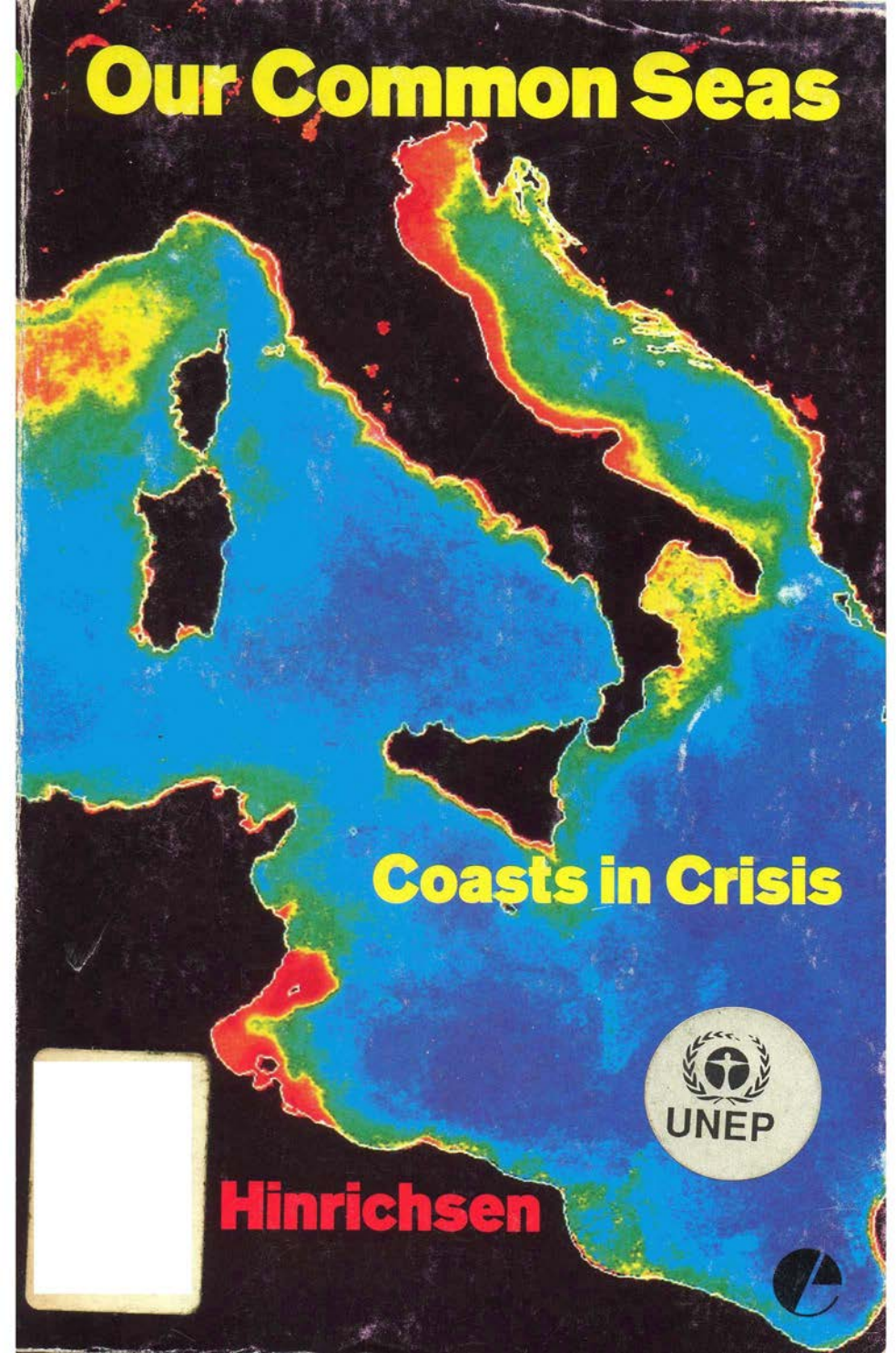
Our Common Seas



Coasts in Crisis

UNEP

Hinrichsen

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Our Common Seas: Coasts in Crisis

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Don Hinrichsen,
London
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Preface

The 1990 Report on the State of the Marine Environment* highlights the rapid deterioration in the coastal areas of the world's oceans, which threatens to cause significant harm to the marine environment in the next decade unless strong, co-ordinated national and international action is taken now.

In order to bring the crisis affecting coastal areas to the widest possible audience, the United Nations Environment Programme (UNEP) supported the International Institute for Environment and Development (IIED) in preparing a book describing what is happening to coastal areas around the world, with particular reference to the coastlines covered by UNEP-sponsored Regional Seas Action Plans, and documenting the efforts being made to solve the problems. This book by Don Hinrichsen is the result. It should be emphasized that the views expressed herein are those of the author and may not necessarily correspond with the views of UNEP or IIED. Similarly, the designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of UNEP or IIED concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

If parts of this book make for depressing reading, it is because the problems are growing rapidly, and the efforts being made to control them still far from adequate. Hopefully it will inspire those who read it to increase the pressure for effective national and international action to protect and manage our fragile and critically important coastal areas while there is yet time.

*GESAMP (IMO/FAO/Unesco/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution): *The State of the Marine Environment*. UNEP Regional Seas Reports and Studies, No. 115. UNEP, 1990.

Introduction

The world's coastlines, mercuric and ever-changing, have been settled since the dawn of time. They have nurtured humanity through countless centuries.

Today coastal areas are beginning to sag under a human onslaught. Home to much of the world's population, coasts and near-shore areas are being over-run with people. Six out of ten inhabitants of the "blue planet" now live on or within 100 kilometres of the seashore. The result is too much development and too much competition for limited resources. Coastal cities and towns multiply out of control, like some genetic experiment gone awry. Industries spread with little regard for environmental amenities. Resources are used and abused with thoughtless abandon. Everywhere, it seems, coastal zones are under tremendous pressures.

Despite the threats, the resources of the world ocean are regarded as infinite. This homocentric notion is reinforced by the vastness of the world's seas, which cover nearly 362 million square kilometres. The earth is really misnamed. It should be called "water", or more accurately, "sea". As the first satellite pictures of earth dramatically demonstrated, our planet is 70 per cent seawater. Viewed from space, the main feature of earth is its vast interconnected ocean. Land appears almost as a geological after-thought. The Pacific Ocean alone accounts for almost 32 per cent of the planet's surface, more than all the land masses put together. Yet we know precious little about our seas, or how they work. The biology of most land creatures is well-known, as are biogeochemical cycles. Yet we know little about many of the ocean's residents, or how they interact. Except for general patterns, not much is known about currents – those great underwater highways constantly on the move.

What we are learning – the hard way – is that our seas are not immune from what happens on land. Much of humanity's refuse ends up sooner or later in coastal waters, washed down by rivers or dumped directly. Rivers also bring into the seas billions of tonnes

of sediment. Bound to these sediments are unknown quantities of poisonous residues from agricultural chemicals and heavy metals from industrial discharges.

Ocean pollution is now universal. Toxic chemicals – such as pesticide residues – dumped in the North Atlantic may very well end up in the South Atlantic or the Antarctic. Radioactive waste tossed into the South Pacific may find its way into the food chain of Indian Ocean fisheries, or even that of the Arctic. DDT residues were found embedded in the fat of Antarctic penguins and seals, thousands of kilometres away from any potential source. Lead compounds were discovered in open ocean surface layers in the Atlantic. Polychlorinated Biphenols (PCBs) were found in sediment taken from under the Arctic icepack. Plastic pollution is now a blight – and a deadly menace – for marine life on all our seas.

Meanwhile, exploitation of coastal resources – mangrove forests, estuaries, seagrass beds, coral reefs, and the fisheries they foster – has reached an unprecedented scale. Even open ocean fisheries, once thought inexhaustible, are now being fished to their limits. Some fisheries, like herring and cod, have been periodically overharvested in the North Atlantic and in the North and Baltic Seas. Others, such as the Peruvian anchovy fishery, have collapsed entirely, due to a combination of over-exploitation and the bizarre weather patterns known as *El Niño*.

It is high time to start managing the world's seas and coastal areas, instead of merely exploiting them. Although the crisis of our coasts has been recognized by some governments, international agencies (like the United Nations Environment Programme and UNESCO) and non-governmental organizations (like Greenpeace), we have a long way to go. Much of what we know about the state of our seas is due to the collective work of thousands of over-worked and under-funded university research centres and other bodies set up to study various aspects of marine science. For the most part, high-powered think-tanks have yet to discover the sea.

Despite all the bad news, there are signs that more and more governments – both North and South – are beginning to recognize the value of managing their coasts and near-shore waters. Coastal area management plans are being drawn up by over 50 countries, while 20 others have management regimes already in place and working. International co-operation in pinpointing and solving common problems related to the use and abuse of shared seas is

on the increase. The international aid community is also shaking itself awake to the enormous problems posed by the over-use and destruction of coastal resources.

One United Nations organization has been a catalyst in spurring on scientific research and international co-operation on solving the crisis of our coasts. The United Nations Environment Programme's "Oceans and Coastal Areas Programme Activity Centre" has been instrumental in ringing the alarm bells of concern and in getting sovereign governments, sharing a common sea, to deal with their problems in concert. From a modest beginning in the mid-1970s, with the launching of the Mediterranean Action Plan (signed by all Mediterranean countries, except Albania), UNEP went on to set up nine more "regional seas programmes" involving 120 countries.

Although shocking, the alarming contents of parts of this book are not meant just for shock value. The problems described should not be underestimated. But at the same time, behind the problems are people and institutions trying to make a difference. People, after all, are both the cause and the cure. Most of the abuse heaped upon earth is human-induced. The buck stops with us.

More than a portrait of pollution, this book is also a portrait of people – from the artisanal fisherman in the Philippines to the Greek ship-owner – who are dependent upon and who draw their livelihoods from the world's seas. And it is a portrait of what the collective action of communities, governments and international agencies can accomplish.

No book yet written on the world's seas has tackled all the issues related to such a vast and complex topic. This book does not even attempt to come close. By concentrating on the seas of the South, it is limited in scope to the problems and prospects of tropical and sub-tropical developing countries (with the exception of most countries rimming the Mediterranean). As with land-bound development issues like the destruction of tropical rainforests, the crisis of the coasts is most pronounced in those areas lacking the personnel, money and motivation to do something about them. This focus of the book, however, in no way is intended to exempt the North from a great deal of responsibility for the mess our seas are in. Not one developed country with a coastline is blameless. But books must begin and end somewhere. This one concentrates on that wide swathe of ocean around which two-thirds of humanity lives, and where people are increasingly suffering from the limitations of resources.

Our seas are embroiled in local, regional, and international conflict. Just being aware of what is at stake is a beginning. More important, however, is the next step: getting people to do something about it. Although much of this book is devoted to the crisis of our coasts, it is dedicated to all those who are struggling – against great odds – to make a difference.

1. On Distant Shores

In the year 2100, assuming we last that long, history may very well judge the late twentieth century by its catalogue of failures, rather than its successes. True enough, we do live in extraordinary times. Peace is breaking out all over the world. Traditional East–West rivalries are being discarded. Co-operation is replacing confrontation. The Cold War may soon be confined to the dustbin of history. But all these wonderful political, economic and social achievements may be overshadowed by humanity's frustrating inability to manage sustainably our resource base in accordance with the needs of a growing global family. A healthy environment is not a luxury, it is an absolute necessity if life on this planet is to be sustained into the twenty-first century and beyond.

The decade of the 1990s is being called the "decisive decade". Decisions not taken over the course of the next ten years to resolve the critical resource and population challenges facing humankind will no doubt undermine the future of generations born next century. Already we are losing a minimum of 6 million hectares of agricultural land to erosion every year. Desertification is threatening about one-third of the world's land surface, or 48 million square kilometres. Tropical rainforests, repositories of immense biological wealth, are being destroyed at the rate of 10 million hectares a year – an area the size of Austria. Through ignorance, greed and neglect, we may be condemning several million species of plants and animals to extinction.

In some cases it is too late to alter biogeochemical processes that have already been set in motion. It appears that humankind is facing the almost certain prospect of global climate change on some level, regardless of what we do during the next decade. Because of the great quantities of carbon dioxide and other trace gases produced by industries and vehicles the atmosphere is heating up like a greenhouse. But if nothing is done to ameliorate rising sea levels and hotter temperatures, the effects of widespread climatic change

could have devastating consequences for developed and developing economies alike. Instead of confronting a crisis that could be contained, if we acted in time, we may be faced with a human and resource tragedy of untold proportions.

Indeed, in many regions throughout the world, humankind appears to be waging a kind of war against coastal ecosystems and marine life. Marine mammals – especially seals and dolphins – are killed off by the hundreds of thousands, entangled and drowned in fishing nets or deliberately wiped out because they compete with fishermen for fish. Fish and shellfish succumb to lethal doses of pollution flushed into coastal waters by industries and municipalities. Increasingly, seas are used as sewers and garbage dumps. Coastlines are fouled with all manner of industrial detritus and discarded plastic. Coastal habitats, such as wetlands, are smothered by imported sediment torn out of agricultural lands in the interior. Mangroves, estuaries, seagrass beds and coral reefs are plundered in the name of development.

Although coastlines everywhere are suffering from an influx of people, accompanied by resource destruction, the coastal crisis is qualitatively and quantitatively different between North and South. Coastal zones in the developed, northern countries suffer more from a glut of untreated industrial and municipal wastes, than from indirect effects of runaway population growth. Furthermore, the rich countries have the capital and technology to control pollution of coastal waters. They have a wide array of policy options and technologies to choose from. For example, turning off the pollution pipeline would make a big difference in the North and Baltic Seas.

For the South, however, there are fewer options, and fewer solutions. Third World coastal nations have the unenviable task not only of coming to grips with pollution, but they must also try to cope at the same time with the human and resource consequences of burgeoning coastal populations. In many instances grappling with the population challenge means dealing with the causes and consequences of migration from the hinterlands. It means developing strategies to attract people away from coastal areas, especially cities and towns. It means confronting a host of complicated, but related, problems, such as finding ways to keep upland farmsteads viable and productive. There are no easy technical fixes for the developing world's coastal crisis.

For these reasons, the focus of this book is on the seas of the South, and particularly those regions with the highest rates of population growth and the least amount of resources, on a *per capita* basis, to deal

with this growth. Year by year, as numbers escalate, resources shrink and traditional management systems begin to break down. As with many other environmental and resource crises, developing countries are least equipped to cope with either the causes or the consequences of coastal degradation.

People and their needs are at the centre of the problems and at the centre of the solutions. But as coastal populations continue to grow, solutions become harder to find and to implement. Along the over-populated coastlines of Pakistan, India, Bangladesh and Sri Lanka, for example, population densities often reach up to 500 per sq km, more than twice the number of people living in the interior. On the island nations of the Philippines and Indonesia, coastal populations are growing by 4 per cent or more a year, compared to rates of 3 per cent or less for the uplands. Probably 60 per cent of humanity, or nearly 3 billion people, live on or within 100 km of a sea coast. In parts of Southeast Asia, 75 per cent of the population lives along the coast.

Human numbers overwhelming coastal resources and ruining marine habitats are certainly not difficult to perceive. Take the Mediterranean Sea. Any population density map shows the problem in graphic detail. The entire coastline is etched in with a black ring – thicker on the northern rim than the southern – representing coastal crowding. A satellite photo at night would reveal a necklace of lights around the entire seacoast. From space, it looks like a continuous coastal village. Indeed, demographers are predicting that the Mediterranean's resident population may swell to 200 million by the beginning of the next century.

But there is another, often overlooked, aspect to coastal degradation and pollution; one that is not so easy to see, or to combat. Coastlines also pay the ultimate price for mismanagement of the *land*. Watersheds denuded of forests quickly erode. Sediment is washed out of the hills and transported to the coasts via rivers and streams, where it smothers estuaries and coral reefs, depleting fisheries. The River Ganges, which drains an area of just over one million sq km of intensively-worked farmland and heavily-harvested forestland, delivers 1.46 billion tonnes of sediment to the Bay of Bengal every year. By contrast, the Amazon River, which drains a much larger area, takes only 363 million tonnes of sediment into the Atlantic each year. Runoff from fertilizers and pesticides poisons freshwater systems, which eventually dump their toxic load into coastal waters. Wastes discharged into rivers eventually reach the sea.

Attempts to make the critical links between land and sea often flounder on the shoals of development and economic priorities that sacrifice one for the other. Integrated management of land and sea has been beyond the capacities of most governments. Even developed countries – with a few exceptions like Sweden – have not managed to evolve integrated management strategies. Coastal zones may be managed, but such management is often divorced from what happens a few tens of kilometres inland. In much of the Third World there is no resource management at all.

Coastal resources in danger

The loss of vital coastal resources – mangroves, seagrasses, coral reefs – can be attributed as much to ignorance as to outright greed. In many areas of the world, coastal peoples do not understand the crucial role these ecosystems play in providing them with food, fibre, building materials and other necessities. Conservation is not usually something that comes easily to the poorest billion people living on the edge of survival.

Sustainable management is impossible if coastal communities are forced to live from day to day. It is also impossible if the consumption of the richest billion is not curbed. For example the Japanese woodchip industry destroys more mangrove forests in Indonesia than poor fishing communities who chop them down to build fish ponds. Still, the combined effects often obliterate mangrove swamps. With mangroves gone, fish and shellfish catches decline, robbing those who fish of their livelihoods and robbing populations of essential sources of protein. Incredible as it may sound, the importance of mangroves, seagrasses and coral reefs to the human food chain is not recognized by many small-scale and subsistence fishing communities. They have evolved many ingenious ways to get food, but they have no idea where the fish come from, how they reproduce, or what factors make fish stocks increase or decrease.

The importance of coastal wetlands as spawning, nursery and feeding areas for fish and shellfish cannot be understated. Globally, nearly two-thirds of all fish caught are hatched in tidal areas. Roughly 90 per cent of all commercial species of fish caught in the Gulf of Mexico and the Caribbean are dependent on estuaries, mangroves, seagrasses and coral reefs for critical stages in their life cycles. Likewise, some 80 per cent of the Indian fish catch from the lower delta region of the Ganges and Brahmaputra Rivers comes from the

mangrove swamps of the Sundarbans, which cover 6,000 sq km. Half the current 500,000 tonne take of fish in the Lower Mekong Basin is of wetland origin. In 1981, the fisheries value of the Mekong Delta contributed around $90 million to the struggling economies of Cambodia, Thailand and Vietnam, while supplying 50–70 per cent of the protein needs of the Delta's 20 million people. Tropical Pacific islanders depend on coastal marine resources for at least 90 per cent of their protein intake.

Biologists consider mangrove forests to be one of the most productive and biologically diverse wetlands on earth, supplying important habitats for over 2,000 species of fish, invertebrates and epiphytic plants. The root zones of mangroves provide sanctuary for sponges, crested worms, crustaceans and molluscs, as well as green, red and brown algae. Intertidal zones create habitats for a variety of crabs and small animals, while hundreds of species of birds nest in mangrove canopies. Mangrove estuaries shelter marine mammals such as dugongs, manatees and otters, as well as reptiles like the endangered South American caiman and the Indo-Pacific crocodile.

Some 60 species of salt-tolerant mangrove trees and shrubs cover roughly 24 million hectares of intertidal, lagoonal and riverine flatlands throughout the world. Most species are found in a wide tropical belt, reaching their greatest concentrations along the coasts of South and Southeast Asia, South America and Africa. The largest expanse of mangrove forests – about 20 per cent of the world's total – borders the Sunda Shelf, a region in Southeast Asia encompassed by Vietnam, Kampuchea, Thailand, Malaysia and the Indonesian islands of Sumatra, Java and Borneo.

Mangrove communities manufacture a nutrient-rich broth for sustaining a wealth of marine life. Concocted from the decomposition of mangrove leaves and twigs, this broth is the first link in a long food chain that extends seaward through seagrass meadows, to coral reefs, and finally to open ocean fisheries. The abundance of offshore shrimp, for example, is directly related to the amount of mangrove nurseries available. On the Fiji Islands, about half of all fish caught by commercial and artisanal fishermen are dependent on mangrove forests for at least one stage in their life history.

Scientists have estimated that one hectare of mangrove forest, if properly managed, could produce an annual yield of 100 kilogrammes of fish, 25 kg of shrimp, 15 kg of crabmeat, 200 kg of molluscs, and 40 kg of sea cucumber. In addition, this same area could supply an

indirect harvest of up to 400 kg of fish and 75 kg of shrimp that mature elsewhere.

Unfortunately, properly managed mangroves are a rarity. In many areas of the Third World, they are not managed at all. Despite their value as fish and shellfish nurseries, land builders and shore stabilizers, and wildlife habitat, mangroves are in retreat throughout their range. Clear-cutting for timber, fuelwood and wood chips, and outright destruction for the creation of brackish fish and shellfish ponds, and for the expansion of urban areas and agricultural lands has claimed millions of hectares globally. Indirect threats include run-off from pesticides used on agricultural fields and erosion sediment brought in by coastal development, the deforestation of upland watersheds and mining operations.

In the everyday struggle for survival it is easy for hard-pressed coastal communities to overlook the importance of mangroves, until it is too late. The pace of mangrove destruction rivals that of tropical forests. Yet there is a stupefying lack of awareness of the problem and its consequences. From government policy-makers down to subsistence fishermen, mangrove forests are often regarded as wastelands, to be exploited and converted to more "productive" uses.

In many cases the damage is not irreversible. Small-scale mangrove rehabilitation projects have been started up in fishing communities in South and Southeast Asia, Africa and the Caribbean. Much remains to be done, however, before the destructive trends of the last 40 years can be halted and reversed. Education is the first step. Without an appreciation for the value of mangroves, particularly among commercial fish pond operators, timber harvesters and artisanal fishing communities, the destruction is likely to continue.

Much of the damage being done to coral reefs, however, may prove very difficult to reverse. Of all the vital coastal ecosystems under threat, it is coral reefs – the marine versions of tropical rainforests – which are being decimated faster than any other marine resource. It is possible that they are being extinguished more rapidly than rainforests.

Although there are estimated to be 600,000 sq km of coral reefs in the world, with 30 per cent concentrated in Southeast Asian seas, their condition is thought to be deteriorating nearly everywhere. Wherever coral reef inventories were carried out, the results have been depressing. Of 632 reefs surveyed in the Philippines, for example, only 10 per cent were found to be completely undamaged.

In an extensive coral reef survey sponsored by the United

Nations Environment Programme and the International Union for Conservation of Nature and Natural Resources (IUCN), marine biologist Sue Wells discovered that dynamite fishing is a serious problem in 41 countries, while 50 countries report excessive sedimentation on parts of their reefs.

The main threats to reefs include a combination of improper land management, especially deforestation of coasts and uplands, and outright destruction through coral mining and blast fishing. As forests are cut down for timber and to make room for more agricultural land, huge quantities of erosion sediment can be flushed off the land and into shallow coastal waters. Without mangrove forests to trap the sediment, it is often transported to coral colonies, where it suffocates the living polyps. Sedimentation of reefs can transform thriving communities into dead ones. When forests are converted to farmland, the run-off of nutrients is greatly accelerated. Nitrogen and phosphorus poison corals and reduce their ability to compete with other organisms, such as algae.

Coral mining and blast fishing are particularly destructive since most coral species grow very slowly. It takes about 20 years for a brain coral colony to grow as big as a man's head. Coral reefs are like oases in the desert; once destroyed, the habitat reverts to "desert", where only a tiny fraction of their former inhabitants can survive.

The destruction is made more horrific when one considers that coral reefs are among the oldest living communities of plants and animals on earth, having evolved some 450 million years ago. Most modern coral reefs are between 5,000 and 10,000 years old; many of them forming thin veneers over older, much thicker reef structures dating back several million years. Most of the reef colony is actually dead. Only the upper layer is covered by a thin changeable living skin of coral. Coral polyps (the animals that build reefs) are the master bricklayers of the sea, cementing their homes upon the remains of their predecessors.

Coral reefs rival tropical rainforests in species richness and diversity. The 150-km long barrier-reef surrounding Palau in the Pacific, for example, has nine species of seagrasses, more than 300 species of corals, and 2,000 varieties of fish. The Great Barrier Reef of Australia has 400 species of coral providing habitat for over 1,500 species of fish and 4,000 different kinds of molluscs.

Nearly one-third of all fish species live on coral reefs, while others are dependent on reefs and seagrass beds for various stages in their life cycles. Although estimates as to the amount of fish that can be

harvested from reefs varies from 1–30 tonnes per sq km per year, a sustainable harvest of some 15 tonnes per sq km of fish, molluscs, and crustaceans should be possible. Almost 90 per cent of all fish caught by artisanal fishermen in Indonesia are reef-dependent, as are some 55 per cent of the fish consumed by Filipinos.

The high productivity of coral reefs is due to their efficient biological recycling and retention of nutrients. Biologist Rodney Salm, Project leader of IUCN's coastal-zone management programme in Oman, explains how this remarkable recycling system works:

> The coral animals have tiny algal cells, called *zooxanthellae*, in their tissues. These process the coral polyp's wastes before they are excreted, thereby retaining valuable nutrients. Nutrients such as nitrates, phosphates and carbon dioxide produced in the polyp are used by the *zooxanthellae* during photosynthesis to generate oxygen and organic compounds which in turn may be used by the coral polyp. In this way the *zooxanthellae* recycle waste products to form nutrients within the tissues of the coral animal, saving the polyp the energy it would have expended on these activities. In addition, movement of water over reefs by waves and currents constantly washes the corals, and eliminates the need for the polyps to clean themselves. The energy freed up in these ways can go into damage control and new growth.

Reef-building coral animals, efficient as they are, still depend on sunlight. They cannot reproduce in murky water. Unless the water is exceptionally clear, most coral growth stops at a depth of 20 metres (although coral growth as deep as 40 has been found).

In order to appreciate the wealth of marine life that reefs shelter, coral communities can be viewed as "apartment house complexes", where many different kinds of organisms find shelter and food. The secret to the reef's richness of species lies in its complex architecture. Resident reef fishes, which forage during the day, share their living quarters with other, nocturnal species. While the diurnal (daytime) fishes are feeding, their living space is occupied by a fish which is only active at night. During the night the roles are reversed. This sharing of quarters allows a reef to shelter two separate populations of fish. It has been suggested that reefs can support 5–15 times the number of fish found in the North Atlantic. "But putting yields aside," points out Rodney Salm, "the fundamental thing to remember is that coral reefs

are no-cost, self-perpetuating fish farms which produce high quality protein from essentially empty sea water."

The high species diversity on coral reefs gives rise to another, often over-looked, benefit: their potential as sources for new drugs. In order to help reef organisms cope with competition, many have developed substances harmful to other organisms. Researchers have discovered that a number of these highly active compounds may have useful medical applications. For example, certain reef-dwelling seafans and anemones possess compounds with antimicrobial, antileukemic, anticoagulant and cardioactive properties. Such species may prove invaluable in developing anti-cancer drugs, or other pharmaceuticals. The Australian Institute of Marine Science, for instance, has isolated a compound which protects the coral from sunburn. This compound has great potential for application in sunscreen products, and is in the final stages of testing for commercial production.

Coastal zone management

There are no easy solutions to the human and resource crises afflicting the world's coastal areas. Land and sea must both be managed in a way that permits economic development yet sustains the resource base. This involves the balancing of a multitude of human uses with each other, as well as managing resources in such a way that future needs are not sacrificed for the expediency of the moment.

Most coastal management schemes, unless painstakingly worked out with coastal communities and their needs in mind, soon find that they worsen problems they were meant to solve. Tanzania learned this lesson the hard way. In the late 1960s, the government decided to set aside some marine reserves south of Dar es Salaam. No one bothered to try and build support for the reserves among the local fishing communities. Several years later when researchers visited the proposed sites to take an inventory, they were appalled when five of the reefs slated for protection could not even be found. Villagers had blasted them apart for building material.

The other blatant shortcoming of most management schemes is that they are not integrated with land management or coastal resource-use. Fisheries management is nearly always that and nothing more. Caretaking mangrove forests, seagrass beds and coral reefs, upon which most tropical fisheries are dependent, is not included in traditional "fisheries management". And there

is little co-operation between relevant government departments. Mangroves are cleared for agricultural land under the jurisdiction of an agricultural ministry which does not take account of the decline in fish catches that the loss of mangroves entails. Fisheries suffer, while agricultural output increases. One group benefits, another is impoverished.

And in the long term, often no one benefits at all. When mangrove swamps were cleared for agricultural plots on Fiji, the improperly drained soils soon became too acidic to support rice. After a few harvests, the land was abandoned. Only an expensive reclamation scheme could salvage the soil for crop production, or anything else.

Tourist development, without the benefit of coastal management plans or environmental impact studies, can be absolute folly. An example is Dumaguete City on the island of Negros (the Philippines), which decided to lengthen the runway at the local airport so that bigger jets could land with more tourists. But planners failed to take account of the environmental impacts that might result from extending the runway into the bay. No one paid any attention to likely impacts on the city's coastal areas. A few months after the runway was completed, the resort hotels along the coast noticed that their beaches were eroding. Huge wedges of sand were being gouged out and carried away. Subsequent studies revealed the cause: extending the runway into the bay altered tidal currents, which now sweep along the shore scouring out the beaches. A hasty wall had to be built so that the hotels themselves would not be devoured by the sea. Since tourists seek clear water and generous beaches, few bother to come to Dumaguete City.

