping" in the UK and as "sanitary landfill" in the US).

Batch incinerators, with little or no air pollution control, were replaced by a new generation of direct incinerators, with dust control and, in many European countries, heat recovery.

Over the last 20 years, waste management in developed countries has emerged as a scientific and engineering profession. Environmental standards of refuse incineration and landfilling have improved gradually and new methods of refuse sorting and resource recovery have been developed. Research, for example, has been directed at the behavior of waste in landfills, focusing on leachate production and its potential for water pollution. Industrial and hazardous wastes have become a major concern, with complex legislation and control systems, and networks of sophisticated treatment and disposal facilities being developed in parallel. The political priority given to waste management has increased sharply, due largely to public concern over well-publicized incidents, such as Love Canal in the US and Lekkerkerk in Holland, where uncontrolled disposal of hazardous waste in the past has given rise to serious environmental contamination.

Developing countries are at various stages in the evolution towards "modern standards" of waste management. In many of the less-developed countries, and in the low-income areas of major cities such as Bangkok and Manila, the first task is still to get the refuse out from under foot. The standards of waste disposal are still almost universally low, with open dumping as the most popular method in most countries. Hazardous waste is beginning to be recognized as an urgent problem, but most developing countries are at a relatively early stage in developing and implementing action programs.

The experience of developed countries in the last 50 years is highly relevant to developing countries that continue to tackle solid waste management problems. They can learn from the successes and failures of past programs of the developed countries. But the priorities of the 1990s in developed countries are likely to be very different from those in developing countries. In addition, technologies and management systems from developed countries will almost always require adapting to become more appropriate to the specific problems and needs of each developing country. The purpose of this paper is to explore technologies and management systems, which are "fit for purpose" in developing countries.

THE NEED FOR SOLID WASTE MANAGEMENT

Any program to improve solid waste management needs to be established as a political priority. In industrialized countries, this was achieved largely through a recognition of the public health and environmental consequences of inadequate management practices. These are the five major aspects:

1. Most municipal refuse contains human fecal matter. In developing countries, this is due mainly to inadequacies in the sanitation infrastructure and management; in developed countries, the culprit is the practice of using disposable diapers for young children. Human excreta is a critical vehicle for the widespread transmission of communicable diseases. Municipal refuse carries pathogens that may be passed on by direct exposure to refuse collectors, scavengers and playing children, or indirectly via flies and other insects which breed in the refuse. Uncollected waste tends to block drains and cause stagnant water, which is a breeding ground for various species of mosquitoes.
2. Decomposition of the organic materials in municipal solid waste can give rise to heavily contaminated water, known as "leachate," which may pollute both surface- and groundwaters. Water pollution is a major problem associated with uncontrolled dumping of solid waste, particularly in major cities situated in low-lying coastal areas.
3. Air pollution results from the continuous burning of refuse. Causes include high temperatures from the aerobic decomposition of the refuse; the concentration of the sun's rays by glass on the surface; methane gas from anaerobic decomposition; or deliber-

ate combustion by scavengers. Whatever the cause, a burning refuse dump is almost impossible to extinguish.

4. The uncontrolled discharge of toxic waste into watercourses may pollute drinking or irrigation water supplies. Its uncontrolled disposal with other urban wastes in open dumps exacerbates all the previous problems, e.g., posing a health risk to scavengers and others who are in direct contact with the refuse, polluting groundwater resources and adding to the air pollution risk.
5. An area of particular current concern is the uncontrolled disposal of clinical waste, given the reports of Acquired Immune Deficiency Syndrome (AIDS) and hepatitis epidemics threatening cities such as Manila and Bangkok.

AID RESPONSE

International development agencies have been providing more funds over the last two decades for urban infrastructure and health improvement projects in developing countries. Their initial thrust was towards water supply and drainage projects, with solid waste management as a subsidiary problem.

Many international aid projects have attempted to solve the solid waste problem by importing western technology and equipment, sometimes by means of "turnkey" contracts where the equipment supplier is allowed to specify equipment needs. In many parts of the world, there are sophisticated incineration or composting plants which have been abandoned, sometimes without commencing operations, because the recipient country lacks the necessary financial and manpower resources for their operation and maintenance; in other words, they are not "fit for purpose".

Over the last few years, an encouraging consensus has emerged that locally sustainable solutions must be based on intermediate level technologies appropriate to the local situation (Cointreau 1982; Jackson 1988). A Japanese study committee recommends that (Sakurai 1987):

> ...international cooperation projects in the field of... solid waste management should be formed carefully taking into account the technical and management capacity of recipient countries, *using appropriate technologies and paying special attention to operation and maintenance.*

Thus, technical assistance studies undertaken by consultants must always focus on what is appropriate to the local situation. In this context, early training of local staff is important to enable overseas consultants to be managed properly, and to develop the local capability to assess and implement their recommendations. It may be preferable to have a series of short-term consultancies on specific well-defined topics, rather than a single massive study. Again, there are Southeast Asian cities where a series of major consultants' reports have been prepared, often funded by bilateral aid programs, and have never been implemented.

Three factors can help make consultancy studies more applicable:

1. The terms of reference should be drawn up in such a way that there is a parallel focus on not only the long-term but also a series of implementable initial steps, as part of a short-term action plan.
2. Local counterpart staff should be identified and incorporated as far as possible into the consultants' team. An example of explicit training was a study carried out by ERL in Bangkok in 1987, under the Commission of the European Communities-ASEAN cooperation agreement, where nominees from four ASEAN member-countries joined the team for a four-month period.
3. Technical assistance from experts of a developed country should be balanced by a "horizontal corporation," i.e., personnel from one developing country help those from another. An example is a recent project team mobilized by ERL for a Japanese technical assistance project on hazardous waste and emergency response to chemical accidents in Southern Jiangsu Province in

China, where the project team included experts from Europe, Canada, India and the Philippines.

ADAPTING WESTERN TECHNOLOGIES AND MANAGEMENT SYSTEMS

These are some of the reasons for adapting western technologies and management systems to the local situation in a developing country:

1. nature of the solid waste;
2. climate and geographical situation;
3. institutional constraints; and
4. nature of industry and other differences specific to hazardous waste.

The nature of waste

The focus of this section is municipal solid waste which includes waste from households, commercial premises and institutions such as schools and hospitals (but excluding clinical waste); market waste and street sweepings.

Waste Generation Rates. Measurement of waste generation rates in developing countries is both uncommon and difficult (Cointreau 1982). Rates are often quoted in the range of 1-2 kg/capita/day in developed countries and perhaps 0.4-0.8 kg/capita/day in developing countries.

But there is no substitute for local measurement. An ERL study in Uganda showed an average generation rate from households of around 0.8 kg/capita/day. On further investigation, this relatively high rate turned out to be due almost entirely to the consumption of a seasonal vegetable, *matoke*. A variety of plantain, its consumption rate is 1.2 kg/capita/day, 50% of it being waste.

Waste Density. Density values from municipal solid waste vary widely. Generally, however, waste tends to have a lower density in industrialized countries than in developing countries, due to the predominance of non-putrescible components such as paper, plastics and other packaging materials. Typical waste densities in North America or Europe are between 100 and 150 kg/m^3, while in Southeast Asia, the typical densities at the point of collection vary between 250 and 500 kg/m^3. Densities tend to be higher at communal collection points, due to self-compaction.

Waste Composition. Refuse composition also varies enormously, between locations in the same country, from season to season and from day to day. "Typical" values for industrialized, middle- and low-income countries are shown in Fig. 1. Of particular importance is the content of vegetable and putrescible matter, which is typically in the range of 20-40% in industrialized countries and 40-80% in low-income developing countries.

Moisture Content. The moisture content of waste is directly related to its putrescible content, so that it is lowest in industrialized countries (20-30%) and highest in low-income developing countries (40-80%).

Size Distribution of Waste Materials. The average particle size of solid waste in developing countries tends to be significantly smaller than in industrialized countries. This means, for example, that many modern mechanized methods for resource recovery from developed countries, which rely on size reduction as a preliminary step, are often inappropriate to developing countries.

Climate and geographical situation

The geographical setting of a city is important in designing an appropriate waste management system. Many cities in developing countries are characterized by:

- hot climate, some with high seasonal rainfall;
- a high population growth rate, due to continuing rural-urban drift;
- cramped living conditions with little or no space for waste storage receptacles;
- slum and shanty dwellings, accessible only by narrow walkways or unpaved lanes;
- slow moving traffic because of the great number of bicycles, animal carts or cars for the available road network;
- limited availability of suitable sites for waste disposal within a reasonable travel time; and
- low-lying land with a high water table,

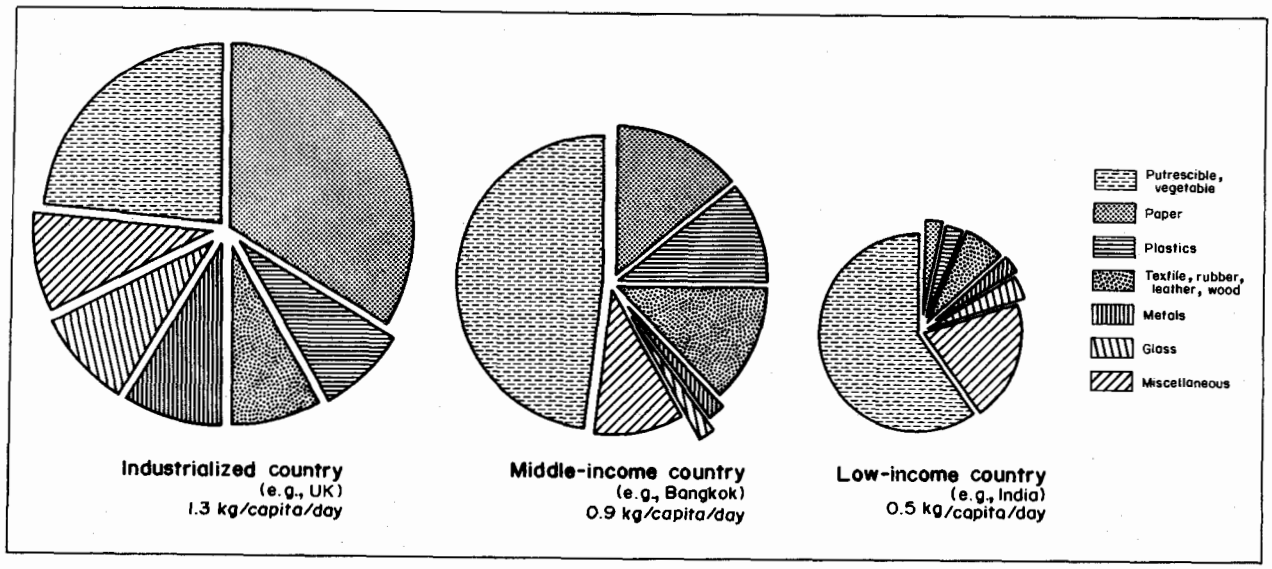

Fig. 1. Comparative solid waste composition in industrialized, middle- and low-income countries.

where groundwater pollution is a major constraint to waste disposal.

A direct consequence of the combination of a hot climate, limited storage space in living premises and a high putrescible content of the refuse, is that the refuse collection frequency in densely populated areas in developing countries is often every day, or at most every other day.

Institutional constraints

Many planning efforts in developing countries have emphasized technology at the expense of management support systems. An acceptable level of service for waste management depends critically on well-planned management, operating within an adequate institutional arrangement, and capable of generating the financial resources required to meet operating, maintenance and investment costs.

Among the common weaknesses in existing institutional systems are untrained staff, poor pay scales, the lack of incentives to do a good job and corruption. Related key problems are inadequate supervision of workers and poor maintenance of vehicles. Industrialized countries have 1 supervisor for every 5-7 collection vehicles, whereas developing countries have 1 per 10-30 vehicles. In addition, supervisors in developing countries often have no means of moving about within their service areas.

Similarly, while average downtime for vehicles might be around 10% in an industrialized country, typical figures in the cities of developing countries vary from 20 to 50%. Maintenance is often reactive, repairing vehicles after they have broken down, rather than preventive, i.e., regular servicing and routine maintenance in well-equipped workshops. This problem is often exacerbated by inadequate funds for vehicle repair and the lack of spare parts.

In many cities in developing countries, the solid waste management service is by far the largest employer of labor and user of transport, and spends the largest proportion of the revenue budget of the city; yet it is relatively uncommon to find at senior management level an individual with direct line responsibility for all aspects of solid waste management operations. There is often a small Cleansing Department at City Hall, with all laborers and supervisors managed on a decentralized basis in city districts. Frequently, there is no planning unit, and records which are essential to monitor and improve service performance are poor or nonexistent.

Providing adequate funds for solid waste management on an ongoing basis is a major problem in many cities of developing countries. As it takes up a large proportion of the

total city budget, solid waste management implies an effort to improve the overall municipal administration system. This is because the money for running the service usually comes from the general municipal revenue. Direct user charges for refuse services are relatively uncommon, and where they do exist, collection rates are often very low. Three particular problems with direct charges are: those who can afford to pay live in better-income areas; there is usually no viable means of shutting off service to a resident with unpaid bills; and a direct charge encourages indiscriminate dumping.

The objective of solid waste management in developing countries is to provide an adequate and affordable service, through the use of viable low-cost techniques. The objective of minimum cost, however, is subject to constraints such as employment objectives, the real cost of imports, limitations on capital expenditure, shortage of skilled labor for operation and maintenance, and the availability and affordability of spare parts.

Differences specific to hazardous waste

These are some of the factors to be considered in adapting hazardous waste management methods to the local needs and circumstances of developing countries (Wilson and Balkau 1990):

- Climatic differences may require changes in waste handling and the design and location of facilities. For example, air drying of sludges is difficult in wet tropical climates. The siting and design of landfills in a dry region may require less strict standards to achieve the same objectives than in a wetter climate (Wilson and Vreeland 1988).
- Transport network inadequacies may require local or regional more than national solutions.
- Unsophisticated government bureaucracy may mean that complex "cradle-to-grave" control systems are difficult to implement. A major priority is finding simpler and more implementable systems.

In addition, there are significant differences in the nature of hazardous waste generators. For example, in industrialized countries, effluents from the metal finishing industry are normally pretreated on site, with sludge going to a centralized treatment facility for further processing. In many Southeast Asian countries, however, this is impractical, because the majority of generators are small and operate in cramped quarters.

One difference which can be turned into an advantage is that many developing countries are actively encouraging new industry. Most countries have a licensing system for new factories that should be extended to include explicit provision for industrial and hazardous waste minimization, recycling, treatment and, as a last resort, proper disposal. An attractive option is to provide industrial estates for a particular type of waste-producing industry, e.g., electronics, where the provision of centralized waste treatment facilities at an economic (shared) cost could encourage investment.

Nonindustrial sources of hazardous waste may also be relatively more important in some developing countries which are at an early stage of industrialization. Ubiquitous problems include stocks of unusable agricultural chemicals accumulated over many years, hospital waste, waste oils from transportation and dry cleaning solvents.

SOLID WASTE STORAGE AND COLLECTION

In many cities of developing countries, the first priority is literally to get the refuse out from under foot. In Bangkok and Manila, around 20-30% of solid waste are uncollected, providing breeding grounds for disease vectors, both directly and indirectly. The lowest level of service, because inaccessible, is inevitably in the slum and shanty neighborhoods.

A number of studies have also addressed the selection of appropriate technology and management systems for refuse storage and collection (Flintoff 1976; Cointreau 1982; Lohani 1988). Factors to be considered include:

- the need for daily collection in many countries due to the hot climate;
- a primary storage and collection sys-

tem which results in single-handling of waste. (Present collection systems often involve double-handling or, when nontipping trucks, trailers or trolleys are used, even triple-handling of waste. The principle of picking up waste once only can be applied using simple indigenous equipment such as handcarts or pedal rickshaws working in conjunction with tractors, trailers, or container-handling equipment);

- the improvement of existing pushcarts and other low technology methods for primary collection in slum and shanty neighborhoods;
- the use of tractors or animal-powered collection vehicles where traffic speed is typically under 40 km/hour;
- the use of low-technology transfer stations for pushcarts and small vehicles;
- the use of compaction trucks more suited to the high waste density in developing countries;
- the improvement of vehicles for manual loading (In a number of cities, compaction vehicles appear to be used primarily because of the low loading height of the hopper rather than the need for compaction. Refuse collectors in sideloading vehicles used in Bangkok, for example, discharge containers at higher than head height. These vehicles can be designed to allow loading at a more reasonable chest height.); and
- the need for an appropriate management structure and workshop facilities for routine servicing and rapid repair of vehicles.

The experience of developing countries has shown that simple changes in collection systems, using indigenous, low-cost and low-maintenance equipment, can provide improved services to more people at no increase in cost.

RECYCLING

Recycling systems are often well established in developing countries. A schematic representation of the recycling systems in Bangkok is shown in Fig. 2 (Wilson et al. 1988):

- Newspapers, cardboard and metals are collected from door to door in 3-wheeler bicycle carts.
- Waste collectors spend perhaps 30-50% of their time sorting saleable materials from the refuse, both at the collection point and (in the case of sideloading vehicles) during transport.
- Communities of 200-500 families living on each of the dumpsites scavenge for their livelihood.
- They sell to middlemen who often perform some simple sorting and cleaning.
- The middlemen sell to wholesalers and hence, back to primary industries.

Although the health conditions of scavengers living on open dumps are obviously poor (Kungskulniti 1990), it is not possible to dismiss the current informal recycling systems. Many people choose to work as scavengers on the dumps rather than in factories because: (1) unemployment is high, so the value of jobs to the economy is considerable; (2) the level of income from scavenging is competitive with that from other forms of employment, and indeed, refuse collectors in Bangkok often more than double their income through scavenging; and (3) the savings in both raw materials and energy costs through recycling make an important contribution to economies and environments.

Existing informal recycling systems, however, could be improved. One possibility is to increase the proportion of waste which is separated at source by the householder, employing more scavengers in the initial stage of collecting separated materials from door to door (Lohani 1988). Paying householders for these preseparated items makes for much higher participation rates than those often achieved in industrialized countries for such "source separation" schemes. A major constraint, however, can be lack of space in households for storage of separated refuse, even with frequent collection. Nevertheless, pilot schemes along these lines should be encouraged. One advantage of source separation is the possibility of separating a clean organic fraction to serve as an input to composting.

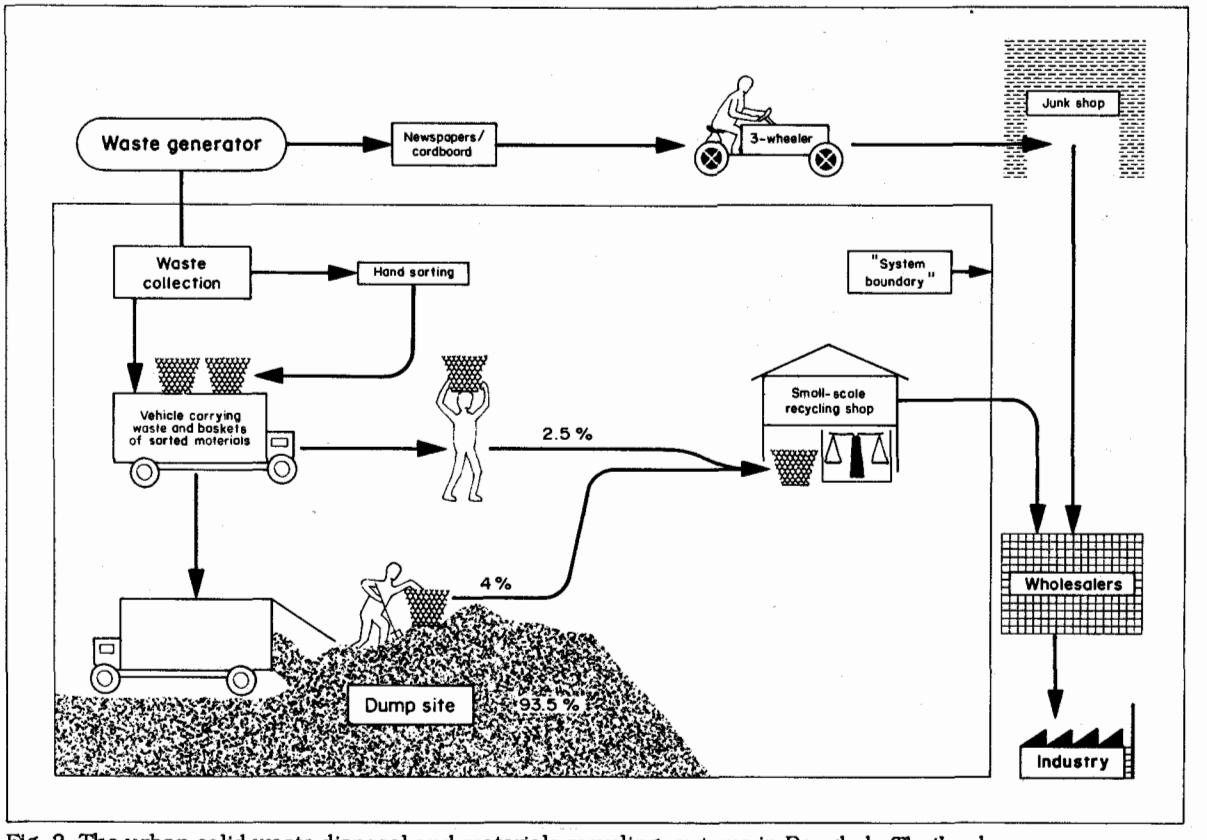

Fig. 2. The urban solid waste disposal and materials recycling systems in Bangkok, Thailand.

An alternative or complementary approach to separation at source is to improve the effectiveness of current manual separation systems. Ideally, such separation should take place at a number of centralized points, such as transfer stations or disposal sites. Refuse collection can be more efficient and effective if scavenging by waste collectors can be eliminated through their participation in a time-saving, centralized recycling scheme, the profits of which can provide them with a realistic basic wage.

A number of studies have shown that a combination of manual and mechanical sorting can make recycling more effective. An early ERL study in Bangkok showed that a low-technology approach that utilizes the skills of the scavenger community could increase resource recovery (excluding the initial separation at source) from around 7 to 16% by weight. In addition, a sorting plant would produce an organic-rich fraction for composting and a residual stream for use as a potential fuel. One of the major attractions of such a system is that the local private sector could be encouraged to invest in it because of the revenue that would be generated (Wilson et al. 1988).

Further research and pilot schemes to demonstrate these and other ideas that build on the informal recycling sector should be strongly encouraged. In doing so, the socio-economic aspects of the scavenger communities must be considered.

SOLID WASTE TREATMENT AND DISPOSAL

Landfilling

The present disposal method for solid waste in developing countries is generally open dumping, with associated water pollution and public health problems. Upgrading open dumps into properly managed, environmentally acceptable landfills must be the first priority. In practice, however, this can be very difficult due to the lack of suitable sites,

potential water pollution problems, shortage of cover material and the presence of scavenger communities who depend on the waste for their livelihood.

The ASEAN member-countries urgently need demonstration projects to show that upgrading of existing dumps into (partially controlled) landfills is possible and that establishment of properly controlled new landfill sites is feasible. Such projects are needed to address both technical (e.g., preventing water pollution) and institutional problems (i.e., gaining public acceptance for new sites and displacing scavenger communities).

Moreover, the difficulties in achieving proper landfilling standards, particularly water pollution control, should not be underestimated. However, considerable improvements over current open dumping practices, can be made at a relatively low cost. There should be proper site selection and management of the site, i.e., the cellular method whereby the waste is brought to its final level in one area as quickly as possible, rather than being spread in a thin layer over all of the site; this way, there will be less rainwater being transformed into contaminated leachate. The shortage of cover materials may make it difficult to cover the waste every day, but the relatively small particle size of waste in developing countries, together with the possibility of making cover material from the composted organic fraction of the waste, should make this problem manageable. Adequate compaction of the waste to eliminate void spaces and discourage rats and other vermin should be possible without the use of sophisticated landfill compactors used in developed countries.

Incineration and composting

Traditional aid-funded solutions for solid waste disposal have often involved the export of western technology, i.e., incineration or composting. In many cities, the moisture content of the refuse is too high to burn without the addition of expensive support fuel, unless stringent measures are taken to prevent the recycling of paper and plastics. In our opinion, recycling is a preferable method of waste management to waste treatment, so that any such prohibition would be a retrograde step. Given the extremely high capital cost of incineration, the need for skilled labor, and the high cost of imported spare parts, we believe that the potential for incineration in developing countries is extremely limited, outside of special situations such as that in Singapore, and of particular specialist applications such as for clinical and selected hazardous wastes.

Composting appears to be a more promising option because of the high organic content of refuse in developing countries. Many projects have failed, however, because of the sophistication of the plant. In addition, the use of pulverizers for size reduction has resulted in a compost product which is contaminated with finely ground glass and small pieces of plastic. Even without concerns about contamination with heavy metals (originating from batteries and urban air pollution), their presence in the compost have made it extremely difficult to market in many countries.

Intermediate technologies

An intermediate technology approach to refuse treatment and disposal is a combined transfer station and sorting plant that uses a blend of manual and mechanical methods for refuse sorting. Such a plant could increase the efficiency of separating materials for recycling, while providing both an organic-rich fraction and a possible feedstock for incineration.

Separation of a clean organic fraction for composting, either from such a plant or at source, could feed directly into a series of simple facilities to produce compost using the traditional windrow system. This would eliminate the need for sophisticated imported technology and could also provide a valuable plant growth medium for soil lacking organic content.

A clean organic fraction could also be used as a feedstock for anaerobic digestion, producing biogas. Indeed, a landfill may be viewed under favorable circumstances as the simplest form of such a digester. While this idea has certain attractions, and could qualify as "intermediate technology," experience in industrialized countries has thus far not been particularly positive.

PUBLIC VERSUS PRIVATE SECTOR OPERATION

Collection and disposal of solid waste within an urban area has traditionally been perceived as the responsibility of the local municipal government. Provision of these services is expensive, even when the most primitive methods are employed. Usually, the cost comprises 20-40% of a municipal budget, 70-80% of which goes to collection and transportation, with disposal comprising the remainder.

In industrialized countries, the private sector is becoming more involved in refuse collection and disposal. In Europe, the service is still the responsibility of the local government who contracts the private sector for its operation. The local government collects the appropriate fees and supervises service provision. In the US, the private sector works directly with and collects a user fee from the householder. In both Europe and the US, industrial waste services are provided directly to industry by the private sector.

The "Hong Kong model" has two refuse transfer stations and a centralized hazardous waste treatment service (including collection) which have so far been "privatized". The government retains responsibility, but has contracted the private sector for the detailed design, construction and the first 15 years of facility operation.

There is currently considerable interest in introducing the private sector to solid waste management services in developing countries. While this is potentially cost-saving, it is certainly not a panacea for all problems. Two particular pitfalls need to be avoided.

First, a direct service, where a householder pays the waste collector directly, would tend to serve mainly the middle- and upper-income levels, as low-income people could not afford the expense. Similarly, if the private collectors are performing the service to make a profit from the recyclables, they would again tend to serve only those residents with "rich" waste. In either case, a substantial proportion of the city's refuse would be left uncollected.

Second, the lowest bid from the private sector could mean poor service. An interesting case study is provided by three refuse collection contracts operating in Bangkok in 1987. These contracts were causing problems due to the "unsatisfactory" performance of the contractor. An ERL study examined these and suggested that a number of deficiencies in the contract or the contracting system be corrected:

1. improve prequalification procedures to eliminate companies without the resources or experience to support their tenders;
2. improve the quality of contract documentation, with particular reference to the specification of services, penalty clauses and bills of quantity;
3. extend the contract period from two to five or seven years, and require the contractor to purchase purpose-built refuse collection vehicles (one complaint was that the contractors were all using flat-bodied trucks);
4. increase the responsibility of local district officers in supervising contractors (e.g., in inspection works and the approval of contractors' invoices, which was then handled centrally by the Department of Public Cleansing);
5. expand contracts to include all cleansing services within the contracted area (refuse collection, streetsweeping, drain cleaning, etc.) to reduce overlap and possible conflict of responsibility with parallel city services;
6. insist that contractors improve their image (e.g., by use of uniforms), to enable both the city and the public to distinguish easily between contracted and city services; and
7. insist that contractors maintain a staff office in the contract area to improve liaison among the contractor, the city and the public.

HAZARDOUS AND OTHER SPECIAL WASTES

Hazardous waste management in developing countries has received increasing attention from international and other organizations over the last ten years. But it is still not high on the political agenda in many coun-

tries. A 1986 workshop in Singapore organized jointly by the United Nations Environment Programme (UNEP) and Association of Southeast Asian Nations (ASEAN) resulted in "Guidelines for establishing policies and strategies for hazardous waste management in Asia and the Pacific" (UNEP 1986). The World Bank, World Health Organization and UNEP published a technical manual, "The safe disposal of hazardous waste: the special needs and problems of developing countries" (Batstone et al. 1989).

As well as being involved with both of these initiatives, one of the authors had the privilege of chairing the developing country program of the International Solid Waste Association's (ISWA) Working Group on Hazardous Wastes, which organized the Workshop on Adapting Hazardous Waste Management to the Needs of Developing Countries (Dean and Wilson 1990). This brought together a series of 16 case studies, mainly drawn from Southeast Asia, illustrating attempted or specific local solutions, and more generic reference material on approaches to a specific aspect of the overall hazardous waste problem.

Recent publicity has been given to attempts to export hazardous waste from developed to developing countries. The publications show that developing countries also need to develop control systems to deal with the hazardous waste being generated within the country. Currently, there is uncontrolled waste disposal on land and in watercourses. Short-term public health risks may ensue through pollution of water supplies for drinking or for irrigation, or to scavengers who work on open dumps. In the longer term, uncontrolled dumping on land may pollute groundwater resources and cause hazards when the land is reused in the future. Cleaning up is much more expensive than correct management in the first place.

Developing countries can learn much from the experience and mistakes of industrialized countries in controlling hazardous wastes (Tables 1 and 2). Sophisticated control methods and technologies cannot simply be transferred, since adaptation to local needs and circumstances is necessary. Moving from a situation of little or no control to one of absolute control is not possible; in most developed countries, the control system has

Table 1. Common elements in the successful implementation of hazardous waste controls.

- a "package" of actions and measures, not a single technical or regulatory initiative;
- support-building for waste control measures among the public and government officials;
- a cooperative and a coercive exercise which ultimately relies on contributions from a range of government ministries, industrial bodies and individual companies;
- practical implementation and enforcement programs within the limits of available resources and skills;
- gradual building up of successive measures over immediate implementation of grandiose master plans; and
- immediate implementation of short-term actions and a phased approach to implementing long-term actions.

Source: Wilson and Balkau (1990).

Table 2. Common constraints and difficulties in implementing hazardous waste controls.

- inadequate early identification and quantification of waste arisings and of the extent of environmental problems;
- insufficient enforcement of existing pollution and solid waste laws, that keeps much of the hazardous waste problem hidden;
- the long delay between recognizing the need for both facilities and competent personnel and actually providing them which tends to encourage indiscriminate dumping and waste export;
- loss of public confidence in technical solutions due to poor performance of earlier disposal facilities; and
- the complexity of the administrative response needed to control all parts of the waste cycle. Frequently, resources for enforcement are inadequate and administrative responsibilities are fragmented.

Source: Wilson and Balkau (1990).

evolved gradually over a period of perhaps 20 years.

A major recommendation from the ISWA workshop is to develop a two-part strategy that will implement a short-term action plan for hazardous waste control (Wilson and Balkau 1990). It includes interim arrangements for hazardous waste treatment and disposal which should not be underestimated because they reduce risks considerably and immediately. Equally, these interim solutions should be recognized for what they are, as a first step toward more permanent measures.

Examples of these include (Wilson and Balkau 1990):

- codisposal in municipal waste landfill sites of asbestos waste (suitably packaged and handled), treatment plant sludges or organic chemicals of moderate toxicity (Safe codisposal is only possible at a controlled landfill, *not* on an open dump.) ;
- solidification of selected hazardous waste prior to landfill;
- chemical treatment off-site of electroplating and textile effluents, as in Bangkok;
- coincineration of combustible oily waste, pesticides or similar materials in cement kilns;
- export to approved overseas facilities of difficult wastes such as polychlorinated biphenyls (PCBs) for incineration; or
- concrete entombment of nontreatable toxic wastes.

CONCLUSIONS

Solid waste management is an essential component of proper environmental management, particularly in urban areas. The environmental and public health implications of inadequate solid waste management are considerable.

A historical chronology of waste management in industrialized countries shows that the first priority is to get the refuse out from under foot. An efficient and effective refuse collection service needs to be extended to *all* sections of the community, including slum and shanty neighborhoods. Perhaps the most important single factor in improving efficiency is to substitute single-handling (picking up the waste once only) for the double- and even triple-handling systems still commonly found in the cities of developing countries.

The second priority is to provide an acceptable standard of service at an affordable price, through the use of viable low-cost techniques. Evaluation criteria should include not only the least cost but also employment objectives, the real cost of imports, the ease of maintenance and limitations on capital.

Waste reduction and recycling is environmentally preferable to waste treatment and disposal. Some developing countries, however, tend to discourage the existing, and often extremely efficient, informal recycling systems, for example, to allow the introduction of high technology (e.g., Western incineration plants).

These systems make an important contribution to national economies, as they provide employment, reduce consumption of raw materials and energy, and reduce the quantities of waste to be transported and disposed of. Municipalities should encourage recycling and reinforce the informal recycling sector by providing adequate services to protect the workers' health, facilitating the marketing of recycled materials, and developing and demonstrating schemes to improve workers' productivity through the use of simple technology.

Short-term improvements to the standards of waste disposal are most likely to come through the introduction of controlled landfills. Upgrading existing open dumps and developing new landfills are very real problems, the solutions of which can involve demonstration projects. These projects can show municipal officials that controlled landfilling is possible under their own particular constraints and circumstances.

In many industrialized countries, it was nearly 100 years from recognition of the public health problems of uncollected solid waste to that of hazardous industrial waste. Given the pace of industrialization in some developing countries, it is simply not possible to wait to solve one problem completely before tackling the next. Thus, alongside a program for solid waste management, it is important

for all developing countries to lay the foundations for hazardous waste management. Emphasis here is on taking a number of first steps towards solving the problem, rather than simply investigating it. Among these steps is the development of interim arrangements for hazardous waste treatment and disposal, pending the development of permanent disposal facilities.

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Ecological Impacts of Waste Disposal in the Coastal and Marine Environment

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ABSTRACT

In the coastal zone, pollution from improper disposal of waste is known to cause adverse ecological impacts on coastal resources. Successful solutions require public support and adequate funding. A preliminary risk assessment should consider public perception and resource use; critical habitats and species; fate of pollutants; toxic hazard, persistence and natural detoxification mechanisms; and exposure.

Discharges of mercury and chlorinated hydrocarbons have adverse effects on human health. Mercury, pesticides, and polychlorinated biphenyls (PCBs) are, clearly, priority pollutants in view of their toxicity and detoxification mechanisms, persistence and the assimilative capacity of the marine environment.

INTRODUCTION

The driving force in coastal resources management (CRM) is the public. Failure to recognize this will doom most programs designed to protect coastal resources. Long before modern governments were established and regulatory programs were enacted, people had already established through common practice what and how coastal resources would be used for their personal benefit. In one form or another, these beneficial uses remain.

The objectives of CRM are to minimize resource use conflicts and maintain sustainable resource use. Efforts to solve ecological problems caused by waste disposal in the coastal zone will be fruitless unless resource managers consider both public and scientific inputs as to the important issues. If public input is not obtained or is ignored, it is highly probable that management approaches will be unimplementable, or that management priorities will not coincide with the public's priorities. If scientific input is not obtained, management approaches will most probably be ineffective because they violate natural laws or overlook key ecological processes.

Effective resource management, therefore, nurtures the interaction between public and scientific input. This interaction gives birth to effective policies, regulations and enforcement measures. Fig. 1 illustrates the interaction between public and scientific inputs in the management of resources for

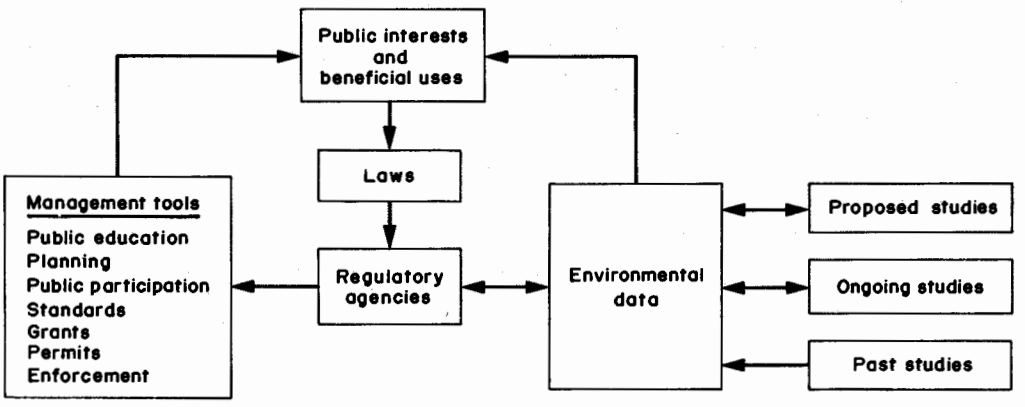

Fig. 1. Interaction among beneficial uses of resources, regulatory agencies, management tools and environmental data.

the benefit of society. Public perceptions and interests produce the laws that authorize and govern resource management decisions, but scientific data must be used by resource managers to educate the public so that reasonable laws are enacted and public support is obtained for effective enforcement. Similarly, public perceptions and the needs of the resource manager influence the type of scientific research that must be undertaken.

Rural coastal people seem to be more aware of the state of their environment, perhaps because their means of livelihood are most susceptible to degradation and resource use conflicts. On the other hand, their concerns are least often heard, perhaps because their voices are few and distant from decisionmakers.

Nongovernmental organizations (NGOs) with particular interest in the environment are now increasing in number and slowly beginning to pressure government authorities to stop environmental degradation. The NGOs are potentially valuable in conducting educational seminars and workshops on environmental issues. These potential roles of NGOs should be actively encouraged because a community that is aware of its environment is the best protection from environmental degradation. Hence, active participation of the public is needed for the success of resource management thrusts.

RISK ASSESSMENT

When decisions are made to address pollution problems in the coastal zone and budgets are limiting, the public and the environment are best served when the limited funds are used to address those issues that have the highest risk of adverse effects on public health and livelihood.

The factors to consider in establishing priorities include public perception and resource use; critical habitats and species; fate of pollutants; toxic hazard, persistence and natural detoxification mechanisms; and exposure.

In the decisionmaking process, a matrix approach may be useful in establishing priorities. In other words, a pollution situation in which three or four different factors rate high in degree of concern may be classified as higher priority over a situation in which only one or two factors rate high. The remainder of this paper focuses on these factors and offers ideas that may be valuable in risk assessments.

Public perception and resource use

In most Southeast Asian nations, primary uses of coastal resources include fisheries and coastal tourism. Public perceptions of pollution problems in the coastal zone vary from place to place, but it is safe to say that the most common concerns are those that are visible. Thus, improper disposal of solid waste (garbage) and high rates of discharge of sediments, including mine tailings, are likely to rank high in public perceptions of significant pollution problems. This is not only because of visible turbidity in the water column but also because of the smothering effect of the discharges on coral reefs. In

addition to dead coral reefs, dead fish and birds bobbing in the surf zone are sure to attract public concern.

Habitats and species

The occurrence of critical habitats and species varies. In Southeast Asia, however, a few general principles apply. Mangroves and coral reefs are recognized as critical habitats. Both protect shorelines from erosion and are important spawning and nursery areas for coastal fish and shellfish species and other marine organisms. Healthy stands of both habitats are rapidly disappearing from the region. The tropical coral reef is the marine environment's analog to the terrestrial environment's tropical rain forest: both habitats support the highest abundance and diversity of species on the planet. When corals die, the wide variety of reef fish and other animals on which reef fish feed also die. The overall cumulative effect is a great reduction in the productivity of marine fisheries in the coastal zone, and a potentially significant loss to the planet's biodiversity as well as people's livelihood. Fisheries, tourism and coastal recreation are not compatible with industrial or urban pollution that destroys coral reefs. Tourists in the coastal zone usually come for clean beaches, swimmable water and healthy coral reefs with lots of beautiful tropical fish. Tourists will go elsewhere if any one of these is lacking.

