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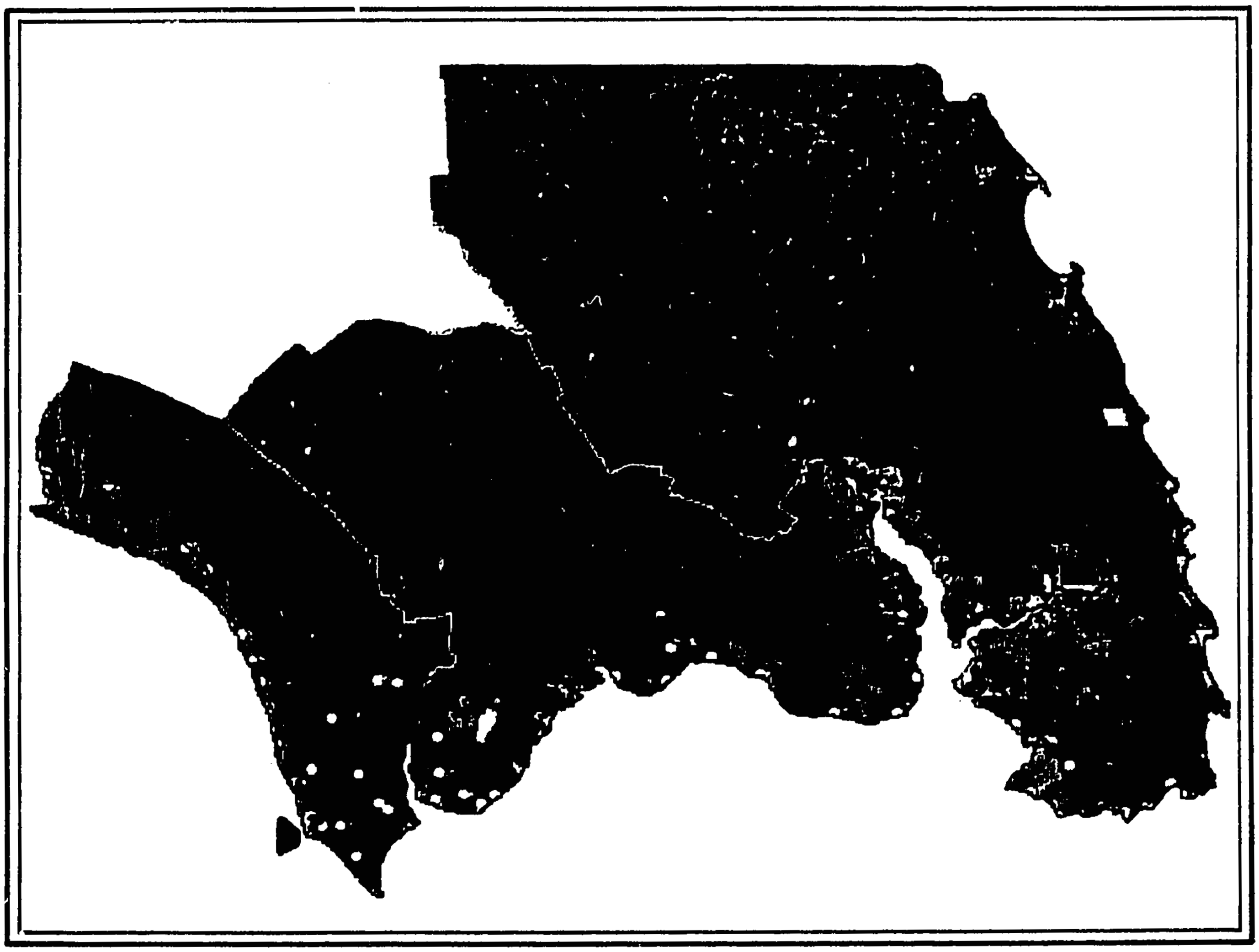
The Coastal Environmental Profile of South Johore, Malaysia



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The Coastal Environmental Profile of South Johore, Malaysia

1991

ICLARM

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The Coastal Environmental Profile of South Johore, Malaysia

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Cover: *(Front):* Map of physical features and land uses of South Johore, Malaysia (prepared by Noel A. Robles, ICLARM, based on GIS data from Kam Suan Pheng, Universiti Sains Malaysia).

(Back): Landsat image showing Pasir Gudang and part of Johore River, Malaysia (supplied by Ch'ng Kim Looi, Ministry of Science, Technology and the Environment, Malaysia).

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List of Acronyms and Abbreviations

ADB	Asian Development Bank
ASEAN/US CRMP	Association of Southeast Asian Nations/United States Coastal Resources Management Project
BOD	biological oxygen demand
CAM	coastal area management
COD	chemical oxygen demand
CRM	coastal resources management
DDG	dust deposit gauge
DO	dissolved oxygen
DOE	Department of Environment
DOF	Department of Fisheries
DOFor	Department of Forestry
EQA	Environmental Quality Act
FC	fecal coliform
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
FTZ	Free Trade Zone
GDP	gross domestic product
JICA	Japan International Cooperation Agency
JPA	Johore Port Authority
KEJORA	Lembaga Kemajuan Johore Tenggara (Southeast Johore Development Authority)
MD	Marine Department
mld	million liters per day
MOSTE	Ministry of Science, Technology and Environment
MPN	most probable number
NCES	National Coastal Erosion Study
PUB	Public Utility Board
PWD	Public Works Department
SEDC	State Economic Development Corporation
SS	suspended solids
UPM	Universiti Pertanian Malaysia
USEPA	United States Environmental Protection Agency
WQI	water quality index
WQMS	water quality monitoring station

Foreword

The coastal waters of Southeast Asian countries have some of the world's richest ecosystems characterized by extensive coral reefs and dense mangrove forests. Blessed with warm tropical climate and high rainfall, these waters are further enriched with nutrients from the land which enable them to support a wide diversity of marine life. Because economic benefits could be derived from them, the coastal zones in these countries teem with human settlements. Over 70% of the population in the region lives in coastal areas where resources have been heavily exploited. This situation became apparent between the 1960s and 1970s when socio-economic pressures increased. Large-scale destruction of the region's valuable resources has caused serious degradation of the environment, thus affecting the economic life of the coastal inhabitants. This lamentable situation is mainly the result of ineffective or poor management of the coastal resources.

Coastal resources are valuable assets that should be utilized on a sustainable basis. Unisectoral overuse of some resources has caused grave problems. Indiscriminate logging and mining in upland areas might have brought large economic benefits to companies undertaking these activities and, to a certain extent, increased government revenues, but could prove detrimental to lowland activities such as fisheries, aquaculture and coastal tourism-dependent industries. Similarly, unregulated fishing effort and the use of destructive fishing methods, such as mechanized push-nets and dynamiting, have seriously destroyed fish habitats and reduced fish stocks. Indiscriminate cutting of mangroves for aquaculture, fuel wood, timber and the like has brought temporary gains in fish production, fuel wood and timber supply but losses in nursery areas of commercially important fish and shrimp, coastal erosion and land accretion.

The coastal zones of most nations in the Association of Southeast Asian Nations (ASEAN) are subjected to increasing population and economic pressures manifested by a variety of coastal activities, notably, fishing, coastal aquaculture, waste disposal, salt-making, tin mining, oil drilling, tanker traffic, construction and industrialization. This situation is aggravated by the expanding economic activities attempting to uplift the standard of living of coastal people, the majority of whom live below the official poverty line.

Some ASEAN nations have formulated regulatory measures for their coastal resources management (CRM) such as the issuance of permits for fishing, logging, mangrove harvesting, etc. However, most of these measures have not proven effective due partly to enforcement failure and largely to lack of support for the communities concerned.

Experiences in CRM in developed nations suggest the need for an integrated, interdisciplinary and multisectoral approach in developing management plans that will provide a course of action usable for the daily management of the coastal areas.

The ASEAN/United States (US) Coastal Resources Management Project (CRMP) arose from the existing CRM problems. Its goal is to increase existing capabilities within ASEAN nations for developing and implementing CRM strategies. The project, which is funded by the US Agency for International Development (USAID) and executed by the International Center for

Living Aquatic Resources Management (ICLARM) in cooperation with ASEAN institutions, attempts to attain its goals through these activities:

- analyzing, documenting and disseminating information on trends in coastal resources development;
- increasing awareness of the importance of CRM policies and identifying, and where possible, strengthening existing management capabilities;
- providing technical solutions to coastal resources use conflicts; and
- promoting institutional arrangements that bring multisectoral planning to coastal resources development.

In addition to implementing training and information dissemination programs, CRMP also attempts to develop site-specific CRM plans to formulate integrated strategies that could be implemented in the prevailing conditions in each nation.

Johore is one of the coastal states of Malaysia with the longest coastline--facing the South China Sea in the east, the Strait of Malacca in the west and the Strait of Johore in the south. Coastal resources, especially the living marine resources, are the main source of income, employment and food of the coastal communities. In line with the national government's policy towards industrialization, economic development in Johore, especially along the coastal area, is rapid. This results in the growing problem of environmental quality deterioration, which includes destruction of habitats and pollution of the coastal and inland waters, among others. Recognizing that if this trend continues, sustainable development is in jeopardy, Malaysia joined the ASEAN/US CRMP.

South Johore was chosen as the pilot site because, in part, it represents one of the fast-growing areas in the country. The site also has environmental problems similar to those of the pilot sites of the other participating nations. Further, South Johore shares with Singapore the Strait of Johore, a waterway which receives development impacts from both areas.

The preparation of *The coastal environmental profile of South Johore, Malaysia* is the first step in the planning process towards developing an integrated coastal zone management plan for South Johore. The profile contains 12 chapters which provide background information on the various economic uses of the coastal resources; outline the existing legal and institutional framework governing the use and management of these resources; and highlight the management issues and constraints concerning the various resources use conflicts. It is hoped that this profile will serve as a basic database which can be further enriched by follow-up research.

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Department of Environment (Johore)
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District Office of Johore Bahru
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Chapter 1
Introduction

Pontian, Johore Bahru and Kota Tinggi are the southernmost districts in the State of Johore at the southern tip of Peninsular Malaysia. They are also collectively referred to as South Johore.

Chosen as the project site, South Johore has experienced rapid development over the past 20 years, fueled primarily by the exploitation of coastal resources and the utilization of coastal space. Its economic growth can continue on a long-term basis, but only if development of coastal areas is planned properly and coastal resources are managed effectively.

The district of Johore Bahru is undergoing heavy industrialization and urbanization. Due to lack of proper industrial and domestic waste treatment facilities, pollution is becoming a serious problem in Johore Strait. If left unchecked and without proper contingency schemes, pollution could severely damage important industries such as capture fisheries and aquaculture.

The district of Kota Tinggi is experiencing a boom in tourism. Consequently, inland forests, mangrove areas and beaches may be degraded further if well-devised management plans are not implemented. When the equilibrium of the ecosystem is disturbed, the natural attractiveness of the area deteriorates. Thus, without efforts to conserve the remaining forest cover, the tourism industry will suffer.

Conflicts over resources use are also serious concerns. Capture fisheries and aquaculture interests may be at odds as the clearing of mangroves for fishponds destroys the breeding and nursery habitat of important marine species. Artisanal fishermen and their commercial counterparts are beginning to compete for the same resources as the fish production of South Johore's waters appears to be leveling off. Sand mining must be monitored and regulated. Mining in rivers and off the east and west coasts is occurring with limited regard for its negative impacts on marine life and the physiographic balance of the areas involved.

One of the key reasons for the issues cited above is the lack of a strong and effective legal and institutional framework in regulating and managing coastal area activities. Thus, coastal area management (CAM) has a crucial role to play in providing concrete solutions to these problems.

This profile provides baseline data on all aspects of South Johore's coastal environment as a tool for planners in designing an integrated CAM plan. The profile highlights major coastal resources and activities as well as critical issues that must be addressed before South Johore can benefit from sustainable development. It is hoped that with the successful implementation of an integrated CAM plan, South Johore will serve as a model site for future development efforts in all the coastal areas of Malaysia.

Chapter 2
Physical Environment

The State of Johore is surrounded by three distinct bodies of water. Its eastern coast faces the South China Sea. The Strait of Malacca lies between the state's western coast and the island of Sumatra. To the south, Johore is separated from the island of Singapore by the narrow Johore Strait. To the north, Johore shares borders with the Malaysian states of Pahang, Negeri Sembilan and Malacca. The entire State of Johore comprises a total land area of 18,988 km^2. South Johore, the area of concentration of this profile, covers 6,220 km^2 of land in the districts of Pontian (919 km^2), Johore Bahru (1,818 km^2) and Kota Tinggi (3,483 km^2) (Fig. 2.1). (Note: The offshore islands of the East Johore District of Mersing are also discussed in the chapters dealing with coral reefs and tourism.)

Physiography

The coastline exhibits a variety of geomorphologies as it stretches over some 400 km between latitudes 1° 15' N and 2° 40' N and longitudes 102° 30' E and 104° 18' E.

The east coast stretches along a general line from the north-northwest to the south-southeast and features predominantly sandy beaches broken by small river mouths and rocky headlands. Inland is low undulating hilly terrain with ridges running north-northwest to south-southeast. Further inland is hilly to mountainous terrain characterized by steep slopes and deep, narrow valleys. In some areas, alluvial flood plains of varying widths border the coastline.

The western coastline stretches in a general northwest to southeast direction and consists mostly of mangrove swamps and mudflats, except for isolated areas where narrow sand beaches have formed. Several estuaries break up the monotony of the muddy coastline. Many parts of the coastline have undergone aggradation through rapid sedimentation. A broad coastal plain, which widens to about 30 km at the southwest end, is found inland. The plain is remarkably flat except for a few low hills in the south near Batu Pahat. Part of the plain where mangrove swamps are found is flooded by daily tides. Peat swamps are located inland of the mangrove swamps. Further inland of the plain are gently undulating hills and broad, often alluviated valleys.

The southern coastline has a complex shape. Its western half runs in a southeast to northeast direction, while the eastern half stretches in an east to west direction. Several large estuaries break the southern shoreline of the Johore Strait. They are characteristically fringed by mudflats and mangrove swamps. Some sandy beaches, separated by rocky headlands, are also found. The area inland of the swamps and beaches undulates between hills and valleys.

Central Johore is mostly an area of low relief, having undulating to hilly terrain with low hills and broad valleys. Isolated mountain peaks, such as Gunung Muntahak, Gunung

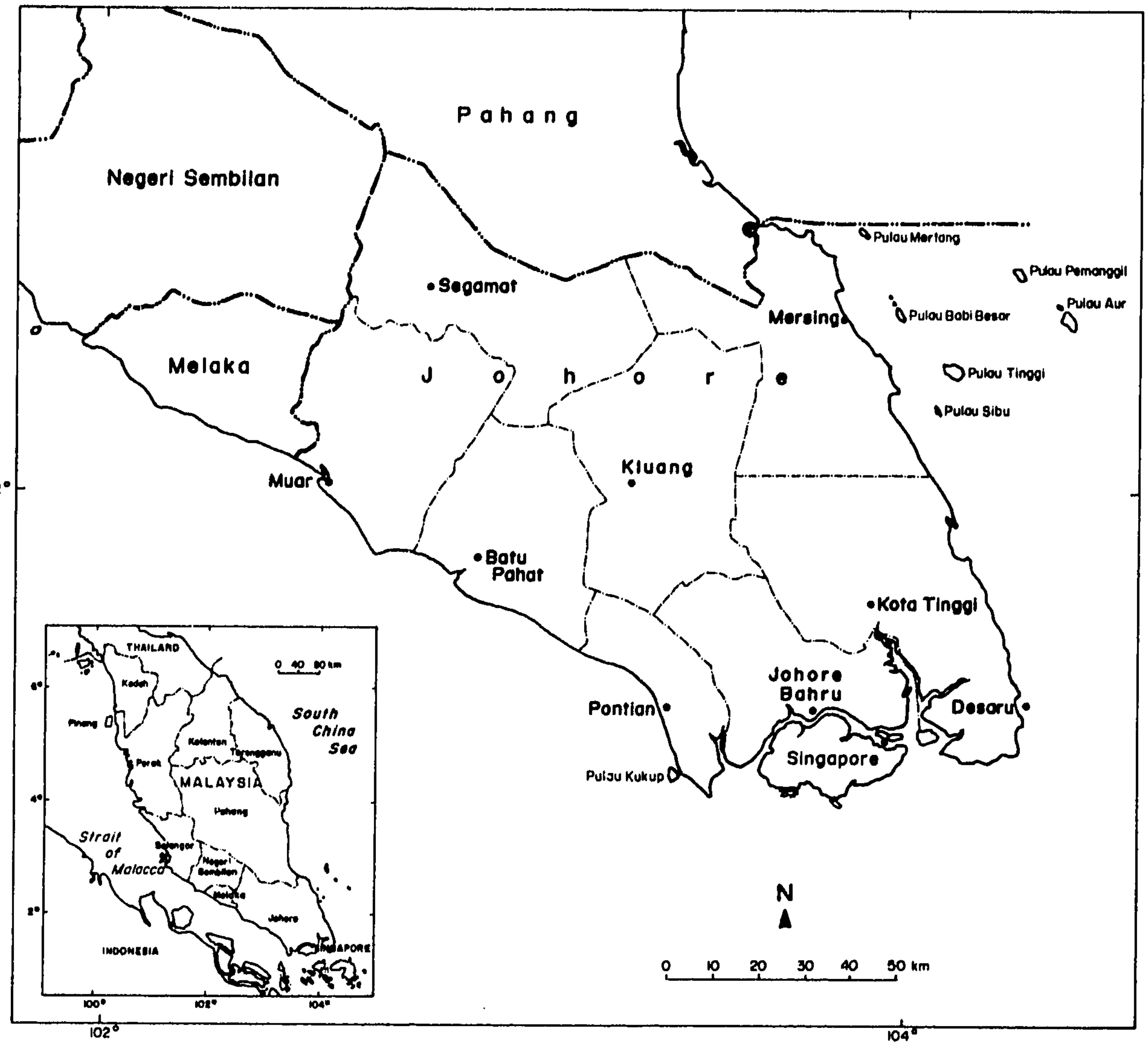

Fig. 2.1. Map of Johore.

Sumalayang and Gunung Belumut rise over the center. On the western side are two mountain peaks, Gunung Ledang in the north and Gunung Pulai in the south.

Climate

Like any other part of the Malaysian Peninsula, the State of Johore is within the equatorial zone and experiences an equatorial climate, which is hot and damp throughout the year. It receives the influence of both the northeast monsoon wind from November to March and the southwest monsoon wind, which is usually wetter, from around March to August.

Temperature

The variation in mean temperature from month to month and among locations in the state is small (Fig. 2.2). Diurnal variation in air temperature is about 5-6 °C. The highest mean

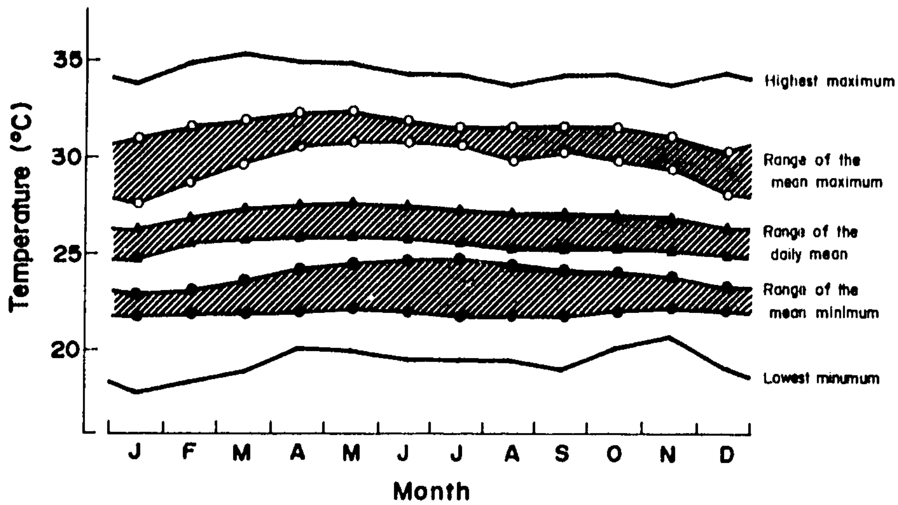

Fig. 2.2. Temperature range for Mersing, Kluang and Singapore (Hunting Technical Services Ltd. 1971).

monthly temperature of 27.4 °C in nearby Singapore occurs in June and the lowest, 24.6 °C, at Kluang in January.

Rainfall

Rainfall is common throughout the year. Annual rainfall averages approximately 2,400 mm in the region. The most frequent type is convectional rain in the afternoon induced by surface heating and enhanced by lack of wind. Heavier and more prolonged orographic and boundary rains often cause flooding around Kota Tinggi and in the western coastal areas. The heaviest rain occurs during the transition periods from mid-March to mid-May and from October to November. The lowest rainfall is recorded during the monsoon peaks from mid-January to mid-March and from June to July. The former is drier compared to the latter. The wettest areas of the state are the northeast and the southwest. The driest areas are in the western portion, primarily in the district of Muar. In South Johore specifically, the heaviest rainfall is registered in northeastern Kota Tinggi and northeastern Pontian. The driest areas are located in the northwest near Ayer Hitam and in central Johore Bahru.

Johore's heavy rains and high temperatures promote prolific plant growth needed for productive agriculture, but they also activate heavy weathering of rock as well as surface and deep soil erosion. They bring about flash floods, which are particularly serious for badly drained areas. Poor drainage can be traced to the natural topography as well as to logging and stream diversion.

Geology

Rocks ranging from Devonian to Quaternary (390-70 million years ago) are found in the State of Johore. Sedimentary, metasedimentary and igneous rocks of pre-Quaternary age underlie approximately 80% of the state while the remaining 20% is covered by unconsolidated to semiconsolidated Quaternary sediments. Pre-Tertiary rocks (over 70 million years ago) are slightly to moderately deformed. In general, older rocks show a greater degree of metamorphism than rocks of a younger age. Faulting has affected all rocks except for Quaternary deposits.

Pre-Quaternary geology

Devonian-Permian (390-230 million years ago). The oldest rocks in Johore are represented by a small body of Devonian metasediments comprising amphibole gneiss and quartz-mica schist. These metasediments underlie some 20 km in northwest Johore and are formed as a result of regional metamorphism and subsequent metasomatic alteration of argillaceous sediments.

There is no record of Carboniferous rocks in the state. In east Johore, metasediments and volcanic rocks of the Middle to Late Permian period are common. The metasediments consisting of tightly folded indurated shale, argillite, slate, phyllite, metasandstone and schist occur in an almost continuous belt along the east coast. West of this belt, volcanic rocks are widespread and are sporadically distributed in the southern portion of Kota Tinggi District. These rocks are acid to intermediate tuffs and ignimbrites and minor lava flows of rhyolitic to andesitic composition.

Triassic-Cretaceous (160 million years ago). The main phase of igneous intrusion took place in Early Triassic time during which granitic rocks were implaced in the greater part of central and east Johore and to a lesser extent in northeast Johore. These rocks are principally medium- to coarse-grained biotite granite with minor phases of granodiorite, fine-grained and hornblende-bearing varieties. In the south, small bodies of gabbro and diorite are found associated with granite.

In west Johore, Middle to Late Triassic sedimentary rocks of marine origin form an extensive belt. These consist of shale, mudstone, siltstone, sandstone and minor limestone lenses. Interbeds of tuff are common within this openly folded sequence.

Sedimentary rocks of Late Jurassic-Early Cretaceous age are found as unconformable outliers in many places in Johore. These rocks are sandstone, shale and mudstone with minor conglomerate and volcanic bands. These sediments are continental in origin and show only slight effects of deformation.

Tertiary (70 million years ago). Small bodies of Tertiary lacustrine sediments consisting of carbonaceous shale and minor coal beds are found in several places. Basalt of Tertiary age is found near Segamat.

The overall structural trend of Johore is north-northwest. The pre-Jurassic sediments and metasediments are folded along this trend, while the major granitic bodies are elongated in a similar direction. Paleozoic sediments have undergone at least two phases of deformation.