Trying to close off coastal environments to any kind of development is pointless, unless proper management is introduced. Hundreds of marine parks and protected areas have been declared throughout the world, but many of them suffer from the lack of even a simple management plan. When the Organization of American States (OAS) carried out a review of protected marine areas in the Caribbean in 1986, they discovered that there were 112 with legal protection, accounting for nearly a quarter of the protected marine areas in the world. On closer inspection, the OAS research team found that of these 112 marine parks and reserves, only 28 of them had a budget and staff, a management plan, and institutional support. The rest – 75 per cent of the total – proved to be nothing more than "paper parks". In most cases their borders are not known or respected by local populations, so the parks continue to be exploited.

Lack of coastal management in the Caribbean could begin to translate directly into lost tourist dollars. Already, studies reveal that nearly all of the coral reefs of the Caribbean have been damaged or disturbed to a certain degree. The only pristine reefs left are off the coasts of Belize and Panama, and around some of the more remote islands of the Lesser Antilles. If management plans do not begin to take hold during the course of the next decade, those tourists seeking more than a beach chair in the sun will take their holidays somewhere else.

When countries finally do draw up coastal management plans and carry out resource inventories, little of the work ever gets translated into action. Although the Environmental Management Bureau of the Philippines has prepared voluminous documents on the country's vast coastal zone and drawn up recommendations for its management, no action has been taken to implement the relevant recommendations.

Even projects which do include coastal management can be irritatingly inept in making the proper links with land-based problems which affect coastal areas. On the long, thin and largely undeveloped island of Palawan in the Philippines, an Integrated Management Project focuses on upland logging, with a coastal zone component. Unfortunately, the project has not developed an integrated approach towards resolving coastal development and related management problems. Both logging and tourist development continue, but there is little understanding of their impact on each other. At Bacuit Bay, the site of two tourist complexes, logging in the watershed has increased erosion by as much as 200 per cent; five per cent of the reef is already dead. Gregor Hodgson, a biologist working in the Bay, calculates that if logging continues over the next ten years, there could be a loss of $41 million in potential fisheries and tourism revenues.

Even Thailand, which has taken a leading role in resource management in Southeast Asia, has not been able to evolve working coastal-zone management strategies. The Thais have introduced coastal-zone development planning, but such plans contain little in the way of sustainable management of coastal resources.

Coastal-zone management may be difficult, but it is not impossible. There are successful management programmes in place that can be used as models. Probably the most acclaimed and complicated management plan ever devised and implemented is the one that governs Australia's Great Barrier Reef Marine Park. The Great Barrier Reef is by far the largest marine park in the world, covering

345,000 sq km – bigger than the United Kingdom. It extends for over 2,000 m along Australia's north-east coast, and includes 2,900 separate reef formations and coral islands, with 70 vegetated cays. The area also includes nearly 600 "high islands" located close to the mainland, which are managed by the State of Queensland. Technically, the region is not a park, but rather a multiple-use management system.

The Great Barrier Reef Marine Park was formed in 1975 by an Act of Parliament which had the support of all political parties. Public outrage at the prospect of offshore oil drilling and mining on the reef was the driving force behind the formation of the park. The Great Barrier Reef Marine Park Authority was established to administer the park, with broad powers to regulate and prohibit activities within its borders. Perhaps more importantly, the Act gave the Commonwealth Government the right to interfere in land-based activities that might threaten the integrity of the region's reefs.

But declaring the entire area a marine park was only the first step. Managing it in a sustainable way required comprehensive planning. Before a management strategy could be worked out, a complete resource inventory was taken and highly detailed maps of the entire reef system were drawn up. At the same time the Marine Park Authority sent out thousands of detailed questionnaires to individuals and organizations that used the reef regularly, in an effort to learn how the reef was used, where and by whom. The Authority followed up this process with public meetings and information campaigns, designed to enlist the support of the public and special interests (e.g.) recreational and commercial fishermen, and divers) for their proposed zoning plans.

Once the information was available, the Authority began the task of dividing the entire reef into management zones. In order to facilitate the management of such a vast area of sea and coast, the Barrier Reef itself was divided up into four huge management sections, running from north to south. Within each section, the Authority designated five different kinds of management zones, each prohibiting or permitting certain kinds of activities. These zones include:

- *General Use Zones*. These are all-purpose zones in which most activities, other than mining, drilling and bottom trawling, are permitted.
- *Marine National Park A Zone*. This is a kind of recreational zone where a variety of activities are permitted, including

general recreation, trolling for pelagic species, line fishing, and research;

- *Marine National Park B Zone.* This is a "look but don't touch" zone. All fishing is prohibited so that people may appreciate and enjoy the area in a relatively undisturbed state;
- *Scientific Research Zone.* As the name implies, this zone is limited to scientific research; and
- *Preservation Zone.* In these zones, no activities are allowed, with the exception of special scientific research which cannot be carried out anywhere else.

"The only activities that are not permitted in any part of the Barrier Reef are oil exploration, mining, littering, spear-fishing with SCUBA gear, and the taking of large specimens of certain species of fish," explains Graeme Kelleher, Chairman of the Great Barrier Reef Marine Park Authority, a post he has held since 1979.

Most of the sections have large areas of "General Use" zoning, where multiple activities are permitted. Still, the success of the entire management concept rests on the voluntary compliance of the general public and specialized user groups. "We cannot possibly patrol the entire reef with only 60 field staff and a few airplanes," points out Kelleher. "Some reefs are only visited once a year, despite the fact that we spend some $700,000 a year on aerial surveillance."

With limited staff and funding, the Marine Park Authority directs much of its efforts at educating the public about the different zones and the need for self-policing. So far, this tactic seems to be working. There are few violations of the zoning restrictions: only about 60–70 serious violations occur each year.

The Barrier Reef's main source of income is from tourism, which is developing rapidly. In 1986–7, for example, 160,000 tourists visited the region's 24 island resorts. By the year 2000, the Reef may see half a million visitors annually. Despite early fears that the Reef would be over-run with trophy-hunting tourists, so far the number of off-shore resorts has been kept in check.

Until recently commercial fishermen have been the park's "biggest human problem," according to Kelleher; "They opposed all restrictions and wanted the entire reef open to trawling." Fortunately, however, Kelleher has witnessed a recent improvement in co-operation from the fishermen and their organizations.

But by far the most controversial issue on the reef is the crown-of-thorns starfish, a natural predator with a taste for the coral polyps

which build reefs. Normally, a few starfish feeding on coral polyps make little difference to the reef's ecosystem. However, the crown-of-thorns starfish has a disturbing habit of descending on reefs by the millions. Since each individual starfish can eat its own area of coral in a day, a large infestation can soon destroy an entire reef. Worse, each female crown-of-thorns starfish is capable of laying 20–100 million eggs. The offspring of just one individual, if they survive, are enough to cause a dangerous infestation. So far, nearly one-third of the entire Barrier Reef has been affected by this menace.

The problem is complicated by the fact that the crown-of-thorns has few enemies. Nothing seems to eat it, except the rare triton mollusc. So far, large-scale controls have been impossible to apply. Divers have been conscripted to inject starfish with poison and in some areas fences have been erected to keep them out. But given the scale of the invasion, these steps remain inadequate.

So far, there is no method of control which works, despite the $1 million being spent on research each year. "We have 30 research projects involving 50 scientists," claims Kelleher. "But we just don't know enough about this starfish to know whether or not general controls should be instituted. Any reef-wide control strategies that might work, would cost tens of millions of dollars."

Kelleher believes that the most serious problem facing the Great Barrier Reef in this decade will be the need to reduce run-off of sediments and nutrients from the mainland into reef waters.

Barring natural catastrophies, the multi-use management concept for the Great Barrier Reef seems to be a promising way to preserve coastal resources from over-exploitation, without declaring the entire area off-limits to any kind of use. The lessons learned by the Marine Park Authority in managing such a vast region could well be applied elsewhere.

Organizations like the International Centre for Living Aquatic Resources Management (ICLARM) in Manila seem to have learnt from the Great Barrier Reef Authority. But the coastal problems afflicting most Third World countries are far more complicated than those confronting the Great Barrier Reef. None the less, motivating local people to accept management plans is fundamental to the success of any coastal management strategy, an issue that ICLARM and other NGOs are beginning to address.

International NGOs, such as the International Union for Conservation of Nature and Natural Resources (IUCN), are helping

developing countries draw up management plans for marine parks and protected areas. Presently the IUCN is active in 22 countries.

In some cases, as on the island of Negros (the Philippines), local communities are taking measures into their own hands without government or other outside help, to conserve and manage their coastal resources.

Unfortunately, much of what passes for coastal zone management misses the mark. Far too often, coastal management plans are not integrated with overall development objectives. There are few success stories, and nearly all of the sustainable projects tend to be local and small-scale.

Turning the tide of destruction that has beset coastal environments in every one of the regional seas that wash Third World coasts requires nothing less than a full-scale national programme of action, tied into regional-scale strategies for sustainable development of the sea and its coasts. In this sense UNEP's Regional Seas programme offers one of the best conduits for international, and above all regional, co-operation for combating common problems.

The threat of rising seas

One global problem that is receiving a great deal of attention from the United Nations, international NGOs, governments, academics, the media, even local citizens' groups, is the imminent threat of climate change and sea level rise. If this obsession with the likely impacts of sea level rise – especially for low-lying islands and coral atolls – generates better management of coastal areas, so much the better. It is the only coastal issue, for the moment, which is capable of arousing a truly international response. In order to address this threat in a realistic manner, coastal nations will also have to begin to manage coastal resources and near-shore waters. Leaving things to chance, or trying half-measures, will not do; if the sea level is going to rise, it will. Some scientists, like Dr Irving Mintzer, Director of Policy Research at the Center for Global Change, University of Maryland, believe we are destined for a temperature increase and expanding sea levels, no matter what we do. The questions are: by how much, and where will the worst affected areas be?

Greenhouse gases – carbon dioxide, methane, nitrous oxide tropospheric ozone and chlorofluorocarbons (CFCs) – already released into the atmosphere insure a temperature rise of anywhere from 2–5° Fahrenheit by early next century. "This may not sound like

much of an increase," observes Mintzer. "But a warming of just two degrees would take the planet outside the temperature range which has been experienced in the last 10,000 years." The seas have already risen by 20 centimetres, due to the thermal expansion of seawater when heated. More incremental rises are expected as temperatures increase and icecaps begin to melt as well.

UNEP, along with a host of other national and international organizations, are busy compiling reports and studies that attempt to answer the questions posed by climate change. There is a sense of urgency. Even a rise of as little as one metre would inundate coastal lands, particularly river deltas, mangrove forests, and coral islands. A billion people could be turned into environmental refugees by a 1–2 m rise in the world's seas. According to Stjepan Keckes, Director of UNEP's Oceans and Coastal Areas Programme Activity Centre in Nairobi, "sea level rise for many island states and territories, as well as some mainland nations, could be the most serious environmental problem confronting them over the course of the next century."

Speaking at the Commonwealth meeting in Kuala Lumpur, Malaysia in the autumn of 1989, the President of the Maldives, Mr Maumoon Abdul Gayoom, told the assembled heads of state that if the sea level rose as predicted by one m, by 2050, many countries in the Commonwealth "will simply disappear". With most of his nation's islands no more than two m above sea level, the Maldives is, in Gayoom's words, "an endangered country".

Similarly, Bangladesh reports that a one m rise in the Bengal Sea would flood 15 per cent of the entire country, killing off thousands of hectares of mangrove forests in the Sundarbans and displacing at least 10 million people. Tens of millions would be forced to flee the floodplains of the Indus River Delta in Pakistan and the Nile Delta in Egypt.

A UNEP report detailing the effects of sea level rise in the South Pacific claims that those of the region's 5 million people living on coral islands and atolls could suffer drastic consequences from a 1–2 m rise in the Pacific. Many island countries, such as Tuvalu, Kiribati and the Marshall Islands, would be swamped or under water, their populations forced to move to higher, drier islands or the mainland countries around the Pacific rim.

Rising seas could flood over a quarter of Papua New Guinea's 17,000 km coastline, inundating floodplains and river deltas. A one m rise would lead to saltwater intrusions into water tables, the waterlogging of soil and massive coastal erosion.

With rising seas come increased effects from storm surges, like hurricanes and typhoons. A one m rise in the world's seas could mean terrible consequences for mainland coastal populations, like those of Bangladesh and India. Storm surges in the late 1970s killed 300,000 Bangladeshis and reached 150 km inland. A higher sea level would translate directly into higher death tolls and escalating property damage from storms.

The same could be said for virtually every one of the smaller and lower-lying islands of the Caribbean Sea and Indian and Pacific Oceans. It took a full half year before Jamaica recovered from Hurricane Gilbert, which struck the island in 1988. A hurricane which swept over Dominica in 1979 destroyed 85 per cent of the island's houses; a typhoon in Tonga in 1982 wiped out half the island's houses and devastated that year's fruit crop. Imagine how much worse these storms would have been if the sea had been a metre higher.

With just such a scenario in mind, Mr Gayoom of the Maldives proposed to the Commonwealth meeting in Kuala Lumpur that since the poorer countries of the developing world had nothing to do with causing this human-induced catastrophe, the rich nations should mobilize international assistance for those countries most vulnerable to climate change and rising seas. Something will have to be done, warned Mr Gayoom, unless the world wants to be "inundated with environmental refugees", most of them poor.

The Prime Minister of Malaysia, Mr Mahathir bin Mohamad, even proposed that an international fund be established to help developing countries pay for imported technologies, reforestation schemes, and other programmes to protect the environment from the effects of global warming and inexorably rising seas.

One of the best results that could emerge from all the concern over climate change and swollen seas would be the development of workable coastal management plans for all developing countries with a coastline. Proper, well-conceived and executed coastal zone management strategies would permit billions of people to utilize their resources better and give them time to prepare for rising seas. Such plans would also allow coastal populations to build for a sustainable future. Perhaps more importantly, they might help give millions of the poorest people, those constantly living on the edge of survival, a sustainable present.

2. The Regional Seas of the Developing World

When the United Nations Environment Programme (UNEP) began the first of its regional seas programmes, in the Mediterranean Sea in 1974, few officials then could have predicted its evolution into one of the most comprehensive UN programmes ever launched to control marine pollution and promote better management of coastal and near-shore resources. After its auspicious beginning in the Mediterranean, the programme went on to encompass 10 of the world's regional seas, involving 120 countries. With the sole exception of the Mediterranean coast, which includes both highly developed and barely developing economies, all of UNEP's efforts at setting up regional mechanisms for managing seas and coasts in a sustainable manner have been concentrated in the South. The following chapters describe each of these seas in turn.

Despite initial successes in setting up regional programmes – the Mediterranean, Persian Gulf and the Caribbean, for example – the record is a very uneven one. The beginning promised much. Many governments were quick to recognize the value of a regional seas approach in confronting the crisis of their coasts. But following up lofty proclamations with skilled labour, money and, most important of all, management plans, took years of painstaking work by UNEP and the relevant states. Many countries involved in the regional seas network have yet to evolve coastal management strategies or put them in place. Of the ten regional seas programmes currently operating, perhaps four – the Mediterranean, Wider Caribbean, the Gulf of Arabia and the South-east Pacific (west coast of South America) – can point to some progress in setting up sustainable management regimes. None of the programmes, with the notable exception of the Mediterranean, has had much success in combating pollution. But even the Mediterranean states trod water on this issue; it was a decade before anti-pollution measures began to take hold.

This is not to say, however, that the other programmes have run aground. In many regions, with their nationalist rivalries and

history of confrontation, the simple fact that a regional forum exists for dealing with common environmental concerns is something to celebrate. South Asia, for instance, has not yet endorsed an action plan to protect and manage its seas and coasts. Yet the first hurdles have been overcome. Structures have started to develop for dealing with the problems on regional level. More importantly, perhaps, the very fact of launching regional seas programmes has strengthened national institutions charged with managing coastal and sea concerns. At the least, research capabilities have improved and the training of specialists has been given some priority.

Institution building takes time, especially for poor countries with no planning or management foundation to build on. Dr Ed Gomez, Director of the Marine Science Institute at the University of the Philippines in Manila, believes that scientific research into Southeast Asia's marine and coastal problems has been greatly enhanced because of the regional seas programme. "We would certainly not be this far along in our research without COBSEA, the regional seas programme for this region." The same could be said for virtually every one of the other programmes, no matter how far along they are in tackling their common problems. In many regions, there is no network of scientific institutions dealing with marine research and related problems. Scientists have had to form informal contacts with colleagues in neighbouring countries and elsewhere. At least the regional seas network provides a forum for scientists and policy-makers to exchange information and ideas.

Peter Thacher, former Deputy Executive Director of UNEP, describes the underlying factors which influence UNEP's marine policy:

> There are two fundamental notions in back of the regional seas philosophy. The first is the idea that while marine pollution problems are global in scale, the most efficient way to solve them might be through co-operative programmes at the regional level. The second is that although marine pollution problems are perceived to be somewhere "out there", off-shore and over the horizon, the origin of most of them is in fact here on dry, sovereign land.

By the time the Stockholm Conference on the Human Environment took shape in 1972, there was already a consensus among policy makers and scientists that land-based activities were a significant

source of marine pollution. But getting the issue of ocean pollution firmly on the Stockholm agenda was largely the work of Maurice Strong, UNEP's first Executive Director and one of the movers behind the environment movement. In preparations for the Stockholm Conference, Strong recommended the formation of a working group on marine pollution for the following reasons:

> First to establish the broad design for a master plan to safeguard the health of the oceans for the greater benefit of all mankind, and second to initiate action with a view to intergovernmental agreement by the time of the Stockholm Conference on some particular measures which are both urgent and feasible, such as a convention on the control of ocean dumping.

After UNEP was established, as a result of the Stockholm Conference, one of the first mandates given to the fledgling organization was to come up with a programme of action to reduce marine pollution and loss of vital coastal resources.

At the same time, the Stockholm Conference took the issue of the health of the oceans even further and endorsed, as Strong had suggested, what came to be known as the London Ocean Dumping Convention, a legally binding treaty to curtail the dumping of dangerous and hazardous substances in the world's seas. It was opened for signature in early 1973, less than a year after the Stockholm Conference.

Naturally, the momentum of Stockholm gave impetus to initial efforts at setting up the first regional seas programme in the Mediterranean. It was the obvious sea with which to open the programme. Despite its many languages and different cultures, most Mediterranean peoples think of the sea as *mare nostrum*. Peter Thacher recalls that representatives from a number of Mediterranean states, who would not talk to each other, nevertheless approached UNEP to urge that something be done. "At the time there were outright hostilities between various states from one end of the Mediterranean Basin to the other. This made dramatic the hope that if – a big 'if' in those days – agreement could be won to allow governments to co-operate in preserving their common future, it might have beneficial effects on current, day-to-day relations between them."

The framework established for the Mediterranean Action Plan has been copied elsewhere. Although each programme reflects different

priorities from region to region, they all share some common ground. Thacher stresses that "each has, for example, a common table of contents setting forth co-operative work in scientific, economic, political/legal areas with a section on the institutional and financial means by which to ensure that action is taken."

But progress in implementing the action plans varies a great deal. It may have taken only one "power lunch" for Dr Tolba, the current Executive Director of UNEP, to pull together a financial arrangement for the Persian Gulf, but others, like the Caribbean, were stymied for years behind financial constraints. Many of the programmes are still hampered by slack budgets and institutional inertia.

Too many governments have yet fully to recognize the crisis of their coasts. A kind of resigned lethargy has settled over some of the regional seas programmes, as national institutions dealing with seas and coasts struggle to get their priority issues onto the political agenda, with only limited success. In many cases, agencies or ministries charged with environmental concerns do not even have direct access to the levers of power. They are isolated and removed from the give and take of governance. Environment is the unwanted step-child of development.

Until the crises which threaten to overwhelm sea coasts are given credence, progress towards confronting the challenges will be desultory. In some regions they may peter out altogether as other more pressing economic matters consume budgets and staff resources. Meanwhile, the regional seas programmes, along with other national and international efforts to resolve the problems caused by growing populations and loss of coastal resources, will continue to sound the alarms. The question is: will they be heard in time?

3. The Mediterranean Sea

The Mediterranean Sea is the centre of western civilization. Along its shores flourished some of the world's greatest empires: Egyptian, Persian, Phoenician, Assyrian, Minoan, Macedonian, Greek and Roman. It was (and still is) a cauldron of cultures and has always been a vast highway over which goods were traded and people transported. It was a vital link in the spread of cultures, political systems and religions throughout the world. Even 100 years ago, Homer's wine dark sea seemed vast and unconquerable.

The modern Mediterranean, however, has shrunk. It has become, in the words of French historian Paul-Marc Henry, "a small, crowded lake, and a polluted one at that". By the mid-1970s the Mediterranean had been turned into a huge waste-bin, a receptacle for millions of tonnes of pollution. Its shores were scarred with unbridled development; its cities and towns bursting at the seams with people. At the same time, the sea was being transformed into one of the world's favourite summer playgrounds. During the summer months upwards of 100 million tourists scramble for its beaches.

Recognizing the urgent need for regional action to save the Mediterranean, UNEP launched its first of ten regional seas programmes. In 1975, the Mediterranean states agreed to an Action Plan for the Protection of the Mediterranean Environment. The following year, delegates from all 18 Mediterranean countries (except Albania) signed the Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution, plus two protocols. It was the beginning of a long and complicated process to reverse the degradation of the sea.

For UNEP, the Mediterranean Action Plan (MAP) was a diplomatic coup. Within the context of the plan Greek, Turkish and Cypriot marine biologists have agreed to see their coasts as an environmental issue, rather than a political one. Israeli sanitary engineers have sat down with their Arab counterparts. The plan

remains the only international forum through which regional co-operation in the Mediterranean Basin is made possible.

Too much geography, too little sea

In a sense, the Mediterranean Sea is a victim of unfortunate geography. Although it is relatively deep (averaging 1,500 m), it is not a very big sea, covering an area of about 2.9 million sq km. The volume of water amounts to 3.7 million cubic km. Impressive as these numbers sound, they don't add up to much. The Mediterranean is too far north to support coral reefs and mangrove swamps. And it is not blessed with vast submarine meadows. Continental shelves are non-existent; shallow coastal waters suddenly plunge to depths of 1,000 m or more. Instead, the sea is nutrient-starved and relatively fish-poor.

The lands around the Mediterranean are as barren as the sea. Low rainfall in many areas means agricultural land must be irrigated. Except for Libyan oil, it is poor in mineral and energy resources. In the dry eastern and southern parts of the Mediterranean Basin, water is often more expensive than oil.

Because of its unfortunate geography, pollution tends to accumulate in the Mediterranean Sea. As any map shows, it is a confined, enclosed sea, bottled up behind the Strait of Gibraltar. Its hydrological pump works slowly, taking at least 80 years for its waters to renew themselves. Also, since there are no tides to speak of, there are no tidal currents to flush away pollution.

Crammed along the 45,000 km of Mediterranean coastline is a permanent population of around 130 million, supplemented every year by over 100 million tourists. Demographers predict that its resident population may soar to 200 million by the turn of the century.

Most of the region's big cities are located on or near the coast. In order to cope with the tourist boom, which stretches from May to October, entire coastlines have been purged of their natural habitats and reshaped to accomodate the annual invasion of northern tourists. For nearly half the year the population of the region doubles. The result has been widespread devastation of coastal resources, particularly wetlands, forests and the Mediterranean Maquis (a shrub-dominated ecosystem somewhere between grasslands and forests). But croplands have also been lost to urban expansion and

the helter-skelter development of resort hotels and other tourist accommodations. In Spain, France, Italy and parts of Greece there are practically no undeveloped coastlines left. Along the Catalonian coast of Spain, only a small fraction of its 580 km-long shore has been spared from urban, port, industrial or tourist development. Seventy-five per cent of Italy's Romagna coast is "developed". Twenty years ago the south coast of Attica between Athens and Cape Sounion was nothing but olive groves and croplands. Today it is dominated by inter-connected tourist complexes and summer villas. Unpaved roads running back from the coast into scorched hills are lined with garbage, construction rubble and household junk.

Development along the Mediterranean has been lopsided. The booming economies of the industrialized northern rim countries stand in stark contrast to the poor, developing economies of the southern rim. By the mid-1970s most of the northern rim countries were highly industrialized, while Egypt and Algeria were just beginning to enter the industrial age. The populations of the southern rim countries – Egypt, Algeria, Libya, Morocco and Tunisia – are growing by two per cent a year and above, while the populations of the North are stabilizing, or growing at almost imperceptible rates (with the exception of Turkey).

There is also a religious divide between the Christian north- and Muslim south-rim countries.

Coastal pollution

Since the 1960s, the Mediterranean has acquired the reputation of being one of the most polluted seas in the world. Millions of tonnes of pollutants, both natural and synthetic, are spilled into the sea every year, mostly via river systems. Only some 30 per cent of the sewage from over 700 coastal towns and cities receives any form of treatment before being discharged into the sea. Often sewage outfalls don't extend far enough from shore, their contents spilled in shallow, near-shore waters where they create health hazards. The famous marine explorer Jacques Cousteau once described the sea as a veritable "garbage dump".

World Health Organization (WHO) scientist Richard Helmer breaks down the annual input of some (but not all) pollutants entering the Mediterranean from land-based sources as follows:

- 12 million tonnes of organic matter
- 320,000 tonnes of phosphorus
- 800,000 tonnes of nitrogen
- 100 tonnes of mercury
- 3,800 tonnes of lead
- 2,400 tonnes of chromium
- 21,000 tonnes of zinc
- 12,000 tonnes of phenols
- 60,000 tonnes of detergents
- 90 tonnes of organochlorine pesticides.

Most of this pollution is transported into coastal waters by the region's 70 major river systems (and numerous small streams). Not only does the coastal population of the Mediterranean foul its own nest, but much of the municipal and industrial wastes of the entire basin find their way into the sea as well.

Heavy metals such as mercury, lead, zinc, chromium, copper and cadmium continue to enter the Mediterranean in unregulated quantities. Since toxic metals are all considered persistent poisons, accumulating in food chains and bottom sediments, they represent chronic health threats in certain areas. Filter-feeders like clams, mussels, and oysters are known to concentrate heavy metals in their tissues. High levels of copper have been found in oysters in the Rio Tinto Estuary in Spain, and mercury concentrations of up to 47 ppm (parts per million) have turned up in bottom sediments along the southern coast of Tuscany (Italy) and in the northern part of the Gulf of Trieste. High mercury levels have also been found in commercially important fish and shellfish such as bluefin tuna, striped mullet and Norway lobster. Most of these metals are brought by rivers, but some fall from the atmosphere attached to minute particles of soot and dust.

In general, the developed northern rim is more contaminated with pollution than the less-developed southern rim. However, nearly every one of the Mediterranean's 70 major cities (those having more than 100,000 people) create local "hot spots" of pollution from the discharge of untreated sewage and industrial wastes. Chronically high pollution levels are recorded in the northern Adriatic, Izmir Bay (Turkey), Elevsis Bay (Greece), in the Lagoon of Tunis, and in the coastal waters of Alexandria, Egypt.

Elevsis Bay, outside Athens, is said to be suffocating from industrial pollution pumped into its waters from 29 industrial

enterprises along the northern coast of Attica. Untreated effluents from shipyards, refineries, steel mills, electrochemicals, canneries, textiles, and glass and cement works have rendered the Bay's once clear waters a dingy brown. Most marine life has been exterminated.

The coastal waters of Alexandria are in worse shape. Around one million cubic metres of untreated municipal and industrial wastes are discharged every day through outfalls too short to allow these wastes to be diluted or dispersed. Instead, the entire waterfront of Alexandria reeks with rotting sewage, algal scum, household slops, construction debris and industrial wastes. By the summer of 1986 bathers along Alexandria's beaches began complaining of pollution-related skin sores, rashes, and intestinal disorders.

A $500 million joint US–Egyptian project, called the Updated Alexandria Wastewater Master Plan, aims to renovate and upgrade two existing sewage treatment plants, neither of which functions at present. But even when these plants start operating sometime in 1991, some 300,000 cu m of sewage a year will still escape treatment. A UNEP task-force was sent to the city to advise municipal authorities on how to treat and dispose of their growing mountain of wastes. So far, no action has been taken.

Despite clean-up efforts, the Mediterranean is still shamefully polluted. Sea-side vacationers risk everything from skin rashes to viral hepatitis and food poisoning (salmonella) from bathing in dirty waters and eating contaminated fish and shellfish. One-fifth of all beaches are still so polluted as to be unsafe for bathing. Athenians are now accustomed to driving 70 kilometres to find clean beaches. And many of the region's shellfish growing areas do not produce seafood fit for the table. Typhoid is said to be 100 times more frequent in the Mediterranean than in northern Europe. Even periodic outbreaks of cholera have been reported over the years. In the summer of 1973 a cholera epidemic struck Naples and southern Italy, with 325 reported cases and 25 deaths. The cause was traced to mussels contaminated with raw sewage.