Based on literature from a wide range of conditions, it is widely acknowledged that various groups of organisms are more sensitive to certain types of pollutants than others. At the risk of oversimplifying the findings, the following appears to be the general trends.

Plankton. Plankton refers to the group of plants and animals found drifting or floating in the water column, unable to swim against currents for significant distances. Phytoplankton are planktonic organisms capable of manufacturing their own food, i.e., usually single-celled algae. Phytoplankton are adversely affected by suspended sediments (turbidity) and toxic chemicals in the water column. Turbidity reduces the penetration of light into the water column, thus, hampering their photosynthetic activity. Toxic chemicals of most concern to phytoplankton appear to be biocides (used in cooling water systems), heavy metals (especially copper) and dissolved petroleum hydrocarbons. Sewage discharges that are neither turbid nor toxic are typically beneficial to phytoplankton for their nutrient supply.

Detecting effects of pollutants on phytoplankton in the field is difficult because currents constantly move phytoplankton into and out of impacted areas. Furthermore, populations vary in abundance and distribution on very small spatial and temporal scales.

Zooplankton are planktonic animals. They include animals that spend their entire life cycle as plankton and the eggs, larvae or juveniles of other organisms which as adults are capable of swimming against the current for significant distances. Zooplankton are adversely affected by turbidity, low oxygen supply and toxic chemicals in the water column. Turbidity interferes with feeding and fouls respiratory structures (gills). Generally, zooplankton, especially the larvae of most organisms, tend to be most sensitive to low oxygen supply and toxic chemicals. Effects, however, are as difficult to detect in the field as with phytoplankton.

Benthos. Benthic species live near, on or in the bottom sediments of the sea. Broadly, they include bottom-dwelling fish. Benthic species, many of them nearly immobile, are most likely to be affected by the persistent aspects of waste discharges.

Benthos are most susceptible to deposition of sediments, high organic enrichment of the sediments, and the uptake of toxic chemicals and heavy metals that are discharged and settle at the bottom with particulate matter. Lethal environmental effects include smothering by sediments or suffocation due to consumption of oxygen by organically enriched sediments. In areas receiving only light deposition of sediments, suspension feeders such as corals, crinoids, ophiuroids and some bivalves and polychaetes are often the first to suffer (Rhoads 1974).

Reef Fish and Other Pelagic Biota. Reef fish tend to stay near the coral reefs that provide them with food and shelter. Although reef fish may not be particularly susceptible to suspended sediments and toxic chemicals, the corals upon which they depend are very sensitive. Oil spills may also have sublethal toxic effects on not only the fish but also the reefs.

Pelagic biota includes species that feed and swim primarily in the water column. These include marine animals and fish species that typically do not associate themselves with reefs. Because of their mobility, these species are likely to avoid adverse water quality conditions or suffer only brief exposure to waste discharges. Detecting effects of toxic constituents or turbidity in the field may be difficult because of the mobility of these species.

Marine Birds. Marine birds are most susceptible to the adverse effects of oil spills. They are likely to forage over a large area, minimizing the risk of long-term exposure to a polluted area. However, once exposed to spilled oil, most marine birds rapidly lose body heat because the oil destroys the insulative capacity of feathers, and the birds die of hypothermia. Lightly oiled birds may survive the exposure, but in the process of preening the oil from their feathers they ingest sufficient quantities to reduce egg-laying capacity or cause other detrimental physiological effects.

Fate of pollutants

The fate of pollutants is closely tied to the environment into which they are discharged. In particular, the degree of mixing and flushing of the receiving water affects the rate at which pollutants are diluted, dispersed and deposited. Their potential for building up to levels that affect ecological conditions, therefore, also depends on the degree of flushing and mixing.

Pollutants can be broadly classified according to their fate in the environment: biodegradable pollutants, nonpersistent pollutants and persistent pollutants.

Biodegradable Pollutants. The most common biodegradable pollutants include sewage and putrescible solid waste. Their pollution potential in the marine environment is measured by the amount of oxygen (biological oxygen demand or BOD) that is required by bacteria to metabolize them. In well-flushed marine environments, BOD can be readily assimilated with little ecological harm because the oxygen content of the seawater is rapidly replenished by algal photosynthesis, mixing and circulation. Poorly flushed or confined water bodies such as estuaries and shallow embayments, however, are often highly susceptible to oxygen depletion.

Gonzales and Fernandez (1988) identified BOD as the pollutant of greatest concern in the Philippines with reference to volume of waste and its impact on rivers, estuaries and the coastal zone. Estimates show that the average Filipino generates 35-70 g BOD/person/day as sewage and 640-1,600 BOD/person/day as solid waste (Gonzales and Fernandez 1988). Assuming seawater contains approximately 7 mg/l dissolved oxygen (DO), then the untreated organic waste produced every day by each individual is potentially capable of depleting oxygen from 100 to 240 m^3 of seawater each day. Although these numbers are ridiculously high because they do not account for various natural mechanisms for replenishing DO in seawater, the impact of thousands or millions of people in a coastal urban area dumping essentially untreated waste into rivers or estuaries in the coastal zone is potentially significant.

Nonpersistent Pollutants. Some pollutants are not readily biodegradable but are not persistent in the marine environment. For example, high or low pH wastewater discharges and high temperature may have adverse ecological effects in the immediate vicinity of the discharge point, but these effects rapidly disappear outside this limited zone. Seawater has a high buffering capacity, so significant changes to pH are only likely to be observed in confined or poorly flushed water bodies. Similarly, the ocean's immense heat sink capacity makes temperature changes difficult to induce except in water masses with poor circulation or of relatively low volume compared to the volume of discharge.

The viruses and pathogens in sewage and solid waste exert potentially adverse effects on public health. They are eventually killed by the bactericidal effect of sunlight or by consumption by microorganisms in seawater. Because it is difficult to detect viruses and pathogens in the environment, fecal coliform bacteria are used as an indicator of the presence of human waste and the viruses and pathogens associated with them. For the protection of public health, a variety of governments and international health organizations have recommended guidelines or standards for fecal coliform contamination of seawater. As tourist developments increase

around desirable waterfront locations, inadequate sewage treatment and solid waste management facilities destroy their recreational values (clean beaches and swimmable water).

Persistent Pollutants. Persistent pollutants are not degraded in the environment or are degraded very slowly. The most common pollutants of this type include silt and sediments, heavy metals, and chlorinated hydrocarbons (e.g., PCBs and pesticides). Silt and sediments reduce productivity of marine ecosystems by reducing the penetration of sunlight for algal photosynthesis and smothering benthic (bottom-dwelling) organisms, particularly corals. Heavy metals and certain persistent chlorinated hydrocarbons, including some pesticides, are known to be toxic to marine biota at low concentrations.

The discharge of large volumes of silt and sediments (including mine tailings) in shallow water usually has adverse impact over an area much larger than the primary area of sediment deposit. In shallow water, winds and waves often keep the water column well mixed, and winds and tides effectively move water masses over large distances. Thus, silt and sediments are likely to remain in the water column for longer periods of time and transported farther away from the discharge point before settling. Finer silt is subject to frequent resuspension by waves and currents and advection to another location.

There is a substantial body of information on the toxic effects of pollution in urbanized and industrialized harbors, bays and coastlines from all over the world (Johnston 1976; Bryan 1979; Macek et al. 1979; Sinderman 1979; Young et al. 1980; Sherwood 1982; Young 1982a; 1982b; Brown et al. 1986; and Anderson et al. 1987). But, when most people think about toxic effects of pollutants on marine life, they think about dead fish and dead corals. Toxicity, however, also refers to effects that decrease prospects for survival, growth or reproduction. In short, toxic substances are poisons, but they do not necessarily result in death. Other harmful effects include: reduction in growth rates and reproductive success, and increase in susceptibility to disease or parasites, but these are often difficult to observe in the marine environment.

Heavy metals and most persistent organic compounds are readily absorbed by particulate matter. These pollutants usually settle at the sea bottom along with associated particulates and gradually build up concentrations in the sediments as long as the source of the discharge remains. Because benthic organisms tend to have little or no mobility, it is much easier to observe toxic effects in corals, clams, sea urchins, sea stars, worms and bottom-dwelling fishes.

The appearance of potentially toxic chemicals in fish and shellfish tissues is commonly accepted as proof that a variety of pollutants bioaccumulate in organisms and eventually will adversely affect human health. Concern about bioaccumulation is fueled by well-publicized harmful effects such as the effect of mercury on humans (Minamata disease) who have consumed contaminated fish and shellfish, the linkage between PCBs and cancer in humans and the effect of dichlorodiphenyltrichloroethane (DDT) on eggshells of predatory birds (i.e., eagles, ospreys and pelicans).

The terms "bioconcentration," "bioaccumulation" and "biomagnification" are frequently used. Unjustified fears arise partly because of misuse of these terms. Macek et al. (1979) have recommended the use of the terms as defined in one of the leading reference texts in aquatic toxicology. Bioaccumulation is the uptake of chemicals via both bioconcentration (uptake through external tissues) and from food sources (i.e., through the intestinal wall). Biomagnification is the process by which the concentrations of contaminants in the tissues substantially increase as these contaminants move up the food chain to higher trophic levels. For example, if the concentration of DDT in the tissues of a carnivore were 10-100 times higher than the concentration of DDT in the tissues of its main food source in the same contaminated body of water, biomagnification of DDT occurred in that food chain.

Few chemicals are known to biomagnify in the aquatic food chain, but those that are known to do so lead to adverse effects on higher trophic levels, including human consumers of seafood. Thus, chemicals that have high potential for biomagnification are of concern to the marine environment.

Macek et al. (1979) suggested that only DDT was likely to biomagnify in food chains. However, Thomann (1981) showed that PCBs also biomagnify. Data from southern California suggest that methyl mercury, DDT and PCBs have biomagnification potential (Young et al. 1980). They found no evidence of increase in concentrations in nine of the ten metals investigated, methyl mercury being the exception. Bryan (1979) also concluded that the more persistent chlorinated hydrocarbons such as DDT and its metabolites and methyl mercury show appreciable biomagnification.

Once in the aquatic environment, mercury tends to be absorbed rapidly by organic and inorganic materials. Thus, suspended solids and bottom sediments rapidly scavenge mercury from the water column. Bottom sediments develop high concentrations of mercury relative to the water column. In anaerobic bottom sediments, the mercury rapidly reacts with sulfides to form cinnabar. In oxygenated sediments, bacteria will slowly transform inorganic mercury into methyl mercury, which is highly reactive with organic matter and is rapidly taken up by biota.

Toxic hazard and persistence

Toxicity and bioaccumulation alone are not useful measures for assessing risk to biological communities or human health. Many chemicals undergo some degree of bioconcentration and bioaccumulation; but when organisms are transferred to a clean environment, many of these chemicals are rapidly excreted. Macek et al. (1979) noted that a hazard of bioaccumulated contaminants is their persistence in tissues.

Both the toxicity and bioaccumulation potential of a toxic compound are greatly affected by the rate of elimination from the organism. Common processes by which organisms can cleanse themselves of contaminants include excretion, defecation, diffusion, body secretions (e.g., mucus) and molting (in the case of crustaceans) (Bryan 1979). In most cases, self-cleansing (depuration) implies that the organism is exposed to reduced external levels of contamination. This is the case, for example, of a pelagic fish species that might briefly stay in an area contaminated by wastewater, but then moves on to a cleaner area.

Some marine organisms are capable of regulating tissue levels of certain metals while still in the contaminated environment. Polychaetes, decapod crustaceans and fish show some evidence of regulation of metals in tissues, whereas bivalve mollusks do not (Bryan 1979). Most animals that have been examined harbor a group of proteins of the metallothionein type (Brown et al. 1985). These proteins bind metals, thereby making the metals nontoxic (Sanders et al. 1983). Research suggests that metallothioneins are effective detoxification mechanisms for metals unless the metal levels in the environment are so high or increase so rapidly as to exceed the body's capacity to manufacture and store these proteins.

When present in the human body in high concentrations, methyl mercury compounds produce irreversible damage to the brain and nervous tissues (Hammond and Beliles 1980). Usually, the first sign is impairment of the peripheral sensory nerves, i.e., vision, and later, of the sense of touch, hearing and balance. Loss of intellectual ability is associated with methyl mercury poisoning. Damage to the brain structure occurs long before signs of mercury toxicity appear. Minamata disease (mercury poisoning) was discovered and diagnosed 20 years after the discharge of 220 t of mercury into Minamata Bay (Japan) over a 4-year period. Thus, methyl mercury poisoning is particularly deadly because the victims suffer irreparable harm long before the symptoms appear. Furthermore, the symptoms may appear long after exposure.

Data from a wide range of polluted estuaries, harbors and coastal areas in industrialized countries indicate that PCBs and DDT are directly implicated in sublethal toxic effects on the health of fish populations (Sindermann 1979). These are synthetic compounds of comparatively modern (post-World War II) origin against which most organisms have had no time to evolve detoxification mechanisms.

Exposure

Highly mobile organisms such as pelagic fish species, birds and mammals often are

able to avoid areas of poor water quality. If exposed to a wastewater plume or a contaminated area, the duration of exposure may be short, with a quick return to a cleaner environment.

Benthic biota, in particular, may be more susceptible to urban and industrial waste discharges because they are unable to avoid adverse water conditions and are more likely to be exposed to high levels of persistent pollutants.

CONCLUSIONS

1. Waste management in the coastal zone involves knowledge of public concerns and their interactions with ecological research.
2. A preliminary risk assessment indicates that benthic species, including coral reefs and reef fish, are highly susceptible to pollution, particularly high rates of sedimentation, organic loading and discharge of persistent toxic chemicals.
3. Biodegradable pollutants are probably insignificant except in poorly flushed water bodies or shallow embayments.
4. Viruses and pathogens from poorly treated domestic wastewater pose threats to users of coastal recreation areas.
5. Discharges of mercury and chlorinated hydrocarbons have adverse effects on human health.
6. Pollutants that persist in the environment are significant in terms of long-term build-up to harmful levels in sediments or biota. Chlorinated hydrocarbons (including pesticides and PCBs) and mercury are clearly priority pollutants from the standpoint of toxicity and detoxification mechanisms and the assimilative capacity of the marine environment.

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Solid Waste Management in Singapore

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ABSTRACT

The reputation of Singapore as a "clean and green city" is a testimony to the effectiveness of the solid waste management system. Important factors which contribute to this are sound planning, advanced technology, a well-trained workforce, and effective legislation and enforcement.

INTRODUCTION

Proper refuse collection and disposal is one of the most visible challenges in environmental management.

In the early 1960s, Singapore faced an increasing population and rapid industrialization which produced more and more refuse each day. An efficient waste management system became imperative. To meet this challenge, the Environmental Public Health Division was formed in the early 1960s to provide refuse collection and disposal services. These duties were transferred to the Ministry of the Environment (ENV) in 1972.

Today, the reputation of Singapore as a "clean and green city" is a testimony to the effectiveness of its solid waste management system.

One of the first things Singapore did was to tighten its legislation. The laws against littering were improved (e.g., fines were enhanced). A "Keep Singapore Clean" campaign was launched in 1968 to educate the public on the importance of a clean environment.

SOLID WASTE MANAGEMENT

Public cleansing

The ENV now operates a fleet of 56 mechanical sweepers. As part of ENV's ongoing program to mechanize its operation, 25 "Billy Goats" have been deployed to sweep roads and walkways. There are also beach cleaning machines. Manual sweeping is done in areas which are not amenable to mechanization.

Refuse collection

Singapore is one of the few countries in the world where refuse is collected daily. For

effective control, the country is divided into seven collection areas, each of which is managed by an Environmental Health Office (EHO).

The amount of refuse collected in Singapore increased from 1.5 million t in 1985 to 2.1 million t in 1990. The ENV collects wastes from households and commercial areas. These wastes form nearly 50% of refuse collected in the country. Refuse from industrial and institutional premises are normally handled by private waste collectors licensed by ENV.

The ENV uses rear-loading compaction trucks fitted with hydraulic lifting mechanisms to handle refuse contained in bulk and small bins. Whenever road condition permits, bigger compaction trucks are used to improve efficiency of collection. Also, roll-off compactors have been used in large bin centers to improve productivity and reduce odor nuisance at the bin centers.

Refuse collection trucks are deployed daily from the seven EHOs early in the morning and again in the afternoon. The ENV operates and maintains a fleet of 209 trucks.

The two basic types of collection are:

1. Direct collection - refuse is directly discharged from the houseowners' bins into the truck by manual labor.
2. Indirect collection - refuse from high-rise apartment blocks is transferred to bulk bins and roll-off compactors. The trucks collect refuse stored in bulk bins at the bin centers.

Items that are too bulky to be collected by trucks are removed by special scowl-end crane tippers.

New public housing blocks are also designed to have centralized refuse chutes. The refuse collected will be directly discharged into a dust-screw compactor at the bottom of the chute. This will dispense with the need for bin centers for refuse storage and collection.

A centralized vehicle workshop repairs and maintains ENV's fleet of refuse trucks and mechanical sweepers. With computerized stores and maintenance systems, mechanized tools and precision-testing equipment, the workshop ensures a quick turnaround time. A computerized "waste management system" provides on-line monitoring of status performance of each refuse collection vehicle.

Over the years, ENV has acquired substantial experience in the planning and management of refuse collection. Its engineers have continuously improved equipment to suit local conditions. For example, the refuse collection vehicles supplied by foreign companies were found to be unsuitable for tropical weather. Unlike those in temperate countries, our refuse has higher water content. Using in-house expertise, the engineers were able to modify the specifications of the vehicles to solve the leaking and corrosion problems.

Disposal by sanitary landfill

Before 1979, solid waste was disposed of by sanitary landfill in swampy areas. The two landfills in Singapore are at Lorong Halus (Tampines) and Lim Chu Kang. At these landfills, the refuse is first weighed at the weighbridges. The ENV computer system records the weight, source and type of refuse upon insertion of an account holder's magnetic card. The refuse disposal charge is also computed automatically.

The ENV has acquired substantial expertise in the design and management of landfills. These are lined with impermeable liners to prevent leachate from contaminating the ground- and seawater.

Incineration

Although landfill disposal is relatively simple and satisfactory, land is scarce in Singapore. Hence, alternative methods of solid waste disposal were studied in the early 1970s. Incineration was found to be the most cost-effective as it reduces the volume of solid waste by 90%. The first incineration plant at Ulu Pandan was commissioned in 1979 with an initial capacity of 1,200 t/day which increased to 1,600 t/day in 1982. A second incineration plant at Tuas was completed in late 1986 with a capacity of 2,000 t/day. About 60% of the total collected solid waste is burned in the two incineration plants.

A third plant with a capacity of 2,400 t/day is under construction in Senoko. It is expected to be commissioned in 1992. Together, the three incineration plants would

be able to handle the incinerable waste till the turn of the century. As about 85% of the refuse is incinerable, the remaining 15% has to be disposed of by sanitary landfill.

Similarly, refuse collection vehicles entering the incineration plants are weighed at the weighbridges. The refuse is then emptied into refuse bunkers through discharge bays at the reception hall. Overhead grab cranes operating from a control room feed the refuse into the incinerators. After incineration, the residue goes through overhead magnetic separators which pick up scrap metal. The ash is later transported to the dumping ground for disposal while the recovered scrap metal is sold to a steel mill for recycling.

The heat from incinerators is used to generate steam which in turn drives a turbine generator to produce electricity. Part of the electricity generated is used to operate the plant, and the surplus is sold to the Public Utilities Board.

To prevent air pollution, equipment such as electrostatic precipitators have been installed to control dust and smoke emissions. This ensures that the gases discharged through the chimney into the atmosphere is clean.

Years of experience in the operation and maintenance of two incineration plants have equipped ENV engineers with the expertise to ensure that the new plant will have all the necessary features to suit our tropical conditions.

Transfer station

The Kim Chuan Transfer Station was built in 1986 following an ENV operational research study on the collection of refuse.

Refuse collected from the eastern half of the island is compacted into 20-t container-trailers at the transfer station. These container-trailers are then driven to Tuas for refuse disposal. This method has resulted in better utilization of refuse trucks as well as reduced manpower requirements and haulage cost. Total cost savings amount to S$19.5 million per year.[1]

CONCLUSION

Sound planning, advanced technology, a well-trained workforce, and effective legislation and enforcement are important factors contributing to an effective solid waste management system in Singapore.

Armed with solid expertise, ENV drives forward to make the country a model environment city. This expertise can now be tapped by overseas parties through ENV's newly formed private subsidiary company, the Singapore Environmental Management and Engineering Services Pte. Ltd. (SEMES).

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[1]September 1991: S$1.69 = US$1.00.

Assessment of Waste Management in the ASEAN Region

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ABSTRACT

This paper presents a general survey of the nature and physical extent of waste collection and disposal problems confronting the coastal areas of the six ASEAN member-countries. Current management practices for domestic, agricultural and industrial wastes are also summarized. Estimations of present and future waste generation and pollution loading rates are based on current and projected populations, rate and type of industrialization, and the level of pollution control in each nation.

Domestic sewage is a major source of organic pollutants in the region's coastal waters. Except in Singapore and Brunei Darussalam, sewage undergoes little or no treatment before being discharged into rivers and the sea. Agricultural waste, mostly from livestock farms, pesticides and fertilizers, is also a major cause of organic pollution, except in those two countries. Solid waste, on the other hand, is often dumped in unauthorized locations due to lack of proper disposal sites. Untreated industrial effluents are discharged into the waters, except for Singapore and Malaysia. Hazardous waste, which has been a major problem in more industrialized nations, is just beginning to cause concern in the ASEAN region.

It is suggested that the ASEAN make progress by taking "bite-size chunks" to avoid being overwhelmed by the waste management crisis, which could induce a lack of focus and direction.

A menu of possible technical solutions and suggestions under varying circumstances for each nation is presented.

THE ASEAN REGION: AN OVERVIEW

The geographic, socioeconomic and demographic features and the general environmental conditions of the individual ASEAN member-countries are summarized in Tables 1 and 2.

Negara Brunei Darussalam

Brunei Darussalam is a small coastal country bordering the South China Sea. More than 85% of the population lives in the coastal zone, in urban areas around the capital (Bandar Seri Begawan) and in Kuala Belait-Seria. Residents have a high per capita income of over US$12,000 and a corresponding high standard of living (Chua et al. 1987; De Silva et al., this vol).[1]

[1]Costs are in US$ unless otherwise specified.

Table 1. Physical and climatic features of ASEAN member-countries.

Country	Land area (km²)	Land use (%)	Physical features	Vegetation	Climate
Brunei Darussalam	5,765	Cultivated 0.3 Forest 85 Pasture 1	• Rugged and hilly except for narrow coastal plains • Mountain territory heights of 300 m • Highest point is Bukit Pago at 1,841 m	• Covered by tropical forest with large variety of hardwood species	• Governed by equatorial monsoons • Hot and humid • Heavy rainfall (2,500 mm on coast; 5,000 in interior) • Heaviest rainfall in November and March • Average temperature is 27°C
Indonesia	1,904,569	Cultivated 31 Forest 31 Pasture 6	• Consists of 13,600 islands • 6,000 inhabited islands • Pronounced mountain ranges and extensive lowlands on larger islands • Little coastal plains on smaller islands that rise steeply from the sea • Volcanic eruptions common	• Variable dense tropical forests and tidal swamps, normal lowlands and savannah • Forests thinner towards the east	• Heavy rainfall all year-round with peak periods in the west and greatest amounts from December to March • Little variation in high temperatures (26-27°C) • Dry season in the south (June-October) • Maritime equatorial climate
Malaysia	329,758	Cultivated 15 Forest 80 Pasture 2	• Mountain ranges reach 2,100 m and run north to south, swampy forests and lowlands to the east of Peninsular Malaysia, Sabah and Sarawak • Wider lowlands and longer rivers in Sabah and Sarawak; outstanding feature is Mt. Kinabalu at 4,101 m	• Equatorial forest cover • More dense and continuous on Sabah and Sarawak than in the peninsula	• Variable rainfall in Sabah and Sarawak • Rainfall average 2,540 mm/year in the peninsula • Average temperature is 21-32°C • Equatorial climate
Philippines	300,000	Cultivated 41 Forest 53 Pasture 1.4	• Consists of 7,107 islands • More than one dozen active volcanoes • Interior mountain ranges reach 2,400 m in larger islands • Extensive lowlands in a few islands	• Both hard- and softwood species in forest cover	• Regional variation in rainfall • Mean annual temperature is 27°C • More exposed parts of country subject to typhoons • Maritime tropical climate
Singapore	626	Cultivated 3.2 Forest 4.6 Pasture -	• Island's granite core reach heights of 100 m • Surrounded by marshy lowland • Height rarely exceeds 15 m	• Remaining rainforests being preserved	• Hot and humid • No defined seasons • Average rainfall is 2,367 mm/year • Average temperature is 27°C
Thailand	513,115	Cultivated 50 Forest 29 Pasture 8	• Mainly narrow coastal lowlands backed by low mountain ranges in Peninsular Thailand • North consists of uplands at varying heights surrounding a large central plain	• Includes tropical monsoon forests • Denser in the uplands, thinning in the lowlands	• Tropical temperature range of 24-30°C throughout the year • Rainfall below 1,500 mm/year • Hot and dry season from October to February • Rainy season from May to September

Sources: Compiled from EPL (1990) and *The New Encyclopedia Britannica* (1991).

The country's economy is based on its petroleum resources. Most of the economic activities, including the petroleum-based industry, are found in the coastal zone, with only a small area devoted to agriculture (Chua et al. 1987; EPL 1990 and De Silva et al., this vol.).

There appears to be no major pollution problems along the coast, other than the potential pollution from oil and gas exploration activities, and some discharges of partially treated and untreated domestic sewage, especially from water villages. Brunei Darussalam has antipollution legislation, but enforcement has yet to be improved (Chua et al. 1987).

Indonesia

Indonesia is an archipelago of some 13,600 islands, of which around 6,000 are inhabited. Its coasts face the Indian Ocean on the west and south, and the Strait of Malacca and the South China Sea on the north. Indonesia has the second longest shoreline in the world.

Table 2. Some ASEAN socioeconomic data.

Regional performance figures	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Population						
Total 1989 (million)	0.3	184.6	17.4	64.9	2.7	55.6
1989 density (person/ha)	517	948	526	2,163	43,200	1,082
% average annual growth 1981-1988	2.7	2	2.5	2.8	1.2	1.7
Projected year 2000 (million)	0.3	222	20.9	85.5	2.9	65.5
Urban population (%)	59	26	35	41	100	17
Infant mortality (per 1,000)	11	83	31	48	7.4	50
Life expectancy (year)	71	58	67	66	73	65
Workforce						
Total (million)	0.09	72.2	6.30	25.2	1.3	30.4
% Commerce/services	26.4	29.8	27.6	36.2	63.5	20.5
% Manufacturing	8.6	8.3	17.3	20.6	28.5	10
% Agriculture/fishing	5	56.1	30.8	10.0	0.4	57
% Construction	33[a]	-	6	7.6	6.7	2.7
% Government and public authorities	40	5.8	13.5	25.7	5.5	6.3
Social						
Person per hospital bed	260	1,550	668	628[b]	270	600
Person per doctor	1,690	7,440	2,700	6,667	837	5,000
Car (thousands)	89	1,320	1,600	377	239	1,150
Production and prices (1988)						
GDP at market prices (US$ billion)	2.9[a]	64.15	24.5	39.2	24.5	56.1
Per capita income (US$)	12,772[a]	403.7	1,875	667.4	8,162	1,038
GDP, real growth (%)	-	3.59[a]	8.7	6.4	11	11
Agriculture as GDP	1.46[a]	25.5	18.2	23.0	0.4	16.9
Manufacturing as GDP	52.4	13.93	25.6	25.1	30.1	24.4
Consumer prices (% rise)	-	5.47	2.5	8.8	1.6	3.8

[a]1987.
[b]1986.
Source: FEER (1991).

More than 60% of its 180 million people live in rapidly growing cities in the coastal zone (Salim 1985; EPL 1990).

The country faces major challenges in environmental management because of the large and very fragmented land area, low per capita income (below $500) and uneven distribution of resources and population. Most of the industries are concentrated on the islands of Java, Madura and Bali, which represent only 7% of the country's land base but have 65% of the country's population. Most financial and technical resources are also concentrated in Java and Jakarta.

Oil and gas exploration is a significant component of the economy. Oil is mainly produced and processed in Sumatra, the largest exclusively Indonesian island. Other activities are tin mining, onshore and offshore agriculture (rice, rubber and coconut) and aquaculture (EPL 1990). Although manufacturing forms a small percentage of the country's economic activity, the discharges from palm oil industries and coconut processing plants affect the quality of coastal waters. The recent government initiative to add value to domestically produced raw materials and move from small-scale agricultural and forestry processing to large-scale petrochemical plants and hard-metal processing units has compounded the water pollution problem.

Coastal resources use will increase as the population grows. Because of coastal and upland activities, the marine and coastal environment is subjected to stress and degradation, including pollution from oil

spills, siltation, pesticides, fertilizers and other untreated wastes (NDPA 1988).

The major constraints to improving environmental quality are the lack of adequate training facilities and technical manpower as well as insufficient financial resources. Establishing an environmental control program can address the problem.

Malaysia

Malaysia comprises Peninsular Malaysia, which includes a number of islands, and the states of Sarawak and Sabah, which form Eastern Malaysia. Peninsular Malaysia is bordered by the Strait of Malacca on the west and the South China Sea on the east. The latter also abuts Eastern Malaysia.

Most large cities like Kuala Lumpur, the capital, are located in the peninsula, which has 65% of the total population (EPL 1990). In addition, Peninsular Malaysia accounts for approximately 90% of the country's manufacturing output.

The country has the largest tin deposits in the world, but one of its main economic resources is petroleum. Recent government policies promote diversification of manufacturing industries into electronics and transportation equipment. Agriculture's major produce are rubber and palm oil (EPL 1990).

Rapid economic growth (seen in the per capita income of about $2,000) and political stability have contributed to the implementation of good environmental programs. A water quality monitoring program, which can document the state of the environment and the performance of pollution control measures, has been implemented (DOE 1989). The country also has institutions of higher education which provide excellent training in environmental science.

Philippines

The Philippines' total population of more than 60 million inhabits only 880 of the country's 7,107 islands, with 70% living in coastal areas (EPL 1990). Increasing urbanization is seen in the concentration of 40% of the populace in urban areas. Metro Manila alone is home to approximately 8 million people and 69% of the industries (DENR 1990).

The economy depends mostly on the primary sector (agriculture/fishing/forestry). In spite of government efforts during the 1980s toward import substitution, the manufacturing sector is weak.

The country has developed environmental laws and regulations which form the essential framework for future progress, but geographical fragmentation, low per capita income (around $700), political instability and division of responsibilities among numerous government agencies, hinder pollution control efforts.

Singapore

Singapore is a large urban center, densely populated and highly industrialized. It is located on a major international sea-lane for commercial shipping and is the world's busiest port in terms of shipping tonnage (Chia et al. 1988; EPL 1990). The low but stable population growth and rapidly growing economy (around $10,000 per capita income, a close second to Brunei Darussalam) have resulted in a relatively affluent population.

In the 1960s, Singapore's textile-, clothing- and electronics-dominated industry was characterized as labor-intensive. In the 1970s and 1980s, it moved towards more skill-intensive, high-technology enterprises such as the manufacture of petrochemical products, precision instruments and transportation equipment (including shipbuilding and aerospace manufacturing), and biotechnology. This new orientation towards industries that require higher skill levels and technology has resulted in higher value-added industries in Singapore's economy.

Coastal water pollution is not considered a serious problem because of the dynamic pollution control program and the good flushing effect of strong tides and currents in the south of Singapore Island (Chia et al. 1988; EPL 1990). Johore Strait, however, has become polluted due to the partial restriction on water circulation created by the causeway linking Singapore to Malaysia, and the urban and industrial developments on both sides of the strait.

The country has a well-developed legal infrastructure and well-trained technical and administrative personnel for waste management. It has an excellent wastewater collection/treatment system and the most stringent environmental standards and procedures in the region. Waste management measures, which include the "polluter pays" principle, are strictly enforced.

Thailand

The greater part of Thailand lies on the north of Bangkok, its capital. Peninsular Thailand, which extends south to Malaysia, is bordered by the Gulf of Thailand and Andaman Sea.

The country's limited degree of urbanization is shown in the relatively even socio-geographic distribution of its 55 million people (with a per capita income of $1,000). An estimated 17% of the population lives in urban areas, 10% of which lives in Bangkok.

The main natural resources are provided by agriculture, although there are some natural gas reserves, tin deposits and small quantities of petroleum (EPL 1990). The Thai industry is no longer dominated by primary resource processing, particularly agricultural (e.g., rice milling). The textile industry, however, was the largest export earner for 1986. The manufacturing trend is towards more high-technology industry such as electronics.

Climatic and demographic features and environmental status of the region

The region's climate, with year-round high temperatures (average of 27°C) and heavy rainfall (2,000-5,000 mm/year) is a significant factor in waste management. For example, solid waste, which has a high moisture content, has to be collected daily, not weekly, as is the case in most industrialized nations. Ground disposal of wastewater may be inappropriate in many parts of the region due to a high groundwater table.

The region's population density is approximately 325.5 million people on a total land area of 3.05 million km^2. The projected ASEAN population is 400 million by the year 2000. Thus, proper management of domestic sewage and solid waste is crucial, especially in major urban centers.

The income level is known to correspond with the waste generation rate of each nation. It is also an indication of the health care system, life expectancy and infant mortality rates (Table 2), which may be affected by the prevailing waste disposal system. Singapore and Brunei Darussalam provide good medical systems and thus, show higher life expectancy and lower infant mortality rates. Indonesia has the lowest life expectancy and the highest infant mortality rates.

The lack of agricultural waste management has drastically affected the environmental quality of nations with dominant agricultural and fisheries sectors, particularly Thailand, Indonesia and Malaysia (Table 2). The relatively small percentage of gross domestic products (GDPs) from the manufacturing industry in each nation means that hazardous waste does not yet pose a major threat, but this situation will change with rapid industrialization.

Singapore is the only nation in the region whose waste management activities are centralized within the Ministry of Environment. The others have yet to consolidate waste management activities, for which responsibility is still fragmented among many agencies. Singapore has skilled manpower and good laboratory facilities for monitoring, enforcing and implementing waste management regulations and plans. In others, budget constraints and the lack of skilled manpower and laboratory facilities impose waste management difficulties. Compliance with existing legislation is seldom monitored or enforced. There are waste management plans, but their implementation has been very slow.

STATUS OF WASTE MANAGEMENT SYSTEMS

Sewage

The major source of organic pollutants in ASEAN coastal waters is domestic sewage from both rural and urban centers. The increasing population density in coastal and

urban areas has further worsened the environmental condition of marine waters, due to the lack of services, policies and plans for the prevention, management, collection, treatment and disposal of waste. The level of domestic sewage pollution is high, particularly in the Upper Gulf of Thailand, Manila Bay, Strait of Malacca, West Coast of Peninsular Malaysia, North Coast of Java Island and Jakarta Bay.

Sewage collection is a basic problem in countries with few piped sewer systems. Sewage treatment plants (STPs) are generally lacking. The most common method of wastewater disposal is direct discharge into rivers or the sea.

The majority of the populations in Indonesia, Malaysia, the Philippines and Thailand use the individual septic tank system, which is also widely used in Brunei Darussalam. The septic tank drain fields are often installed in inappropriate soil and groundwater conditions, and effluent is often discharged into street drains or the nearest stream. Household wastewater, other than excreta, is also often disposed of in drains.

Most urban areas in Brunei Darussalam have sewers that lead to STPs, where sewage is given secondary treatment. An exception is the Pintu Mabim plant, which gives only primary treatment (De Silva et al., this vol.).

There are places which are not yet served by STPs (e.g., Kuala Belait). A particular problem area is Kampong Air, a water village on the Sungai Brunei Estuary. Its approximately 25,000 inhabitants throw their sewage and garbage into the surrounding waters, contributing about 10% of the total biological oxygen demand (BOD) to the country's waterways (PWD 1990; De Silva et al., this vol.).

A two-pronged approach has been considered: relocate residents and improve waste disposal facilities for the remaining residents, i.e., install gravity and vacuum sewer systems with central treatment (PWD 1990).

Around 5% of the population of Malaysia is served by sewers, and about 70% of households use either septic or Imhoff tanks. Up to 40% of the inhabitants do not reside within a municipality or a district, and thus receive no organized sanitation service.

Penang has sewers which collect waste from approximately 60% of its households. Raw sewage is disposed of through an ocean outfall. As a result, fecal coliform levels near the outfall are high enough to prohibit shellfish farming or fishing in the vicinity. Aquaculture farms have also experienced diseases from fecal microbial contamination (Sivalingam 1984).

Jakarta, Indonesia's capital, lacks sewer systems. Most household sewage that has not been in contact with excreta is discharged through open channels into rivers. This poses a health problem, since gray water can still have high fecal coliform levels. In about 60% of households, human waste is disposed of in septic tanks and septage is pumped for disposal. Other households do not have a septic tank system or an adequate sanitation facility (Ruddle 1981).

The Jakarta Sewerage and Sanitation Project plans to provide comprehensive sanitation management to the Setiabudi area in the center of Jakarta. The pilot project will service 400,000 people, which is about 10% of the city's population. It will provide conventional sewers to areas that have the ability to pay, and experimental sewers to less affluent areas. The existing subsurface disposal systems of the nonsewered areas will also be improved. Because much of the collected sewage will be discharged untreated, there are plans for sewage treatment facilities (SEATEC 1988).

In the Philippines, only about 12% of Metro Manila's population is served by a sewer system (DENR 1990; Triatmodjo 1990). A central collection system conveys sewage to the Tondo pumping station, and then to a 2.7-km outfall into Manila Bay. Sewage is discharged untreated. Communal septic tanks are also used in parts of Metro Manila (e.g., Quezon City).

Manila Bay's bacterial counts have reached unacceptable levels, and eastern beaches are unfit for bathing, fishing and aquaculture. All five rivers of Metro Manila are biologically dead.

The provision of sanitary sewerage services for other Philippine cities is not a high priority because the need to develop water supply systems is more urgent (SEATEC 1988).

Almost 90% of Singapore's population is served by a system of sanitary sewers and STPs. There is no provision for stormwater treatment, although parking lots have oil and

grease traps while construction sites are required to install silt traps.

All six central STPs in Singapore have activated sludge systems, which provide secondary treatment, and more than 500 government STPs have been built to service individual developments. Sludge produced at the STPs is used in development projects and land reclamation sites (Tan, this vol.). The treated effluent is discharged into the sea, approximately 1.15 km from the shore. Some of the effluent is treated further at the Jurong Industrial Water Works to produce industrial water (Triatmodjo 1990; Tan, this vol.).

The estimated sewage generation rate in Singapore is 140 l/capita/day (lcd) from public housing, and 240 lcd from private housing. Average flow to the sewerage system is approximately 300 lcd, including non-domestic contributions. This flow rate is comparable to industrialized nations'.

Almost 95% of urban households in Thailand have modern pour-flush or cistern toilets, although fewer than 100,000 people are served by conventional sewerage or centralized STPs (UNDP-WB 1991).

In Bangkok, for instance, there is a lack of conventional sewerage since groundwater supply is considered more important. Because of growing concern with pollution, however, the government plans to design and construct large STPs in and near Bangkok (SEATEC 1988; UNDP-WB 1991). The Bangkok Metropolitan Authority (BMA) is planning to privatize these facilities.

At present, seven Thai cities operate wastewater treatment plants. The Public Works Department has identified 67 cities where wastewater treatment systems are to be built over the next 12 years (UNDP-WB 1991).

Phuket Island, a popular tourist destination, is greatly affected by organic pollution. To reduce the severe environmental impacts caused in part by sewage contamination of the major watersheds, an STP was built in Patong and has been in operation since 1989. Plans are being developed for another STP in Karon/Kata (Branan 1990).

Solid waste

The dumping of municipal solid waste (MSW) has become a serious environmental problem in the region due to increasing population densities and the absence of adequate collection and disposal facilities. Some MSW are buried, some are open-burned and a lot are dumped directly or indirectly into the river systems or the sea. These also accumulate in some unauthorized dumping locations. They enter and clog surface drains and are flushed into coastal waters. In Metro Manila, solid waste deposited in rivers has caused floods, creating serious health hazards as in increased gastrointestinal cases during the rainy season.

The typical MSW in the region consists mostly of putrescible vegetable matter with a high moisture content. The second largest component is paper, which cannot be burned easily without the addition of another type of fuel (e.g., gas).