West-northwest trending faults are prominent. Other less prominent faults are oriented in the north-northwest to northeast directions. The faults are late Mesozoic to Tertiary in age.

Quaternary geology

Quaternary deposits comprise unconsolidated to semiconsolidated gravel, sand, clay and peat (Fig. 2.3). These occur extensively in the coastal lowlands and form the sediment cover in the broad lower reaches of the main rivers in some lowland valleys.

West Johore. The coastal plain of West Johore is underlain largely with marine clay and silt, and paludal peat deposits of Holocene age. On the seaward side, marine clay and silt are found along almost the entire coast and extend as far as 30 km inland along several river valleys. The marine clay and silt sequence contains shells, fine sand laminae and, toward the upper part, abundant plant remains and wood fragments. These indicate decomposition within shallow marine, intertidal mudflat and mangrove swamp environments.

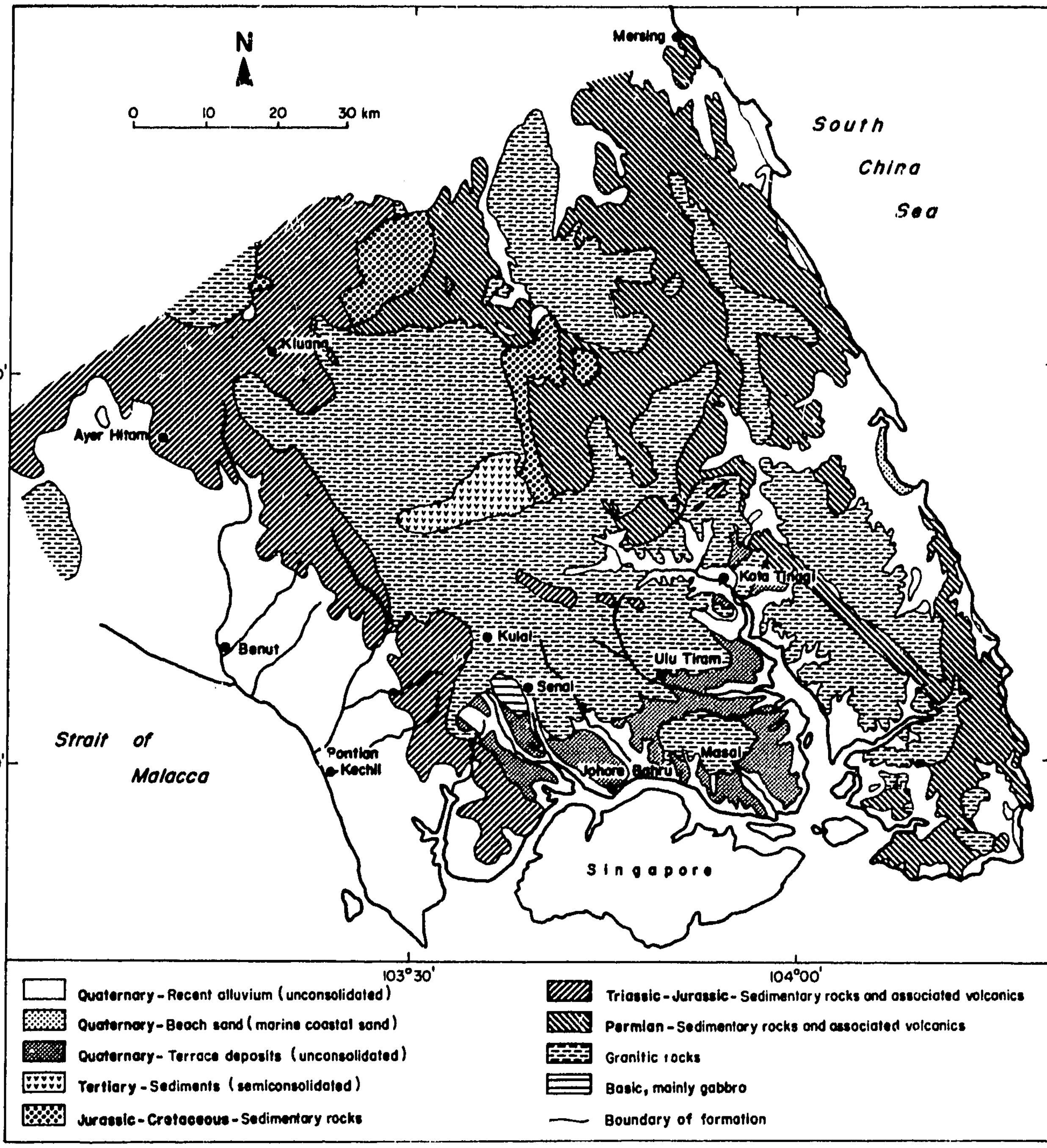

Fig. 2.3. Geological map of South Johore (Geological Survey Department, Malaysia).

On the inland side of the coastal plain, extensive peat deposits occur, up to 6 m in thickness. In most places, the peat is underlain with marine clay and silt. Marine sand ridges found in the southern and eastern margins of the granite body near Batu Pahat are up to 8 km long and 300 m wide and represent former beach ridges of Holocene age. Terrestrial deposits of sand, silt and clay are found in the valleys penetrating inland.

East and South Johore. In contrast to West Johore, exposures of marine clay and silt are very limited along the coastal regions of the east and south. In East Johore, the sandy beach barriers occur as slightly elevated linear bodies that convex inland. Immediately inland of the sand ridges are extensive peat deposits. These are less than 2.5 m thick and contain wood remains loosely disposed in the upper half of the deposits but relatively compact in the lower half. Underlying the peat deposits are marine clay and silt. Terrestrial deposits consisting of clay, silt, sand and gravel are found in the inland valleys.

In the south, Pleistocene terrestrial deposits are widespread while marine clay and silt are restricted to the valleys around the estuary, Johore River and the coastal fringes. The Pleistocene deposits are composed of semiconsolidated coarse feldspathic sand, sandy clay and gravel. Coarse gravel within the deposits is well-rounded but rarely exceeds 30 cm in diameter. The upper part of the deposits is almost always weathered and stained by iron oxides down to 3 m below the ground surface.

Offshore Areas. Limited information regarding the Quaternary sediments in the offshore areas of Johore indicates that the sea-bottom sediments consist mainly of marine clay, silt and sand of Holocene age.

Chapter 3
Natural Resources Endowment

Water Resources

Surface water

The average annual runoff of South Johore varies between 800 mm and 1,600 mm. Rainfall loss, which is the difference between the rainfall and the natural runoff, is attributed to evapotranspiration, an increase in soil moisture and groundwater recharge. The annual loss due to evapotranspiration, considered uniform across the mixed land-use region, has been estimated to be approximately 1,340 mm (JICA 1985).

Johore's rivers are the major sources of freshwater for domestic and industrial use. There is a joint accord between the governments of Malaysia and Singapore for the judicious development of the river system's water sources to meet supply needs for both countries. Currently, the Public Utility Board (PUB) of Singapore operates a water intake in the Johore River upstream of Kota Tinggi with an abstraction rate of about 270 million liters per day (mld). The Public Works Department (PWD) manages other smaller intakes, which withdraw water from the tributaries of Johore River. Elsewhere, PUB withdraws water from Pulai, Tebrau and Skudai Rivers. About 18% (668 mld) is retapped from the PUB system to Johore in the form of treated water.

Groundwater

Groundwater is not an appreciable source of water in urban areas because all water piped by PWD to such areas is abstracted from surface water. In contrast, groundwater is important in meeting domestic water demand in rural areas. As an example, under the Rural Environmental Sanitation Program of the Ministry of Health, wells have been dug to serve about 10,000 rural domestic users.

For industrial use, groundwater accounts for only 1% of the total water supply (JICA 1985). Supplied by medium-scale capacity pumps, groundwater is used mainly for washing, treatment and drinking water for workers in rubber factories and pineapple-processing plants. A few wells supply groundwater for agricultural purposes, but no irrigation system in the region uses groundwater.

The most favorable geologic formations within the area for groundwater exploration are the alluvial flood plains (unconsolidated aquifers) and the Panti sandstone formations (consolidated aquifers). Having noted this, the prospects for exploiting the alluvial plains are limited. In the west, there is a dominance of overlying clay and saline intrusion; in the east, there is only a small quantity of groundwater associated with the sediments.

Future water supply and demand

The Japan International Cooperation Agency (JICA 1985) conducted a study of future water availability and demand in South Johore. The agency's calculations assume an average annual population growth rate of 2.3% and the implementation of all proposed water resources development plans. The projected water demand includes provisions for river maintenance flow. A comparison of the projected river runoff and projected water demand indicates that water deficits are expected to develop by the year 2005. The study's simulations predict deficits of 16 mld and 44 mld at Skudai and Tebrau Rivers, respectively, and an increasing deficit at Johore River of 77 mld in 1995 to 189 mld in 2005. The study team proposed the use of dams and barrages to address the anticipated deficits.

Groundwater is considered to be a useful backup to surface water during periods of prolonged drought. Nonetheless, the former's potential to satisfy a large part of the projected water deficit in the region is unlikely, due to its limited availability.

Soils

The soils of Johore can be classified, according to their parent material, into three broad groups: sedentary, colluvial and alluvial. On the basis of similar characteristics, of which parent material is most important, these soils have been differentiated into several soil series and associations. The distribution pattern of these soil series and associations reveals a close relation with those of different geological lithologies within the state.

Sedentary soils

Found in undulating to hilly areas, sedentary soils are developed from igneous, metamorphic and sedimentary bedrock. Several soil series and associations have been differentiated in these areas, based on the type of underlying bedrock.

Over the coarse-grained acidic igneous rocks (granites), the soils developed are usually sandy to gravelly in texture, weak in structure, low in nutrient levels and nutrient-retaining capacity and are sometimes highly susceptible to erosion. In the areas underlain by fine-grained acidic igneous rocks (rhyolites and tuffs), the soils developed are usually clayey, well-structured and though still low in nutrient levels, have high nutrient-retaining capacity and are less susceptible to erosion.

Sedentary soils developed in areas with sedimentary and metamorphic bedrock differ in texture and structure, occasionally show varying degrees of lateritic formation, generally have low nutrient levels and are susceptible to erosion.

Sedentary soils developed over the semiconsolidated, old alluvial deposits (older alluvium) are usually shallow and sandy to gravelly in texture and hence, highly susceptible to erosion and low in nutrients.

Colluvial soils

Though not extensive, colluvial soils are found at the bottoms of hills where they have accumulated through downslope transport of soil materials by gravity and surface wash. These soils are texturally more coarse-grained than the sedentary soils located upslope, have little horizontal differentiation, weak structural development, and low nutrient levels and retaining capacity.

Alluvial soils

Alluvial soils show a wide range of properties because they have developed over a variety of fine- to coarse-grained sedimentary deposits. Along the eastern and southeastern coasts, these soils are generally sandy, consisting mainly of quartz grains, are excessively drained (except in depressions), and low in nutrient content and retaining capacity. Along the western and southwestern coasts and the flood plains of the large rivers (particularly close to their mouths), the alluvial soils are generally clayey with sticky or plastic consistencies, poorly to very poorly drained and are sometimes inundated by seawater. Such clayey alluvial soils have high nutrient content and retaining capacity, but the nutrient balance in some areas needs correction for agricultural use.

Further inland, along the small rivers, the soils developed on the narrow flood plains have differing textural and structural features depending on the types of sedimentary deposits found in the drainage basin. These soils are poorly to well-drained and their texture varies from clay to sand.

Among the alluvial soils are the organic soils, which range from organic clays to muck and peat, and are extensively present in low-lying inland areas along the west coast. Patches of these soil types are found along the southern and eastern coasts. The organic clay deposits are particularly well developed along the western coastal plain and reach a thickness of over 3 m. The peat soils are generally more than 2 m thick, contain less than 35% mineral matter and are composed of plant tissue in a high state of preservation (Null et al. 1965). Organic soils are often acidic with reaction pH values ranging from 3.2 to 4.9. In their natural state, these soils have formed under water-logged conditions and thus are poorly drained. Although with a high organic content, they have low nutrient levels, except where marine clay occurs close to the ground surface. These soils are highly porous, and great care is needed in draining them for agricultural use to ensure that they do not dry up irreversibly. When properly drained, however, the organic clays and mucks can support many tree crops including rubber and oil palm.

Mineral Resources

Metallic minerals

The Geological Survey Department had prospected several areas of the state and reported the presence of ores of tin, aluminum, iron, gold, copper, lead, molybdenum, titanium and tungsten. Iron and bauxite have been mined in many places. The bauxite deposits are the result of prolonged weathering of several types of bedrock and are particularly well developed in the southeastern coast. Tin ore, primarily related to late Paleozoic granitic rocks, is found in workable form in alluvial deposits in the eastern and western parts of the state.

Nonmetallic minerals

Several nonmetallic minerals are found in the state. Granitic and marble bedrock, used for construction and road building, is taken from several quarries. Clay, used for pottery, is obtained from several deposits derived from prolonged weathering of sedimentary and metamorphic bedrock. Sand deposits, found along the eastern coast in the form of beach ridges and in inland areas in the form of alluvium, have also been widely extracted for use as construction material. A more recent activity is the mining of sand off the southern coast of Kota Tinggi District, along the eastern side of Johore River and at the mouth of Lebam River (Fig. 3.1).

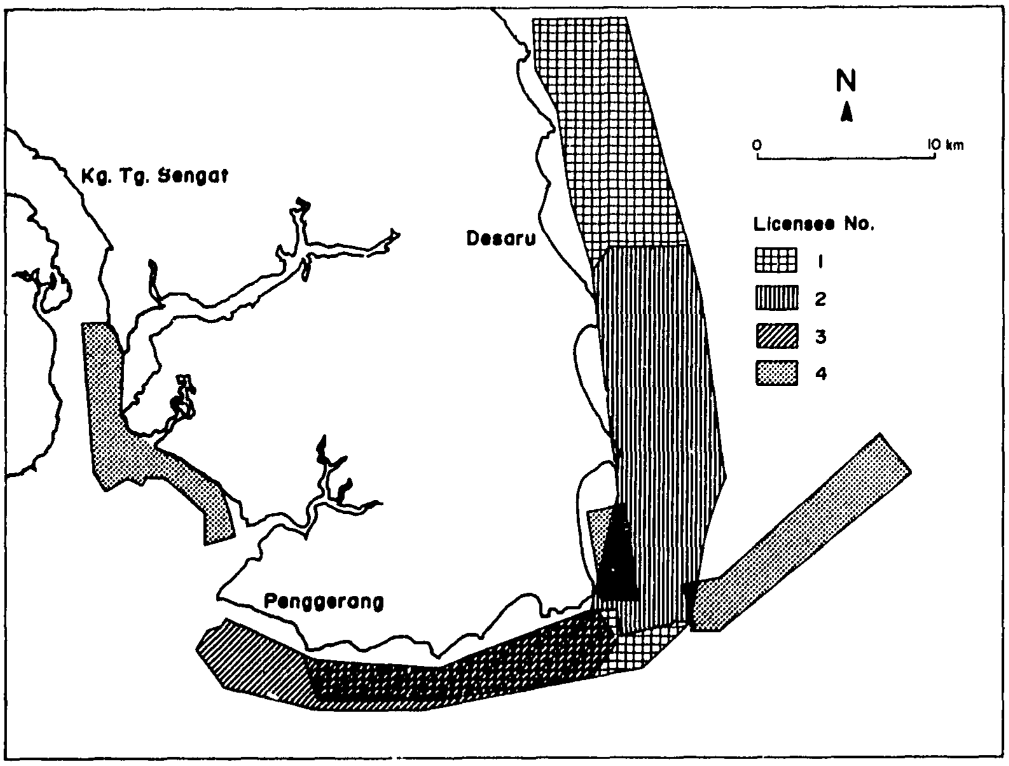

Fig. 3.1. Sand mining in Johore (Department of Drainage and Irrigation, Malaysia).

Inland Forests[a]

Inland forests are divided into three categories: peat, lowland and hill forests. Peat forests contain peat soil and usually occur in low-lying areas. Lowland (or lowland dipterocarp) forests are found at elevations between sea level and 300 m, and the soil is generally clayey or sandy clay. Hill (or hill dipterocarp) forests are located at elevations of 300-600 m. Malaysia's lowland and hill forests are some of the richest ecosystems in the world in terms of biological diversity. In an average area of 1 ha, these forests may contain as many as 4,300 individual plants belonging to 100-200 different species.

Status

Johore has experienced a significant loss of its forest cover. At one time, virtually the entire state was forested, but much has changed. Peat forests, once found extensively in the district of Pontian, have been converted to agriculture for oil palm, pineapple and other food crops. Lowland and some hill forests have likewise been cleared for rubber and oil palm. In 1974, the forests of the coastal area of southeast Johore covered 81,730 ha. By 1986, only 43% of this forest cover remained because large parts had been converted to agricultural use, primarily for the production of oil palm (nearly 25,000 ha) and rubber (5,900 ha). Of the areas formally gazetted as (inland) forest reserves in southern Johore (Fig. 3.2), sizable portions have been cleared (Table 3.1). The Panti Reserve, for example, has lost more than 85% of its area to development or other human-related activities.

[a]Mangrove forests are discussed in Chapter 4.

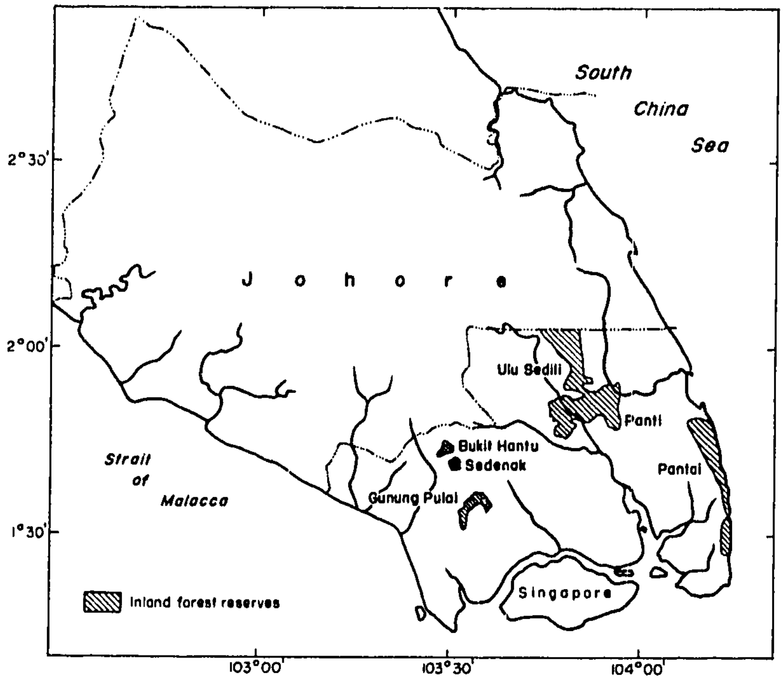

Fig. 3.2. Inland forest reserves of South Johore (Department of Forestry, Malaysia).

Table 3.1. Status of selected inland forest reserves (ha), 1986.

Forest reserve	Total area	Logged area
Bukit Hantu	765	561
Panti	15,836	13,503
Sedenak	587	22
Gunung Pulai	3,884	-
Ulu Sedili	29,998	12,239
Total	51,070	26,325

Source: Department of Forestry, Malaysia.

Such clearing is not always contrary to public policy. Several government agencies, among them the Federal Land Development Authority (FELDA), the Federal Land Consolidation and Rehabilitation Authority (FELCRA) and the Lembaga Kemajuan Johore Tenggara (KEJORA) (or the Southeast Johore Development Authority), are mandated to encourage economic or agricultural development. Consequently, they have leased or alienated much of the forested land under their control for various projects. From the agencies' perspective, it is more profitable to use the land for agriculture-related activities than for the harvest of forest products from regenerated forests. This situation will continue, despite the recent decrease in the forest rotation cycle from 70 to less than 20 years, unless fast-growing species are introduced and considerable advances are made in the utilization of smaller trees.

The need for forest management

The loss of inland forests in South Johore provides cause for concern. Furthermore, present development plans indicate that the deforestation will not abate. At least 17 sawmills and 3 chipboard factories in the area will depend on continued logging. Agricultural development projects proposed by FELDA and KEJORA are to be implemented in portions of the remaining lowland forests. Other projects such as dams will require the clearing and/or submersion of forested lands. Clearing of forests can have deleterious effects on terrestrial and coastal environments. Thus, there is an urgent need to manage South Johore's remaining forests properly.

Fisheries

Johore is the only state in Malaysia that has access to both the Strait of Malacca and the South China Sea. Hence, its coastal resources are relatively richer and more diverse compared to other coastal areas of Malaysia. This advantage serves as a catalyst for economic development.

Finfish

The total catch of marine fish in 1986 was slightly over 45,000 t, about 10% of the total catch for Peninsular Malaysia (DOF 1987). (This percentage is remarkably low considering that the State of Johore occupies about one-fifth of the total coastline of Peninsular Malaysia.) Nearly 36% of the catch by weight was landed in West Johore, while the 64% was landed in East Johore.

Shrimp

Shrimp is one of Johore's most economically important aquatic resources. In 1986, 4,333 t were harvested in the state, 72% of it in West Johore. About 9% of the total shrimp landings of Peninsular Malaysia were from Johore's waters (DOF 1987).

Shrimp is caught predominantly in nearshore waters using trawl nets. Most shrimp species stay in mangrove areas during some stages of their life cycle (Unar 1972; Macnae 1974). Shrimp catches in the southern Strait of Malacca show a linear relationship with the surface areas of adjacent mangrove swamps (Martosubroto and Naamin 1977). Many species, such as banana prawn (*Penaeus merguiensis*), spawn offshore. Peak spawning periods are during the high rainfall months of May-June and October-December (Chong 1979). The newly hatched larvae drift into mangrove-fringed areas where they grow to the juvenile stage and then return offshore as they approach maturity. Exposure to brackishwater, found where rivers flow into mangrove swamps, is obligatory for the larvae of some freshwater prawn that migrate down and up rivers. The species locally called *udang galah* (*Macrobrachium rosenbergii*) is the best known example.

A few shrimp species, such as the green tiger prawn (*Penaeus semisulcatus*) and some species of *Parapenaeopsis*, do not rely on mangrove areas during their life cycle (Macnae 1974). Nevertheless, the status of Johore's mangrove swamps is inseparably linked to the success of the state's shrimp industry.

Shellfish

Though small amounts of green mussels (*Perna viridis*), cockles (*Anadara granosa*) and oysters (*Crassostrea belcheri*, *Saccostrea cucullata* and *Ostrea folium*) are harvested from Johore's waters, shellfish remain relatively unimportant economically. Nevertheless, the culture of shellfish from spat collected from areas of natural spatfall is a potentially profitable activity for coastal residents. Raft culture of green mussels produced 546.3 t in 1987. Cockle beds are found in Tanjong Agas (24.3 ha) and Parit Jawa (13.4 ha) (EPU 1985) and oyster beds in Muar Estuary (16 ha), all in northwestern Johore.

Crabs

The production of the mud crab, (*Scylla serrata*), an important fisheries resource, depends on the extent and state of the mangrove ecosystem. The blue crab, (*Portunus pelagicus*), is a pelagic crustacean mainly caught with stationary-bottom nets.

Wildlife

Species of mammals and birds are usually shared between mangrove and inland forests or mangrove forests and open country. A few species occupy all three habitats, while a few are restricted to mangrove swamps.

Mammals

Two species of monkeys are abundant. The long-tailed macaque (*Macaca fascicularis*), despite its economic significance as an export commodity for scientific research, is a pest near human settlements. In contrast, the silver-leaf monkey (*Presbytis cristata*) has aesthetic and ecological value as a component of the mangrove community but has not been important economically. These two primates form the bulk of mammalian biomass in mangrove forests (Lim and Sasekumar 1979; Aldrich-Blake 1980; Marsh and Wilson 1981).