The other black death

The scourge of oil pollution, on the other hand, knows no boundaries. Because the Mediterranean is one of the major crossroads for the world's merchant and tanker fleets, oil is found nearly everywhere. Both north and south suffer. Until recently, the Mediterranean Sea

was regarded as one of the most oil-fouled bodies of seawater in the world. Philippe Le Lourd, former Director of the Regional Oil Combating Centre in Malta, estimates that somewhere between 500,000 and one million tons of oil (and oil-related products) are flushed into the Mediterranean every year. Most of this pollution comes from routine shipping operations and tanker traffic through the discharge of dirty ballast waters, bilge slops, and oily wastes.

In the mid-1970s, the Mediterranean was covered with so much oil that scientists trying to study marine life often pulled in nets filled with tar balls instead of fish. In 1977, during a research cruise in the eastern Mediterranean, scientists from the International Atomic Energy Agency's laboratory at Monaco made the following observation: "between Crete and Libya a 30-minute neuston (surface) tow completely filled a one-litre collecting jar with tar balls. Oil and tar residues were omnipresent and great caution was necessary when lowering plankton nets through the surface film to avoid contamination." In other areas, as much as 500 litres of tar per sq km of water surface have been found. The largest concentration of tar was found in the Ionian Sea off Libya and between Libya and Sicily. By 1980, the Mediterranean Sea accounted for nearly a fifth of all oil spilled into the world's oceans from accidents and routine shipping.

Today, around 600 million tonnes of petroleum products are shipped into and through the Mediterranean every year. About half of this amount ends up at 18 ports scattered around the sea. Although still a general problem, oil pollution has been reduced thanks to the installation of oil-waste handling facilities at major ports around the region.

De-oiling the Mediterranean

Although a Regional Oil Combating Centre was established on Malta, to co-ordinate efforts at fighting oil pollution from accidents, this strategy left unsettled the matter of routine oil pollution from normal shipping activities. Action on this front got underway in the early 1980s, led by Greece, whose maritime tradition goes back 3,000 years.

Instead of opting for land-based facilities, the Greek government decided to promote the construction of floating facilities for the reclamation of waste oils and other petroleum products. Today,

the country has seven such facilities scattered around the country at major ports like Piraeus, Patras, Siros, and Thessaloniki.

Both the International Maritime Organization (IMO) and the European Community support the construction of floating facilities. Given the success of the Greek operations – in 1987 Greece was able to collect nearly 2.6 million tonnes of oily wastes, from which they extracted over 26,000 tonnes of recovered oil – more of them are expected to be set up in ports around the Mediterranean and elsewhere. Recently, two more went into operation: at Rejeka in Yugoslavia and at Port Said in Egypt, where 20,000 ships pass on their way through the Suez Canal every year.

The first oil reclamation facility in Greece was built by a young entrepreneur named Denis Yatras, using, appropriately, a retired oil tanker. His ship, the *Delta*, is currently anchored in Elevsis Bay wedged between huge ocean-going tankers. Yatras explains how his operation works. "In 1987 we processed over 400,000 tonnes of tanker slops and bilge water and were able to get 17,274 tonnes of recovered oil. We then deliver our oil, which still contains three per cent water, to a local refinery, where it is re-processed. In return for the oil, we receive 75 per cent of the value of the oil in the form of fuel oil, which we market ourselves." This swap system seems to work well. After all, Yatras does not need to pay for the oily wastes, only for the maintenance of his ship and oil-water separator system, and the salaries of his engineers. So far, the *Delta* pays for itself.

Meanwhile, Yatras is working on a more sophisticated computer model, which will enable him to squeeze more recoverable petroleum products out of oily wastes from shipping. His goal is to design a system that will get better separation of oil from water, using less energy than his current process. He intends to market the system worldwide.

Yatras is convinced that floating oil recovery systems are the wave of the future. "The point is not just recovering oil, but pollution prevention. Just taking the 17,000 tonnes of oil that the *Delta* recovered in 1987 means that 1,700 square kilometres of sea are not polluted with oily residues one centimetre deep." According to the IMO, all major ports are now required to have oil-waste handling facilities. Unfortunately, requirements are often one thing, reality another. Too many ports have yet to introduce even basic oil-water separators.

Fisheries

The Mediterranean is a fish-poor sea. The 5.5 million tonnes of fish caught every year amount to a mere two per cent of the world take. There is no real fishing industry in the sea. Ninety per cent of all fishing activity is labour-intensive and small-scale. Most fishing boats are no longer than 30 feet, with crews of 2–4 people. Net fishing is concentrated in shallower, near-shore waters and around the sea's many islands.

Nevertheless, over the past 20 years a deep sea trawling industry has evolved. Concentrated around Sicily, these vessels can stay at sea for weeks and harvest great quantities of pelagic fish. The trouble is that over half of what they catch is tossed overboard because only certain kinds of fish, like tuna, fetch the high prices necessary to pay the overhead on large trawlers. Today, deep sea fishing around the Mediterranean is becoming more difficult as more and bigger ships are needed to bring home the same catches.

Fishing pressures are becoming intense along much of the northern rim, and along the coasts of Algeria, Morocco and Egypt as well. In many areas catches of popular shellfish, such as lobsters, have declined due to over-exploitation.

Because the Mediterranean's meagre fish catches cannot keep pace with demand, nearly two-thirds of all fish consumed in the region are imported from other seas, most notably the Atlantic. Still, the price of Mediterranean fish remains high. Its limited fisheries are worth about $700 million a year – a full five per cent of the value of the total world catch of fish and shellfish. As long as fish stocks remain low and hard to get, the artisanal nature of Mediterranean fisheries will prevail. Increasingly, big trawler operations cannot stay out long enough to take in profitable catches.

Marine mammals

Like marine mammals everywhere, those in the Mediterranean are under siege. Dolphin populations have fallen, despite conservation efforts, as have the numbers of sea turtles and seals. In most cases, pollution is not the problem. Marine mammals are running out of space as their breeding habitats are destroyed or disturbed to make room for more people.

Perhaps the most critically endangered marine mammal in the region is the Mediterranean monk seal (*Monachus monachus*). With a current population hovering around 600, it is restricted to a few isolated Greek islands and the Aegean coast of Turkey in the eastern Mediterranean. Unfortunately, the monk seal is a victim of both habitat loss and commercial fishing pressures. Fishermen view the seal as a competitor for limited fish stocks and kill them whenever they can. Others are strangled and drowned when they become entangled in fishing nets. Although there may be more conservation groups trying to save this animal than there are seals to save, the few remaining monk seals stand little chance of survival, unless local fishermen are enlisted for their protection.

Land degradation

In many areas of the Mediterranean Basin, land is being degraded from over-cultivation, deforestation, poorly planned and installed irrigation systems, and the spread of deserts.

The arid zone, which incorporates the south-eastern part of Spain, Morocco, Algeria, Tunisia, Libya, Egypt, Israel and Syria, suffers principally from soil erosion and advancing deserts. In southern Tunisia alone an area of 12,500 sq km was lost to the Sahara in less than ten years. The reasons were attributed to inappropriate agricultural practices, over-grazing of rangelands by domestic animals, and poorly managed irrigation schemes. In this area, the loss of topsoil averaged ten tonnes per hectare per month. On the fringes of the Sahara Desert, soil losses as high as 250 tonnes per hectare per year have been recorded.

Deforestation consumes around 60 million hectares of shrub and forestland every year. Much of this wood, perhaps as much as 60 million tonnes, is burned for fuel. Although some of this degraded forestland regenerates itself during rainy years, vast tracts remain treeless, and increasingly desertified. As more land becomes degraded, more people are forced off the land and into coastal areas.

In addition, somewhere between 30,000 and 40,000 hectares of irrigated croplands are lost every year due to salinization and alkalization of the soil. These processes effectively sterilize the land, rendering it unfit for agricultural production. Degraded land can be reclaimed, but it is expensive and time consuming.

The Mediterranean Action Plan

In 1975, 16 of the Mediterranean's 18 states gathered in Barcelona for an historic occasion: the approval of an Action Plan for the Protection of the Mediterranean Environment. The plan called for a broad three-pronged approach to controlling pollution and managing the sea's resources collectively: a series of legally-binding treaties to be drawn up and signed by Mediterranean governments; the creation of a pollution monitoring network and the co-ordination of scientific research efforts; and a socio-economic programme that would reconcile vital development priorities with a healthy Mediterranean environment.

The following year, those same countries, plus the European Community and Syria, returned to Barcelona in February to sign the Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution. The convention committed the Mediterranean states to "take all appropriate measures . . . to prevent, abate and combat pollution . . . and to protect the marine environment". It provided the legal muscle for the action plan which had been adopted in 1975. Two significant protocols were also signed on 18 February 1976. The "Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft" blacklisted dangerous wastes such as mercury, cadmium, crude oil, chlorinated hydrocarbons, pesticides and radioactive substances, prohibiting their disposal in the sea. A grey list of substances that could be dumped under special circumstances (by permit only) was also included. A second "Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency" commits governments to co-operate in combating oil and chemical spills. In 1976 a regional oil-combating centre was established in Malta as part of the Action Plan.

In many cases, the protocol on oil pollution was buttressed by national legislation already in place. Greece, for example, has an extensive set of laws protecting the marine environment from oil pollution. "Every port authority in Greece – some 90 in all – has plans and equipment for combating oil spills," states Captain D. Doumanis, Head of the Marine Environment Protection Division in the Ministry of Mercantile Marine. "This has helped enormously in lessening the coastal impacts of oil spills."

As the first step in regional co-operation to combat pollution, the participants in the Action Plan agreed to set up the Mediterranean Pollution Monitoring and Research Programme (called MEDPOL). The first phase, which ran from 1976 to 1980, involved scientists from 83 research centres and laboratories from 16 Mediterranean countries. The initial years were devoted to finding out just how polluted the sea really was by conducting numerous baseline studies. The Action Plan countries also established standardized analytical procedures so the data gathered by one institution, in say Egypt, could be utilized and understood by colleagues in France or Italy.

By introducing standardized pollution monitoring and data collection methods, a scientific network could be established throughout the region and expensive duplication of research avoided. By 1985, 102 research projects were being carried out by 62 research centres in 16 Mediterranean countries. Today, 14 countries have implemented national monitoring programmes in co-operation with UNEP.

In 1979 a "Blue Plan" for the long-term management of the Mediterranean Sea was launched as part of the socio-economic component of the Action Plan. It was intended to "take the long view", dovetailing future development plans with environment protection measures. A regional centre for co-ordinating Blue Plan research was set up in Sophia Antipolis, on the French Riviera.

The centre has issued numerous reports dealing with a wide spectrum of issues, including freshwater management, industrial growth and industrialization strategies, energy needs, population movements, urbanization, and the impact of tourism on coastal areas. One future scenario elaborated by Blue Plan research predicts that, if present trends hold, by the middle of the next century the Mediterranean might see 95 per cent of its coastline urbanized to meet the needs of a resident population that has swollen to 200 million, supplemented by 200 million seasonal tourists. Roads, by then, would have to accommodate 150 million private cars (compared to the current 50 million). Balancing the needs of such a staggering number of people with environmental considerations will require regional co-operation on a level not yet achieved.

In 1980, after lengthy negotiations, the 17 members of the Action Plan signed the Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources. This landmark agreement identifies measures to control coastal pollution from municipal sewage, industrial wastes and agricultural chemicals. It

also has a black and grey list of substances similar to those noted in the dumping protocol.

Each government, however, is responsible for implementing the protocol in its own way. Good intentions are not enough. With the total costs of coastal cleanup estimated at $15 billion over the next 10–15 years, a number of the area's cash-short countries have yet to act substantively on this mandate.

At a meeting in Geneva in 1982, the Mediterranean governments also approved a protocol providing special protection for endangered species of fauna and flora as well as critical habitats. Officially called the Protocol Concerning Mediterranean Specially Protected Areas, it entered into force in the spring of 1987, after nine countries and the European Community had ratified it. By 1988 it had been ratified by 13 countries. A regional centre was established in Tunis to assist governments in applying the protocol.

The agreement binds signatories to set up areas of biological interest – fisheries, breeding grounds for protected species, and monk seal and sea turtle sanctuaries – within the next few years. Under the umbrella of the protocol, a number of marine parks and protected areas will also be created.

Through UNESCO's International Council on Monuments and Sites (ICOMOS) Mediterranean countries have identified over 100 special historic sites that merit protection. The sites, which have to be of common interest to the peoples of the Mediterranean – not just nationally significant – range from Malta's pre-historic megaliths, which predate Stonehenge by a thousand years, to the beautiful walled city of Rhodes. The sites were approved by all of the Mediterranean Action Plan countries, who have agreed to help preserve and protect them.

Action in the Action Plan

Despite periodic financial setbacks, the Mediterranean Action Plan (MAP) co-ordinating unit, headquartered in Athens, is currently operating with an annual budget of $5 million. Although the Action Plan functions as part of UNEP, programme decisions are taken by the governments of the region. Since MAP is now self-sufficient, UNEP no longer contributes funds for its operation. "Instead," explains Aldo Manos, director of MAP, "the programme now pays UNEP $500,000 a year for co-ordinating activities in Nairobi." The 17 countries of MAP set up a Mediterranean Trust Fund

to underwrite costs for the secretariat in Athens, the five regional centres, and to provide core funding for the Plan's far-flung research, monitoring and conservation programmes.

"We now have strong political commitment on the part of our supporting governments," states Manos. "Countries also give additional contributions to fund specific projects of interest."

Although the first decade of MAP was noted mainly for its accumulation of data, the action part of the Action Plan is beginning to get results. MEDPOL has moved into the management of coastal resources. In addition, most of the countries of the region have begun to take concrete measures to reduce pollution from land-based sources under the terms of the protocol mentioned above.

At a meeting in Genoa in 1985, the MAP countries agreed to sweeping measures in a co-ordinated effort to make the Mediterranean Sea cleaner and safer. Ten priority targets were set for the second Mediterranean decade (1985–95). Included among them were commitments to establish more reception facilities for dirty ballast waters and oily wastes from shipping; the construction of sewage treatment plants in all cities with over 100,000 inhabitants, as well as the installation of outfalls and/or treatment plants for all towns with more than 10,000 residents; the application of environmental impact assessments in coastal development; co-operation to improve the safety of maritime navigation, particularly for those ships carrying dangerous or highly polluting cargoes; and measures to reduce industrial pollution of coastal waters, as well as the proper disposal of solid wastes.

Despite foot-dragging, a number of countries have begun to build sewage treatment plants for their large cities. Istanbul is spending $2 billion to clean up the once glorious Golden Horn, contaminated with raw sewage, slaughter-house offal and industrial wastes. Marseilles recently inaugurated a giant $180 million underground sewage treatment plant to handle the municipal wastes of the city's one million inhabitants. The European Investment Bank has allocated $5 billion to clean up the Po River in Italy, a major source of pollution of the northern Adriatic. And in Athens a huge sewage treatment plant on the island of Psitalia, which will process all municipal wastes from the city's 4 million inhabitants, is nearing completion.

Between 1983 and 1985 Spain spent 7 billion pesetas (about $40 million) on beach protection, access roads and pedestrian paths. But nearly five times that amount was expended between 1975 and 1985

on water supply, sanitation and sewage networks for 181 communities along Spain's Mediterranean coast.

In the summer of 1988, certain countries began to issue public reports on the state of their bathing beaches. Until then, the condition of most beaches was considered a state secret. No government wanted to disclose pollution data for fear that tourists would go elsewhere.

"All that has changed," asserts Manos. "France and Italy have taken the lead in being open and forthright about the state of their beaches. They have, so to speak, gone public. In France, for example, the government now publishes a booklet on the state of all its hundreds of beaches, describing their condition. It's also available in three languages." Other Mediterranean countries are expected to follow suit.

Still, most governments refuse to provide data on sourced points of pollution, such as factories or sewage outlets. "This remains a problem for us," confesses Manos, an Italian lawyer born on the Dalmatian coast of Yugoslavia. "Governments will not even give us hard data on pollution from specific rivers flowing into the Med. What we have are regional totals." Many countries still hide behind collective pollution figures; what one Mediterranean scientist calls "collective guilt".

Manos doubts whether the MAP countries will achieve all the goals of the Genoa declaration by 1995, but some will be accomplished. And there are, of course, numerous efforts by national non-governmental organizations (NGOs) designed to assist in the cleanup of the Mediterranean. Many small coastal towns in Italy, for example, no longer sell plastic bags with purchases, only paper ones. This is the result of local NGO action. Beach cleanups have been organized by citizen action groups. One of the biggest challenges facing MAP is how to harness the tremendous energy of environmental NGOs around the Mediterranean Basin and channel it where it will do the most good.

4. The Persian Gulf

Were it not for vast quantities of oil and gas lying around and under the Gulf, the countries of the region might still be poor and developing. Instead, oil wealth has projected them into the modern age. The eight Gulf States – Kuwait, Bahrain, Iran, Iraq, Oman, Qatar, Saudi Arabia, and the United Arab Emirates – sit above the largest reserves of oil in the world, some 51 billion tonnes of it. Ironically, in a region dominated by fierce political, economic and religious rivalries, oil is the only thing most of them have in common. The other common definition is desert, which stretches from North Africa across the Red Sea through the Arabian Peninsula to the Persian (or Arabian) Gulf and across to Iran.

Historically, the Gulf States are better known for what separates them than for what brings them together. Perhaps the only thing the eight countries of the Gulf really share other than sand, oil and heat, is the sea.

The lands that surround the Gulf contrast sharply with its waters. Barren land is met by a very productive sea. The region may be energy-rich, but it is resource poor in every other sense, except fisheries.

As the beginning of the world's largest oil highway, the Persian Gulf is perhaps the most strategic body of water in the world. It is an important part of the world's energy life-line. Yet the Gulf is the region's life-line in other ways too. Most of the Gulf's population is squeezed along the coast and it is a source of food and drinking water.

Recognizing that the health of the Gulf is a common concern throughout the region, the eight Gulf States, in co-operation with UNEP, launched the Kuwait Action Plan in 1978.

Geography of scarcity

An old Arab proverb from the Gulf says "the sea is life, the sea is sustenance. Without it we perish under the sand." With a geography

dominated by sand, this statement could not be more true. Summer temperatures regularly rise above 40° Centigrade, making the Gulf one of the hottest places on earth. Asphalt roads turn into mush, concrete crumbles, water evaporates in minutes, buildings need constant repair from heat damage. It is also one of the driest regions on earth. The Arabian Peninsula receives less than 10 cm of rainfall a year.

The Gulf itself is not very big. It stretches only 1,000 km from the Shatt Al Arab waterway in southern Iraq to the Strait of Hormuz, and varies in width from 75 to 350 km. With an average depth of only 35 m, it is considerably shallower than the Mediterranean or Red Seas. On the other hand, strong tidal currents rapidly flush out the Persian Gulf. Its total water volume is completely replaced every 1–3 years. This fortunate hydrobiological feature means that oil and other pollutants from domestic, industrial and agricultural activities are pushed out into the much deeper and larger Arabian Sea.

Around 10 million people live along the Gulf's highly developed coastline. With the exception of Iran and Iraq, nearly all of them are packed into the coastal zone, bolstered by some 5 million migrants and foreign "contract workers". Population growth is also concentrated along the Gulf. With the one exception of Iran, all the Gulf countries' populations are growing by more than three per cent a year, doubling their numbers every 20 years.

This very growth threatens to undermine the region's economic stability. For the moment, Saudi Arabia grants every citizen a plot of land and an $80,000 government loan to build a house on it. There are no income taxes and all public services are free. By the twenty-first century, these luxuries may have to be cut.

"The entire coastline of Kuwait is packed with people," observes Dr Manaf Behbehani, professor of marine science at Kuwait University. "The pressures on our coastline are enormous. Nearly all new construction is along Kuwait Bay: offices, homes, resorts. And this urban expansion has ruined tidal flats and wildlife habitat. The shoreline of Kuwait City has actually been extended 60 metres into the Bay. Our shoreline is expanding at the expense of coastal resources." The same story is heard throughout the entire western and southern rim of the Gulf. Oil wealth has fuelled a building boom – everything from flats to industrial complexes – which has outpaced government efforts to control it. Although Kuwait City has a master plan for phased development, many other cities in the region do

not. Some cities have doubled their populations in as little as four years.

Kuwait now has a development plan for its entire coastline. But land reserved for oil and gas production, and other industrial uses, accounts for over 50 per cent of it.

Fresh water is a scarce commodity in the Gulf and more valuable than oil. Kuwait, like the other Gulf States, must get most of its drinking water from the sea. Five big desalination plants produce 148 million litres of potable water per day. This is produced by mixing distilled water produced by the plants with brackish water from coastal aquifers. A sixth plant went on stream in 1990.

In all the Gulf there is only one hydraulic laboratory which studies the effects of coastal engineering on tides, currents, and marine organisms: the Hydraulic and Coastal Engineering Department of the Kuwait Institute for Scientific Research (KISR). Kuwait, like its neighbours, is hobbled by a lack of co-ordination when it comes to coastal management. There is not one government department charged with overall responsibility for managing the coastal zone. Instead, management is fragmented between several competing ministries and research departments. Too often the result is coastal chaos, rather than coastal management.

Coastal pollution

The Gulf States have transformed themselves from medieval to industrial economies in a mere 40 years. But such rapid, often unplanned, urban and industrial growth has also resulted in severe coastal pollution and loss of wildlife habitat. Millions of tonnes of untreated industrial wastes are discharged into the Gulf every year. Oil pollution is even more serious.

All of the Gulf States have working sewage treatment plants, covering most of their coastal populations. Nearly 95 per cent of Kuwait's population is now served by three-stage sewage treatment plants, which process 80,000 cu m of sewage water per day. Similarly, 74 per cent of Bahrain's population is covered by sewage treatment networks, as is 96 per cent of the United Arab Emirates', and 79 per cent of Iran's.

By contrast, most Gulf States have done little to control industrial pollution. Kuwait is in the process of building a mammoth industrial waste water treatment plant for its big industrial zone in the south near the city of Al Fuhayhil. The complex is expected to be operating within three years.

In the meantime, coastline investment in the Gulf is estimated to be between $20 million and $40 million per km, with 20 major industrial centres completed or under construction. So far, few states have well-established integrated pollution control programmes.

On the other hand, controlling industrial and municipal pollution is receiving increased attention in the Gulf, if for no other reason than most of the region's drinking water comes from the sea. The intake valves for all desalination plants are monitored carefully for dangerous pollutants. A chlorine plant on Kuwait Bay was closed down when scientists discovered it was discharging mercury into coastal waters. Another problem is jellyfish, which clog the intake pipes of desalination plants and thermal power stations (which use seawater for cooling purposes). Although there is no clear proof that jellyfish swarms are linked to pollution, circumstantial evidence points in that direction.

Red-tides in the Gulf have also increased in recent years, badly affecting fisheries, particularly maricultured species like groupers and sea bream. Although these killer algae have been around for centuries, their outbreaks are aggravated by untreated industrial and municipal wastes which consume oxygen needed by marine organisms. Throughout the Gulf, coastal waters near industries and cities are increasingly oxygen-starved.

Oil: a curse of riches

The Persian Gulf is the most crowded oil highway in the world. Before the war between Iran and Iraq spilled over into the Gulf, some 100 tankers a day sailed through the Strait of Hormuz. Currently, 25,000 tankers sail in and out of the Gulf every year. Around sixty per cent of all oil carried by ships throughout the world – a billion tonnes a year – is exported from 25 major oil terminals scattered around the region. Most oil is carried by tankers at least as large as the quarter-million tonne *Amoco Cadiz*. Before the "tanker war" (1984–8), there were over 800 offshore oil and gas platforms operating in the Gulf as well.

With all this oil being pumped and transported, the Gulf's waters are heavily contaminated with oily residues and tar balls. Around one million tonnes of oil is dumped into the Gulf's waters every year from the routine discharge of dirty ballast water and tanker slops. "Oil pollution is our biggest problem," states Dr Hosny Khordagui, a research associate at KISR in Kuwait City. "Oil pollution affects

a lot of our marine biota, tainting fish and mussels." Near shipping lanes and offshore oil rigs, petroleum residues 100 times higher than in uncontaminated waters have been found in the tissues of mussels. Fish are also affected. One KISR scientist states that "fish so far show no signs of pollution stress from hydrocarbons, but every fish we have sampled contains oil in its tissues. Fortunately the levels are too low to raise health concerns."

The eight-year war between Iran and Iraq did not help the situation. When the conflict began to embroil the Gulf itself, in what became known as the "tanker war", during a four-year period 545 tankers were hit by missiles, bombs and mines. "But we were fortunate again," explains Dr Badria Al-Awadi, co-ordinator of the Regional Organization for the Protection of the Marine Environment (ROPME), based in Kuwait. "Despite all the shooting and bombing many of the stricken tankers were on their way into the ROPME sea area when hit, so they were empty. Others managed to contain the oil spills before they spread." Nevertheless, there are untold kilometres of beaches under black oil, oxidized and baked to pavement consistency by the sun.

Besides luck, the flushing capacity of the Gulf and its warm waters help protect it from oil pollution. "As a consequence of repeated oil spills, most beaches in the region are heavily contaminated with tar," observes Olof Linden, a senior scientist at the Swedish Environmental Research Institute in Stockholm. "However, the background levels of petroleum hydrocarbons in sediments and biota are not exceptionally high. This is probably due to rapid degradation and weathering in the Gulf's warm, shallow waters." And to those wonderful tidal currents, which sweep pollution out of the Gulf.

Fisheries: abundance from the sea

The Persian Gulf is endowed with rich marine life. Unlike the Gulf's human population, fisheries benefited from the fighting. Reduced fishing activity in the Gulf gave fish and shellfish stocks a chance to recover from years of over-exploitation. The autumn of 1988 was one of the best years on record for shrimp landings by Kuwaiti and Saudi fishermen. One species of shrimp (*Penaeus semisulcatus*), accounts for 90 per cent of all trawl catches. In the month of September 1988, 2,800 tonnes of shrimp were taken in Kuwaiti waters alone.

Fish stocks have also increased. Groupers, sea bream and snappers

are caught with fish traps and gillnets throughout the Gulf. Fish consumption averages about 8 kilogrammes per person per year in the Arab Gulf States. With the war over (for the moment) seafood consumption is on the increase.

Most Gulf States have established fishermen's associations which regulate the number of fishermen and boats allowed to exploit fish and shellfish stocks. In most countries, fishermen need a licence before they can operate, usually controlled by the fishermen's union. Altogether there are probably around fifty commercial operations and about fifty-five artisanal fisheries in the northern part of the Gulf, involving roughly 1,100 boats.

Both Kuwait and Saudi Arabia have imposed bans on shrimping from 1 March to 1 September, giving the shrimp time to spawn. No commercial trawling is permitted in Kuwait Bay, within three miles of shore. This allows artisanal fishermen who specialize in trapping fish in tidal areas a chance to make a better living.

Some Gulf States, like Kuwait, are also developing large-scale fish-farming enterprises for the domestic and export markets. At KISR's Mariculture and Fisheries Department, three species of fish – sea bream, grouper and tilapia – are being experimentally farmed in Kuwait Bay. Sea bream in particular show promise for commercial production in large sea cages. At the moment, KISR researchers have achieved a 12 per cent survival rate for sea bream fry, but hope to be able to increase this to 20 per cent. Groupers are more difficult to farm since they take longer to reach marketable sizes and don't take well to crowded cages. Although stocking rates are lower that with sea bream, the higher prices paid for groupers still make them profitable.

Perhaps the most novel and promising development that KISR researchers have come up with is combining sea bream and tilapia in one big farm, with separate cages. It is more economical to farm two species instead of one. "We have managed to develop tilapia which grow in seawater and brackish water," explains research scientist James Bishop. "Combining sea bream with tilapia has great commercial potential."

Marine conservation

The Gulf War, although beneficial for fish, has not helped conservation efforts. Scientists are still unable to co-operate on Gulf-wide research projects aimed at setting up marine parks and protected

areas. Extensive coral reefs off the coast of Saudi Arabia should be protected from exploitation and pollution, but so far nothing has been done to set up reserves. Kuwait is considering a proposal to establish a few marine parks around several of its coral islands, but no action has been taken to implement the plans.

Meanwhile, both habitats and marine life suffer. In Kuwaiti waters there is only one small undisturbed island left where marine turtles can nest; efforts are just getting underway to declare it a sanctuary. Coral reefs, seagrass beds and mangroves are all under stress from coastal development, land reclamation and channel dredging. Land reclamation and dredging, in particular, churn up bottom sediments which kill off seagrass meadows and coral reefs. Island reefs are damaged by boat anchors and trawling operations. About forty per cent of Qatar's coral reefs and nearly a quarter of those around the coast of Bahrain have died, killed by sedimentation and pollution.

Between August and October 1986, thousands of dead and dying dugongs, dolphins, turtles and fish washed up on beaches along the coasts of Qatar and Saudi Arabia. Scientists still don't know what killed them. But industrial pollution and oil are at the top of the suspects' list.

There seems to be little concept of conservation in the Gulf States. In such a harsh environment there may be little to conserve, but what wildlife survives in the desert is often hunted for sport. Bird watchers in other countries complain that migrating birds, particularly raptors and storks, are slaughtered by the thousands on their way through the Gulf region on their way to wintering grounds in Africa.

"At Al Khiran in southern Kuwait, a sea inlet harbors a unique colony of pre-Cambrian blue-green algae known as *Stromatolites*," states Dr Manaf Behbehani. "These animals are 2 billion years old – among the oldest living things on earth – yet the government has done nothing to protect the area from development."