Collection. In Brunei Darussalam, collection services are available in urban and surrounding areas. Soon, Kampong Air will be serviced, based on the positive results of a pilot project for solid waste collection here in 1989 (PWD 1990; De Silva et al., this vol.). Twenty-five percent of Indonesia's MSW is collected as often as once a day in some areas (Sicular 1989; Sri Bebassari et al., n.d.). In Malaysia, 90% of urban solid waste is collected by municipal crews and private contractors; 80%, in incorporated rural areas. The high percentage of the municipal budget allotted to solid waste management (about 20-80%) must be partly the reason for its MSW collection efficiency. In the Philippines, about 80% of the MSW in urban areas is collected (DENR 1990). In 1987, 80% of Bangkok's households received MSW collection services (Trivichien 1988; Thongkaimook 1990). Singapore has daily collection services, so illegal dumping is rare.

Land Disposal. Generally, collected MSW is deposited in open dumps, but other disposal methods are now becoming more common.

One is the sanitary landfill. Singapore has two landfills, with another under construction. Indonesia, Thailand and the Philippines (near Metro Manila) have their own, too; one is being planned in Brunei Darussalam (in Muara District) (De Silva et al., this vol.).

Another means is dumping it in low-lying areas for land reclamation. This practice, however, can result in the production of

leachate, which may contain heavy metals that may contaminate the groundwater and affect the water supply. It can also result in floating debris along coastlines. Malaysia has recently dumped MSW for land reclamation near Penang, and water quality monitoring in the area indicates that heavy metals are rapidly leaching out into the coastal waters (Sivalingam 1984).

Recycling. Uncontrolled and widespread scavenging takes place in the collection areas and open dumps of the region. In 1990, an estimated 300 t/day, or 8% of the total solid waste generated in Metro Manila, was recycled by scavengers and MSW collection crews. Recycling programs are being established in Singapore for paper and cans, and in Malaysia for paper, through a National Council for Recycling. In 1990, Singapore recovered 18,500 t of scrap metal, about 3.8% of the country's total solid waste, at two incineration plants. The recovered scrap metal was sold at $0.82 million the same year (Tan, this vol.).

Composting. Indonesia and Thailand are operating formal public composting facilities with limited success. In both countries, use of the facilities is not maximized, and produces a high percentage of rejects. Thailand's composting installations, which operate at about 50% capacity, work in conjunction with small incinerators which burn the composters' rejects. Composting operations in the country are not economically viable, as the cost of hauling compost to the agricultural lands exceeds the market value of the compost (Trivichien 1988). Nevertheless, a new 100-t/day composting plant is scheduled for construction in 1991 (Thongkaimook 1990).

Incineration. Incinerators are in use in Indonesia, Malaysia, Singapore and Thailand. Singapore disposes of 57% of its MSW as it produces surplus electricity that can be sold. Another incinerator is being built, so all combustible solid waste (approximately 90% of the total solid waste) can be burned (Tan, this vol.). The high cost involved is justified because of the value of land in Singapore. Incinerators have been rejected in Brunei Darussalam because they have not been found to be cost-effective (De Silva, et al., this vol.).

Agricultural waste

Agricultural waste is the second most important source of organic pollutants in the region. The three main components of agricultural pollution entering the rivers and coastal waters are: organic refuse from livestock farms; fertilizers and pesticides; and siltation from erosion.

There is no evidence of agricultural pollution problems in Singapore and Brunei Darussalam. In Brunei Darussalam, however, stormwater runoff carries substantial amounts of silt due to the presence of highly erodible soils.

Livestock Farms. Although most livestock manure is merely recycled by spreading it on agricultural land, poultry and pig wastes are produced in large quantities constituting a significant source of pollution in the marine environment, except in Singapore and Brunei Darussalam (Leong 1988; Tan, this vol.).

In Malaysia, an estimated 10-25% of the agricultural organic wasteload to the coastal waters is from livestock effluents, particularly from pig farms located beside rivers. Due to the government's current stringent environmental regulations, livestock wastes have to undergo primary treatment in oxidation ponds prior to disposal (Sivalingam 1984). Singapore, on the other hand, has phased out pig farms entirely and placed controls on poultry farms (Leong 1988; Tan, this vol.).

In Thailand, 50% of the agricultural solid waste is sold as soil conditioner and approximately 10% is discharged into fishponds. Solid waste from other agro-industries is often recycled as fuel or composted.

Fertilizers and Pesticides. Synthetic fertilizers and pesticides are widely used in agriculture (Table 3). Several countries, recognizing the dangers these substances pose to the environment, have taken regulatory and enforcement steps to control their use. Indonesia formulated new policies which ban some pesticides and remove government subsidies for fertilizer. Thailand also eliminated financial grants for the purchase of chemicals and instituted government training programs for farmers to help them reduce or eliminate the use of chemical fertilizers and pesticides.

In Indonesia, pests and diseases cause estimated yield losses of 20-30% in rice and

Table 3. Fertilizer and pesticide use in the ASEAN region.

Country	Total cropland area (ha)	Ha/capita (1989)	Irrigated land[a] (%)	Fertilizer use (kg/ha)	Pesticide use[b] (t)
Indonesia	21,200	0.12	34	100	16,344
Malaysia	4,380	0.26	8	154	9,730
Philippines	7,930	0.13	18	4,415	-
Thailand	20,050	0.37	20	26	22,289

[a]1985-1987.
[b]Active ingredient.
Source: WRI (1990).

10-20% in other crops. Agricultural pesticides, which are used in small farms and large estates, are propineb, carbofuran, butylphenyl-n-methylcarbamate (BPMC), dalapon and phenthoate. Of the total pesticide use in the country, insecticides account for 75%, with application on rice crops making up 75% of the total insecticide use (ADB 1987).

The principal pesticides used in Malaysian agriculture are paraquat, dalapon, diuron, 2,4-D, methamidophos, permethrin, cypermethrin, malathion and carbaryl. Three crops, i.e., rubber, oil palm and rice, account for 90% of the annual pesticide use. Seventy-five percent of the pesticides are herbicides for rubber and oil palm plantations. Insecticides, however, are more commonly used on vegetable, rice and tobacco crops (ADB 1987).

In the Philippines, the main pesticides used are monocrotophos, phenamiphos, tridemorph, butachlor, chlorothalonil, mancozeb, endosulfan, azinphos-ethyl, chlorpyrifos + BPMC and parathion-methyl. Insecticides are most extensively used, at 55% of the total. Rice production is the largest consumer of all insecticides at 46% of the total, and vegetable crops at 20% (ADB 1987).

Pesticides are the most popular means of crop protection in Thailand, particularly for rice, vegetable and cotton crops. Generally, insecticides are used in vegetable and rice production; herbicides, in rubber, palm oil and sugar cane production; and fungicides, on vegetables and fruit crops. Key pesticides in Thailand are: 2,4-D, paraquat, dalapon, parathion-methyl, copper oxychloride, atrazine, monocrotophos, dimethoate, diuron and ametryne (ADB 1987).

The ASEAN member-countries have similar health and environmental concerns with respect to pesticide use in agriculture. Some of these concerns are: potential toxic residue on locally consumed foods and exported crops; possible adverse effects on fish and other marine life, soil and water bodies; pest resistance; and occupational and accidental poisoning due to indiscriminate farm use and careless handling during manufacturing, toxic waste disposal and effluent discharge by pesticide manufacturers.

Siltation from Erosion. Deforestation, land-clearing and agricultural practices without proper erosion control and protection of watersheds have resulted in increased silt and sediment deposition in rivers and coastal waters. This accelerated sedimentation is sometimes considered one of the most dangerous forms of pollution in the coastal waters of Southeast Asia. Sediment accumulation can smother coral reefs, change the characteristics of the surrounding waters and block navigation channels. The mining industry also contributes to increased siltation, but its effect is not as widespread or as damaging as that of poor agricultural activities.

In the Philippines, almost 30% of the total land area is subject to major soil erosion caused by deforestation and farming practices (Ruddle 1981). This is aggravated by the presence of 50% of the operating mines in the coastal vicinity which use the sea as the final disposal site of mine tailings. Aside from the high solid content, mine tailings contain metals and toxic chemicals used in metal extraction processes, which have reportedly smothered coral reefs, particularly in Southern Philippines (Deocadiz 1990).

In Thailand, poor agricultural practices and the lack of reforestation schemes are causing silt from eroded soil (1.5 million t/year) to be deposited at the mouth of rivers that empty

into the northern part of the Gulf of Thailand. This has resulted in a delta (measuring 3,700 km^2) and turbid inner gulf waters. In Malaysia, a combination of farming, forestry and mining operations has also led to high sediment loads in most rivers, particularly in Peninsular Malaysia.

Agricultural practices and the inadequate protection of watersheds have been blamed for the accelerated sediment deposition in the waters of the urbanized Indonesian coast. The forest industry and tin mining operations account for sedimentation in rural coastal areas.

Industrial waste

The major industries in the region involve palm oil, rubber, tapioca, pulp and paper, sugar cane and petroleum processes, which are not concentrated in urban centers. The agro-industries, a significant fraction of the industrial base in the region, are distributed in remote rural areas.

More than half of the manufacturing industries are located along riverbanks or in coastal areas. Coastal waters, in effect, are made convenient "wastebaskets" of untreated industrial wastewaters. Industrial waste control is the responsibility of individual plant systems, but industries tend to use less advanced technologies, which result in marine contamination by undesirable substances in these wastewaters.

The introduction of waste treatment standards is perceived to increase production costs and thus, make industries less competitive. In Singapore, for example, some industries such as tanning, moved out because of the added cost for wastewater treatment due to the strict regulations on effluent limits of wastewater discharging into municipal sewers. Singapore's policy is to attract more value-added, rather than pollution-causing industries.

Singapore and Malaysia have been leaders in the establishment of industrial waste treatment standards. Both have implemented pollution control regulations specifying discharge limits and a licensing system based on the "polluter pays" principle. As a result, a large number of medium and large industries have installed pollution control and wastewater treatment facilities. Industrial parks have been established and the sharing of a central waste treatment facility encouraged.

Petroleum and Natural Gas Industry. A principal concern is oil pollution, which results from oil spills that occur in Southeast Asian waters (particularly the Strait of Singapore and the Strait of Malacca), in the transport of petroleum and natural gas (Chia et al. 1988). It is also caused by oil exploration activities, deballasting and tank cleaning, and discharges from bilge, bunker and dry dock. Refineries, petrochemical plants, oil ports and coastal oil fields also produce wastewater with high concentrations of phenols, ammonia, salts and heavy metals. Their discharge can cause long-term, low-level contamination.

In Brunei Darussalam, hydrocarbon contamination of the coastal waters from Brunei Shell Petroleum (BSP) activities has been observed in Seria. The BSP now has a treatment plant for oily wastes and has developed an Environmental Management Plan to address in-house waste management practices (De Silva et al., this vol.).

In Indonesia, oil pollution from spillage, blowouts, disposal of brine, deballasting operations, uncontrolled cleaning and accidents have affected some delicate estuarine areas and mangrove swamps (Wisaksono and Bilal 1985; ENRM 1989).

In Malaysia, sea-based pollution prevention measures have been taken for the Strait of Malacca. These include: standard operational procedures; local, national and regional contingency plans; and a set of environmental criteria, established by the international oil industry. Malaysia also prosecutes for deliberate oil discharges (DOE 1989).

In the Philippines, effluents from petroleum-based industries and ship discharges have resulted in chronic localized petroleum hydrocarbon pollution, particularly on the east shore of Manila Bay. Oily wastes from docked or passing ships are expected to render shellfish growing in the bay inadvisable.

Singapore has five major oil refineries on its coast which discharge oil-wastewaters. Treatment of slop, sludge, dirty ballast and tank washings is available at the Slop and Sludge Treatment Centre (Ruddle 1981; Chia et al. 1988).

The oil and gas industry is not a major activity in Thailand, although tar balls along

the water's edge have been reported. Because of the oil spill frequency in the Gulf of Thailand, oil companies have formed a consortium to handle cleanup operations.

Palm Oil Industry. The palm oil industry is one of the major agro-industries in Southeast Asia, with Malaysia and Indonesia as primary producers.

Producing approximately 60% of the world's supplies of palm oil, Malaysia has established regulations for the control of effluent from palm oil industries (DOE 1989). Effective methods of treating palm oil wastewater were developed and implemented and by 1980, approximately 50% of the mills had installed some form of treatment. The enforcement of regulations has resulted in high compliance levels (83% of palm oil industries) with increasingly stringent effluent standards (DOE 1989). There had been a significant reduction (97%) of the net organic load of effluent from 1985 to 1990, even though the industry has expanded. But its wastewater effluent is still known to cause significant organic pollution in ASEAN coastal waters. The combined wastewater discharges from the palm oil and rubber industries amount to 0.5 million kg/day BOD. Approximately 2.5 t of effluent is discharged for every 1 t of palm oil produced.

Indonesia has been producing substantial amounts of palm oil (over 2 million t in 1988). Most mills are located in northern Sumatra, often in rural areas beside oil palm plantations. Because of poor water quality (i.e., high BOD concentrations) near milling operations, standards for BOD, chemical oxygen demand (COD), suspended solids (SS), oil, grease, pH and temperature have been established by the government. Enforcement, however, has not been as efficient as in Malaysia.

The best treatment methods for high strength palm oil wastewater involve anaerobic and facultative ponds. Although their overall performance is good, the resulting effluent still does not satisfy SS and nitrogen standards. The technology is land-intensive; thus, it may not always be practical outside rural areas. Malaysian authorities have set up a program to research further on palm oil wastewater treatment (ESCAP 1982b).

Rubber Industry. The rubber industry is another significant source of organic waste. Rubber processing plants continuously discharge high BOD and SS concentrations. Highly contaminated latex concentrates or large quantities of block-rubber effluent are produced, depending on the processing method.

In Malaysia, industrial effluent standards have been established and treatment systems, installed. As a result, the net organic load from rubber effluents in Malaysia has been reduced by 80% between 1980 and 1985. Majority of rubber plants now comply with the standards, but pollution from rubber remains high, because of the uncontrolled discharges from a significant number of smallholdings.

Rubber plants in Indonesia, which produced 1.2 million t in 1988, are also major dischargers of organic pollutants. Government standards have been established for parameters such as pH, BOD, COD, SS and ammonia nitrogen for both latex concentrate and dry-rubber processing. Although the pollution control technology is available and relatively inexpensive, mechanisms have been underdeveloped (SEATEC 1990). As with palm oil mills, most plants are located in rural areas near the rubber plantations.

Most rubber factories in Thailand are equipped with wastewater treatment facilities. The treatment technology for latex effluents, which are still thought to pose a serious environmental threat, is more sophisticated than for other types of rubber (SEATEC 1990). Waste from rubber plants, on the other hand, is treated biologically, mostly using anaerobic and facultative ponds. This system can reduce the organic load effectively and inexpensively, but it is limited to locations where land is available. There is ongoing research into mechanical treatment processes for use where land is scarce. Anaerobic filter beds, rotating biodiscs and aerated lagoons are currently being evaluated.

Sugar Industry. Sugar refineries and associated liquor distilleries are also major industrial sources of organic pollution. The manufacture of sugar produces large volumes of wastewater, which contains high SS and BOD levels. Sugar mills, which are located in rural areas, discharge untreated wastes into surface waters, or spread them on land with or without pretreatment to remove SS, oil and grease.

A notable exception is the sugar mill wastewater treatment facility in Thailand. Thirteen mills on the Inner Gulf of Thailand discharge their wastes into a centralized industrial treatment plant, which has anaerobic and aerated lagoons as well as oxidation/polishing ponds. This centralized approach is effective, particularly since the sugar industry is seasonal. Plant wastes from other sugar mills are handled by local treatment systems, consisting of anaerobic ponds, followed by aerobic lagoons with mechanical mixing, and a polishing pond. The treatment capacity, however, is inadequate for condenser cooling water waste from cane sugar mills (Frankel et al. 1978; ESCAP 1982a).

Traditionally, the sugar industry has been of major importance to the economy of the Philippines. Sugar cane production has been concentrated on the island of Negros, where close to 70% of sugar-growing land in the country is located. Due to a mid-1980s drop in sugar prices, sugar land cultivation and mill operations have declined. The Philippines still produces over 1 million t of sugar, somewhat less than the total production of Thailand.

Intensive research has led to practical and economical approaches to sugar mill wastewater treatment. Although the availability and cost of land are a constraint, anaerobic digestion and/or aerobic treatment by activated sludge have been found to be effective and economical (ESCAP 1982a).

Mining. Various pollutants are released from mining operations. Cationic polymers are often added into settling ponds, which lessen siltation problems from open mines. Although excessive polymer use can be toxic to fish, research has identified effective polymer combinations that are not very hazardous (e.g., anionic polymers).

Pyritic hosting rocks in mines may generate sulfuric acid, the major cause of acid mine drainage. Acidic conditions promote leaching of heavy metals. Ore processing (e.g., flotation) uses toxic chemicals which can be released from the site. Nutrients (phosphorus from overburden and nitrogen from excessive use of explosives such as ammonium nitrate fuel oil [ANFO]) can also be released from mine operations.

Tin and gypsum mining usually involves hydropower washing and, therefore, releases extensive amounts of fine silts. To control silt release from mining operations, a series of settling ponds with long retention times are often installed, and wastewater recycling is sometimes also attempted.

Table 4 summarizes the major mining activities of four ASEAN member-countries in 1989. The quantity of mine tailings varies widely, depending on site conditions. The order of magnitude of mine tailings is shown as a percentage of production. Some items (e.g., tin and gypsum) are very difficult to estimate without knowing the site conditions and nature of mining operations.

Mine tailings are frequently disposed of in marine waters, e.g., in the Philippines, 50% of operating mines are located in the vicinity of coastal areas and use the sea as the final disposal site of mine tailings (Deocadiz 1990). Approximately 300,000 t/day of mine tailings are generated and about half are disposed of directly into marine waters. Some mining companies have established mine tailings dams which help control pollution, but these dams change river hydrology and eventually affect the ecology of bays.

Offshore tin mining in Malaysia results in significant pollution because it releases excessive fine silts. Thailand also exploits offshore tin deposits in its coastal waters. The concern over the high SS concentrations has led the government to establish water quality standards for Karon Bay (Paw et al. 1988). In Indonesia, coal-mining, which is expected to increase operations, causes pollution through solid waste discharges and siltation from erosion.

Other Industries. The lighters serving the ships off the coast of Singapore have been a major source of coastal riverine water pollution. They have been prohibited in Rochore, Kallang and Telok Ayer basins, and in Singapore River and Marina Bay (Chia et al. 1988).

Along the coast of the Inner Gulf of Thailand, a number of factories discharge effluents with high BOD. Tapioca flour mills alone are estimated to contribute 35% of the total BOD load reaching the Gulf of Thailand.

In Malaysia, the metal finishing industry poses severe pollution problems with discharges containing heavy metals. Although

Table 4. Major mining activities.

Item (t)	Tailings (% of production)	Indonesia (1988)	Malaysia (1987)	Philippines (1988)	Thailand (1989)
Bauxite	10	506,000	482,000	-	-
Coal	20	2,855,000	-	1,336,000	-
Copper	90	295,000	122,000	217,000	-
Iron	60	-	161,000	-	177,000
Gypsum		-	-	-	5,477,000
Lignite	10	-	-	-	8,995,000
Nickel	90	1,733,000	1,349,000	1,349,000	-
Tin		31,000	-	-	20,000
Zinc	80	-	-	-	413,000
Gold[a]	100	4,700	30,500	30,500	-
Silver[a]	100	61,500	34,600	34,600	-

[a]In kg.
Source: EPL (1990).

effluent standards are in place, the industry has displayed poor compliance (DOE 1989).

Old, abandoned car bodies are also a solid waste management problem in Brunei Darussalam because on average, each person in the workforce owns a car (Table 2).

Hazardous waste

The problem posed by hazardous wastes in Southeast Asia is not of the same magnitude as that in highly industrialized nations. Still, it is beginning to cause concern in concentrated industrial zones such as Jakarta, Bangkok, Metro Manila, Kuala Lumpur and Singapore. The production rate of non-recyclable hazardous waste in the region is expected to grow rapidly with the current economic growth and increased industrial sophistication. All ASEAN member-countries are now preparing hazardous waste management planning studies and formulating policies and strategies.

In Brunei Darussalam, small quantities of toxic wastes such as pesticides, spent solvents and oil production wastes are produced from current industrial and agricultural activities (De Silva et al., this vol.). While some biomedical wastes are merely incinerated, most wastes may have been deposited in the completed or currently operating disposal sites; but their type and quantity are not known, nor how well-contained these wastes are.

Hazardous waste in Indonesia is becoming a serious concern, with the country's industrialization and poor existing management practices. Authorities have been experiencing difficulty in imposing standards to control industrial hazardous waste (DOE 1989).

Regulations for hazardous waste control in Malaysia were drafted in 1988. As in other ASEAN member-countries, biomedical waste collection from small clinics and doctors' offices is a problem. Biomedical wastes from major hospitals are incinerated. These wastes were recently found to be responsible for the contamination of Juru River Estuary, which resulted in fish kill. Malaysia has been considering centralized treatment and disposal facilities under private initiatives. The proponents of privatization, however, want to have government guarantee on the quantity of waste to be processed and disposed of at the facilities.

There are no centralized facilities for industrial hazardous waste treatment in the Philippines. These wastes are usually burned or incinerated, buried at the site where they are generated, or collected, then disposed of at municipal dumps, in drains or on open land. Waste exchange has been promoted by concerned agencies. The quality of the hazardous and toxic wastes produced is generally unknown, although the total annual generation is estimated at 100-190 million l.

Some hazardous wastes and their sources include: heavy metal sludge from semiconductor industries; high heavy metal concentrations from geothermal plants; oil residues/volatile organic carbons from petroleum industries; arsenic/sulfur oxides/other

heavy metals from copper roasting or smelting processes; pesticide-loaded polyethylene bags from banana plantations; mercury from small-scale gold mining; chromium and other heavy metals from leather tanning and finishing industries; wastes from agrochemical industries; and radioisotopes, pathologic/infectious agents and other toxic chemicals from hospital/laboratory wastes.

In Singapore, hazardous waste management facilities are in operation at two landfill disposal sites and an incinerator plant. A number of chemical waste disposal contractors process and treat hazardous wastes. Larger industries have in-house treatment, and some carry out hazardous waste recycling and recovery. Biomedical wastes from hospitals are disposed of in a dedicated incinerator, while the collection of those from small clinics is currently being studied.

The primary generators of hazardous waste in Thailand are manufacturing industries, electrical utilities, hospitals and laboratories, and coal/lignite-based industries. The projected total volume of waste collected for 1991 was 1.99 million t (Thongkaimook 1990). In Bangkok, there has been a successful pilot project for the centralized treatment of spent chemicals, hydroxide sludges, mercury wastes and other hazardous wastes from small industries such as dyeing and electroplating factories. Yet, some problems with transportation and disposal sites are still unresolved (Phantumvanit et al. 1990). The BMA is planning to build an incinerator for biomedical waste disposal.

DISCUSSION

The current geographic, socioeconomic and waste management conditions of each country are the bases of these conclusions:

1. Singapore's current and planned waste management practices are comparable with those of any industrialized nation. New initiatives have been considered to further improve efficiency and to deal with new challenges. These include the Geographic Information System (GIS)-based tracking of hazardous waste movement; solid waste collection system optimization; a centralized hazardous waste treatment and disposal facility; operation and maintenance (O&M) cost monitoring system for waste management facilities and activities; control of inflow and infiltration to sewerage systems; and stormwater runoff quality management.
2. Brunei Darussalam has made good progress in sewage collection and treatment, but solid waste collection and disposal require further improvement. Solid waste collection activities are fragmented among several agencies. Landfill siting, design and operation do not meet the standards of modern sanitary landfilling. A management plan for biomedical and other hazardous wastes has not been prepared. Since the country intends to diversify its industrial base, the environmental impact assessment (EIA) process for new industrial establishments needs to be streamlined and the implementation of EIA findings closely monitored.
3. Malaysia has been a leader in agro-industrial waste management in the region. Plans are largely in place and water quality monitoring programs have been established. The implementation of plans, however, has been slow due mainly to insufficient funds. Sewage treatment in urban areas is urgently required.
4. In Thailand, 10% of the national population and the major portion of industries are based in the Metro Bangkok area. Therefore, adequate waste management in this area is most important. Numerous studies have been completed but the implementation of their recommendations has also been hampered by the lack of public funds. The BMA is contemplating privatization of the required facilities.
5. In the Philippines, waste management in Metro Manila has been studied and some of the needed facilities have been installed (e.g., sanitary landfill). A number of other major urban centers should be given attention, e.g., Davao, Cebu, Cagayan De Oro, Iloilo

and Iligan. Wastewater treatment and prevention of unauthorized waste dumping are urgently required.

6. Indonesia's challenges are similar to those of the Philippines'. A national waste management plan needs to be developed.

In general, there is little or no sewage treatment at all in the region, except in Singapore and Brunei Darussalam. Solid wastes are often disposed of at open dumps. Proper sewage treatment and solid waste disposal should be a high priority in the government agenda, considering the large existing population and its projected growth.

Industrial waste management is neglected in rural and nontourist areas, as little or no data are available on the quantity or characteristics of either hazardous or nonhazardous wastes. Management should begin with a compilation of inventory data through waste audits. An industrial waste discharge permit system, which can identify the need for central facilities for industrial waste treatment and disposal, must be established and enforced. Such a centralized treatment disposal system should be considered for the region and subregions. Any nation hosting the facility could be compensated by user-nations.

Impact of sewage disposal on coastal areas

The impact of sewage disposal may be presented in terms of the five-day biological oxygen demand (BOD_5). Laboratory analysis results at Singapore STPs indicate that BOD_5 of raw sewage before treatment is in the range of 250 mg/l to 560 mg/l (405 mg/l on average) (Tan, this vol.). Average flow to the STPs has been measured at 300 lcd. Thus, average per capita BOD_5 loading of sewage generated in Singapore is 120 g/day or 43.8 kg/year, the value also used in Brunei Darussalam. This is comparable to that of other industrialized nations. On the other hand, measurements taken of Malaysia's sewage show an average per capita BOD_5 loading of 50 g/day or 18.25 kg/year (PWD 1986). This value is used for Indonesia, the Philippines and Thailand.

The BOD_5 removal efficiencies for the two levels of treatment available in the region are assumed to be 30% for primary (including functioning septic tanks), and 90% for secondary.

Table 5 presents estimates of the daily BOD_5 loading from sewage discharges in the ASEAN coastal areas in 1989 and 2000. Although further concentration of population in coastal urban areas and expanded sewage treatment services are expected in the year 2000, the current ratios are used to project the future impact. That is, the scenario shown in Table 5 for the year 2000 assumes that there will be no large increase in the amount or level of sewage treatment provided.

Solid waste generation and composition in the ASEAN region

Fig. 1 compares per capita waste generation rates of various nations, including those of ASEAN. As shown, Singapore's waste generation rate ranks second, next to Canada's. Brunei Darussalam's rate is also comparable to that of other industrialized nations, while the Philippines and Indonesia generate much lower amounts of waste than the rest. These rates, however, have been derived from the amount received at authorized waste disposal sites. As much as 35% of the solid waste generated in some parts of the region is reported to be disposed of at unauthorized sites, and many areas do not have collection services.

Table 6 estimates the daily amount of solid waste arriving at authorized disposal sites. The waste generation rate in Singapore can be reduced through implementation of waste reduction and recycling programs. It will increase in other nations with expanded collection services and increased personal income. Nevertheless, the same rates are assumed to project the waste quantities in the year 2000.

The population in coastal urban areas is expected to increase faster than in other areas. But the current percent population in coastal areas is assumed to be maintained in the year 2000. Daily solid waste quantities received at authorized disposal sites in coastal areas in the year 2000 have been estimated under this assumption.

Like sewage and solid waste generation rates, the solid waste composition varies with

Table 5. Estimated BOD_5 loading from sewage discharges in coastal areas.

Year/loading	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
1989							
Population (million)	0.25	184.60	17.40	64.90	2.70	55.60	325.45
Total daily BOD_5 loading (t)	30	9,230	870	3,245	324	2,780	16,479
Population in coastal area (%)	85	60	65	70	100	40	
Coastal population (million)	0.21	110.76	11.31	45.43	2.70	22.24	192.65
Daily BOD_5 loading in coastal areas (t)	26	5,538	565	2,272	324	1,112	9,837
Secondary treatment (%)	30	0	5	0	90	1	
Primary treatment (%)	40	60	70	60	10	70	
Daily BOD_5 removal by treatment (t)	10	997	144	409	272	244	2,076
Residual daily BOD_5 disposal (t)	16	4,541	421	1,863	52	868	7,761
2000							
Population (million)	0.29	222	20.90	85.50	2.90	65.50	397.09
Total daily BOD_5 loading (t)	35	11,100	1,045	4,275	348	3,275	20,078
Coastal population (million)	0.25	133.20	13.58	59.85	2.90	26.20	235.98
Daily BOD_5 loading in coastal areas (t)	30	6,660	679	2,992	348	1,310	12,019
Daily BOD_5 removal by treatment (t)	12	1,199	173	539	292	287	2,502
Residual daily BOD_5 disposal (t)	18	5,461	506	2,454	56	1,023	9,518

Source: Authors' estimates based on information obtained from country papers (this vol.) and interviews with local contacts.

Table 6. Estimated daily solid waste tonnage arriving at authorized disposal sites in coastal areas.

Year/quantity		Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
Per capita daily rate (kg)		1.00	0.40	0.75	0.46	2.00	0.66	
Population (million)	1989	0.25	184.60	17.40	64.90	2.70	55.60	325.45
	2000	0.29	222.00	20.90	85.50	2.90	65.50	397.09
Daily quantity (t)	1989	250	73,840	13,050	29,854	5,400	36,696	159,090
	2000	290	88,800	15,675	39,330	5,800	43,230	193,125
Daily quantity in coastal areas (t)	1989	213	44,304	8,483	20,898	5,400	14,678	93,976
	2000	247	53,280	10,189	27,531	5,800	17,292	114,339

Source: Authors' estimates based on country papers (this vol.) and interviews.

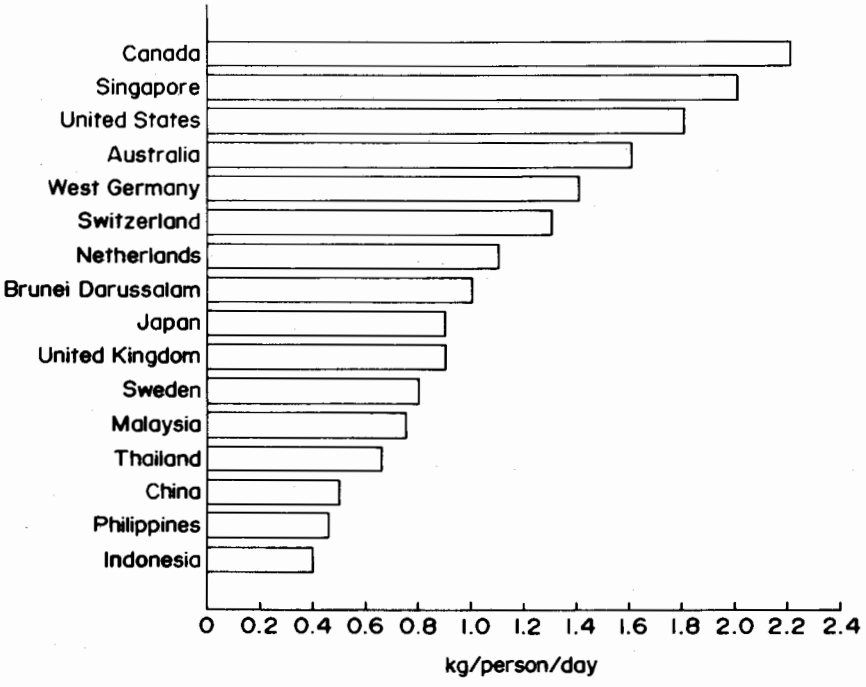

Fig. 1. Solid waste quantities (kg/person/day) received at authorized disposal sites.

the disposable income level. More affluent societies tend to generate more paper and less organics. The composition data supplied by local authorities in Canada and the ASEAN member-countries have been regrouped into six common categories (Table 7).

Tables 8 and 9 present an increase in the estimated average daily quantities of the most common solid waste types received at authorized disposal sites in coastal areas in 1989 and 2000. These also show that the solid waste composition is dominated by organic (putrescible) materials and paper.

Apparently, opportunities exist for recycling of paper and composting of organics, although solid waste composting in various nations, including Thailand, has not been very successful. Separation of recyclables and compostables at the generation sources and securing markets are two key elements in developing successful programs, although sufficient subsidization is also required.

Substantial amounts of plastics are discarded as waste in the region, although they are retrieved by scavengers in the less affluent member-nations. As the wastes have been sampled at authorized disposal sites only for composition analyses, plastic content in Table 7 does not include amounts blown away or carelessly thrown in streets, watercourses and beaches.

BOD loading of industrial waste

In 1989, the Malaysian government estimated national organic pollutant loading from various sources in terms of BOD (t/day), as follows:

Domestic sewage	366	80%
Animal husbandry	60	13%
Manufacturing industry	21	5%
Agro-based industry	11	2%
Total	458	100%

A recent study in Thailand which estimated annual BOD loading from various industries is shown in Table 10.

The study could not obtain necessary data on other high BOD-loading industrial facilities such as noodle and soy sauce factories; palm mills; and fruit processing, monosodium glutamate and textile industries. Thus, the actual industrial BOD loading would be higher than the estimates. Nevertheless, the study projected that the BOD loading in the year 2000 would be more than twice the estimated 1990 loading due to the expected industrial growth in Thailand.

Table 7. Solid waste composition (%) of ASEAN member-countries and Canada.

Component	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Canada
Paper	26	2	25	10	28	19	38
Glass	6	1	3	2	4	6	5
Metals	11	4	6	3	5	4	5
Plastics	13	3	8	9	12	10	9
Organics	41	87	56	70	44	55	34
Others	3	3	2	6	7	6	9

Source: Country papers and UNDP (1987).

Table 8. Estimated average daily quantity of solid wastes (t) received at authorized disposal sites in coastal areas in 1989.

Component	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
Paper	55	886	2,121	2,090	1,512	2,789	9,453
Glass	13	443	254	418	216	881	2,225
Metals	23	1,772	509	627	270	587	3,788
Plastics	28	1,329	679	1,881	648	1,468	6,033
Organics	87	38,544	4,750	14,628	2,376	8,073	68,458
Others	6	1,329	170	1,254	378	881	4,018
Total	212	44,303	8,483	20,898	5,400	14,679	93,975

Source: Authors' estimates

Table 9. Estimated average daily quantity of solid wastes (t) received at authorized disposal sites in coastal areas in 2000.

Component	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
Paper	64	1,066	2,547	2,753	1,624	3,285	11,339
Glass	15	543	306	551	232	1,038	2,675
Metals	27	2,131	611	826	290	692	4,577
Plastics	32	1,598	815	2,478	696	1,729	7,348
Organics	101	46,354	5,706	19,272	2,552	9,511	83,496
Others	7	1,598	204	1,652	406	1,038	4,905
Total	246	53,290	10,189	27,532	5,800	17,293	114,340

Source: Authors' estimates

Table 10. Estimated industrial BOD loading (t) in Thailand.

Industry	1989 Establishments	1989 Workers	1990 Loading	2000 Loading
Sugar	508	30,443	140,700	302,200
Pulp and paper	234	17,849	93,200	217,900
Rubber	44	10,381	89,700	169,600
Beverages	31	17,376	84,000	163,000
Tapioca	142	14,249	36,700	81,300
Slaughter	57	5,018	14,900	19,400
Canned fish and crustaceans	50	5,902	10,100	19,400
Tannery	143	1,627	9,600	35,400
Canned fruits and vegetables	131	51,597	3,500	5,200
Total	1,340	154,442	482,400	1,013,400

Source: Kritiporn et al. (1990).

In addition, 60% of registered industries are located in coastal areas in Thailand (i.e., Bangkok Metropolitan Region and South Region). Thus, industrial BOD loading in these areas, estimated at 793 t/day in 1990, would be 1,665 t/day in 2000. This means that it would exceed the domestic sewage BOD loading in the year 2000 (Table 5). Similar rapid growth in industrial BOD loading is expected in Indonesia and the Philippines, although the quantification is difficult without the existing and projected data on high BOD-loading industrial activities. Therefore, the removal of BOD and other pollutants from industrial effluent should be required.

Hazardous waste

Table 11 shows the results of a study completed in 1989 on hazardous waste quantities in Thailand, which vary with the type of industry (MSTE 1989). It indicates that:

1. Over 60% of the total national hazardous waste is generated by the basic metal industry.
2. Over 95% of the total national hazardous waste is generated by industries, especially manufacturing.
3. The total quantity in the year 2001 would be about 5 times the 1986 quantity due to the projected rapid industrial growth.
4. Infectious wastes from hospitals and laboratories would increase by about 4.3 times the 1986 level in 2001 due to the improved health care system.
5. The hazardous waste generation rate of households would be greater than the projected population growth rate as the society becomes more affluent due to economic growth.

Singapore has discouraged hazardous waste-producing industrial establishments by imposing stringent waste disposal requirements and hazardous waste transportation manifests. The countries' requirements have not been as stringent nor their enforcements as effective. Therefore, it is quite conceivable that Singapore's industrial hazardous waste generation rate would be less than that of Thailand.

Due to the lack of available data, the hazardous waste generation in the region has been estimated under these assumptions:

1. The industrial hazardous waste generation rate per industrial manufacturing GDP of other ASEAN member-countries, including Singapore, would be the same as that of Thailand.
2. The infectious hazardous waste generation rate per doctor of other ASEAN member-countries would be the same as that of Thailand.

Table 11. Estimated hazardous waste quantity (t) in Thailand.

Industry	1986	2001
Basic metal	732,508	4,070,027
Fabricated products	132,868	393,896
Transport equipment	63,993	31,147
Electrical machinery	50,990	282,699
Chemical products	37,916	217,566
Machinery	30,158	166,627
Textiles	17,362	100,432
Printing/publishing	14,867	95,558
Rubber/rubber products	8,273	58,159
Paper/paper products	2,737	16,462
Petroleum products	1,978	12,431
Miscellaneous/necessities	1,821	11,861
Furniture/fixtures	1,092	11,381
Wood/cork	515	3,324
Total industrial waste	1,097,078	5,471,570
Hospital and laboratory waste	46,674	200,699
Household hazardous waste	11,787	31,093
Total hazardous waste	1,155,539	5,703,362

Source: MSTE (1989).

3. The household hazardous waste generation rate per person would be proportional to per capita income.
4. Other ASEAN member-countries would experience the same economic growth as Thailand.

Table 12 presents the estimated hazardous waste quantities generated in the region under the above assumptions. The required data for estimation are derived from Tables 2 and 11.

TECHNICAL OPTIONS FOR WASTE MANAGEMENT

Adequate policies and technologies for waste management in the region are those which lead towards sustainable development and which must be implementable and affordable.

Specific pollution problems have been identified and research effort has been focused on local technologies, which are cost-effective in the context of developing countries. But the approach has been to adopt the standards and systems of more industrialized countries. A sustainable plan must first be defined to meet standards and objectives which are achievable within the local conditions and circumstances. More stringent standards can then be established as the treatment and disposal technology is developed and tested.

The decision to apply a certain technology should depend on the following criteria:

- the need to control pollution and the public's desire to obtain a certain service;
- its capability to meet the required standard;
- its affordability;
- the availability of the other required infrastructure, such as power, water supply and roads;
- operational capability of the user based on the thorough understanding of the technology;
- local availability of parts and materials for O&M and repair; and
- cultural conditions.

Domestic sewage

On-site Treatment and Sewage Collection. Domestic sewage management consists of collection, treatment and disposal. Since the introduction of the first waterborne underground sewerage system in England in the 1840s, this system has become the standard collection practice in urban areas on the basis of overall economic, social and health benefits. It is, however, very expensive to build. The unit capital cost is estimated at, on average, $350/capita of service population, varying widely with the size of the facility, local labor costs, terrain, construction material costs, etc. The cost, regardless of the local conditions, is onerous to most developing nations, which is why only a few waterborne sewerage systems exist in the region.