Colonies of island flying foxes (*Pteropus hypomelanus*) are found on both coasts, but are more abundant on the east coast. There are a few other bat residents (mainly insectivores). Others, mostly fruit bats, visit flowering trees in mangrove forests from their roosts in caves or inland forests. The main species, the cave fruit bat (*Eonycteris spelaea*) and the long-tongued fruit bat (*Macroglossus minimus*), contribute to the healthy functioning of the mangrove forest ecosystem by pollinating various flowering plants. These species have also been linked to durian (*Durio zibethius*) production further inland (Lee 1980).

Locally abundant wild pigs (*Sus scrofa*) forage on the landward side of the mangrove forests. Two species of squirrels (*Callosciurus notatus* and *C. caniceps*), and one each of mongoose (*Herpestes* sp.) and mousedeer (*Tragulus javanicus*) are also observed within mangrove swamps. Two amphibious mammals, the small-clawed otter (*Amblonyx cinerea*) and the smooth-coated otter (*Lutra perspicillata*), are likewise mangrove residents (Macnae 1968).

Birds

Nisbet (1968) has recorded about 120 bird species (20% of the Malaysian total) within Malaysian mangrove habitats. All but 2 species have been noted in Johore, 4 are confined to mangrove areas, while 3 have resident populations there but occur elsewhere on the peninsula as migrants.

Mangroves are particularly important as roosting, nesting and feeding sites for herons, egrets and storks. The rare lesser adjutant storks (*Leptoptilos javanicus*), numbering only 250-300 individuals in the whole of Peninsular Malaysia, are found in the Benut Forest Reserve and Pulau Kukup. The even rarer milky storks (*Mycteria cinerea*), about 115 in Peninsular Malaysia, are in the Benut Forest Reserve.

Mangrove forests and mudflats on the west coast are critically important in the maintenance of populations of migrant waders (stints, sandpipers, plovers, etc.) en route from Siberia and Japan to Australia. Sites on the South Johore coast are used by at least 20 species (Hawkins and Howes 1986; Howes et al. 1986).

All of the waders depend on the high biomass and productivity of marine invertebrates associated with mudflats. Another 50 species of birds are dependent on arboreal and semi-open country. An additional 15 species are shared between mangrove and lowland forest habitats. Mangrove forests act as sources of birds that colonize open-country areas; many urban and suburban birds originate from mangrove habitats. A species of the woodpecker (*Picus vittatus*) and the white-collared kingfisher (*Halcyon chloris*) have recently spread inland from mangrove forests (Wells 1985).

Reptiles and amphibians

There is a small but distinctive reptile community within Johore's mangrove forests. The community is composed of snakes (*Cerberus rynchops, Boiga dendrophila* and *Trimeresurus purpureomaculatus*), sea snakes and lizards (*Mabuya multifasciata* and *Varanus salvator*).

The only frog known to live within the mangrove habitats is the crab-eating frog (*Rana cancrivora*), which has salt-tolerant larvae (Gordon and Tucker 1965).

Invertebrates

Mosquitoes and *kerengga* ants (*Oecophylla amaragdina*) are ubiquitous in mangrove areas (Vanderplank 1960; Macnae 1968). At night, synchronously flashing fireflies (*Pteroptyx malaccae*) can be observed (Bassot and Polunin 1968).

The potential economic importance of honeybees (*Apis dorsata*) is high. They utilize nectar and pollen from flowering mangrove trees. Prolonged flowering cycles within mangrove forests provide a dependable food supply. The bees can move far inland during months when inland forest trees flower heavily. Similar to the case of fruit bats, such mobility demonstrates the importance of interactions between mangrove and inland habitats mediated by an economically important insect.

Several species of tree-nesting termites are major agents in the breakdown of deadwood in mangrove areas. The principal defoliators of mangrove trees are larvae of moths (*Cleora injectaria* and *Ophiusa serva*). Within small areas, these species can even kill trees. Weaver ants help control outbreaks of these pests (Piyakarnchana 1981; Whitten and Damanik 1985).

General descriptions of mangrove invertebrate communities given by Macnae (1968) and Sasekumar (1974) are broadly applicable to Johore's mangrove areas. Crustaceans (crab and shrimp) and gastropod mollusks dominate the community in numbers and biomass. Arboreal gastropods are conspicuous. Listed in decreasing order of their normal height on foliage are the *Littorina* species, i.e., *L. melanostoma, L. scabra, L. carinifera* and *L. undulata.* Other arboreal mollusks encrusting tree trunks include *Cerithidea, Crassostrea, Thais* spp. and *Nerita birmanica.* A few crustaceans, like barnacles of the genera *Balanus* and *Chthamalus*, are also found attached to trees.

Crabs, a group of crustaceans that are most conspicuous, mobile and diverse, form a substantial part of the mangrove forest biomass. One genus alone, *Uca*, has a biomass of up to 10.3 g dry weight/m^2, and a mean productivity of 2.6 g/m^2/year (Macintosh 1977). There are seven species of *Sesarma* found within the mangrove area proper and others confined to nipa zones and landward ditches (Macnae 1968; Sasekumar 1974). At least one species (*S. sediliensis*) appears to be endemic to Johore. In one locality, species diversity of *Sesarma* may be greater than that of *Uca*, but biomasses of the latter are usually higher. These crab species are too small to be of importance commercially; however, the mud crab and the blue crab provide significant fisheries income.

Differences among invertebrate faunas (including economically important shrimp) of Johore's west, south and east coasts can be expected to arise from:

1. landward retreat of peat and freshwater swamp forests;
2. seasonal distribution of rainfall with an average of two peaks per year in the west and one larger peak in the east;
3. differences in sand and mud content of the substrate; and
4. the extent of upstream clearing and industry.

Chapter 4
Coastal Ecosystems

Mangroves

In South Johore, mangroves are found most extensively along the coasts and estuaries in the south and the west. The largest mangrove forests are located in the estuaries of Pulai, Pontian Besar, Pontian Kechil, Lebam and Johore Rivers, and in the forest reserves of Benut, Pendas, Santi and Pulau Kukup (Fig. 4.1). Mangroves thrive in these areas because they are sheltered from heavy winds and waves. Moreover, the nature of the soils (clayey, with high nutrient level and water-retaining capacity) is conducive to mangrove growth.

Mangroves support nearshore fisheries production and stabilize coastal shorelines that would otherwise be prone to erosion (Saenger et al. 1983). Many commercially important fish and crustaceans spend part of their life cycles in mangrove areas. In the early 1980s, an estimated 32% (209,000 t) of the fish landings of Peninsular Malaysia was reported to be associated with mangroves (DOF 1982). Mangroves produce leaf litter and detrital matter that serve as food for many marine animals and extract nutrients from circulating waters, thereby reducing the potential for eutrophication (Snedaker and Brown 1981).

Mangroves do not only have environmental attributes, but a commercial value as well. They provide fuel and building materials, and it is not at all coincidental that scores of charcoal kilns are located adjacent to most of the mangrove forest reserves in South Johore (Fig. 4.1). Mangrove swamps are also cleared for aquaculture and other economic activities. The consequence for South Johore is that it had almost 23,000 ha of gazetted mangrove reserves in 1960; by 1986, however, this area had diminished by over 20% (Table 4.1). Most of the loss was due to agricultural development and shrimp culture, particularly, in the Benut and Pulai Forest Reserves, both of which are in Pontian District.

Beaches

Two main beach types dominate the coastline of South Johore: muddy-estuarine and sandy (Fig. 4.2). The magnitude and frequency of waves and longshore currents are the main environmental factors determining beach type. Low wave action on the west coast, facing the Strait of Malacca, promotes sedimentation and the development of muddy beaches. High wave action and strong longshore currents on the east coast remove most of the easily transported fine-grained mud, leaving clean, sandy beaches.

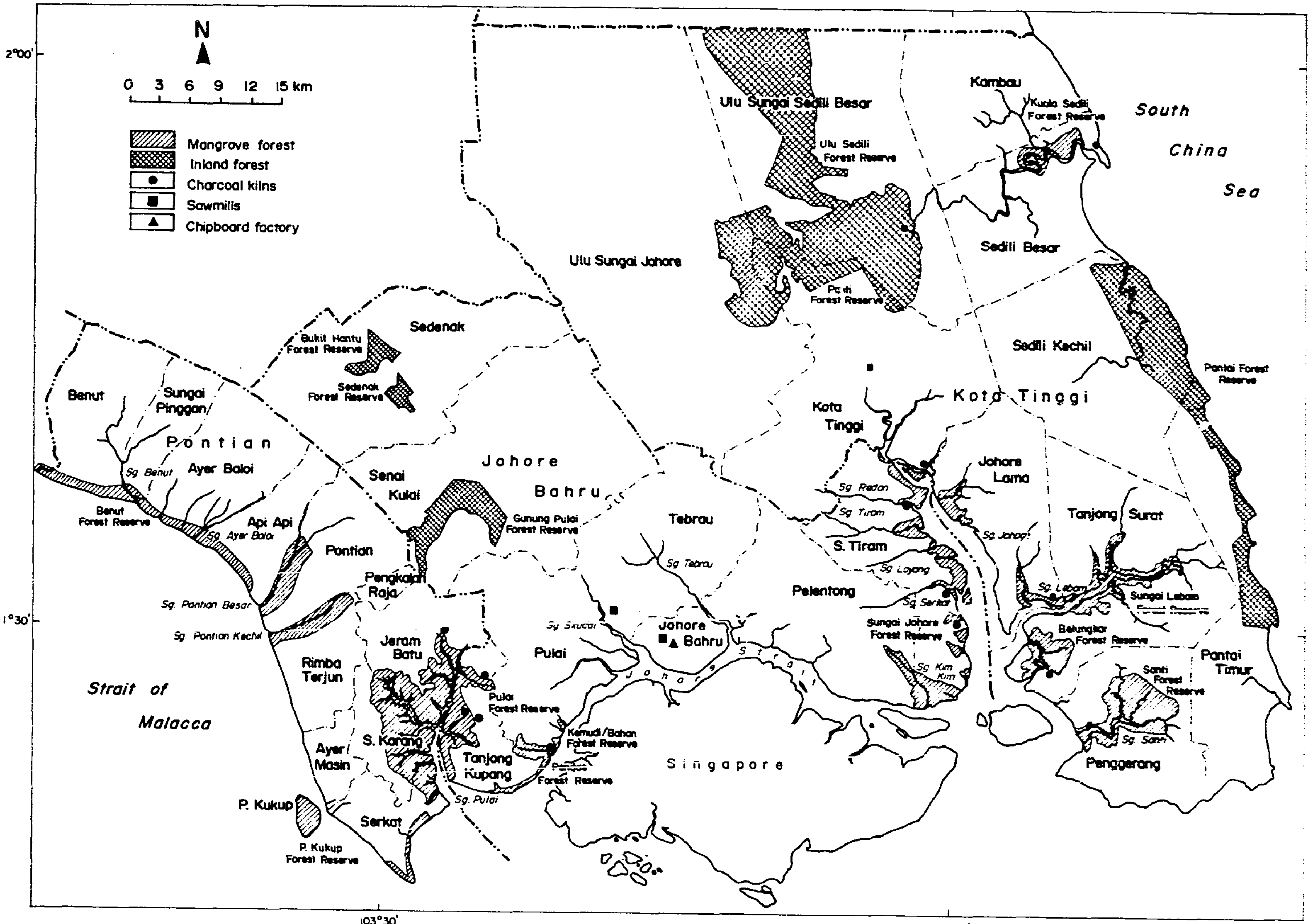

Fig. 4.1. Mangrove and inland forest reserves of South Johore (Department of Forestry, Malaysia).

Table 4.1. Mangrove forest reserves (ha) in South Johore.

Mangrove forest reserve	1960	1986	Loss
Pulai	9,148.6	7,633.2	1,515.4
Pendas	815.6	545.8	269.8
Kukup	650.0	650.0	0
Johore River	3,800.3	3,215.8	584.5
Santi River	2,502.1	2,453.5	48.6
Belungkor	1,261.8	1,261.8	0
Lebam	1,473.0	1,354.0	119.0
Benut	2,661.0	300.0	2,361.0
Kuala Sedili	433.0	433.0	0
Kemudi/Bahan River	155.6	155.6	0
Total	22,901.0	18,002.7	4,898.3

Source: Chan and Parrish (1989).

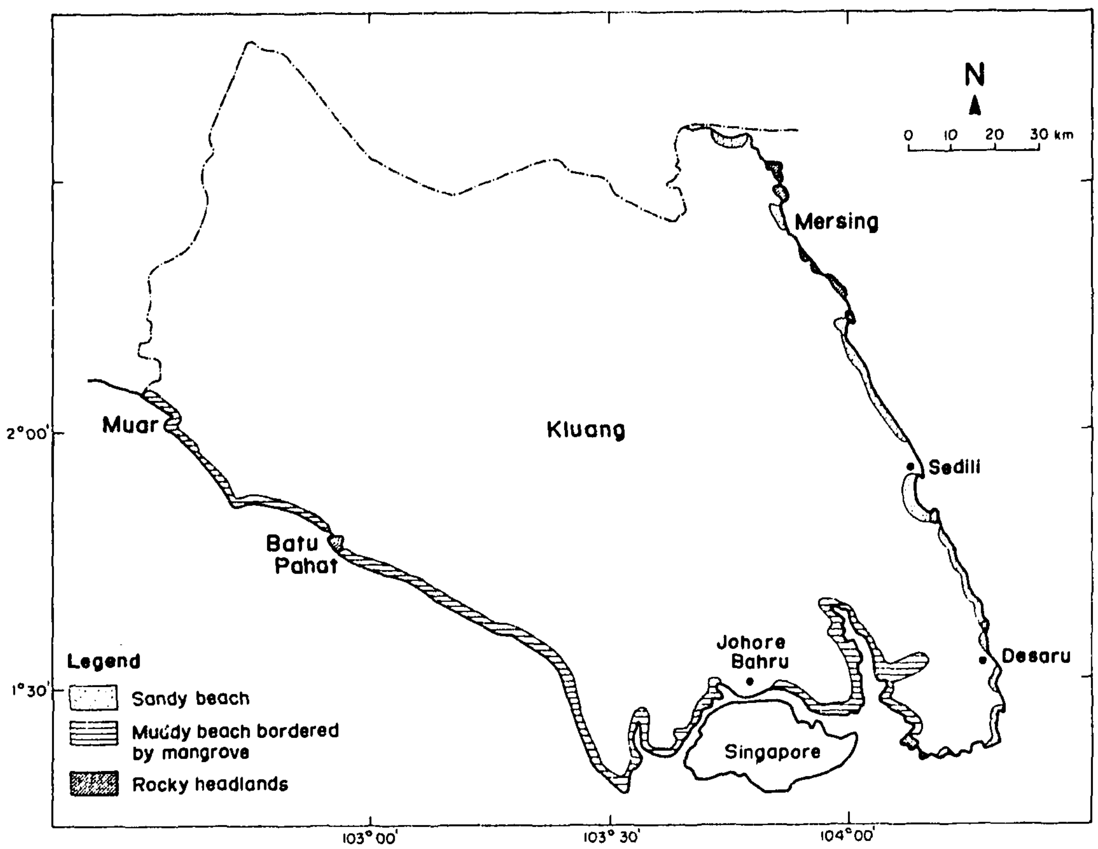

Fig. 4.2. Beach types around Johore coastline.

Muddy beaches that line most of the west coast are broken by isolated patches of sandy beach, estuarine beaches of major rivers and some rocky headlands. Mangroves are often found landward of these beaches.

Sandy beaches that line almost the entire length of the east coast and a small portion of the south coast are broken by a number of headlands. Many of the beaches on the southeast coast are formed along hook-shaped bays. These beaches form between headlands when the regional net longshore transport capacity is from the headland toward the indented part of the hook-shaped bay (Sharifah 1987).

Estuaries

Major estuaries are located at the exit points of the river systems (Fig. 4.3). Mudflats and mangrove forests border all of these estuaries. The natural properties of these estuaries tend toward a state of dynamic equilibrium by adjusting continuously to physical, chemical and biological inputs originating from riverine and marine systems. Thus, the estuaries' shapes, flow patterns, suspended sediment distribution, bottom topography and biological productivity are altered whenever there is a change in inputs from either the marine or riverine systems.

Due to upstream development in catchment areas, riverine input to many of South Johore's estuaries is high in sediment load and pollution. In the Pulai and Johore estuaries, for example, waste from palm oil mills and high sediment loads from sand mining activities can be detrimental to other estuary-based economic activities such as aquaculture and mangrove lumbering. Within estuaries are found mangrove forests that support nearshore fisheries. Thus, the productivity of nearshore fisheries is also linked to the integrity of estuarine ecosystems.

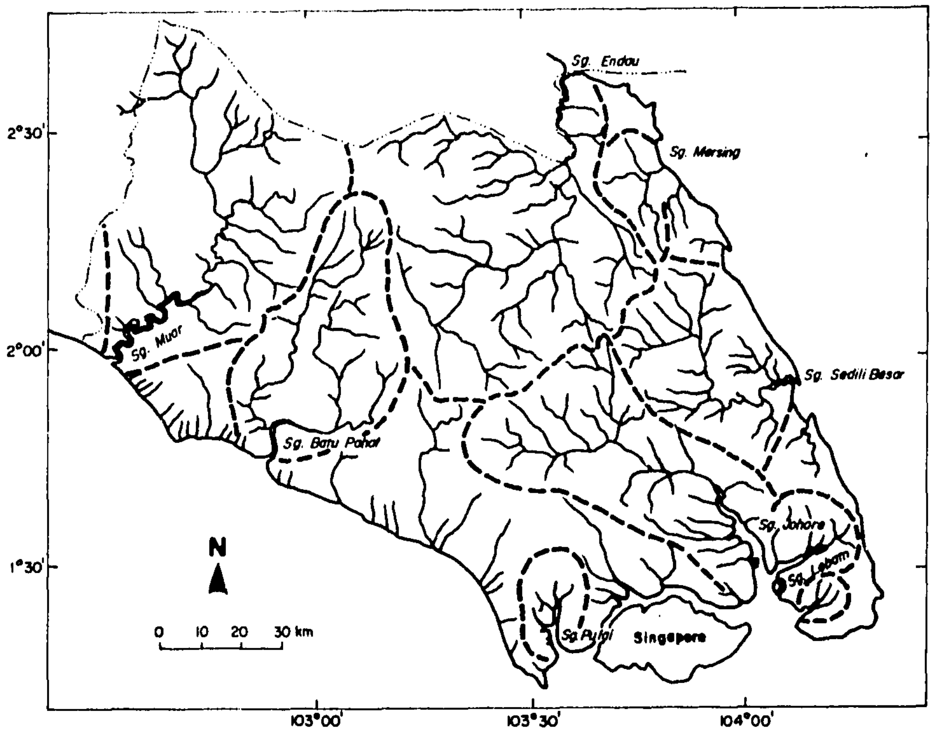

Fig. 4.3. Major river systems and catchment areas of Johore.

Mudflats

Mudflats stretch from the mouth of Tampok River southward to Johore Strait for a distance of 74 km. This curvilinear length of coastline consists of a series of shallow bays. The principal soil type along the mud coast is marine clay. These clay beds have depths exceeding 25 m. The primary littoral material found here is fine-grained sediment formed from decomposing clay. A thin surface layer of shell and sand is often present.

Soft-bottom Communities

Organisms that live in or are occasionally associated with soft substrate are collectively known as "soft-bottom" benthic organisms. They thrive in mudflats, seagrass beds and sandy areas.

In the sandy beaches in the east coast of Johore, 22 species belonging to taxonomic groups Annelida, Arthropoda, Mollusca, Gastropoda and Echinodermata were reported (Leong 1984). This suggests that these areas support rich soft-bottom communities.

In contrast, seagrass beds are considered special types of soft-bottom habitats. They are feeding and nursery grounds for commercially important fish species and a source of organic nutrients necessary for productive nearshore fisheries. The nutrients are recycled by organisms inhabiting these areas.

Since many organisms in these habitats are sessile, they are usually sensitive to pollution. Species diversity and composition of soft-bottom communities have been used as indicators of the onset of unacceptable marine pollutant levels. Simultaneously monitoring pollutant concentrations and soft-bottom community compositions would help in the early detection of marine pollutant levels that would adversely affect the biological productivity of South Johore's coastal waters.

Coral Reefs

Coral reefs are significant from ecological and economic standpoints. Fringing and barrier reefs act as natural breakwaters that protect low-lying coastal areas from erosion. Moreover, coral reefs contribute to terrestrial accretion by providing sand for beaches and low islands. Some food products derived from the reef are edible algae and sea urchins. There is a flourishing international trade in ornamental corals and aquarium fish thriving in coral reefs. Another economic benefit relates to tourism, particularly skin and scuba diving. Coral reefs also serve as a natural laboratory for marine scientists.

The islands off the east and west coasts of Peninsular Malaysia are rich in corals (Searle 1956; Pillai and Scheer 1976; Batterton 1981). In Johore no significant corals have been located off the coasts of Pontian, Johore Bahru or Kota Tinggi Districts, but an impressive array of corals are found in many islands offshore of Mersing (Fig. 4.4). In his investigations in this area, Batterton (1981) described over 200 species of hard corals. Considerably little research has been conducted on soft corals.

In recognition of the importance of protecting coral reefs, Malaysia's 1985 Fisheries Act designated seven of Johore's islands as marine parks, almost one-third of the total gazetted marine parks in Peninsular Malaysia. The goal of designation is "to protect, conserve and manage in perpetuity marine environments of significance and to encourage public understanding, appreciation and enjoyment of Malaysia's natural marine heritage by present and future generations of Malaysians" (Ch'ng 1988).

Perhaps due to the high diversity and attractiveness of Johore's coral reefs, the nearshore islands off Mersing have become increasingly popular as tourist destinations. With tourism comes development, not all of which is appropriately planned, environmentally sound or has prior approval of the public authorities concerned. Evidence to date indicates that tourism has led to the harm of the islands' coral reefs. In addition to loss from souvenir hunters and the sale of corals by local residents, coral reefs are experiencing stress from uncontrolled pollution discharges, sedimentation from development-related activities, destructive fishing practices and carelessly dropped anchors. In short, the need for careful management is obvious if further irreversible damage is to be avoided.

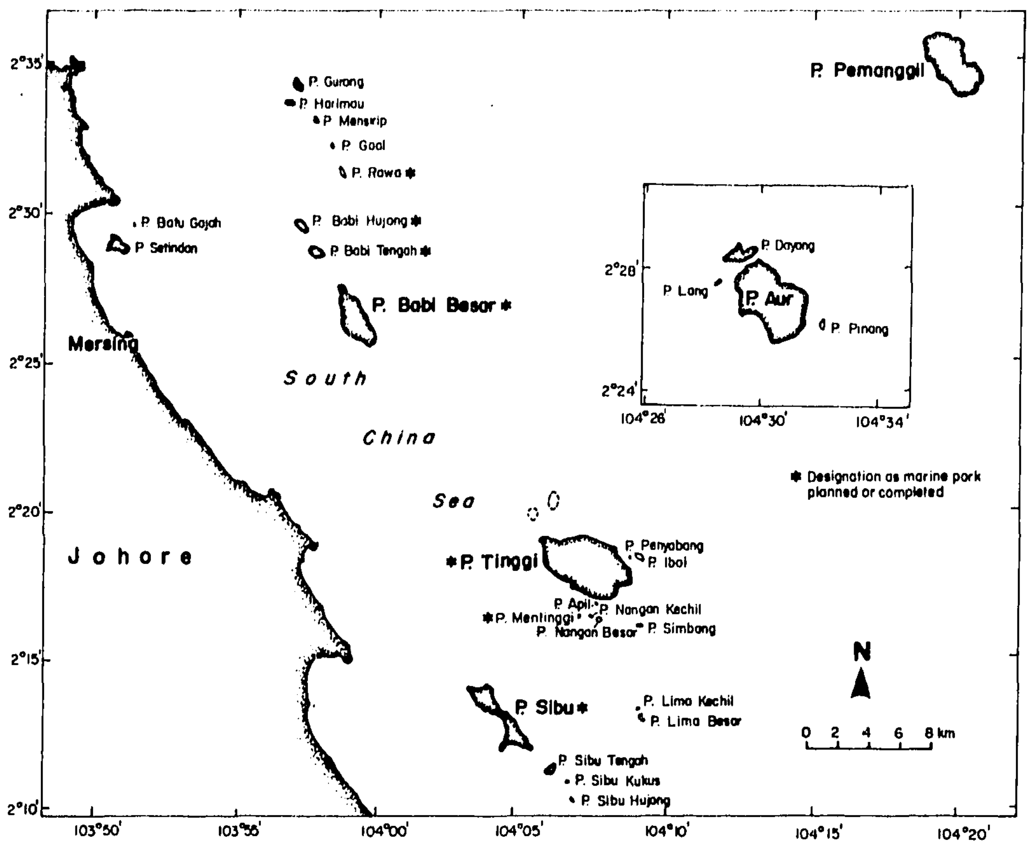

Fig. 4.4. Islands off the coast of Mersing (Department of Fisheries, Malaysia).