Every spring the Environment Protection Council of Kuwait launches a public information campaign in an attempt to alert people to the need for conservation of desert habitats and the animal life they shelter. "Now that the war is over," states one Council official, "the Gulf environment is being re-discovered."

The Kuwait Action Plan

The eight governments of the Gulf adopted a Convention and Action Plan in 1978. Two legal instruments – the Regional

Convention, and a protocol concerning "Regional Cooperation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency" – were ratified and came into force in 1980.

The United Nations Environment Programme acted as interim co-ordinator for the Action Plan until the Regional Organization for the Protection of the Marine Environment (ROPME) began operating on 1 January 1982. The ROPME secretariat was set up in Kuwait.

In connection with the protocol concerning regional co-operation in combating oil spills, the Marine Emergency Mutual Aid Centre (MEMAC) was established in Bahrain in August 1982. "MEMAC's objective is to help contracting states develop their own national capabilities to combat pollution from oil and other harmful substances as well as to co-ordinate information exchange, technological co-operation, and training," points out Hamid Shuaib, President of the Kuwait Environment Protection Society. "MEMAC took a leading role in combating oil pollution during the Naw Roz oil-field disaster in 1983 and the Assimi oil tanker disaster in 1985."

A second protocol on controlling oil pollution, this one designed to combat pollution from offshore activities, was signed in December 1988. And two more protocols are in the works: one dealing with the control of land-based sources of pollution, and another concerning the transport of hazardous substances.

During the initial phase of the Action Plan, the Gulf States concentrated on oceanographic studies and baseline pollution surveys. A major emphasis has been on making data comparable with information gathered in other regional seas programmes. Many technical specialists were also trained. Since 1982 more than 500 technicians have received special training in oil and non-oil pollutant sampling, data handling, oceanographic modelling, marine monitoring and research, and marine pollution prevention.

The Action Plan as a whole focuses on oil pollution, industrial wastes, sewage treatment, fisheries resources, and the environmental impact of coastal engineering and mining. "The Gulf is like a big lake for us," states Dr Badria Al-Awadi, of ROPME. "Now that the war is over, our biggest priority for the next five years is the management of coastal resources, particularly fisheries."

The Iran–Iraq War has dominated the region for eight years. Now that peace has come, perhaps the Gulf States can start co-operating on a regional level and begin to use the Action Plan for the betterment of the Gulf environment. Even during the darkest hours of fighting,

scientists from both Iran and Iraq still attended ROPME meetings. In late October 1988 an emergency meeting of ROPME was called in Kuwait, attended by representatives from both Iran and Iraq. At the top of the agenda was a plan to deal collectively with hazards to Gulf shipping posed by the leftovers of war: unexploded mines and other munitions, and the wreckage of ships sunk during the tanker war. Perhaps if the Gulf States can co-operate on this level, they can also co-operate on regional security matters.

Unfortunately, for the most part the war has made the environment an issue of secondary importance. And ROPME has suffered from a general lack of interest in its programmes. The oil-rich states of the Gulf have handicapped ROPME with a budget of only $1.5 million a year, barely enough to pay for basic co-ordination work. Yet ROPME remains the only truly region-wide forum in the area through which co-operation on marine and environmental issues can be achieved.

5. The Wider Caribbean

The Caribbean is an area so diverse that it defies description. "Races of all continents have miscegenated here, cultures and customs most foreign to each other have syncretized, nature has exploded into myriads of forms, and the constant feast of color and sound has goaded the formal carnival to paroxysm" writes literary critic Ramon Mendoza in the *Caribbean Review*.

Yet behind this carnival of abundance there is scarcity – of jobs, skills, materials, and money. And in many parts of the Caribbean, resource abundance is giving way to degradation and over-use. Despite frequent development initiatives like former President Reagan's proposed "mini-Marshall Plan" for the region, poverty is now more widespread than ever.

Diversity – economic, ecological and cultural – brings its own set of problems. This bizarre assortment of tropical and sub-tropical ecosystems, encompassing 24 island states and territories and 12 mainland nations, has long been divided between the Hispanic group of countries and the separate English-, French- and Dutch-speaking states. As a result, communication, not to mention co-operation, has often been rare.

Co-operation has been hampered also by the economic divide which cuts through the region. Sitting on top of the Caribbean is the United States, while the southern rim is dominated by the the rapidly developing economies of Colombia and Venezuela. In between lies the penury of most of Central America and the islands (with a few notable exceptions, such as Costa Rica).

Despite spasmodic attempts at modernization, many Caribbean countries start the development process with severe handicaps. Grappling with the environmental effects of crushing poverty means that hasty development projects often contribute to the problems rather than the solutions. Caribbean ecosystems are beset by problems: chemical pollution produced by industry and agriculture; silt from dredge-and-fill operations and poor land management;

irrational exploitation of coastal resources; untreated wastes from coastal cities and tourist centres.

Realizing that the Caribbean needed a mechanism through which regional co-operation could be achieved in combating environmental degradation and resource impoverishment, 23 of the region's countries and territories adopted an Action Plan for the Caribbean Environment Programme in April 1981. The Caribbean Environment Programme, drawn up by UNEP, remains a landmark in regional co-operation; one of the few forums available for dealing collectively with common environmental concerns.

The Wider Caribbean is not nearly as landlocked as the Mediterranean Sea or the Persian Gulf. It consists of two huge basins: the Caribbean Sea proper and the Gulf of Mexico. Its surface area covers over 4 million sq km. The "American Mediterranean" is also deep, averaging 2,200 m, with the deepest part – known as the Cayman Trench – plunging down to 7,100 m.

The drainage basin of the sea is equally enormous, encompassing some 7.5 million sq km and eight major river systems, from the Mississippi in the Gulf to the Orinoco in Venezuela. These rivers also freight in millions of tonnes of pollutants from the hinterlands.

The Caribbean is the origin of the Gulf Stream. The Caribbean Current and Antilles Current join up at the tip of Florida to form this huge wedge of warm water which then sweeps across the North Atlantic to northern Europe, and finally to Scandinavia and into Arctic Russia, making life in Northern Europe more bearable.

Most of the 22 islands states and territories are very small, with more people than the land can support. Collectively, they comprise a mere five per cent of the region's total land area and hold only 15 per cent of the Caribbean's population. Yet, with the exception of Cuba and the Dominican Republic, population densities on the Antilles islands exceed 100 people per sq km; Barbados has 550 people per sq km.

Small may be beautiful, but too many Caribbean states, especially the islands, must somehow subsist on one or two primary export commodities. Jamaica's main export is bauxite, Cuba's sugar, Costa Rica's bananas, Trinidad and Tobago's oil.

Another consequence of too little land and too many people is the necessity to import food. Most of the Caribbean islands even have to import seafood. In Dominica and St Kitts local demand for fish exceeds supply by more than 250 per cent, while imports of fish to St Lucia were valued at more than $2 million in 1982.

Squeezing the coasts

Most of the smaller islands in the Greater and Lesser Antilles consist of nothing but coasts. But even along mainland Central America and the Caribbean coast of Colombia and Venezuela, human numbers are rapidly outstripping resources. Most of the Basin's 170 million permanent residents (including those along the Gulf coast of Mexico and the United States) live on or near the seashore. They are joined every year by 100 million tourists, nearly all of whom end up at the coasts. The Caribbean has become one of the world's most popular holiday destinations (second only to the Mediterranean).

Alfred Taylor, a native Barbadian and president of the Caribbean Hotel Association, says:

> Tourism is the future of the Caribbean. But at the same time, we have to be very careful about our environment. Solid waste disposal is now a serious problem. Our waters are getting more polluted. Our reefs are dying. On a lot of islands the hotels are too close to the beaches. The sewage pollution is killing the reefs, which then causes beach erosion. If we are not careful, we will end up with loads of hotels, but no beaches and tourists.

The environmental effects of coastal crowding are obvious. Mangroves give way to squatter settlements and shanty towns or are cut down for timber or to make room for tourist resorts. Coral reefs are over-fished and over-exploited for building materials and coffee table trophies. Without proper regulations and zoning restrictions, coastal development spreads unchecked. And population growth rates continue to hover between two and three per cent a year for many of the poorer Caribbean islands and mainland states. This means that for countries like Haiti, Honduras, and the Dominican Republic, already struggling to balance human needs with dwindling resources, their populations double every 23–35 years.

Demographic trends remain unsettling. During the past three decades the growth of urban centres has continued unabated. Most of it has occurred in medium-sized and large cities; those with populations of 100,000 or more. This uneven distribution of population works against attempts at managing resources sustainably. Since most of the new migrants to urban areas are poor peasants forced off exhausted land no longer capable of supporting

them, they join the ranks of the unemployed and under-employed, in squatter settlements and shanty towns. Here they contribute to the problems municipal governments face in attempting to provide basic services such as potable water, sanitation facilities, health care and education. In most cases beleaguered governments cannot hope to match services with ever-increasing numbers of urban poor. Hence, the conditions of most urban slums and squatter settlements continue to deteriorate. And so too does the state of coastal resources, overwhelmed by numbers and needs.

Diarrhoeal diseases caused by water pollution and contaminated food are among the leading causes of death in the region, particularly of children under five years of age. In the late 1970s, diarrhoeal diseases in Guatemala and Nicaragua accounted for 26 per cent and 34 per cent, respectively, of all the deaths registered.

Life expectancy varies considerably too. The average Haitian can expect to live only 51 years, compared to 74 years for Puerto Ricans and 75 years for Gulf Coast Americans.

Coastal pollution

As coastal populations increase, resources suffer and pollution mounts. In 1979, UNEP studies showed that the wastes from at least 30 million people flowed into the Caribbean's coastal waters without treatment of any kind. Today, less than 10 per cent of the wastes generated by the Basin's 170 million residents receive any form of treatment before being dumped in coastal waters or into rivers which end up discharging their loads into coastal areas. On top of this comes the untreated wastes of the tourists.

The waters along nearly every urbanized coastline are clogged with raw sewage and municipal garbage. In some cases – as on Haiti – health alerts have been issued, and bathing beaches closed. There have even been sporadic outbreaks of cholera and typhoid, and pollution-induced diarrhoeal diseases are endemic throughout much of the region. The near-shore waters around cities like Port-au-Prince, Havana, Kingston and San Juan are so choked by untreated sewage and other municipal wastes that they are becoming oxygen-starved.

Not only municipal wastes contribute to the pollution problems of the Caribbean. The high organic loads from sugar-cane mills and food-processing plants rob shallow coastal waters of oxygen, causing anoxic conditions in which few marine organisms can survive. In

the Mississippi Delta south of New Orleans, Kingston harbour, Jamaica, and off the coast of Trinidad, toxic industrial wastes kill fish and destroy marine habitats. In March 1988 a raft of dead fish 1.5 km long and 300 m wide was found in the Gulf of Paria – between Venezuela and the islands of Trinidad and Tobago – victims of industrial wastes and hydrocarbon pollution.

Heavy metals from mining operations and metal smelting pose serious threats to coastal marine habitats in many areas of the Caribbean. In the Coatzacoalcos Estuary in the Gulf of Mexico, bottom sediments and marine fish and shellfish contain high levels of lead, cadmium, mercury and copper. Dangerously high levels of mercury pollution have also been documented for the Bays of Cartagena in Colombia, Guayanilla in Puerto Rico and for Puerto Moron in Venezuela. Havana Bay is full of heavy metals, including mercury, lead, and cadmium.

The widespread use of agro-chemicals and pesticides contributes another set of pollutants to the marine environment. Like heavy metals, these persistent poisons lodge in sediments and bio-accumulate in fish and shellfish. Around Puerto Rico and the islands of the eastern Caribbean, measurable levels of pesticides have been recorded in the water column. Pesticide run-off into coastal waters has killed fish around Jamaica and off the coast of Colombia. Years after both were banned from general use, long-lived pesticides such as DDT and DDE have shown up in the tissues of reef-dwelling fish like groupers taken in the Gulf of Mexico and the Grand Bahamas. Shrimp and plankton from the northern Caribbean were found to contain measurable levels of DDT as well, but not in high amounts.

The destruction of near-shore marine habitats – mangrove forests, seagrass beds and coral reefs – by pollution and unplanned coastal development is drawing considerable attention from Caribbean governments, not to mention conservationists, fisheries managers, resource planners and the concerned public. The combined effects of increasing populations and degraded resources are prodding many Caribbean governments into developing coastal area management plans.

Oil pollution

Every day some 5 million barrels of oil are transported through the Caribbean. Predictably, like all seas in which oil or gas is

extracted and through which petroleum products are transported, the Caribbean suffers from oil pollution. Every year on average, about 7 million barrels of oil are dumped into the Caribbean. Some 50 per cent of this pollution is thought to be accounted for by tankers and other ships, discharging oily wastes, dirty bilge waters and tanker slops in direct violation of IMO treaties. A significant amount of oil also finds its way into Caribbean waters from offshore oil rigs and exploratory drilling (in 1978, nearly 77 million barrels of oil were released from oil rigs).

The Gulf of Mexico has the distinction of hosting the world's worst oil spill. In the early morning hours of 4 June 1979, the Ixtoc 1 exploratory oil well in the Bay of Campeche blew out. It was finally capped on 23 March 1980, 290 days later. During this time 475,000 metric tonnes of oil were spilled into the warm waters of the Gulf. Although hundreds of thousands of oil-soaked crustaceans were washed up on Gulf beaches for months, the full extent of the damage was never calculated.

The oil-producing countries – Colombia, Venezuela, Mexico, Trindad and Tobago and Barbados – extract oil at the rate of 3.5 million barrels a day. The big three – Colombia, Venezuela and Mexico – have petroleum reserves totalling 12 billion metric tonnes. Not only does the Caribbean produce oil and gas, exporting most of it, but much of it is refined in the region. Across the Caribbean, including the Gulf of Mexico, some 73 refineries are capable of handling over 12 million barrels of oil per day.

To a large extent, oil has fuelled the development plans of Mexico, Colombia, Venezuela and Trindad and Tobago. Another result of the oil boom has been devastated coastal ecosystems in major oil producing areas – the Gulf of Mexico, Venezuela, Trinidad – and along tanker routes. Mangrove swamps, seagrass meadows and coral reefs have been wiped out by oil spills in many parts of the Caribbean. The windward exposed beaches from Barbados to Florida are heavily contaminated with tar balls and oily residues; in some cases as much as 100 grammes of tar have been found per metre of beach front. Oil not only tars beaches and reduces tourist dollars, it kills marine life. Sea turtles are especially susceptible, since they sometimes ingest floating tar and die. And once oil hits coastlines, it can devastate marine communities, killing off entire populations of shellfish and crustaceans and fouling habitats.

Endangered ecosystems

Mangrove swamps, seagrass beds and coral reefs, in addition to being the most biologically productive marine habitats, are also prime nursery grounds for commercially important fish and shellfish. They are all coming under increasing stress throughout the Caribbean from pollution, sedimentation, and the direct effects of dredging and coastal land reclamation. If left unchecked, the destruction of these vitally important habitats could sterilize coastal areas, greatly reducing their productive capacities. Such a development would have drastic effects on poor coastal populations.

Everywhere in the Caribbean, with a few exceptions, mangrove swamps are being degraded and destroyed at unprecedented rates, especially on the islands of the Greater Antillies. Puerto Rico's mangrove forests, for example, have been reduced by 75 per cent since the first Europeans began colonizing the island. Nearly all of Haiti's mangroves have been felled by poor peasants and sold for timber, fuelwood, or charcoal.

Large areas of mangrove forests have been destroyed in the Orinoco Delta of Venezeula, mostly through the opening up of ship channels. Similarly, parts of the Caroni Swamp on Trinidad have been ruined by the construction of channels and port facilities.

Increasingly, deforestation of uplands and coastal areas brings in its train erosion of agricultural lands, coupled to landslides during the rainy season and droughts during the dry season. Rivers draining such area run swollen with sediments. As more soil is washed into coastal areas, seagrasses and coral reefs are smothered and killed.

Seagrasses are particularly susceptible to disturbances. They are the only flowering plants that have returned to the sea, and look very much like their ancestors on land. Their entire life cycle, including pollination, occurs underwater. Some 50 species of seagrasses are distributed throughout both temperate and tropical seas, thriving in clear, shallow waters. Seagrass meadows are an important link in the complicated food chain which ties coastal wetlands such as estuaries and mangroves to offshore coral reefs.

Like mangrove forests, seagrass meadows help collect and anchor sediments, making surrounding waters less turbid. This cleansing ability of seagrasses improves water quality not only for themselves but also for associated communities of filter-feeders (clams and oysters) and nearby coral reefs. Submarine meadows provide a

host of organisms with shelter, nurseries, and food. Many fish and invertebrates, as well as sea turtles and dugongs, graze the meadows, eating algae and other plant matter that grow on the surface of seagrasses or in their litter. In addition, because of their strategic position between mangrove wetlands and coral reefs, tropical seagrass communities act as effective buffers, modifying wave action and taking nutrients to and from these other ecosystems.

Seagrass beds share a similar fate, and are affected by some of the same kinds of pressures which destroy mangroves. The greatest threats facing seagrass meadows in the Caribbean (and elsewhere) include dredge-and-fill operations, erosion sediment from coastal deforestation and poor agricultural practices, fishing with bottom trawls, and water pollution caused by industrial and municipal wastes, thermal discharges from power plants, and oil spills.

Unlike mangroves, the magnitude of the destruction of seagrass beds is largely unknown. Seagrass loss has been documented in only a few countries, notably Australia and the United States. One study carried out in Boca Ciega Bay, Florida, following a dredge-and-fill operation to enlarge a boat harbour, revealed that a full 20 per cent of the seagrass community in the bay had been wiped out, causing an 80 per cent reduction in fish species and a fisheries loss estimated at $1.4 million.

Often the trouble starts when mangrove forests are clear-cut. But probably nothing is more harmful to seagrass beds than dredge-and-fill operations. Whether for the construction of harbours, residential estates, coastal industries, or ship channels, dredging churns up enormous quantities of bottom sediment. Water quality is impaired and visibility reduced as suspended particles of sand and mud clog the water column. The resulting turbidity interferes with photosynthesis and reproduction, and when the sediment finally settles, it often buries seagrasses. To make matters worse, dredge-spoils (the "fill" part of the operation) are often dumped indiscriminately over seagrass beds.

In efforts to correct past mistakes and to better manage coastal environments, a number of countries (mainly France, Australia, England, the United States and the Philippines) have launched programmes to rehabilitate seagrass meadows. So far, restoration efforts have been successful with four varieties, including one of the most common species (*Thalassia testudinum*), known as turtlegrass. But the costs of re-introduction are high: ranging from $3,000 to $25,000 per hectare.

Dr Anitra Thorhaug, professor of biological sciences at Florida International University in Miami, has successfully replanted seagrasses in Biscayne Bay, Florida, using student labour. But it is time-consuming and hard work, since the seedlings have to be planted by hand. Thorhaug states that

> seagrasses and the important fish nurseries associated with them have been badly neglected and damaged throughout many areas of the world, particularly in the Caribbean. But efforts are underway to conserve remaining seagrass meadows and to restore others which have been lost. Unfortunately, the combination of seagrass vulnerability to pollutants and their tendency to grow close to shore, where dumping occurs most frequently, has left large parts of the Caribbean denuded of seagrass.

Caribbean forests are rapidly disappearing as well. Every year on average 1.8 million hectares of Caribbean forests are destroyed, while only 34,000 hectares are replanted. According to Norman Myers, author and consultant to various UN agencies, the forested area of Central America and Panama decreased by 112,800 sq km between 1961 and 1978. Much of this forested land was turned into cattle ranches and cash crops. But slash and burn subsistence cultivators and loggers are mostly responsible for the destruction of upland watersheds. In the rural areas of some energy-poor islands like Haiti, Martinique and Guadeloupe, fuelwood gatherers also contribute to the process of deforestation.

In *Bordering on Trouble*, environmental journalist Larry Mosher describes what is happening to the forests of St Lucia, a beautiful volcanic island in the Lesser Antilles.

> Much of its forest loss stems from the monoculture export of bananas. In addition to degrading the island's fragile topsoil, such plantation practices have forced many farmers off the best land and into the hills, where they slash and burn to raise food as well as grow more bananas. This exacerbates soil loss through erosion, which in turn forces the farmers to move on to other areas after several growing seasons when their crop yields diminish. The vicious cycle can ultimately change the microclimate, transforming farmland into semi-desert.

Once the forest cover has been stripped away, hilly areas quickly shed their topsoil. Panama has nearly one million hectares of eroded soils, Venezuela has ten times that amount. Measured rates of soil loss in the Caribbean are as high as 35 tonnes per hectare. Soil stabilization and reclamation measures could rehabilitate some of this degraded land, but the costs are usually prohibitive.

The alternative to rehabilitation, however is often far worse. "Once you've lost the hills, you lose the sea," points out Beverly Miller, Senior Programme Officer in the Regional Co-ordinating Unit of the Caribbean Environment Programme, based in Kingston, Jamaica. "We are making the critical links between what happens on land and how this affects what goes on in coastal areas." Coastal-zone management plans now call for reforestation of the uplands in many areas to guard against further degradation of near-shore resources.

Fisheries

The Caribbean does not have extended continental shelves stretching out from land masses and the islands. Because of a pronounced lack of upwellings of nutrient-rich subsurface water, surface water is generally poor in nutrients. Consequently, mangrove forests, seagrass meadows and coral reefs play major roles in providing critical breeding and nursery habitats for many species of fish, lobsters, crabs, mussels and oysters. Seagrass beds alone account for around eighty per cent of the breeding grounds for a wide variety of fish.

Caribbean fisheries are confined largely to smaller-scale commercial operations and artisanal activities. Nevertheless, the Inter-American Development Bank reported that Caribbean fisheries landed some 9 million tonnes in 1980, worth around $3 billion. Altogether, some 2 million people are directly engaged in fishing around the Wider Caribbean.

The richest fishing grounds in the Caribbean are found on the Campeche Bank in the Gulf of Mexico (site of the Ixtoc I oil spill), the Mosquito Bank off the coasts of Honduras and Nicaragua, in th Gulf of Paria (with industrial and municipal pollution) between Venezuela and Trinidad and Tobago, and in the coastal waters of Guyana and Suriname.

Unfortunately, two of these important fishing areas are chronically polluted. The Campeche Bank is filled with offshore oil drilling platforms and is the site of the notorious Ixtoc 1 oil spill. The Gulf

of Paria is contaminated with industrial and municipal effluents.

In the last few years, longlining has increased significantly in the deeper waters of the Caribbean. Commercial fleets from Japan, Taiwan and South Korea dominate longline fishing operations. There are fears that this technique might well deplete certain stocks of Caribbean fish, especially tuna and billfish (like the marlin). One UNEP study indicates that a sustainable yield of fish and shellfish should not exceed 2.6 million tonnes a year. If true, then the Caribbean is already being over-fished by around 6 million tonnes a year. In many areas of the eastern Caribbean, fish stocks are becoming depleted. Management is badly needed to get Caribbean fisheries onto a sustainable footing.

Meanwhile, there is great potential for aquaculture and mariculture in the Caribbean. Pond-raised shrimp, prawns, and spiny lobsters are being marketed in Panama, Colombia, Venezuela, Mexico and the US Gulf States. The Dominican Republic has introduced large-scale aquaculture and mariculture operations. Caribbean spider crabs (*Mithrax spinosissimus*) are being raised in ponds. They can grow up to two feet long and weigh two kilogrammes. On tiny Dominica, the government introduced a programme to culture Marron lobsters, a freshwater lobster from Australia that can grow as large as Atlantic lobsters from Maine.

Marine conservation

With so many critical habitats in the Caribbean being destroyed by unplanned coastal development, sediment from deforestation, coastal erosion and dredging, municipal and industrial pollution, and oil spills, it is hardly surprising that most marine mammals and many amphibians and reptiles are now on lists of endangered species.

The Caribbean monk seal (*Monachus tropicalis*) is thought to be almost or entirely extinct. The number of manatees is constantly declining due to habitat loss, entanglement in fishing gear, and collisions with motor boats. Crocodiles and alligators continue to be poached throughout the Caribbean, despite laws against it. Dolphin species are dwindling, victims of fishing nets.

Tragically, virtually all of the region's marine turtles are endangered: loggerhead, green sea, hawksbill, Kemp's Ridley, Central American river, and leatherback. They are running out of nesting areas as their beaches are taken over for tourist resorts, housing, or

industries. Adult sea turtles are killed for their meat and shells. In 1974 some 40,000 sea turtles came ashore to lay eggs in the Gulf of Mexico. By 1976 only 700 were found, and a year later the total was a mere 450.

The loss of wildlife habitat and species in the Caribbean is a scandal. It has been estimated that roughly forty per cent of all global vertebrate extinctions have occured in the Caribbean Basin. Many of these extinctions are attributed to the indiscriminate destruction of upland forests and coastal mangroves, and the extensive use (and misuse) of agricultural chemicals.

Coastal erosion

Shore and beach erosion, often due to the destruction of mangrove forests and coral reefs, is a growing menace in Puerto Rico, Jamaica, Trinidad and the States bordering the Gulf of Mexico: Florida, Mississippi, and Louisiana.

Beach stabilization projects are being tried out in Florida and Mississippi, with a certain degree of success. Mangroves are being replanted along the Louisiana coastline, in an attempt to hold back the sea. But clearly the best way to avoid coastal erosion is to prevent it from ever happening – and to do this an effective coastal management programme is needed.

The Caribbean Environment Programme (CEP)

In 1976 UNEP, in co-operation with the Economic Commission for Latin America, established a joint project aimed at developing an action plan for the sustainable management of the Caribbean environment. After lengthy consultations with Caribbean governments, the CEP's Action Plan was finally adopted at a high level meeting in Montego Bay, Jamaica in April 1981.

Priority projects were selected for the first phase of the Action Plan and a trust fund was established to finance the programme. Unfortunately, "for almost three years, the Caribbean Action Plan remained merely a diplomatic vision," writes Larry Mosher. "Its nine member monitoring committee met twice, first in New York City and then in Cartagena, Colombia, mostly to agree that nothing could start until its trust fund grew larger. By mid-1982, a year after CAP's inauguration at Montego Bay, its trust fund had received only $25,355 out of initial pledges that totaled $1.[illegible] million." It was not

until the autumn of 1983 that the monitoring committee finally had enough money to begin work.

Their first effort suffered from financial difficulties, but was still impressive. An Intergovernmental Meeting in Cartagena, Colombia, in 1983 adopted two important legal instruments for dealing with common environmental concerns: "The convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region" and a "Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region".

The Regional Co-ordinating Unit, set up in Kingston, Jamaica, finally opened in September 1986, five years after the Action Plan had been adopted. Both the Cartagena Convention and the Protocol on oil spills were signed or acceded to by 16 countries and the European Economic Community and entered into force in October 1986.

Over the past 9 years, the Caribbean Environment Programme has received around $8 million, mostly from UNEP's Environment Fund and from contributions by the CEP countries. The United States, by far the dominant economy of the region, has given no money to the Caribbean Trust Fund. Instead, the US donates experts to the Co-ordinating Unit in Jamaica and provides other services in kind. Congressional and State Department politics, revolving around Cuba's participation, have prevented the US from fully participating in the Caribbean Environment Programme, a situation that irritates many of the poor Caribbean states. "If France was giving $375,000, we had hoped for $500,000 from the United States," recalls Arsenio Rodriquez, the UNEP official who helped organize the Caribbean Action Plan. "But because the United States consistently sabotaged the trust fund, the action plan faced a severe financial crisis. It's so petty, just to keep a few dollars from going to Cuba."

Despite of the weakness of the US involvement in the CEP, the governments of the region seem to be taking resource management and environmental issues seriously. "Environmental concerns are now a part of each election in the region," notes Beverly Miller. "In fact, the environment is one of the most important political issues in the Caribbean." In February 1989, Michael Manley replaced Edward Seaga as Prime Minister of Jamaica. He won re-election partly on a green platform, promising better resource management.

One of the reasons environmental and resource issues are finally being considered by politicians is the success of information

campaigns carried out by the largest conservation NGO in the region: the Caribbean Conservation Association, based in Bridgetown, Barbados. The awareness fostered by this NGO has led to the demand for action to be taken to solve the environmental and resource problems now facing the Caribbean.

A milestone was reached recently when the CEP countries agreed to initial proposals for the development and implementation of a long-term strategy for sustainable economic growth, through the rational management of the marine and coastal resources of the Wider Caribbean.

Despite chronic budget problems, the Caribbean Environment Programme has managed to implement a number of important baseline studies and has set up institutional mechanisms for co-operation in the region. One of CEP's most successful projects was carried out by the Caribbean Environmental Health Institute; it produced country reports for the island states on all major land-based sources of pollution of their marine and coastal environments. The next stage will involve clean-up programmes and the development of coastal-zone management plans. For now, CEP has made the management of coastal and marine resources, and the assessment and control of marine pollution, urgent priorities.

6. The South Pacific

The island chains of the South Pacific are nothing more than tiny specks of sand, coral and rock strewn across a vast expanse of ocean. Many archipelagos are isolated from each other by hundreds of kilometres of sea. These vast distances are made wider by ethnic and cultural divisions that split the Pacific into three distinct parts: Micronesia, Melanesia and Polynesia. Even within these major groups, island cultures are often at odds with each other over political, economic and social issues. Language barriers can be formidable: in Papua New Guinea alone, some 700 different languages are spoken.