The first step towards sewage management in a less affluent society should be improvements to sanitation and the limitation of human exposure to waste. Appropriate individual or shared household systems include ventilated improved pit latrines, composting toilets and pour-flush toilets combined with septic tanks.

The advantages of these systems over traditional latrines and sewerage systems are:

- they are simple, reliable, hygienic and affordable (as low as 5% of the cost of a sewerage system);
- they can be constructed using local materials rather than imported ones, require little technical expertise for design and construction, and can be constructed by individuals or communities with only moderate professional help;
- they occupy little space, making them ideal for congested slum and squatter areas;
- they require little or no water (e.g., pour-flush toilets require around 2 l per flush);
- central sewage treatment can be delayed;
- they can be upgraded to more elaborate systems; and
- they have proven to be acceptable to the people using them (e.g., India) (Kalbermatten and Middleton 1991).

As water usage increases, especially when running water becomes available within

Table 12. Estimated annual hazardous waste generation (t).

Year/waste source	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
1989							
Manufacturing	121,793	716,212	502,689	788,594	591,053	1,097,100	3,817,441
Hospital and laboratories	646	104,201	27,064	40,881	13,547	46,700	233,039
Household	414	9,297	4,070	5,404	2,749	7,200	29,134
Total	122,853	829,710	533,823	834,879	607,349	1,151,000	4,079,614
2000							
Manufacturing	572,498	3,366,605	2,362,928	3,706,843	2,778,286	5,157,000	17,944,160
Hospital and laboratories	2,518	406,093	105,476	159,324	52,796	182,000	908,207
Household	1,611	36,156	15,828	21,014	10,692	28,000	113,301
Total	576,627	3,808,854	2,484,232	3,887,181	2,841,774	5,367,000	18,965,668

Source: Authors' estimates based on MSTE (1989).

dwellings, the quantity of domestic sewage will increase to 200 kg/day compared with 1-2 kg of human waste without water supply connections. This increase will require more elaborate on-site treatment in the form of septic tanks and septic fields (underground soakaways). This type of treatment has encountered failures due mainly to inappropriate design for adverse conditions (e.g., high groundwater table and dense population) and inadequate desludging, wherein septic tank sludge is not pumped out on a regular basis and not properly treated in a central location prior to disposal. As a result, poorly treated effluent is discharged into open drains or forms pools on the ground surface. On-site treatment generally services a limited population and can be applied only where appropriate site conditions exist. It can also contaminate groundwater supply, if improperly designed.

Such situations can be corrected by installing a solid-free sewerage (SFS) system. This is a network of small bore pipes (often plastic) laid to carry the effluent from septic tanks to some point where it can be discharged into a trunk sewer or treatment plant. The SFS system can also be used with a simple interceptor tank to give primary treatment to ensure that all solids are broken down. This may not be significantly cheaper than conventional sewerage, but it is much more flexible or capable of adapting to changing circumstances. It can also be an option to a conventional sewerage system.

Highly polluted watercourses in the ASEAN metropolitan areas can be converted into combined trunk sewers by enclosing them. Interceptors can then be built to direct dry-weather flows to STPs. The enclosed watercourses can be used as roadways to relieve traffic congestion, as in Korea. Chung-Gyae Creek in Seoul has been converted into a major trunk sewer and two level highways with 12 combined lanes.

A simplified version of the conventional sewerage system, pioneered in Brazil, can be considered as well. By allowing fewer manholes, shorter design periods, smaller minimum pipe size and shallower cover, a capital cost savings of 40-50% can be realized over the conventional version, but it would have increased maintenance costs and a shorter life span (Kalbermatten and Middleton 1991).

Lastly, an appropriate collection technology, which is important to limit human exposure to waste, should be selected to suit local conditions.

Treatment. The collected sewage from large service populations should always be treated, whatever collection system is used. This is because the amount of sewage that the environment can receive without the creation of objectionable conditions is limited. Establishing those limits is of primary importance in determining sewage treatment and disposal requirements.

Treatment reduces the contaminant level of sewage so that it can be disposed of safely without significant environmental impact on either land or receiving waters such as rivers, lakes and the sea. Treated sewage undergoes further modification by natural purification processes.

An inexpensive treatment method is the use of natural or engineered wetlands (or marshes). Engineered marshes are self-contained water pollution control systems that use natural biological and physico-chemical processes to treat liquid wastes.

Plants and microorganisms growing in the aquatic media provide biological oxidation and adsorption of waste components using oxygen from the atmosphere through dissolution at the surface and photosynthetic processes.

Aerated and facultative (aerobic-anaerobic) lagoon systems can be highly effective in treating sewage prior to disposal. These consist of large ponds created to retain sewage until it is biologically stabilized. They are designed either to achieve aeration through mechanical or diffused means (aerobic), or to obtain the necessary amount of oxygen from the surface adsorption and photosynthetic activity (facultative). When organic matter is biologically oxidized and SS start to settle, effluent can be easily disinfected. Operation does not require high technological capability.

Still, lagoon systems have disadvantages. These require more land than do fully mechanized (activated sludge) plants. Also, facultative ponds give rise to odors.

Mechanical STPs are more expensive than other methods. These include all or part of pretreatment, primary, secondary and tertiary treatment processes, and disinfection (Fig. 2).

Pretreatment consists of the screening out or comminution of solids such as paper, plastic, rags and wood as well as grit removal to protect mechanical equipment. Preliminary treatment alone has been considered sufficient in some ocean disposal situations where a long outfall to deep waters removes the wastewater from the shoreline and where adequate mixing and dispersion exist. Floatables such as oil, however, are not removed.

Primary treatment. A primary treatment plant generally provides preliminary treatment and clarification for the removal of floating and settleable solids. The solids so removed may be digested anaerobically or aerobically to improve their dewaterability, reduce their volume and make them relatively innocuous before ultimate disposal. Other primary sludge treatment methods include partial dewatering by filtration or centrifugation followed by composting, incineration or burying.

Secondary treatment. Secondary treatment is mainly BOD removal from large sewage flows. A common method involving land and technological support is the activated sludge system. As shown in Fig. 2, the effluent from the primary settling unit enters an aeration tank where the organic component is bio-

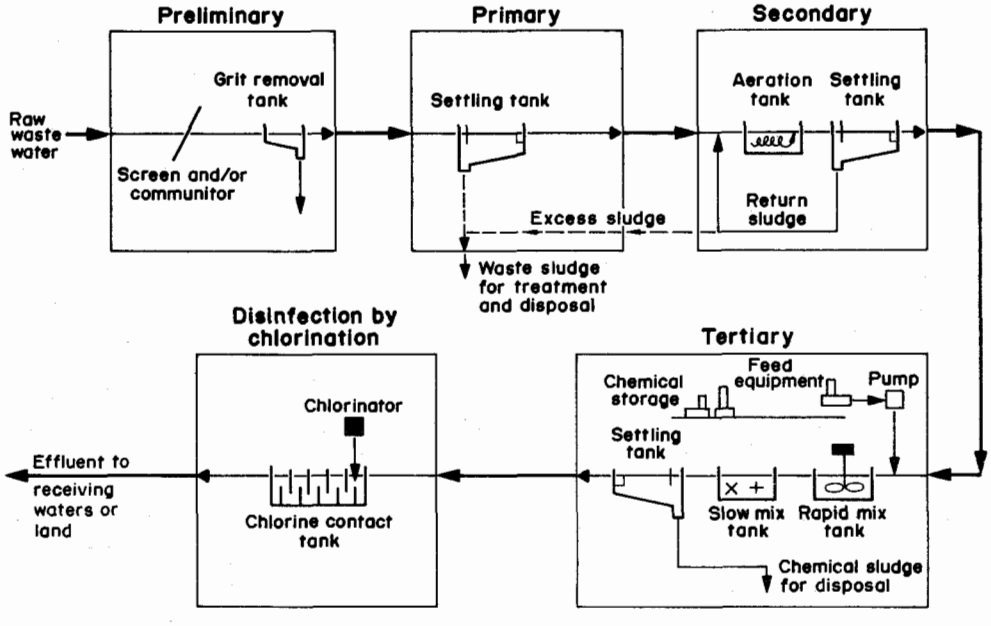

Fig. 2. Examples of wastewater treatment systems.

degraded by a culture of microorganisms. The effluent then goes to a secondary settling tank where the biological solids are allowed to settle. A fraction of the settled solids, or activated sludge, is returned to the aeration tank. This sludge recycle is the key to building up a large population of microorganisms (1,500-10,000 mg/l).

The fixed bed contactor, trickling filter or rotating biological contactor (RBC) are alternatives to the activated sludge system. The biological contactor contains natural or plastic media over which sewage flows. Biological growth forms on the surface of the media and oxidizes wastewater organics, which provide food for synthesizing additional biomass. Excess biomass sloughs from the media and is carried with the liquid to a final clarifier. Although more land-intensive than the activated sludge process, the contactor is considered a robust method because it is relatively easy to operate and it is less subject to process refinement to meet waste variations.

Some typical activated sludge processes and fixed media contactors are compared in Table 13.

Tertiary treatment. The effluent discharge from primary or secondary treatment plants into a river or lake can result in an increase in the concentration of nutrients which promotes growth of nuisance organisms. This is especially critical with respect to lakes, since these tend to age and accumulate nutrients through natural processes, and the introduction of waste may greatly increase the rate of aging and enrichment. When lake enrichment reaches critical levels, very abundant algae growths can rapidly turn the water into a green soupy slime, thus becoming aesthetically unacceptable and losing their recreational appeal. Tertiary treatment involves chemical feeding, rapid mixing, flocculation and sedimentation of the secondary effluent (Fig. 2). The chemicals commonly used are lime, alum or ferric chloride. Sometimes, a small amount of polyelectrolyte is added to improve the settling characteristics of the chemical precipitate. Most of the recent developments, however, have centered around removal of nutrients, particularly phosphorus and nitrogen.

Recently, biological means of nitrogen and phosphorus reduction have been successfully implemented in South Africa and Canada. This technology relies on the production of nitrifying bacteria and bacteria capable of internally storing phosphorus. Removal of the phosphorus-storing bacteria and production of denitrification conditions reduce nutrient levels. Biological nutrient removal is usually achieved within the secondary treatment process.

Disinfection. Treated sewage, which may contain pathogens, is disinfected as a public health measure. For the routine disinfection of municipal wastewaters, chlorine has proven to be both effective and reasonably inexpensive. Chlorination, however, may make the effluent toxic to aquatic life, and dechlorination to reduce toxicity may be necessary. Ozone and ultraviolet (UV) radiation are also effective but more expensive than

Table 13. Comparison of some reliable secondary treatment methods.

Criterion	Activated sludge alternatives				RBC	Trickling filter
	(Coarse bubble)	Air-activated sludge (Fine bubble)	(Surface aeration)	Oxygen-activated sludge (Cryogenic)		
Energy consumption (kWh/kg BOD removed)	1.33	0.70	0.99	0.70	0.55	0.60
Complexity of operation	Moderate	Moderate	Moderate	High (oxygen plant)	Low	Low
Maintenance requirements	Moderate	Moderate to high	Moderate	High	Moderate	Low
Aerosol generation	Moderate	Moderate	High	Nil (with gas collection and combustion)	Low	Low
Technological sophistication	Proven technology	Proven technology; increasing use of low-maintenance diffuser with lower energy requirements	Proven technology	Proven technology; particularly applicable to high-strength wastes	Proven technology; particularly applicable to small- and medium-size plants (0.5-50 million l/day)	Proven technology
Relative capital cost ratio	17	16	13	17	27	17
Annual O&M cost ratio	0.59	0.47	0.55	0.65	0.45	0.55

Source: Data from UMA Engineering, Ltd.

chlorine because exceptionally low SS concentrations are required for these processes to be effective. Table 14 compares various disinfection alternatives, and Table 15 compares the typical efficiency and relative costs of sewage treatment at different levels.

Disposal. The STP effluent can be disposed of on land or in receiving waters. The degree of treatment applied prior to disposal depends on the disposal location. The minimum treatment requirements for each method are typically:

- spray irrigation or lakes after secondary treatment;
- subsurface land disposal, rivers or streams after primary treatment; and
- open marine waters after preliminary treatment.

In many cases, a degree of treatment higher than the minimum is required for environmental or public health protection.

The most common and widespread land disposal method consists of subsurface drains laid in gravel trenches, preceded by a septic tank or small mechanical treatment plant. The success of these systems depends on the presence of permeable soils and low water tables, but even then, these are acceptable only for low population densities.

Another is irrigation by spraying or surface spreading at sufficiently low rates to prevent surface runoff and ensure that the applied effluent is purified by a combination of physicochemical and biological processes. Effluent irrigation is only possible when net evapotranspiration exceeds net precipitation. For the rest of the year, the effluent must be stored.

The STP effluent is commonly discharged into rivers and lakes, following a treatment level dictated by the degree of dilution and natural treatment available, and the existing and intended use of the receiving waters (e.g., domestic water supply, shellfish harvesting, recreation, etc.).

Marine disposal through outfalls equipped with diffusers is often used in coastal areas. The successful design of a submarine outfall depends on the knowledge of the characteristics and behavior of the receiving waters. The measurement and evaluation of the influence of tide, wind, wave and current should permit accurate prediction of any possible adverse effects on recreational areas, bathing waters and shellfish growing areas.

Municipal solid waste

Minimization through the four Rs. Compared with those of industrialized nations, the solid waste generation rates of some ASEAN member-countries are lower and can still be decreased further (Table 7).

The focus of solid waste management in the region should be minimization of disposal needs through the four Rs: reduction, reuse, recycling and labor-intensive (not mechanical) resource recovery.

Reduction should be government-initiated, which may include: surtax on excessive packaging and problematic waste materials (e.g., plastic, tires and car batteries); ban on the sale of products using nonrefillable containers; subsidy for waste exchange; and consumer education.

The government should also create market-driven reduction programs to facilitate the participation of the industry and consumer market. But mechanized waste processing facilities for recycling and resource recovery should be avoided due to high costs and O&M difficulties.

The government and nongovernmental organizations (NGOs) should work together to organize community- or institution-based reduce/reuse/recycle/recover programs and educational campaigns. In Manila, for example, the World Ecologists Foundation has initiated a recycling program for squatters along Pasig River.

Organic waste composting can be carried out by individual households or communities. With community-based composting, co-composting of sewage sludge and septage is possible. For large-scale composting, markets for the recycled or recovered materials have to be secured. Subsidies for creating such markets should also be considered.

Incineration is an expensive reduction option. But the scarcity of land and public opposition to landfill siting (i.e., "not-in-my-backyard" syndrome) have made incinerators imperative in countries like Singapore. Factors for consideration include: air emission quality; ash toxicity and disposal site; amount of noncombustible waste; energy

Table 14. Comparison of disinfection methods.

Criterion	1(a) Gas chlorination	1(b) Gas chlorination-dechlorination	2(a) Hypochlorination	2(b) Gas chlorination-dechlorination	3 Chlorine dioxide	4(a) Ozone from air	4(b) Ozone from oxygen	5 UV light
Public health impact	Forms chlorinated organics and trihalomethanes; not completely effective as virucide at normal dosage and contact time	Effect of dechlorination on chlorinated organics and trihalomethanes not clear	Same as 1(a)	Same as 1(b)	Does not form trihalomethanes; superior virucide to chlorine; chlorite ions might be harmful	Superior virucide to chlorine; effective over broad pH range		No known adverse effects
Public safety	Potential serious hazard in transporting Cl_2 through populated areas	In addition to 1(a), hazard in transporting SO_2	Safer than 1(a)	Safer than 1(b)	Depends on chemicals used for generation of ClO_2; safer than 1(a) using sodium chlorite and acid	Much safer than 1(a) since O_2 is generated on-site		No known safety problems
Operator safety	Potential serious hazards from gas inhalation and chemical burns	In addition to 1(a), SO_2 increases potential hazard	Potential hazard from chemical burns		Potential serious hazard from gas inhalation and explosion	Potential serious hazard from gas inhalation; ozone generator explodes when improper cleaning solvents used	In addition to 4(a), leaking O_2 may provide a potentially explosive atmosphere	Potential serious hazard to eyes and skin
Environmental impact	Chlorine residuals greater than 0.002 mg/l reported toxic to salmonids and other aquatic farms	Excess SO_2 can remove O_2 from the receiving water; effluent post-aeration may be necessary	Same as 1(a)	Excess thiosalts can remove O_2 from the receiving water; effluent post-aeration may be necessary	Exhibits lower and faster depleting residual than Cl_2; however, effluent reported to be toxic to fish	No toxic residual; high effluent CO may be beneficial to receiving stream		No residual
Complexity	Moderate		Moderate		Moderate	Moderate to high		Low
Reliability	Good with trained operators	Generally good Difficulty in providing continuous measurement of chlorine residuals near zero	Good with trained operators		Appears to be good with trained operators	Reliable power supply essential; some new plants have experienced significant startup problems		Highly dependent on good effluent quality
Technological sophistication	Established technology		Established technology		Limited pilot-scale testing	Emerging technology in wastewater field; pilot and full-scale experience reported in literature		Limited experience with full-scale plants
Relative costs								
• Capital	Low	Low	Low	Low		Very high	High	Appears moderate
• O&M	Low	Moderate	Very high	Extremely high		Very high	High	Appears moderate
• Present worth	Low	Low to moderate	Moderate	Moderate to high		Very high	High	Appears moderate

Source: Data from UMA Engineering, Ltd.

Table 15. Typical efficiency and relative cost of different sewage treatment processes.

Degree of treatment	Process components	SS	Sewage treatment efficiency (% removal) No chlorination BOD	Coliform	With chlorination BOD	Coliform	Total phosphorus	Total nitrogen	Relative cost ratio Capital	Annual O&M
Preliminary	Screening, comminution and/or degritting	2	2	-	15-30	90-99	-	-	-	-
Primary	Sedimentation for settleable solid removal	40-65	25-35	45-55	40-48	99.9+	5-15	5-20	32	1.7
Secondary	Primary treatment + conventional activated sludge	85-95	85-95	90-99	88-96	99.99+	20-40	20-50	55	1.4
Tertiary	Conventional activated sludge + post-secondary tertiary works	90-95	90-95	95.99.9+	92-96	99.999+	80-95	25-55	65	1.6

Source: Data from UMA Engineering, Ltd.

recovery in terms of electricity or steam; and O&M requirements.

Residue Disposal. For some wastes, ocean disposal may be economical and acceptable. But it should be taken as a last resort because waste is difficult to control in the mobile aquatic environment. Landfilling then becomes one of the more viable final disposal options.

Landfilling considerations include: prudent siting and impact prediction; modern operation and monitoring; and engineering measures.

To avoid human health hazards and environmental concerns, the highest priority should be given to prudent siting, which can also substantially reduce the capital and O&M costs. A site underlain by natural impervious soils (e.g., clay) could eliminate the need for a leachate liner system. Wide natural buffer areas around a landfill could lessen problems associated with landfill gas, odor, aesthetics, noise and dust. Landfill owners should protect the buffer areas from being developed.

Modern landfill operation techniques (e.g., maintaining a small working force and frequent covering) will allay worries regarding birds and rodents that scavenge in the sites, odor and litter. Also, a steady source of cover material and a dust/litter control program are part of the landfill operational plan.

To detect possible environmental problems, regular monitoring is necessary. It may trigger operational improvements and engineering measures for environmental protection. These measures are to: extend a communal water distribution system to replace supply sources affected by landfill operation; construct surface- or groundwater barriers to reduce leachate production; provide a leachate collection/treatment/disposal system; extend sanitary sewers to transmit leachate to an STP; install landfill gas vents, a gas collection and flaring system or an energy recovery system; establish erosion, sediment and surface water management systems to protect downstream water quality; and install noise berms and sight/wind screens.

Clearly, the shortcomings of a landfill site can be overcome by engineering measures but these entail an increase in capital and operating costs. There is no ideal or perfect landfill site, and trade-offs among potential sites must be weighed. The suggested siting and EIA process has four steps (Fig. 3):

1. The study area is screened using existing land use information to identify "candidate areas."
2. These areas are assessed to identify "potential sites" using aerial photograph interpretation and site capacity considerations.
3. A short list of "candidate sites" is developed by eliminating those which have severe constraints relative to human health and the environment.
4. The short list of sites is evaluated for social and economic considerations. To facilitate site selection, a framework is developed and the pros and cons of each candidate site are identified. The site comparison is a qualitative assessment using a logic matrix based on risk assessment techniques.

Collection. The most obvious MSW management problem is not disposal or recycling but collection. The failure to collect the garbage in the first place results in "unaccounted-for garbage" (the difference between the amount of generated MSW and

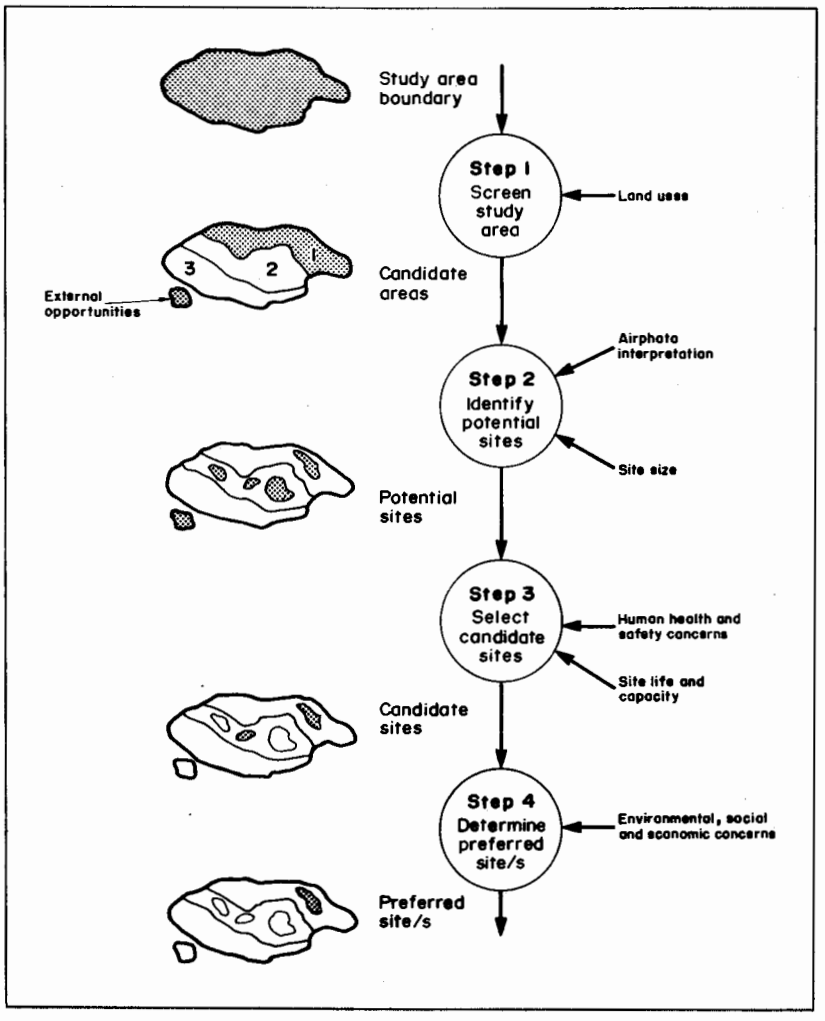

Fig. 3. Landfill site selection process.

what is collected), which is usually over 30% of the total. It accumulates in front of houses, on the streets, in side alleys, storm drains and open spaces. This attracts more rodents and insects, and obstructs drainage, which leads to flooding in monsoon climates. It contributes to the atmosphere of pervasive squalor which discourages people from making any attempt to help themselves, because the situation seems hopeless.

Attempts by developing countries to adopt the MSW collection system of industrialized nations have been generally unsuccessful. The technology is eventually found to be unsustainable, i.e., it suffers from high initial equipment costs, lack of skilled operators and maintenance mechanics, difficulties in obtaining spare parts, weak management and insufficient operating budgets. The region's MSW contains a high proportion of organic materials and a high moisture content (even reaching a density of 400 kg/m^3 in some countries as against the typical 100 kg/m^3 in industrialized countries) (Kalbermatten and Middleton 1991). The wet, dense waste is too heavy for compactor trucks designed for bulky, lightweight waste. In addition, a large number of people live in slum or squatter areas where road access is poor or non-existent.

The benefits of a low-cost, labor-intensive collection system should not be overlooked. It could include informal recycling that brings social, environmental and economic benefits to the community. Instead of being discouraged, the ubiquitous private sector collection and scavenger activities in the region's cities should be given assistance. Community-

managed collection and recycling projects should be encouraged especially in inaccessible squatter areas. These are means to improve environmental and health conditions within the community and to raise funds (through voluntary service) for the benefit of the community as a whole.

Collection systems (including equipment, vehicle routings and transfer points) can be optimized and monitored easily and inexpensively using personal computer (PC)-based GIS software. Solid waste management expenditures can also be planned, monitored and controlled by simple and inexpensive PC software.

Agricultural and industrial waste

Singapore's "polluter pays" principle should be considered in industrial waste management. In Malaysia, it has been effective in substantially reducing pollution caused by agro-industries, which abided by a series of interim requirements through a phased program of pollution control measures (EMDI 1990). Table 16 shows gradual changes in palm oil mill effluent standards since 1978 (EMDI 1990). A similar approach has been taken for rubber plant effluent.

Industrial projects at the siting stage should be subjected to an EIA. Upon approval, monitoring and environmental law enforcement are essential. Thus, adequate agencies with skilled manpower and laboratories must be established.

Sharing of common treatment facilities among industries should be encouraged for economy of scale. A successful example is the industrial treatment facility for sugar mills in Thailand.

Nonhazardous Waste. Agro-industrial facilities such as palm oil processing plants, sugar refineries and rubber plants produce high-strength organic liquid wastes. Some ASEAN member-countries, particularly Malaysia, have developed treatment technologies that are relatively inexpensive and efficient.

Palm oil mill effluent is given primary treatment by physicochemical methods (e.g., gravity settling followed by air flotation) to remove oil, grease and SS as well as biological treatment to reduce BOD. The most commonly used biological process in Malaysia consists of anaerobic and facultative ponds in series, which provides a retention time of 75-120 days (EMDI 1990). This process, however, requires that land be available. An alternative cost-effective method that is not as land-intensive is anaerobic digestion in a closed digester followed by oxidation in a deep oxidation ditch. In-house measures for water conservation and good housekeeping for the prevention of spillages and leakages are essential to reduce the pollution load from palm oil mills and other agro-industries.

Sugar cane mill effluent can be used for irrigation. The effluent, pretreated to correct the pH and remove oil and SS, can be applied on land used for sugar cane cultivation. Inadequately pretreated effluent, however, gives off odors (EMDI 1990).

Table 16. Malaysia palm oil mill effluent standards.

Parameter	Year enacted					
	1978	1979	1980	1981	1982	1984
BOD (3-day 30°C)	5,000	2,000	1,000	500	250	100
COD	10,000	4,000	2,000	1,000	-	-
Total solids	4,000	2,500	2,000	1,500	-	-
SS	1,200	800	600	400	400	400
Oil and grease	150	100	75	50	50	50
Ammonia nitrogen	25	15	15	10	150[a]	100[a]
Organic nitrogen	200	100	75	50	-	-
Total nitrogen	-	-	-	-	300	200[a]
pH	5.0	5.0	5.0	5.0	5.0	5.0
	9.0	9.0	9.0	9.0	9.0	9.0
Temperature (°C)	45	45	45	45	-	-

[a]Denotes the value of filtered sample.
All units (except pH and temperature) are in mg/l.
Source: EMDI (1990).

Because of the seasonal nature of the sugar industry, anaerobic ponds and an oxidation pond can be an economical treatment for effluent before discharge into surface water. In Thailand, a centralized treatment facility for effluent from 13 sugar mills (average flow of 3,000 m^3/day) uses this approach to meet an effluent objective of 60 mg/l BOD (Frankel et al. 1978; EMDI 1990 and ESCAP 1982a). The facility has a total area of 155 acres, and is reported to have cost $1.6 million in 1979 (excluding land costs), with annual O&M costs of approximately $425,000.

Where land is scarce and expensive, alternative effluent treatment processes are closed digesters and/or direct aerobic treatment using the activated sludge process. The efficacy of the aerobic treatment is improved by the addition of phosphorus and nitrogen to the wastewater.

Rubber industries in Malaysia have implemented treatment facilities that comply almost fully with regulations. Anaerobic and facultative ponds are most commonly used. Alternatively, oxidation ditches are selected by factories with insufficient land, with higher operating costs. The capital and operating costs of a pond system for a 20-t/day rubber plant were $27,600 million in 1975, and $120 million/month, respectively (EMDI 1990). Research into mechanical treatment processes is ongoing. Being evaluated are anaerobic filter beds, rotating biodiscs and aerated lagoons.

A recent study by the Asian Development Bank on agricultural waste recycling indicates that forced aeration composting is feasible for the treatment of animal manure, (e.g., from pig farms). Composting destroys pathogens and can be economically viable in developing countries. The compost can then be applied on high-value vegetable crops.

The biogas process, however, has not been found to reduce pathogens adequately, based on the experience of 600 backyard piggeries with biogas units in the Philippines. The O&M problems and the fact that methane gas cannot be stored, resulted in the resumption of commercial cooking gas use in almost all pig farms. Treatment systems that involve biogas production will likely be more successful in large facilities where all the gas produced is consumed.

The reduction of the load of toxic chemicals discharged into the environment from agricultural practices can be achieved by promoting the use of organic fertilizers and reducing or removing subsidies on chemical pesticides and fertilizers.

To minimize erosion and subsequent siltation in watercourses and coastal waters, land-clearing practices should be controlled and monitored. Guidelines and standards for erosion and siltation prevention should be developed and implemented.

Petroleum refineries in the region should provide adequate oil separation as a minimum treatment requirement. This is generally considered the baseline treatment level in highly industrialized countries and may be the only treatment in others. To control other effluent components, secondary treatment may be required. Biological treatment can be used to remove phenols and BOD. There are more advanced treatment such as filtration, carbon adsorption and metals removal, depending on the uses of the receiving water (e.g., shellfish production and drinking water supply).

Hazardous waste

The first step towards hazardous waste management (HWM) is to define hazardous waste through legislation. It can be based on its characteristics (i.e., ignitable, reactive, corrosive, infectious and radioactive) or its sources (e.g., primary metal industry; organic chemicals, pesticides and explosives industry; electroplating and metal surface finishing industry; inorganic chemical industry, etc.). The former approach requires extensive laboratory work for accurate characterization. The latter is simpler to administer, but it does not exclude outright the nonhazardous waste from some sources. A practical definition of hazardous waste in ASEAN member-countries with limited laboratory facilities can be formed based on lists of hazardous wastes originating from nonspecific sources (e.g., wastes containing polychlorinated biphenyl [PCB]) and specific sources (e.g., sludges from re-refining used oil products). For example, Malaysia uses a list called "scheduled wastes." The onus of proving that a scheduled waste from a specific source is non-

hazardous should be placed on the waste generators.

The HWM methods include:

- reduce waste through a change of process and primary materials;
- separate and concentrate wastes into manageable quantities;
- exchange wastes among industries;
- recover energy or material;
- use chemical, biological or physical treatment (i.e., high temperature incineration, neutralization, oxidation, reduction, disinfection, etc.); and
- install a secured landfill.

The cooperation of government agencies and private industries is necessary for HWM. Centralized treatment and disposal facilities, which may be owned and operated by a qualified member of the private sector, is more efficient than a fragmented system. For its part, the government must demonstrate its strong will to establish and enforce the necessary regulations.

Mobile processing/destruction technologies for hazardous waste have been developed and tested in highly industrialized nations. These would be an attractive option for the region, considering the small amounts of hazardous waste generated in scattered areas. In addition, tracking of hazardous materials movement should be carried out on an international level. Singapore's manifest system for hazardous material generation and transportation, which may be further improved by applying GIS technologies, may be adopted for this purpose.

CONCLUSION

The relative magnitude of the environmentally related social and economic problems in ASEAN member-countries may be greater than those in more industrialized countries. Nevertheless, both have dealt (or are still dealing) with waste management dilemmas that are no different from each other in many respects. The tasks that await ASEAN waste management are to:

- establish the right priorities for waste management actions and where limited resources should be assigned;
- develop strategies that are most likely to be effective;
- enact and implement specific legislation, in light of social and economic conditions that will make strategies work;
- source the funds or financial structure that will support the strategies; and
- search for the expertise and technology to construct, operate and maintain physical waste management facilities.

These challenges should be pursued in "bite-size chunks" to avoid being intimidated by the problems, which could induce lack of focus and direction.

GENERAL RECOMMENDATIONS

The coastal areas of the region have been adversely affected by inadequate waste management practices. Many coastal locations have become unsafe for water contact recreation, and the resource base for coastal area inhabitants (e.g., fisheries and tourism) has also suffered. These areas are expected to deteriorate further due to population growth, increased urbanization and industrialization.

Recognizing challenges resulting from increasing waste generation rates, ASEAN member-countries have developed waste management plans for priority areas (e.g., metropolitan areas, water villages, etc.) or on a national basis.

To facilitate plan implementation, skilled manpower should be developed (e.g., through more practical on-the-job training programs) and laboratory facilities updated.

Governments should create favorable environmental market conditions by banning problem products or imposing a surtax on them and providing subsidies for environmentally friendly products and services.

Governments should work hand in hand with environmental groups and other NGOs to promote public education and participation, which could result in waste minimization.

The effluent quality criteria should be technically achievable and economically

affordable. These should vary with the type of establishment (e.g., landfills, STPs, the different industrial plants, etc.) and the quality of the receiving water. Inappropriate criteria can be counterproductive and tend to discredit the government's regulatory operations. Thus, a series of interim criteria with an ultimate goal would be ideal, as in the successful effluent control for palm oil mills and rubber factories in Malaysia.

Finally, ASEAN should consider achieving the same quality criteria among nations, sharing resources for training and research on waste management, developing coastal zoning for specific uses, regularly sharing experiences in waste management and monitoring the state of coastal zones affected by urban, industrial and agricultural activities.

So far, ASEAN waste management plan implementation has been hampered by financial, institutional and policy constraints. For instance, some political leaders still consider waste management and environmental protection to be in conflict with industrial development and economic growth; thus, budget allocations are limited (only a small fraction of the budget is alloted for power, communication and transportation).

Sewage

A well-planned staged implementation can restore deteriorated environmental conditions as long as there are strong political commitment and public support.

Although the benefits and total costs (over $400 million direct costs plus unknown indirect costs) of the Singapore River Cleanup Program have not been quantified, it appears that sufficient gains have been achieved to compensate expenditures made over the ten-year period between 1977 and 1987 (Leong 1988). The benefits include land value appreciation, increased confidence of foreign investors and reduced downtime of labor forces due to clean environment. The program also helped eliminate or minimize, the sources of pollution in Singapore (e.g., squatters, street hawkers, lighters, pig farms and small industrial establishments).

A less aggressive approach, such as Korea's Han River Cleanup Program, can also be taken. In this case, many polluted river tributaries were enclosed and converted into major combined trunk sewers. Interceptors were built to direct low flows to STPs. The top portion of the enclosed watercourses has been used as roadways, easing traffic congestion. In highly polluted areas such as Bangkok, Jakarta and Manila, this approach may be more cost-effective than that of Singapore's.

Low-cost sewer systems as tested in Brazil, combined with inexpensive and easy maintenance systems such as sewage lagoons and wetlands, are viable collection and treatment alternatives. A plan should be developed to secure lands at strategic locations for the construction of these land-intensive but effective options while they are still available at reasonable prices.

As shown in Table 15, primary treatment is cost-effective (i.e., high pollutant removal per dollar spent). Progressive upgrading of sewage treatment should be considered to achieve high return for the limited funds available. A "triage" approach should be considered to prioritize sewage treatment location and technology. Rivers and coastal waters should be categorized into three groups: problem-free, hopeless and recoverable. Treatment efforts should be concentrated on watercourses with recovery potential. Some may require more than primary treatment to achieve the desired level of recovery.

Sewage collection and treatment, or appropriate on-site systems, depending on the density of development, should be required for any new development on a local area basis. Developers and facility users should be responsible for capital and O&M costs, respectively.

The use of the septic tank design standards should be strictly enforced for new installations. A licensing system for contractors should be considered to impose accountability (e.g., cancellation of a contractor's license due to tank malfunction from improper design/installation). Regular removal of septage from septic tanks, services of which should be paid for by owners, should be mandatory. The removal services can be provided by a government agency or private companies under a contract with the agency. But septage disposal methods should be specified. While existing STPs frequently

receive such wastes, composting, incineration or land disposal are alternatives.

In rural areas, improved latrines or pour-flush toilets should be installed. The sewage lagoon or wetland treatment can be considered for densely developed rural settlements.

In urban areas, phased sewerage systems should be installed as follows:

1. improve existing septic tanks, maintain and impose tight control over new installations (Brunei Darussalam, Indonesia, Malaysia, Philippines and Thailand);
2. install an SFS system for septic tank effluent where feasible (Brunei Darussalam, Indonesia, Malaysia, Philippines and Thailand);
3. enclose highly polluted urban watercourses and use them as trunk sewers where appropriate (Indonesia, Philippines and Thailand);
4. construct interceptor sewers (Indonesia, Malaysia, Philippines and Thailand);
5. install primary treatment facilities, including engineered marshes and wetlands (Indonesia, Malaysia, Philippines and Thailand); and
6. convert primary to secondary treatment (Brunei Darussalam).

Solid waste

Waste minimization should be promoted, specifically through low-technology and labor-intensive means as well as the expansion of recycling industries in the region.

The installation of incinerators and mechanized resource recovery plants producing refuse-derived fuel or compost should be examined carefully, especially with respect to operational difficulties and the market for recovered energy and materials.

Collection systems adapted to local physical and socioeconomic conditions (e.g., roads, scavenging) should be developed. For instance, collection equipment may be locally manufactured. Collection services can also be improved using inexpensive PC-based GIS software.

Landfill sites should be identified systematically (Fig. 3). Good landfill sites, including adequate buffer zones, should be secured when they are available at reasonable costs.

Industrial and agricultural waste

Effective and practical technologies for the treatment of wastewaters from the main industries in Southeast Asia have been locally developed. These, however, are not extensively used. Partially treated or untreated wastewaters are still discharged into rivers and marine waters. Existing effluent standards are not strictly enforced.

The implementation of waste management plans proposed in EIA documents for new industries should be monitored closely. Sharing of facilities and waste exchange among industries should be encouraged. This can be facilitated by actively pursuing the relocation of existing industries and establishment of the new ones in industrial estates.

Centralized facilities for hazardous waste treatment and disposal should be considered for ASEAN member-countries, which should work together to promote waste exchange and keep track of hazardous materials movement. The host nation of such a facility should be compensated by user-nations on the basis of a preagreed formula. The privatization of such facilities would be possible only after demonstrating political will to enforce control regulations. An industrial waste discharge system, which should be established to quantify the type and amount of waste, can identify the need for a central industrial waste treatment and disposal system. Mobile processing and/or destruction units can be used when dealing with small amounts of hazardous waste in scattered areas.

The use of toxic chemicals in agriculture should be limited. Soil testing should be done to determine the need for fertilizers.

Lastly, preventive measures for erosion and siltation should be developed and enforced for all land-clearing activities.

COUNTRY-SPECIFIC RECOMMENDATIONS

Brunei Darussalam

- Continue to expand sewerage services to less urbanized areas.
- Streamline the responsibilities of various agencies in solid waste management.

- Secure landfill sites in advance and control the land use in the surrounding areas.
- Implement erosion and siltation control measures at all land-clearing sites.
- Closely monitor the implementation of the BSP environmental management plan.
- Improve waste management of water villages (e.g., Kampong Air).
- Consider the development of abandoned autobody recycling industries.

Indonesia

- Prepare a national plan for waste management, incorporating low-cost and easy-operation technologies.
- Prioritize the waste management plan with emphasis on major urban centers such as Jakarta, Bandung and Surabaja.
- Consider a phased implementation of the plan to ease the financial burden.
- Develop skilled manpower in the field of waste management.
- Build laboratory facilities for monitoring purposes.
- Enhance public education programs for environmental awareness.

Malaysia

- Continue to implement the national solid waste management plan called "ABC" (Action Plan for a Beautiful and Clean Malaysia).
- Develop a similar plan for wastewater management.
- Share the success in agro-industrial waste management with the other ASEAN member-countries.
- Pursue centralized hazardous waste treatment and disposal facilities as well as consider mobile units.
- Increase the budget for local governments with respect to waste management by revising revenue-sharing formulae.
- Implement erosion and siltation control measures at mining, land-clearing and construction sites.
- Implement a PC-based management system for municipal O&M activities on a national basis.
- Improve waste management conditions in water villages.