Chapter 5
Population and Socioeconomics

The State of Johore had a total population of 1,600,946 in 1980 and a population density of 84/km^2, a little below the national average of 87/km^2. Of the state's residents, about 40% (i.e., 649,168) lived in the three districts that comprise South Johore, with an average population density of 104/km^2. By far, the district with the largest population is Johore Bahru (Table 5.1). Fig. 5.1 shows the spatial distribution of South Johore's largest towns and cities in 1980.

If one considers only the coastal areas within the three districts, the estimated population in 1980 was 443,209. For purposes of calculating this figure, the coastal zone was defined to include all areas of marine influence (i.e., wetlands, estuaries, beaches, mangroves and rivers) anu extends inland from the coast to the point where land uses have no significant impact on the marine environment. With a few exceptions, the landward boundary of the coastal area was set at 5 km inland from the coastline.

Table 5.1. Estimate of coastal population of South Johore, 1980.

District	District	Coastal	Coastal(%)
Johore Bahru	417,434	273,156	65
Pontian	121,643	85,539	70
Kota Tinggi	110,091	84,514	77
Total	649,168	443,209	68

Source: Khoo (1982).

Population Growth

Johore's population increased by approximately 25% between 1970 and 1980 and that of South Johore, by about 44%. As might be expected, however, this growth was not equally distributed among the three districts. Pontian's population size remained relatively unchanged; in fact, most of its *mukim* (the lowest level of formal administrative authority) actually suffered a loss of population during the decade. Of those people who left, most moved to either Johore Bahru or Kota Tinggi. In contrast, Johore Bahru increased by almost 75% from 271,929 to 417,434 while Kota Tinggi nearly doubled in size from 61,551 to 110,091 (Chander 1972; Khoo 1982). Kota Tinggi's rapid growth can be attributed to the state's concerted efforts to develop the district, beginning in the late 1960s and early 1970s.

Such levels of population growth can be expected to continue, at least in Johore Bahru and Kota Tinggi. The national government's policy has been to encourage population growth throughout the country.

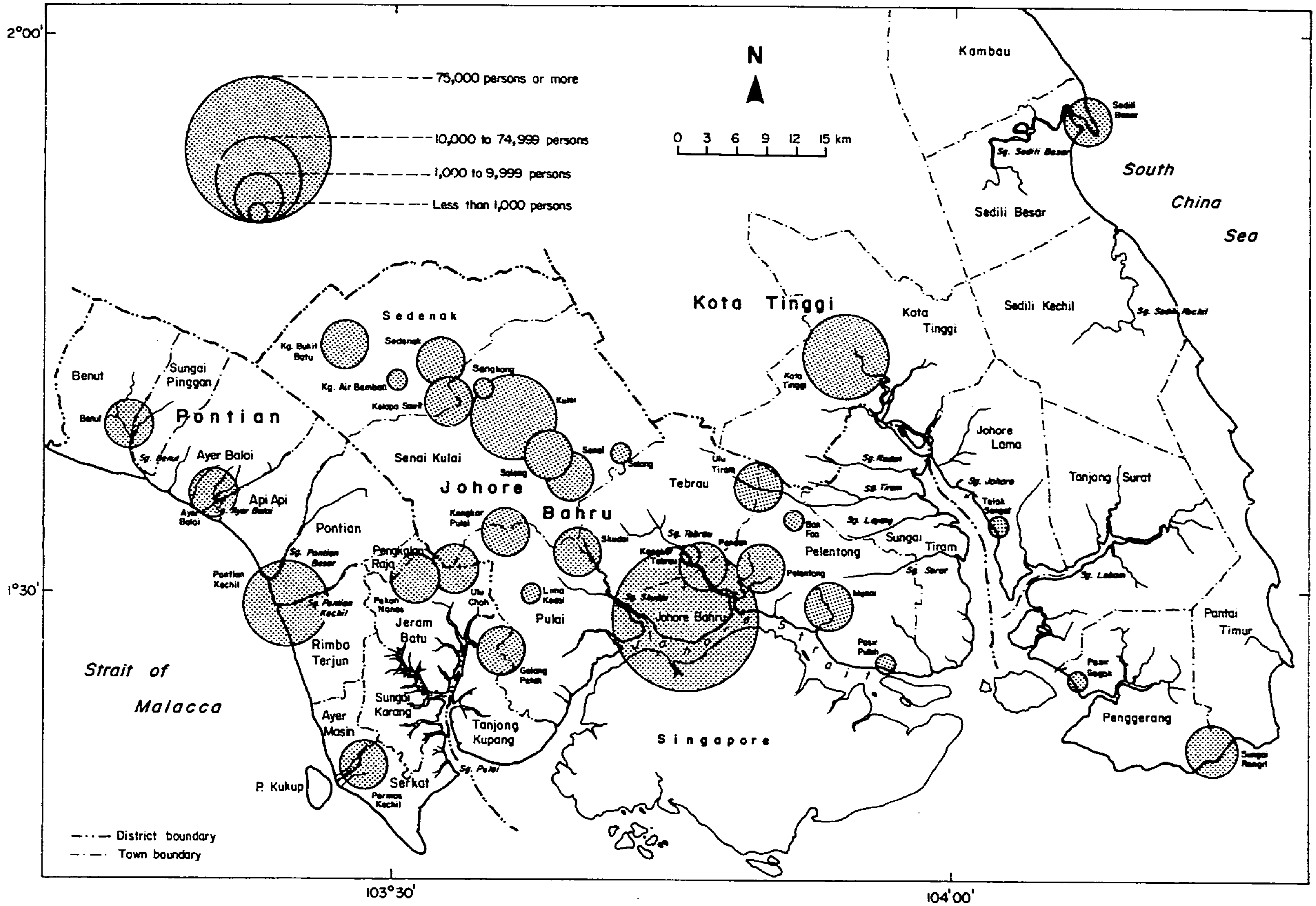

Fig. 5.1. South Johore's largest towns and cities in 1980 (Town and Country Planning Department, Malaysia).

Migration

Analysis of the 1980 census data discloses the nature of population shifts within South Johore. Movement among the three districts accounted for the bulk of net migrations, mostly outmigration for Pontian and inmigration for Kota Tinggi and Johore Bahru (Wong and Chang 1989). The district of Johore Bahru had a slightly higher proportion of interstate net migration compared to Pontian and Kota Tinggi. This confirms that a fair portion of urban migration is among states while the bulk of rural migration is among districts within the state. This is not surprising because the vast majority of land-scheme settlers are from Johore--the bias is stipulated in the land-development agreements between the federal and state governments. A certain percentage of land schemes must be used to resettle the state's residents. Participants in these schemes typically come from rural areas.

Fertility and Mortality

Aside from migration, fertility and mortality are other factors that determine changes in population size. The level of fertility in all three districts was higher than the state average of 30.6 births/thousand population in the mid-1980s (Table 5.2).

Table 5.2. Rates of fertility and mortality in South Johore, 1984.

District	Crude birth rate	Crude death rate	Crude rate of natural increase	Infant mortality rate
Pontian	32.1	6.0	26.1	14.9
Johore Bahru	32.4	4.4	28.0	14.1
Kota Tinggi	36.9	3.6	33.3	13.9

Notes:
Crude birth rate - number of live births in one year per thousand mid-year population.
Crude death rate - number of deaths in one year per thousand mid-year population.
Crude rate of natural increase - crude birth rate - crude death rate.
Infant mortality rate - number of infant deaths in one year per thousand live births in the same year.
Source: DOS (1986).

Low levels of mortality were recorded in Kota Tinggi and Johore Bahru as compared to Pontian. The death rate in Pontian was slightly above the state average of 4.8 due to the higher proportion of elderly persons relative to the other two districts. All three districts had infant mortality rates lower than the state average of 15.5/thousand. The level of infant mortality can be used as an indicator of the social and economic well-being of a population, so the average socioeconomic condition of South Johore's residents may be slightly better than that of people in other areas of the state.

Ethnic Composition

Malaysia's ethnic diversity is well reflected in South Johore. Large numbers of Malays and Malaysians of Chinese and Indian descent are found in the three districts (Table 5.3). As

Table 5.3. Percentage distribution of population by community groups, South Johore, 1970 and 1980.

District	Malay	Chinese	Indian	Others	Total
1970					
Pontian	61.1	37.6	1.3		100.0
Johore Bahru	45.6	42.1	10.8	1.6	100.0
Kota Tinggi	64.8	27.8	6.2	1.2	100.0
1980					
Pontian	62.1	36.8	1.1		100.0
Johore Bahru	50.7	39.7	9.3	0.3	100.0
Kota Tinggi	80.2	15.4	4.3		100.0

Sources: Chander (1972); Khoo (1984a).

might be expected, however, the greatest diversity is found in the most urban of the three districts, Johore Bahru. In contrast to the diversity in the city of Johore Bahru, most rural and coastal areas in South Johore are predominantly Malay, with the exception of a relatively large number of ethnic Chinese fishermen along the west coast of Pontian District.

A significant growth of the Malay population occurred in Johore Bahru and Kota Tinggi between 1970 and 1980. In the latter district, for example, Malays represented 64.8% of the total population in 1970; they comprised over 80% ten years later. Both Johore Bahru and Kota Tinggi Districts also experienced high inmigration, suggesting that the change in ethnic composition can also be attributed to ethnic differences in migration, i.e., the inmigrants to these districts were predominantly Malay.

Other Socioeconomic Variables

Figures on the educational attainment of residents within South Johore's coastal areas are not readily available. To address this deficiency, researchers involved with the ASEAN/US CRMP (Malaysian component) conducted a survey of 12 coastal villages in South Johore in September 1988 (Wong and Chang 1989). A total of 560 households (3,165 residents) were surveyed with regard to several socioeconomic variables. Only coastal villages were included in the survey, so it is inappropriate to generalize for the entire state. Nonetheless, because coastal inhabitants are vital to the success of any CAM plan, their backgrounds are instrumental in understanding their attitudes and potential reactions to calls for improved management of coastal resources.

Among the heads of households surveyed, the level of educational attainment was quite low. Almost 17% of the population had no formal education while 67% had at least some elementary education. Less than 5% had completed secondary school, and only 7 people had attended (or completed) a college or university program.

The housing status of the population did not reflect its residential stability (i.e., about 70% of the respondents had never lived in any other place). Despite this stability, only 31% of the respondents owned their places of residence. Another 20% lived in dwellings that other family members owned, and 17% lived on a Temporary Occupation License. Fourteen percent reported that they were squatters, and the remainder had some other arrangements.

About two-fifths of the respondents reported that they owned land. In all cases, however, the amount of land owned was quite small, with an average of less than one hectare per landowning household.

Employment

Significant portions of the population aged 10 and over were outside the labor force in Pontian and Kota Tinggi Districts in 1980 (53.5% and 50.5%, respectively). In contrast, of the working age population in Johore Bahru, only 45.8% was not part of the labor force. Those outside the labor force included those people not looking for paid employment, namely, housewives, students and pensioners.

Among those employed in Kota Tinggi, about six out of ten depended on primary resources--agriculture, hunting, forestry, or fishing--for their livelihoods, whereas just under half did so in Pontian (Khoo 1984b). In Johore Bahru, reliance on manufacturing and community and social services was significantly more likely; only about a fifth of the district's population was engaged in primary occupations.

These percentages no doubt changed between 1980 and 1990, and will change further as South Johore continues to industrialize. Anticipating this growth, the State of Johore has projected its employment needs to the year 2005. Overall employment in the three districts is expected to rise dramatically to more than 700,000 (compared to only 229,266 in 1980). Most of the anticipated increase will occur in the secondary and tertiary sectors while employment in the primary sector is expected to provide livelihoods for only a quarter of the workforce in 2005, compared to one-third in 1980. Spatially, most of the increase in jobs is expected to occur in the district of Johore Bahru (Wong and Chang 1989).

Chapter 6
Land Use

Most major land use changes in South Johore since the 1960s can be attributed to the activities of such land development agencies as KEJORA, FELDA, FELCRA and Johore's State Economic Development Corporation (SEDC). These agencies are mainly responsible for developing forest lands into agricultural, residential, urban and commercial areas. To a lesser extent, the private sector has also contributed to some land use changes such as the conversion of rubber plantations to oil palm fields. Most of the cleared land is still used for agriculture, but there have been large increases in urban and commercial areas since 1966.

Land Use Trends

Johore State

There was a steady expansion in the area of developed land from 613,479 ha in 1966 to 936,934 ha in 1981. Cultivated areas rose from 32% to 49% of the total land area over the 15-year period. This represents an annual increase of 3.15%. The rate of increase in land used for nonagricultural purposes (urban and estate building and associated areas, mining and quarrying areas, and powerlines) was even higher (at 5.40% per year) than that for cultivated land. As a result of this conversion to developed land, there was a corresponding reduction in Johore's undeveloped land. Over the 15-year period, the areas under forest and scrubland dropped from 50% to 34.8% of the total land area. Swampy and other idle lands decreased from 15.5% to 11%. The area classified as newly cleared land, most of which went to cultivation, averaged about 3%.

Over the period of 1966-1984, there were huge increases in land area cultivated for oil palm, coffee and cocoa (Table 6.1). Land used for pineapple cultivation dropped in the early 1980s. The area used to grow coconuts has likewise decreased since 1983. Due to price and marketing problems, growers abandoned these crops for others that produce higher economic returns.

South Johore

From 1966 to 1986, the general trends of land use in the three districts of South Johore paralleled those of the entire state. Areas classified as urban and agricultural increased, while undeveloped land area decreased (Table 6.2). As in the rest of the state, oil palm production

Table 6.1. Agricultural use of land (ha) in Johore State, 1966-1984.

Crop	1966	1974	1981	1982	1983	1984
Rubber	471,473	463,970	449,784	414,060	398,356	405,850
Oil palm	41,076	154,270	326,865	325,936	368,560	393,536
Coconut	52,123	61,221	63,829	68,447	55,388	54,318
Coffee	855	1,992	5,086	6,546	7,761	8,276
Cocoa	6	760	7,761	15,478	15,281	15,962
Pineapple	14,656	19,907	20,089	12,485	12,105	11,019
Total	580,189	702,120	873,414	842,952	857,451	888,961

Source: MOA (1985).

Table 6.2. Land use (percentage of total hectares) in the three districts of South Johore.

Land use	Johore Bahru		Kota Tinggi		Pontian	
	1966	1986	1966	1986	1966	1986
Urban areas	.02	5.68	.00	0.29	.00	0.40
Agricultural areas	55.92	74.97	8.98	38.48	64.67	72.95
Grassland, forest and recently cleared land	29.34	12.59	75.47	44.98	9.95	13.03
Swamps	10.23	6.63	12.94	8.68	21.45	13.46
Others	4.49	0.13	2.61	7.57	3.93	0.16
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total area in ha	178,507.2	170,326.3	349,172.1	343,879.9	94,913.5	94,742.4

Sources: MOA (1985; 1987).
Note: Theoretically, the land areas for each district should remain constant between 1966 and 1986. In fact, however, errors in measurement as well as different measuring techniques no doubt explain part of the difference. Likewise, additional land can be "created" through reclamation or the accretion of mangrove forests or lost because of coastal erosion.

was the major reason. Less than 3,400 ha was used for oil palm in 1966; 20 years later, it rose to more than 91,000 ha. As an illustration, land devoted to agriculture in Kota Tinggi increased more than fourfold between 1966 and 1986. This can be attributed to one of KEJORA's development schemes, which began there in 1970.

Kota Tinggi also experienced growth in its urban areas but not as much of that of Johore Bahru District. The significant increases of Kota Tinggi and Johore Bahru were due mainly to rapid population growth between 1974 and 1981. Growth was still occurring in 1986, but the rate had decreased somewhat from earlier years.

The expansion in agricultural and urban land use was at the expense of forest, grass and swamplands. From 1966 to 1986, there was continuous reduction in these undeveloped lands in all three districts, most notably Johore Bahru and Kota Tinggi as would be expected because of the growth in agriculture.

Land Use in the Mid-1980s

Agriculture dominated Johore Bahru's land use in 1986. Rubber was the single most important crop, occupying almost 43% of the total land area and 57% of the area devoted to agriculture. The acreage of rubber remained under estates, individual smallholders and FELCRA subsectors. The second most important crop, occupying almost 30% of the district's total area, was oil palm. Since the mid-1960s, there has been a sharp increase in the acreage of this crop, partly at the expense of rubber. Other crops, such as cocoa, mixed horticulture, coconut and pepper, took up a much smaller portion (3.1%) of the total area.

Johore Bahru's urban areas occupied 5.7% of the land, almost seven times larger than the comparable areas of South Johore's other two districts.

Almost 54% of Kota Tinggi's total land area was classified as forest, swamp or scrub in 1986. Agriculture used most of the remaining land. Oil palm, the predominant crop, covered 27% of the total area, the bulk of which comprised estates established by KEJORA and FELDA. Rubber followed with 10%, primarily on the land of smallholders. Less than 0.5% of Kota Tinggi was devoted to other crops.

In Pontian, agriculture was the most important land use, covering 73% of the district's total land area in 1986. Some 42% was devoted to rubber, which smallholders typically farmed. Coconut, the second most important crop, used about 12% of the total area. Although technically not an industrial crop, coconut was grown by smallholders for home consumption and as a shade crop. The land used for pineapples was equally divided between estates and smallholders. Price controls imposed by the Malaysian Pineapple Industry Board caused many smallholders to change to other crops such as rubber and oil palm. Other crops took up less than 3% of the total land. Finally, undeveloped lands covered more than one-quarter of Pontian.

Chapter 7
Fisheries and Aquaculture

Capture Fisheries

The capture fisheries sector in Johore accounts for about 3% of the state's gross domestic product (GDP). The sector provides livelihood to nearly 10,000 full-time fishermen or about 1.5% of the labor force (working-age population). Based on 1986 statistics, the sector produced about 47,530 t of marine fish, about 10.3% of the total marine catch of Peninsular Malaysia (Fig. 7.1). In 1986, Johore had 20.3% of the total fishing boats, 20.3% of the total fishing gear and 16.2% of the total fishermen in Peninsular Malaysia.

As is the case in other parts of the country, the fisheries sector in Johore is dualistic in nature; a small-scale or artisanal sector operates side-by-side a large-scale commercialized sector. Based on licensed fishing gear statistics, Johore's fisheries are still predominantly artisanal. Trawl and purse seine fisheries are not as well developed in Johore as they are in other states such as Selangor, Perak and Penang on the west coast of Peninsular Malaysia. Johore's trawlers are concentrated mainly in the three districts of Mersing, Pontian and Kota Tinggi. Nearly two-thirds of all the state's purse seiners are found in Mersing and Kota Tinggi.

Among the artisanal or traditional fishing gear, drift/gill nets are the most significant, accounting for about 70% of the total licensed fishing gear in Johore in 1986.

The fishing industry supports a number of ancilliary activities such as boat repair, fish marketing and distribution, ice factories and refrigeration. There were about nine ice plants in Johore at the end of 1986 with a total production capacity of 514 t/day (DOF 1987).

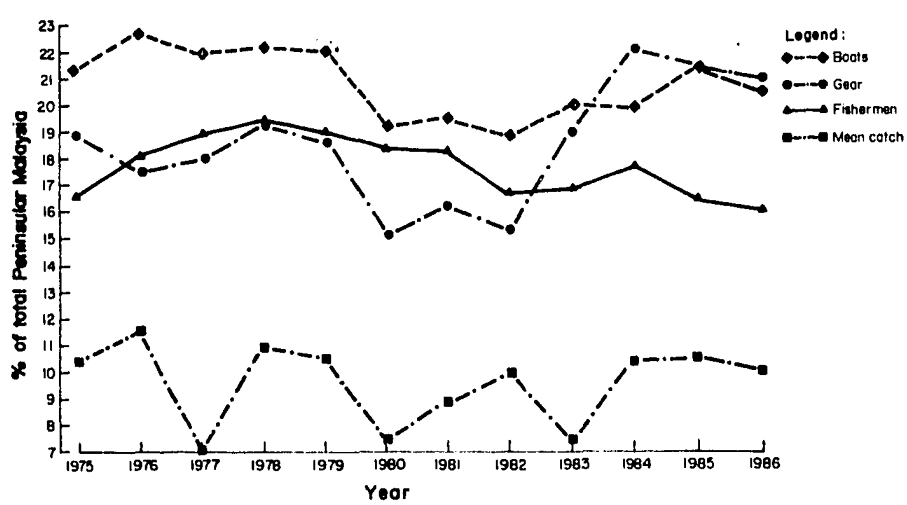

Fig. 7.1. Fisheries data for Johore, 1975-1986 (DOF 1976-1987).

Fishing effort

The number of licensed fishing boats in Johore increased considerably from 1975 to 1980 but declined thereafter (Fig. 7.2). To a large extent, this was a result of the national government's Fisheries Comprehensive Licensing Policy to reduce fishing effort through a License Limitation Scheme in the early 1980s (Sulaiman and Ch'ng 1987). Because of overcongestion problems and conflicts between artisanal and commercial fishermen in nearshore waters, licenses are now issued only to large trawlers capable of operating in the offshore waters (beyond 48 km). High operating costs and dwindling catches may have also caused boat owners to withdraw from the industry voluntarily.

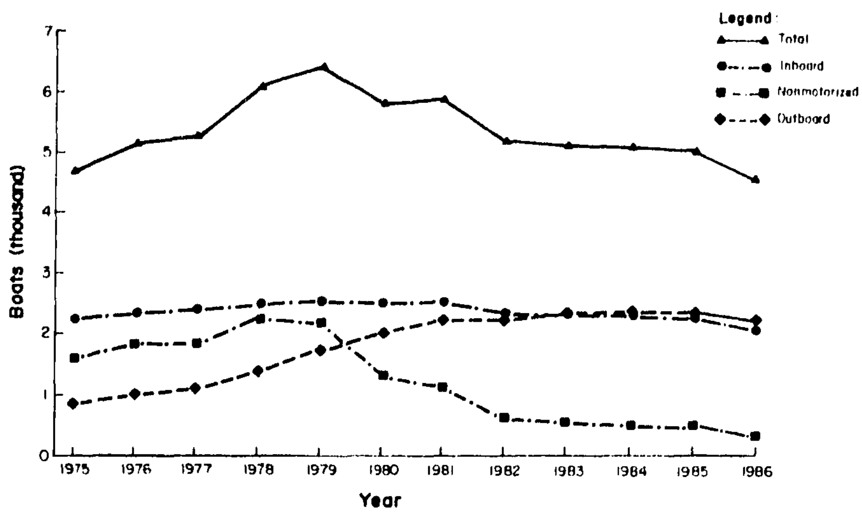

Fig. 7.2. Number of licensed fishing boats in Johore, 1975-1986 (DOF 1976-1987).

From 1975 to 1985, there was a steady decline in the number of nonpowered boats and a surge in the number of outboard-powered ones in Johore (Fig. 7.2). Two-thirds of the inboard-powered fleet weighed less than 10 gt. Only 8% were 40 gt or more, suggesting that offshore fisheries using large vessels are not well developed. Indeed, no such boats operated from Johore's west coast.