"The picture postcard image of the South Pacific is, in many places, false," asserts Dr John Pernetta, Associate Professor of Vertebrate Biology at the University of Papua New Guinea. "Behind the facade of palm trees waving gently in the breeze is the stark reality of grinding poverty set against a backdrop of some really basic environmental problems."

Among these basic problems are: widespread destruction of mangrove forests, seagrass beds and coral reefs around populated islands and atolls; runaway urbanization; depletion of fisheries resources along densely populated coasts; deforestation of upland watersheds; soil erosion; mis-use of pesticides; pollution of rivers and streams from mining activities; improper disposal of industrial and municipal wastes; lack of sewage treatment facilities; inadequate provision of fresh water; and species loss.

As settlements grew and cash economies developed, many island communities found themselves displaced by the very development that promised a better life. Limited island resources are capable of supporting limited populations. For many Pacific island societies, which had evolved practical and sustainable ways to utilize their resources, Western style development proved their downfall. Too many people pushing upon the coastlines ruin critical habitats for marine turtles and nesting birds, and economically important fish and

shellfish. Too many farmers in the hills bring about deforestation and the erosion of soils needed to sustain them, adding to the problems of the coasts. Too much big development, without regard to local needs, more often than not exacerbates the problems instead of contributing to solutions.

As Pacific societies struggle to modernize their economies, resource issues are often neglected. To counter this neglect, and recognizing that small, isolated islands have more in common than just the vast sea around them, the 22 island states and territories of the Pacific have established several mechanisms to deal with collective resource and environmental problems. One of them is the South Pacific Regional Environment Programme (SPREP), initiated with assistance from UNEP, the South Pacific Commission and the South Pacific Forum (through its Secretariat, formerly the South Pacific Bureau of Economic Cooperation).

The largest ocean

The South Pacific region encompasses the largest expanse of ocean in the world, covering about 41 million sq km: nearly twice the size of the Soviet Union. Disregarding Australia and New Zealand, only two per cent of the area is land. Many of the islands are so tiny they have to be exaggerated to be seen on a map.

The distances are daunting. From Guam to Tahiti the distance is 8,000 km, and from the North of the Marianas to Noumea it is 5,500 km. It is 11,000 km from Pitcairn to Palau, equivalent to the distance from Tromsö, Norway to Cape Town, South Africa. From Papeete (Tahiti), the nearest continental landfalls are Sydney at a distance of 6,000 km; San Francisco at 6,600 km; Terre Adelie at 7,000 km; Vladivostok at 7,500 km; and Panama at 8,200 km.

Like the Carribbean, much of the Pacific's waters are nutrient poor. In the surface area of the tropical Pacific, the thin warm upper layer of water becomes quickly deprived of nutrients because of photosynthesis and the removal of organic matter as a result of sedimentation. In this subsidence zone, no upwelling of the richer subsurface water is possible and the most extreme conditions of oligotrophy can be found (oligotrophy is the environment in which nutrient concentrations are low and organic production small). These nutrient poor areas are referred to as "ocean deserts". The very clear water results from the absence of suspended particles and hence is very blue. There are few living organisms. For this

reason, fisheries are concentrated around island shelves and coral reefs.

Not only is the South Pacific wide it is also very deep. The average depth of much of the Pacific is around 4,000 m, twice as deep as the Caribbean. The various island chains and archipelagos are sometimes bounded by very deep trenches. The deepest and best known of these is the Marianas Trench in Micronesia. The most impressive part of this trench – the Challenger Deep – is over 11,000 m deep.

Except for the continental islands like New Guinea and New Caledonia, most of the Pacific islands have been thrust up out of the sea by volcanic activity. Some islands still sit atop active volcanoes, whereas others have been worn down over the years and are now covered by coral and sand. By contrast, New Guinea's topography ranges from thick tropical lowland jungle to peaks on the Indonesian half of the island which are over 4,000 m and permanently snow-capped.

The urbanization of the Pacific

The island states of the Pacific have been changed dramatically by their integration into the global economy. As rural economies have collapsed, migrants from the interior have swollen city and town populations. The resulting problems – increasing population density, the spread of shanty-towns and squatter settlements, social dislocation and environmental degradation – are all intensifying. Most of the South Pacific's 5 million people are coastal residents. Even in Papua New Guinea the urban and coastal populations are growing more rapidly than those in the forested uplands. Urbanization is a trend the Pacific islands share with virtually every region of the world. But small islands, with limited space and resources, can least afford the damaging affects of crowded coasts. And this lopsided demographic pattern has resulted not only in coastal congestion, but in the depopulation of many small outer islands and atolls.

Not all of the migrants, however, have moved to urban centres on larger islands. Many have emigrated to the developed rim countries: the United States, Canada, New Zealand and Australia. Auckland, New Zealand has become the largest Polynesian city in the world – in the early 1980s these were around 60,000 Polynesians of Pacific island origin there. Similarly, there are twice as many Niueans in

Auckland as there are on Niue and more Cook Islanders than on any of the Cook Islands. Honolulu has more than 20,000 Pacific islanders (including around 14,000 Samoans), and Vancouver, Canada has more than 12,000 Indo-Fijians.

The reasons for this movement of people, both out of the Pacific and to urban centres in it, is explained by Professor John Connell, Senior Lecturer in Geography at the University of Sydney:

> employment opportunities and services (especially education and health) are concentrated in the urban centres; in the small island states of the Pacific, where manpower and capital are often limited, this urban concentration is inevitable on some scale, hence rural – urban migration inevitably follows. In some cases this movement has not affected either agricultural or marine resource production because it has been a movement of "surplus" population. But the usual patterns of labour migration have entailed substantial production losses so that the development of outer islands and especially atolls has become a major problem in many South Pacific countries. The resulting pressure on coastal land and water resources is often very great.

Despite some successful family planning programmes, as on Fiji, the *average* population growth rate of the South Pacific states continues to hover around 2.5 per cent a year, doubling their numbers every 28 years. A large percentage of the population is under the age of 30. The region is still characterized by high birth rates and low death rates. As a result, populations are growing rapidly throughout the Pacific, especially in Melanesia and parts of Micronesia. Much of the growth in Polynesian populations continues to be siphoned off through emigration to the rim countries.

Fiji, however, has well-organized family-planning programmes which have been able to make a big difference in population growth rates. From a growth rate of over three per cent a year in the 1970s, Fiji's present annual increase in population is down to 1.5 per cent.

The Marshall Islands, on the other hand, are reminders of the problems which unplanned urban growth and overcrowding can create. Because these islands lack resources and employment opportunities, most of the archipelago's population lives into two urban centres: the main city of Majuro, and on the island of Ebeye, residence of the Kwajalein atoll workforce, where US nuclear missile systems and radar are tested. The population density of Majuro is

over 6,500 per sq km and on Ebeye it is an astounding 25,000 per sq km. Visitors have described both places as unbearably cramped and polluted with all manner of wastes. Water rationing has been introduced in efforts to conserve what little fresh water the islands have. In the dry months, water is supplied for one hour every second day, making flush toilets useless. Without landfills, most household garbage and human wastes end up in shallow lagoons.

Having declared themselves a republic in early 1982, the Marshall Islands quickly discovered that they had nothing to offer anyone except their land. In May of 1982 the government signed a Compact of Free Association with the United States. In exchange for giving the Americans complete control over military matters and a 15-year lease on the Kwajalein atoll, the US, in turn, agreed to pay some $700 million over a 15-year period. "What this has meant," explains Akio Heine, a reporter for *Pacifica 90 Newsmagazine*, "is that the Marshall Islands have gone from subsistence to subsidy." The subsidies have given the islands an economy, but they have not given the people a more liveable environment.

Throughout the Pacific region the problems are beginning to look similar. Unable to provide basic services – sewage treatment, clean water, medical care – for current populations, overcrowded cities and towns continue to expand. Chronic water shortages are forcing many islands to introduce "water hours". Raw sewage, household slops and untreated municipal and industrial wastes are dumped in coastal waters in ever increasing amounts.

Coastal pollution

The urban revolution in the Pacific has contributed greatly to the degradation of coastal resources and to high pollution levels in near-shore waters. The pace of pollution is accelerating, in many cases faster than efforts to control it.

The worst problem facing 90 per cent of the South Pacific's islands is the disposal of sewage and liquid domestic wastes. There are virtually no sewage treatment plants in working order in the region. Nearly all sewage and municipal waste ends up in shallow coastal waters, where it poses grave risks to human health and the environment. In the last few years several cholera epidemics have been traced to shellfish contaminated with raw sewage.

In the interior of most islands, sanitation facilities are non-existent. Fresh water supplies are often fouled by household wastes and human

faeces. Intestinal diseases are endemic. Solid wastes are dumped in coastal mangroves or lagoons, where they create breeding grounds for disease organisms. Few islands have bothered to develop solid waste management plans, and supervised landfills are rare.

The coastlines around nearly every urban centre in the Pacific are polluted with untreated sewage, municipal wastes, and household garbage. "One of the main problems is that too many people in the Pacific have acquired a throw-away mentality," states Professor David Mowbray from the University of Papua New Guinea. "In the old days, the people only discarded biodegradables, now they are throwing away everything from plastics and tin cans to car shells."

Industrial pollution affects only a few of the islands – notably Fiji, New Caledonia, Guam and Papua New Guinea. The water in Suva Harbour, Fiji, for example, is toxic from untreated domestic and industrial wastes. The pollution from food-processing plants, oil storage depots, a cement factory, chemical plants, and households is concentrated because Suva Harbour is surrounded by a barrier reef which restricts the mixing of harbour water with the open ocean. This leaves domestic and industrial wastes fermenting in the lagoon, and also permits the accumulation of sediment brought in from bare hills and badly planned coastal development. Poor subsistence fishermen remain dependent on the highly polluted mud flats and lagoon for their source of food.

Another problem afflicting coastal ecosystems is the disposal of pesticide residues and other hazardous chemicals either directly into coastal waters or into rivers which soon dump their toxic loads on the coasts. Many pesticides which are banned or restricted in developed countries are still in use in the Pacific. Even some of the more hazardous organochlorines, like DDT, are being used. Stored chemicals also present hazards. In Tokelau, a warehouse containing barrels of toxic Lindane was swept into a lagoon during a typhoon; the resulting spill killed off a large area of reef and its marine inhabitants.

The danger from pesticides in the Pacific is out of proportion to the amount used – a mere 1,450 tonnes in 1981, compared to over 800,000 tonnes sprayed on Southeast Asian croplands that same year. Unfortunately, many of the people who use pesticides do not recognize the dangers and often don't understand how to mix or apply pesticides safely. Accounts of pesticide poisoning and contamination of coastal areas are on the increase.

There are frequent disasters with toxic chemicals. In August 1983 a barge carrying 2,700 drums of deadly cyanide, destined for the gold

and copper mine at Ok Tedi, capsized near the mouth of the Fly River on the south coast of Papua New Guinea. The drums, each containing 102 litres of the poison, were never recovered and the effects of the spill on the ecology of the river mouth are still not known. In another incident at Ok Tedi, the effects were all too evident. When a worker at the ore treatment plant left a valve open, 270 tonnes of cyanide were released into the Fly River. Thousands of fish and crustaceans and scores of salt water crocodiles and water birds were killed. In the early 1980s, subsistence fishermen in the Cook Islands were using highly toxic Dieldrin to kill fish, which they then sold in the local market. The practice was discontinued after several people became seriously ill.

Two of Papua New Guinea's major rivers, the Fly and the Jaba, are routinely polluted with sediments and heavy metals from mining operations. The Jaba River, in particular, is so full of sediments and heavy metals from the Bougainville Copper Mine that its slate-grey waters are completely dead. Researchers claim that wading into the river to take samples is like inching through moving mud. Once the toxic contents of these rivers flow into coastal waters, little is known of how they might contaminate marine organisms, or enter food chains.

In the gold-mining region of Bulolo in eastern Papua New Guinea, miners use mercury to separate gold from the ore. Some of them are beginning to show classic symptoms of mercury poisoning: disorientation and tunnel vision.

As more people migrate from island interiors and from distant atolls to population centres, coastal pollution worsens. Many of the new arrivals find themselves confined to over-crowded shanty-towns and squatter settlements, usually built on the most degraded land. The Koki Settlement in Port Moresby, capital of Papua New Guinea, was built on stilts over the remains of a mangrove forest. Now that there is no forest to blunt storm damage, the poor people of Koki take the brunt of storms themselves. The water around the settlement reeks with garbage and human excrement.

Endangered resources: upland forests, coral reefs and mangroves

Throughout the Pacific, nearly all of the inhabited islands with hilly and mountainous interiors need to conserve vital watersheds. Over-logging in the Gogol Valley of Papua New Guinea might cause

increased erosion and landslides (which can occur even on heavily forested slopes) in nearby watersheds. On Fiji, uplands have been cleared for mono-cropping, but logging remains a problem in some areas. Small-scale farmers who strip away vegetation in the hills are frequently rewarded with the erosion of their garden plots during tropical storms. A quarter of Fiji is very degraded land brought on by deforestation, agricultural development on steep slopes and town and city development along the coasts. "The problem is, no one is taking land degradation as a serious environmental problem," complains John Morrison, Director of the Institute of Natural Resources at the University of the South Pacific in Fiji.

Mining for nickel, gold, copper, cobalt, lead, zinc, and chrome has left huge scars in New Caledonia's landscape and caused considerable deforestation over the entire area of the main island, especially in the southern part, where rivers run thick and red with sediments scoured from open-cut mines. At an open-cast nickel mine outside Noumea, a sign in French reads: "Here the earth bleeds". Agricultural activities and the expansion of urban centres have contributed to the destruction. Many of New Caledonia's endemic pines (there are 43 species), decimated from mining operations, are now threatened by logging and coastal development.

Small, heavily-populated islands like Truk, one of the Federated States of Micronesia, are especially hard hit by development. Upland soils are eroding rapidly and coastal areas are being cleared for urban housing and small-scale industrial activities. With 45,000 people on 127 sq km of land, the island's environment is in jeopardy.

Deforestation of uplands and coasts causes the sedimentation of shallow lagoonal and coastal waters. Sediment chokes mangrove forests and smothers coral reefs. This is now a universal problem throughout the South Pacific, wherever coasts have been developed and forests cut down. On New Caledonia, mining and logging in the hills allowed tonnes of fine-grained laterite clay to be carried to coastal waters, where it killed mangroves and filled in estuaries. There are practically no undisturbed mangrove stands left on the entire island.

Fiji has destroyed over 4,000 hectares of mangrove forests for agricultural expansion, mostly to increase sugar cane production. "The irony of the situation," insists Padma Narsey Lal, a Fijian researcher at the East–West Center in Honolulu, "is that, for the most part, mangrove land destroyed in the name of agricultural development has still not been put to use; and where it has been,

yields have been very low. This is due in part to acid sulfate conditions in the soils, and the absence of any one authority responsible for the administration of coastal lands."

There are large areas of coral reefs and atolls in the South Pacific – by some estimates as much as 77,000 sq km. Unfortunately most reefs located near inhabited areas are degraded to one degree or another. Coral reef conservation has become a priority for many of the region's countries and territories.

Some of Fiji's reefs have silted over, victims of upland deforestation, the destruction of coastal mangroves for agricultural development, and expansion of coastal towns and cities. On the Solomon Islands, large-scale deforestation and mining activities have ruined near-shore shellfish beds and coral reefs. The pace of upland destruction threatens to get worse; there are now 50 mining companies prospecting for minerals.

As explained in the Introduction, the biggest immediate threat facing Australia's Great Barrier Reef is the crown-of-thorns starfish (*Acanthaster planci*), the coral polyp's natural enemy. Fiji, Western Samoa and Tahiti have suffered extensive coral damage from this predatory animal as well.

Another threat facing the Great Barrier Reef is land-based development. The destruction of Queensland's semi-tropical and tropical forests continues unabated, despite increasingly vocal protests. Much of the coast is already denuded of forest cover and coastal mangroves are now being cut down to make way for urban expansion and tourist centres.

The Queensland coast abounds in classic examples of "counter-development". The town of Cardwell is the main staging area for all tourists who want to camp on Hinchinbrook Island, recently declared a national park. The only way to cross the three kilometres of sea that separate it from the mainland is by boat. In order to make room for the increasing numbers of visitors who want to visit this undeveloped island, the local government in Cardwell decided to clear a stand of mangroves. The predictable result: tonnes of erosion sediment, once trapped by the mangroves, are now heading seaward towards the coast of Hinchinbrook Island. To make matters worse, logging concessions in the watershed around the town may condemn more coastal ecosystems to death by sedimentation. There will be fewer tourists and less money for the town when the reef is dead. In the end, who, except the loggers, really benefits?

Fisheries

Traditionally, Pacific islanders have derived about ninety per cent of their protein from the sea. Many continue to do so. Most of the fishing is artisanal and small-scale, confined to reefs and lagoons. A wide variety of techniques are used, depending on the region and the species of fish to be caught. Fishing craft range from the simple rafts and dug-out canoes with single outriggers used by Polynesians and Melanesians, to the larger double outrigger canoes employed by Micronesians and Papuans. Fishtraps are used extensively in Melanesia; Fijians use nets as well. Normally, fishermen take as much as they need for their own use and sell the rest to neighbouring villages and towns. Artisanal fishing is highly evolved and based on principles of sustainable yield. By obtaining seafood from different habitats – fish from lagoons, shellfish and seaweed from exposed reefs, crabs, lobsters, and molluscs from mangrove swamps, land crabs from the coast, and freshwater prawns from rivers – Pacific islanders are able to diversify their food sources.

Throughout some areas of the Pacific – particularly Melanesia – fishing villages often specialize in different species of fish and shellfish. Since people from one village who want to fish in the waters of a neighbour must first get permission, over-harvesting is usually controlled. When stocks are low, limits are placed on the amount of fish outsiders can harvest.

In New Caledonia, Kanak fishing villages (established on tiny coral islands and islets between the extreme northern end of the main island and the Belep Islands) have evolved some unusual ways to ensure the sustainable use of their coastal resources. Clans are organized into independent management units called a *Kavebu*. There may be more than one clan in each. Besides being a social organization, each *Kavebu* has a well-defined land and marine territory, within which members can harvest freely to satisfy their own needs. *Kavebu* are barred from utilizing each others' territory unless permission is granted. Often, a *Kavebu* will specialize in catching one or two varieties of fish or shellfish. "Techniques are not monopolized," points out social anthropologist Marie Preston, "if a particular fish is found in their *Kavebu*, then they think it is special for them." Some take mostly clams and sea-cucumbers, while others harvest lobsters and rabbitfish.

"Generally, their system works very well," says Preston, who has studied these remote Kanak fishing villages for four years.

"The islands are dry, so they don't have much agriculture. And their fishing is almost exclusively subsistence. Problems arise when outsiders try to fish in their *Kavebu*." A Tahitian who wanted to net fish within a coral lagoon controlled by a *Kavebu* was sent away. In another case, a professional fishing boat from Noumea, filled with weekend anglers, had all their gear confiscated by angry Kanaks, after they tried to fish in a *Kavebu* without obtaining permission.

Although this largely subsistence culture seems to manage its resources well, many of the men have left to join the cash economy on the main island. The women, who do more and more of the fishing, have decided to introduce a small-scale industry of their own: making buttons from trochus shells. In the early part of this century, village women prospered from gathering trochus shells, but they were quickly over-harvested and the industry collapsed. Now, in an effort to re-introduce this source of income, trochus shells are being cultivated for the button trade.

Around other islands subsistence fisheries are in trouble. The Cook Islands and Palmerston Island face the unexplained decline of parrotfish on their coral reefs. On Kiribati, fish stocks are declining and over-fishing is becoming a problem.

This need not happen. If harvested rationally, reef fisheries can supply a tremendous amount of protein. Reef fish around Palau appear to have a potential sustainable harvest of between 2,000 and 11,000 tonnes a year, comparable to the offshore tuna catch. Fish and shellfish from well-managed South Pacific reefs may provide subsistence and small-scale commercial fishermen with 100,000 tonnes a year.

In some areas of the Pacific, fishing is being transformed from a subsistence activity into big business. As the island states and territories of the South Pacific struggle to modernize their feeble economies, a number of indigenous commercial tuna fishing operations have developed. The Solomon Islands, American Samoa and Fiji all have their own tuna fleets, which compete with the deep water fleets from Japan, Korea, the Soviet Union and the United States.

Exclusive Economic Zones (EEZs)

With the advent of United Nations Convention on the Law of the Sea, nearly all of the island states and territories of the South Pacific will benefit immensely from the declaration of 200-mile

Exclusive Economic Zones (EEZs). Much to the consternation of those rim countries with deep water fishing fleets, this development has reduced the area of open ocean in the South Pacific by 30 per cent. At the same time, it has given the small island states and territories of the Pacific a new voice in resource management, and a new source of potential income. Many of the islands are now selling fishing rights within their EEZs to foreign fishing fleets. Kiribati, for example, has sold fishing rights to the Soviet tuna fleet for $1 million a year. Vanuatu has concluded a similar deal. Others are denying access until resource inventories can be completed.

Still, the tuna fleets of Japan, the United States, and Korea, in particular, continue to fish within declared EEZs, since most of the Pacific island states have no way to enforce their claims. This may change if the Law of the Sea Convention can be sorted out to the satisfaction of both the United States and the European Economic Community.

Hazardous wastes in the South Pacific.

At a meeting of South Pacific countries in Noumea, New Caledonia in June 1988, representatives discovered that they had something in common besides the long agenda of shared environmental problems. Within the previous six months, they had all been approached by a US-based company seeking to peddle hazardous wastes from America. On the verge of signing a deal with the waste firm, the King of Tonga was talked out of it at the last minute by his environment representative. Despite the offer of contracts worth millions of dollars, none of the poor Pacific nations approached wanted to make money by taking on imported toxic wastes and the environmental damage they might inflict. The ensuing discussion strengthened their resolve to resist efforts by the developed countries of the Pacific rim, especially the United States and Japan, to foist their toxic waste onto the emerging nations of the Pacific.

Most South Pacific island states have been approached with offers to store everything from poisonous chemical residues to radioactive wastes. The Japanese want to dump low-level radioactive wastes in the Marianas Trench, but will not be allowed to until after the 1990 moratorium on ocean dumping expires. What happens then is unclear. The Japanese have around 600,000 containers of radioactive wastes from their nuclear reactors. So far, they have not been able to

ship them somewhere else, and they may end up disposing of their toxic wastes on their own land.

In the early 1980s the US announced plans to store 10,000 tonnes of highly radioactive wastes from Japan, Taiwan and South Korea on three of their Pacific islands: Palmyra, Wake and Midway. When the environmental impact study was completed for this scheme, however, the plans were quietly shelved. Another plan by the US Navy to scuttle 100 out-dated nuclear submarines in the Pacific was abandoned after US environmental groups protested.

Realizing that they are easy targets for other people's hazardous wastes, the countries of the South Pacific took a strong stand on the issue at Rarotonga in 1982, where they gathered to launch a regional environmental programme. Their concerns were translated into the Rarotonga Declaration, in which the conference declared that "the storage and release of nuclear waste in the Pacific regional environment shall be prevented," and "testing of nuclear devices against the wishes of the majority of the people in the Region will not be permitted." Although these declarations are largely rhetorical and unenforceable, their intentions are admirable.

Another issue related to imported hazardous wastes is that of the continued French testing of nuclear weapons on Mururoa and Fangataufa, two remote islands in the Tuamotu group in French Polynesia. Until 1974 the French insisted on conducting atmospheric nuclear tests, resulting in the irradiation of thousands of Polynesians and Melanesians. Wide areas of the South Pacific have been exposed to radioactive fallout by these tests and by the 66 atomic bombs which the Americans dropped on the islands of Bikini and Eniwetok between 1946 and 1958. The Americans have since moved their testing programme to the Nevada desert, but the French have continued to test their bombs in the South Pacific, despite angry protests from virtually every country in the region and in bare-faced contempt of the Rarotonga Declaration.

There are fears that radioactive waste from the French tests, which have been conducted underground since 1974, pose an unacceptable threat to the health and well-being of thousands of Polynesians. Since the French have consistently refused to disclose any data on the amount of fallout their bombs have caused, or on the amount of radiation leaking from their nuclear dump sites, health and environmental risks can only be guessed at.

"Nuclear fallout engendered by the 41 atmospheric tests, made at Mururoa and Fangataufa between 1966 and 1974, is still with

us (mostly absorbed in our bodies), and the 63 underground tests made since 1975, instead of diminishing the health hazards, have added several new sources of radioactive pollution," writes Bengt Danielsson, explorer and historian (a member of Thor Heyerdahl's Kon-Tiki expedition in 1947), who lives in Papeete, Tahiti.

French intransigence on the issue of nuclear weapons testing continues to anger the South Pacific states. The issue remains contentious and raw. "No resolution will come until France ceases its mad bombing of the Pacific," notes Danielsson.

Greenpeace: policing the seas

When the *Khian Sea* left Philadelphia carrying 14,000 tonnes of the city's toxic incinerator ash in its holds, the owners, Amalgamated Shipping, thought it would be easy for the ship to dump its cargo in some tropical, cash-short Third World country. They were wrong. In 1988, after 27 months wandering around the world's seas – visiting five continents – the ship was reportedly anchored off Singapore in international waters, having discarded most of the toxic ash somewhere in the Indian Ocean. Earlier, about 4,000 tonnes of the ash were simply left on a Haitian beach, labelled as fertilizer.

The odyssey of the *Khian Sea* was carefully monitored by Greenpeace activists around the world. The ship was tracked across the Caribbean Sea and Indian Ocean and into Southeast Asia and the Pacific. As the *Khian Sea* went from one Pacific island to the next making large cash offers to any government that would take the toxic ash, Greenpeace representatives were busy informing the region's governments about the ship's cargo and what it might mean to their fragile environments if they accepted. In the end, there were no takers.

Largely through the efforts of Greenpeace the ship was unable to find a legal dumping site. "Still, we couldn't track it all the time," admits Sebia Hawkins, Greenpeace's Pacific Campaign Co-Co-ordinator. "We are still trying to find out where the ship dumped its waste ash in the Indian Ocean."

Sebia and her colleagues in the Washington DC office fear that as toxic waste mountains continue to accumulate in the developed world, there will be more voyages like that of the *Khian Sea* to the developing world. "This may be a portent of things to come. We have to be prepared to deal with more of these kinds of incidents."

As the only international NGO which actually polices the seas, Greenpeace is one of the few organizations that attempts to monitor those who treat the oceans as a garbage dump.

Since its inception in the early 1970s, one of Greenpeace's priorities has been a nuclear-free Pacific. In fact, the Nuclear Free Pacific Campaign is the oldest on Greenpeace's agenda. Ever since David McTaggart, one of the founders of Greenpeace, sailed his own yatch into a French nuclear testing zone in Polynesian waters in 1972, drawing world attention to the atmospheric testing of nuclear weapons, Greenpeace has had passionate presence in the South Pacific. In part as a result of the Greenpeace protest and the media coverage of the incident, President Giscard d'Estaing finally abandoned atmospheric testing in 1974. Undeterred by vocal protests from governments in the region, however, France simply went underground with its nuclear programme, just as the Americans and Russians had done in the early 1960s. But there is one significant difference: whereas the United States and Soviet Union now conduct tests within their own home territories, the French continue their tests far away from their home land for the dubious benefits of a nuclear arsenal.

"We now have three major issue areas in the South Pacific," explains Hawkins, "ocean ecology, particularly coral-reef conservation and marine-mammal preservation and management; the production, transport and disposal of toxic wastes; and nuclear weapons testing, both warhead and delivery systems." Within these areas, Hawkins and her colleague Bunny McDiarmid must co-ordinate a campaign that includes the Pacific Rim countries, along with 19 island states and territories. Five of the latter have been targeted for priority attention: Papua New Guinea, the Solomons, the Marshall Islands, Palau, and French Polynesia.

"Dealing with such a plethora of inter-connected issues over such a vast area, we have learned to be sensitive to the development objectives of each island state, including controversial areas such as mariculture, tourism, even the logging of rainforests," explains Hawkins. "The last thing we want is to be labelled 'white eco-imperialists' in this region."

The South Pacific Regional Environment Programme (SPREP), set up with the support of UNEP, is a convenient focus for Greenpeace campaigns. "One of the reasons we like UNEP's regional seas programme," admits Hawkins, "is because they have a mandate from the governments of the South Pacific to

do something. The governments want this programme or UNEP wouldn't be here. Greenpeace is playing an active role in both SPREP and the Pacific Forum, lobbying both organizations on specific environmental issues."

Within the framework of SPREP, Hawkins and her crew are working on a protocol which would make all low-lying coral atolls in the South Pacific protected areas where no hazardous activities of any kind would be permitted. Specifically, such a protocol would prohibit nuclear testing along with the storage of toxic wastes and other industrial garbage from the developed world. It might also ban land-based incineration of wastes, because, as Hawkins explains, "small coral atolls and islands are mostly coastal, and any kind of atmospheric or land-based pollution quickly enters the marine environment. On small tropical islands, the environment is all they have."