Philippines

- Prepare a national plan for waste management, incorporating phased implementation of low-cost, easy-operation technologies.
- Assign high priorities to waste management in major urban centers such as Metro Manila and Cebu.
- Enforce industrial waste management regulations, even on those industries found in rural and nontourist areas (e.g., mining and agro-industries).
- Develop and implement a public education program for environmental awareness.

Thailand

- Concentrate on the improvement of waste management in Metro Bangkok and surrounding areas.
- Closely monitor the waste management practices in large industrial estates and major tourist resort sites.
- Improve law enforcement capabilities.

Singapore

Singapore's waste management practices compare well with any industrialized nation. Nevertheless, further improvements on their efficiency should be considered.

- Reduce inflow/infiltration (I/I) to sanitary sewer systems through a systematic rehabilitation program.
- Optimize solid waste collection systems, including routing, equipment selection/replacement, crew size determination, etc.
- Track hazardous materials movement using computers.
- Monitor stormwater runoff quality for possible treatment.

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Incineration Technology and Refuse Disposal

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ABSTRACT

This paper focuses on incineration technology for refuse disposal. Incineration reduces refuse volume, concentrates pollutants in refuse for safe processing and disposal, and generates energy. If properly implemented and complemented by recycling and source reduction, it would be the best method in solid waste disposal.

INTRODUCTION

Refuse disposal is a problem as old as civilization itself. Until recently, it was assumed to have disappeared as soon as the refuse went out of sight. With rapid industrialization, however, some refuse became less disposable by natural means and toxic or environmentally risky in other ways. Their concentration grew with the size of industrial units and the complex specialization of the industrial sector.

Households also generated hazardous waste such as polyvinyl chloride (PVC), batteries, fluorescent tubes, thermometers, solvents, paints and pesticides.

Large amounts of these refuse can be disposed of either by direct landfill or incineration with subsequent landfill of ash and other residues. But the method that is both environmentally acceptable and economically feasible is incineration.

INCINERATION TECHNOLOGY

The minimum requirements for the proper combustion of organic materials are a furnace and a boiler. Regulations require that particles and gas streams be exposed at least 1 second at temperatures of 850°C and above.

About 6 t of refuse per hour and unit, or ideally, a minimum size of 10 t/hour is needed for workable relations among length, width and height in the combustion chamber of the incinerator.

This capacity requirement, however, excludes practically all so-called compact incinerators, the dimensions of which are too small to meet the minimum safe combustion requirements.

Where large amounts of refuse are not available, it is advisable for neighboring municipalities to join forces to build a regular plant rather than a compact one.

A well-founded feasibility study should therefore be undertaken before decisions regarding the main parameters of an incineration plant are made. Factors include:

- amount of refuse to be incinerated;
- projection of amounts over the lifetime;
- heating value of refuse;
- projection of heating value;
- present and future flue gas cleaning requirements;
- site location and infrastructure; and
- traffic schemes, etc.

Baseline information is always more accurate than projections, so refuse composition should be investigated thoroughly as it may vary substantially between different areas. When projecting refuse parameters into the future, potentials of source reduction and residue recycling should also be considered. At this stage, learning from the experience of others can help avoid mistakes which otherwise can be corrected at high cost during project implementation.

POLLUTANTS AND RESIDUES

In recent years, the discussion on refuse incineration has generated heated arguments that are not very well substantiated. A look at the pollutants in the refuse and their status after incineration is thus in order. Their average values are as follows:

Chlorine	0.5-1.0%
Sulfur	approx. 0.1%
Zinc	0.3-0.4%
Lead	0.2-0.3%
Copper	approx. 0.1%
Nickel	approx. 100 ppm
Cadmium	approx. 20 ppm
Mercury	3-5%

All these are still found in the residue of the incineration process. Heavy metals are concentrated in the combustion residue. Chromium, copper, nickel, lead and zinc are found in the bottom ash; cadmium, zinc and lead in the fly ash. Mercury is concentrated in the reaction products of the flue gas treatment process like halogens which take the form of salts, mainly chlorine, sulfur and fluorine.

Incineration is the best known method that concentrates the pollutants in refuse so they can be safely processed and disposed of.

Bottom ash that is free from fly ash and ferrous metals may be used as a base material for road construction or landscaping. Leachate tests however have shown that freeing heavy metals is very slow and takes place only to a minor degree.

Fly ash has to be disposed of at controlled landfills or stabilized by mixing with cement to control the leaching out of heavy metals. Another method now under trial in pilot plants is the vitrification of fly ash at temperatures of 1,400 to 1,600°C. This destroys all potential organic pollutants and transforms heavy metals into salts for recycling and processing. The vitrified ash may also be utilized as construction material.

Using recently developed pilot plants to produce sodium chloride or chlorine from the reaction products of the flue gas treatment plants will reduce even further the residue from incineration. Using all methods available can bring the ratio of residue to be landfilled down to 1% of the original waste volume.

Untreated organic pollutants, most prominent being dioxines and furanes, are reduced by about 80-90% during combustion. Using additional activated coke filters in the flue gas stream as tested in Europe will bring the reduction efficiency to near 95% and above.

ENERGY RECOVERY

Another aspect of incineration is energy. Many environmentalists considered the mass burning of plastic refuse a waste of resources. So they developed costly processes to recycle plastic waste. They also burned valuable fuel oil in power stations instead of using energy recovered in the incineration process. Energy from refuse is just as valuable as that from fuel oil and it can provide between 3 and 5% of the energy demand of a society. Energy generated from food waste and waste paper is energy utilizing renewable resources.

IMPLEMENTATION SCHEDULE

Refuse incineration plants are large investments for municipalities concerned with refuse disposal. Therefore, the feasibility study as the initial stage should be done very carefully. It will take between six and nine months including data collection, depending on the availability of basic information.

Another six to nine months will be needed for the conceptual and detailed project design as well as the preparation of specifications for tendering.

Contract periods for incineration plants depend on size and conditions for the construction and vary between 30 and 42 months, exclusive of the periods for evaluation and decisionmaking, which are subject to administrative and political procedures.

However, once the need for an incineration plant is established, it requires a minimum implementation period of about five years from feasibility study to start of operations.

REFUSE MINIMIZATION AND DISPOSAL: THE GERMAN EXPERIENCE

In an attempt to curb the ever increasing amounts of refuse, the German anti-pollution law requires processes that generate waste (e.g., industrial and commercial) to submit to a series of questions before they are granted a license to commence or continue operations.

First, is it technically feasible or economically viable to recover the refuse and can it be recycled properly and safely into other processes? If so, there will be no refuse since the residue becomes a resource for some other downstream process.

Second, if recycling is not possible, is it technically and economically feasible to avoid waste generation? If so, there will be no refuse.

Many processes, however, cannot control waste generation. But resource recovery and source reduction are also possible, within limits: some components of the refuse can be separated for recycling and reuse, thereby reducing its volume and toxicity.

In some cities of the Federal Republic of Germany, households separate recyclable products from domestic refuse, reducing the total household refuse from 15 to 32%.

Recycling, however, has technical and economical constraints. For instance, not all paper can be manufactured using recycled paper, nor can all glass be produced from recycled glass.

Clearly, the volume of refuse can be reduced by recycling and reuse, but there always will be a part that will have to be disposed of in a conventional way.

Third, can the refuse be disposed of without threatening present and future public well-being? If a safe and acceptable refuse disposal is not possible, the government refuses to grant the license to operate, or revokes it.

Incineration is one of the options that is both safe and acceptable. It treats refuse to reduce toxicity and the volume that goes into landfills, thereby minimizing the use of valuable land for refuse disposal.

The future German law on refuse, for instance, intends to require refuse pretreatment before landfill disposal. Likewise, in other growing cities of the world where refuse transport and storage is extremely difficult, pretreatment is becoming more of a necessity.

CONCLUSION

Considering the present and future waste management needs, there is no way "back to nature". We must move "forward to nature" with a technology adequate for the protection of man and environment. Incineration, if properly implemented and complemented by recycling and source reduction, is the best available method today.

Session 3: Economic Implications and the Role of Political Leadership in Waste Management

The Role of Political Leadership in Improving the Environment

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ABSTRACT

This paper discusses the importance of political will in improving the state of the environment. Laws, rules and regulations are strictly enforced by the government through the Department of Environment and Natural Resources (DENR). Using the Philippine Strategy for Sustainable Development (PSSD) as a framework, DENR implements programs to rehabilitate forest ecosystems as well as urban and coastal environments. Some of these are the National Forestation Program (NFP) and the River Revival Program, which use a multisectoral approach.

INTRODUCTION

The success of any human endeavor is often measured in terms of how much resistance an individual has to overcome to attain a given goal. More often than not, the triumph of hurdling the obstacles is as grandly celebrated as the object of success itself.

This is especially true in the Philippine setting, with its pluralism, newfound democratic space, institutions and the social ills that continue to haunt it. It was against this setting that environmentalism regained a voice. But even with its small number of advocates, it was a rough start for Philippine environmentalism.

First, environmentalism did not always dovetail what the working class thought their priorities then were. For many, these were as simple as bread on the table and a roof over their heads. To be sure, fresh air, clean rivers and lush forests were nice to smell and behold, but if these meant losing jobs due to plant closures or to timber concession cancellations, then, environmentalism did not seem very appealing at all.

Second, environmentalism was still a novel concept in the legislative branch of government. Although it was seen as an undeniable virtue, it rarely made first cut when it came to determining budgets and prioritizing outlays. In the light of these realities, it became clear that environmental rehabilitation and protection, at least in our country, could not be left to the edict of laws.

Further, our democratic and pluralistic traditions made it even clearer that the environment and natural resources sector needed a leadership to reassess and improve on environmental laws and create a climate conducive to their implementation, implement them in no uncertain terms, and at the

same time, manage the changes that the enforcement of these laws would surely bring.

In short, it became evident that the progress of environmentalism in our country needed a political will that would try to promote the concept among our people, despite conflicts of interest, general ignorance and an advanced state of environmental despoilation.

THE PHILIPPINE EXPERIENCE

The major concern of the new DENR in 1987 was the rapid destruction of the environment particularly evident in the state of the tropical rain forests. Consider these scenarios:

1. Logging has become a venue for graft and corruption since the end of World War II, with every administration adding its own list of bootleggers to the roster of timber concession holders.
2. Although there were responsible loggers, the industry itself showed little sign of being policed by government, or by its own administrative body. After all, many of the loggers represented the economic and political elite; and the industry could not be expected to muster enough will to reform itself.
3. The former administration relied heavily on natural resource exports, especially timber, to sustain a mismanaged economy.
4. The virgin forests were indiscriminately being cut, with no apparent effort to conserve them for biodiversity and environmental management purposes.

Apart from the problems of the timber industry, the uplands were also plagued by the massive migration of lowlanders due to the interaction of these prevalent socio-economic factors: the lack of a genuine land reform program, the persistence of feudalistic relationships in the rural areas and the general neglect of agriculture and croplands. By 1987, around 18 million Filipinos were already living in classified upland and forest areas, most of whom practised slash-and-burn agriculture or *kaingin* and gathered timber and other forest products.

Similarly, it was a case of inequities, numbers and a lack of resources in congested urban areas. Squatters multiplied as a result of waves of migration from the impoverished rural areas. Shanty towns mushroomed and were often coddled because they were rich sources of votes. These settlements only served to tax the already stretched carrying capacities of the country's major urban centers, resulting in such environmental crises as biologically dead rivers, heavy air pollution, and solid waste disposal problems. In short, the situation in the urban areas portrayed the classic dilemma of development versus environment.

Thus, the Aquino administration inherited not only a devastated economy but also a ravaged environment. Unfortunately, it also inherited a government machinery that was not equipped to deal with the realities of a despoiled environment nor to effect the badly needed immediate rehabilitation. The old Ministry of Natural Resources (MNR) was largely a regulatory organization. Environmental law enforcement, which is its principal function, was left to an inefficient pollution control commission. Moreover, environment and natural resources were perceived to be two mutually exclusive concerns, which reflects a lack of understanding of the dynamics between them.

The old bureaucracy was also saddled with a highly centralized system of decision-making, command and resource allocation, which upheld the primacy of Metro Manila over the larger number of Filipinos living in the rural and upland areas. Thus, decisions that affected the lives of Filipinos living in a province a thousand miles away were still made in Manila by bureaucrats who were not necessarily familiar with that province.

These problems were so evident that among the first acts of the new administration was the reorganization of the executive line agencies.

CURRENT EFFORTS AND FUTURE DIRECTIONS

The reorganization of MNR into DENR was inspired, in large measure, by the Brundtland Commission Report, which called for sustainable development. For its broader acceptance

by a high-consumption and natural resource-dependent society, DENR translated sustainable development into the Filipino context, with its unique needs, problems, culture, resources and ecosystems. The DENR was then set to become one of the first implementors of the principle of sustainable development in a third world developing country.

The Philippine Strategy for Sustainable Development

The rise of Philippine environmentalism provided the impetus for the rapid development of PSSD. Developed through the efforts of DENR and the broad cooperation of the private sector and the growing network of environmental nongovernmental organizations (NGOs), PSSD provides a blueprint for the rehabilitation and development of the country's resource bases and ecosystems. This document represents the first triumph of political will as applied to environmental problems.

Decentralization

Another direct consequence of the reorganization was the decentralization of DENR to make it more accessible to the public. Thus, 85% of its funds were reallocated away from the central to the regional offices. Most of its better management and technical staff were deployed in the field. Provincial and community offices were created to extend the reach of the department. Also, the regional offices assumed many of the developmental and regulatory functions of the central office.

Policies and physical movement of personnel and resources, however, are of little help if these do not support a vision, which should be carried through with the force of will. After all, the previous administration did not lack studies and policy initiatives, but it failed to move its policy agenda beyond paper, and on to the field.

Rehabilitation of upland and forest ecosystems

Priority was given to the rehabilitation of upland and forest ecosystems. Considered the most important resource base, the forests directly provide livelihood for at least 18 million Filipinos and indirectly affect the rest of the population through other related ecosystems such as croplands and coastal areas.

With PSSD, DENR began the systematic clampdown on illegal loggers, especially those hiding under the guise of legal timber concessionaires, and timber poachers. To begin with, checkpoints were established in areas where illegally cut logs may be transported to processing and marketing centers. Likewise, DENR monitored these centers for signs of illegal trafficking of timber from illegitimate sources.

Initial success prompted DENR to enjoin the citizenry to become watchdogs against illegal loggers, through an innovative and generous reward system. Further, illegally sourced timber being sold in the market were also confiscated. Overall, DENR's message was that illegal logging would not be a profitable undertaking in the long term.

The next step was the purging of unscrupulous logging concessionaires from the industry. In 1987, 36% of classified forest lands was under timber license agreements (TLAs). The number of large TLAs indicates that access to natural resources, then, was biased toward the elite. There were 137 TLA holders, some of whom were violating the terms and conditions of their respective licenses. Erring licenses were suspended or cancelled outright by DENR.

Consequently, in 1991, only 20% of forest lands is under 63 TLAs. The number of TLAs is expected to decline further, with the shift of focus to the development of resource access and opportunities to upland dwellers.

At the same time, DENR paid close attention to policy aspects that would help slow down the decimation of the remaining old- and secondary-growth forests. For example, a log export ban has been enforced to eliminate one of the principal reasons behind illegal logging and timber smuggling. Later, a lumber export ban would also be implemented to encourage the downstream processing of lumber into finished wood products within the country.

Policy initiatives in TLA regulation were also pursued. For example, the annual allowable cut of these concessions was reduced by an average of 50%, to reflect the shrinking

timber resource base. With the advent of a Philippine Master Plan for forestry development, the policy of shifting timber production from old- to secondary-growth forests was also adopted to preserve the 900,000 ha of remaining virgin forests and their biodiversity.

Because loggers have started taking new environmental regulations more seriously, logging operations have slowed down to pave the way for resource base rehabilitation through reforestation.

The National Forestation Program

Political will was needed to implement reforestation for the following reasons. First, the government needed to borrow funds externally for such an undertaking. Second, the bias for government reforestation had to be overcome in favor of contract reforestation. Third, uplanders had to be convinced that contract reforestation was not another government scam or propaganda vehicle, but a genuine effort to improve their environment and give them better livelihood opportunities. Fourth, a constituency had to be built upon which the future of these restored forests can depend.

Thus, DENR's NFP, which is the primary vehicle for all reforestation activities, had to be reasonably successful in all four counts. On the first count, DENR's developmental efforts would be worthless without environmental integrity and natural resource sufficiency. Consequently, the Asian Development Bank (ADB) was tapped for funding. Fortunately, ADB was, at that time, already receptive to the idea of funding environment-related projects, because of the growing political strength of environmentalism in the developed countries that fund ADB. Further, the Overseas Economic Cooperation Fund of Japan matched the commitment of ADB for this program.

Simultaneously, DENR had to promote the concept of contract reforestation (as against administrative reforestation) within the department and outside. Administrative reforestation, the strategy that has been used for the last half-century, was found wanting because it did not involve uplanders who could have been given interest in and stewardship of the plantations. Contract reforestation, on the other hand, had been tried on a limited scale, with mixed success.

With the funding and the strategy in place, the next step was to convince the uplanders that the program was sensitive to their requirements. The decentralization of DENR greatly helped in convincing them of the program's viability and in facilitating program participation, training and instruction, and the distribution of materials, the mobilization fund and other payments.

Lastly, the citizens themselves had to be convinced that planting trees is needed to secure the future of the nation. Thus, a constituency for the forests, and to a greater sense, for the environment could be built. The DENR started by launching a massive information, education and communication campaign for the restoration and protection of our forests and the environment as a whole. The NGOs which had effective grassroots networks were tapped to spread the word rapidly in the hinterlands. The media had to be convinced that environment could sell newspapers and air time; nontraditional publics like the clergy and civic organizations had to be approached. Also, DENR had to sell the idea of NFP and good environment to officials in the national government and the legislature.

In 1990, NFP reforested 191,663 ha of denuded forest area, resulting in net forestation in the last two years--a feat achieved for the first time in Philippine development history. In terms of employment, NFP has generated an equivalent of one job for every hectare planted. This fact alone has enabled NFP to gain further credibility as a potent vehicle for upland development in the eyes of the uplanders, the government and the donor institutions. To prove this, the second NFP, which will have more resources, is under negotiation with ADB.

Of course, the problems in the uplands are far from over. Poverty, illegal logging and *kaingin* are still around. This is why constituency-building is an important dimension in the politics of environment and sustainable development. Since changes cannot be effected overnight, or even in five years, there is a need to develop a body politic that will continue to push the national leadership for the needed reforms, and the required will to

pursue them. This solid group of people will push for better environment with their votes, voices and checkbooks.

The NFP and the uplands, however, represent only some of DENR's areas of concern. Others are the rapid growth of urban areas and coastal settlements, which have pressured DENR to apply the lessons of its upland experience to solving coastal and brown environment problems.

Urban and coastal environments

The problems in the urban and coastal environments represent the interplay of the same dynamics found in the uplands. This time, however, technology plays a major role, for the rehabilitation of these environments require major technological inputs which are often capital-intensive.

Many of the problems in urban and coastal areas are rooted in high population concentration and growth rate: the coastal cities, towns and villages contain nearly two-thirds of the population. Pressure on the coastal zone resources mounts as the demands of people that depend on them for life and livelihood multiply, as population levels increase and because of domestic sewage and industrialization in these areas.

As the ultimate repository of wastes, sediments and other waterborne debris, the coastal zone represents a complex management challenge. Clearly, a common property management system must be created. The history of the deterioration of mangroves and coral reefs clearly illustrates the failure to define and implement an integrated management system in these areas. In the early 1900s, mangroves covered an estimated 450,000 ha. The 1987-1988 spot satellite survey indicated that only about 149,000 ha of mangroves remain, or 33% of what they were at the turn of the century. Further, only about 40,000 ha can be classified as old-growth mangroves; the rest is residual.

The rapid destruction of mangrove resources reflects the past emphasis on the release of such areas for fishpond development. Like the forest resources, many of these fishponds are controlled by the economic and political elite.

The wave of environmentalism, however, has resulted in a more serious assessment of the ecological and commercial value of the mangrove resources. Adding pressure is the reduced viability of the municipal fishing grounds resulting from overfishing, pollution and the loss of breeding areas due to the destruction of coral reefs and coastal mangroves.

In response to the growing coastal crisis, the government created in 1988 an interagency coastal resources management committee with NGO representation tasked with coordinating the rehabilitation, development and use of the country's coastal resources. Its positive developments include the:

- ban on the conversion of thickly vegetated mangrove areas into fishponds;
- ban on the cutting and debarking of mangroves for commercial purposes except those found in fishponds and commercial plantations;
- automatic reversion of abandoned or underdeveloped fishponds to public domain;
- issuance of certificates of stewardship over mangrove areas; and
- establishment of communal mangrove forests.

Moreover, DENR is undertaking mangrove reforestation through a component of NFP and the Fisheries Sector Program, which is also ADB-funded. There are also aquasilviculture pilot projects being launched with the Department of Agriculture.

As in the uplands, DENR's work is hampered by a general lack of public appreciation for the importance of maintaining sound coastal ecosystems. Therefore, a lot of extension work, education and community organizing has to be done before community management of resources like mangroves can be fully implemented.

In the urban areas, focus has been directed toward the elimination of industrial and domestic waste discharge in major urban waterways. Priority has been given to the River Revival Program, a cleanup of Metro Manila's heavily polluted waterways.

The first cleanup project involves the Navotas-Malabon-Tullahan-Tenejeros system, the largest river system in northern Manila that empties directly into Manila Bay. Similar

to the multisectoral approach used in implementing NFP, DENR sought the cooperation of local groups such as the citizenry, civic organizations like the Rotary Club, industrial plants situated on the river banks and large corporate sponsors whose interests also lie in the river system.

Again, DENR was able to get broad support from these groups, even when it was ordering the closure of polluting firms in the area, resulting in a temporary loss of jobs among local residents. The acceptance was, again, due to the full force of laws, rules and regulations behind the closure. Thus, none of the firms could complain, since it was obvious that DENR was determined to carry out its job. In fact, even the main corporate sponsor of the program had one of its plants in the area closed, after it was found to be a major polluter of the river system.

Because a moral basis was established for the implementation of the program and the will to implement laws, rules and regulations was manifested, support began to well from unexpected quarters. The most noteworthy example is the banding together of local industrial firms into an environmental NGO that will police industrial users of the river system for compliance with antipollution regulations.

CONCLUSION

The achievement of such self-policing speaks volumes for the potency of political will in moving environmentalism forward across many traditional social, cultural and economic barriers, which represent society's resistance to change. After all, environmentalism and sustainable development represent new ideas, fresh conflicts, displacement and sacrifices. Thus, it is important to show through strength of will and the virtue of moral ground that the planned changes are imperative. As in any successful process of social transition and movement, the key ingredient is managing change. That, in sum, is what the use of political will is all about.

The Economics of Coastal Waste Management

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ABSTRACT

This paper reviews the economic implications of waste collection and disposal practices in key coastal areas of the ASEAN region. Current financial commitments to waste management in urban centers are estimated, along with potential societal returns associated with increased commitments. Financial expenditures relative to the gross domestic product (GDP) are compared among countries.

Three beneficiaries of improved waste management practices, public health, fisheries and tourism, were considered. Singapore is used as a standard of expected beneficial impacts. Although the trend in fish landings and tourist arrivals is increasing within the region, inadequate programs will limit the potential of these activities. Increases in income associated with the development of the manufacturing/service sectors, and the associated increase in urban populations, continue to pressure coastal resources at the expense of lower-income traditional sectors such as fishing.

The relative commitments of GDP to waste management programs indicate that governments have placed a higher priority on waste management than is apparent from current pollution loads. The solution to effective coastal waste management, therefore, is the development of programs which will effectively utilize funds to reverse the continued deterioration of coastal resources. This paper includes a cost comparison of alternative solid waste and sewage treatment programs in the region.

INTRODUCTION

Proper disposal of household garbage, industrial waste and sewage is a major environmental problem in the world, particularly in the coastal areas of the member-countries of the Association of Southeast Asian Nations (ASEAN). Concerns vary from the identification of suitable land for disposal sites to the indiscriminate dumping of wastes into the seas or coastal wetlands. Further, increasing concentrations of urban population release sewage and nondegradable plastic refuse into coastal waters. The result is rapid coastal degradation, particularly adjacent to urban centers.

The purpose of this paper is to estimate the economic and financial aspects of waste collection and disposal practices in ASEAN key coastal areas as well as evaluate the economic merits of various waste management or mitigation strategies to identify the most socially costly problems and the most cost-effective interventions.

This paper should be read in conjunction with "Assessment of waste management in the ASEAN region" (Lee and Troxler, this vol.), which presents the existing waste management practices, issues, and alternative approaches to the resolution of the issues. This paper highlights their major findings and conclusions. Much of the information in this paper was generated through consultation with various ASEAN country experts.

SOCIOECONOMIC OVERVIEW

Resources overview

The ASEAN region is highly oriented to its coastal resources, with approximately 70% of all human activities and, consequently, economic activities, existing within the coastal areas (Chua and Scura 1991). The total land area is 2.64 million km² with 106,179 km of shoreline.

There are 325 million people living in the region with population densities ranging from 500 persons per hectare in Malaysia to 43,000 per hectare in Singapore. Currently $^1/_3$ to $^1/_2$ of the ASEAN population is considered to be in the workforce. Population growth rates vary from 1 to 3% per year.

Nearly one-half (46%) of the workforce is engaged in agriculture and fishing. In Indonesia, the proportion is 56%; in Malaysia, 31% and in Thailand, 57%. The GDP generated by agriculture, fishing and forestry is 26, 21 and 17%, respectively, and 19% for the ASEAN region. These industries thus give a relatively low return, which, given the large number of people engaged, partially explains the income disparities within the region (Fig. 1). For example, 20% of the lower-income households in the Philippines account for 5% of all household income generated, while 20% of the higher-income households account for 37% of all household income in the country. Typically, where income distribution is not as equitable as in industrialized countries', the lower-income sectors reflect agricultural, fishing and forestry incomes which contribute proportionately less to national income than the lower-income sectors in industrialized countries. Consequently, there is implicit pressure to continue industrial development at the expense of these more traditional sectors.

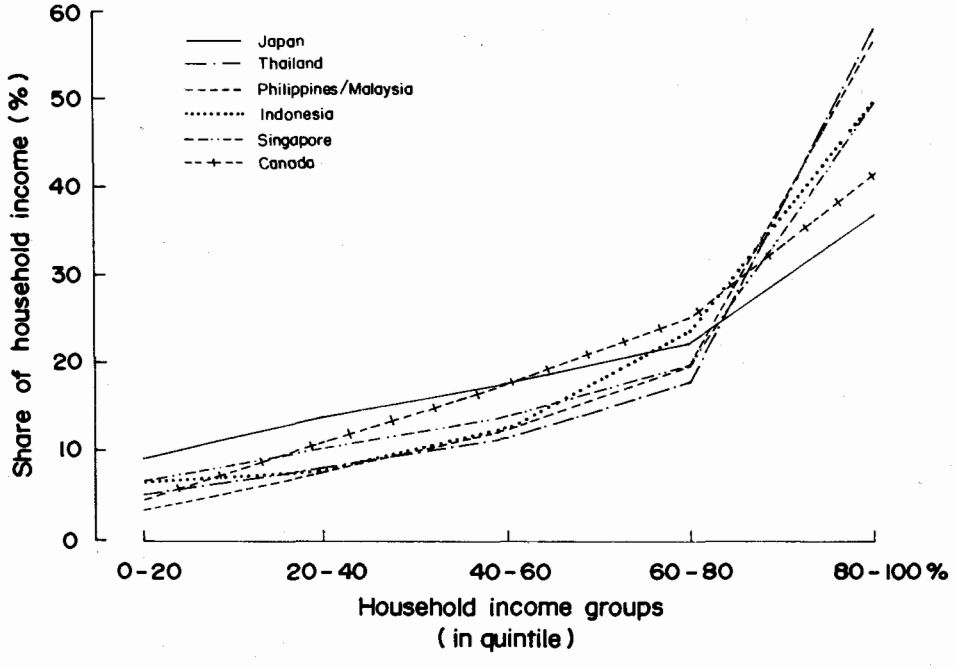

Fig. 1. Income distribution in ASEAN member-countries, Japan and Canada.

The employment and income created by industrialization were expected to more than offset the loss in the primary resource sectors (e.g., fishing) resulting from pollution. Thus, the emphasis has been focused on industrialization and continued urban growth.

The Southeast Asian seas supports highly productive fisheries with 10% of the world's reported landings occurring in the ASEAN region (Chua and Scura 1991). The total annual marine catch in the region is 5.8 million t, with a regional increase of 44% over the annual catch ten years ago, which indicates continued pressure on local fisheries (WRI-IIED 1989). A major issue is the impact of pollution on the regional fishing industry, although overfishing may be a more fundamental problem. This is of particular concern, given that fish supplies over $^1/_2$ of the animal protein consumption within the region (Chua and Scura 1991).

Economic activities

While manufacturing is the largest production sector in all countries except Indonesia, agriculture/fishing/forestry is generally the second largest production sector employing the largest number of people (Table 1). The majority of exports from the region are manufactured goods and machinery at approximately 55% of the export value, compared to 45% of export values of primary goods such as food, crude materials and mineral fuels (Table 2).

Table 1. Economic activities.

GDP/economic activity	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
GDP at market prices (US$ billion)	2.9	64.2	24.5	39.2	24.5	56.1
Per capita income (US$)	12,772	403	1,875	667	8,162	1,038
GDP (%)						
Agriculture/fishing/forestry	1.1	25.7	21.0	22.3	0.3	17.2
Primary industry (petroleum, mining, etc.)	64.2[a]	13.2	10.3	1.9	0.1	3.1
Manufacturing	0.7[b]	14.0	24.3	24.3	27.3	24.8
Services	35.9	37.4	42.8	48.5	62.6	39.1
Others		9.9	2.2		9.6	17.5

1989: US$1.00 = B$1.95; Rps 1,700; M$2.77; ₱21.70; S$1.95 and Baht 25.70.
The figures for Brunei Darussalam, Malaysia and Singapore are for 1989; the Philippines and Thailand, 1988 and Indonesia, 1987.
[a]Limited to the oil and gas industry.
[b]Includes mining and quarrying.
Source: EPL (1991).

Table 2. International trade-exports (US$ million).

Export	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Food and beverage	-	2,069.8	1,084.0	1,133.7	2,011.7	6,814.4
Crude materials (inedible) and animal and vegetable oils	-	3,200.3	6,706.8	1,120.9	2,429.1	1,381.0
Mineral fuels, lubricants	1,824.5	7,723.2	3,246.3	118.1	5,710.2	142.0
Chemicals	-	345.7	450.4	278.6	2,941.4	251.0
Manufactured goods	-	5,435.3	3,076.8	1,937.0	7,639.3	3,634.3
Machinery and transport	-	126.2	5,782.7	940.1	22,120.8	3,568.5
Others	69.3	318.0	80.4	2,292.3	1,815.7	4,276.8
Total	1,893.8	19,218.5	20,427.4	7,820.7	44,668.3	20,067.9

The figures for Brunei Darussalam, Philippines, Singapore and Thailand are for 1989; Indonesia and Malaysia, 1988.
Source: EPL (1991).

ECONOMIC AND FINANCIAL IMPACT OF WASTE MANAGEMENT

The continued environmental deterioration in the region is a result of urbanization, industrial development, excessive use of agricultural chemicals, inadequate design of intensive livestock facilities, overfishing and clear-cutting of forests. Given that the detrimental impact of these activities is best mitigated at their origin, waste generating sources are categorized as urbanization, agriculture and industrialization. Approximately 80% of coastal waste problems in Malaysia are associated with domestic waste. Assuming similar conditions exist in other countries, domestic waste is given emphasis in this analysis.

Urbanization

Urbanization promotes the concentration of people in small areas, which results in the generation of sewage, domestic solid waste and surface runoff from extensive roofs and paving. All major urban centers are located in coastal regions where large amounts of untreated sewage are either disposed of directly into coastal waters, or deposited into coastal streams in such proximity to the coast that it precludes the possibility of streams assimilating the polluted discharges to acceptable levels before entering coastal waters. Currently, 80% of biological oxygen demand (BOD) loads are deposited in the coastal areas, although residual loads are expected to be reduced to 50% by the year 2000. Solid waste is incinerated, deposited in landfills, accumulated in the urban centers or, in some circumstances, dumped directly into coastal waters. Solid waste impacts on the coastal area by leaching from improperly designed inland landfill sites, stormwater runoff carrying debris from streets and vacant lots (e.g., 30% of Jakarta's coastal stream BOD loads are from solid wastes) and, obviously, from direct dumping into coastal waters. Currently 82% of the 94,000 t of solid waste generated annually in the coastal region is received at authorized disposal sites.

The current waste disposal practice in several urban areas of the region has an impact on the immediate coastal waters which is significant, although limited to a radius of several kilometers from the urban centers.

Solid waste costs

Brunei Darussalam currently spends US$1.3 million per year for operation and maintenance (O&M) of solid waste disposal programs for approximately 25% of the solid waste generated in the country.[1] Other waste services such as the military, Brunei Shell and hospitals attend to the other 75%. Anticipated sanitary landfill costs over the next five years are $8.3 million and $14.6 million per year for capital and operating costs, respectively.

Indonesia collects about 80% of its solid waste. Approximately 30% of the organic load in surface waters within Jakarta is attributed to solid waste from direct dumping or leaching. Private collectors receive $8.50, $5.60 or $0.10/month/household, depending on the nature of the household, for solid waste collection and disposal.

Most solid waste collection in Malaysia is through private contractors in the major urban centers. One of the problems is obtaining the financial commitment of urban squatters and rural residents. Total annual costs for solid waste management in 1974 were estimated at $4.00/capita in Irian Jaya. Incineration costs for waste disposal are $28/t and higher, with improved air emission controls, and $4/t for landfill disposal. Because of the solid waste composition, 30% by weight is unburnable; incinerated material would generate 10% of the current landfill volume. Consequently, 50% still requires landfilling, even with the incinerator program. Malaysia has rejected incineration because of the relatively high costs. The sum of $1.8 million/year is budgeted over the next five years to develop landfill sites, weighbridges and others for Kuala Lumpur.

The major problem facing urban centers in the Philippines, particularly Manila, is inadequate roads, thus requiring small vehicles for collection and transfer of solid waste to landfill sites (Gomez et al. 1990). The issue is one

[1]Costs are in US$ unless otherwise specified.

of improving the transportation system or increasing the number of landfill sites. Obviously, improving the roads requires a much more comprehensive program than direct investment in waste disposal systems. Increasing the number of dumping locations creates the problems of "not-in-my-backyard" syndrome, plus the increased costs associated with landfill construction, operation and monitoring.

In Thailand, only 20% of total solid waste is collected for the entire country, with no collection services in the rural area and 84% collection in Bangkok. Costs for sanitary landfill and compost are estimated at $5 and $35/t, respectively. Estimated compost product value is $18/t at the compost site. Because of the technical nature of the composting machinery and the relatively high operating costs, the composting plants are currently operating at 50% of capacity. Total waste collection and disposal costs are estimated at $10/t, yet the householder pays $2.70/t or a total of $1.95/year.

Singapore has developed a highly effective waste management system. Approximately 85% of solid waste is incinerated, with 28% of incinerator costs recovered from sales of electricity and recyclables. The rest of the solid waste and the incinerator ash are landfilled. Operating costs in excess of sales revenues amount to $47 million/year, or $17/capita/year. The capital investment in the incineration plants, transfer station and landfill sites is $200 million. Assuming a 15-year depreciation period, this is $13 million/year. Efficient transportation systems and planned housing developments allow for large, efficient state-of-the-art collection, transfer and disposal systems.

Table 3 summarizes these statistics.

Sewage

Proper sewage disposal is a major concern in the region. Gomez et al. (1990) have stated that:

> The most pronounced biological effects in the region are those resulting from organic pollution and eutrophication. Biological effects resulting from other types of pollution are much less obvious.
>
> The major source of organic pollution in the region is sewage, much of which is discharged raw into coastal waters whether directly or through rivers and waterways.

All urban areas in Brunei Darussalam receive secondary treatment except Kuala Belait which has primary treatment and Kampong Air which has none. The new treatment plant planned for Kuala Belait will cost approximately $15 million (PWD 1986). Capital costs to collect and treat Kampong Air sewage are estimated at $13.5 million. A further $1.5 million is estimated for annual O&M costs.

To bring sewage services in Jakarta to North American standards will cost around $4 to 10 billion, which is $530 to $1,330/capita. Indonesia is currently focusing on on-site industrial treatment and, of those industries contacted to implement it, 60% have voluntarily complied. Its progress, however, is hampered by lack of registration. Of the estimated 25,000 industries in Metro Jakarta, only 3,000 are registered or have licenses to operate.

It will cost $738 million to implement sewage collection and treatment in major Malaysian urban centers, which will serve 40

Table 3. Solid waste management statistics.

	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Urban population (million)	.17	48.0	6.1	26.6	2.7	9.5
Generation per capita per day (kg)	1.0	.4	.8	.4	2.0	.7
% collected	95	80	85	83	100	84
Current annual cost per capita ($)	17	3	8	4	22	3

Sources: Lee and Troxler (this vol.) and in-country interviews.

to 50% of the population. The cost to retrofit an older area with sewer services is five times that of incorporating services into an area during construction. Capital investment estimates for septic services for rural areas and water villages are $185-370/household.

Metro Manila Sewage and Sanitation Project estimates are for expenditures of $726 million over the next ten years, or $72.6 million/year. Projected services are to upgrade and expand sewage collection and disposal from 745,000 to 875,000 people by the year 2000. Current annual O&M costs for 745,000 people is $2.6 million.

In 1976, at the start of the Singapore River cleanup program, 80% of the population was served by sewage collection and treatment facilities, and the services budget was approximately $5 million/year. In the last 20 years, Singapore has spent $46 million on capital investments and $40 million for O&M annually. The sewerage system now serves 97% of the households. This intensive program will continue to require high capital investments as older collection systems are replaced and facilities expanded to meet a projected population of 3.4 million by the year 2030.

Table 4 is a synopsis of sewage collection and treatment statistics.

POTENTIAL BENEFICIARIES OF IMPROVED COASTAL WASTE MANAGEMENT

Pollution costs are often considered a necessary cost of the industrialization/urbanization process. However, benefits, although often not readily measurable, do exist such that effective waste management policies must be considered.

> Ideally, the aim would be for a universal catalogue of costs of potential pollutants, and for an inventory of all pollution-generating activities as well as of the value of the benefits derived from them. However, there are only estimates of some costs in some circumstances, and somewhat subjective views of the benefits. The long-term, widespread effects in the marine environment are not always evident, and this has led to the still not uncommon practice of using it as a "free" service with no defined limit to its capacity to accept wastes (GESAMP 1990).

Although the idealistic condition of quantifiable impacts on the various beneficiaries are not readily available, these categories indicate beneficial impacts of effective coastal waste management policies in the urban areas: fishing, tourism and health. Sustained biodiversity has not been included, as this analysis concentrates on urban activities which impact on localized coastal regions and, therefore, universal destruction of unique biota is unlikely.

Fishing industry

The region's bountiful coastal areas have, in the past, provided a resource base for an

Table 4. Sewage collection and treatment statistics.

Cost ($/capita)	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
% population with access to sanitation services						
Urban	85	33	100	83	100	78
Rural	-	38	60	56	-	46
Current annual costs (capital and O&M for metro centers)[a]	-	-	-	7	28	-
Projected annual costs for the next 5-year period[a]	25[b]	-	22	17	32	-
Total investment required to serve urban population within North American standards	100	930	120	-	0	-

[a]Per population served.
[b]Estimated.
Source: WRI-IIED (1989).

extensive fishing industry. Fish are directly consumed and bartered or sold commercially. Local concern is increasing as fish populations in these areas have declined by as much as one quarter from precommercial fish population levels. A combination of increased human populations concentrated in urban areas and their associated pollutive actions, industrialization, and increased commercial fishing have led to this decrease. Manila Bay, which has been subjected to all these pressures, has just been closed to commercial fishing. Although this study focuses on the impacts of improper waste management practices, exploitative commercial fishing is a significant factor in the overall loss equation. Gomez et al. (1990) noted "a general decline in fishery resources in the ASEAN region as a whole, mainly due to overexploitation."