The number of licensed fishing gear in Johore more than doubled between 1975 and 1986, reaching a peak of 6,119 in 1985 before dropping precipitously the following year (Fig. 7.3). This trend was due to increases in traditional gear, at least until 1986. Numbers of highly commercialized gear stagnated over much of the period as a result of the decline in the number of commercial fishing vessels.

The population of fishermen is derived from the number of working boats, so the trend of total fishermen for the state closely resembles that of the fishing boats (Fig. 7.4). Malays accounted for nearly 60% of the total population of fishermen while Malaysians of Chinese descent comprised about 38%; the remaining 2% are ethnic Indians, etc. The racial composition of Johore's fishermen did not change much from 1975 to 1986.

Catch trends

The total fish landings in Johore reveal wide fluctuations in the catch levels in the early years of the period 1975-1986, but a decreasing trend after 1978 (Fig. 7.5). Landings of trawlers were generally only slightly greater than those from traditional gear and have also declined

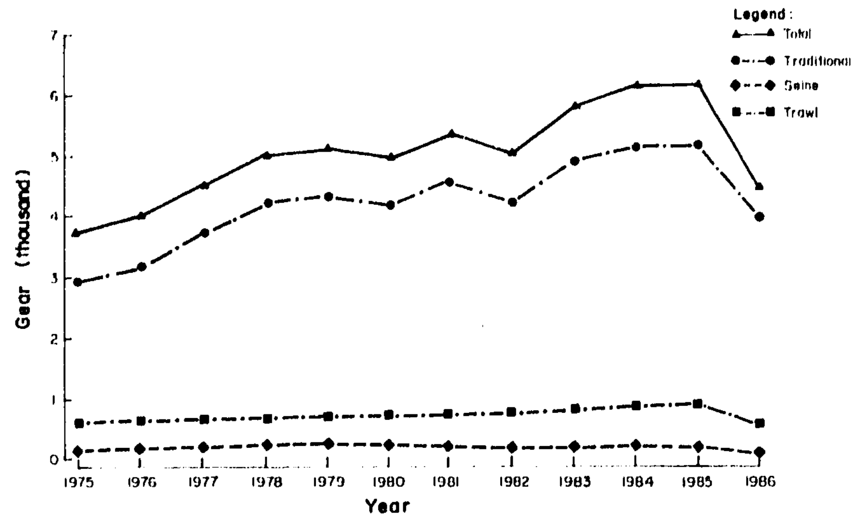

Fig. 7.3. Number of licensed fishing gear in Johore, 1975-1986 (DOF 1976-1987).

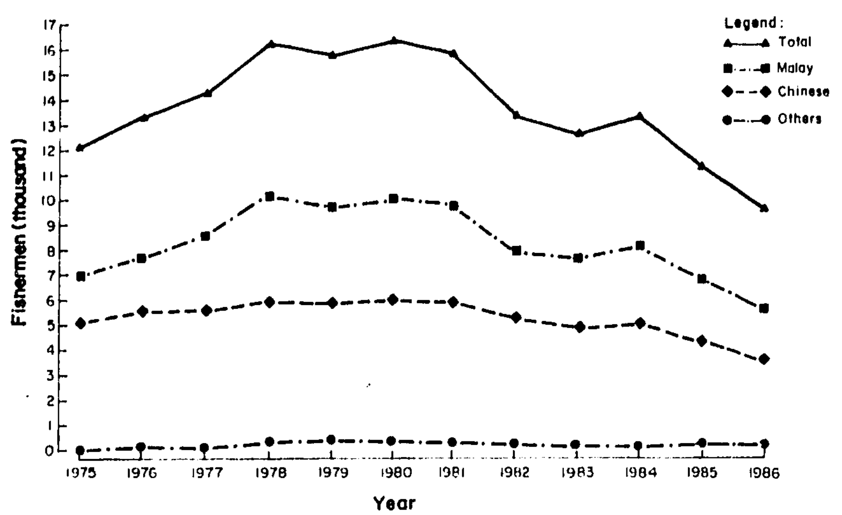

Fig. 7.4. Ethnic composition of fishermen in Johore, 1975-1986 (DOF 1976-1987).

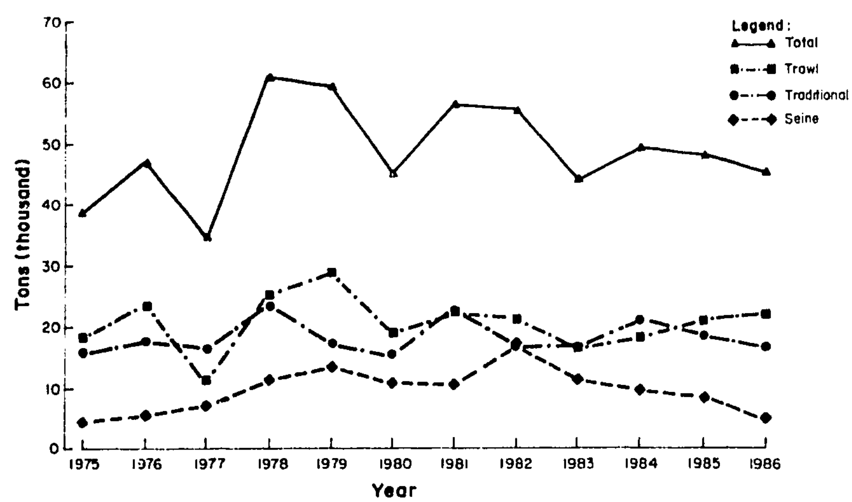

Fig. 7.5. Fish landings by type of gear in Johore, 1975-1986 (DOF 1976-1987).

since 1979. Landings from purse seiners increased until 1982, but they too dropped in subsequent years. Landings of demersal species were generally greater than those of pelagic species.

Aquaculture

In 1986, Malaysia's aquaculture industry produced 51,600 t of fish, amounting to 11.5% of the total fish landings of Peninsular Malaysia (DOF 1987). The production of large quantities of food from aquaculture has been identified by the Department of Fisheries (DOF) as a way of coping with the predicted increase in fish demand and the decrease in catch from capture fisheries. Agencies that have studied the potential of aquaculture in Johore include the Malaysian Ministry of Agriculture (MOA 1980), the Asian Development Bank (ADB 1985) and the Universiti Pertanian Malaysia (UPM 1985). The industry has been growing rapidly, especially in the areas of shrimp culture and marine cage culture. Table 7.1 lists the major types of aquaculture being practised and the species cultured.

Table 7.1. Main species of shrimp and fish, and types of aquaculture practices in Malaysia.

Aquaculture practice	Shrimp and finfish commonly cultured		
	Local name	English name	Scientific name
Marine aquaculture			
Pond culture	*Udang harimau*	Tiger prawn	*Penaeus monodon*
	Udang putih	Banana prawn	*P. merguiensis*
	Ikan siakap	Giant sea perch	*Lates calcarifer*
Cage culture	*Ikan kerapu*	Grouper	*Epinephelus* spp.
	Ikan siakap	Giant sea perch	*L. calcarifer*
	Ikan jenahak	Golden striped snapper	*Lutjanus johnii*
Raft culture	*Kupang/siput*	Mussel	*Perna viridis*
	Sudu		
	Tiram	Oyster	*Crassostrea* spp.
Cockle culture	*Kerang*	Cockle	*Anadara granosa*
Hatchery	*Udang harimau*	Tiger prawn	*P. monodon*
	Udang putih	Banana prawn	*P. merguiensis*
	Ikan siakap	Giant sea perch	*L. calcarifer*
Freshwater aquaculture			
Pond culture	*Lampan kawa*	Javanese carp	*Puntius gonionotus*
	Kap rumput	Grass carp	*Ctenopharyngodon idella*
	Kap kepala besar	Bighead carp	*Aristichthys nobilis*
	Lee koh	Common carp	*Cyprinus carpio*
	Sepat siam	Snakeskin gourami	*Trichogaster pectoralis*
	Jelawat	Sultan fish	*Leptobarbus hoeveni*
	Keli	Catfish	*Clarias* spp.
	Tilapia biasa	Tilapia	*Oreochromis mossambicus* (*Tilapia mossambica*)
	Tilapia merah	Red tilapia	*Oreochromis* spp. (*Tilapia* spp.)
	Udang galah	Giant freshwater prawn	*Macrobrachium rosenbergii*
	Ketutu	Marble goby	*Oxyeleotris marmoratus*
	Patin	Giant catfish	*Pangasius pangasius*
Cage culture	*Lampan jawa*	Javanese carp	*P. gonionotus*
	Kap rumput	Grass carp	*C. idella*
	Kap kepala besar	Bighead carp	*A. nobilis*
	Jelawat	Sultan fish	*Leptobarbus hoeveni*
	Tilapia	Tilapia	*Oreochromis* spp. (*Tilapia* spp.)
Hatchery	*Sepat siam*	Snakeskin gourami	*Trichogaster pectoralis*
	Lampam jawa	Javanese carp	*P. gonionotus*
	Tilapia	Tilapia	*Oreochromis* spp. (*Tilapia* spp.)
	Udang galah	Giant freshwater prawn	*M. rosenbergii*

Pond culture

The use of freshwater ponds once dominated the age-old practice of pond culture, until the 1980s when brackish ponds gained the lead in production.

The normal practice in freshwater ponds is either monoculture of grass carp (*Ctenopharyngodon idella*) or polyculture of Javanese carp (*Puntius gonionotus*), common carp (*Cyprinus carpio*), sultan fish (*Leptobarbus hoeveni*), snakeskin gourami (*Trichogaster pectoralis*) and giant freshwater prawn. In Johore, the average pond size is less than 0.2 ha. The largest farm, operated by DOF, has an area of about 20 ha. The total production in 1986 from all the freshwater ponds in Johore amounted to slightly over 200 t.

Monoculture of either tiger prawn (*Penaeus monodon*) or banana prawn (*P. merguiensis*) is practised in the majority of brackishwater pond farms. A small percentage of brackishwater ponds, located predominantly on the east coast, culture giant sea perch (*Lates calcarifer*). Brackishwater ponds are situated largely in mangrove habitats. Such areas provide shelter from storms and erosion, shade and a suitable clay substrate for excavation and water retention. Furthermore, with such ponds, the movement of water requires minimal effort (Chan 1984).

In 1987, ponds occupied about 600 ha of mangrove areas in Johore (Fig.7.6), far more than in any other state in Peninsular Malaysia. Indeed, Johore had more than half the total of brackishwater ponds and more than 80% of Peninsular Malaysia's total area of such ponds in 1986. Brackishwater pond production in Johore in 1986 totaled 245.3 t (DOF 1986), and this represented more than 80% of Peninsular Malaysia's total production from brackishwater ponds. Production per hectare per crop varies from 1.0-4.0 t for tiger shrimp, to 0.5-2.0 t for banana shrimp and 0.5-3.0 t for seabass. Culture period varies from two to five months depending on the species.

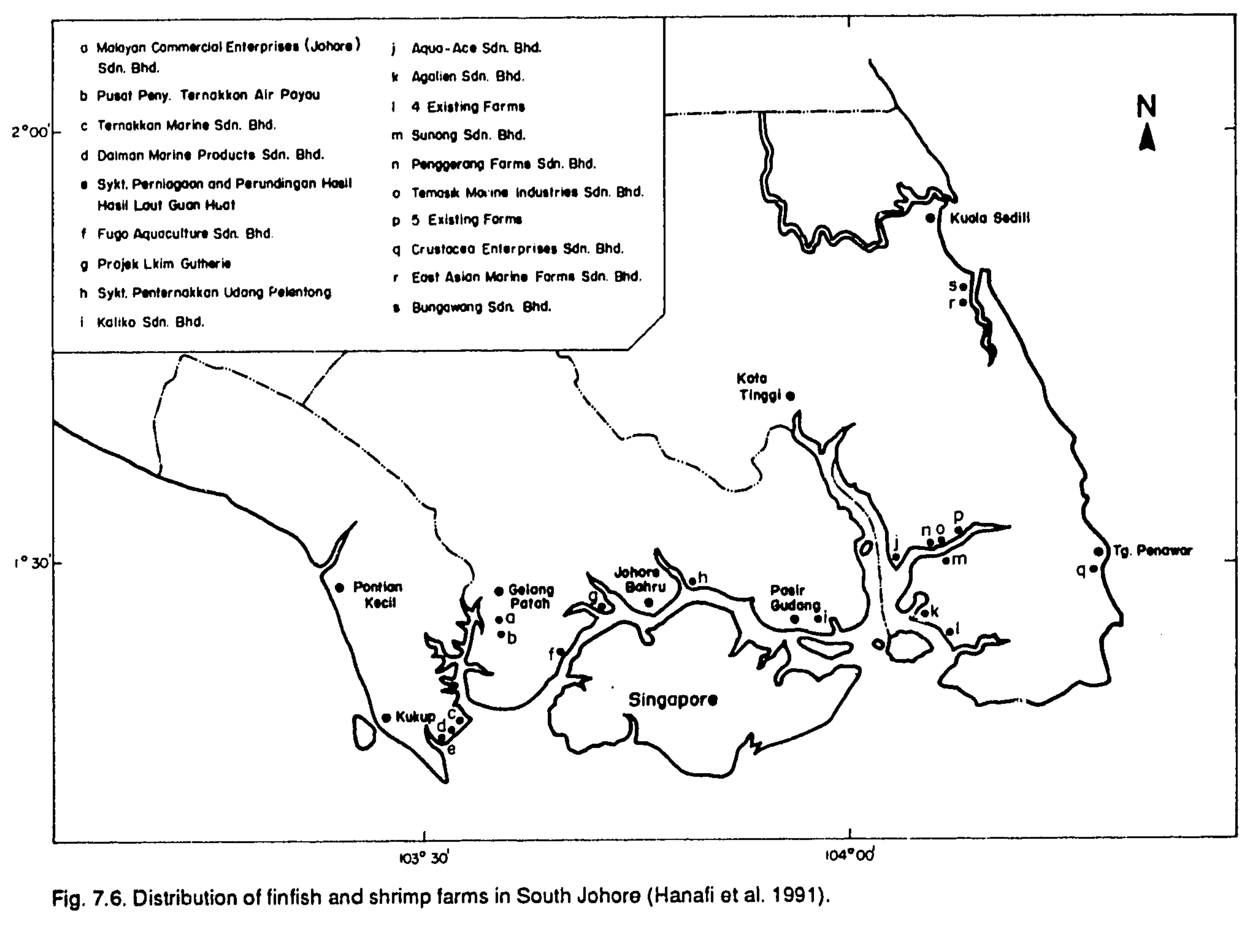

Fig. 7.6. Distribution of finfish and shrimp farms in South Johore (Hanafi et al. 1991).

Cage culture

In 1982, there were 224 freshwater cages and 750 marine cages in Johore. By 1986, however, the number of marine cages had soared to 2,753 while that of freshwater cages declined to a mere 42. This indicates that the freshwater cage culture industry is in decline while the marine cage culture industry is developing rapidly. This is particularly true in Johore, which, once again, was the leader in Peninsular Malaysia in terms of the total number of marine cages, total area devoted to these cages and production.

Freshwater cage culture is normally carried out in deep mining pools and lakes by farmers. Tilapia and various species of carp are the main species being cultured.

Marine cages, which farmers or traditional fishermen typically manage, are located in protected coastal areas (Fig. 7.7). The types of fish produced by marine cage culture are predominantly groupers (*Epinephelus* spp.) and giant sea perch. In 1986, marine cages produced 440 t in Johore, representing 44% of the state's total aquaculture production.

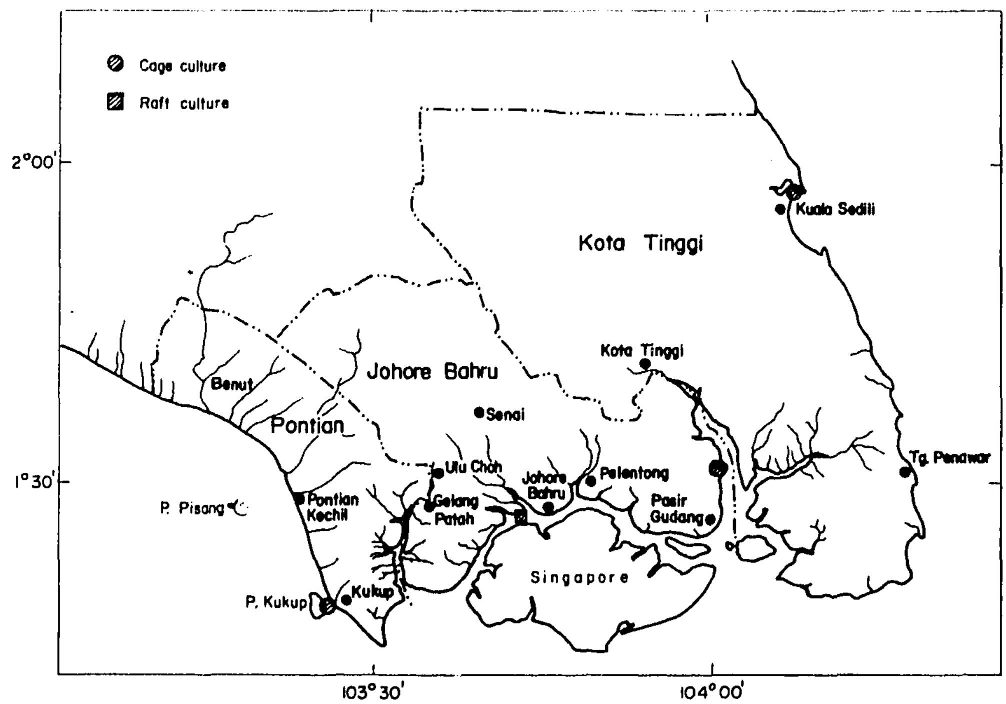

Fig. 7.7. Marine cages in South Johore (Hanafi et al. 1991).

Raft culture

Raft culture of mussels, well-developed in Johore, has been helped by the abundant occurrence of natural spat in Johore Strait. The number of rafts in the state increased from 20 in 1980 to 283 in 1987, a majority of which are ıocated in Johore Bahru District (Fig. 7.7). The state's mussel production was 233 t in 1986.

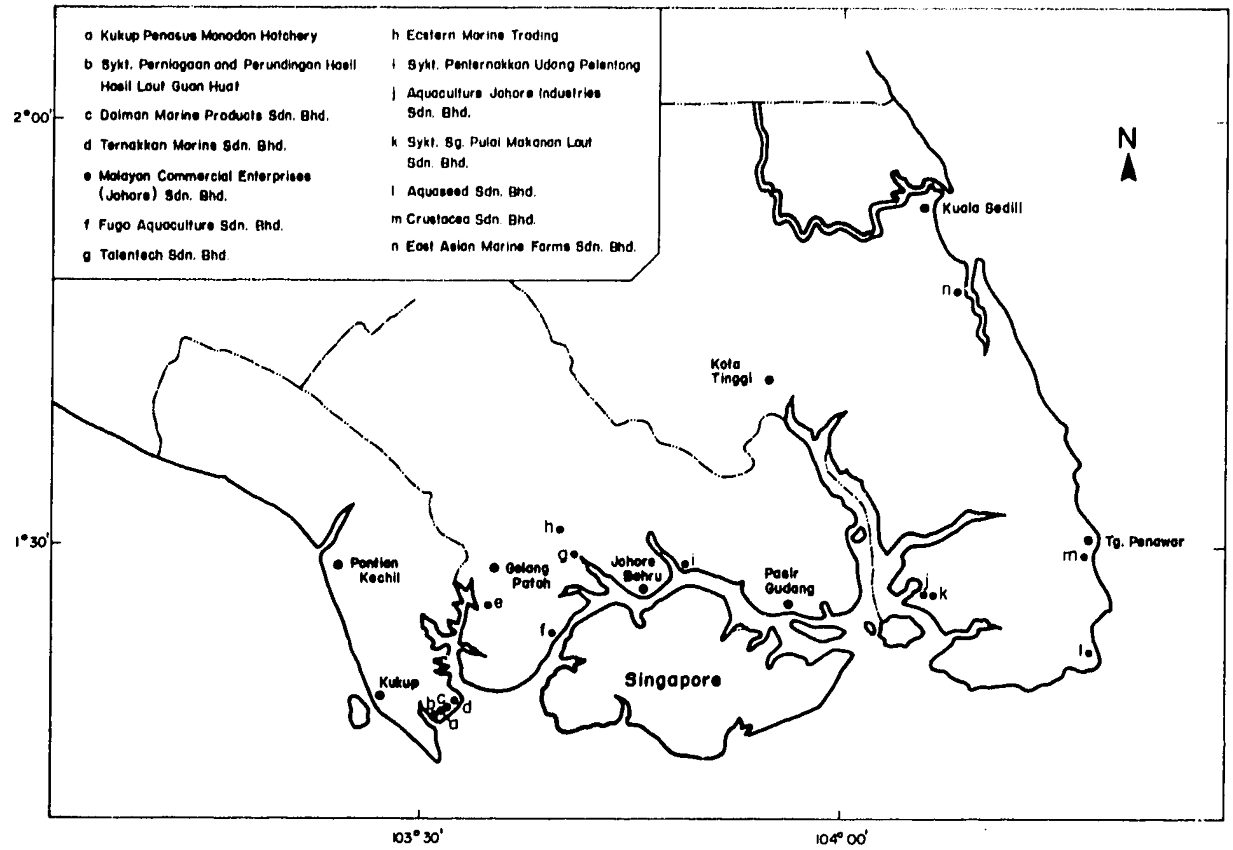

Fig. 7.8. Shrimp hatcheries in South Johore (Hanafi et al. 1991).

Freshwater and marine hatcheries

There are three freshwater hatcheries in Johore producing the fry of red tilapia (*Cyprinus carpio*) and various aquarium fish. Due to the strong growth of the shrimp culture industry, the number of private shrimp hatcheries has increased rapidly and totaled 14 in 1987 (Fig. 7.8). An estimated 200 million shrimp fry are sold to local pond operators annually. The local market consumes almost all of the fry from Johore's hatcheries and the small excess is exported.

Future development

Pond Culture. The development of brackishwater pond culture depends on the availability of suitable sites. Studies by ADB (1985) and UPM (1985) have identified hundreds of additional hectares as possible sites for expanded aquaculture production.

There are limitations, however, to the rapid development of the shrimp industry. Market prices can be erratic, particularly because of the possible overproduction that often follows boom years. Likewise, the mangrove areas cleared for ponds are part of an integrated resources system. Benefits to the economy due to the clearing of large areas of mangrove for pond culture must be weighed against the loss in the overall productivity of the coastal zone in terms of the resulting degradation of the coastal habitat and possible reduction in capture fisheries yield.

Cage Culture. The emphasis on marine cage culture is due partly to an increase in demand for marine fish and a decrease in demand for freshwater varieties. Culturing alternative freshwater species of higher demand like goby (*Oxyeleotris marmoratus*) might improve the industry. At present, however, the availability of fry of these species is low because they are available only in the wild. Marine cage culture is a booming industry, yet eventually there may not be sufficient suitable sites to accommodate the increase in numbers of marine cages.

The ADB (1985) has identified additional potential sites for marine cage culture totaling 955 ha. Most of the potential sites are located in Johore River in the southeastern part of the state. Cage culture has advantages over pond culture because the former does not destroy mangroves, has fewer risks and requires less capital. Due to the lower market value of finfish versus shrimp, cage farming is best suited to individuals seeking supplementary income. Promoting its development could decrease the environmental pressure placed on mangrove areas by pond farming. Cage farming must be adequately regulated, though, to minimize the organic pollution that can result from intensive feeding.

Raft Culture. The limited availability of appropriate sites can hinder further expansion of the industry. This can be remedied through the seed transfer method whereby spat are collected in an area of high spat fall and transferred to areas of low spat fall that are otherwise suitable for raft culture.