Another new area for Greenpeace is the question of the management of coastal resources. "We haven't done much on this yet," says Hawkins, "we are still getting our sea-legs on this issue." Greenpeace representatives in the Pacific are already beginning to co-operate with a number of local and regional NGOs, in an effort to develop their capacity to advise South Pacific governments on the efficacy of various management options. "Soon Greenpeace will be in a position to link development/environmental management specialists with local policy people and other NGOs," explains Hawkins.

In a related exercise, the Greenpeace Washington office is involved in the drafting of a Coral Reef Protection Act for the United States. "If we can get something like this through Congress," says Hawkins, "it will have an immediate impact on how the US Trust Territories in the Pacific are managed."

In the end, it is the people of the Pacific who will have to make the difficult decisions. By working together with Pacific-based NGOs, as well as intergovernmental organizations and the United Nations, Greenpeace hopes to help the countries of the Pacific grapple with those choices.

Currently, Greenpeace is expanding its interests well beyond marine concerns. "Since many of the problems afflicting our coasts and seas are land-based, we have to be sensitive to a whole range of issues that might seem at first to be disconnected from the sea," explains Hawkins. Issues such as tropical forest destruction, the mismanagement of uplands, the use of pesticides on croplands, wetland conservation and many others are all being studied for their possible impact on coastal areas.

"I like the diversity of tactics, the various responses to issues that we at Greenpeace have," explains Hawkins. "When we take on an issue, we can go as far as we need to." This militant approach to environmental activism does get results. "I feel very fortunate to have this job, because I know that I am doing everything I can to improve the environment," confesses Hawkins. "But so much remains to be done in the Pacific. If only there was more time."

Biodiversity

As to be expected the Pacific islands are wonders of biodiversity. Geographical isolation has made them that way. Islands that were once connected to continental land masses, such as New Caledonia and Papua New Guinea, are now a refuge for species that were driven to extinction long ago by evolutionary processes on the continents. As a result, most Pacific islands, including coral atolls, have a large number of plants and animals found nowhere else. New Caledonia has many primitive gymnosperms and flowering plants; 80 per cent of them are indigenous. Most of them are also endangered by habitat loss and competition from introduced species.

Isolation alters evolutionary processes in plants and animals. It produces a great variety of species, but they are often unable to cope with invasions of non-native species. So long as islands remain islands, this is no problem. However, once Europeans began colonizing the Pacific in the eighteenth century, they introduced many new, highly-competitive species like cats, rats, dogs and pigs. The new arrivals often annihilated indigenous populations of fauna and flora, which had not evolved ways of dealing with predators and their diseases, or with habitat competition. Wanton destruction of forests and coastal areas killed off others. "Today, there are probably more endangered species per person in the South Pacific than anywhere else in the world," stresses Arthur Dahl, Deputy Director of UNEP's Oceans and Coastal Areas Programme Activity Centre in Nairobi. For instance, there are 54 endangered bird species, or one for every 92,000 inhabitants of Oceania. Equivalent figures show one endangered bird for every 400,000 people in Australia and New Zealand, and one for every 670,000 people in the Caribbean, the other region noted for its extinctions.

So far 15 countries have set aside parks and protected areas to safeguard their natural heritage. In many cases the parks are not much more than proclamations on a piece of paper. Serious efforts

must be launched if the South Pacific is to preserve even a small part of its unique communities of plants and animals.

The South Pacific Regional Environmental Programme

The need for a regional approach to environmental problems was recognized early. The South Pacific Conference first voiced concern over the sad state of the region's environment in 1969. Consultations between the South Pacific Commission and UNEP began in 1974. These initial discussions were soon joined by the South Pacific Forum – the political association of independent Pacific countries – through its Secretariat (the South Pacific Bureau of Economic Cooperation) and the Economic and Social Commission for Asia and the Pacific (ESCAP). Protracted discussions led eventually to the decision to organize a conference on the human environment in an effort to create an integrated regional approach to environmental management.

After a long and complicated process, the 22 island states and territories of the South Pacific finally met at Rarotonga in the Cook Islands in March 1982 to endorse the South Pacific Regional Environment Programme Action Plan. Thus, ten years after the Stockholm Conference on the Human Environment launched UNEP, the South Pacific states set up their own programme.

Because existing funding mechanisms were in place to finance the action plan, a trust fund administered by the countries of the region, was not formed. Also, tight budgets meant that no one wanted to be held accountable to pledged donations on a yearly basis. Funds to cover programmes were contributed on a case-by-case basis, with most of the initial money coming from UNEP's Environment Fund.

In the beginning, the programme was handicapped by a general sense of inertia about environmental problems and how to solve them. SPREP's priority programmes suffered from a lack of political commitment on the part of the region's governments. Despite these problems, SPREP was able to carry out a number of important baseline pollution studies and set up a network of scientific institutions and specialists. Since its inception, SPREP has produced over 140 scientific reports and studies. Most countries in the region now have fairly complete resource inventories, along with pollution data, and so can begin to formulate strategies for sustainable development.

In November 1986, 12 independent Pacific states and four other nations with territories in the Pacific adopted the Convention for the Protection of the Natural Resources and the Environment of the South Pacific Region. It had taken nearly five years of hard negotiations, involving more than 20 countries and territories of the region, to reach an accord.

The Convention commits signatories to "prevent, reduce and control pollution in the region from ships, land-based sources, any exploitation or exploration of the seabed, atmospheric discharges, all forms of dumping and the storage of toxic and hazardous wastes." Following the spirit of the Rarotonga Declaration, the states also agreed to prohibit the dumping and storage of radioactive wastes in the Convention area, and to "prevent, reduce and control pollution that might result from nuclear tests in the region". Known as the SPREP Convention, it will enter into force after 10 of the 22 eligible Pacific states ratify it.

With a legal framework, SPREP's action programme can begin to accelerate. But first the programme must develop more diversified and stable sources of finance. Since the preparatory phases of SPREP, over $5 million in contributions have been spent, with more than half coming from UNEP's over-burdened Environment Fund. UNEP is now concentrating its support on specific priority projects, and other parts of the action plan are being funded from other sources.

Obviously, these small island states will never be able to exert much pressure on the international scene. However, by forming a block of interests on certain key issues (like nuclear weapons testing, dumping of radioactive waste, and driftnet fishing) they may still become a persuasive lobby at international forums like the United Nations General Assembly. Their effectiveness, indeed their future, depends on clear policy, decisive action and genuine regional co-operation.

7. The South-east Pacific

The Pacific coast of South America stretches over 10,000 km from Panama in the north to the very tip of Chile. From the dense tropical rainforests of the Colombian coast to the cold deserts of northern Chile it is one of the longest and most varied coastlines in the world.

This region, comprising Panama, Colombia, Ecuador, Peru and Chile, is beset by many of the same problems that afflict the Caribbean and South Pacific. With the exception of Colombia, coastal populations are growing more rapidly than elsewhere. Upland forests have been degraded to make room for subsistence agriculture and grazing lands for cattle and sheep. Mining operations have turned entire mountains into rubble, denuded watersheds and caused massive erosion and siltation of rivers and streams. Industries pump millions of tonnes of pollutants into coastal waters. Rivers which flow into the Pacific often bring in toxic mine tailings and raw sewage. Municipal wastes from coastal towns and cities are dumped untreated into the ocean. Mangroves are being cut down to make room for commercial shrimp ponds.

If some areas have escaped development – like most of Colombia's Pacific coast – it is not because of proper resource management. Usually it is because the area is considered too remote and inhospitable, or too far from traditional population centres and markets.

The economies of the region are still developing, saddled with huge external debt and increasingly forced to export their resources to pay off loans. These five countries have total debt burdens amounting to around $64 billion. Over 25 per cent of the exports of Chile, Colombia, and Ecuador must go to service their debts. With such economics, the South-east Pacific states often find themselves tied to development programmes that sacrifice sustainable resource management for short-term gains. Most of these countries are forced onto the "development treadmill", exporting raw materials

and agricultural produce, rather than finished goods. Unfortunately, the prices for basic commodities continue to fall. In virtually every category – metals and minerals, timber, cereals, fruits, beef, and fats and oils – the prices are lower now than in the 1970s. Lower prices result in over-exploitation of limited resources: more marginal land must be cleared to grow more produce or produce more beef; more fertilizers and pesticides must be used to boost yields; more timber must be cut and more minerals extracted. The environmental price for such exploitation is very high.

Recognizing that they have many of these problems in common, the countries of the South-east Pacific, with assistance from UNEP, launched the Action Plan for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific in 1981.

The coastal waters of the South-east Pacific teem with fish and shellfish. Coastal areas also provide some of the best agricultural land in the region. In the mountainous interiors of Ecuador, Peru and Chile, good agricultural land is scarce; in each case the Andes Mountain chain cuts the coast off from the rest of the country. Most of the people living in Peru and Chile are confined to thin coastal strips of land, varying in width from 20–90 km.

Narrow coastal shelves are rich in sea life because the cold and deep Humboldt Current sweeps up the coast of Chile and Peru from the Antarctic, bearing tonnes of bottom nutrients. An offshore version of the Humboldt Current is known as Peru's Oceanic Current. Together these transport systems flow north at the rate of 10–15 million cu m per second; more than the discharge rate of all the world's major rivers combined. This creates nutrient-rich upwellings of cold water along the coast of Chile, Peru and Ecuador. Were it not for this current, the waters of the South-east Pacific might be as barren as much of the South-west Pacific.

Not surprisingly, fishing (and fish processing) is a big industry. Other major economic activities include mining and metal smelting, oil production, food processing, textiles, leather and tanning, forestry, pulp and paper, petroleum refining and chemical production.

Among the diverse habitats of the Pacific coast of South America are large, brown-water river systems. Coastal marshes and estuaries formed at the mouth of these sediment-rich rivers form fecund nurseries for fish and shellfish. Unfortunately, many of them are also polluted with the toxic debris from mining operations and untreated wastes from towns and industries located in the watershed. For

example, by the time the Guayas River in Ecuador meets the sea, its waters are laden with industrial wastes, pesticide residues and raw sewage. An estuary once teeming with life is now choked with pollutants. It's an all too familiar pattern. "South America's Pacific coast is the ultimate toilet into which is flushed a multitude of sins," observes Jairo Escobar, UNEP consultant to the Permanent Commission for the South-east Pacific in Bogota.

Cities of the coast

With the sole exception of Colombia, most of the region's people live along the Pacific coast, or within 60 km of it. Roughly thirty-two million people inhabit this coastal zone, most of them crammed into cities and towns. Like the rest of Latin America, the urban population of these five countries is growing more rapidly than the rural. Ecuador's population is growing at the rate of 2.7 per cent a year, while the population of Guayaquil – its largest city – grows at 4.5 per cent a year, doubling in size every 15 years. Most of this growth is attributed to migration from the impoverished countryside. With a current population of 1.7 million, Guayaquil may very well end up with 2.7 million people by the turn of the century. Many of the new arrivals live in slums and squalid shanty-towns built over the remains of mangrove swamps, or next to sewage outfalls and garbage dumps.

Already, 85 per cent of Chile's population is urban, as is 70 per cent of Colombia's and Peru's. In Chile, three-quarters of the people live along a 500-km stretch of coastline between Valparaiso and Concepcion, on 15 per cent of the total land area. The Lima–Callao area of Peru contains nearly 8 million people, 30 per cent of the country's total. Most Panamanians live on the Pacific coast, 760,000 of them in Panama City.

Attempts to encourage the growth of secondary towns away from coastal areas have not had much success. Peru launched a decentralization drive in 1959 in an effort to encourage the development of industrial centres in the largely neglected interior. Despite the creation of industrial parks in cities such as Cuzco, Huancayo and Pasco, the Lima–Callao area still contains 65 per cent of the country's industries.

Colombia, with two coasts to choose from, sensibly chose to develop its more accessible Caribbean side. As a result, Colombia's population is concentrated in the fertile arc extending along the

north-central part of the country, and along the Caribbean. Only within the last few years has the government come up with plans to develop its sparsely populated Pacific coast, which at the last census contained only 615,000 people, spread out along 1,300 km of mangrove swamps. Planners in Bogota joke that one of the reasons the Pacific coast has never been developed is because the area's most numerous occupants are mosquitoes, many of which carry malaria and yellow fever. In coastal towns like Tumaco, near the Ecuadorian border, the locals refer to their mosquitoes as "flying hypodermics". Mosquitoes aside, the Pacific coast has been neglected because of a combination of factors: lack of interest on the part of the Colombian government, the absence of infrastructure, and remoteness from traditional markets. Few roads have been cleared through the jungle. Tumaco is connected to the outside world by one potholed road, which is washed out for half the year. The small fishing town of Guapi, some 200 km up the coast from Tumaco, cannot be reached at all except by plane or boat. Only the main Pacific port of Buenaventura has a functional road linking it to the rest of the country. Some on the frontier scoff at the notion of development. One Colombian fisherman from Guapi remarked, "the rivers are our highways, we don't need roads. No one here can drive anything but a boat."

Given the intense level of development along the rest of the Pacific coast, the governments of Ecuador, Peru and Chile wish they had Colombia's options. As more people press upon the coast, pollution mounts and resources are destroyed. "We have heaped this abuse upon ourselves," claims a government planner in Peru. "We have not managed to distribute our growing populations away from the coast. We have not been able to encourage industries to go elsewhere, and so there are fewer jobs in the interior. Our uplands are starving for development, while our coasts are drowning in it."

Coastal pollution

Not only is the South-east Pacific a receptacle for direct discharges of pollutants from coastal cities and industries, it also receives all the pollution washed down from the watershed. Most of the major river systems bring in poisons from mining operations in the Andes, pesticide residues from agricultural land, and tonnes of untreated sewage and municipal wastes from towns and cities.

Nearly every urban area along the coast flushes its wastes into the Pacific untreated. From Porto Armuelle in Panama to the tip of Chile, some 70 major coastal towns and cities deposit everything from raw sewage to solid wastes in shallow coastal waters. Industrial centres add their effluents to the sea.

"There are virtually no sewage treatment plants in Colombia, nor in any of the other countries in the region," points out Jairo Escobar, a UNEP consultant in Bogota. "Industries don't treat wastes either, everything goes into coastal waters – organic wastes from fish and food processing plants and slaughter houses; mine washings; and toxins from tanneries, metal smelters, and chemical plants."

The results can be seen and smelled: coastal waters near every urban and industrial centre are polluted. Panama Bay receives some 34 million tonnes of untreated sewage a year from three rivers and 20 outfalls in Panama City and the port of Balboa. The resultant pollution has created "anoxic" areas in the Bay, where oxygen-starved waters support no fish. Pollution and sedimentation have caused a drastic reduction in the diversity of marine life in the bay.

"Although 95 per cent of Panama City's 760,000 residents have access to potable water, 96 per cent of the city's municipal wastes go directly into the Bay untreated," points out Dr Luis D'Croz, Director of the Center for Marine Science and Limnology at the University of Panama. "We don't have sewage treatment plants and the sewage line outlets go into shallow coastal waters."

To complicate matters, the Bay's sediments also contain traces of Lindane and Eldrin, two toxic pesticides sprayed on croplands along the coast.

Pollution is contributing to a decline in the catches of shrimp and anchovies. The shrimp catch alone is worth around $70 million a year. Trawlers now have to go further out into the Bay in order to find economical quantities of shrimp and fish. As catches decline, over-fishing becomes rampant. Recently, the government imposed a two-month closed season on shrimping, as well as regulations on the type of nets used and the number of boats operating in efforts to bring over-harvesting under control.

Near-shore mussel beds, too contaminated to be harvested, had to be moved elsewhere. Poor artisanal fishermen can no longer make a living from Panama Bay's polluted waters. Instead, some have turned to smuggling.

Meanwhile, the population of Panama City is expected to reach one million by the year 2000. Authorities think the Bay will get worse

before some control measures are brought into effect. One solution being discussed is to extend the current sewage outfalls further out into the Bay – a "solution" that will not reduce pollution, but simply spread it out over a larger area.

The only polluted areas on Colombia's mangrove coast are Buenaventura Bay and Tumaco Cove, both fouled with organic wastes from fish-processing plants, untreated sewage, assorted municipal wastes, and oil. Parts of Buenaventura Bay are now rich in nitrogen and ammonia and poor in oxygen, due to the massive discharge of raw sewage from the city and three rivers. Municipal wastes flow into the Bay at the rate of 54,000 cu m per day. Bacteria (coliform) counts in the Bay are exceptionally high. Floating algal scum, faecal matter and rotting garbage collect around boats in the harbour. A common joke in Bogota is that visitors can smell Buenaventura before they see it. For the people condemned by poverty to live around the Bay, its sorry state is no joke. Many of them have to make a living from what they can gather from the Bay's waters. It is not surprising that the major cause of death for children under one year of age is diarrhoea, caused by drinking water fouled with human faeces, and eating tainted fish and shellfish.

Ecuador, with its highly developed coastline, suffers from acute deterioration of its coastal waters. Some 20 coastal cities are responsible for pumping 90 million cu m of waste water into the Pacific; 60 per cent of this is accounted for by Ecuador's largest city, Guayaquil. In addition, Guayaquil Bay receives the wastes from the Guayas River Basin, which covers 34,000 sq km, the second largest on the west coast of South America. Its waters dump sewage, pesticide residues, and heavy metals from mining operations into the Bay. Copper concentrations in the Guayas River and its tributary, the Daule River, exceed safe levels. Some of the toxicity of the copper, however, is thought to be offset by the huge quantities of domestic sewage found in Guayaquil Bay. Health effects from heavy metals have not yet been detected, perhaps because many of the Bay's poor people suffer from chronic stomach and intestinal disorders brought on by eating seafood contaminated with sewage and drinking dirty water. Viral hepatitis is epidemic, as is malaria.

The waters around the cities of Lima and Callao have turned into cesspools from municipal and industrial effluents. Untreated sewage often washes up on the nearby tourist beaches of Ventanilla, Pampilla and Herradura, prompting city authorities to declare them off-limits

for months at a time. The 15,000 industries in the Lima–Callao area dump most of their wastes directly into the sea.

The other source of chronic pollution to Peru's coast is from mining and metal smelting. Mining operations in the Andes routinely flush millions of tonnes of polluted mine washings into rivers and streams, which carry them to the coast. In the mountainous province of Tacna, on the Chilean border, two huge copper mines pump more than 73 million tonnes of mine debris and tailings into local rivers every year. So much of it ends up in the Pacific that near-shore waters contain 21 parts-per-billion of copper, enough to poison a wide variety of marine organisms. In the mountains above Lima, 11 mines deposit 1.8 million tonnes of pollution a year into the Rimac River, which runs through metropolitan Lima before entering coastal waters. Nearly all mine tailings and debris contain a deadly assortment of heavy metals such as copper, cadmium, mercury, lead and nickel.

Further south at Pisco, copper mines pollute the Pisco River with heavy metals, before it flows into shallow coastal waters. Mussels have been contaminated with high levels of copper and cadmium, making them unfit for human consumption. Unfortunately, the people who fish in these polluted waters have little choice.

Untreated sewage is a problem in the Bays of Valparaiso and Concepcion, Chile. The Bio Bio River, which flows into the Gulf of Arauco, just south of Concepcion Bay, is laden with sewage and heavy metals, particularly mercury and lead, from towns and industries in its watershed.

Mining, however, is the major cause of coastal pollution in Chile. In the northern part of the country, copper and gold mines flush nearly 12 million tonnes of polluted tailings and process water directly into the sea. Since mercury is used in refining gold ore, the mercury level in these waters is extremely high. Its effects on marine organisms are not known.

Over-use, or mis-use of toxic pesticides is another source of pollution. In all, the South-east Pacific region uses some 60,000 tonnes of pesticides every year, most of it on croplands. Like the South Pacific region, pesticides banned in the North, such as DDT, are still being applied to crops. Panama Bay, the estuary of the Guayas River in Ecuador, and Concepcion Bay and San Vicente Gulf in Chile are all contaminated with pesticide residues.

"We are currently developing a programme to monitor the use of pesticides in our environment," states Rafael Vasquez Montoya, an

officer with the Panamanian National Environment Commission. "The use of really deadly pesticides like DDT is continuing in Panama. We are trying to keep track of what is being used and where."

Degraded resources

With the exception of Colombia, most of the region's tropical forests are being converted into pastureland and cash crops. Panama's Pacific watershed has been logged and replaced by cattle ranches. The country is said to be losing around 36,000 hectares of forest a year. The only region with intact tropical forests is the San Blas, on Panama's Caribbean coast, an area controlled by the Kuna Indians.

Ecuador's coastal mangrove forests are being destroyed to make way for brackish-water shrimp ponds (as described below). Inland, its tropical hardwoods are being cut down and the uplands given over to farms and cattle ranches. Ecuador's pastureland has more than doubled in area since the 1960s, at the direct expense of its tropical forests: the country has been losing around 340,000 hectares a year during the 1980s. There are now only a few ragged remnants of true wilderness left in the entire country. Many of Ecuador's forests consist of secondary growth.

Chile and Peru still have extensive tracts of unlogged woodland in the Andes watershed. Each country has around 30 per cent of its total land area covered by wilderness. But both countries are losing timber faster than it is being replaced; Peru is losing, on average, 270,000 hectares a year, and Chile 50,000 hectares.

There is one factor working in favour of preserving forests. For practical reasons – access to labour and cheap transportation – the many mines operating in both countries tend to be near populated coastal areas and in the Pacific watershed, leaving vast areas of northern and eastern Peru and much of southern Chile free from heavy resource exploitation. So far these sub-tropical and alpine forests have remained inaccessible.

Nevertheless, as upland forests give way to mining, agriculture and ranching, soil erosion is one of the inevitable consequences. In Colombia's central highlands around Bogota, deforested hills are being washed down into the valleys. Hillsides are slit from top to bottom with gulleys carved out by torrential rains. Rivers and reservoirs are silting up.

The Tomine Hydroelectric Dam, 60 km from Bogota, near the village of Sesquile, was faced with closure because of erosion sediment flowing into its 690 million cubic metre storage reservoir. The Tomine Electric Authority decided to fight back with a massive reforestation campaign. Over the past two years, some 1.2 million trees – 80 per cent of them acacia – have been planted on the slopes surrounding the reservoir. The project aims to stabilize 1,200 hectares of badly eroded hillsides by 1991. "Already we have greatly reduced erosion sediment flowing into the lake. And by planting trees, we have reduced the effects of wind erosion as well," states a spokesman for the Electric Authority. So far around 600 hectares have been replanted. Most of the seedlings have been placed on carefully worked up terraces, in an effort to ensure their survival during the rainy season and further stabilize the soil.

In some areas, deep gulleys torn out by heavy rains have been sandbagged in an effort to cut down on the amount of soil reaching the valley and the reservoir. By reforesting bald slopes around the dam, the peasant farmers in the region have also been given another chance. "Before all they could do was watch as their topsoil washed away," observes an official from the Electric Authority. "Now they can see the benefits the trees bring. In some cases they are replanting their own trees."

In this case the watershed has been saved. In many other regions, however, they have been lost. In the uplands of Ecuador, Peru and Chile – particularly in mining areas – deforested hills show huge erosion scars. In some parts of Peru and Chile, entire mountain slopes have broken apart during heavy rains, sending mud avalanches into valleys, smothering villages. Soil erosion in Peru approaches 15 tonnes per hectare per year across the entire country.

Mangrove forests, the regulators of coastal erosion, are being lost throughout the region. All but ten per cent of Panama's mangroves are concentrated along the Pacific coast, where they total around 5,000 sq km. Conversion of mangroves to brackish water shrimp ponds is continuing despite recent economic difficulties. Luis D'Croz calculates that the country is losing one per cent of its mangrove resources every year. "There is some hope, however, that we will still be able to preserve a sizeable portion of our mangroves," explains D'Croz. "With the economy in a tailspin and the costs of opening up new areas getting more expensive, shrimp farming is now less attractive than it was a few years ago."

Colombia's mangroves are largely intact, occupying 280,000 hectares along its Pacific coast – the largest stand in Latin America, outside Brazil. Still, there are fears that as Colombia's Pacific coast becomes more developed, mariculture will accelerate as it has in Panama and Ecuador. Already 5,000 hectares of mangroves have been taken over by shrimp and prawn ponds around Buenaventura.

Ecuador's mangrove resources, except near the border with Colombia, have been decimated and replaced by shrimp farms. Out of a total area of 177,000 hectares, some 60,000 hectares of mangroves have been converted and there are plans to develop another 50,000 hectares.

Since mangroves are essential breeding and nursery areas for shrimp and prawns, cutting down mangroves for shrimp farms simply increases one type of yield at the expense of another. Indeed, commercial shrimp farmers often depend on shrimp fry, hatched in mangrove areas, to restock their ponds.

Coral-reef resources in the region are not extensive. Most Panamanian and Colombian reefs are in the Caribbean, not the Pacific. Because of waters rich in nutrients, fisheries in the region are not reef dependent. The only reefs of any size are off the coast of Panama, and around the Galapagos Islands (Ecuador) and Gorgona Island (Colombia).

Fisheries

The cold nutrient-rich waters swept up the west coast of South America by the Humboldt Current and its offshore counterpart ensure that the waters off the coasts of Chile and Peru are teeming with marine life. Local upwellings in the coastal waters of Ecuador, Colombia and Panama are met by wedges of freshwater brought in by tropical rivers which bring nutrients – and pollutants – from the interior.

The annual take of fish and shellfish from the region amounts to just under 10 million tonnes, or roughly fifteen per cent of the world's total commercial harvest from the sea. Peru and Chile account for all but a fraction of that tonnage. In 1985 their deep water fleets caught over 9 million tonnes of fish, mostly anchovies, sardines, hake, and jurel. In addition, Peru produced 1.4 million tonnes of cultivated crustaceans, while Chile cultured 7,000 tonnes of clams, oysters and algae. Most cultured shellfish are exported to Japan and North America.

Panama Bay is rich in marine life because of an upwelling of deeper, nutrient-laden water. Nearly ninety per cent of the Panamanian commercial fishery is based in Panama Bay and Panama Gulf. Three species of white shrimp are caught, amounting to 7,000 tonnes a year. Many anchovies are also taken, and scallops are harvested by artisanal fishermen working in the less polluted southern part of the Bay. But mounting pollution is exacting a toll on the Bay's fisheries. "At the moment, we are not getting the maximum sustainable yield from our fisheries because of over-fishing and pollution of near-shore waters," states D'Croz.

In Ecuador the fishing industry ranks second, after oil production, as a source of foreign revenue. The total amount of fish and shellfish exported amounts to around 300,000 tonnes a year. The export of farmed shrimp is also accelerating, as is organic pollution from shrimp farms, which is pumped into coastal waters.

By contrast, the Pacific coast of Colombia is unique: it is virtually undeveloped. From the metropolis of Buenaventura in the north to the small fishing village of Tumaco near the Ecuadorian border, the mangrove coast stretches for over 600 km. It is one of the most unspoiled mangrove wildernesses left on earth, broken only by meandering brown-water rivers that flow lazily into the Pacific. There are no roads through the jungle.

From the air, the sight of so much unbroken tropical greenery is breath-taking. Along the entire length of the mangrove coast only one town of any size appears on the map – Guapi, situated at the mouth of the Guapi River. The few fishing settlements consist of tin-roofed wooden shacks, bounded on all sides by imposing mangrove swamps. During the last century the sugar boom prompted the establishment of a few plantations, worked by slaves from West Africa. But the plantations failed, unable to withstand the effects of disease and their remote location.

Unable to make a living from the land, the people of the mangrove coast have turned towards the wealth of the sea. Everything from giant prawns to grey whales lives here, but it is the langustino shrimp (*Penaeus occidentalis*) which sustains most of the estimated 5,000 people who ply the coast in simple dug-outs or motor-boats. Since there are no large trawlers operating in these waters, the region's fisheries are under-developed. Only around 17,000 tonnes of fish and shellfish are taken every year; a mere fraction of the annual potential yield which has been calculated at between 130,000 and 156,000 tonnes.

El Niño

The disruptive, and destructive, weather patterns which periodically sweep through the Pacific have come to be known collectively as El Niño, The Child. However, its effects are anything but child-like.

When this bizarre weather pattern hit the west coast of South America in 1972, the anchovy fishery, worth millions of dollars, collapsed. Years of over-harvesting had of course, contributed to its demise.

El Niño can perhaps best be understood as a sort of ocean drought. Climate controlling ocean–atmospheric interactions are disrupted on a large scale. Temperatures climb and surface waters become much warmer than normal. Warmer surface temperatures cause more nutrients to be sedimented out of the water column, depleting coastal waters of the food needed to sustain marine life, including commercially important fish. With food sources reduced and water temperatures becoming unbearably warm for cold water fish, they go elsewhere.

Those creatures who cannot leave, learn to take advantage of the warmer waters or perish. Hence, during the last devastating visit by El Niño, in 1982–3, coral reef communities in the Gulf of Panama simply died off as water temperatures soared to 31° Centigrade. Tropical crabs, on the other hand, were able during the same period to expand their breeding ranges further south thanks to the warmer waters.

The El Niño of 1982–3 turned out to be the worst of this century. Heavy rains drenched Colombia, Ecuador and Peru. In northern Peru, rainfall was 340 times greater than normal. Some rivers carried over 1,000 times their normal flow. The widespread flooding that ensued took a terrible toll on crops, livestock, roads, bridges, schools and homes. In Ecuador, 40,000 families were made homeless by flood waters. Unable to catch anything in the warmer surface waters, tens of thousands of fishermen across the Eastern and South Pacific were left idle. In Southeast Asia and Australia, prolonged droughts ruined crops and turned soils to dust.