Increased total revenues accruing to fish production is not an accurate measure of total societal gain from improved waste management practices, as many costs, including purchased imports such as equipment and possibly fuel, are required to produce the harvest. Consequently, only returns to a country's basic resources of land, labor and capital as measured by GDP are used to measure the societal returns from fisheries.[2]

Estimated GDP associated with the marine fishing industry for the region is $4,891 million (Table 5).

Although the reduction in marine fishery adjacent to urban centers is significant, overall, a small proportion of a country's coastline is affected by inadequate waste management in these centers. If coastal conditions were to improve, an increase of 10% in coastal fisheries potential may be realized. Total GDP gain to the region would be $490 million. There is no expected increase in fishing opportunities in the Singapore and Brunei Darussalam coastal areas associated with improved coastal waste management practices.

[2]See Appendix for GDP methodology.

Tourism

The region is a prime location for tourist development. Factors such as predictably warm weather, particularly during the northern hemisphere's cool seasons; beautiful beaches; unique flora, fauna, wildlife and fish; and distinctive cultures are conducive to a strong tourism industry. The tourist, however, is an elusive customer who is easily frightened off. For example, the Middle East war and the recent airline crash in Thailand have resulted in a large number of tourist cancellations. The tourist is also health-conscious, as demonstrated by an incident in Malaysia. As a result of a press report of a cholera outbreak in a Malaysian tourist area last year, approximately 50% of local reservations by foreign tourists were immediately cancelled. Although there is an extensive coastal area to attract tourists within the region, much advertising and physical investment goes into developing an area for tourism. Good reputations come slowly and leave quickly. If an area becomes fouled, the recreation site cannot be automatically relocated. Instead, tourists are attracted to other competing geographic regions.

The number of annual visitors to the region is 20.41 million (Table 6). Visitors expected to utilize coastal/marine resources are 10.1 million/year and they will spend $3 billion.

Table 5. Fishing industry.

	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
GDP ($ million)	3	1,474	551	1,132	19	1,712
Length of coastline (km)[a]	161	80,716	4,675	17,460	132	2,960
Average annual marine catch (thousand t)[b]	3	1,732	670	1,330	22	2,012
% increase in fisheries[c]	73	73	33	14	31	42

[a]Chua and Scura (1991).
[b]WRI-IIED (1989).
[c]1983-1985 compared with 1974-1976.

Table 6. Tourism information.

	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Number of visitors per year (million)	.01	1.6	7.9	1.2	4.9	4.8
Coastal/marine tourists per year (million)	.006	1.6	3.3	0.4	3.2	1.6
Expenditures by marine coastal tourists ($ million)	0	423	679.2	247	1,050	650
GDP ($ million)	0	224	360	131	557	345

Sources: WRI-IIED (1989) and Chua and Scura (1991).

The GDP associated with it is $1.6 billion, which represents 1% of regional GDP.[3]

Over 50 % of respondents to visitor surveys in the Philippines rank friendly people and beautiful scenery as its most favorable attractions, and 40% of respondents ranked dirty environment and poor traffic conditions as the conditions disliked most (DOT 1989).

Given the tourists' aversion to poor environmental conditions and attendant health risks, a decrease of 20% in coastal/marine-based tourism may not be unrealistic. This would represent an annual loss of $610 million in tourist expenditures and $323 million in GDP for the region. Coastal waste management practices do not limit tourism potential in Singapore or Brunei Darussalam and, therefore, losses have not been included for these countries.

Health

The oft-quoted factor influencing the need to manage waste is public health and safety. It is also one of the most elusive factors to quantify. Four infectious diseases were selected as indicative of the environmental impact on human health, i.e., cholera, dysentery, hepatitis and typhoid. Only their incidence is selected as an exposure indicator rather than the associated number of deaths, since death may reflect the subsequent health care rather than exposure. Other popular health indicators such as expected life spans and infant mortality are considered as health care factors, rather than exposure indicators. Unfortunately, the incidence of these diseases is not available for some countries and only for the urban centers in others. Thus, data was extrapolated to reflect incidence throughout the respective countries' populace (Table 7).

Caution must be used in cross-country comparisons of disease incidence, insofar as data were not derived from a common survey technique and the basis of reporting diseases will vary by country. However, the information has been included in this analysis as an indicator of regional gains to be realized through proper coastal zone waste management.

[3]For estimate of GDP coefficient, see Appendix.

Table 7. Disease incidence per 100,000 urban population per year.

Disease	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Cholera	6.4	12[a]	6	6.5[a]	1.1	6.3
Dysentery	7.2	200[a]	4	110[a]	2	103
Hepatitis	20[a]	100[a]	26	60[a]	4.5	50
Typhoid	6.8	100[a]	20	60[a]	4	50

[a]Author's estimates.
Sources: In-country interviews; MHLG (1988) and De Silva et al. (this vol.).

The quantification of the costs of these diseases is further complicated by the fact that the incidence of exposure is higher among children than adults. Lost adult earnings would be one measure of detrimental health impacts, however, lost time by school children, costly medical services and adult home care are also important economic factors. Because of the extra health services required for children and the interruption in the educational process, no differentiation was established for the economic consequences of disease exposure among various ages. It was also assumed that all socioeconomic levels of the population have a similar incidence of exposure.

Given the above assumptions, the national per capita GDP can be utilized as a measure of a person's contribution to the national economy. Arbitrary lost time allowances (year) made for each disease are as follows: cholera, .006; hepatitis, .100; typhoid, .040; and dysentery, .006.

All reported incidence cannot be attributed to coastal waste management practices, although through comprehensive waste management programs, countries such as Singapore have minimized exposure to disease. It is assumed that the regional disease incidence could eventually be reduced to that of Singapore, because of proper waste management. As exposure to disease is a result of a multitude of factors, the Singapore standard would be the maximum that could be reasonably attributable to proper coastal waste management programs (Table 8).

Regional GDP associated with the reduction in disease exposure can be up to $4.757 million/year. Much of Singapore's disease incidents are imported from the local region. Thus it is expected that the incidence in Singapore will also decrease.

Multiplier impacts

Direct gains from improved waste management practices in the urban centers in fishing, tourism and personal health are measured as increased GDP. Direct gains, however, underestimate the national impacts, as there are spinoff benefits from increased productivity, particularly in underemployed economics. The multiplier concept measures the extended impact as expanded fisheries purchase more boats and nets, and hire more employees. The multiplier is a measure of these increased economic activities. The GDP multiplier in more developed countries is 1.3 to 1.7 for primary sectors such as fishing, and 2.0 to 2.5 for manufacturing and service sectors which cater mainly to tourism activities (SC 1987). For example, if GDP within the fishing sector increased by $1.00, total GDP within the country will increase by $1.30 to $1.70, which includes the $1.00 increase from the fishing sector plus $0.30 to $0.70 for GDP realized in the fishing supply sectors. Conversely, a loss in GDP will have the reverse multiplier impact.

If GDP multipliers of 1.5, 2.25 and 2.0 are assumed for fishing, tourism and health, respectively, total GDP increases associated with improved coastal management practices are increased from $702 to $1,217 million for the region (Table 9).

Table 8. Lost regional GDP due to disease incidence in urban population ($ million/year).

Disease	Brunei Darussalam	Indonesia	Malaysia	Philippines	Thailand	Total
Cholera	0.001	0.001	0.003	0.005	0.003	0.022
Hepatitis	0.031	1.595	0.185	0.892	0.436	3.138
Typhoid	0.002	0.641	0.055	0.360	0.176	1.235
Dysentery	0.001	0.198	0.001	0.104	0.058	0.362
Total	0.035	2.435	0.244	1.361	0.673	4.757

The above figures were computed as follows:

$$\frac{\text{Per capita GDP} \bullet \text{urban population}}{100{,}000} \bullet \text{incidence} \bullet \text{time lost}$$

Table 9. Multiplier impact on increased GDP ($ million).

GDP		Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Fishing	DI	-	147	55	113	-	171
	MI	-	221	83	170	-	257
Tourism	DI	-	45	72	26	-	69
	MI	-	101	162	59	-	155
Health	DI	.03	2.4	0.2	1.4	-	0.7
	MI	.06	4.8	0.4	2.8	-	1.4
Direct increase		.03	194	127	140	-	241
Multiplier impact		.06	327	245	232	-	413

DI - direct impact. Derived from Tables 5, 6 and 8.
MI - multiplier impact. This is a product of DIs and multipliers of 1.5, 2.25 and 2 for fishing, tourism and health, respectively.

Comparison of benefits and costs

Both costs and benefits are measured on an annual flow basis, i.e., what are the annual benefits accruing to waste management strategies and what are the annual costs of these programs? This approach is consistent with Singapore's experience. Singapore had invested heavily in waste management facilities prior to the 1976 Clean Rivers campaign. Investments for program maintenance and improvement at the conclusion of the project remain high. An overview of Singapore's national accounts and government expenditures does not indicate a significant increase in overall expenditures, government debt, nor a major shift in ministry budgets during the river cleanup campaign. The program was rather a focus of existing budgets to accomplish a specific goal.

Applying this concept of continued investments to other countries, improvements in coastal waste management practices cannot be viewed as a lump sum investment, but rather as an ongoing change in philosophy with continual attention and investment in the coastal environment.

In keeping with the above philosophy, and using Brunei Darussalam per capita expenditures as a regional standard, solid waste collection costs would increase for the other countries from current levels to $17/capita. Total annual increased costs would be $1,093 million for the region (Table 10).

Data for sewage collection and treatment costs are not complete. However, if average increased expenditures of Singapore are extrapolated to Indonesia and Thailand, increased regional expenditures for sewage collection and treatment facilities will cost around $828 million. Total regional costs for solid waste and sewage collection and treatment facilities similar to that in Brunei Darussalam for solid waste and Singapore for sewage treatment will cost $1,921 million.

The full impact from improved coastal waste management practices will not be seen immediately. In time, however, annual benefits for protection from loss of tourism, increased fisheries potential and reduced exposure to disease will be realized (Table 11).

Care must be used in interpreting the above, as not all benefits are quantifiable, e.g., quality of life and environmental obligation intangibles. The $1,217 million in potential benefits cannot be ignored and cost-effective programs must be incorporated for some of these potential gains.

Affordability

Programs that, in the long term, are in the best interests of society often are impossible to initiate because of lack of finances. This is demonstrated by comparing per capita GDP with waste management expenditures. The per capita GDP for Singapore is $9,074, and current solid waste management and sewage treatment programs are costing $60/capita or approximately 0.67% of GDP.

Table 10. Increased waste management costs ($).

Waste management cost	Brunei Darussalam	Indonesia	Malaysia	Philippines	Thailand
Urban population (million)	.2	41	5.7	26	9.3
Solid waste net costs per capita (per year)[a]	0	14	9	13	14
Total increased costs to serve urban population	0	574	51	338	130
Sewage collection and treatment net costs per capita (urban) (per year)[b]	3	-	6	11	-
Total increased costs to service urban population	1	413	34	286	94

[a]$17 less current expenditures per Table 3.
[b]$28 less current expenditures per Table 4.

Table 11. Regional benefits (GDP $ million) from improved waste management.

Benefit	Health	Fishing	Tourism	Total
Direct annual benefits	5	486	212	703
Direct plus multiplier benefits to local economy	9	731	477	1,217

Table 12. Percentage expenditures in GDP ($).

GDP/expenditure	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Per capita GDP[a]	11,600	348	1,408	604	9,074	1,009
Current per capita expenditure for waste management[b]	42	21	30	21	60	21
% in GDP	0.4	6.0	2.1	3.5	.7	2.1

[a]Estimated from Lee and Troxler (this vol.).
[b]Per Tables 3 and 4.

Estimated waste management programs in other countries, with the exception of Brunei Darussalam, vary from $21-30/capita; however, these programs are costing from 2.1 to almost 6% of per capita GDP (Table 12).

The answer to the affordability dilemma is to seek low cost, but effective alternative waste management programs. Given the high rate of real growth, industrialization and urbanization in the region, a further delay of effective waste management programs will require more expensive solutions as the problems intensify. Therefore, the emphasis is to create affordable programs now.

Alternative waste management program costs

Alternatives for solid waste management in the region include open landfills, sanitary landfills, incineration and a composting process. Each of these options is not available to all countries as it would be impractical, for example, for Singapore to compost solid waste as extensive agricultural land to receive the compost is nonexistent. In other countries where suitable land is available for sanitary landfills, incineration is comparatively expensive.

Since each country is not experienced in all forms of solid waste disposal, relative costs are extrapolated to other countries (Table 13).

Costs for sewage collection and treatment facilities will vary by population densities, zoning policies for urban development, whether the sanitation system is retrofitted to an established area or is incorporated into a new development. Table 14 demonstrates the relative costs of various treatment facilities.

The effect on the coastal environment of the several solid waste management programs presented in Table 13 is similar in all cases except open landfill. The most effective program for each country, therefore, is the most practical and least-cost alternative which can be incorporated into local conditions. The efficacy of the sewage treatment alternatives as presented in Table 14, on the other hand, varies and consideration must be given not only to costs but also to the ability of the various processes to achieve national effluent standards. Given the increasing rate of urbanization in the various countries and

Table 13. Annual solid waste management costs ($/capita).

Cost	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Waste generation (kg/day)	1.00	0.40	0.80	0.40	2.00	0.70
Collection ($14/t)	5.10	2.00	4.10	2.00	10.20	3.60
Disposal						
Open landfill ($3.50/t)	1.30	0.50	1.00	0.50	2.60	0.90
Sanitary landfill ($4.00/t)	1.50	0.60	1.20	0.60	2.90	1.00
Incineration ($20.00/t)[a]	7.30	2.90	5.80	2.90	13.60	5.10
Compost ($17.50/t)[b]	6.40	2.60	5.10	2.60	12.80	4.50
Total annual costs						
Open landfill	6.40	2.50	5.10	2.50	12.80	4.50
Sanitary landfill	6.60	2.60	5.30	2.60	12.90	4.60
Incineration	12.40	4.90	9.90	4.90	24.60	8.70
Compost	11.50	4.60	9.20	4.60	23.00	8.10

[a]Net after electricity sales.
[b]Net after compost sales.

Table 14. Estimated cost ($/capita) of sewage treatment facilities (annual costs including investment costs).

Cost	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
BOD generation (tons per million population)	120	50	50	50	120	50
Sewage treatment[a]						
Capital						
Primary	76.5	32.1	32.1	32.1	76.5	32.1
Secondary	132.6	55.2	55.2	55.2	132.6	55.2
Tertiary	156.6	65.3	65.3	65.3	156.6	65.3
O&M						
Primary	6.8	2.9	2.9	2.9	6.8	2.9
Secondary	5.6	2.3	2.3	2.3	5.6	2.3
Tertiary	6.3	2.7	2.7	2.7	6.3	2.7
Septic	2.9	1.2	1.2	1.2	2.9	1.2
Sewage collection						
Capital	120.6	50.3	50.3	50.3	120.6	50.3
Annual O&M	4.5	2.0	2.0	2.0	4.5	2.0
Annual total[b]						
Primary	24.4	10.4	10.4	10.4	24.4	10.4
Secondary	27.0	11.3	11.3	11.3	27.0	11.3
Tertiary	29.3	12.4	12.4	12.4	29.3	12.4
Septic[c]	8.8	3.7	3.7	3.7	8.8	3.7

[a]Includes outfall.
[b]Includes depreciation.
[c]Does not include collection.

the associated accumulative impacts on coastal resources, the selection of appropriate treatment facilities should be based on affordability and not on least-cost criteria.

RECOMMENDATIONS

Recommendations have been made within the engineering study component, given the various financial limitations faced by individual countries.

Brunei Darussalam

Brunei Darussalam's financial commitment to the waste management sector is sufficient and waste management is becoming more effective. Budgets for waste management for Kampong Air were included in projected costs over the next five years. These facilities can be handled within the overall capital and O&M budget commitments for the continual upgrading of facilities. Other recommendations are administrative-oriented and should be implementable without significant budget increases.

Indonesia

An all-out program to implement a waste management program equal to Singapore standards is cost-prohibitive. Current practices and expenditures indicate a lower priority to waste management programs such that coastal conditions are deteriorating rather than improving. Alternative practices, as described by Lee and Troxler (this vol.), should be investigated and financial commitments increased, although Indonesia's current commitment to waste management appears to be the highest in the region in terms of percent GDP. Alternative funding sources are required to stem the continued environmental deterioration around the urban areas.

Malaysia

Waste management budgets in Malaysia indicate progress in alleviating coastal waste management concerns. Intergovernmental responsibilities and budgets, however, need to be correlated such that budgets are allocated more efficiently. If funds are effectively allocated, adequate standards of urban waste can be achieved.

Philippines

Although the Philippines has a waste improvement plan for limited areas, with projections of $90/capita/year over the next five years, this will only serve 10% of the Metro Manila population. The problem of coastal waste management will still continue to grow. More cost-effective and comprehensive waste management programs must be implemented. These programs need to access a larger proportion of the urban population and must address other limits within the urban infrastructure, e.g., transportation for efficient waste removal. The Philippines also has to pay a high proportion of national income for waste management programs. The required investment to reverse the continued deterioration in coastal resources appears to be beyond the capacity of current in-country financial resources.

Singapore

Singapore's budget commitment to sanitary services indicates a continued upgrading of current state-of-the-art programs.

Thailand

Thailand's accelerated economic growth is quickly outpacing investments and improvements in waste management, particularly regarding domestic sewage in the Bangkok area. Reprioritization of funds and long-term comprehensive programs are required to offset continuing coastal resource deterioration. One option is to capitalize on the aggressive private investments occurring in the region to include more of the waste management costs associated with increased economic activities.

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Appendix

Tourism and Fishing Gross Domestic Product

The GDP measures the value added or returns to primary resources within an economy. Measures of gross sales or total expenditures overstate societal gains, as this measure records the value of a commodity several times as it progresses through the production process. For example, a fish caught by a fisherman is sold to a processor, then to a retailer and eventually to the consumer. If the total sale is recorded as a societal gain for each of the three sales, the same fish would have been counted thrice. Rather, GDP is the net increase in value, i.e., the initial value of the fish plus the value added by catching, processing and marketing the fish.

Tourism

Tourism values to a country are often recorded as total tourist expenditures. These values are used to indicate the relative importance of tourism to the country, but because of the requirement to include only the value added to an economy in an economic analysis, total expenditures need to be converted to a GDP measure.

Appropriate GDP measures of tourism activities, and their relationship to total tourist expenditures for the region, are not readily available. An approximation for local use was developed based on North American economic accounts.

Expenditure patterns of tourists entering the region are estimated for four industry types: accommodation, 37%; food and beverage, 20%; local transportation and travel services, 4%; and shopping and souvenirs, 39%.

The ratios of GDP of the four industries to total sales are: restaurants and hotels, 56; local transportation and travel services, 59; and shopping and souvenirs, 42 (SC 1984).

The weighted average of total tourism expenditures to GDP ratios yields a factor of .53 (i.e., for every tourist dollar spent in a

particular country, its GDP will increase by .53 of a dollar).

Fishing

The Philippines is the only country reporting GDP for the fishing industry. Fishing GDP for all other countries is aggregated with the agriculture and forestry industries. As fishing is one of the direct beneficiaries of coastal waste management, approximations of marine fishing GDP are necessary. The proportion of fish tonnage to GDP in the Philippines is extended to the other five countries and to the marine fishery in the Philippines.

In 1988, the marine and inland fish tonnage was 2.0124 million. Its GDP in 1989 was $1,713 million, generating $851 per ton of fish.

	Average annual marine catch (million t) 1983-1985[a]	GDP ($ million)
Brunei Darussalam	3	3
Indonesia	1,732	1,474
Malaysia	670	570
Philippines	1,330	1,132
Singapore	22	19
Thailand	2,012	1,712

[a]Source: WRI-IIED (1989).

The Role of Government in Waste Management: The Metro Manila Experience

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ABSTRACT

The government's role in waste management is to coordinate the involved sectors of society; issue regulations; monitor compliance and establish and implement effective and efficient management systems. This paper highlights the role of the Metropolitan Manila Authority (MMA) in waste management in the Philippines.

BACKGROUND

Global ecology, a movement to protect, conserve and properly utilize the earth has gained great momentum and an increasing number of supporters. Its adherents include not only enthusiastic private organizations but also increasingly involved national governments and regional governmental organizations. Hence, it has become a legal and a policy concern. This paper focuses on the role of government in waste management in the coastal areas of the ASEAN region.

Presidential Proclamation No. 824 issued on 7 November 1975 created the Metropolitan Manila Commission now MMA. It is the administering agency of a geopolitical unit called Metropolitan Manila--an integration of four cities (Manila, Quezon City, Pasay City and Caloocan City) and thirteen municipalities of the provinces of Rizal and Bulacan (Las Piñas, Makati, Mandaluyong, Marikina, Malabon, Muntinlupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Taguig and Valenzuela).

The MMA is a manager-council type of organization tasked with the delivery of basic urban services requiring coordination and direction, e.g., solid waste management.

The MMA's implementing arm for cleanliness, beautification, and garbage collection and disposal is the Environment Sanitation Center (ESC), then known as the Refuse and Environmental Sanitation Center. The ESC is headed by an executive director and is composed of five sector offices and two deputy directors, one for finance and administration, and one for solid waste management.

The major task of ESC is land-based clean-up services. In 1990, the estimated waste generation rate is 459 kg/capita. Metro Manila generates an average of 13,110 m^3

daily with an average density of 330 kg/m³. For the period 1988-1991, waste generation increased by an average of 5.4%. The composition of Metro Manila's waste, excluding commercial and industrial, fall into 13 major classifications. These are paper, cardboard, food waste, plastic, textile, rubber and leather, petroleum products, yard and field waste, wood, fines, metals, glass and inerts. The bulk of waste is composed of yard waste (35.5%), wood (11.5%) and food waste (11.0%).

THE WASTE MANAGEMENT CONCEPT

Waste management is considered as the most efficient and sanitary means of throwing, collecting, segregating and disposing of leftovers, refuse, discards, by-products and other garbage. It is a cycle, a system, a process or simply a task. In the sense that it is a never-ending occurrence which always returns to the first step, it is a cycle. It is a system in that it is a unified, coherent and correlated set of procedures geared towards a specific goal that is environmental sanitation and beautification. It is a process when it is made up of a set of actions in a given logical order. It is a task considering that it is a duty of all sectors of society.

The waste management cycle is made up of five component processes. These are waste generation, packing/storage, collection, segregation/sorting and disposal.

THE ROLE OF GOVERNMENT IN WASTE MANAGEMENT

Waste management, as a task, is the collective responsibility of all sectors of society comprising governments, banking institutions, donor agencies, private sector and communities. The input of one sector is vital to the whole such that if any sector fails to do its part or performs it in a substandard manner, the whole task suffers and the quality of output declines.

The role of the government in the system is one of management, i.e., planning, organizing, staffing, directing and controlling.

The government plans when it determines the specific work to be done and the proper sequence for the successful cleanup of the environment. Done in consultation with the lower-level officials and the field officers, it is repeated during the yearend or early year planning workshop and during the preparation of the annual work program of each department. The top management then organizes and assigns tasks for all parties involved, including MMA personnel and volunteers from the private sector. Staffing includes task formation for special projects and reshuffling of personnel assignment.

Directing is primarily the job of the political leaders, chiefly the head of the agency and, to some extent, his subordinate officials. The head synthesizes all the efforts of the various groups involved. Also, he liaises with the public and private sectors through personal dialogues, press releases and TV appearances. A better understanding of the issues makes for the least resistance to MMA projects. Moreover, conflicting interests are unearthed, threshed out and resolved. Motivating the involved sectors is also important. Towards this end, top management uses the incentive system to get results.

Finally, controlling is done by the political leadership when it sets the minimum acceptable standard of performance, issues implementing rules and regulations, evaluates periodic performance, monitors program effectiveness and efficiency, and corrects deviations.

THE METROPOLITAN MANILA AUTHORITY EXPERIENCE

Since the MMA's inception in 1975 until the present, environmental contamination caused by improper waste disposal is still a problem. Notwithstanding the regular cleanup by metro aides (Metro Manila streetsweepers), the maintenance of a garbage-free environment is yet to be attained. Public awareness of the importance of cleanliness is still very low as shown in the littering in the streets and waterways of Metro Manila.

Cell-based collection

For a more systematic and efficient garbage collection, the cities and municipalities were divided into collection cells/routes. A *cell* is a fixed area consisting of one or more streets with an estimated waste generation of 12 m^3 daily, also the average load capacity of a collection truck. The 1,099 cells are classified as regular, major thoroughfare or stationary. The area coverage of each cell/route is updated on a regular basis to conform with the latest volume generation and load capacity of collection equipment.

Regular cells (door-to-door collection) are covered at least thrice a week. Major thoroughfares and stationary cells (markets and other high-refuse generating areas/institutions) are covered daily.

Except in rare cases, collection is scheduled on a two-shift basis to avoid traffic congestion and inaccessibility of some residential neighborhoods:

First shift: 6:00 P.M. - 12:00 midnight
Second shift 12:00 midnight - 6:00 A.M.

Collection time varies in different neighborhoods. In high-income areas where garbage contains more recyclable items, collectors segregate garbage, thereby increasing collection time. The average collection rate in high-income areas is low at 4.5 m^3/hour compared with 5.3 m^3/hour in middle-income and 8.3 m^3/hour in low-income areas. The average collection rate is 6 m^3/hour.

From 1988 to 1990, the volume of collected garbage increased by an average of 10.38% at an average collection rate of 80%.

Monitoring system

Ocular inspection is done to monitor levels of cleanliness, especially of garbage-prone streets (so-called because of the recurrence of uncollected or indiscriminately dumped garbage). These are identified and documented.

The monitoring of the level of cleanliness is cell-based. From a given set of criteria, evaluation considers the volume of garbage monitored and the manner in which garbage is stored. An area is rated from a scale of one to five, with one as the lowest.

The results are submitted to the area managers for use as a tool in planning operational strategies. Furthermore, a list of the identified problem areas may be recommended to *Pook Kalinisan* (Cleanliness Area) for monitoring and maintenance by a community or nongovernmental organization.

Collection equipment

Garbage collection is undertaken by ESC and private contractors.

On the average, MMA contracts 397 6-wheeler trucks and 45 10-wheeler trucks with a minimum capacity of 12 m^3 and 18 m^3 of garbage, respectively. Service contracts are renewed monthly or quarterly.

Rental cost ranges from ₱505.96 to ₱832.71 for the 6-wheeler trucks and ₱1,185 to ₱1,220.12 for the 10-wheeler trucks[a]. A contractor-supplied *palero* (laborer) is paid ₱34/trip in Manila and the South Sector, and ₱56.66 in the other areas. Three *palero* are allowed for the 6-wheeler and four for the 10-wheeler trucks.

At 100% availability, 100% load efficiency and operating on two shifts, the estimated collection capability of the trucks is 11,148 m^3 or 85.03% of the estimated daily waste generation. At 80% availability, 83% load efficiency and operating on two shifts, the estimated collection capability is 7,427.68 m^3 or 56.65%.

The MMA has also its own garbage collecting equipment: 5 15-m^3 compactors, 5 13-m^3 compactors, 6 arm roll trucks complemented with 15 arm roll containers and 85 2-m^3 containers for compactor trucks. These were acquired in 1986 through the World Bank Loan for Solid Waste Improvement Program.

Equipment acquired in 1987 from the Japanese government were 26 15-m^3 compactors, 51 8-m^3 compactors, 39 5-m^3 compactors; and in 1991, 40 compactors.

Of the 156 compactors, 40 are not yet in use. Ninety-one are distributed to the sectors and 25 to the Special Project Division (SPD) of ESC. The units retained at SPD are dispatched to the areas requesting backup.

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[a]September 1991: ₱26.48 = US$1.00.

Transport system

The transport system being used in ESC operations is completely primary haul, i.e., the direct transport of garbage by collection vehicles to the disposal sites. Average haul distances from the end of the collection route to the disposal sites vary from 3 to 28 km depending on the proximity of the existing disposal sites (except the sanitary landfill sites) to the collection site being served.

Travel time ranges from 7 minutes to 1 hour with an overall average of 30 minutes. It is adversely affected by heavy traffic, heavy rainfall that cause flash floods or poorly maintained dumpsite roads.

Waste disposal

Except for the newly opened Metro Manila Landfill I at San Mateo, Rizal, the present disposal system is open dumping.

The open dumpsites are Balut or Smokey Mountain, Aroma, Catmon, Pasig and Payatas. Landfill sites include Fort Bonifacio and San Pedro.

Preparatory to the phaseout and closure of the open dumpsites, MMA has started to develop sanitary landfill sites (a technically prepared disposal area with engineering devices to treat garbage scientifically) which shall meet the total disposal requirements. At present, two sites are being developed. These are the Metro Manila Sanitary Landfill I and the Metro Manila Landfill Site II in Carmona, Cavite.

Transfer station

The Las Piñas Transfer Station was designed to complement the operation of the Metro Manila Sanitary Landfill II. Instead of direct haul, collection trucks will deliver their loads to the station where these will be transferred to trailers which will transport the same to the landfill. For this purpose, MMA has already acquired 20 transfer trailers with prime movers. The station is 70% complete as of 31 December 1990.

Streetsweeping

Metro aides totalling 4,853 maintain the cleanliness of Metro Manila's main thoroughfares, and secondary and tertiary streets.

The collection capability of MMA equipment at 100% availability, 80% load efficiency and operating on two shifts (a 5-m^3 canter makes 4 trips a day) is 5,941.6 m^3 or 45.32% of the estimated daily generation.

Cleaning of canals and waterways

The ESC Waterways Sanitation Services is tasked with the clean-up of refuse and vegetation in small bodies of water such as rivers, estuaries and canals. Its scope of operations does not include coastal areas for which it has no facilities.

Solid waste management support projects

Subsidiary projects in support of the solid waste management function are:

- Metro Clean and Green - a tree planting project;
- *Balik-Gamit* (Return to Use) - redemption centers that collect reusables to limit waste disposal;
- *Pook Kalinisan* (Cleanliness Area) - a multisector group that helps maintain cleanliness by monitoring problem areas;
- Sanitary Enforcement - an anti-illegal dumping and littering campaign that deputizes policemen to strictly enforce sanitation ordinances;
- Grass-cutting - at center islands, parks and government areas; and
- Garbage-free Zones - a formal declaration of an organization in a certain area signifying a commitment to implementing the above activities with a sustained monitoring system to maintain a beautiful, clean and healthy environment.

Session 4: Role of Donor/International Agencies, International Banking Institutions and the Private Sector in Waste Management

The Implementation Constraints in Waste Management in Malaysia

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ABSTRACT

This paper highlights the current constraints in waste management in the ASEAN region, particularly in Malaysia. The major constraints include lack of funds, land limitations, inadequate legislation, lack of law enforcement by the relevant local authorities, and a low degree of coordination and planning among government agencies.

INTRODUCTION

The year 1991 marks not only the end of the New Economic Policy of Malaysia but also the beginning of the Second Outline Perspective Plan 1991-2000 and the National Development Policy. Both the plan and policy were recently launched by the Prime Minister of Malaysia, the Rt. Honorable Dr. Mahathir Mohamad, on 18 June 1991. The plan provides a firm basis for the country to move ahead towards achieving the status of a developed nation by the year 2020.

In the last two decades, the country has witnessed a high rate of economic growth despite the many challenges it had to face internally and from abroad. However, this accelerated rate of development has also brought numerous environmental problems such as overexploitation of natural resources and pollution that threatens human well-being, thus, negating some benefits of socio-economic development.

To address fully the range of environmental problems, the government made legal and institutional arrangements in 1970. It set up an Environmental Law Drafting Committee in 1971; prepared a Country Report for the United Nations Conference on Human Environment in 1972; enacted the Environmental Quality Act (EQA) of 1974; set up the Division of Environment and later, the Department of Environment (DOE); and prepared the chapter "Development and the Environment" in the Third Malaysian Plan 1976-1980 which outlined Malaysia's environmental policy objectives. The government also wrote the Amendment to the EQA of 1974 in 1985, making environmental impact assessment (EIA) mandatory in 1987. The EIA has been enforced since 1 April 1988. Under the EQA of 1974, the DOE has strictly implemented a

series of regulations for the control of smoke-free emissions in 1977, of palm oil and rubber effluents in 1978, of industrial air emissions in 1978, of industrial effluents in 1979, of lead content in petrol in 1985, and of toxic and hazardous wastes in 1989.

The full implementation of these regulations has effectively controlled pollution generated by the agro-based and manufacturing industries. But it has not addressed water pollution caused by partially treated or untreated human and animal wastes. The proper handling of animal waste, in particular piggery waste, depends to a large extent on the private sector's response to the government policy on the reconsolidation of animal farms, the majority of which are not only small but also widely dispersed throughout the populated parts of the country. Sewerage treatment, however, depends largely on the multilateral agencies' support of waste management projects.

This paper highlights the current constraints in the management of human and organic waste, particularly, agro-based and other industrial waste, sewage and solid waste, silt, pesticides and hazardous waste.

IMPLEMENTATION CONSTRAINTS

Agro-based industrial waste

Malaysia's management of waste from the agro-based industries has been very successful. From 1986 to 1989, agro-based industries contributed only 2.7% of the total biological oxygen demand (BOD) load in Malaysia (Table 1). The pollution loads of the palm oil mills and natural rubber factories were reduced by over 98% and 95%, respectively, making these factories insignificant contributors to inland water pollution in the country. This success is attributed to the substantial investment in research and development in waste treatment technology by plantation industries as well as by the Palm Oil Research Institute of Malaysia and the Rubber Research Institute of Malaysia.

Other industrial waste

Efforts to control industrial waste have not been as rewarding. The organic pollution load of the manufacturing sector in 1989 was 21

Table 1. Organic pollution load by sector in Malaysia, 1986-1989.

Sector	1986 BOD load[a]	1986 %	1986 Population equivalent[b]	1987 BOD load	1987 %	1987 Population equivalent
Agro-based industries (palm oil and rubber)	11	2.7	0.22	11	2.5	0.22
Manufacturing industries	30	7.3	0.60	20	4.6	0.40
Agriculture (animal husbandry)	55	13.4	1.10	55	12.7	1.10
Population (sewage)	314	76.7	6.28	348	80.2	7.16
Total	410		8.20	434		8.68

Sector	1988 BOD load	1988 %	1988 Population equivalent	1989 BOD load	1989 %	1989 Population equivalent
Agro-based industries (palm oil and rubber)	11	2.5	0.22	11	2.4	0.22
Manufacturing industries	19	4.3	0.38	21	4.6	0.42
Agriculture (animal husbandry)	55	12.4	1.10	60	13.1	1.20
Population (sewage)	358	80.8	7.16	366	79.9	7.32
Total	443		8.86	458		9.16

[a]In t/day.
[b]In million, using a BOD load of 0.05 g/capita/day.
Source: Department of Environment, Malaysia.

t/day (4.6%) of BOD compared to only 11 t/day (2.4%) of the agro-based industrial sector (Table 1). This was because 90% of the industries in Malaysia were small-scale. For instance, the electroplating industries lacked land, funds, technical know-how and skilled operators for the treatment facilities. The tapioca and sago processing industries required an extensive area for ponding, the lack of which reduced their total pollution load by only 40%.

Animal waste

Since the late 1980s, organic waste from animal husbandry has been a major problem. Although technology and financial resources are available, the waste problem remains unsolved because of land tenure issues and the lack of political support, i.e., the inadequate land allocation for modernizing this activity. Society's low regard for animal husbandry as a backyard activity rather than a modern industry also needs to be overcome.

Partially treated or untreated sewage

Partially treated or untreated domestic sewage contributed around 80% of the total pollution load in 1986-1989, making it the major polluter of both inland and coastal waters in Malaysia (Table 1). This is because many coastal towns in the country lack proper sewage disposal systems. More often than not, raw sewage is discharged directly into the sea. A number of river stretches are also contaminated in areas with dense populations and inadequate sewage treatment facilities. The worsening sewage problem is aggravated by the lack of financial and political support to develop sewage treatment and sewerage facilities, poor siting of good sewerage projects and the inability of the average household to pay for the provision of community sewerage services.

Garbage and solid waste

Rapid urbanization in the country and the significant population increase have made solid waste management the most serious urban environmental problem. In Malaysia, solid waste management is a local authority function under the Ministry of Housing and Local Government. The two critical functions, namely, collection and disposal, take up a substantial portion of the total revenue collected by the local authority. Solid waste collection is the most costly, as many existing dumpsites have become not only inadequate but also too close for comfort to the residential areas. New sites are also increasingly difficult to find, due in part to the high cost and scarcity of land in urban areas, and the "not-in-my-backyard" (NIMBY) syndrome that still prevails among the majority of local residents.

Soil erosion and siltation

Silt (or mineral solids) polluting the waters originates from intensive land clearing and development, mining and logging activities in water catchment areas, and tin mining effluents. Although the discharge of tin mining effluent is prohibited, it is nevertheless allowed particularly during heavy rainstorms. But the industrial discharge limit enforced by the Department of Mines is by far in excess of the limit set by DOE.

Further, there are no specific regulations for the other sources of silt pollution. While there are established laws, there is also a lack of enforcement by the relevant local authorities. Compounding the implementation problem is Malaysia's three-tiered government system, i.e., federal, state and local. For example, land is strictly a state matter, therefore pollution arising from land development activities is entirely within the state's jurisdiction but beyond the federal government agencies'.

Pesticides

Pesticide use or abuse is extensive, and the number of pesticides in the market is large. The Pesticides Act of 1974 regulates the importation, manufacture, sale and storage of pesticides as well as the presence of pesticide residue in food. It also provides for the investigation and reporting of pesticide-related accidents, deaths and personal injuries.

Restrictions, however, have to be imposed on the sale of pesticides hazardous to human health and the environment. Also, educational programs for persons working with pesticides need to be enhanced and a pesticide exposure limit established.

Toxic and hazardous waste

Since May 1989, regulations on "scheduled waste" have been enforced. The "cradle-to-grave" management concept is used for toxic and hazardous waste, i.e., waste is tracked from its generation point to its storage, transportation, treatment at offsite facilities and finally to its disposal or repository sites. Because fund availability is crucial in managing toxic waste, the government decided that the private sector participate fully in the establishment of an integrated central waste treatment facility. Initially, however, the main constraint was the lack of political commitment at the state level. Nonetheless, at least one of two private firms appointed by the Ministry of Science, Technology and Environment has been making progress recently.

CONCLUSION AND RECOMMENDATIONS

Thus, the implementation constraints in waste management in Malaysia include the lack of funds, land limitations, inadequate legislation in some areas, lack of enforcement by relevant local authorities, and a low degree of coordination and planning among state and local government agencies. One of the challenges then, is to secure the funds for the adoption of technologies, the concessional rates of which the majority of the households can afford.

The country has noted the current scope of the Global Environment Funding Facility established by the World Bank with the support of the United Nations Environment Programme and the United Nations Development Programme. The facility, however, has yet to address the protection of both inland and coastal waters. It is, therefore, our hope that the multilateral funding agencies, such as the Asian Development Bank, look into the prospects of establishing a Regional Environment Funding Facility that is sensitive and responsive to the pressing needs of Asians, particularly those in the ASEAN region.

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Coastal Waste Management and the United Nations Conference on Environment and Development 1992

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ABSTRACT

This paper discusses the conclusions and recommendations of the Halifax meeting of experts on land-based pollution on 6-10 May 1991 and the decision of the First Preparatory Committee for the United Nations Conference on Environment and Development (UNCED) in Nairobi in August 1990. It also attempts to describe the important connections among the Halifax meeting, the Waste Management Conference and UNCED 1992. Future global steps/actions that can be taken to address marine pollution concerns before, during and after UNCED 1992 are also presented.

INTRODUCTION

May I open my remarks by saying how grateful I am to have the opportunity to address this most important conference. As the Special Advisor on the Environment to Canada's Minister for External Affairs, I am familiar with the types of threats that improperly managed waste can pose to coastal regions. Similarly, I am acutely aware of the magnitude of the challenges we face in developing and implementing better ways to reduce, reuse, recycle and safely dispose of waste products.

Despite my growing store of knowledge in this field, I have not come here today with definitive solutions. In fact, I have come to Singapore both to learn from you who have hands-on knowledge of waste management problems and to pass on to you the results of related discussions held recently on this same issue.