Raft culture has the same advantages over pond culture as cage culture has. The market value of mussels is much lower than that of shrimp, however, and large-scale production has not been proven highly feasible. Raft farming, therefore, is suited to individuals who need extra income.

Further Considerations. The development of coastal aquaculture in general is occurring at a fast pace in Malaysia. Johore is Peninsular Malaysia's leading state in aquaculture development. Brackishwater pond culture of shrimp and cage and raft culture of marine species are increasing at a rapid rate.

Despite the promise of large revenues from aquaculture, the economic risks of its rapid development should not be overlooked. Coastal aquaculture projects represent high capital investment within small physical areas. Small and local environmental disturbances can, therefore, cause substantial losses to affected aquaculture projects. Aside from uncontrollable factors such as weather, the effects of industrial growth on the aquaculture industry must also be considered.

Oil contamination caused by spills from accidental groundings or discharges from tankers during cleaning threatens the quality of Johore's waters and the aquaculture industry. There is a need for adequate berthing and cleaning facilities for tankers using Johore's waters. For example, an oil spill drifting from Indonesia threatened fish cages and shrimp farms in the Kukup area worth M$33 million in 1987. The impact on the local community of losses due to environmental problems like pollution could be significant. While an investor can face financial loss from the failure of an aquaculture venture, the local community stands to lose jobs and suffer shifts in population and other social problems.

In sum, the development outlook for aquaculture in Johore is quite good. Planners and developers should promote practices like cage and raft culture that do not destroy mangroves. Brackishwater pond culture of shrimp and finfish promises to be a potentially profitable endeavor. This development can be sustained if the conversion of mangrove areas to fishponds is based on a plan that includes thorough consideration of the effects of mangrove destruction on the coastal environment and related sectors of the economy like capture fisheries.

Chapter 8
Other Economic Sectors

Johore's GDP and per capita GDP have grown at relatively rapid rates, which parallel national growth rates (Table 8.1). Johore is a middle-income Malaysian state. In 1985, its per capita income was only slightly lower than the national average.

From 1970 to 1985, the contributions to the national GDP from the primary sector declined, while those from the secondary sector increased (Table 8.2). Although the contribution from the secondary sector increased considerably over the 15-year period, the primary sector still accounted for a greater proportion (30% vs. 23%) of the GDP in 1985. Much the same situation exists in Johore.

Table 8.1. Economic growth in terms of average annual growth rates of GDP and per capita GDP (%/yr), 1972-1985.

	GDP		Per capita GDP	
	1972-1980	1981-1985	1972-1980	1981-1985
Malaysia	8.1	6.4	5.6	3.8
Johore	8.4	5.7	6.2	3.3

Sources: Third and Fourth Malaysian Plans.

Agriculture

Over 50% of the total land area of Johore is devoted to agriculture (see Chapter 5). Agricultural activities can be classified into broad divisions: oil palm, rubber, coconut, cocoa and fruits. Various government agencies, such as KEJORA and FELDA, have been primarily responsible for the rapid development and diversification of agriculture.

Oil palm plantations take up slightly over 40% of all the cultivated land in South Johore. Abcut two-thirds of these plantations are found in Kota Tinggi District. The FELDA is responsible for 37% of the area under oil palm cultivation. Private estates own 29% and the rest is divided among other government agencies and small private landowners.

There are about 20 oil palm mills in the region with a total processing capacity of 655 t/hour. From 1980 to 1984, palm oil production increased by 11%/year, while palm kernel production grew by almost 25%/year. Johore is now Peninsular Malaysia's largest producer of palm oil and palm kernel. Given the 1984 prices of palm oil at M$1,582/t and palm kernel oil at M$2,115/t and an extraction rate of 5.5% (weight percentage of oil extracted from palm kernel), the revenue generated by the oil palm industry of Johore was about M$2 billion that year.

Table 8.2. Malaysia's GDP (M$) by origin, 1970-1985.

Sector	1970 (%)	1980 (%)	1985 (%)	Average rate of yearly growth 1970-1980	1981-1985
Primary					
Agriculture, forestry and fishery	625.0 (43.52)	1,087.6 (36.61)	1,191.4 (29.91)	5.6	1.8
Mining	32.0 (2.23)	20.6 (0.69)	29.5 (0.74)	-4.3	7.4
Total	657.0	1,108.2	1,220.9	5.4	1.9
Secondary					
Manufacturing	217.0 (15.11)	638.2 (21.48)	910.3 (22.86)	11.4	7.4
Construction	32.0 (2.23)	143.4 (4.83)	278.8 (7.00)	16.2	14.2
Total	249.0	781.6	1,189.1	12.1	8.7
Tertiary					
Transportation, storage, utility and communication	99.0 (6.89)	226.0 (7.61)	334.9 (8.41)	8.6	8.2
Trade: wholesale and retail, hotel and restaurant	111.0 (7.73)	274.3 (9.23)	377.8 (9.49)	9.5	6.6
Finance, insurance, real estate, business services	112.0 (7.80)	189.6 (6.38)	299.4 (7.52)	5.4	9.6
Government services	162.0 (11.28)	328.1 (11.04)	479.9 (12.05)	7.3	7.8
Other services	46.0 (3.20)	63.0 (2.12)	83.9 (2.11)	3.2	5.9
Total	530.0	1,081.0	1,575.9	7.4	7.8
Grand total	1,436.0	2,970.8	3,982.9	7.5	6.0

Sources: Third and Fourth Malaysian Plans; Mid-term Review of the Fourth Malaysian Plan.

Most of the agricultural lands opened in the early decades of the century were planted with rubber trees. Now, about 45% of the total agricultural land of South Johore is devoted to this crop. Rubber is most prevalent in Johore Bahru, followed by Kota Tinggi and Pontian.

Rubber production decreased slightly from 1980 to 1984. Based on the 1984 price, the rubber industry earned more than M$200 million for South Johore and about M$780 million for the entire state in that year.

Only about 3% (13,000 ha) of South Johore is used to grow coconut. More than 80% of this is in the district of Pontian. Most coconut plantations are in the hands of private landowners.

One of the newest crops in Malaysian agriculture is cocoa. Thus, the total area (2,478 ha in 1986) is still small in Johore. Cocoa is planted mostly as an intercrop in coconut areas.

About 50% of the area under fruits is devoted to durian. Rambutan covers about 20% and *duku*, about 11%. Most of the hectarage is under smallholdings.

Forestry

In 1986, about one-quarter of the 858,726 m^3 of timber harvested in Johore came from South Johore. Fees collected for taxes, licenses and leases by Johore's Department of Forestry (DOFor) amounted to more than M$5.4 million in the same year. Logging supports several wood-associated industries, including almost two dozen sawmills and about 30 furniture factories.

Mangroves are harvested extensively in South Johore for fuel and building materials. Licenses to log mangrove forests for charcoal production are issued in the forest reserves of Pulai, Johore, Lebam and Belungkor. These areas are logged on a 20-year rotation (DOFor, pers. comm.). At least 78 charcoal kilns have been built in South Johore, capable of processing a combined total of 36,000 t of mangrove wood annually. Poles of *Rhizophora* species, used as building pilings, are another important product obtained from mangrove forests.

Livestock

Raising pigs is a prominent activity in South Johore, and more than 100,000 are typically bred at any point in time. Many pig farms are unlicensed, most of them small- to medium-sized, with the attendant neglect of adequate anti-pollution measures (Babjee et al. 1983).

Ports and Shipping

Port facilities in Johore include 1 port at Pasir Gudang, 11 minor ports and 24 fishing jetties. The major facility at Pasir Gudang is a bulk cargo port. Managed by the Johore Port Authority (JPA), it covers an area of about 300 ha and is surrounded by industrial and planned urban areas of almost 3,000 ha. The port possesses about 1.2 km of quay length, encompassing six berths, and operates a twin-berth jetty for vegetable oil and a hazardous cargo jetty for dangerous goods. Water depth ranges from 5.5-12.8 m.

The amount of cargo handled by the port has increased significantly since 1977 (Table 8.3). The principal export cargo handled at Pasir Gudang is oil palm. The main import cargoes are fertilizers and chemical products (Table 8.4). Other important cargoes include wheat, maize, soya beans and palm kernel expeller. Including private jetties, some 4,327,560 t of cargo were handled in the waters of JPA in 1985.

The total number of ships calling at the facilities operated by JPA rose from only 252 in 1977 to 1,794 in 1985. Most of these were foreign vessels (Table 8.5).

Pasir Gudang's port is the only one in Malaysia to be located in the Free Trade Zone (FTZ). The zone offers suitable sites for a wide range of industrial activities including manufacturing, packing, blending, processing and assembly as well as other export-oriented industries. The JPA administers the FTZ, which was initiated in 1984.

The port's operations generated an income in excess of M$47 million in 1987, an increase of nearly tenfold since 1977. With the present construction of two additional container and general cargo berths, another vegetable oil jetty, and the expansion of the dangerous-cargo jetty, the income generated from the port should continue to grow.

The minor ports and fishing jetties at Johore cater not only to the fishing industry and passenger transportation services, but also to nearby oil depots.

A result of Johore's continuing rise to economic prominence is the likely need for additional port facilities, and the mouth of Pulai River in southwest Johore has been proposed as a site. Although such a port would relieve much of the pressure at Pasir Gudang, construction at Pulai River would entail significant environmental impacts. As an illustration, the massive dredging and reclamation required would increase the river's turbidity. Similarly, the river is currently used for aquaculture, which would suffer from the increased siltation and pollution associated with a port. In short, solving one problem may bring another set of problems to the forefront.

Table 8.3 Dry and liquid cargo handled in Johore Port facilities.

Year	Liquid cargo	Dry cargo	Total
1977	205,240	220,208	425,448
1980	672,952	547,393	1,220,345
1985	1,657,710	1,249,849	2,907,559

Source: JPA (1986).

Table 8.4. Bulk cargo (in million tons) handled at Pasir Gudang, 1984-1985.

Cargo	1984	1985
Oil palm	1.3	1.45
Palm kernel expellers	0.15	0.23
Grains	0.3	0.3
Fertilizer	0.62	0.7

Source: JPA (1984; 1985)

Table 8.5. Number of ships calling at Johore Port facilities area and private jetties.

Year	Foreign-going	Home trade	Local trade	Barge/tug	Total
Facility area					
1977	120	54	30	48	252
1985	779	461	96	24	1,360
Private jetties					
1984	75	1	38	443	557
1985	91	1	7	335	434

Source: JPA (1986).

Industry

There were 12 industrial estates in Johore in 1984 with a total planned area of 1,867 ha. The total developed area was 1,411 ha. The estate size ranged from only 12 ha in Kota Tinggi town to 1,161 in Pasir Gudang (Table 8.6). Several hundred hectares are still available for further development. Incentives, such as a ten-year tax exemption, have been offered to promote development in the industrial estates. An additional 361 industries are located outside the industrial estates, 203 of which are in South Johore.

Table 8.6. Industrial estates (ha) in Johore, 1984.

Estate	Total area planned	Total area developed	Salable land
Lackin and Tamuau	167	167	159
Pasir Gudang	1,161[a]	948	812
Senai II	40	40	38
Tongkang Pecah	15	15	13
Tg. Agas	80	80	60
Segamat I	40	40	31
Perit Raja	28	28	22
Sri Gading	125	5	5
Kota Tinggi	12	12	10
Kluang I	52	52	46
Bandar Tenggara	118	24	24
Bandar Penawar	29	-	-
Total	1,867	1,411	1,225

[a]Includes the FTZ.
Source: State Economic Development Commission.

Further development of industrial estates is under active consideration. Several sites on Johore River are being assessed for what would be the state's largest industrial estate--about 2,400 ha. The estate would be the location of several petrochemical facilities and, possibly, even a steel mill. Other industrial enterprises being considered at still other sites include an oil sludge disposal facility on Santi River and an oil sludge/oil slop reprocessing facility on Lebam River.

The likely placement of these facilities will require considerable attention to their anticipated environmental consequences. At the least, planners must be willing to take into account the effects on water quality, mangroves, fisheries and aquaculture as well as existing land uses, such as for agriculture.

Transportation

The road systems in Pontian and Johore Bahru Districts are relatively well developed. Many of the existing roads converge on the city of Johore Bahru. The North-South expressway plays an important role in determining the pattern of economic activities in the state. Many settlements along the expressway will benefit economically from nearby interchanges. In the district of Kota Tinggi, few good roads connect Kota Tinggi town with various other towns and places of interest. The main modes of transportation are buses and taxis.

The present railway network connects the city of Johore Bahru with Singapore to the south and Kuala Lumpur to the north. Apart from providing substantial passenger services, the railway also handles cargo, most of which is bound for Singapore. Cement is the major imported railway cargo. In addition to the main rail line, there is also a 40-km span between Pasir Gudang and the city of Johore Bahru.

There are five airstrips and one international airport in the district of Johore Bahru. The 557-ha international airport at Senai is about 30 km from Johore Bahru City. The annual growth rate of passengers was about 26% over the period 1980-1985. Domestic cargo includes textiles, poultry, vegetables and reading materials.

Chapter 9
Tourism

With the active encouragement of Johore's state government, tourism plays an important role in the state's economy. Given the state's excellent beaches and close proximity to Singapore, millions of tourists come to or pass through Johore each year (Table 9.1). Moreover, as the state attempts to capitalize on its increasing attractiveness to tourists, there are obvious incentives to construct additional facilities in coastal areas to accommodate the visitors. Among all tourists that visited the state in 1987, it is estimated that about 60% visited at least one coastal area (JICA 1985). Furthermore, the expansion of the Desaru tourist complex in southeast Kota Tinggi District is expected to attract three-quarters of the total tourist arrivals to the southeast coast of Malaysia by 1995.

Table 9.1. Number of visitors to Johore via the causoway, 1983-1986.

Year	Singapore	India	Thailand	Japan	Philippines	Others	Total
1983	2,766,602	28,330	59,339	40,620	4,359	150,002	3,049,252
1984	3,387,042	33,524	53,003	96,457	15,359	191,241	3,776,626
1985	5,466,514	9,362	31,141	38,483	6,220	90,117	5,641,837
1986	3,299,253	5,037	17,974	29,961	4,605	75,451	3,432,281

Source: Unit Perancang Ekonomi Negeri Johor.

It is surely profitable to attract more tourists to Johore, but there is a need to balance economic/tourism objectives with environmental considerations. Development that is poorly planned and implemented will not only jeopardize the state's coastal and environmental resources but, potentially, the tourism industry itself. Tourists find no reason to experience littered beaches, polluted oceans, eroded coastlines or decimated coral reefs. Unfortunately, these and other environmental problems may result if tourism is allowed to grow unchecked. In short, the opportunities associated with tourism also create challenges to coastal area planners.

Johore Bahru

There are no coastal resorts developed for tourism in this district. Lido and other pocket beaches are unsafe for recreational activities. Water pollution from raw domestic and industrial sewage has made the coastal areas along Johore Strait largely inappropriate for tourism.

In the coastal city of Johore Bahru, tourists are attracted to many excellent seafood restaurants. Other places of interest include the causeway, Istana Besar and Istana Garden, and a handicraft center. Historical sites are also popular, such as Abu Bakar Mosque, the Government Offices Building, the Dewan, Bukit Serene Palace, the Royal Mausoleum and the monuments of Sultan Abu Bakar and Daing Ibrahim.

Pontian

The district's coast offers only a few sandy beaches. Tourism is limited mostly to visitors seeking to explore life in the villages. The Kukup fishing village, 20 km from Pontian town, is famous for its houses on stilts and floating seafood restaurants. Several hundred visitors, predominantly Singaporeans, visit the Kukup area each weekend. At present, however, no organized agency manages the tourist activities in the Kukup and Pontian areas. There are also few day- or overnight-visitor facilities.

Kota Tinggi

The waterfalls at Lumbung are a tourist attraction, and the area has picnic and day-visitor facilities. Officially opened in 1965, the facilities are able to generate income from food concessions and entrance and parking fees.

The beach at Teluk Mahkota, some 46 km from Kota Tinggi town, is a popular destination of day visitors. The area lacks the necessary amenities and is thus more popular with local rather than foreign visitors.

Desaru

Although the Desaru tourism zone is within the district of Kota Tinggi, Desaru requires a separate discussion because of its size, attractiveness and potential impact on the environment. Desaru is situated on the southeast coast of the district. For many years, the area was relatively undeveloped, attracting only small numbers of tourists willing to endure rather spartan facilities. With KEJORA's development of a master plan for the area, however, as the number of appropriate facilities increased, so also did the number of tourists. In anticipation of this growth, KEJORA hired an international consulting firm (Shankland Cox Partnership 1973) to assess the potential for development. Based on the consultant's report, KEJORA recommended the:

1. improvement of access and services to the coast in the area between Tanjong Lompat and Tanjong Penawar;
2. improvement of day-visitor facilities, including a restaurant, parking space, bathrooms and changing rooms, and provisions for recreational activities to serve 1,000 tourists;
3. construction of a 200-bed medium-class hotel covering an area of 4 ha and a 400-bed first-class hotel covering an area of 6.5 ha;
4. construction of an international standard 18-hole championship golf course;
5. development of 17.4 ha of land around the golf course for high-quality houses; and

6. delineation of a jungle area surrounding the proposed development sites as a conservation area to ensure that the resort retains its natural character.

Facilities

Day-visitor Facilities. Construction of the 10-ha day-visitor complex was started in 1974 and completed in 1977 (Fig. 9.1). Facilities include a restaurant, a coffeehouse with bar, 35 deluxe and standard chalets, 13 food stalls, souvenir shops, changing rooms, bathrooms, a minisports complex, and facilities for horse riding, camping, boating, golf and yachting. A subsidiary of KEJORA, Desaru Sdn. Bhd., was incorporated in 1976 to manage the complex.

In 1983, over 150,000 day visitors came to the Desaru area. The most popular months were April, May, August and November. Due to bad weather, February and March were the leanest months. The majority of the day visitors are from Johore, and they spend most of their time sightseeing. Sports like golf, horse riding and camping are relatively unpopular because these activities are expensive and alien to many of the tourists.

Hotel Facilities. The Merlin Inn, a medium-class hotel covering an area of 4.2 ha, was opened at the end of 1981. Built over a period of four years, it cost M$4.2 million. In 1982, the 139-room luxury Desaru View Hotel was opened. The Hotel Beach Desaru was also completed in the 1980s.

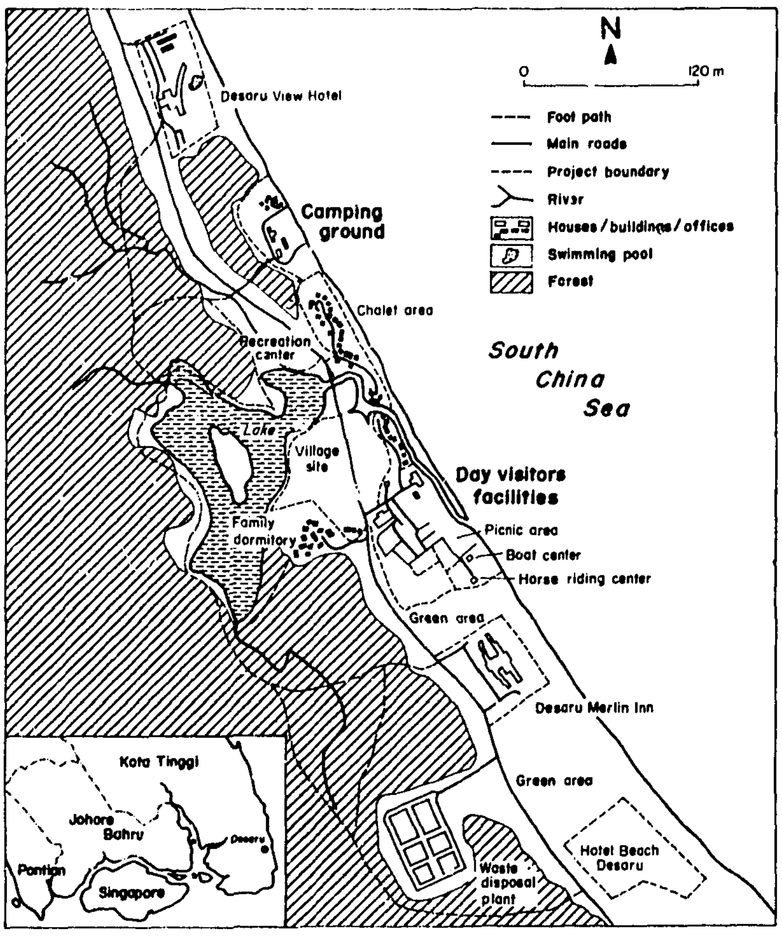

Fig. 9.1. Visitor facilities at Desaru (Tourism Division, KEJORA).

On weekends and holidays, it is not unusual for the Desaru View Hotel to have 100% occupancy whereas at the Merlin Inn, it is considerably lower. Among visitors who stay in the hotels, about 10% are Malaysian, 30% are Singaporean and 60% are from overseas.

The hotels are all built on beach ridges because: (1) sparse vegetation makes these areas easy to clear; (2) the areas are higher than the surrounding land and thus allow for good drainage; and (3) the beach is easily accessible. The sandy, sparsely vegetated nature of the beach ridges makes them highly prone to erosion, so further development on the ridges must minimize erosion and other negative environmental impacts.

Golf Course and Realty Development. KEJORA manages the 18-hole championship golf course at Desaru that opened in 1985. The golf course and surrounding realty development covers an area of 323.9 ha. Bungalow houses surround the golf course. Realty development is undertaken by the KEJORA Golf Sdn. Bhd.

Effect on regional development

KEJORA's master plan sees tourism in Desaru as part of the overall regional development of Johore Tenggara. Other development undertakings in the region with significant effects on the tourism industry include infrastructure and industrial zones, the improvement of social facilities and the establishment of forest reserves.

Social facilities in the towns and growth centers in the region provide the communities with basic services. In addition to projects undertaken by various government agencies, KEJORA has provided other facilities such as rural health clinics and centers, police bases and substations, mosques, multipurpose halls and a community center.

Physical infrastructure is necessary to support the tourism industry. In the 1980s, the region gained four major roads. A permanent water supply from Lebam River for Desaru and surrounding areas has been completed. A power station now supplies electricity. A telecommunications system is now operational after the completion of the rural automatic exchange building.

Industrial zones in Bandar Tenggara and Bandar Penawar are being considered with caution due to their anticipated negative impacts on tourism at Desaru. Bandar Penawar is less than 9 km from Desaru, so only light and service industries are being developed. These include a bakery; laundry; handicraft, batik material and weaving factories; and a printing press. Several of these industries could affect water quality at Desaru if not carefully regulated.

Preservation and development of forest land and wildlife have been greatly emphasized in the master plan, especially within the tourist development area. Forest reserves not only ensure ecological and sedimentary stability, but also allow the surrounding area to maintain its aesthetic quality. A warden and ranger unit has been established to protect existing wildlife from poachers; to introduce new wildlife appropriate to the area; and to develop a system of "nature interpretation" as a tourist attraction.

Offshore Islands

There are 37 islands arranged in a loose cluster from 10 to 60 km east of Mersing (Fig. 4.4). Many of the islands are uninhabited and only a few have proper accommodations and organized activities for tourists. Based on the number of visitors using Mersing Port facilities in 1982, as many as 5,000 tourists, mostly Singaporeans, travel to the islands monthly during the fair weather period from March to October.

The main attractions of these islands are the unspoiled marine environment, the beautiful scenery and the sociocultural background of the islands' residents. Tourist activities include swimming, snorkeling, scuba diving, camping, land touring and hiking.

Anticipated Growth

Looking towards the future, tourist arrivals on the southeast Johore coast are expected to increase to about 450,000 in 1995, achieving a growth rate of about 13.7% per annum. The total guest nights in Johore is estimated at 1.12 million in 1995 with 0.8 million guest nights in Desaru alone. Per capita expenditure by international tourists in the southeast Johore coastal area is calculated at M$250-330 per guest night. The total estimated expenditure is M$250-320 million. An additional 5,800 direct and 3,400 indirect job opportunities are expected as spin-offs from development in the area (JICA 1985).