"We now have a regional research programme in place to study this phenomenon," says Jairo Escobar, "it is a really big problem for us. The last time it struck, there were droughts across the Pacific island states and Southeast Asia, while Colombia, Ecuador, and northern Peru suffered heavy rains. Our entire economy was affected."

The South-east Pacific Action Plan

The Action Plan for this region is nearly a decade old. The five countries of the South-east Pacific gathered in Lima, in November 1981, to approve the "Convention for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific". At the same time they also approved the "Agreement for Regional Cooperation to Combat Pollution of the South-East Pacific due to Oil Hydrocarbons and other Noxious Substances in Cases of Emergency". The Permanent Commission for the South-east Pacific (CPPS) was designated as the co-ordinating agency for the Action Plan. The Lima meeting was the product of four years of preparatory work carried out by the Permanent Commission for the South-east Pacific and the region's governments, in co-operation with UNEP.

Subsequently, in 1983, another important protocol was added to the Convention: the "Protocol for the Protection of the South East Pacific Against Pollution from Land-based Sources". They were all duly ratified and came into force in 1987.

One of the first things that the CPPS did was to set up a network of national contact points in each of the participating countries. Then a research programme was worked out and approved in an effort to assess the state of the marine environment and to pinpoint polluted areas in need of priority attention.

"When we started this programme, we had no information at all as to the state of our coastal waters and marine resources," points out Jairo Escobar. "We are still trying to upgrade our database, but at least a good beginning has been made."

The pollution research and monitoring programme now has its own network and its own name: CONPACSE. So far, baseline pollution studies and assessments have generated a wealth of data and scientific expertise – some forty technical reports are now available to national authorities trying to grapple with coastal pollution. CONPACSE research has involved 42 regional institutions.

In addition to this research work, CPPS has supervised the training of 320 experts in marine pollution evaluation, environmental impact assessment, and analytical techniques. "We have two phases to the programme," states Escobar, "to provide basic information on the state of the region's resources, and to promote sustainable land-use planning."

As data continue to be gathered, the five countries of the region are now in a position to begin formulating, together, land-use management strategies that will have a direct impact on reducing coastal pollution.

A priority Action Plan has also been worked out for the region. It includes three areas: the control and treatment of municipal and industrial wastes; the development of artisanal fisheries; and the promotion of sustainable mariculture and aquaculture industries.

"We have managed to educate the experts," notes Escobar, "next we have to educate the public about the need to conserve coastal resources and to manage them properly. We have already launched a programme in Buenaventura to teach high school students about the marine environment and its importance to them."

At the same time the commission has established links with its counterpart in the South-west Pacific, in order to facilitate co-operation on important pan-Pacific issues, such as efforts to make the entire South Pacific a nuclear-free zone. With a Trust Fund set up and money flowing in, Escobar is confident about the future. "We may have a lot of problems, but we now have the information we need to begin to solve them."

8. East Asia

Virtually all east Asia's major cities are coastal, as are countless thousands of villages. It is here (and in south Asia) where sheer numbers are overwhelming coastal resources. More people than ever before are now dependent upon coastal areas for their livelihoods: for fishing, mariculture, forestry, building materials, agriculture and tourism. Yet the very resources they depend on for survival are being needlessly over-exploited and destroyed.

Mangrove forests are cut down to make room for urban expansion, rice paddies, coconut plantations, and brackish water fish and shrimp ponds. Coral reefs are smothered by siltation brought in by coastal dredging, mining development and deforestation. Offshore reefs are blasted apart by dynamite fishermen, heedless of the destruction they inflict on coral communities. Wastes from industries and municipalities are simply dumped into the sea untreated. Rivers bring in more pollutants: sewage, pesticide residues and industrial effluents.

The economies of Thailand, Malaysia, Singapore, Indonesia and the Philippines vary a great deal. Thailand and Singapore are booming, Malaysia is muddling along, and Indonesia and the Philippines are in crisis. Without coastal management plans in place the brunt of unplanned development and economic expansion will be borne by the coasts. Without sustainable management of resources, coastal economies will not be sustainable either. Coral reefs are pillaged by coral collectors and dynamite fishermen, ruining tourism. Mangroves are cut down for fish farms, reducing offshore shrimp and fish catches. In too many places the link is not made between what happens on land and what happens in the sea.

Like the countries of the South-east Pacific, Southeast Asian nations are caught in a trap of debt and development. As debts rise, more resources must be exploited to pay the interest on loans. The Philippines is poorer now than it was 20 years ago; nearly sixty per cent of the population lives below the official poverty line, which

has been set at $120 a month. Fiscal mismanagement is blamed, but international debt is also a factor. In 1988, the Philippines was condemned to see 28 per cent of its export income swallowed to service debts.

A sea of islands

Nearly all the territory of Indonesia and the Philippines – the two biggest island archipelagos in the world – is coastal. Malaysia, a thin peninsula, is bounded by sea. Singapore is an island. Only Thailand has some land-mass to spare.

South-east Asia's seas are dotted with islands. Indonesia's 5,000-km long archipelago contains nearly 14,000 islands; the Philippines has 7,100; and there are hundreds in the Andaman and South China Seas. Disregarding Canada and Greenland, Indonesia and the Philippines also have the longest coastlines in the world. Indonesia's serpentine coastline exceeds 54,000 km. If stretched out in a straight line, it would encircle the earth twice.

The geography of South-east Asia is a geography of coasts, more so than perhaps any other region. Many of Indonesia's islands consist entirely of coastal zones. With the exception of the largest islands, like Borneo, what happens inland has coastal repercussions. In the Philippines, which lost over 60 per cent of its tropical forests during the past four decades, increased erosion of the uplands has translated into massive sedimentation of shallow coastal waters.

The location of these island and peninsular states has forged the region into one of the world's major trading crossroads. Indonesia, Malaysia, the Philippines, Singapore, and Thailand form one biogeographical unit, separating Asia from Australia and the Pacific from the Indian Ocean. The region covers almost 9 million sq km, or 2.5 per cent of the world's ocean surface.

Travel writers often refer to this area as the "Asian Mediterranean". Weather may have something to do with the comparison. Both the Mediterranean and South-east Asia have definite wet and dry seasons, although Asia's are governed by the monsoons. Both areas also concentrate people – and pollution – along their varied coastlines. Beyond that the similarity ends. The Mediterranean has a relatively stable average depth of around 1,500 metres, while in Southeast Asia there are extensive shallow continental shelves and deep basins perforated with trenches and troughs. The whole area is studded with volcanic and coral islands.

Seasonal trade winds allowed the "spice islands" to be visited by Arabs from the west, Chinese traders from the east and Europeans from both directions. While trying to find a short-cut to the East Indies – meaning the Indonesian and Philippine archipelagos – Colombus accidently discovered North America. Not knowing where he was, Colombus called the islands of the Caribbean the "Indies" and their inhabitants "Indians". Meanwhile, the real "East Indians" quickly became major world suppliers of spices, rice, coffee, tea, sugar, palm oil, rubber and tin.

The area has been frequently colonized. The Philippines were Spanish, and then American, while Indonesia remained Dutch until 1949, when it gained independence. Malaysia and Singapore were English. Only Thailand was never under foreign domination.

Today the region finds itself on a major oil route. All Middle East crude destined for Japan, China, Hong Kong and South Korea must pass through either the narrow Strait of Malacca or the Lombok Channel. One of the reasons for the US military bases in the Philippines is to protect these vital shipping lanes.

Most of the region's people are coastal, or live within 50 kilometres of the sea. There is a wide assortment of racial and religious groupings: anthropologists claim there are at least 110 different cultural and racial groups in the Philippines alone, speaking some 70 different languages, ranging from the Muslim Malays in the southern Sulu Islands to Episcopalian Igorots in the mountains of Luzon. Indonesians speak 250 languages and dialects, making communication between villages, not to mention islands, somewhat of a challenge. Thailand contains more than 30 distinct ethnic groups.

The one thing most South-east Asians have in common is a dependency on the sea for food, livelihood, and transport. The Buginese of Indonesia, known as the "sea gypsies", spend most of their lives on the sea. "They are born, grow up, get married, have children and eventually die on the sea", says Jakarta journalist Winnarta Adusibrata.

Like the rest of Asia, the populations of these five countries – with the exception of Singapore – continue to grow, but not nearly as fast as during the 1960s and 1970s. Both Thailand and Indonesia launched highly successful family planning programmes in the 1970s. Only Malaysian and Filipino populations continue to expand at more than two per cent a year. Indonesia initiated its two-child family campaign ("Dua anak cukup") in 1970 with assistance

from the United Nations Population Fund. Today, Indonesia's large population is growing at an acceptable 1.8 percent. Still, this national figure conceals some troublesome trends. The growth rate of Javan coastal cities like Jakarta and Surabaya approach four per cent a year, doubling their populations every 17 years. Swelled by an influx of migrants from the uplands, the majority end up in squatter settlements or slums, under-employed or under-paid.

Emil Salim, Indonesia's Minister of State for Population and the Environment, has a job many consider impossible. Not only must he keep an eye on the country's population growth-rates, but he must also try to balance the needs of increasing human numbers against dwindling resources. As a cabinet minister, Salim must hold his own against powerful colleagues who want development, no matter what the environmental costs. "He must walk a tightrope every day," remarks an Indonesian official. "It is not an easy place to be. In order for him to be effective, he has to have the support of the President."

Today, Salim's ministry plays only a co-ordinating role in efforts to stall population growth. The real authority lies with the National Family Planning Co-ordinating Board (BKKBN), which operates with a massive budget and support from the United Nations Population Fund. Despite the fact that Indonesia's population is still growing at the rate of three million a year, family planning and widespread access to contraceptives and basic health care have made a big difference. The fifth most populous country in the world "would be in infinitely worse shape were it not for family planning and the two child family campaign," points out Erna Witoelar, Director of the Indonesian Consumers' Organization.

Salim's most difficult task is to try to balance environmental protection needs with national development goals. Contradictions abound. As more forests are cut for timber export and to expand agricultural production in the uplands, hydropower reservoirs silt up, reducing the lifespan of hydro-electric dams to a mere 30 years. Rivers, swollen with silt, dump more of it into coastal waters, killing mangrove forests and coral reefs. Conserving some timber in vital watersheds would provide a little insurance against soil erosion in the hills and silted-up dams and rivers. But in the rush for development, such considerations are often overlooked. With less tree cover in the hills, droughts become more severe and floods more frequent.

In his efforts to make the development of his country sustainable, Salim continues to struggle with the harsh realities of an international marketplace that seems to penalize those countries forced to sell

basic commodities. "My greatest enemy in terms of environment protection is world trade," observes Salim. "Today, we have to export three times as much timber, for example, to buy one tractor as we did in the 1970s." Saddled with a national debt of $50 billion, and a devalued dollar, Indonesia must export 40 per cent more of its resources – timber, oil, gas, rubber and bauxite – in order to meet interest payments on its loans. The environmental price for this is almost extortive. "We can't just say, hands off the tropical forests," argues Salim. "We do what we can to conserve resources, but in the end we have to export in order to develop."

As agricultural land shrinks on a *per capita* basis, coastlines are becoming inundated with people. Hence, coastal management has become one of Salim's priorities and one of his biggest challenges for the decade ahead. "We still must press ahead with family planning programmes, the re-distribution of our population from over-crowded islands like Java, and the intensification of agricultural production," claims Salim. "But at the same time, coastal area management has become vital for our survival."

During 1989, Salim introduced a sustainable development strategy into national development plans for the next five years. One of the main features of this plan is its attempt to manage coastal resources. "Our challenge is to find ways to incorporate environmental considerations into development plans," says Salim. "We must find ways to translate this message into language that planners and economists can understand."

Resource destruction

So far, South-east Asia's record of resource management is disappointing. Part of the reason is the overwhelming numbers of poor people forced by circumstance into abusing and over-using common resources. Another reason is government's inability, or unwillingness, to come up with realistic management plans for utilizing resources, particularly coastal resources, in a sustainable fashion. Coastal area management schemes have been drawn up by government planners and high-priced consultants, but few get implemented outside of test sites. Furthermore, so long as most of these schemes ignore the people they are meant to benefit, little progress will be made.

Mangrove destruction in South-east Asia is the most extensive anywhere. Although the region still has about five million hectares

left, this figure is thought to represent less than half of the original area. Between 1920 and 1988, the mangrove area of the Philippines was reduced from 500,000 hectares to a mere 38,000 hectares. Much of the destruction took place over the past two decades; between 1967 and 1975 the country lost 24,000 hectares of mangrove forests every year. Most of them were clear-cut for their timber, exploited for tannin (a natural preservative), or were cut down and converted into brackish water ponds for the cultivation of prawns and milkfish. Others succumbed to urban expansion or were filled in to create rice paddies.

On the island of Negros, in the southern part of the Philippine archipelago, only one significant stand of mangroves survives on the east coast, in Bais Bay. Even these consist mostly of secondary growth. Nevertheless, a portion of Bais Bay's mangroves have been declared a sanctuary and are now the subject of intensive study by marine biologists from Silliman University in Dumaguete City. With the loss of the island's mangroves (along with most of its coral reefs), fish and shellfish stocks declined dramatically. The poor fishing communities on Negros found it increasingly difficult to make a living from the sea. Competition for limited numbers of edible fish encouraged destructive fishing practices such as dynamite fishing and the use of poisons, killing fish indiscriminately and further damaging valuable marine habitats. As on many other islands, the pattern of destruction worsened as desperate fishermen tried to feed their hungry families by any means possible. Unlike many other islands, however, the fishing communities around Bais Bay began to rebuild their ravaged resources by planting new mangroves and by constructing artificial reefs and fish shelters.

Ricardo lives in the small fishing village of Okiot on the north rim of Bais Bay. Most of the fishermen in this community trap fish in "corrals" made from bamboo and nylon mesh. A corral is simply a fence in the water with an opening at one end. Fish enter the corrals during the day while feeding, sometimes attracted by fish shelters placed inside the enclosure. At night, fishermen using lights attract the fish in the corral to an opening where they are caught with dip nets. "Mostly we catch rabbit fish this way," says Ricardo. "And during the day women pick over the tidal flats for abalone, oysters, mussels and crabs."

Traditionally, Ricardo's village has always trapped fish, rather than raising them in pond cultures. But with fish catches remaining low, Ricardo and his neighbours are thinking of building brackish

water ponds to raise milkfish from fingerlings. One of the reasons the community must begin to farm fish is because both their mangrove and coral reef resources have been severely damaged. "We have to watch our remaining mangrove forests very carefully," points out Ricardo, "otherwise people from other islands and sometimes farmers from the hills come to cut the trees at night." Since rabbit fish use mangroves for part of their life cycles, the people of Okiot see the trees as a direct link in their own food chain.

Like the fishing communities further north, Okiot plans to reforest the coast with mangroves in an effort to restore fish stocks. They have even formed a sea-patrol which cruises the shallow waters of Bais Bay apprehending fishermen who use dynamite and poison – instead of hooks and lines, or nets – for catching fish.

The resource problems of Bais Bay are not unique to the Philippines nor to South-east Asia in general. As fish stocks continue to decline, many people on Negros and other islands have been forced to become small-scale fish farmers. At the same time entrepreneurs clear mangroves to build brackish water ponds for raising tiger prawns or shrimp for the export market. But as more ponds are built, there is less room to restore mangrove forests and less incentive to protect coral reefs. Ricardo's village is trying a middle course. The fishermen of Okiot are conserving their mangroves and farming fish.

Unfortunately, the steps taken on the east coast of Negros are rarely followed. Across South-east Asia and the Pacific, familiar patterns of destruction are repeated. By 1970, over 1,200 sq km of mangrove forests on Sabah (Malaysia) – 40 per cent of the total – were allotted for woodchip export to Japan. Today, Malaysia is losing 5,000 hectares of mangroves a year for the production of woodchips. Thailand has lost a full 20 per cent of its mangrove forests over the last ten years, cut down for timber and to make room for fish ponds. Most of Singapore's mangroves have been removed by urban expansion.

Perhaps the greatest destruction of mangroves is taking place in Indonesia. Currently, more than 2,000 sq km of mangroves are being exploited by the Japanese woodchip industry. In addition, some 10,000 sq km of mangroves have been converted to brackish water ponds, called *tambaks*, in order to cultivate prawns, shrimp and milkfish. On the east coast of Sumatra, over 32,000 hectares of mangroves have been cleared for *tambaks*. Nearly the entire

north coast of Java, once lined with mangroves, is now lined with *tambaks*. At Cilacap, on the south coast of Java, mangroves have been clear-cut to build fish ponds, and at least 50 sq km have been turned into agricultural land to produce rice, coconuts and other cash crops.

In the province of Kalimantan on the large island of Borneo, extensive tracts of mangroves have been cleared to make room for new coastal settlements – part of Indonesia's controversial transmigration programme which relocates people from the over-crowded islands of Java, Madura, Bali and Lombok. So far, some 700,000 Indonesian families have been sent to these new lands.

Indonesia's loss of mangroves has affected the livelihoods of millions of small-scale commercial and artisanal fishermen. Off-shore shrimp and prawn catches have fallen, as have landings of groupers, jacks, mullet, and snappers.

Declining fisheries is also linked to the loss of coral reefs. Thirty per cent of the world's coral reefs, representing all known genera of corals and all morphological types of reefs, are found in South-east Asian seas, but they are being degraded and destroyed at a shocking rate. When the Philippines carried out a survey of 632 reefs in 1982, researchers discovered that two-thirds of them were in poor to fair condition, with less than 50 per cent live coral cover. Since then, the reefs have deteriorated further – today less than ten per cent have healthy, undamaged coral. The widespread destruction is attributed to siltation from massive deforestation, uncontrolled blast fishing and use of poisons, and coral mining for the building industry and for export.

While conducting the 1982 coral reef survey, researchers from Silliman University discovered that five coral islands off the coast of Cebu had actually disappeared. Victim of the rapacious mining interests on Cebu, the coral had been excavated, piece by piece, for use in making cement and building materials. "The main terminal building at Cebu City airport is made partly from coral tiles," states Professor Angel Alcala, head of the Marine Laboratory of Silliman University in Dumaguete City on Negros. "The tiles look like marble, but they are really made from coral." A national ban on the export of coral products has had little effect: too many people find the profits irresistible, and there is no enforcement of the ban.

Indonesian reefs are under increasing stress from both commercial and artisanal fishermen. Thailand's corals are suffering from siltation

churned up by huge bucket dredges that scour the bottom sediments of near-shore waters for tin. It can take weeks for the suspended sediments to drift back to the bottom. Often they end up smothering nearby seagrass communities and coral reefs.

Conservation efforts have not yet been able to preserve much of the diversity of the region. But that may change as governments put more emphasis on conserving genetic resources. More parks and protected areas are being established. Indonesia has set aside 17 parks and reserves with marine areas. In the early 1980s, government policy called for the establishment of 10 million hectares of marine and littoral protected-areas by 1990. A Marine Conservation Data Atlas was produced with assistance from IUCN, to help in planning a full-scale system of marine parks. Unfortunately, too many of the declared sites are parks only on paper, without a management programme to guide their operation.

Coastal pollution

Parts of South-east Asia's coasts are among the most polluted of any region. With 210 million people living on or near a coast, many in expanding cities like Bangkok, Jakarta and Manila, heavy pollution is inevitable. With the exception of Singapore, none of the cities or towns of the region has adequate sewage treatment plants. Open drainage canals channel raw municipal effluents and industrial wastes directly into coastal waters, or into rivers which transport their wastes to the sea.

Nearly all of South-east Asia's river systems are polluted with organic wastes, sewage, plastics, and junk. Rivers like the Juru (Malaysia), the Pasig (Philippines), and the Chao Phraya (Thailand) are open sewers by the time they reach the sea. All of Metro Manila's rivers are so full of pollutants that they are said to be biologically dead. Because of the amount of municipal and industrial wastes dumped into the Bays of Manila and Jakarta, large sections of each suffer from a loss of oxygen and cannot support much marine life. The Chao Phraya estuary in the Gulf of Thailand is so polluted from Bangkok's wastes that its murky brown waters can no longer sustain shellfish like clams and oysters. Artisanal fishing for shrimp and prawns has stopped. Those lacking motor boats have had to abandon fishing altogether; they are unable to catch anything worth eating in the Gulf's near-shore waters.

The raw wastes of 8.5 million people and 10,000 industries end up in Manila Bay. Its polluted, malodorous waters are filled with human faeces and rotting garbage. "The bacteria (coliform) count in Manila Bay is over 100 times above safe standards," admits Celso Roque, Under Secretary of the newly-formed Department of Environment and Natural Resources in Manila. "Our first priority is to reduce the domestic sewage loads to Manila's five rivers. Industries have been asked to clean up their own mess." Manila Bay is also plagued by high levels of mercury, cadmium and lead in its sediments.

Unfortunately, a coastal-zone management plan was turned down by the government on the grounds that it would interfere with decentralization efforts. Meanwhile, the entire waterfront of Manila is covered with squatter settlements: flimsy bamboo huts built on waterlogged rafts, half-sunken barges, or perched on wobbly stilts over fetid waters. More than two million people in Metro Manila are crammed into these floating slums. Others occupy any unused land they can find, such as the empty field surrounding the unfinished National Insurance Building. One entire community makes its living from Manila's huge garbage dump, called "Smokey Mountain", recycling whatever they can salvage.

There are many small fishing communities around Manila Bay, despite its sorry state. They have nowhere else to go. Children bathe and swim in its filthy waters. Fishermen must go further and further to catch fish. Those who cannot afford the extra petrol for their motors must somehow make a living closer to shore. The Bay's waters are so polluted that freshly-harvested oysters smell as if they've been dead for a week: clam and oyster farms in the southern part of the Bay should be moved elsewhere for health reasons. City officials agree, but ask "where to?" Meanwhile, the polluted products from the Bay are sold to the city's poor. Stomach and intestinal diseases are reaching epidemic proportions. Many children under one year of age die from chronic diarrhoea.

The fishing communities on Jakarta Bay, just north of the capital of Indonesia on the island of Java, pay a similar price for their poverty. Over the past 20 years the Bay – once rich in fish and shellfish – has turned into an open cesspool. Millions of tonnes of industrial and municipal wastewaters are discharged into the Bay every year without treatment of any kind. One village struggling against the effects of pollution and unplanned urban growth is the fishing community of Muara Angke.

"I've spent nearly my entire life on the sea," says 78-year-old Sho Boen Seng, the unofficial head of Muara Angke. "Twenty years ago fish were plentiful in Jakarta Bay, but not now. Today our fishermen must go out more than 12 miles from the shore to catch quantities of fish," explains Seng. The round-trip, in small out-board boats, takes at least six hours. Even the bigger boats have to stay out much longer to land profitable catches of fish than was the case in the 1950s and 1960s.

Pollution and sedimentation are the main culprits. Coliform (bacteria) counts and toxic metals in the Bay exceed US Environmental Protection Agency (EPA) standards on a regular basis. Parts of the Bay are becoming starved of oxygen due to the heavy input of nutrients from untreated sewage and industrial wastes. Sedimentation from dredging and landfilling operations have helped to obliterate vital near-shore spawning areas for shellfish like shrimp and clams.

Pollution has reached such proportions that much of what is caught in the Bay is contaminated and unfit for human consumption. Unfortunately, the poor fishing families of Muara Angke have little choice: they must eat what they catch in the Bay's waters. Most people cannot afford the bigger boats needed to fish in open seas. The poorest are condemned to fish with simple dip nets off oil-covered jetties in the harbour. As a result, many residents suffer from chronic intestinal and stomach disorders likey dysentery, diarrhoea, and gastro-enteritis.

Muara Angke, built on land reclaimed from the sea, became a special fishing village in 1977. The government-sponsored village was put up as a place for subsistence and small-scale commercial fishing families who were being displaced by urban sprawl. It still lacks many basic amenities, such as potable water and sanitation. The village's own wells have become too saline, so fresh water is brought in by vendors, who sell it door-to-door by the bucket. Sanitation facilities are also primitive, consisting mostly of pit latrines or open drainage systems which channel sewage and household slops directly into the Bay.

Like all of Muara Angke's 3,000 residents, Seng and his wife and daughter live in a simple house made from breeze blocks and concrete with a tin roof. Seng's main work consists of trying to get the government to pay more attention to the needs of the village and its people. In 1980 the government banned trawlers from Jakarta Bay in an effort to give small-scale fishermen a better chance to make a

living. It was a good gesture, but came too late to have much impact on fish catches. The Bay's shallow waters were already so degraded and over-fished that trawlers would have left anyway.

Meanwhile, Muara Angke remains caught between the old ways and the need to adapt to change. "The government provided small loans to local fishermen so they could buy cheap out-board motors for their boats," explains Seng. "They even trained us to use and service them. But too many fishermen here still fish with primitive gear. And our small harbour still lacks cold-storage facilities." The fish that are brought into Muara Angke have to be sold the same day in the local fish-market, or salted and dried in the sun.

The low prices paid to the fishermen of Muara Angke for their fish are also determined more by middle-men, the money-lenders who control finance in the village, than by open market forces.

Seng, who has the equivalent of a high school education, thinks many of the village's problems come from a lack of education: "Most of the fishermen here have no more than a primary school education; and many of the children don't attend school because they must go to sea at an early age to help support the family." The other big problem is the inability to communicate with each other. There is no common language in Muara Angke. Many fishermen don't even understand Indonesian. Instead, they speak a variety of local dialects.

In an effort to forge a real community, Seng is striving to organize the fishermen into a co-operative union. This way they would be able to get better prices for their fish, and they could draw on co-operative reserves during lean times. "The problem is most of these poor, uneducated fishermen don't want to put in their own money," explains Seng. "They think they'll never see it again. But without a co-operative, this village will always be at the mercy of the money-lenders. We will never be able to stand on our own feet."

Indonesian coastal pollution is not limited to Jakarta Bay. Since over 75 per cent of the country's cities are situated along the country's 54,716 km of coastline, many coastal areas are inundated with untreated wastes. High coliform bacteria counts are common in Ambon Bay and the Flores Sea. The entire coastline of Java is crowded with cities and towns, interspersed with shrimp and fish ponds and agricultural lands. The wastes from cities, shrimp cultures, milkfish ponds and industries end up being dumped in the sea, creating oxygen-starved conditions in shallow coastal waters.

In Thailand, many of Bangkok's slums are water-bound. Thousands live on water-logged barges moored on the city's many canals, or along its four major rivers: the Chao Phraya, the Thachin, the Maeklong and the Bangpakong. These four rivers deposit roughly 10,000 tonnes of raw sewage and municipal wastes into the Gulf of Thailand every day.

Although Bangkok has drawn up water-quality guidelines and has initiated a Master Sewerage Plan for the city, half the population would still not be covered by a sewage treatment network by the plan. The World Bank has calculated that the cost of connecting all of Bangkok's residents to sewage lines would be a prohibitive $1.4 billion. An alternative system utilizing the city's many refuse-clogged canals is now being developed.

Along Thailand's 2,600 km of coastline, some twenty major urban centres and 9,000 fishing villages can be found. Over twenty million people live around the Gulf of Thailand alone. Tourist centres are mushrooming, particularly in the resort area of Phuket, in the far south. The household and municipal wastes from all these communities are flushed into coastal waters.

Industrial pollution often has immediate and disastrous effects on coastal ecosystems and on the economies of villagers dependent on the sea for their livelihoods. The small fishing village of Dauis on Bais Bay on the island of Negros, the Philippines, has had a sugar mill for four decades. The mill regularly pumps untreated toxic wastes from sugar processing, including bagasse, into the Bay's shallow waters. If the Bay is polluted with sugar wastes at the time of the year when young crabs and shrimp fry are developing, it can eliminate an entire half-year's income for the village.

In July 1988, one such discharge killed off around 200,000 blue crabs, along with thousands of shrimp, which the villagers of Dauis could have harvested at the end of the year for a sizeable income. Masses of fish were also found dead and dying in the Bay. The people of Dauis estimate they have lost some 20 million pesos a year since 1979 because of pollution from the sugar mill and a paper mill further up the coast.

"We have been protesting to Manila since 1954," says one angry villager. "The people who led the original protests have all died, but the pollution remains."

Around 10,000 people in the region, including eight fishing villages, depend on Bais Bay for their survival. The sugar mill employs only a few technicians, and it is losing money.

Fisheries

In order to avoid the tragedy of Dauis, many coastal fishing villages are turning to shrimp and fish ponds, where inputs can be controlled. The problem is that many mariculture and aquaculture farms are built on the remains of mangrove swamps, taking away critical habitats for a wide variety of fish and shellfish. As a result, wild stocks are reduced. This creates what one marine biologist terms "the Mobius Loop of resource degradation". As wild stocks get more difficult to find and catch, more people are encouraged to build their own fish or shrimp ponds. More mangroves are cleared. The process repeats itself again and again until there are no more mangroves or lowland coastal forests.

In some areas, as on the north coast of Java, mangrove destruction can touch off a chain reaction of coastal degradation. Marta Vannucci, Director of the UNDP/UNESCO Regional Mangrove Project, explains:

> The most senseless exploitation is the clear felling of mangrove areas to build shrimp ponds that still rely on the recruitment of larvae from the reproductive stock at sea for seasonal re-stocking. Likewise, shrimp ponds built on clear-felled mangrove land cease to be economically viable enterprises after a couple of years because natural recruitment of larvae is no longer possible. New mangrove areas are cleared to set up new shrimp ponds and further destruction follows. Thus, a downward spiral of degradation from a more to a less productive system takes place.