Most notably, I would like to discuss the conclusions of the Intergovernmental Meeting of Experts on Land-based Sources of Marine Pollution, hosted recently by the Government of Canada in the coastal city of Halifax. In addition, I plan to explain the importance of the issue of land-based sources of pollution, including coastal waste management, within the context of UNCED 1992.

THE HALIFAX MEETING

The Halifax meeting of experts on land-based marine pollution was convened on 6-10 May 1991 in response to a decision taken

at the First Preparatory Committee for UNCED in Nairobi in August 1990, which endorsed the offer made by Canada to host such a meeting.

Canada's interest in this meeting was based on two facts. The first was the conclusion of the 1990 State of the Marine Environment report of the Group of Experts on the Scientific Aspects of Marine Pollution that 80% of marine pollution comes from land-based sources. The second was the acknowledged inadequacy of existing legal regimes to address land-based sources. Canada felt the need to bring together the world's experts on land-based sources of marine pollution to focus on the challenges this issue presents and the need for action.

More than 90 experts from 35 countries attended the Halifax meeting, including a strong representation from the ASEAN region. As chairman of the meeting, I set out the following goals in my opening remarks:

- develop principles for protection of the marine environment from land-based sources of pollution;
- study the various scientific, social, economic and legal elements to be addressed for a concerted global attack on the problem; and
- develop a recommended strategy and action plan for consideration at the Third UNCED 1992 Preparatory Committee in August 1992.

I also emphasized the need to maintain a broad perspective on ocean pollution and the close relationship among land-based sources, atmospheric pollution and living marine resources conservation.

After four days of fruitful and lively discussion, the meeting adopted a set of conclusions and recommendations and issued a statement. The recommendations in brief are:

- Current global, regional, national and local efforts are inadequate to halt and reverse the deterioration of the marine environment and consequently, action is needed at all levels. A comprehensive and coordinated approach should be taken involving all sectors and looking at air, land and water interactions.
- Experts strongly urge the adoption of an anticipatory, rather than a reactive approach to marine pollution problems.
- The existing legal regime does not address adequately the problem of land-based sources, and an umbrella strategy or framework is needed. While views differed over the precise nature of such a strategy, it was widely agreed that a convention by the time of UNCED 1992 was not feasible. Instead, a declaration of principles and an action plan should be put forward for adoption at UNCED.
- A follow-on Meeting of Experts should be held in late 1991 to develop a declaration for signature by heads of governments at the 1992 conference and the specific elements of a strategy and action plan that would form an important chapter in Agenda 21, one of UNCED's key outcomes. Both of these would draw on the Halifax conclusions and relevant UNCED documents.
- Future work should focus on strengthening existing cooperative instruments, mechanisms and institutional responsibilities as well as developing new programs relating to major global land-based sources and the application of policies to development activities.

Some of the more substantive scientific conclusions are:

- Human activities on land are a major polluter of the marine environment.
- Contaminants reach the sea from rivers, through the atmosphere and from more direct or point-source inputs in the coastal zone.
- All economic sectors are involved, including agriculture, industry, fisheries, maritime activities, tourism and, of course, human settlement.
- In keeping with the anticipatory approach, clean production and minimal waste is the way to proceed.

The Halifax meeting devoted considerable attention to the economic and developmental aspects of marine pollution, going beyond purely environmental issues. The UNCED process then presents an opportunity to link solutions with other agenda items such as

hazardous waste, air pollution, land and agriculture, and fresh water as well as cross-sectoral issues such as poverty, public health, human settlement and economics.

The Halifax experts concluded that there is a close connection between good waste management practices and marine pollution, specifically sewage, nutrients and synthetic organic compounds. Of the many significant land-based sources of pollution, these three were felt to be "of greatest concern on a global scale considering future trends."

Sewage discharge to the coastal marine environment is directly related to human population pressure. Over half of the world's population lives on or near the coast and continues to grow, especially in developing regions. Many developing countries do not have sewage treatment facilities. Statistics show that the construction of waste treatment facilities has not kept pace with population growth in recent years. Hence, pollution associated with sewage discharge will continue to increase unless more efficient management strategies are implemented.

Nutrients are being mobilized and transported to the marine environment as a result of man's activities at a pace exceeding natural rates. Growing world fertilizer consumption will lead to increased inputs in the future along with those associated with sewage discharge. The development and use of new organic compounds is increasing rapidly. Coupled with growing pesticide use, this is cause for concern.

CONCEPTUAL MANAGEMENT STRATEGY

The Halifax experts accepted two working assumptions for a management strategy that could significantly reduce land-based sources of pollution.

First, the measures to be taken should follow a comprehensive and coordinated approach involving all sectors and recognizing the interaction among air, land and water. It is both ethically wrong and scientifically unsound to take measures to protect one sector of the environment without considering the implications of that action on other sectors or the costs and benefits involved.

Second, while there is still a need for more scientific information, current deficiencies in the scientific understanding of a problem should not be an obstacle to initiating management action.

Keeping these assumptions in mind, what then constitutes a good waste management strategy? The ten key elements are:

1. Any management framework, whether local, national or regional must involve planning, assessment and adequate legislative and financial arrangements. Measures to reduce and prevent emissions must be part of a broader strategy which integrates management of individual practices with policies for human settlement, and economic development covering coastal lands, watersheds and adjacent seas.
2. Pollution control requires a "cradle-to-grave" approach to chemical and resource use, involving clean production, recycling and excellent control processes, more efficient production and distribution systems, and the careful management of harmful by-products.
3. There is a need for active and ongoing waste minimization and management strategies including waste audits, optimum use of recycling opportunities and selection of the least harmful disposal options.
4. The precautionary approach is fundamental to waste minimization and integrated pollution control. Management strategies must try to predict and preclude damage, thus, reducing inputs of persistent, toxic and bioaccumulative chemical substances, whenever possible.
5. Certain particular toxic, bioaccumulative and persistent substances should be subject to either a global ban or severe restriction.
6. Formulating specific goals and environmental quality criteria and emission standards should be basic procedures.
7. Information and education campaigns help to raise the awareness of the general public and decisionmakers as

to their role in causing and solving problems.

8. Standardized and continuous baselines must be established for measurement and monitoring programs.
9. Partnership should be established between developed and developing countries, either bilateral or multilateral, covering a wide range of relevant areas.
10. Effective and long-lasting programs depend on stable and well-staffed institutions which rely on good training. Ideally, these should be developed locally.

These suggest a hierarchy of activities ranging through scientific research and dissemination; public awareness and acceptance of the need to address potential problems; and environmentally conscious decision-making at all levels of society and implementation of effective strategies to avoid the problems.

Satisfactory action depends upon identifying the pollutant sources; determining appropriate control strategies and actions; ensuring the necessary institutional arrangements for their implementation; and identifying and dealing with problems that prevent or delay effective solutions.

THE SEWAGE PROBLEM

The example of sewage will be explored briefly to illustrate the type of approach to taking action that might be applied to a particular waste management problem. The sources of sewage are obvious enough and many management techniques are available. The strategies might include using sewage for beneficial purposes, treatment processes, and setting water quality goals and standards.

Necessary action might include better planning in urban and industrial development, application of water quality goals and standards, and establishment of treatment facilities. These actions depend upon adequate institutional arrangements for planning, development and application of standards and allocation of funds, taking place at local, national, regional or even global levels.

The key problems to be overcome include a lack of local recognition of and concern for sewage, high initial costs and a lack of local or regional technological capacity. There is no scientific mystery to handling sewage. The challenge lies in management, technology implementation, adequate financing and political will.

A lot of discussion in Halifax focused on sewage because it is universal and the interrelationship between its environmental and developmental aspects is strong.

The sewage problem is by no means limited to developing countries. In Canada, we are still working towards implementing adequate sewage management policies. For a number of years, Canada has been going through a process of tackling sewage and industrial waste. The real challenge is less the handling of the waste already in the sewerage system than the reducing of the amount created at the point of production. This involves a significant investment at the industrial level to capture and sometimes recycle waste, thereby reducing the amount entering the system. The limited funds for sewage and waste treatment has increased its privatization.

As a result, Canada has developed considerable technological expertise in industrial wastewater treatment, including a unique "sludge-to-oil" conversion process. This has given rise to the opportunity to work with other countries to facilitate technological cooperation and partnership.

A COHERENT STRATEGY

Regardless of the level (local, national or regional) at which pollution from land-based sources manifests itself, a coherent strategy is necessary to tackle the problem. Based on a commonly accepted set of principles, a strategy for action must also contain a set of goals situated within a managerial framework. The framework requirements will vary depending on the type of environmental problem and its geographical scope. From their close consideration of the priority problems of nutrients, synthetic organic compounds and sewage, the Halifax experts drew

the conclusion that a national managerial framework should contain at least the following elements:

- appropriate environmental regulation;
- effective licensing and control mechanisms;
- sufficient managerial and administrative competence to implement and enforce legislation and other actions;
- linkage between economic development activity and environmental management;
- information provision to the public, professionals and politicians;
- public education starting at an early age; and
- infrastructure capacity including management, engineering, maintenance and communication.

ECONOMIC, SOCIAL AND LEGAL MEASURES

A final aspect of marine pollution problems addressed at Halifax is especially applicable to the topic of waste management and to the many environment and development issues to be examined by UNCED. It involves the selection and implementation of appropriate economic, social and legal measures. The Halifax conclusions are:

1. Priority should be given to integrated coastal and marine planning and management, with special attention to sewage treatment and possibilities for concessional financing.
2. Adequate financial resources, innovative financing mechanisms and technology transfer are essential for developing countries. Similarly, development aid funds should consider seriously land-based marine pollution objectives.
3. New and more pragmatic concepts and operational tools should be developed for a better assessment of environmental protection. The use of environmental indicators should be promoted for this purpose.
4. The use of economic instruments can often be very efficient and effective in backing up regulatory measures and achieving pollution control objectives. These include better resource pricing, taxes, user fees and tradeable emissions permits, among others.
5. Efforts should be strengthened in the areas of education, training and public awareness, and responsibility to promote better understanding of both the problems and preventive measures.

FUTURE PROGRAMS

While the Halifax meeting did not recommend one preferred international mechanism, it did identify the following basic requirements for future action:

1. build upon the principles of the 1985 Montreal Guidelines for the Protection of the Marine Environment Against Land-based Sources;
2. assign responsibility for coordinating catalytic functions;
3. strengthen regional mechanisms and encourage countries to enter into regional agreements;
4. provide for the exchange of information and the transfer of technology and other resources;
5 provide for more effective data collection and monitoring; and
6. develop a timetable for the implementation of the selected international mechanism.

With the Halifax options in mind, subsequent meetings of the United Nations Environment Programme (UNEP) Governing Council and the UNCED Working Party on Oceans have developed a general momentum towards completing a declaration of principles and an action plan for consideration at UNCED 1992. The declaration consisted of a set of principles and a strategy, both of which were virtually completed at Halifax.

A separate action plan is to be developed by a UNEP Intergovernmental Meeting of Experts in 1991. The Halifax Meeting Statement should provide considerable guidance in this endeavor.

In conclusion, I would like to briefly look past UNCED 1992 to the need for a new, comprehensive and integrated approach to the protection and sustainable use of the marine environment and its resources. We feel it is only consistent with global concerns and ongoing initiatives for the international community to begin considering a conference after 1992 which will tackle the broader issues of marine pollution and coastal zone management.

In the meantime, however, we must keep our feet on the ground and continue to work towards improving our ability to manage waste in coastal areas and to control and alleviate land-based marine pollution in general. If we can help to advance this work, while at the same time keeping in mind the broader marine pollution issues, then we will all be much closer to a solution.

The Privatization of Waste Treatment and Management Facilities

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ABSTRACT

This paper reviews the reasons why municipalities have opted to engage private companies for environmental services such as waste management. Privatization benefits include efficiency and consistency in refuse collection, improved quality of services and cost savings. Some control and evaluation systems for the selection of private companies are also discussed.

INTRODUCTION

Today, as demonstrated clearly by this conference, there can be few more important issues than the need for care and preservation of our environment. A key element of environmental care is the provision of environmental services which involves determining by whom and how to implement these services in a practical and logical way.

Environmental services include the collection, treatment, resource recovery and disposal of municipal, industrial and other types of wastes. Increasingly, government officials are looking to the private sector to provide these services. The trend toward the privatization of various environmental services continues for a variety of valid and important reasons.

The purpose of this paper is to review some of the reasons why municipalities and other government entities around the world are more frequently opting for contracting private companies for environmental services. Some key considerations for government officials selecting a private contractor will also be identified.

There are municipal-owned and operated companies which do a splendid job of providing environmental services. There are undoubtedly a few private contractors who fail to live up to their promises or the client's expectations. In many cases, however, the proper selection of a private contractor has inherent financial advantages to the community and substantial gains in environmental quality.

PRIVATIZATION TRENDS

The trend toward privatization is definite, tangible and strong around the world. The

extent to which it has been carried out varies, however, by country.

The United States, Canada and several European countries including Germany, France and Spain, have the highest percentage of cities contracting private companies. Moreover, many other countries like Japan, Argentina, Venezuela, Hong Kong and Saudi Arabia have active private companies providing contracted environmental services to their major cities.

In the United States, two-thirds of all cities use private companies for refuse collection services. In Los Angeles County alone, the number of cities issuing contracts to private companies increased from 339 in 1973 to 496 in 1982, an increase of 43%. For solid waste disposal, the increase was even more dramatic--143 cities in 1973 compared to 342 in 1982, an increase of 240%.

Private refuse collection contractors serve 80% of the cities of Canada; 70% of West Germany, including 50% of its cities, and almost 50% of the population of France. More than 200 municipal governments in Japan also use private contractors.

Hong Kong is in the process of privatizing its waste collection, transfer, treatment and disposal services. In the past three years, it has contracted private companies to construct and operate two solid waste transfer stations, and an integrated chemical waste treatment center. It also plans to privatize the construction and operation of four transfer stations, three solid waste landfills and a special waste incinerator.

Such long-running experiences have served as good examples for responsible authorities elsewhere to decide to use private contractors for environmental services in cities such as Buenos Aires, Caracas, Brisbane, Barcelona, New Orleans, Riyadh and Jeddah. Although each has its own cultural personality, these world metropolitan centers share a concern for environmental protection and the quality of life.

PRIVATIZATION BENEFITS

These are the advantages of contracting private companies for environmental services:

- significant cost savings for the government;
- more consistent and effective service from proper equipment and personnel management for a cleaner and more beautiful city or region;
- better returns on a community's environmental investment and improved government management and service;
- private investment in plant and equipment and a more manageable government budget; and
- access to the best available technology for environmental problems.

Cost savings

Numerous studies have confirmed that governments can achieve significant cost savings through privatization. Studies by Columbia University in New York, the U.S. Department of Housing and Urban Development and others indicate that in the United States, private contractors are on the average about 30% less expensive than municipal crews.

In Canada, a study for the University of Victoria's School of Public Administration concluded that "exclusive public sector [refuse] collection is 50.9% more expensive per household than purely private collection." Likewise, in Japan, research indicates that the 200 municipalities that contracted private companies have saved an average of 124% in their waste collection and disposal costs.

In 1980, Buenos Aires contracted Manliba, a private company to provide cleaning services for about 60% of the city of 2 million people. The city crews cleaned the remaining area. After one year of service, the city's Environmental Authority reported that Manliba reduced the city's costs by more than 50% per ton. The annual services involved collection of over 700,000 t of refuse and the sweeping of more than 300,000 curb miles of streets. The cost reduction at that time equated to a savings of US$40 million in the first year alone.

As governments make their own cost comparisons, it is essential that they record the true cost of the service. The governmental budgetary process can be complicated, so that service costs may be put into different

departments or are spread across several budgets.

Any environmental service incurs the following costs:

- acquisition and amortization of equipment;
- financing;
- direct and indirect labor;
- maintenance labor and spare parts inventory;
- administration and supervision;
- insurance;
- facility and equipment overhead; and
- consumable items like fuel, oil, uniforms and tires.

Well-delineated service requirements tighten the control process and the budget quickly and visibly. The true cost is there for everyone to see and monitor on a monthly basis.

Better service

Apart from lower costs, service is better in all respects. In Canada, for example, the average number of weekly collections went from 1.08 to 1.13 pickups after private companies became responsible for collection services. In addition, the pickup location became more convenient for the residents.

Two separate evaluations were done for Buenos Aires after the city privatized collection and related services for about half of the city. A Gallup Poll indicated that 69% of the people felt service had definitely improved over services provided previously by the municipality.

In the evaluation of quality of services based on a maximum score of 100%, the municipality-serviced sector scored 39.1% against the private contractor's 87.7%. Further, the private contractor used 1,500 workers to clean streets and collect 3,000 t of waste per day compared with the 4,000 city employees needed to collect 900 t per day.

In France, a survey of 381 communities showed that 213 (56%) were served by private contractors who collected around 20,000 t of refuse per day. This is 79% of the total 225,000 t generated per day. The rest is collected by municipal crews.

Other benefits

Other benefits of privatization include improved management by government administrators, a more manageable government budget process and access to the best available technology.

By engaging private companies, areas of responsibility and lines of authority are clearly established and thus become manageable. The government contract specifies the contractor's operating responsibilities and performance requirements. The government officials' responsibilities then go from operational to managerial.

As Mr. Herb Kidd, head of Knoxville, Tennessee's Department of Public Services, said:

> We've been able to do more with the public service personnel we have. It has allowed me, personally, to work better as a manager. I don't have to spend hours anymore working to resolve personnel problems and equipment problems in the refuse area. In addition, we're getting better productivity now from our remaining public service workers.

Under privatization, the budget process becomes more manageable as the annual costs for the service are well-defined and predictable. The contractor can take on the burden of the large capital investments required in dealing with today's environmental problems. Equipment and facilities costs can be spread over several years of a contract.

The Hong Kong Government, for example, has contracted the design, construction and operation of a chemical waste treatment facility. Its capital cost is about US$125 million, which the government will pay on a monthly basis over a number of years, commencing after the acceptance of the facility.

Finally, given the complexity of today's environmental problems including industrial and hazardous waste, access to technology is critical to obtaining environmental benefits. Selecting a private company with a broad operating and geographical base gives the government access to the most advanced technology applicable to their environmental problems.

Behind the decision to use a private contractor for environmental services is usually a farsighted public official who supports an important if controversial policy to improve the quality of life of the people.

Once the decision to privatize has been made, the specification preparation and contractor qualification processes become important. The city's (or other government unit) objectives must be clear to all. Besides describing the services, considerations like the contractual and legal aspects of the tendering process also need to be reviewed carefully to ensure the best cost advantages for the city.

For example, it is important that the contractor be given exclusive rights and responsibilities to render service in a specified contract area of function. This will result in lower costs, and better and more consistent service to the city.

A contract should be of sufficient duration to enable the contractor to recover its capital investment over a reasonable period of time.

Where operation of a facility (e.g., a waste-to-energy incinerator) is involved, the design, construction and operation should be the responsibility of a single contractor. Otherwise, the city will be unable to enforce specific operating or environmental performance guarantees.

A facility with split contracts for design/construction and operation poses a major problem. In case of failure or inadequate performance, the facility supplier can claim it is an operational problem and the operator can say it is a design or construction defect. Without enforceable responsibilities, governments are often faced with unexpected and substantial costs to remedy the problem.

Payment for services should also be in common quantifiable unit criteria such as payment per ton for collection and disposal or per mile for sweeping services. They provide an accurate measure by volume of the work actually performed.

A successful tender process requires that bidders supply sufficient details in their tender documents so that municipal officials can have a precise idea of the work that the bid price encompasses. It is also vital that they are able to compare equitably prices for services to be provided with those in the specifications. Other tariffs or additional services should also be made clear. By doing this, the city has the flexibility to decide, on a cost basis, what and when special services are necessary.

In addition, these definable services allow the city to control and supervise the contractor closely and fairly and to concentrate on the service deemed most critical.

Next, the city must prequalify the bidding contractors on the basis of experience and years of service in relevant environmental service activities. This way, it will get the best value for its money and the necessary performance reliability.

The two recommended methods are:

- A two-envelope bidding process to ensure that only qualified contractors are considered. In this way, the contracting agency avoids unwarranted pressures to accept a low bid proposal from an unqualified contractor or an unresponsive operating plan.
- A valid and thorough contractor prequalification process prior to price submission.

Properly qualifying contractors is probably the single most critical decision the city will have to make before actually selecting the contractor.

The city should establish clearly the credibility of its potential contractors and form an opinion on each. Individual bidders' approaches may vary, so it is critical that evaluation of the bids is made on a direct comparative basis.

The use of a highly detailed and comprehensive checklist is suggested. The list must be clear, precise and concise. For city cleaning contracts, for example, the use of maps, tables, graphs and charts in defining service areas and services to be performed should provide sufficient information to choose the best contractor.

One recommended method of evaluating the bid is on the basis of 100 maximum possible points for each of the key elements of the proposal. These maximum points are then compared with those actually awarded to each contractor, allowing each to be put on equal footing and weight.

Several criteria to be measured include experience in these fields:

- servicing densely populated cities or other clients with characteristics similar to the city's own;
- providing each environmental service required under the contract;
- different types of waste disposal, treatment and resource recovery;
- large-scale project mobilizations; and
- giving details of the operating plan and the facilities or equipment which may ultimately be owned by the city.

These weigh bidders' total experience and capability.

Evaluating the size of the bidders' business is also important. For example, a bidder should be able to demonstrate financial strength and resources to ensure perfomance by both the local and parent companies. Net worth and total revenues are excellent indicators.

The bidder should also possess the most modern technology and backup support.

References from other municipalities and contracting authorities will also give an excellent insight into the bidder's ability to perform consistently, honestly and reliably over extended periods of time.

Actually, with this or a similar type of rating system, differences in price can also be compared on an equal basis with the scope of services. Through such an evaluation, the city will be spending its money wisely.

A low price on its own may look very attractive, but it is important to confirm and compare the services the bidder says it will provide with the experience and probability of performance. Through this evaluation process, the city authorities can feel assured that they have chosen the most qualified contractor with the best plan.

Once the contract is underway, there must be a means of supervising the contractor. This verification may come from either internal or external sources, but it must ensure that the services are fulfilled according to the programmed guidelines and specifications.

The contract should provide for financial penalties if services are not provided according to the specification. In the case of gross negligence or repeated performance deficiencies, the city should have the ability to call on the guarantee provided by the contractor or its parent company.

In providing environmental services, it is vital to promote citizen awareness of and cooperation in the overall environmental effort. The degree of success of an environmental program may well depend on citizen support.

The contractor should be able to demonstrate its experience in establishing detailed and tailor-made programs to generate the interest and involvement of residents and community officials alike in making their city or area a cleaner and healthier place to live in.

The purpose of the programs is threefold:

- to instill confidence in the people about the service they will be receiving;
- to develop the private citizen's awareness in keeping his city clean; and
- to demonstrate to the people how their cooperation is the key to maintaining a clean environment.

The methods will vary by city and country, but some general examples include:

- school programs to teach young people the importance of environmental protection;
- neighborhood and volunteer organizations;
- the media to publicize improvements and activities;
- working openly with political groups to show them the extent of the activities and their benefit to all; and
- special events which call attention to keeping the city clean.

CONCLUSION

Privatization of environmental services brings substantial and important benefits that accrue with the competition inherent in contracting the services of private companies. Competition is beneficial in that it forces efficiency, innovation, creativity, investment and ultimately, improved results.

When a government decides to ask private contractors to bid on its environmental services needs, it has taken the first step in creating a competitive environment.

Through a tender process modeled on the points raised, experienced and professional contractors will present bids which reflect the competitive nature of the entire bidding process. This will ensure that the contracting authority receives the best value for its money.

Using responsible and experienced private contractors for environmental services ranging from refuse collection to construction and operation of complex chemical waste disposal facilities has produced clean, healthy and more enjoyable environments for countless cities worldwide.

The competitive atmosphere created by farsighted government authorities contracting private companies results in more efficient, thorough and productive services at a lower cost. Moreover, it frees the government authorities from the difficulties of operations and allows them to devote their energies to supervising, managing and establishing policies--the true challenges of governing.

Privatization of environmental services is an ongoing and growing activity because the concept is well tested and proven. Government authorities should consider this attractive alternative to public provision of services.

Session 5: Community Awareness and Participation in Waste Management

Local Government Initiatives in Waste Management

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ABSTRACT

Waste management is an important element of resource management. To solve water pollution and garbage problems in Phuket, Thailand, officials at the provincial, district and community levels strictly enforce environmental regulations and encourage the building of people's awareness and participation, as well as cooperation between government and private sectors.

INTRODUCTION

The province of Phuket, southwest of Thailand, is composed of 39 small islands with a total land area of about 570 km^2. The main island, Koh Phuket is the biggest and is located in the Andaman Sea in the Indian Ocean. About 867 km from Bangkok by road, it is 49 km long and 21.3 km at its widest spot. The terrain is mostly hilly slopes covering about 33% of the island.

Administratively, Phuket is divided into three *amphoes* (districts): Muang, Thalang and Katu. These are further divided into 17 *tambons* (subdistricts) and 107 villages. The local administration is composed of a provincial organization, a municipality and five sanitation districts. The provincial capital is the town of Phuket, which has a population of approximately 48,340 in 1990 and a land area of 12 km^2. It serves mainly as a local housing and commercial complex.

The islands possess a rich variety of resources including clear ocean waters, a uniquely beautiful landscape, white powdery beaches, mineral deposits and an abundant marine life. These have provided the people with a vigorous and diversified economy and a high standard of living.

Faced with the pressures of rapid modernization, the government and the people are thus challenged to sustain their growing economy without degrading their natural resources. An important issue that must be considered is waste management.

WASTE MANAGEMENT ISSUES AND PROBLEMS

Water pollution

The Office of the National Environment Board reported that in 1989, the general water quality was good. Thus, maintaining it is a priority.

The major sources of pollution include siltation caused by land-based cut-and-fill operations, tin mining and poorly treated domestic sewage as well as the industrial outfalls from rubber and seafood processing facilities.

The only water treatment plant on Phuket is found at Patong Beach in Katu District, 14 km from the provincial capital. At present, Patong Beach is the island's most developed beach, with cabin and bungalow complexes, hotels, bars, nightclubs and discotheques. But one treatment plant cannot handle the beach's polluted waters.

Hotels which are being expanded along the west coast beaches of Rawai, Kata, Karon and Bangthao, are a potential source of pollution which needs careful monitoring.

Garbage

Inappropriate development and improper land use are evident in the huge quantity of garbage--about 120 t--that is buried in sanitary landfills each day. The rest of the garbage collected from other parts of the island is dumped in a deserted mangrove area near the town of Phuket. The island is running out of dumpsites and new disposal sites have become quite scarce. This is aggravated by the cabinet resolution which prohibits the use of existing disposal sites for the protection of the environment.

WASTE MANAGEMENT POLICIES AND STRATEGIES

Because waste management is part of resources management, the provincial government follows policy guidelines to: (1) get the commitment of local leaders and residents to waste management by making them aware of the severity of environmental threats to their own community; and (2) explore ways and means to effectively enforce environmental regulations. These are essential to programs designed to improve the management of resources and waste, and minimize the negative environmental impacts of development.

Various management programs and projects being implemented employ these strategies:

- restore damaged or overdeveloped areas;
- preserve areas untouched by development for the benefit of future generations;
- develop sound management principles; and
- enforce strictly environmental laws and regulations.

Specifically, sewage treatment plants shall be constructed in residential and commercial areas. Facilities for collection, treatment and drainage will be installed, as needed. In the pipeline are sewage and water treatment plants for the town of Phuket and the beaches of Katu and Karon.

Provincial authorities are also submitting new proposals for the cabinet's reconsideration of its resolution to prohibit the use of existing disposal sites. They are also seriously exploring modern methods in waste management (e.g., incineration) that are suitable for Phuket.

LOCAL GOVERNMENT EFFORTS IN WASTE MANAGEMENT

At present, waste management in Phuket is a crucial environmental issue. The local government has started taking measures to solve waste disposal problems. Apart from the construction of sewage treatment plants in well-developed areas, hotels are required to have on-site treatment facilities, especially for water that will be discharged into public sewers. Individual homes are required by law to install modern septic systems. Government inspectors have been deployed to enforce regulations and punish violators to forestall environmental hazards.

Local participation is a virtue highly prized in dealing with waste management problems. The involvement of the community folk indicates that needs are more accurately expressed, and services and technologies are more widely disseminated and used. The successful management of several development schemes has usually involved local leaders and communities in various aspects of program design and implementation. Several government programs are based on local participation which is an important success factor. Civic groups such as the Lions Club, Red Cross and women's clubs organize

cleanup campaigns in cooperation with the government. To complement these efforts, public service messages are aired frequently over local TV and radio stations.

The ability to elicit full cooperation from local residents depends primarily on the attitudes and the personal effort of leaders from the provincial, district and down to the village levels. They must involve residents in the decisionmaking regarding local issues. The degree of involvement varies, too, with the level at which it is practiced.

The respective roles of local leaders

1. The provincial governor is:
   - chairman of the provincial development committee and the joint committee of government and private sectors which are responsible for the formulation of policy guidelines for natural resources development and environmental protection schemes throughout the province;
   - head of all government agencies responsible for dealing with the problems of the people, which includes maintaining law and order; and
   - project director and coordinator of various programs of the central government.
2. The district governor is:
   - chairman of the district development committee responsible for the planning, coordination and monitoring of activities of all programs/projects in his district, and supervision of policies set at the provincial level;
   - chief inspector and protector of all natural resources in the district; and
   - head officer of all government agencies in the district. He is responsible for local services and keeping law and order.
3. The village headman:
   - assists the provincial and district administrators and other decisionmakers in analyzing community problems;
   - acts as a conduit between these officials and the people who tend to district or ignore government programs with complex procedures or requirements; and
   - encourages grass roots participation.

The public-private linkage

Cooperation between public and private sectors is essential in the execution of government-sponsored programs. For waste management, the private sector's compliance with new regulations is essential. In addition, there have been several meetings between representatives from concerned government agencies and the private business sector to discuss and seek solutions to garbage collection and water treatment problems. The private sector has agreed to finance waste management facilities, the construction of which has been delayed due to insufficient government funds.

CONCLUSION

Clearly, attaining the goal of economic growth with social equity demands that closer attention be paid to the condition of the biological and physical environment. Both natural and human resources must be appropriately developed to satisfy basic human needs and sustain a higher standard of living.

In Phuket, efforts to address waste management issues imply a reorientation of social goals and a reduction of the demands placed on natural resources. The extravagance that has characterized the island's production and consumption patterns must be replaced with conservation (e.g., through recycling) and innovative technologies.

In summary, these are the guidelines tackling waste management problems in Phuket:

1. Special attention must go to the natural resources development planning at each level. The environmental impact of development and waste management problems must be clarified in both short and long terms.
2. The local populace must be encouraged to participate in planning and

implementation processes because they will be affected by modernization and change.

3. People's awareness should be promoted in the community because an informed public can make intelligent decisions on waste management options. The media can be used for information campaigns and other instructional materials.
4. Preconditions for community development should be established through appropriate planning strategies.
5. Joint ventures between the government and private sectors should be promoted.
6. Rules and regulations on resources management that will lead to improved waste management must be strictly enforced.

Public Awareness and Education Towards Waste Management

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ABSTRACT

Public awareness and education is a prerequisite to good environmental quality and effective waste management. Thus, the Philippine Environmental Journalists, Inc. (PEJI) has an ongoing environmental awareness program since 1987. An informed public is capable of prompt action that can help reduce and control waste generation.

Other ways of increasing public awareness and education include integrating environmental concepts in the educational system, particularly at the elementary and secondary levels, and training village communicators (VCs) who can link up with journalists for environmental awareness programs.

Waste management in the Philippines is a relatively new concept. Thus, it is not surprising that sanitary landfills, incinerators, sewerage systems, water treatment plants, recycling plants and other waste management facilities are practically unheard of in many of the country's 74 provinces, 61 cities and hundreds of towns.

A semblance of waste management is found in industrial zones and some affluent residential communities. But in many areas, collected solid waste is thrown in open dumps, some of which are located in coastal areas. Small town residents either burn and bury their garbage in their backyards or dump it into rivers, creeks, and estuaries. These polluted waterways lead to the sea, practically making it a big wastebasket.

Metro Manila has the country's only public sewage collection and water treatment system, which serves a mere 12% of Metro Manila's population. The rest relies on septic tanks. Untreated and partially treated domestic and industrial wastewater are discharged into waterways, accounting for about 30% of the organic pollutants that are degrading Metro Manila's water resources.

The disposal of hazardous and toxic waste is another problem. In the province of Cebu, some firms at the Mactan Export Processing Zone export their hazardous and toxic waste because these cannot be handled locally.

The government's waste management options are limited by the lack of financial resources. Billions of pesos are needed to provide every town, city and province with proper waste disposal and treatment facilities.

This is where public awareness and education can prove vital, as the limited financial resources can be compensated for by the people's prompt action to control waste buildup.

Public awareness and education may also help decisionmakers both in the government and private sectors to initiate waste management programs funded by aid agencies and private groups. An informed public can also be encouraged to raise funds for the needed waste management system.

In the Philippines today, more people are becoming aware of the need to manage waste through the government and education sectors, nongovernmental organizations and the media.

Media's all-out campaign involves a daily barrage of environmental reminders and stories on print, radio and television. The PEJI, a journalists' group affiliated with the Asia-Pacific Forum of Environmental Journalists, has been undertaking a massive environmental awareness program since 1987.

The PEJI members, who come from print, broadcast and television media undergo training workshops on environmental reporting and contribute to *Tierra*, the PEJI newsletter. Every journalist-member is encouraged to write environmental articles in their own media outlets. Copies of such stories or clippings are sent to the PEJI office in Cebu where they are reproduced for distribution to members and other interested groups. Materials on environmental issues and reports are distributed to members all over the country now numbering close to 100. These have become the bases of many advocacy reports calling for environmental conservation and waste management. Some of the reports are directed at the government which is believed to have the resources, albeit limited, to implement such programs.

The membership of PEJI is not concentrated in highly urbanized areas such as Metro Manila, Metro Cebu or Metro Davao; it covers even the remotest parts of the country. Environmental articles and advertisements in national newspapers and major radio stations often find their way in weekly community papers and small town radio stations.

In recent years, the impact of the awareness program has been very encouraging. Some of the reports have resulted in actual community action. Since waste management facilities are expensive, communities are being mobilized to reduce the amount of waste being discharged into the environment. Urban communities recycle bottles and tin cans, and farming communities compost biodegradable matter. Cleanliness drives have become a common measure to prevent indiscriminate waste disposal. Such campaigns are now ongoing in practically all major cities and towns in the country.

In Metro Cebu, for instance, continued media prodding has prompted the government to plan the construction of a sanitary landfill and an incineration plant which will cost millions of pesos. Undertaken by the Metro Cebu Development Program, the project will involve the construction of similar facilities in the Central Visayas cities of Tagbilaran in Bohol and Dumaguete in Negros Oriental. Funding is from the Overseas Economic Cooperation Fund of Japan.

The larger goal of a national environmental education is now being studied carefully by the government. There is a move to integrate environmental concepts in the elementary and secondary school curricula. Such concepts can also be incorporated in the tertiary and graduate courses in ecology, environmental science, resource management and resource economy, including research and development.

Schools are also being tapped to take the lead in the development of folk media as a means of propagating environmental messages. Environmental themes can be woven into the performing arts such as drama, folk song and dance, and in the visual arts like painting and sculpture.

Many environmentalists in the Philippines, more particularly those in media, are seriously studying the possibility of training VCs who can link up with the regular journalists for environmental awareness and education programs. The PEJI, for instance, is preparing a module to implement this concept in small villages.

The prospective VC will have to undergo mass communication and basic ecology training which will help him identify environmental concerns in his own community. He should have sufficient knowledge of the forests, wetlands, river systems and lakes within his area. He should also know how waste is managed in his community. Thus, environmental problems needing immediate attention can be brought to the attention of a greater number of people, including decisionmakers. Solutions to these problems can

then be found and conservation programs can be carried out more effectively.

Clearly, public education and awareness is necessary for good environmental quality and effective waste management. It can eventually develop a stronger political will to do something about the country's present environmental problems.

The Role of Nongovernmental Organizations in Waste Management

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ABSTRACT

Nongovernmental organizations (NGOs) have been known to provide the main channel for public participation in the government policymaking process. In waste management, they can be categorized as waste or nonwaste generators. This paper discusses the role of NGOs that are nonwaste generators and of those that are concerned with environmental and conservation issues.

BACKGROUND

There has been considerable public interest in environment and pollution in the last few years in the ASEAN region. This trend has corresponded closely with the shift toward and emphasis on industrialization in the region. Recent demonstrations in industrialized countries indicate that a significant percentage of the citizenry regards environmental issues as of major social importance and as warranting firm governmental commitment. This interest also reflects the citizens' general knowledge of the extent to which the environment has been and is being damaged.

Consequently, the environmental issue has emerged as a major political one. Hence there is a need for greater sensitivity to the public's views on the decisionmaking process by the government and the public sectors.

The NGOs, specifically the public interest groups, provide the main channel for public participation in the government's policymaking process. The NGO system is actually more important as a channel in environmental politics than in other areas of social concern because the political parties tend to neglect the environmental issue "anchored as they are to the interests of industry."

In waste management, NGOs can be categorized as waste generators or nonwaste generators. In the following discussion, NGOs refer to nonwaste generators that operate for the benefit of society, specifically, environmental and conservation organizations. These NGOs also belong to social action groups which are generally concerned with the society. The Environmental Protection Society of Malaysia (EPSM), Sahabat Alam Malaysia

and the Malayan Nature Society (Malaysia) are examples of such groups.

THE ROLE OF ENVIRONMENTAL/ CONSERVATION NGOS

As public watchdog

Environmental/conservation NGOs serve as public watchdogs. They continuously monitor alarming situations which could result in loss of life and/or have adverse impact on the environment.

News is usually obtained from print and broadcast media, and from affected individuals or groups. The NGO then resorts to the following options:

- initiate dialogue or open debate with the concerned government or private agency for explanations;
- organize public forums and/or campaigns;
- represent the affected individual or group; and
- take direct action (as is possible in some countries).

The media plays a vital role in information dissemination. It alerts the public and mobilizes it for support. It provides background information on the waste problem or situation. Unfortunately, the media is also known to reverse its role unpredictably. It could "blackout" important and sensitive issues or simply reduce a highly sensitive issue into a low-key, mundane one.

Public awareness

While the media is a vital element in raising public awareness, it cannot be depended upon as allies of NGOs at all times.

As an issue drags on and becomes less sensational, the media drops the coverage. It is the NGOs who pursue the issue to its resolution. In EPSM, we keep track of the outstanding issues and flag them in seminars, conferences and dialogues with government departments, etc. As long as these issues are unresolved, they remain outstanding items in our records.

To maintain independent of the mass media, NGOs organize seminars, forums and exhibitions as well as periodicals. In EPSM, we give out "polluter/preventer" awards as a way of drawing public attention to the concerned individuals or organizations.

Environmental network

The NGOs circulate magazines, bulletins and books among themselves to be up-to-date on environmental issues and developments. Recently, environmental networks have been organized for updating purposes, too.

The Malaysian Environmental and Conservation Network (MECN) and the Regional Environmental Network for Asia-Pacific have the potential to exchange news and collaborate in mobilizing support in a short period. PEGASUS, a database system on environmental/conservation matters based in Australia, is also available to the network organizations.

This system and other facilities enable the ASEAN NGOs to interact with their counterparts regarding experience and technical expertise. For instance, NGOs representing the public have access to an independent expert's viewpoint on coastal resources management issues in evaluating the motives or reasons of the government/private agencies concerned.

Ideally, environmental and conservation NGOs should rely on their local scientific and engineering counterparts for primary data and other resources. But this is not the case in Malaysia.

SUSTAINING AN NGO

In the ASEAN region, an NGO has to operate and sustain itself in an unfriendly atmosphere. There are numerous, little-known obstacles which hinder its functions and sometimes threaten its very existence. It operates at a major disadvantage in relation to the defenders of the status quo.

These obstacles, which vary within the region, include low membership, ineffective

sanction, hostile political conditions, funding difficulty and activist burnout syndrome.

Although an NGO, as a vanguard of environmental issues, represents the public, it remains unattractive in terms of membership mainly because it does not bring direct benefits. Without a large membership, it is thus difficult to pose as a credible and representative organization.

An NGO generally lacks the very effective sanctions which the more powerful economic sectoral groups possess. It does not have the power exercised by a trade union that rests upon its indispensability, i.e., a union provides services without which society cannot operate. Strikes or boycotts quickly get the public's serious attention.