An estimated M$1.18 billion in investments may occur in the southeast Johore coastal area through 1995. The state government has announced plans for the new Desaru International Resort development, an investment that is expected to reach M$1.6 billion. Other parts of Southeast Johore are also scheduled for development (Fig. 9.2).

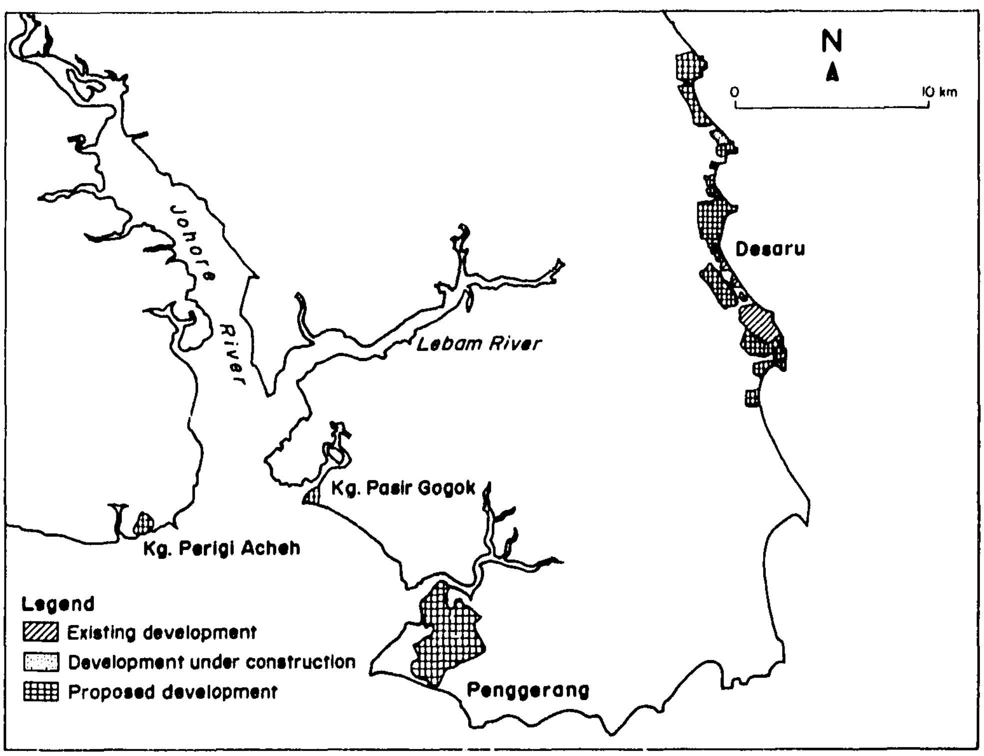

Fig. 9.2. Recreational development pressure in South Johore.

Further development is likewise anticipated for several of the islands off Mersing. In 1987, it was estimated that about one of every ten visitors to Johore spent some time on one or more of the islands (JICA 1985). By 1995, it is projected that more tourists will arrive with a consequent need for appropriate accommodations and concern for protection of coastal resources.

Chapter 10
Environmental Degradation

Coastal Pollution

Economic activities and development pressures have led to the increasingly polluted water resources in South Johore. The primary sources of pollution are agriculture-related activities, industrial emissions (air and water), transportation and domestic wastes. Emissions from power stations and effluents from mining activities add to the pollution load.

The Department of Environment (DOE), which has a regional office in the city of Johore Bahru, is the primary agency responsible for pollution monitoring, assessment and enforcement of pollution control laws. The DOE's functions are confined to those prescribed in the Environmental Quality Act (EQA) (1974) and its Amendments (1986). Activities such as the disposal of municipal solid wastes are under the jurisdiction of the various municipal councils.

Riverine pollution

There are nine major rivers with water quality monitoring stations (WQMS), which DOE operates (Fig. 10.1). Over 20 water quality parameters for coastal waters are monitored by the DOE. Monitored parameters considered important for the characterization of general water quality include pH, dissolved oxygen (DO), 5-day biological oxygen demand (BOD_5), chemical oxygen demand (COD), ammonia nitrogen, suspended solids (SS) and nitrate nitrogen (NN) (Table 10.1).

To facilitate the assessment of water quality, a water quality index (WQI) has been devised. The WQI is a composite measure based on all available water quality parameters. In the computation of the general WQI for the rivers of South Johore, the seven parameters listed above were weighted and combined (Table 10.2). Fig. 10.2 shows the range of the WQI for selected rivers in Johore. More detailed analysis of the data indicates that water quality generally deteriorates toward the estuaries. The water quality in most of the rivers is at least good or medium, with the notable exception of Ayer Baloi River in the central part of Pontian District.

Agro-based Pollution. There are 9 palm oil mills, 19 rubber factories and 4 pineapple processing factories in South Johore. The majority of them are near the basins of Johore and Skudai Rivers (Fig. 10.3). The primary pollutants from these agro-based industries are SS and ammonia nitrogen. The high organic content of the industries' wastewaters contributes to high values of BOD_5 and COD in rivers receiving the wastes. Effluents from palm oil mills contain significant amounts of oil, while those from pineapple processing factories are usually acidic.

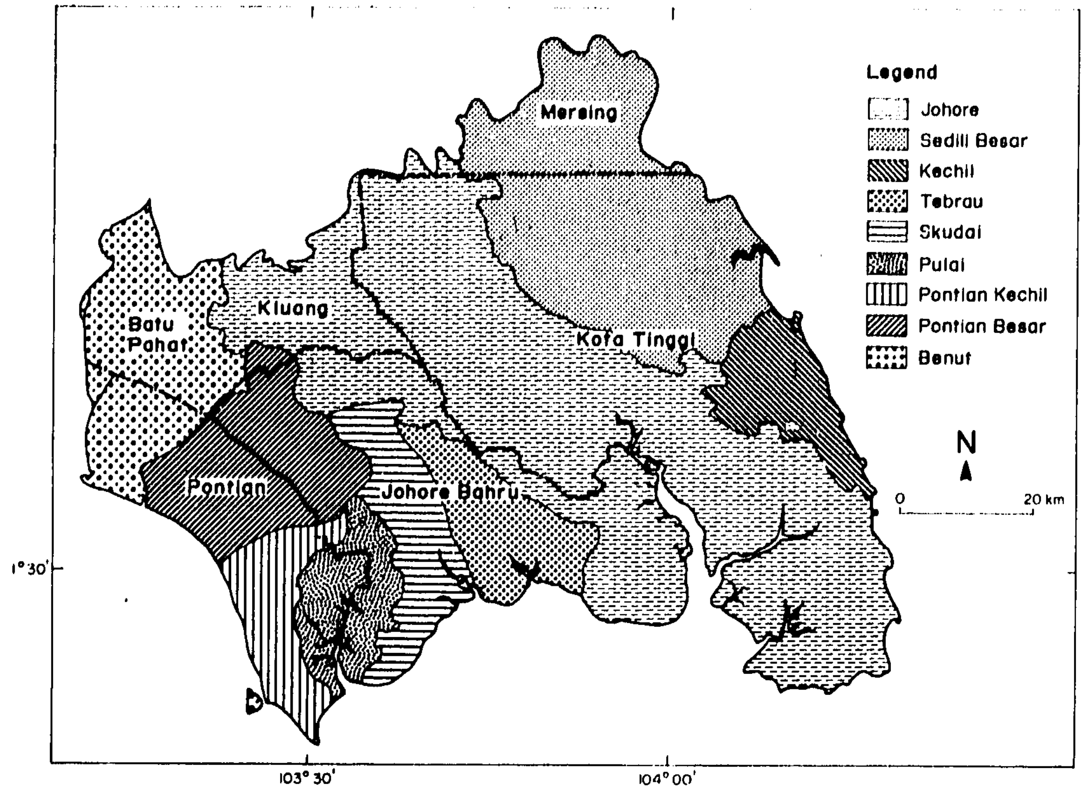

Fig. 10.1. River basins of South Johore (Department of Environment, Malaysia).

Domestic Pollution. Much of this, which is generated in urban areas such as Pontian Kechil, Kulai, Johore Bahru City, Kota Tinggi town and Pasir Gudang, is discharged without treatment directly into rivers and the sea. The major pollutants are SS, phosphorus, fecal coliform (FC) bacteria and various forms of nitrogen. The high organic content of domestic wastes contributes to high levels of BOD and COD in the rivers.

Industrial Pollution. This is emitted from industrial sites such as Johore Bahru and Pasir Gudang. As of 1987, about 700 industries were distributed in 11 industrial estates. Of the latter, 7 are in South Johore. More than 350 other industrial concerns in the state are located outside the industrial estates. Most of these are in South Johore. The types of pollutants being discharged vary according to the industry. Of major concern are those of a hazardous nature, namely, toxic metals, pesticide residues and polychlorobiphenols.

Animal Wastes from Piggeries. Pig farming is the most important agricultural activity in the animal husbandry sector in Johore. With the exception of some overloaded holding ponds for solid waste retention, pig waste is discharged directly into watercourses without adequate treatment. This causes serious organic pollution in receiving watercourses. This pollution has adversely affected downstream aquaculture operations on Gelang Patah River. According to DOE (1988), pig waste now ranks second to domestic sewage in its contribution to the total BOD load discharged into rivers (26% of the total). Based on the 1988 data provided by the Department of Veterinary Services (DOVS 1989), there were 55 pig farms in Pontian District with a population of 53,750 heads. The corresponding figures in Johore Bahru and Kota Tinggi Districts were 43 farms (139,981 heads) and 34 farms (5,376 heads), respectively. Many of the farms have less than 1,000 pigs.

The following features of pig farming hamper the implementation of an effective waste management scheme:

1. the scattered nature of pig farms, which is not conducive to the installation of centralized treatment facilities;

Table 10.1. Mean values of selected water quality parameters of Johore's rivers, 1987.

River	WQMS no.	No. of samples	BOD_5	COD	AN	mg/l NN	SS	DO	pH
Benut	1832604	5	1.9	32	0.24	0.10	21	7.2	6.6
	1833603	5	0.8	20	0.26	0.58	25	5.7	6.4
	1833605	5	2.4	30	0.36	0.34	51	4.5	6.6
	1833602	5	2.0	28	0.42	0.21	44	4.7	6.0
	1732606	5	1.3	85	0.42	0.23	46	4.9	4.6
	1632601	5	1.7	95	0.56	0.33	45	4.3	5.6
Ayer Baloi	1633603	3	1.3	120	0.27	0.19	77	4.5	3.8
	1633602	3	2.0	117	0.43	0.24	104	4.0	4.4
	1633601	3	2.2	150	0.34	0.29	60	4.7	5.5
Pontian Besar	1734614	4	2.0	18	0.43	0.40	15	5.9	6.5
	1534606	4	1.1	69	0.59	0.48	101	4.0	5.6
	1534605	3	1.6	91	0.34	0.18	80	5.3	4.7
	1534604	4	1.4	103	0.52	0.38	51	4.0	5.8
	1534601	4	1.4	1,530	0.53	0.21	132	6.5	7.2
Pontian Kechil	1534603	5	0.9	38	0.23	0.16	22	6.0	6.1
	1434602	4	1.9	496	0.38	0.15	150	6.2	7.1
Skudai	1735608	5	1.6	14	0.28	0.26	45	6.8	6.5
	1635607	5	1.9	17	0.20	0.42	26	6.4	6.0
	1636606	5	3.0	24	0.83	0.46	30	4.7	6.0
	1636605	5	2.4	32	1.02	0.40	10	3.6	6.0
	1636604	5	2.3	20	1.13	0.47	28	3.9	6.1
	1636603	5	2.2	17	1.48	0.50	22	4.8	6.0
	1536602	5	2.4	12	1.22	0.44	8	5.6	6.0
	1536601	5	1.5	17	0.52	0.46	15	4.4	5.9
	1536609	5	2.0	119	0.92	0.28	27	3.0	5.8
	1536610	5	1.2	238	1.18	0.15	33	1.1	6.6
Tebrau	1636612	4	1.2	10	0.26	0.26	16	7.7	5.8
	1537613	4	1.0	10	0.38	0.27	20	6.6	5.7
	1537610	4	2.4	353	0.42	0.28	63	5.5	5.9
	1537609	4	1.7	358	0.61	0.28	36	3.5	6.5
Sedili Kechil	1841605	2	1.2	11	0.14	0.36	23	3.8	4.7
	1841604	2	0.6	20	0.24	0.72	18	6.0	5.8
	1841602	5	1.9	219	0.39	0.20	42	3.6	6.5
	1841601	4	1.4	156	0.30	0.15	10	4.7	6.8
Sedili Besar	2138611	3	0.8	14	0.10	0.12	6	6.8	5.5
	2138610	3	0.6	11	0.11	0.19	10	6.5	5.7
	2038609	3	0.7	12	0.09	0.11	34	6.3	5.7
	2038608	3	1.8	15	0.16	0.10	20	6.4	5.9
	2039606	3	1.0	15	0.09	0.24	11	5.6	5.9
	1839605	3	1.0	14	0.09	0.11	13	6.5	6.3
	1839604	3	1.1	14	0.15	0.21	21	4.3	6.2
	1840602	3	1.4	27	0.16	0.10	10	4.5	4.7
	1941601	3	0.6	417	0.15	0.13	7	5.8	6.8
Johore	1834610	5	1.2	9	0.27	0.32	14	7.6	6.7
	1834609	5	2.7	24	2.16	0.70	26	5.3	5.8
	1835608	5	2.2	19	1.83	[illegible]	34	4.9	5.9
	1835617	5	3.0	31	0.28	0.64	45	5.1	6.1
	1836603	5	2.1	15	0.14	0.20	18	6.8	6.2
	1836602	5	2.0	19	0.31	0.48	23	5.8	5.9
	1837615	5	1.3	10	0.15	0.12	52	7.1	6.0
	1737607	5	2.1	18	0.17	0.27	21	6.3	6.2
	1737606	5	1.5	18	0.24	0.42	27	6.3	6.3
	1739604	5	2.3	15	0.22	0.35	34	5.8	5.9

Source: Department of Environment, Malaysia.

Table 10.2. WQI ratings for rivers.

WQI value	Rating
0- 25	Very bad
26- 50	Bad
51- 70	Medium
90	Good
91-100	Excellent

Source: Lim and Leong (1991).

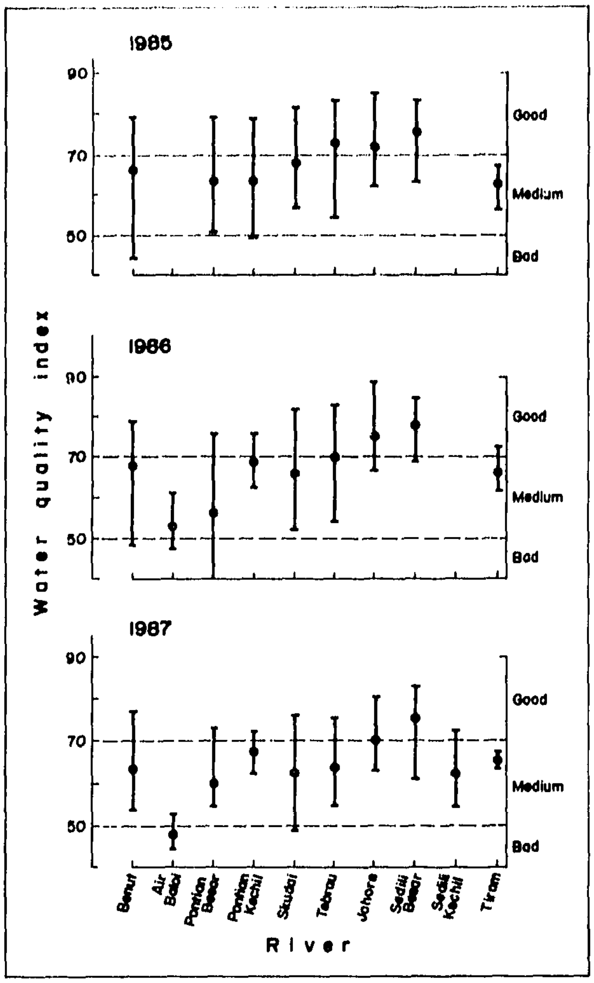

Fig. 10.2. Ranges of WQI for selected rivers in South Johore, 1985-1987 (Lim and Leong 1991).

2. the small size of most of the pig farms, which reduces the economic viability of establishing waste treatment facilities; and
3. the insular nature of pig farmers, which makes them unreceptive to new technology.

Marine pollution

The Johore Strait receives discharges from Johore Bahru City as well as from Skudai, Tebrau and Johore Rivers and others that flow past the major towns and industrial areas of South Johore. Ten rivers in Singapore also discharge wastes and effluents into Johore Strait. Due to its many sources of pollution, most of the DOE monitoring work on marine water quality is conducted in the strait. Out of 13 marine water quality monitoring stations, 9 are located in Johore Strait (Fig. 10.4).

The causeway connecting Singapore to Peninsular Malaysia blocks free passage of water through Johore Strait. The strait is narrow and current flow is relatively insignificant. Hence, little dilution is allowed to occur, and the water has become increasingly concentrated with pollutants.

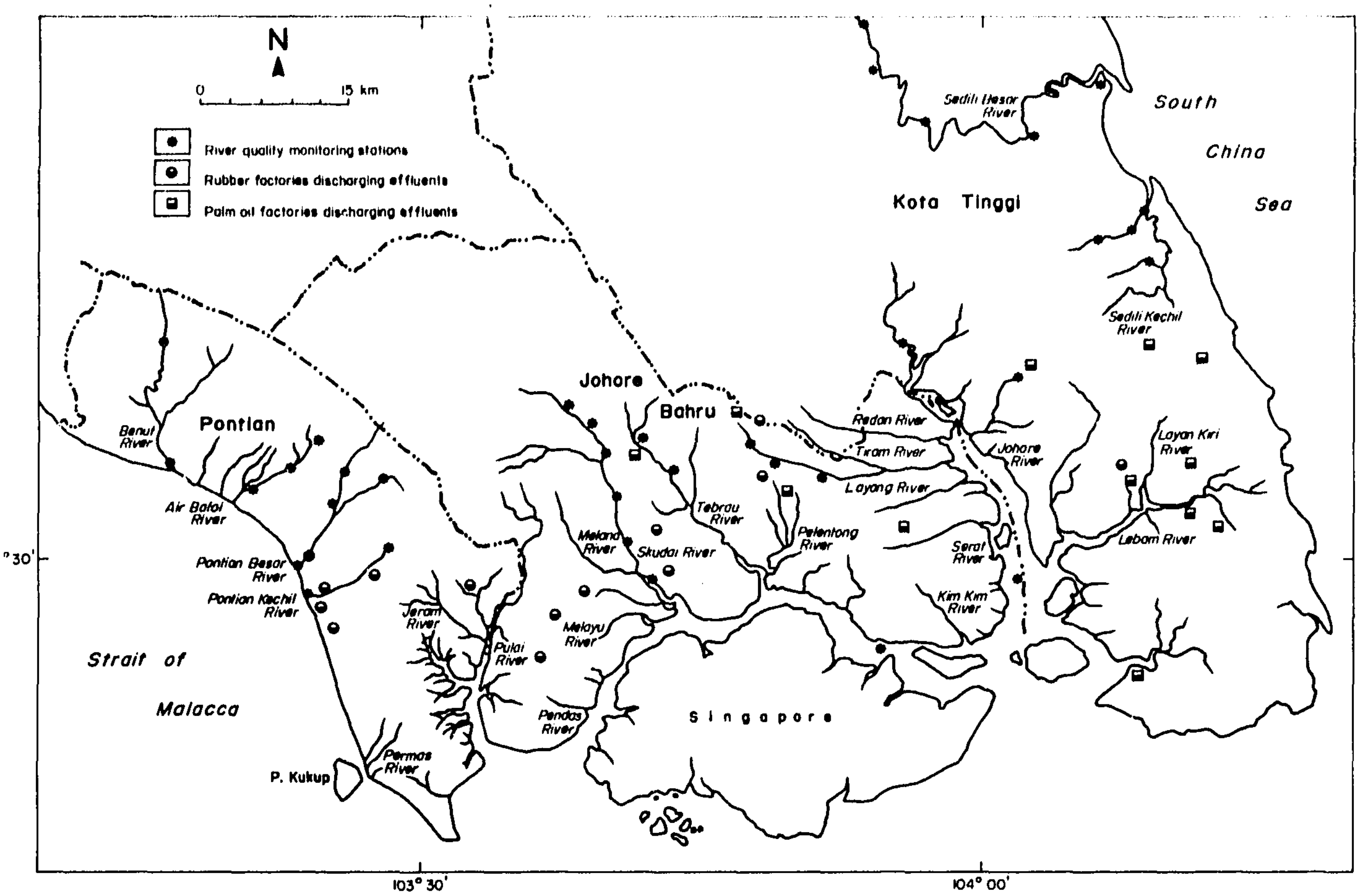

Fig. 10.3. Major sources of agro-based pollutants in South Johore.

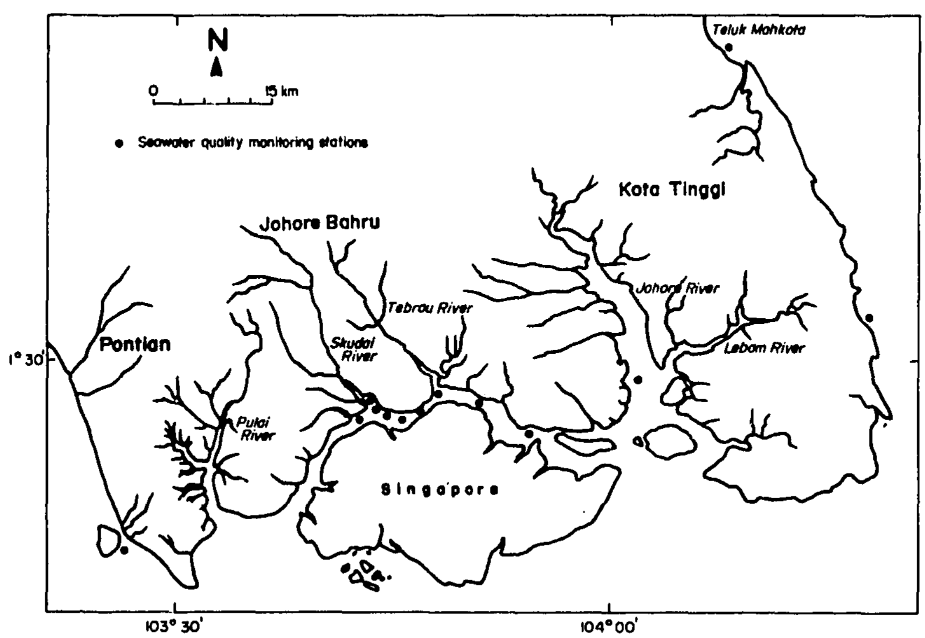

Fig. 10.4. Marine water quality monitoring stations in South Johore (Lim and Leong 1991).

Recreational Use. According to the United States Environmental Protection Agency (USEPA 1976), the maximum acceptable level of FC density for bathing water should not exceed a log mean of 200 MPN/100 ml of water sample, based on a minimum of 5 samples over a 30-day period. The DOE(1986) has accepted this criterion as being suitable for Malaysia. Using this criterion, only 3 sites in the strait are suitable for swimming or bathing, and none is near Johore Bahru City or the causeway. The western part of Johore Strait is consistently more polluted by microbes than the eastern part. This is due mainly to urban wastes from Johore Bahru discharged into the area.

Aquaculture Use. Establishing water quality criteria for aquaculture use of coastal waters is necessary for the protection of human health as well as for the propagation of aquatic species. The former should be of paramount importance (Lim and Leong 1991). Among the aquatic species cultured for human consumption, shellfish, being filter-feeders, require water of high quality to be microbiologically safe for eating. One of the most widely quoted criteria for shellfish-harvesting waters is that of USEPA (1976), which recommended that the medium FC bacterial concentration not exceed 14 MPN/100 ml. Based on this criterion, only two sites were found satisfactory. In view of the widespread dependence on aquaculture in Johore (as well as its anticipated expansion), this finding should justify concern. Excessive levels of FC would undoubtedly doom aquaculture in the state. Nonetheless, the USEPA criterion is considered too stringent for other marine species that are not filter-feeders (Lim and Leong 1991).

Oil pollution

Cases of oil pollution in Johore Strait are common, especially at the port of Pasir Gudang. From 1979 to 1987, there were at least 48 spills in South Johore, all of which involved foreign vessels. In 1987, two major spills in Indonesian waters drifted towards the beaches of southwest Johore. The spills, involving fuel oil and crude oil, adversely affected the ecology and fish catch in the area. The number of oil spills is clearly related to the heavy tanker traffic in the Strait of Malacca.

Air pollution

Automobile and industrial emissions are primary sources of air pollution in Johore. Most of the automobiles are found in the densely populated areas of Johore Bahru. Major industrial sources of air pollution in South Johore include sawmills, chemical industries and palm oil refineries located in the industrial areas of Pasir Gudang and Larkin/Tampoi.

Air Quality Monitoring. The DOE analyzes air samples collected from the following devices: dust deposit gauge (DDG), high volume sampler and B-port sampler. Air quality parameters determined from DDG samples include pH (of rainwater), total solids, ash, calcium, chloride and sulfate. Based on levels of these important parameters, the Larkin Industrial Estate, Pasir Gudang and Johore Bahru City have the most polluted air in South Johore. In 1984, levels of dissolved solids in Johore Bahru City varied between 60-400 g/m^3, well above the goal value of 40-60 g/m^3 set by the World Health Organization. Total solids and total dissolved solids were measured at levels at the high end of the goal values. Sulfate levels as high as 100 g/m^3 were measured in areas near Pasir Gudang. Localized increases in other air quality parameters were also observed.

Forest Destruction

Inland forests

As discussed in Chapter 3, over 50% of the inland forests of South Johore have already been logged. Further logging may prove to have serious consequences in terms of increasing erosion and coastal siltation and overall disturbance of the area's ecological balance.

Clearing vegetation from forest areas, especially on steep slopes, is the main cause of flash floods and low river yields. The forest ground is thickly covered with litter, and the soil has top layers of humus material. The land covered by forest, therefore, has a high capacity to absorb water from precipitation, which minimizes surface runoff. (This phenomenon is popularly called the "sponge effect".) When the forest is cleared for development, however, the litter on the forest floor disappears and the humus content of the soil decreases. The soil then becomes less absorbent and surface runoff increases, which in turn can lead to floods and reduced river yields.

Studies have shown that lowland dipterocarp forest intercepts more precipitation than rubber plantations (Aiken et al. 1982). A great amount of the rainfall intercepted by the surfaces of the forest canopy is transported back to the atmosphere via evaporation. The remaining water reaching the ground infiltrates the soil or is discharged as surface runoff. The amount discharged as runoff depends on the soil type and vegetation cover of the area. Catchment areas covered with primary forest have about 10% less runoff than cultivated catchment areas.

An experimental study undertaken by Hunting Technical Services Ltd. (1971) for the Master Planning Study of Johore Tengah and Tanjong Penggarang areas made measurements of runoff in two adjacent catchment areas; one with forest cover and the other mainly planted with rubber and oil palm crops. The results of the 13-month study showed that the peak storm runoff per unit area for land under plantation crops was approximately twice that for forested land. River low-flow values measured in the plantation catchment area were equal to about half the values measured in the forested catchment area.

Studies undertaken in 12 river catchments in the Cameron Highlands reveal that river low-flow yields were reduced by 50-70% when the areas were transformed from forest to agriculture (Shallow 1965). The results of these studies indicate that hydrological problems such as flooding and low river yields will worsen if forest clearing continues.

Areas covered with forests have less erosion and sediment deposition than areas that are seriously disturbed by agricultural activities (Douglas 1968; Leigh and Low 1973; Aiken et al. 1982). Erosion causes major soil loss and unnaturally high river sediment loads. In addition to the damage erosion causes on land, high sediment loads being discharged from rivers disrupt coastal ecosystems by lowering the light transparency of the water column and smothering benthic communities. Thus, forest cover has value in the prevention of soil erosion and the resulting damage to coastal habitats.

Mangroves

Extensive clearing of mangrove forests for aquaculture activities, especially pond culture, has repercussions on other important industries like capture fisheries and tourism. In most pond culture areas, rivers are the source of freshwater. With the establishment of large-scale pond culture in South Johore, a substantial amount of water is diverted to ponds and holding areas. This reduces the amount of freshwater reaching downstream mangrove areas and affects not only the growth of mangroves but also important aquatic organisms, namely, fish and shrimp.

Clearing of mangrove forests destroys the breeding and nursery habitats of many commercially important marine species, such as shrimp and mullet. Although it is difficult to ascertain the exact ramifications of converting vast areas of mangrove to fishponds, Whitton and Damanik (1985) estimate that the conversion of one hectare of mangrove to brackishwater pond reduces the offshore fish and shrimp production by about 480 kg/year.

Coastal Erosion

The National Coastal Erosion Study (NCES) (Stanley Consultants, Ltd. et al. 1985) reported cases of coastal erosion and established criteria for three categories. Although the marine coastline of South Johore accounts for only 48% of the total coastline of the entire state, all of the reported cases of critical coastal erosion are located in the former (Table 10.3). As much as 80% of South Johore's coastline is being eroded.

Table 10.3. Categorization of coastal erosion area and potential protective measures, South Johore.

Area (district)	Length (km)	Extent of erosion damage	Potential protective measures	Erosion category
West Coast				
Sg. Sanglang to Pt. Hj. Mohd. Damin (Pontian)	10.9	Slightly retreating mangrove.	No protection proposed. Monitor.	3
Pontian Besar to Pekan Rambah (Pontian)	8.3	Mixed agricultural and urban area. Agricultural land lost, existing urban structures and seawalls threatened.	Armor	1
Kg. Kubor (Pontian)	1.5	Shoreline erosion south of existing rock armor.	Extend armor south as required.	1
Kg. Sg. Buntu (Pontian)	0.4	Retreat of mangrove forest. Coastal bund threatened. Existing armor north of present erosion.	Extend existing armor south as required.	1
Kg. Sg. Kuali to Kg. Belukang (Pontian)	6.9	Moderately retreating mangrove forest; ultimately will threaten coastal bund.	Monitor armor as required.	2
Tg. Piai (Pontian)	6.0	Retreat of wide mangrove forest; threatens coastal bund.	No protection proposed.	3
Sg. Belukang to Sg. Chokoh Besar (Pontian)	2.4	Retreat of wide mangrove forest; threatens coastal bund.	Monitor armor as required.	2
Sg. Chokoh Besar to Sg. Pulai (Pontian)	5.1	Retreat of mangrove forest. Threat ot inland fishfarms.	Armor as required.	1
Sg. Pulai to Selat Johore (Pontian)	17.6	Slight retreat of mangrove forest; no impending threat.	Monitor armor as required.	2
East Coast				
Kg. Sedili Besar (Kota Tinggi)	1.0	Gabion revetment used to protect construction of school. Gabions are corroded and a few have failed.	Armor	2
Sg. Sedili Besar to Tg. Kechil (Kota Tinggi)	12.7	Area of slight and acceptable erosion.	Monitor periodically.	3
Kg. Sedili Kechil (Kota Tinggi)	0.3	Minor beach erosion. No structure along coast.	Do nothing; monitor.	3

Continued

Table 10.3 (continued)

Area (district)	Length (km)	Extent of erosion damage	Potential protective measures	Erosion category
Desaru (Kota Tinggi)	2.5	Beach erosion fronting resort. Damaged beaches and trees. Steep beach slopes are also present.	Beach nourishment; groins, offshore B/W segmented	1
Tg. Balau to Tg. Penawar (Kota Tinggi)	12.0	Area of slight and acceptable erosion.	Monitor periodically.	3
Kg. Sg. Rengit (Kota Tinggi)	0.5	Concrete/stone seawall protecting police compound. Evidence of possible overtopping and lowering of beach profile in front of wall.	Do nothing; monitor.	3
Tg. Penyusup to Tg. Pengelih (Kota Tinggi)	25.3	Area of slight and acceptable erosion.	Monitor periodically.	3
Tg. Pengelih (Kota Tinggi)	1.2	Coastal road leading to Custom Office and ferry service jetty is eroding. A rock and gabion revetment has been constructed.	Armor	1

Legend:
Category 1 - critical erosion.
Category 2 - significant erosion.
Category 3 - acceptable erosion.
Source: Stanley Consultants, Ltd. et al. (1985).

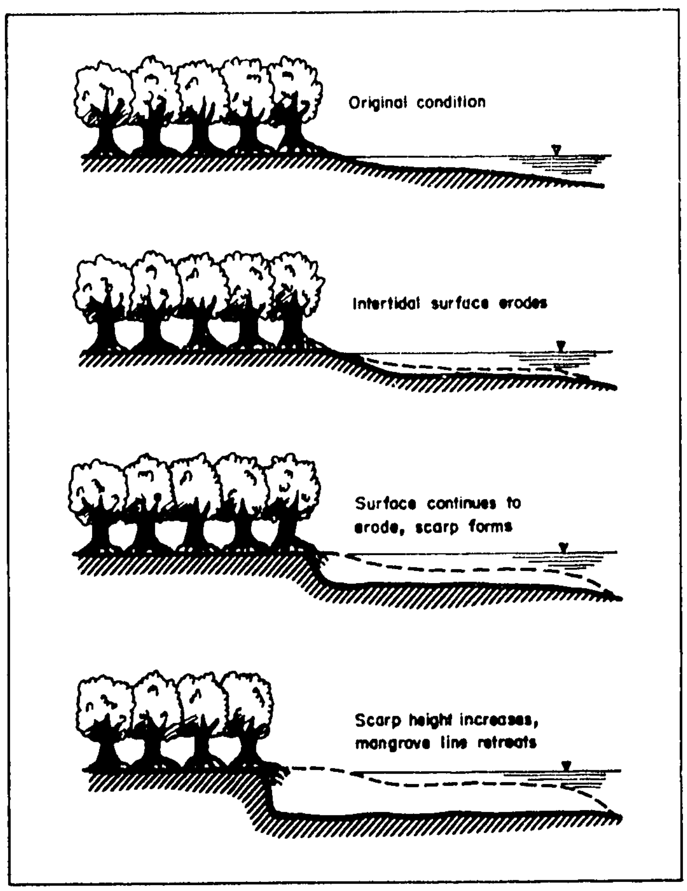

Fig. 10.5. Illustrative erosion of mangrove areas (Stanley Consultants, Ltd. et al. 1985).

Waves mobilize and currents transport coastal sediments. Erosion results when the amount of sediment transported away from an area exceeds the amount transported to it. This condition is common when human intervention produces an imbalance in the supply of sediment available for transport to a coastline. In South Johore, human intervention comes in the form of beach development and sand mining on beaches. On muddy coasts, mangroves stabilize the fine-grained sediments. The clearing of mangroves and/or the retreat of mangroves caused by freshwater diversion is another cause of coastal erosion. Based on site observations, NCES presented a series of field characteristics typical of a stable, retreating or accreting mangrove-fringed coastline (Fig. 10.5). The study cautioned, however, that theories of sediment transport along mud coasts are not well developed. Further investigation in this area is needed to predict accurately coastal erosion trends along Johore's muddy coasts.

Coastal erosion threatens to eliminate a variety of coastal land uses and development projects such as aquaculture and coastal roads. Rock and gabion revetments and stone/concrete seawalls, constructed in an attempt to halt the advancing sea, have met with only limited success. Shore armoring, offshore breakwaters, groins and beach nourishment are other potential protective measures. These are heavily biased toward structural solutions rather than control of the main causes of erosion.

Chapter 11
Legal and Institutional Framework

Laws and Regulations

Both the federal and state governments are responsible for the management of coastal areas. Coastal activities, such as fishing, aquaculture, forestry, agriculture, industrial development, sand mining, shipping, tourism and urban development are regulated by various state and federal laws (Table 11.1). These laws derive their legality from Malaysia's Constitution.

Fisheries

The Fisheries Act of 1985, a federal law applicable to all of Malaysia, is intended to regulate the exploitation of fisheries resources in the country's waters. Under the authority granted by a previous legislation of the same title, the State of Johore enacted two regulations: the Fisheries (Riverine) Rules of 1984 and the Fisheries (Turtle and Turtle Eggs) Rules of 1984. These rules give power to DOF to issue licenses and impose conditions to protect and conserve fish and turtles.

Forestry

In 1984, the Federal Parliament passed the National Forestry Act, which addresses the need for standardized legislation on forest resources conservation and development. Prior to this act, individual states had been entrusted with the responsibility of formulating policies and implementing legislation on forest resources management.

Pollution

The EQA of 1974 revitalizes efforts to preserve the quality of the human environment by controlling pollution. The act gives the Ministry of Science, Technology and Environment (MOSTE) the power to regulate existing and potential pollution problems with the assistance of various government bodies. A subsequent law enacted in 1987 authorizes the use of environmental impact assessments for any development of land greater than 50 ha.

Table 11.1. Selective laws relating to CAM.

Act	Department or agency
Federal Government	
Fisheries Act, 1985 (Act 317)	Fisheries
Environmental Quality Act, 1974 (Act 127)	Environment
Environmental Quality Act (Prescribed Activities) (Environmental Impact Assessment) Order, 1987	
Factories and Machinery Act, 1967 (Act A424)	Factories and Machinery
Merchant Shipping Ordinance, 1952 (Ordinance 70/1952)	Marine
Pesticide Act, 1974 (Act 149)	Agriculture
Continental Shelf Act, 1966 (Act 83) (Revised 1972)	State Land and Mines
Exclusive Economic Zone, 1984 (Act 311)	Relevant agencies
National Park Act, 1980 (Act 226)	Wildlife
Petroleum Mining Act, 1966 (Revised 1972) (Act 95)	Petronas
Geological Survey, 1974 (Act 129)	Geology
Antiquities Act, 1976 (Act 168)	Museum
National Forestry Act, 1984 (Act 313)	Forestry
Protection of Wildlife (Act 76)	Wildlife
Land Conservation Act, 1960	State Land and Mines
State Government	
National Land Code, 1965 (Act 56/1965)	Land Office
Land Conservation Act (Ordinance 3/1960 Johore - En. 13/1960) (Am. Johore En. 5/1961)	Land Office
Mining Enactment, 1929 (Cap 147) Johore (En. No. 69)	Mines
Water Enactment, 1926 (Cap. 146) (Rivers) Johore (En. No. 66)	Land Office
Rearing of Pigs - Johore (En. 5/1975)	Veterinary
Town and Country Planning Act, 1974 (Act 172)	Town and Country Planning
State Park Enactment, 1986	State Economic Planning Unit
Forest Enactment/National Forestry Act, 1984 - Johore (En. No. 58)	Forestry
Irrigation Areas Ordinance (Ord. 31/1953) (Am. Ord. 44/1956, L.N. 332/1958)	Drainage and Irrigation
Drainage Works Ordinance (Ord. 1/1954) (Am. L. No. 332/1958)	Drainage and Irrigation
Land Acquisition Act (Act 34/1960); Land Acquisition (Compensation) (Special Provisions) (Am. Acts A387, A388) (Ord. 21/1948)	Land Office
Johor Tenggara Regional Development Act (Act 75) (Am. Act A201, A2[illegible]1, A376)	KEJORA
Local Government	
Local Government Act 1976 (Act 171) (Am. Act A436)	Local Authority
Street, Drainage and Building Act, 1974 (Act 133) (Am. Act A435)	Local Authority
Ports Authorities (Act 21/1963) (En. No. 35)	JPA
Town Board/Ports and Shipping - Johore Bylaws (Cap 135) (En. No. 118)	JPA

Sand mining

Despite the proliferation of laws, not all coastal resources management (CRM) issues are addressed adequately. As an illustration, either the federal or state government can have authority over sand mining operations depending on the area of operation. All land including the foreshore to 4.8 nautical km from the shore measured from the low-water mark is under state jurisdiction. The seabed and waters beyond the 4.8 km limit to the waters of the continental shelf boundary are under federal jurisdiction. It has been observed, however, that some of the permits that Johore's government has approved do include areas under federal jurisdiction. This complicates matters because state-issued leases in areas of federal responsibility may not be legally enforceable.

The problem of overlapping leases is the result of an apparent lack of understanding by the state government of the extent of its jurisdiction over the foreshore and the waters above it. On the one hand, under Emergency (Essential Powers) Ordinance No. 7/1969, the territorial sea is extended to 19.2 km from the shore measured from the low-water mark for all states (except for Sabah and Sarawak) for all purposes except for those of the Continental Shelf Act 1966, the Petroleum Mining Act 1966, the National Land Code 1965 and laws relating to land in force in Sabah and Sarawak. On the other hand, section 4(2) of the ordinance states that the waters measured from the low-water mark to 4.8 nautical km from the shore are under state jurisdiction. Thus, the law is very clear as to what constitutes federal and state jurisdiction in the matter of minerals and sand extraction.

This problem of dual jurisdiction is compounded by the lack of coordination and consultation on the issue of permits for sand mining. The seabed, whether within or outside the territorial sea, is linked by the sea, and any issue resulting from the mining of sand in one area can have an impact on another area, which need not necessarily even be adjacent to it. Permits given in an area under state jurisdiction do not, therefore, consider the possible impacts on the area under federal jurisdiction.

There are problems also at the operational level, where the lack of monitoring of field dredging operations (pre-mining, mining and post-mining) is due to staff shortage and absence of competent personnel. Dredging operators are typically asked to provide information on the quantity of sand dredged, mainly for revenue computation purposes. This passive monitoring overlooks the transient nature of the dredging-induced turbidity, its subsequent dispersion pattern and the long-term deleterious effects that appear only after the cessation of the dredging operation.

Institutions

Many administrative bodies at both the federal and state levels have overlapping powers and responsibilities for regulating the use of coastal resources and development in coastal areas. The complex manner in which institutions function to effectively address CAM problems, such as oil spills, exemplifies the need for streamlining and better coordination among the various bodies concerned.

In the event of a major oil spill, DOE of MOSTE must combine efforts with the Royal Malaysian Navy and the Marine and Chemistry Departments to prosecute the offender(s) and clean the spill. The JPA is also involved if the spill occurs within its jurisdiction. The Chemistry Department is responsible for ascertaining the source of the spill and then forwarding its findings to DOE. Under the EQA of 1974, DOE has the power to prosecute persons or shipping companies that illegally discharge oil into Johore's waters. The responsibilities and powers of the Marine Department (MD), under the Merchant Shipping Ordinance of 1952, overlap with those of DOE. The MD has the power to detain and arrest officers of vessels, investigate, obtain evidence from witnesses and prosecute. Bound by institutional constraints and differing policies and hampered by the ambiguities of overlapping functions, the activities of institutions can come into direct conflict.

In its efforts to promote economic growth and development, the Malaysian government has given priority to industrialization, urbanization and tourism. Thus, official policy and its implementation have tended to give less attention to such problems as erosion, coastal pollution and environmental degradation. In some cases, existing laws appear to be ignored completely. The discharge of animal wastes into inland waters is regulated under the EQA of 1974 (Sewage and Industrial Regulation 1979). Nevertheless, the practice of dumping untreated pig wastes that pollute Johore's rivers remains unchecked. The discretion of government institutions must be based on more environmentally sound policies to make effective contributions to the management of Johore's valuable coastal areas.

Chapter 12
Issues and Constraints
to Effective Coastal Resources Management

The abundant terrestrial and marine resources near the coasts of South Johore, and the ongoing industrialization, tourism, and urban and agricultural development contribute significantly to the rapid economic progress in the region. The districts of Johore Bahru and Kota Tinggi show an especially strong potential for further development.

Located near the sea, many of South Johore's industries rely on ports and harbors for the import of materials and the export of products. Tourism benefits immensely from the area's tropical beaches and vivid coral reefs, which attract hundreds of thousands of visitors every year. Much of South Johore's urbanization is occurring along the coast. The largest city in the state, Johore Bahru, is a coastal city and its continued growth is directly linked to its strategic location along Johore Strait. South Johore's capture fisheries, supported by two different fishing grounds, provide much of the protein requirements of the residents of Peninsular Malaysia. Aquaculture in coastal areas, especially of prawn and shrimp, is a major export industry in South Johore. Thus, South Johore is becoming relatively prosperous and owes much of this to development along its coasts.

Despite these successes, there are signs that this increasing prosperity may not be sustainable if the rapid development in South Johore, particularly in its coastal areas, is left unplanned. Many of its coastal resources are utilized improperly and even overexploited. If South Johore is to continue benefiting from the vast resources along its coasts, careful consideration must be given to the issues described below.

Management Issues

In February 1989, during the ASEAN/US CRMP Third In-Country Meeting for the Development of a Coastal Area Management Plan for South Johore, Malaysia, the following were identified as important issues:

Coastal forests. Along the east coast, nearly 50% of the coastal forest has already been converted to oil palm estates or degraded to shrubland. Further conversions of these forests will lead to the impairment of their ecological functions and the reduction of the benefits they normally provide. Shortage of freshwater is already a problem in some areas. The diminishing forest areas may also cause rampaging elephants to damage oil palm estates.

Mangroves. The clearing of areas within mangrove forest reserves continues. These reserves were established for sustained forestry and fisheries productivity. From 1970 to 1986, however, about 21% of the reserves had been cleared for aquaculture and agriculture, and about 12% of the stateland mangroves had been alienated.

Water quality. Existing sewage treatment systems are inadequate in Johore Bahru City and other urban areas. As a result, the downstream portions of major rivers and Johore Strait are severely polluted. Untreated wastes from piggeries also contribute to the pollution problem. Further issues include the threat of a major oil spill in the Strait of Malacca and increased river sediment loads due to land development and inland sand mining.

Coastal erosion. Coastal areas are being developed without adequate regard for erosion control. A predicted rise in sea level will also exacerbate the present threat to coastal development.

Sand mining. Mining companies are presently extracting large quantities of sand from nearshore deposits without fully understanding the physical and biological impacts of coastal dredging on the ecosystem. Dredging operations are not sufficiently monitored in terms of their effects on the environment.

Aquaculture. The development and management of aquaculture projects have not been planned systematically. This and a lack of interagency coordination have led to overlaps in jurisdiction and conflicts over proposed land uses. In turn, this has led to the clearing of mangrove reserves.

The benefits of aquaculture development may not be equally shared with small landowners because emphasis is now being placed on large-scale, highly commercialized ventures. The market demand for prawns may drop as other countries, such as Thailand and China, increase their aquaculture production. Moreover, industrial and agricultural pollution will affect aquaculture projects adversely, especially prawn farming.

Tourism. There has been a lack of sound planning and environmental management of the coastal tourism industry. Pollution and erosion will become serious problems if not properly mitigated. Development at Desaru and other coastal resorts must be regulated to ensure the long-term attractiveness of the areas.

Laws and institutions. There is an excessive overlap of powers and responsibilities of governmental agencies involved in the development and utilization of coastal areas and resources. Greater coordination among these institutions is required. Appropriate modifications should be made to delineate clearly the respective duties and roles of the various agencies involved. Laws regulating coastal area development and resources utilization must be updated.

Conclusion

All these resources management issues (and others as well) represent major challenges for South Johore, its government and inhabitants. At the same time, however, the issues provide opportunities to increase dependence on coastal resources while ensuring that they will be nurtured to benefit both present and future generations of Malaysians. As this profile has shown, much of Johore's past success can be traced to its utilization of coastal resources. Such a dependence is not easily changed, but such is not the case with the resources themselves. Their abuse, mismanagement or overexploitation will lead to adverse environmental consequences. In contrast, judicious planning, environmentally conscious management and effective implementation of laws and regulations governing the coastal zone will ensure lasting benefits for all.

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