The hostile political condition in some ASEAN member-countries serves to prevent spontaneous public articulation and suppress NGO activism. There are varying degrees of democratic space, however. In the Philippines for instance, NGOs have the power to take direct legal action on a polluting factory. Official Secrets Act and the Internal Security Acts are some of the glaring manifestations of limited democratic space in other countries where detention-without-trial and bans on environmentalists are not unknown.

THE MALAYSIAN EXPERIENCE

Between 1971-1975, Kampong Kuala Juru experienced siltation and pollution of the river mouth which feed the Strait of Malacca (Malaysia). This issue was widely publicized by the Consumers Association of Penang. By 1975, the river was severely polluted and the fishermen's livelihood destroyed. These were caused by essentially poor planning and uncontrolled effluent discharge from factories located along the river.

The refusal of the government/private sector to respond to NGOs has been consistent. The ongoing massive tourist project in Pulau Redang is a glaring case.

Pulau Redang, an island 45 km off the coast of Kuala Trengganu, is acclaimed as having the most beautiful marine life in Malaysia and is comparable to the Great Barrier Reef in Australia. In 1970, concerned environmental groups and local scientists recommended that Pulau Redang be set aside as a national park. Thus, it was gazetted as a marine park in 1985. In 1989, the Department of Fisheries commissioned the Malayan Nature Society to prepare guidelines for the establishment of a Pulau Redang State Park.

At present, however, this island marine park is being threatened by a M$342-million tourist project which will include a golf-course, hotels, condominiums, holiday villas, bungalows and chalets.[1]

This project commenced even before the preliminary environmental impact assessment was approved by the Department of Environment. Eventually, erosion and siltation due to this project will invariably kill the corals and aquatic flora and fauna; degrade the mangrove ecosystem; and finally destroy the paradise-like island.

CONCLUSION

Clearly, a coastal zone management program cannot be treated in isolation. It cannot confine its attention to coastal areas only because the source of waste lies in the hinterland and offshore.

Application of the proverbial "prevention as a better cure" is recommended as a starting point in a waste management program. Emphasis should therefore be placed on the use of low and nonwaste technology; "pollution prevention pays" technology, and "*womb-to-tomb*" *concept (where a polluter* has total responsibility).

It is extremely important to note also that this conference will be reduced to a mere academic exercise if an implementation program is not realized. The enforcement of this program will, in the long run, give more meaning to this conference.

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[1]September 1991: M$2.75 = US$1.00.

Summary and Recommendations

Waste Management in the Coastal Areas of the ASEAN Region: A Need for Action

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ABSTRACT

The continuing degradation of the ASEAN coastal environment is the result of population growth, urbanization, industrialization and inadequate waste management practices. The realization that coastal zone use is not sustainable has brought about several multilateral initiatives in marine pollution control.

The key elements in integrated waste management include: cooperation among the ASEAN members in the development of waste management strategies, technology, manpower and information exchange; a multisectoral approach to environmental projects; a strong political will; and public awareness and community participation.

INTRODUCTION

The Conference on Waste Management in the Coastal Areas of the ASEAN Region assessed the severity of the environmental threats posed by waste disposal, especially to the coastal zone in the ASEAN region; explored and demonstrated the availability of technologies (especially low-cost ones) and methods in waste management appropriate for developing nations; explored ways in which international banking institutions and donor agencies could assist the ASEAN region in developing and implementing waste management schemes; and solicited the commitment of ASEAN political leadership in the effective implementation of environmental regulations and waste management schemes. Substantial recommendations for action were then made.

This paper summarizes the salient points discussed during the conference and the holistic, institutional and legal bases on which the "Singapore Resolution on Waste Management in the Coastal Areas of the ASEAN Region" was formulated.

ENVIRONMENTAL IMPACTS OF WASTE DISPOSAL ON ASEAN COASTAL AREAS

General

In 1989, the total population of the ASEAN region was 325 million, which is expected to

Table 1. Estimated BOD loading of sewage discharges and daily solid waste disposal in coastal areas of the ASEAN region.

	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
Total population (million) 1989	0.3	184.60	17.40	64.90	2.70	55.60	325.50
Annual growth rate (%) 1986-1990	2.10	2.10	2.60	2.40	1.30	1.70	
Estimated population (million) 2000	0.3	222.00	20.90	85.50	2.90	65.50	397.10
% population in coastal area	85	60	65	70	100	40	
Coastline length (km)	161	54,716	4,675	22,540	193	3,219	85,504
Sewage							
Daily BOD_5 loading in coastal area (t) 1989	26	5,538	565	2,272	324	1,112	9,837
Daily BOD_5 removal by treatment (t) 1989	10	997	144	409	272	244	2,076
Residual daily BOD_5 disposal (t) 1989	16	4,541	421	1,863	52	868	7,761
Estimated daily BOD_5 loading in coastal area (t) 2000	30	6,660	679	2,992	348	3,275	13,984
Solid waste							
Per capita daily generation rate (kg)	1.00	0.40	0.75	0.46	2.00	0.66	
Daily quantity in coastal area (t) 1989	213	44,304	8,483	20,898	5,400	14,678	93,976
Estimated quantity in coastal area (t) 2000	247	53,280	10,189	27,531	5,800	17,292	114,339
Fertilizers and pesticides							
Total cropland area (ha)		21,200	4,380	7,930		20,050	
Fertilizer usage (kg/ha)		100	154	4,415		26	
Pesticide usage (MT active ingredient)		16,344	9,730			22,289	

Source: Adapted from Lee, this vol.

reach 397 million in the year 2000 (Table 1). Roughly 70% lives in and depends on the coastal areas for livelihood.

The coastal areas of the region have been adversely affected by inadequate waste management practices. The resource base of the coastal area inhabitants (e.g., fisheries) is deteriorating. Also, many of the coastal areas are now unsafe for water contact recreation. These areas will deteriorate further due to population growth, urbanization and industrialization.

The major pollution sources are land-based activities, i.e., municipal, agricultural and industrial, and activities at sea such as shipping and oil development and production.

Domestic sewage

The most extensive municipal sewage pollution is found in the Upper Gulf of Thailand, Manila Bay, Strait of Malacca, West Coast of Peninsular Malaysia, West Coast of East Malaysia, North Coast of Java Island and Jakarta Bay.

In 1989, the estimated biological oxygen demand (BOD) loading in the coastal areas of the region was 9,800 t/day (Table 1), only 2,000 t of which are treated. It is expected to reach 14,000 t/day in the year 2000.

Inadequately treated domestic wastes may introduce pathogens to the coastal receiving waters, which are of potential harm to human and other living organisms; reduce oxygen in the waters from BOD loading; and result in poisoning of aquatic life by heavy metals and organic toxins.

Typically, extensive collection systems are few. Almost all major metropolises in the region, except in Singapore, lack sewage treatment systems. In many metropolitan areas, especially those outside the affluent core and newly developed districts, construction of piped sewerage installation would be extremely difficult and disruptive because of traditional settlement patterns. Most households have individual subsurface disposal systems which sometimes malfunction, sending sewage to surface drainage channels. The situation is aggravated during the rainy season.

In the Philippines, only Metro Manila has a sewerage system. It serves only the more densely populated areas (12% of the population). Sewage is discharged untreated into Manila Bay.

In Jakarta, Indonesia, conventional sewers are to be installed in selected areas; and in less affluent areas, experimental sewers. The subsurface disposal systems for approximately 10% of the population are to be improved.

In Singapore, almost 90% of the population is sewered, and sewage is treated before being discharged into the sea. Effluent is also used as a processed water supply by industries and factories.

Seven cities in Thailand operate wastewater treatment plants. The Public Works Department plans to build wastewater treatment systems in 67 cities over the next 12 years. Almost 95% of the urban households have modern pour-flush or cistern toilets.

Solid waste

Increasing population densities and the absence of adequate collection and disposal facilities for municipal solid waste have also resulted in increasing the refuse entering and clogging surface drains, and eventually being flushed into coastal waters.

The per capita solid waste generation estimates in the region range from 0.5 to 2.0 kg/day (Table 1). In 1989, roughly 94,000 t/day were disposed of in designated disposal sites. This excludes uncollected garbage that was disposed of directly or indirectly into watercourses or coastal areas.

Municipal refuse has also been used for land reclamation in these areas. This has resulted in leachate containing heavy metals and plastics dispersion in the marine environment and destruction of sensitive ecosystems.

Solid waste management studies have been undertaken and plans have been developed for Brunei Darussalam, Jakarta, Bangkok, the eastern seaboard of Thailand, Manila and parts of Malaysia. The existing disposal systems are open dumpsites, landfills and incineration.

Industrial and agricultural wastes

More than 50% of manufacturing industries in the region are located along river banks or in coastal regions. They are found mainly in the Manila Bay area, the inner Gulf of Thailand, along the Strait of Malacca and the west coast of East Malaysia, and on the north coast of Java Island (particularly in Jakarta Bay and off Surabaya). Most industrial plants in Southeast Asia also lack waste treatment facilities.

Most of the industrial wastes originate from food and beverage processing, palm oil and rubber manufacturing, pig and livestock farming, tapioca starch industries, commercial fertilizer production, textile manufacturing, pulp and paper industries, tanneries and sugar refineries.

As early as 1976 and 1980, experts have identified oil pollution as a principal concern of the region. Pollution originates from both exploration activities and the transport of oil through the Southeast Asian seas. Oil spills have occurred, particularly in the Strait of Singapore and the Strait of Malacca.

The coasts of the region are contaminated with oil, particularly in areas of major oil exploration activities. In the Philippines and elsewhere, chronic localized petroleum hydrocarbon pollution problems ensue due to weak law enforcement and discharges from small vessels and oil terminals. Although tar balls are frequently considered a significant problem, chronic oil spills are much more significant biologically.

In Singapore, waste from oil tankers is treated at the Slop and Sludge Treatment Centre. Other harbors do not have oily water receiving and treatment facilities.

Other pollution sources include agricultural runoff, halogenated hydrocarbons in pesticides, and heavy metals. Siltation due to a variety of unsound management practices, including dumping of mine tailings, is a significant waste management problem. Table 1 presents the usage level of fertilizers and pesticides in some of the ASEAN members. Clearly, the Philippines and Thailand are the major users of fertilizers and pesticides, respectively.

Heavy metals, i.e., lead, mercury, cadmium and silver, are discharged by mining operations and other industries.

Hazardous waste problems are beginning to emerge in concentrated industrial zones such as in Jakarta, Bangkok, Manila and Kuala Lumpur, although these are not as serious as those of many industrialized countries.

PRESENT WASTE MANAGEMENT INITIATIVES

International initiatives

The essential linkage among terrestrial, aquatic and marine components of the environment is clearly seen in the coastal zone. Through water movement and the mobility of biological resources, the contiguous nature of coastal zones, seas and oceans supersedes political and national boundaries: each nation can detrimentally affect the environment and coastal resources of its neighbors. Thus, several multilateral initiatives have been taken to cooperate at the global and regional levels in the control of marine pollution from land-based and other sources. An estimated 80% of marine pollution is derived from land-based sources.

An effective resolution for coastal environmental quality will depend upon international or regional cooperation in achieving common minimum principles, guidelines and standards. To date, these are the precedents:

1. Recommendations adopted by the United Nations Conference on the Human Environment (June 1972)
   - Principle 21: "States have ... the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction".
   - The Action Plan adopted at Stockholm includes Recommendation 86(f) which urges governments to strengthen national controls over land-based sources of marine pollution.
   - Recommendation 92(b) urges governments to adopt national measures for the control of "all significant sources of marine pollution, including land-based sources" and coordinate their actions regionally and where appropriate on a wider international basis.
2. 1982 Convention on the Law of the Sea

   Drawing upon the Stockholm documents, the convention lays down the fundamental obligation of States to protect and preserve the marine environment (Art. 192):
   - States are required to take all measures to prevent, reduce and control pollution of the marine environment (Art. 195[1]).
   - States are obliged to take measures against causing pollution damage to other States and their environment. (Art. 194[2]). These measures must include those designed to minimize the release of toxic, harmful or noxious substances from land-based sources, from or through the atmosphere, or by dumping (Art. 194 [3][a]).
   - States must:
     - adopt laws and regulations;
     - endeavor to harmonize policies at the regional level;
     - endeavor to establish global and regional rules, standards, recommended practices and procedures.

     All these must take into account the economic capacity of developing States.

Although no global, legally binding instrument has been adopted, nine regions have concluded general conventions covering all sources of marine pollution and three regions have specific agreements on land-based marine pollution (Table 2). The control of seaborne sources of pollution has been addressed (Table 3). Also, a set of recommended actions, the Montreal Guidelines, has been drafted under the sponsorship of the United Nations Environment Programme (UNEP) for the protection of the marine environment against land-based sources of pollution (UNEP 1985).

Some of the common elements of the four instruments with specific requirements are:

- The definition of land-based sources needs clarification, particularly with regard to fixed and mobile offshore sources; some specific sources should be identified for regulation.
- Two categories have been developed for the control of noxious and harmful substances based on toxicity, persistence and bioaccumulation:

Table 2. Regional agreements related to the prevention and control of marine pollution.

Type/characteristics	Name	Application
Comprehensive with specific rules covering all sources of marine pollution	Helsinki Convention (1974)	Baltic Sea area
UNEP Regional Seas Programme Frameworks with general principles and rules applicable to various sources of pollution including land-based sources	Oslo Convention (1972)	NE Atlantic & N. Sea
	Helsinki Convention (1974)	Baltic Sea area
	Paris Convention (1974)	NE Atlantic
	Barcelona Convention (1976)	Mediterranean Sea
	Kuwait Convention (1978)	Persian Gulf
	Abidjan Convention (1981)	West and Central Africa
	East Asian Seas Action Plan (1981)	ASEAN region
	Noumea Convention (1986)	South Pacific region
Specific to regulation of land-based sources of marine pollution	Paris Convention (1974)	NE Atlantic
	Athens Protocol to the Barcelona Convention (1980)	Mediterranean Sea
	Quito Protocol to the Lima Convention (1981)	SE Pacific

Table 3. International agreements relating to sea-borne sources of pollutants affecting coastal zone resources.

International Convention for the Prevention of Pollution from Ships 1973 (Modified by MARPOL 73/78)	Control of operational discharges of ships of a. oil (Annex 1) b. noxious liquid substances (Annex II) c. harmful substances (Annex III) d. sewage (Annex IV) e. garbage (Annex V)
London Dumping Convention (1972)	Control of disposal at sea of wastes loaded for that purpose

- Hazardous (Black List). Parties are required to endeavor to prevent, control, reduce and eliminate substances on this list.
- Others (Grey List). Parties are required to progressively reduce or, in some cases, strictly limit the substances.

The question of the need for a universal Black List is raised.

- Relative to the development of control programs and measures, the agreements vary from States being obliged to cooperate in the development and adoption of specific programs, guidelines, standards or regulations regarding grey substances, to States elaborating and implementing the necessary programs.
- Emphasis is on cooperation in science and technology, which is taking place. Monitoring, however, to assess systematically the pollution levels and evaluate the effects of measures taken, is a more complex operation.
- Each instrument notes the duty of States to act so as not to transfer directly or indirectly, damage or hazards from one area to another, or transform such pollution into another type of pollution.

The majority of existing regional framework areas have no instruments containing specific regulatory standards. These instruments exist mainly in the regions where the required technologies and resources are available. Recent developments that open up new opportunities for coastal States to implement further measures are:

- the firm establishment of the exclusive economic zone (EEZ) or fishery

zone, giving the impetus for States to protect their resources and

- the widespread acceptance of the concept of integrated coastal zone management, enabling the integration of waste management into the wider concept of resources management.

Regional initiatives

- An ASEAN Experts Group on Environment was established in 1978 under the ASEAN Committee on Science and Technology to deal with environmental matters in the region. Of particular relevance to waste management is a project dealing with technology transfer in the treatment of effluent from rubber and palm oil industries.
- The ASEAN Experts Group on Marine Pollution has prepared a contingency plan for the control and mitigation of marine pollution.
- The ASEAN Subcommittee on Marine Science, also established in 1978, is coordinating and implementing three major cooperative programs, which are on:
  - tides and tidal phenomena which will provide valuable information on water movement that could be used in the optimum location of outfalls;
  - living coastal resources which will assist in establishing criteria for the maintenance of environmental quality; and
  - the ASEAN-Canada Cooperative Programme on Marine Science, Phase II which will, in part, assist in the development of criteria for protecting the marine environment.
- Established in 1981, the Coordinating Body on the Seas of East Asia (COBSEA) aims to assess the state of the marine environment and to protect and manage the marine resources in the ASEAN region. In 1982, COBSEA in collaboration with UNEP, drew up the East Asian Seas Action Plan involving research, prevention and control of marine pollution and monitoring in the seas surrounding the region. This plan also aims to promote the management of coastal activities that affect the marine environment and the sustainable use of marine resources as well as to implement specific plans. The matters proposed by this plan directly relevant to waste management are:
  - regional advisory services for oil spill control;
  - guideline setting for discharge of wastes into coastal waters; and
  - marine dumping site selection for hazardous waste.

A major weakness of the plan is reported to be its uncertain financial basis.

- In 1989, a workshop on the methodologies of assessment of pollution from land-based sources was held in Singapore.
- The ASEAN Council on Petroleum (ASCOPE) was established to deal with the environmental consequences of the exploration for petroleum and natural gas.
- In 1990, the ASEAN Senior Officials on the Environment (ASOEN) was established.

National initiatives

Table 4 indicates the extent of legislation enacted within the ASEAN region which is relevant to waste management in the coastal zone. National policies have also been promulgated, environmental institutions established, training courses developed and attended, studies made, and science and technology applied, to waste management.

LESSONS LEARNED AND THE NEED FOR ACTION

Waste management concerns

The three major aspects of waste management problems in the region are finances, policy and planning.

Most developing countries are beset by financial constraints. The lack of financial resources of most developing countries for modern pollution control facilities results in

Table 4. Summary of ASEAN legislation pertinent to waste management.

Nation	Legislation	Commentary
Brunei Darussalam	Solid Waste Management Plan (1987)	Solid waste disposal
	National Water Quality Standards Study (1987)	
Indonesia	Public Water Law (1936)	Disposal of industrial wastes into public streams
	Nuisance Ordinance (1926) (Amended 1940)	Industrial control standards and disposal of harmful wastes
	PD 7 (1973)	Regulation of pesticide distribution, storage and use of pesticides
	Ministry of Agriculture Directives (1973-1975)	Registration, handling and use of pesticides
	Environmental Management Act (1982)	Basic provisions for the management of the living environment
	PROKASIH (1989)	Cleanup of rivers in various provinces
Malaysia	Land Conservation Act (1960)	Silt and erosion
	Waters Enactment Act (Amended 1970)	River pollution
	Mining Enactments 146/147	Effluent waters
	Street Drainage and Building Act (1974)	Trade effluent and domestic wastes into rivers
	Local Government Act (1976)	
	Rearing of Pigs Enactments (1975, 1980)	Waste treatment required
	Environmental Quality Act (1974) (Amended 1985)	Environmental impact assessment Licences for polluting activities (land, air and noise) with regulations for crude palm oil, raw natural rubber, sewage and industrial effluents
Philippines	Republic Act 3931 (Amended by Presidential Decree (PD) 984 (1964)	National Pollution Control Commission with powers to establish and enforce standards
	PD 600 (1967)	Philippine Coast Guard responsible for preventing and controlling marine pollution
	PD 463 (1974)	Disposal of mine tailings
	PD 1151 (1977)	Philippine Environment Policy
	PD 1152 (1977)	Philippine Environment Code (Supplements PD 1151)
	PD 1586 (June 1978/June 1982)	Environmental impact assessment
	PD 1121 (1977)	National Environmental Protection Council
	Several other PDs	Provisions for protection of the environment and creation of agencies
Singapore	Prevention of Pollution of the Sea Act (1971)	Control of oil pollution and other contaminants
	Water Pollution Control and Drainage Act (1975)	Control of effluent discharge from industrial, commercial, domestic and agricultural sources
	Trade Effluent Regulations (1976) (Amended 1977)	Control of trade effluent discharges into sewers and watercourses
	Singapore Port Regulations (1977)	Protection of harbor environment
	Environmental Public Health Act (1978)	Control of solid waste dumping
Thailand	Fishery Act (1947)	Protection of aquatic habitats
	Toxic Substance Act (1967)	Control of toxic substances
	Environmental Quality Act (1975) Sec 17	Environmental impact assessment
	National Environment Promotion Bill of 1976 (Amended 1978)	Office of the National Environment Board
	Public Health Act (1941) and Factories Act (1969) (Amended 1975 and 1979)	Industrial effluent standards/pollution control facilities

inadequate collection systems, lack of manpower and technical capabilities, etc.

Although many countries have developed waste management master plans at the national or local level, particularly in sewage treatment, the question of policy arises. The implementation will require tax imposition which most policymakers would like to avoid. Multilateral or bilateral bank loans are possible but waste management projects are not considered national priority.

Inadequate funding, legislation and enforcement by local authorities and a low degree of coordination among the different sectors and agencies concerned have constrained waste management programs, particularly in Malaysia (Jaafar, this vol.).

Enabling legislation is largely in place in most countries but compliance is seldom monitored or enforced (Lee, this vol.).

Lack of public support is also considered a major obstacle in solving pollution problems. Thus, a preliminary risk assessment should consider public perception and resource uses; critical habitats and species; fate of pollutants; toxic hazard, persistence and natural detoxification mechanisms; and exposures (Van Veldhuizen and Aragones, this vol).

Lack of public support could be attributed to insufficient attention to community participation in waste management. The key to successful waste management may not be funding alone but the energies and resources of the community.

Lessons learned

The experiences of Singapore (e.g., the solid waste disposal scheme and the Singapore River project) and Malaysia (e.g., the treatment of palm oil and rubber effluents) can serve as examples of how capabilities can be developed, existing models modified and new technologies and management strategies adopted to suit local conditions and thus achieve a higher level of self-sufficiency.

Refuse incineration has been found to be a cost-effective waste disposal method of Singapore (Lim and Tan, this vol.; Ramstetter and Phua, this vol.). The contributing factors are sound planning, advanced technology, a well-trained workforce, and effective legislation and enforcement (Lim and Tan, this vol.). The government also encourages industries to minimize waste at source to cut down on materials use and waste disposal cost (Tan, this vol.).

Singapore and many other countries have opted to engage private companies for environmental services such as waste management. The benefits of privatization include efficiency and consistency in refuse collection, improved quality of services and cost savings (Smith, this vol.).

Singapore is the only nation in the region with centralized and coordinated waste management activities in the Ministry of Environment. Among the rest of the ASEAN members, the responsibility is fragmented among many agencies. Thus, a central authority for waste management is recommended.

On the other hand, more emphasis should be given to waste reduction, recycling processes and the adoption of low- and nonwaste technologies. Recycling and resource recovery, which are generally well established in the region, should be reinforced. In addition, intermediate technologies should be developed and implemented instead of improving sophisticated technologies (Wilson and Nair, this vol.).

The problem of environmental pollution is embedded in other more basic processes (e.g., urbanization) which require integrated and long-term solutions. The key elements of integrated waste management are a multisectoral approach to project implementation, a strong political will in moving environmentalism across social, cultural and economic structures, and public awareness and participation.

The need for action

These are some directions the ASEAN members can take:

1. Cooperate among themselves to develop, harmonize and coordinate their waste management strategies and measures, including technology, manpower and information exchange.
2. Strengthen regional and national goals for environmental quality of coastal zones based on integrated

coastal resources management strategies.

3. Undertake practical steps to prevent, control, reduce or eliminate the discharge into the coastal zone of substances harmful to humans, marine and other living resources or that damage amenities associated with the coastal environment.
4. Encourage the participation of community and nongovernmental organizations (NGOs) in the development and implementation of integrated waste management.
5. As part of a global responsibility for sustainable development, encourage multilateral and bilateral funding agencies, including international and regional development banks, to develop more and vigorous technical and financial assistance programs and policies for waste management. These agencies could also be urged to integrate environmental concerns into development programs and projects, especially those that help protect the marine environment and coastal living resources.

Various sectors should undertake specific functions.

The Political Leadership. The political leadership must be strong enough to meet objections, forceful enough to harness all units involved in waste management, and imaginative enough to develop livelihood programs out of garbage (Binay, this vol.). In addition, the government should encourage the participation of all sectors in waste management, particularly in planning priorities.

The Private Sector. Private sectors could provide services for waste collection, processing and treatment. Privatization of environmental services can mean more savings, improved reliability, better return on investments, efficient budgetary management and greater access to technology.

Donor Agencies. Banking institutions could help ASEAN in environmental programs especially for technology transfer, technical manpower training, institutional strengthening, policy reforms and investments. The specific beneficiaries of such assistance could be the national and provincial governments, universities (research and development), NGOs and the private sector (e.g., consulting firms).

The NGOs. The NGOs should serve as the public watchdog and continuously monitor situations which would adversely affect the environment. The media and NGOs should also be responsible for raising public awareness by organizing seminars, forums, exhibitions and using their periodicals. In addition, organizing village communicators who could link up with journalists would help in the awareness and education programs on the environment (Satorre, this vol.).

Community Leaders. Community leaders should give special attention to natural resources in development planning, creation of people's awareness in every community, participation of the local people in planning and implementation, and promotion of activities that would lead to cooperation between the government and the private sector (Phromlert, this vol.).

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ICLARM Contribution No. 824.

Singapore Resolution on Waste Management in the Coastal Areas of the ASEAN Region

issued by
The Conference on Waste Management
in the Coastal Areas of the ASEAN Region
28-30 June 1991
Singapore

RATIONALE

Pursuant to statements made on different occasions in support of conserving and protecting the environment and achieving sustainable development to secure the well-being of the people of the ASEAN today and in the future, including:

1. **Policy Recommendations for Coastal Area Management in the ASEAN Region (October 1988).**

   The most serious management of issues are the following: ...declining water quality and pollution.

   Setting of water quality standards is needed. Integration of river and watershed management should be made, if possible, with water quality zones affected by upland activities. Sampling and monitoring must be standardized for the region or at least, on a national basis. Industries and sectors that violate standards should be closely monitored....

2. **Kitakyushu Declaration regarding solid waste management in Asian Metropolises (October 1989).**

   ...recognizing the need to consider SWM problems and issues in the broader context of rapid urbanization and its associated problems.... SWM systems should be developed with flexibility to accommodate prevailing local socioeconomic conditions in Asian metropolises which are fast changing; should be extended to areas regardless of affordability; governments have to be more committed... to formulate national action programmes; ensure adequacy of financial base and availability of basic laws; promote active community involvement; recognize the need for recycling; strengthen technical cooperation....

3. **The Langkawi Declaration on the Environment (October 1989).**

   We, the Heads of Government of the Commonwealth are deeply concerned at the serious deterioration in the environment and the threat this poses to the well-being of present and future generations;... The main environmental problems facing the world are... marine pollution, land degradation.... We... commit ourselves to the following programme of action: advance policies and programmes which help achieve sustainable development (development that meets the needs of the present without compromising the ability of future generations to meet their own needs--Brundtland Commission)... strengthen and support the development of international funding mechanisms... which will include assisting developing countries to obtain access to and transfer of needed environmental technologies... support efforts to pre-

vent marine pollution including curbing of toxic wastes....

4. **Baguio Resolution on Coastal Resources Management (March 1990).**

Whereas, much of Southeast Asia's population lives in coastal areas... many coastal environments within the Association of Southeast Asian Nations (ASEAN) have become seriously degraded.... we, the participants of the Policy Conference, hereby resolve and further recommend that the ASEAN member-countries, donor agencies and all other groups and organizations give emphasis to the protection of these resources for the primary benefit of coastal communities by: endorsing policies that promote and enhance sustainable development of coastal resources...

5. **The Kuala Lumpur Accord on Environment and Development (June 1990).**

Aware, that the management of the environment and the pursuit of sustainable development are imperative to secure the well-being of the people of the ASEAN today and in the future..., We, the ASEAN Ministers for the Environment... agree to initiate efforts leading towards concrete steps pertaining to environmental management, including:

a. the formulation of an ASEAN strategy for sustainable development and a corresponding action programme,
b. the harmonisation of environmental quality standards,
c. the harmonisation of transboundary pollution prevention and abatement practices,
d. the undertaking of research and development and the promotion of the use of clean technologies.

and the following considerations:

WHEREAS, the ASEAN peoples have a right to use the coastal zone for the necessities of life and to improve conditions for society as a whole;

WHEREAS, some environmental changes as a result of human activity are inevitable;

WHEREAS, social and economic development should be pursued in a way that does not prejudice use of the coastal zone by future generations in meeting their social and economic needs;

WHEREAS, the Montreal Guidelines for the Protection of the Marine Environment Against Pollution from Land-Based Sources (1985) note that: "States should, directly and/or through competent international organizations, promote programmes of assistance to developing countries in the fields of education, environmental and pollution awareness, training, scientific research, transfer of technology and know-how, for the purpose of improving the capacity of the developing countries to prevent, reduce and control pollution from land-based sources and to assess its effects on the marine environment";

WHEREAS, the introductory statement of the United Nations Conference on Environment and Development's (UNCED) Secretary General at the first session of the Preparatory Committee(s) included "... of these issues, the need of developing countries for access to the new and additional financial resources they will require to enable them to participate fully in international environmental cooperation and integrate the environmental dimension into their own development policies and programmes undoubtedly poses the greatest challenge...";

WHEREAS, the governments of ASEAN nations have demonstrated their concerns and responsibilities in resolving national and regional environmental problems that affect sustainability of economic development in the region through the establishment of the ASEAN Committee of Senior Officials on the Environment (ASOEN) to develop common measures and collaborative environment program.

RECOMMENDATIONS

The participants at this conference agree that environmentally sound waste management strategies are vital to the sustainable development of coastal areas. As residents of the global commons and as citizens with clear opportunities to shape our nations' future, we recommend the following principles be incorporated into the environmental policies of ASEAN.

1. **ASEAN nations should cooperate to:**

   a. develop, harmonize and coordinate their waste management strategies and measures, including technology, manpower and information exchange;
   b. monitor and assess the creation and disposal of waste that may affect their regional neighbors;
   c. enhance the effectiveness of existing regional mechanism concerned with transboundary pollution of coastal areas;
   d. establish legal, financial, social and technical structures and capability which recognize the different economies of nations and which will eventually reduce dependency on external financing; and
   e. ensure the availability of the necessary technical and financial assistance and manpower development objectives.

2. **Regional and national goals for environmental quality of coastal zones should be based on integrated coastal resources management strategies and should be defined in order to establish:**

   a. communication with the peoples of ASEAN regarding to the importance of appropriate waste management strategies to mobilize public support and participation;
   b. priorities for waste management measures, including those addressing sewage, garbage, industrial and agricultural waste, toxic substances, hazardous waste and environmental emergency planning and response;
   c. efficient use of financial resources;
   d. measurable objectives for desired uses of coastal areas;
   e. scientific and other environmental quality criteria needed to sustain these uses; and
   f. standards for environmental quality or environmental planning, as appropriate.

3. **Proposed activities or waste management measures that may adversely affect the environmental quality of coastal zones, or the resources that depend upon that quality, should be subject to prior environment assessments that will determine the impacts on the environmental and socioeconomic sectors. Such assessments should include mitigating measures and a requirement for subsequent monitoring to assess compliance and effectiveness.**

4. **Waste management strategies and measures should be guided by the following principles:**

   a. there should be no transfer of damage or hazards from one area to another, directly or indirectly, or transformation of such pollution into another type of pollution;
   b. a 'Precautionary Principle' should be applied to selected substances as a goal wherever feasible. This means the reduction of contaminant discharges, irrespective of the probable impacts on environmental quality, to account for the uncertainty of scientific knowledge of those impacts on coastal resources now or in the future;
   c. innovative processes for waste treatment and disposal that are

applicable to the economic, socio-cultural and physiographic characteristics of the region;

d. effective participation of the private sector in the implementation of waste management programs through appropriate legislation, fiscal policy, resource use policy and incentives; and

e. adoption of practices and encouragement of the use of technologies that minimize the use of space, raw materials, energy, and the generation of waste;

5. The ASEAN nations should take all practical steps to prevent, control, reduce, or eliminate the discharge of substances to the coastal zone that cause harm to humans, marine life and other living resources, or that damage amenities associated with coastal environments. They should:

a. develop a "Black List" and a "Grey List" of polluting substances based on their persistence, toxicity or other noxious properties and their tendency to bioaccumulate. Measures should be taken to eliminate those substances on the "Black List" and to limit and reduce the discharge of those on the "Grey List";

b. develop mechanisms in accordance with their legal systems for prompt and adequate compensation or relief, as well as rehabilitation, in respect of damage caused by pollution of coastal areas under their jurisdiction;

c. introduce effective programs to recycle and reuse waste;

d. promote the use of science and technology to develop cleaner technologies and innovative waste management strategies; to define the linkages between waste discharges and environmental impacts; and to assess the risks and uncertainties associated with waste management practices or the lack thereof;

e. encourage education of the public, policymakers and the producers of waste, in the public and private sectors, about the opportunities for social and economic benefits to be derived from effective waste management strategies as well as the detrimental effects of inadequate or inappropriate management;

f. adopt programs that require polluters to bear the costs of pollution prevention, abatement and compensation; and

g. develop institutional arrangements that integrate waste management into development programs and projects.

6. The participation of nongovernmental and community organizations should be encouraged in the development and implementation of waste management strategies in order to promote the wider participation of the public, especially women and children.

7. As part of a global responsibility for sustainable development, bilateral and multilateral funding agencies, including regional and international development banks, should develop more and vigorous technical assistance, financing programs and policies for waste management projects, including the integration of environmental concerns into development programs and projects, especially those that help protect the coastal living resources and the marine environment.

ADOPTED by resolution at the Conference on Waste Management in the Coastal Areas of the ASEAN Region, 30 June 1991, Singapore.

Closing Ceremonies

Note of Appreciation

ROBERT DAKAN
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This conference certainly covered a wide range of issues that we are all growing with. I feel that we all have moved another step toward solving our mutual problems but recognize from the discussions that there are many steps yet to be taken before the environmental threats caused by waste disposal to the coastal zone in the ASEAN region are resolved. USAID continues to give assistance to ASEAN through the ongoing ASEAN/US Coastal Resources Management Project (CRMP), which has recently been extended for one year until December 1992. The main purpose of the extension is to complete the six site-specific coastal area development plans and important technical publications. I urge the ASEAN governments to find the funds necessary to implement the plans upon completion.

Our USAID/ASEAN office is very interested in supporting both public and private sector efforts to solve environmental problems which are really everybody's problem.

Also, we have recently started the Private Investment and Trade Opportunity Project which holds office in each of the ASEAN capitals. Joyce Rasmussen, together with the Chamber of Commerce here in Singapore, heads this office. This is essentially a trade promotion project. This year, the first trade mission for US Environmental Technologies sponsored by the project will bring US companies to Thailand, Indonesia and Singapore. This will be followed by other trade missions in early 1992 to the other ASEAN countries.

At present, we are designing a new project, the ASEAN Environmental Improvement Project. It addresses the need of ASEAN nations to resolve the damaging environmental effects of rapid industrialization and urbanization through policy and institutional development, technical assistance and training technology, and commercial and investment promotion. We plan to start in early 1992.

I thank all those involved with this successful conference, especially the organizers: the Ministry of the Environment of the Republic of Singapore and the ASEAN/US CRMP of the International Center for Living Aquatic Resources Management. Finally, I have been especially pleased to sponsor this conference with the Asian Development Bank and my colleagues at the Canada-ASEAN Centre.

Thank you all for attending.

Closing Remarks

CHUA THIA-ENG
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As this conference comes to a close, allow me to mention our accomplishments. Building from a spirit of cooperation and understanding, we have successfully defined the roles of the sectors vital to waste management. The ASEAN governments ably represented here by key policy- and decisionmakers have affirmed their commitment to working toward a sound waste management program. Complementing the governments are the donor agencies and multilateral banking institutions who have committed their financial assistance. We can expect their greater involvement in the future. The nongovernmental organizations have pledged their efforts and resources to educating the public on viable waste management strategies such as source reduction, reuse and recycling. The community leaders have also promised their collaboration and commitment. Clearly, simultaneous initiatives on all these fronts will make waste management a success in the region.

More importantly, we have come up with a resolution that not only recognizes the urgent need for an integrated approach to the waste problem but also underscores a course of action for effective waste management. This regional agreement outlines the overall strategy for waste management in the name of environmental protection and economic development. This will be our guide in formulating our future actions.

It is up to all of us now to take up the challenge of the conference recommendations. May this conference and its landmark resolution be the start of coordinated efforts toward a more effective waste management in the coastal areas of our region.

Thank you.

Appendices

Program of Activities

Friday, 28 June
Capricorn Room
Marina Mandarin Hotel
A.M.

Opening Ceremonies
Address: Waste Management in the ASEAN Region: Challenges and Directions. *Dr. Chua Thia-Eng*
Opening Remarks: Singapore's Efforts in Toxic Waste Management. *The Honorable Dr. Ahmad Mattar*
Keynote Address: Waste Management in Coastal Zones: The Role of Multilateral Development Banks. *Mr. In Yong Chung*

Session 1: Waste Management in the ASEAN Region: Status, Trends and Problems
Chairman and Moderator: *Mr. Theng Chye Yam*
Waste Management in the Coastal Area of Brunei Darussalam. *Mohd. Salleh bin Hj. Mohiddin*
Environmental Impact Management in Indonesia. *Mr. Nabiel Makarim*

P.M.

Wastewater Management in Malaysia. *Dr. Abu Bakar Jaafar*
Solid and Hazardous Waste Management in the Philippines. *Dr. Delfin J. Ganapin, Jr.*
Status and Trends of Waste Management in Singapore. *Mr. Tan Eng Gee*
Problems and Trends of Waste Management in Thailand. *Mr. Pornchai Taranatham*
Exhibit tour to the World Trade Centre
Cocktails hosted by Enviro-World '91

Saturday, 29 June
A.M.

Session 2: Waste Management Options
Chairman and Moderator: *Mr. Suvit Yodmani*
Solid Waste Management in Developing Countries. *Dr. David C. Wilson and Mr. Chandran Nair*
Ecological Impacts of Waste Disposal in the Coastal and Marine Environment. *Dr. Harvey D. Van Veldhuizen*
Solid Waste Management in Singapore. *Mr. Lim Hung Siang*
Assessment of Waste Management in the ASEAN Region. *Mr. Ken B. Lee*

P.M.

Discussion
Discussants: *Dr. Abu Bakar Jaafar, Dr. Delfin J. Ganapin, Jr. and Dr. Khoo Chin Hean*

Session 3: Economic Implications and the Role of Political Leadership in Waste Management

Chairman and Moderator: *Mr. Ian B. Robertson*

The Role of Political Leadership in Improving the Environment. *The Honorable Fulgencio S. Factoran, Jr.*

The Economics of Coastal Waste Management. *Dr. K. Dale Russell*

Discussion

Discussants: *The Honorable Jejomar Binay, Dr. Chia Lin Sien*

Reception and dinner hosted by Canada-ASEAN Centre

Sunday, 30 June

A.M.

Session 4: Role of Donor/International Agencies, International Banking Institutions and the Private Sector in Waste Management

Chairman and Moderator: *Dr. Aprilani Soegiarto*

The Implementation Constraints in Waste Management in Malaysia. *The Honorable Law Hieng Ding*

Coastal Waste Management and the United Nations Conference on Environment and Development 1992. *Mr. John P. Bell*

The Privatization of Waste Treatment and Management Facilities. *Mr. Thomas G. Smith*

Discussion

Discussants: *Mr. Goh Kiam Seng and Mr. George Green*

P.M.

Session 5: Community Awareness and Participation in Waste Management

Chairman and Moderator: *The Honorable Senator Heherson Alvarez*

Local Government Initiatives in Waste Management. *The Honorable Chalerm Phromlert*

Public Awareness and Education Towards Waste Management. *Atty. Manuel S. Satorre, Jr.*

The Role of Nongovernmental Organizations in Waste Management. *R. Senthirajah*

Discussion

Discussants: *Mr. Tan Wee Kiat, Mr. Muhamad S. Zulkarnaen, Mr. Suvit Yodmani*

Summary and Recommendations

Closing Ceremonies

Note of Appreciation. *Mr. Robert T. Dakan*

Closing Remarks. *Dr. Chua Thia-Eng*

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ICLARM PUBLICATIONS ON COASTAL AREA MANAGEMENT

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