There is a clear need for regional management of fisheries. "Nearly all Asian waters within 15 kilometres of land are considered over-fished," explains Ed Gomez, Director of the Marine Science Institute at the University of the Philippines in Manila.

Since South-east Asians get most of their protein from the sea, fishing and various mariculture operations have an added importance. Filipinos derive at least 60 per cent of their animal protein from fish, Indonesians 63 per cent. "You have to keep in mind that the average Asian eats rice and fish with nearly every meal," points out Dr John McManus, also of Manila's Marine Science Institute.

Moreover, millions of artisanal and commercial fishermen make

their living from the sea, or through fish-farming and pond cultures. Java has at least 7.5 million artisanal fishermen operating in shallow coastal waters or raising fish and shrimp in small ponds. But as more people fish for a living, resource conflicts escalate and sometimes turn ugly. Before big shrimp trawlers were banned from Indonesia's coastal waters in 1980, gun battles raged between trawlermen and artisanal fishermen. In the 1970s, at least one hundred people were killed from such confrontations.

Before the trawlers were banned from near-shore waters, their fishing techniques earned some fleets the nickname "vacuum cleaners of the sea". Decades of bottom trawling in the Arafura Sea, in western Indonesia, has caused the seabed to look as if it has been crossed with motorways. The nets have scooped up everything in their path, turning the sea bottom into a desert.

Malaysians continue to fight each other over violations of fishing territory. "Because of the mismanagement of coastal resources, there has been a consistently downward trend in coastal fisheries in Malaysia since the 1960s," notes one top-level Malaysian fisheries expert, who wishes to remain anonymous. "Trawlers have often infringed in near-shore waters, coming into direct conflict with small-scale fishermen. A number of fishermen have been killed in such confrontations."

Fishermen in each state of Malaysia are allowed to fish only in their own waters, but there are many violators. Fish stocks are assessed regularly by the Fisheries Research Institute in Penang. Based on such assessments, licences to fish are allotted to each state. "The problem is, too many poor fishermen are operating without licences, and exploitation is getting out of control in some areas," explains the expert.

The other big problem for Malaysian fisheries is misplaced priorities. "We now have a big programme to exploit off-shore fisheries. But in my opinion, we should be putting more effort and money into managing coastal resources, instead of throwing it away on deep-sea fishing," he concludes.

In an attempt to come to terms with depleted fisheries and ruined coastal resources, the Malaysian government wants to reduce the number of coastal fishermen from 120,000 down to 70,000 over the course of the next decade. Those not allowed to fish any more, will be taught to raise fish in pond cultures. Since there are already many fish farmers in Malaysia, this solution may cause more problems than it solves. Moreover, the new ponds

will most likely be built at the expense of the country's remaining mangroves.

One of the region's biggest problems is the widespread use of dynamite and poison to catch fish, especially on coral reefs. Virtually every country in South-east Asia has fishermen who insist on catching fish in this way. Sometimes entire villages specialize in these destructive fishing practices. Not only do they kill fish indiscriminately, but reef habitats are destroyed, depriving other marine life of shelter and food. And when the reefs are gone, so are the fish.

The Lingayen Gulf on the north-west coast of Luzon, the Philippines, is a classic example of over-exploitation, aggravated by habitat destruction from blast fishing and sedimentation from mining operations. Near the fishing village of Bolinao, "fishing areas are so depleted that we can't even assess how to optimize fisheries in this part of the Gulf, because we can't find any fish to study," explains Dr Liana McManus from the University of the Philippines in Manila.

Many reefs have been reduced to rubble. "In 1983 I didn't hear any underwater explosions while diving near Bolinao," observes Dr Helen Yap of the Marine Sciences Institute. "But in 1988 when I returned to do research, I couldn't count the number of explosions I heard during one dive. They were happening all the time."

Conflicts still occur in the Lingayen Gulf between trawlers and small-scale fishermen. Although trawling is not permitted within seven kilometres of the coast, many lay out their nets 2–3 km from shore. Years of trawling, and heavy fishing by the 15,000 artisanal fishermen in the Gulf, have left it impoverished of marine life. Whereas 20 years ago, fishermen could fish 25 days a month during the peak season, they now go out one week a month, and are lucky to catch anything. As resources run out, more of the poor fishing villages turn to illegal and destructive fishing methods.

San Roque (not the village's real name) is one of the poorest fishing villages along the Gulf. Of the 200 families in the village, 80 per cent of them earn their living directly from the sea. As fish stocks – and incomes – continue to decline, the entire village has taken up dynamite fishing. Although they realize that this is destroying the reefs and killing more fish than they can recover, they justify it by claiming that it is better to fish with dynamite than turn to other illegal activities like smuggling.

Often, in order to avoid arrest, the local police are bribed with fish or cash. In many cases, blast fishing takes place with the tacit

approval of the police. "Since some of the local police have relatives in San Roque, they are reluctant to arrest anyone," explains one villager. "The heavy fines imposed on those caught could ruin the family."

San Roque is one of thousands of villages in Asia which, through poverty or greed, destroys the resource base it (and others) depends on. The immediate needs of today win out over the needs of tomorrow. Until alternative incomes can be provided, or the benefits of conservation accepted, the destruction will likely continue.

The Lingayen Gulf may be brought back from the brink of ecological disaster. There is now a coastal management plan, co-ordinated by the International Center for Living Aquatic Resources Management (ICLARM) in Manila. The Coastal Resources Management Project will set aside reserves, declare limited fishing areas, curb heavy-metal pollution from mining activities, and help with the establishment of fish and prawn farms in villages like San Roque. But if the plan is to work, it will require the active participation of all fishing villages along the Gulf.

There is one widespread social factor that is likely to mar attempts at the rational management of coastal resources: landlessness. Most rural households in Asia do not own the land they work. Around 78 per cent of Filipino and 85 per cent of Indonesian peasants own no land. When their soil wears out, or they are unable to pay rent, these poor families are forced off the land. Often, their only recourse is to head for the nearest coast.

Once these migrants arrive at the coast they usually add to the problems of the fishing communities already there. "Migrants are not restrained by webs of family and informal ties, nor do they have, as old fishermen sometimes do, a small plot of land to resort to when catches are poor," explains Dr Daniel Pauly, Director of ICLARM's Resource Assessment and Management Programme in Manila. "Hence, they will usually be among the first to use fishing techniques such as excessively-fine mesh nets, dynamite, cyanide and bleaches. In the Philippines and Indonesia these techniques now constitute the major fishing gear, especially in coralline areas."

Poverty is at the root of many of the problems afflicting South-east Asia's fisheries. "Solutions to fishing problems will be forthcoming only when the central issue, poverty itself, has been resolved," observes Dr Pauly.

Conservation

In some areas poverty has not prevented people from rescuing their resources. Conservation, even on a small scale, has worked wonders. On tiny Apo Island, off the southern coast of Negros (the Philippines), the local fishing community has managed to increase fish stocks by preserving just a small part of the coral reef that fringes the entire island. The sanctuary occupies a mere eight per cent of the 106-hectare reef, located a short distance off the windward side of the island. "Before the sanctuary was set up, it was difficult to catch fish, but now it is much easier," explains Jesus Delmo, President of the Apo Island Marine Management Committee. "Before the reserve came, we had to travel as far as Mindanao to fish, but not now. We can catch as much fish as we need around our own island. More people are fishing, but there are more fish." Even the bigger, tastier fish, like jacks, are beginning to return to the island's reef.

Before the reserve was established in 1986, the 90 fishing families on Apo were using dynamite and poison (sodium cyanide), as well as hooks and lines, to put food on the table. Apo islanders also employed the old *muro-ami* fishing technique, which involves scores of children free-diving down to the reef, pulling a large fixed net behind them. In order to frighten the reef fish out of their coral refuges and into the net, the coral is hit with big wooden mallets. The fish usually oblige by fleeing into the waiting net, but the coral is pulverized in the process. The waters around Apo Island were quickly becoming devoid of edible fish.

Since the villagers had no real concept of conservation, it took two social workers from Silliman University two years to convince them to allow the Marine Laboratory of the University to set up a pilot project on a small section of their reef. Between 1984 and 1986, the social workers spent two weeks of every month living on the island, quietly convincing the people of the value of conservation. Although the process was long and involved, it has paid off. The 200 people on Apo Island now see the reserve as their own and protect it from exploitation by fishermen from nearby islands, and scuba-divers. "We recently confiscated four spear-guns from some Japanese scuba-divers," says Jesus Delmo. "They were trying to spearfish in our reserve."

The "demonstration value" of the reserve has been enormous. "Fishermen on Apo Island have learned that by setting aside a tiny part of their reef for conservation, where no fishing of any

kind is allowed, fish stocks on the rest of the reef have gradually increased," points out Louella Dolar, a faculty member of the Biology Department at Silliman University. The lesson has been passed on to, and accepted by, fishing communities on the neighbouring islands of Bohol, Siguijor and Cebu. So far, five other marine reserves have been established.

Other innovations have come from Professor Angel Alcala's group at Silliman University. Alcala was the first to develop artificial reefs made from discarded rubber tires and bamboo poles back in the late 1970s. They are now in use throughout South-east Asia by fishing communities which have lost their original coral reefs.

The Marine Laboratory at Silliman University is presently cultivating five species of giant clams in tanks. Heavily harvested throughout Asia, clams have disappeared from many reefs. The Marine Laboratory hopes to re-stock reefs with giant clams through controlled breeding and continuous monitoring during their critical first few years of life. Once the clams are seven months old they are transferred to cages placed on a section of protected reef at Apo Island. The local fishing village protects the clams because once they are three years old, islanders will be able to harvest half of them; the rest will remain as brood stock. If the project is successful, then the clams will be introduced to other Philippine reefs.

Dr Alcala is convinced that giant clams can be raised in economical quantities in tanks. If so, he may have laid the foundation for a new mariculture industry, one that will provide jobs and incomes in one of the most depressed areas in the Philippines.

Not far from Apo Island, on the east coast of Negros, another rescue operation is under way: the replacement of a denuded coastline with a young mangrove forest. This was begun by Wilson Vailoces, vice-president of the Tinaogan Fishermen's Association, but is now a full-scale community effort. "I started this activity on my own with no government assistance," says Wilson. "Now my neighbours are copying me and together we will reforest this entire coastline." Recently, the Government granted Wilson and members of his community a 25-year contract of stewardship over the land along the coast. "The protection of this resource is in our hands now," affirms Wilson. "And it is up to us to see that our children reap the benefits of our hard work."

The families who plant mangroves have the right to harvest some of the trees for their own use or to sell timber on the local market. Mangrove wood is highly-prized as building material, since it is very

resilient and resistant to insect pests. But few trees are cut: they are regarded as a kind of savings account for the community and are most valuable where they are.

A hundred metres offshore, fishermen from the co-operative gather around a buoy in their out-riggers. They cast out their fishing lines – just simple hook-and-line fishing, no poles or nets. The fish are plentiful in this spot because Wilson Vailoces and his comrades have built an artificial reef out of bamboo poles to attract fish. "We needed to build a reef because our original reef was badly damaged from dynamite fishing and from the use of coral as building material," confesses Wilson. "Now we know better."

Unfortunately, many poor people on the island do not know better. Poverty, combined with large families, continues to force many subsistence farmers and fishermen alike to over-exploit their limited resources. The population growth rate on Negros stands at over three per cent a year, doubling their number every 23 years. And much of this growth is concentrated along the island's over-crowded coastline. In fact, the average fishing family in the Philippines has six or seven children, one child more than upland farm families.

The continued degradation of coastal resources is aggravated, and sometimes precipitated, by what happens inland. This part of the Philippines suffers from the same wanton destruction of upland forests that has plagued virtually every one of this country's 7,100 islands. Tropical forests, which covered nearly 75 per cent of the country in the 1950s, were reduced in area to less than 20 per cent by 1988. Over the past ten years alone deforestation has proceeded at the rate of about 105,000 hectares a year. Along the entire east coast of Negros only two peaks still retain a few hundred undisturbed hectares of tropical forest. The rest of the land is given over to coconut palms, pastures, agricultural fields and settlements.

The loss of forests has had an unintended side-effect: erosion of agricultural lands in the uplands. On Negros, erosion affects 50 per cent of the land area, a figure which is considered a national average. With less forest cover has come less rainfall. When it does rain, tonnes of soil and rock are gouged out of the hills and washed down to the lowlands and coastal areas. "We now have flash floods," complains Wilson. "And heavy rains wash soils down from the hills into our coasts. Sometimes huge boulders crash down the

hillsides. In the end, nothing remains: no corals, no mangroves, only silt."

The fishing communities of Tinaogan continue to suffer from the mistakes of others. Learning to conserve and manage their own resources is only the first step. The next stage, much more difficult, is to change some local agricultural practices. "The farmers around here spray their rice crops six times a year with pesticides," explains Wilson. "Runoff from this poison goes into our shallow coastal waters and kills off many fish and shellfish." Particularly hard hit are crabs and shrimp fry. To make matters worse, spray guns are often cleaned out in streams which flow directly into the sea, bringing in more poisonous residues.

Wilson and other members of the Fishermen's Association have been trying to persuade local farmers to spray their crops less frequently and to use less harmful kinds of pesticides. So far, they have met with resistance. Farmers insist that the heavy doses of pesticides are necessary to insure higher yields by minimizing insect damage. Using safer pesticides, they claim, costs more money. Wilson is just as adamant. "The rice-farmers and fruit-growers here have to be educated to use poisons properly, not indiscriminately," he says. "The mentality of these farmers is spray, spray, spray. They have no concept of what their poisons do to the environment."

It has been a difficult struggle for Wilson and his neighbours. Not long ago, Tinaogan was very poor. The reef was destroyed, the mangroves cut down and fishing was becoming a precarious way of life, both for the established community and for the newly-arrived, displaced hill-farmers. Faced with disaster, the fishermen of Tinaogan began to fight to rebuild their resources.

A few of the peasant migrants have been assimilated into the fishing communities of Tinaogan. Others have taken employment as agricultural labourers, working for the wealthier farmers along the coast. But many have drifted into nearby towns, particularly Dumaguete City, where they squat in flimsy bamboo huts on the edge of town, taking any employment they can find. Some have turned to petty crime. For many of these "environmental refugees", life has become a daily struggle for basic necessities.

There is new hope at Tinaogan, however. Wilson Vailoces' mangroves are beginning to stabilize eroded shorelines, providing sanctuaries for a wide variety of edible fish and shellfish. Fish stocks are beginning to increase, and the people of the area are not so impoverished. By replanting their mangroves and building artificial

reefs and fish-shelters, the small fishing communities of Tinaogan have learned to manage their resources. The battle is far from over, but a good beginning has been made.

"The education we have received, we will pass on to our children and grandchildren," says Vailoces, "so the investment is worth it. We have learned the hard way how important it is to keep our resources intact." As fish shoal in the shallows, near his mangroves, Wilson smiles: "We depend for our very lives on the sea, so we have to take care of our fisheries and our resources. It's all we have."

Coastal subsidence

Besides pollution, Manila and Bangkok share another unsavoury problem. Both cities are sinking. Excessive withdrawal of groundwater for municipal and industrial use has caused surface land to sink, a process known as subsidence. Saltwater is now intruding into underground aquifers, making them unfit for municipal or industrial use.

Manila Bay has been rising at the constant rate of two centimetres a year for the past 15 years. Scientists are not certain if this is due to subsidence or the fact that huge portions of the Bay have been filled in for land reclamation projects. Whatever the cause, it has city managers worried.

North of Manila, along the coast, fish farms and rice fields are suffering from salt water intrusion into their shallow groundwater supplies. "The entire coastal environment of this region could be permanently altered to a more salty one," explains Ricardo Biña of ICLARM in Manila. "We don't know the consequences of this process. It could be catastrophic."

Bangkok has begun to drill much deeper wells in an effort to supply its citizens with untainted fresh water. But drawing water from deeper wells will not stop the city from sinking. Another reason for the deeper wells is that Bangkok's water supplies are contaminated with raw sewage which seeps into aquifers from unlined sewage canals. It's a problem that is regarded as far more serious than surface subsidence.

Grappling with these immediate problems has not allowed city planners to contemplate another emerging crisis: the effects on their economies of rising sea-levels from global climate change. Global warning means that the oceans are expanding (water expands when heated), possibly to the extent that low-lying coastal areas will be

inundated. What this means for Asia and the Pacific is frightening to imagine. A sea-level rise of as little as half a metre could displace millions of people, most of them poor. Where would they go in an already over populated area?

Singapore's success story

Singapore's waterfront used to be an unsightly scene. Floating scum and rotting garbage covered the harbour and collected around boats. Pig and chicken farms discharged their wastes directly into the Singapore River. Boats dumped their wastes into the harbour. Food vendors washed out their stalls on the streets; the slops washed into the Kallang Basin. All of this pollution eventually collected in the marina and harbour, where it festered.

In 1977 the government decided to rid the city of this eyesore and public health menace. The catchments of the Singapore River and the Kallang Basin would be cleaned up. Ten years and $100 million later, the entire waterfront has been restored.

The job was complicated and time-consuming. Sewage lines had to be built to accommodate some 12,000 unserviced homes and industries. A new two-stage sewage treatment plant was built. Hundreds of pig and chicken farms had to be moved. Around 5,000 street vendors were relocated and given new stalls with proper drains connected to the sewer system. The harbour was dredged.

"Once we removed the main sources of pollution, the rivers cleaned themselves," points out Ms Kuan Kwee Jee, Deputy Director of the Ministry of the Environment. Still, it takes not only money but strong political motivation to carry through with such a massive programme. Perhaps only Singapore, with its authoritarian government, could have achieved such results. Nevertheless, Singapore's success story stands as an example of what can be accomplished.

The East Asian Seas Action Plan

Asian governments, committed to developing their economies, traditionally view environmental protection as a luxury they cannot afford. Although most governments of the region have established bureaus or ministries of the environment, they usually do not give them much authority. Most environment offices are compelled to operate on tiny budgets, with too few experts. Programmes are

swallowed by red tape; co-ordination with other key ministries is lacking.

But attitudes towards environmental and resource management are changing. When UNEP suggested forming a regional seas Action Plan, the governments of the region agreed. South-east Asian countries saw a regional organization as a way to deal with common resource problems.

After a series of preliminary meetings, the East Asian Seas Action Plan was adopted in April 1981 at an intergovernmental meeting in Manila. The Action Plan aims to provide a framework for a comprehensive and environmentally-sound approach to coastal-area development. In order to oversee its implementation the Co-ordinating Body on the Seas of East Asia (COBSEA) was established. This co-ordinating body, with representatives from each participating government, has overall authority to identify priorities and determine the budget. At the request of the participating governments, UNEP is providing Secretariat services for the Action Plan, including management of the Trust Fund.

The fund was set up to cover the costs of the programme. So far, however, contributions to it have only given the Action Plan an annual budget of about $100,000, though UNEP's contributions have totalled $2.2 million. UN officials see the lack of financial commitment on the part of the region's governments as a problem that must be resolved if the programme is to achieve its objectives.

At the sixth meeting of COBSEA in 1987, government representatives proposed a long-term strategy for managing the region's marine and coastal resources. At the same time, UNEP helped launch the Association of South-east Asian Marine Scientists (ASEAMS), in order to involve the science community and provide a mechanism for inter-regional co-operation. Since its inception in 1987, ASEAMS's membership has grown to around 120 and a newsletter is published and widely distributed. The Association held its first international symposium in February 1989, with another scheduled for 1991. Recently, ASEAMS prepared a UNEP-funded report on the likely effects of sea-level rise on the coasts and resources of South-east Asia.

The big issues may not have been tackled yet, but the Action Plan's scientific base has been considerably broadened. The programme has trained 500 technicians and scientists from East Asia. Data collection has improved, along with data exchange. The five countries of COBSEA are beginning to collaborate on a number

of projects, a difficult task before the advent of the Action Plan. "Before the initiation of the programme, the countries of the region had no integrated activities to address the problems of the marine environment," states Ed Gomez. "Through this action plan, scientists and environmentalists concerned with the protection of the marine environment have been able to broaden their focus from a national to a regional perspective."

9. South Asia

South Asia is one of the poorest regions on earth. The average annual *per capita* income for India, Pakistan, Bangladesh, Sri Lanka, and the Maldives is no more than $300. At least a quarter of all Indians live along the coast; a third within 100 kilometres of it. The poorest people of Bangladesh live in over-crowded slums built on stilts in the delta of the Ganges and Brahmaputra Rivers. Here they are at the mercy of flood waters from the land and storm surges from the sea.

Pressures on South Asian coastal resources are tremendous. The effects of these pressures are familiar. Mangrove forest, which stabilize shorelines and deflect storms, are being exploited on a large scale for firewood, tannins and timber, and are also being converted into brackish-water fish and shrimp ponds. Coral reefs face assaults from sedimentation due to coastal construction, soil erosion and dredging of harbours. Coastal forests have been replaced with agricultural land and towns. Over-fishing is a chronic problem along the entire coast from Pakistan to Bangladesh. Over eighty per cent of all wastes are flushed into coastal waters untreated. Many beaches are used as garbage dumps, while solid wastes are often disposed of in shallow coastal waters.

Space is at a premium along the coasts of Pakistan, India and Bangladesh. Coastal populations are increasing, often at more rapid rates than inland. With growing numbers of people comes the proliferation of slums and squatter settlements. Over half of Bombay's population of 10 million live in slums, as do nearly 40 per cent of Calcutta's.

The region's coasts are booming with activity. Unfortunately, nearly all of it is unregulated and unplanned. "The mentality prevailing along the south coast of India is something akin to what the wild west in America must have been like in the last century," says one Indian scientist. "Anything goes, and the guy with the biggest stick is always right."

Land and sea: an uneasy alliance

The north-central part of the Indian Ocean is divided into four distinct parts: the Arabian Sea, the Bay of Bengal, and the Andaman and Laccadive Seas.

The continental shelves vary in width from a few hundred metres to several hundred kilometres, allowing for a diverse fishing industry. Upwellings of nutrient rich water in the Arabian Sea make it a particularly valuable fishing ground.

Perhaps in no other region of the world is the give and take of land and sea so visible. The region is racked by geographical and meteorological extremes. Seasonal monsoons flood coastal areas, swamping lowlands and river deltas. On the other hand, so much sediment runs off the land every year – about 1.6 billion tonnes – that new islands are regularly formed in the huge deltas of the Ganges and Brahmaputra Rivers (in the Bay of Bengal) and at the mouth of the Indus River (in the Arabian Sea). "These two marine areas occupy three per cent of the world oceans, but receive nine per cent of the global runoff," writes Indian scientist Dr Sen Gupta.

Agriculture remains the mainstay of the region's economies, but fishing, tourism, mining and industrial development are growing.

All of the region's countries have declared 200-mile economic exclusion zones. Sri Lanka's EEZ, comprising 1.2 million sq km, is twenty times its land area. With fishing limited to near-shore waters, Sri Lanka is hoping to sell its deep water fishing rights to India and Pakistan, whose tuna fleets range across the Indian Ocean.

Crowded coasts

People remain the region's greatest resource as well as its greatest problem. On the island of Male in the Maldives, 40,000 live on one sq km of land. The city has no public sewer system. Instead, the people of Male use the Gifili system, digging a small new hole for every use. The island's freshwater lens, situated only a few meters deep in the sandy soil, sits precariously atop a wedge of saltwater. Not only are the island's limited supplies of groundwater contaminated with faecal matter, which seeps into it from all the latrines and shallow holes, but over-use is causing saltwater to intrude into the freshwater lens. One result is that diarrhoeal disease and intestinal disorders are epidemic.

With nearly a billion people living on a little more than 5 million sq km, South Asia's population density is high; it averages almost 200 people per sq km. Along its coastline, population densities approach 400–500 per sq km.

The state of Kerala, wedged into the south–west tip of India, has one of the highest population densities in the country. So many people live in this state that it has been described as "one continuous village". But the density of the fishing population along the coast is twice that of the rest of Kerala, at around 1,000 people per sq km.

Urban areas are expanding throughout South Asia, as is the case in virtually every other part of the world. The region's largest cities are all located on or near coasts: Karachi, Hyderabad, Bombay, Ahmadabad, Mangalore, Madras, Vishakhapatnam, Calcutta, Dhaka, Chittagong and Colombo.

Although overall population growth rates are slowing down – averaging a little over two per cent a year – the growth of cities and towns continues to escalate. At current rates of growth, cities like Bombay will double their populations every 17 years. This is a sobering thought, considering that Bombay's slums and squatter settlements already contain nearly five million people. If trends continue, planners predict that 75 per cent of the city will be forced into slums by the turn of the century.

Naven Panjwani, in *The State of India's Environment 1984–85*, describes the shocking conditions in Indian slums:

> A survey of about 4,000 households in nine slums in Bombay reveals that nearly 40 per cent have 2–4 persons packed into one room, another 35 per cent of households have 5–9 persons crammed into one living room, and one per cent have 10 or more people in one room. No house has a private toilet. A quarter of the households do not even have access to community toilets and use the open spaces around the slum for defecation. Over a third have no drainage facilities and another 40 per cent have uncovered drains.

At last count, over 3 million people were living in 3,000 slums around Calcutta. Household slops and wastes are dumped into open latrines and drainage ditches. Respiratory ailments and gastro-intestinal diseases afflict almost three-quarters of all slum-dwellers. Most sickness is blamed on the acute lack of sanitary facilities and access to clean water. Every morning, one of the most common sights across

South Asia is scores of people squatting over drainage canals or by stagnant streams, while a few metres away others bathe themselves and wash their clothes.

As urban populations continue to grow, city authorities find it impossible to provide adequate services. The Calcutta Metropolitan Development Authority has tried since the early 1970s to provide a sanitary latrine for every 25 slum dwellers, a potable water tap for every 100 people and proper drains. Even where this modest goal has been achieved, the facilities have not been maintained. Drains are clogged with rotting garbage, latrines overflow with excrement, and taps run dry. Funds to keep the services working often go into the pockets of unscrupulous contractors.

The World Health Organization estimates that only half of the people of South Asia, around 500 million, have access to clean water and adequate sanitation. Even where sewage systems exist, their contents are pumped untreated into coastal waters or into local rivers and streams. Eventually, most of the wastes of one billion people find their way to the region's coastal areas.

Coastal pollution

Sewage treatment in South Asia is almost non-existent. All of Bangladesh's sewage, for example, is flushed directly into the sea or goes there via the Ganges and Brahmaputra Rivers. Only a tiny fraction of municipal and industrial wastes from Pakistan and India receive any form of treatment before being dumped in coastal waters or into rivers and canals. Bombay discharges around 365 million tonnes of untreated sewage and municipal wastes into the sea every year. Similarly, Calcutta dumps close to 400 million tonnes of raw sewage into the Hooghly Estuary. Karachi, in Pakistan, pumps roughly 175 million tonnes of sewage and industrial wastes into the Arabian Sea annually.

High bacteria counts from untreated wastes are found in nearly all near-shore waters along South Asia's urbanized coastline. Shellfish beds near Madras are contaminated with human wastes, making them unsuitable for consumption. Tons of the mussels are harvested anyway and sold to the city's poor. Sri Lanka's shellfish are contaminated, especially near the capital Colombo. The Manora Channel in Karachi Harbour reeks from hydrogen sulfide fumes, its black, bubbling waters filled with industrial poisons and untreated sewage. Dead fish are a common sight in nearby waters. Although

Karachi has two single-stage sewage treatment plants, their capacity is constantly overwhelmed.

The World Bank is providing Bombay with loans to assist in building a sewage treatment network for the city. Plans call for the outfalls to be stretched three km offshore, but it may be a decade before the system is functional.

Coastal seas are also garbage bins. Some 34 million tonnes of garbage and solid wastes are dumped into India's coastal waters every year, ruining seagrass beds and coral reefs. In Sri Lanka, the ocean is the main receptacle for solid wastes.

Pollution of near-shore waters from chemical pesticides and fertilizers is a serious problem in parts of India, Pakistan, Bangladesh and Sri Lanka. Agricultural communities along India's coast spread 5 million tonnes of fertilizers a year on their fields and use 55,000 tonnes of pesticides. Residues from these chemicals end up in coastal ecosystems, poisoning marine life and adding to the problems of eutrophication (lack of oxygen) initiated by millions of tons of untreated sewage. An Indian marine scientist remarks that "some of our coastal areas are eco-disasters". Pakistan's Indus River is packed with pesticide residues. Sri Lanka uses so much fertilizer on its fields that groundwater reserves are becoming fouled with nitrates. In some areas water-wells are so full of nitrates and other agricultural chemicals that runoff from them kills nearby vegetation.

Industrial pollution is limited to major urban centres. But untreated industrial wastes pose an increasing threat to coastal areas. In the Bangladeshi city of Chittagong, a petroleum refinery's wastes contaminated the city's water supply, making it unusable. Water is brought in by tanker and pumped from neighbouring areas. On Sri Lanka, industrial effluents from food-processing industries and slaughter houses have killed fish in the Kelani River and turned the Valachchenai Lagoon dark brown. The waters off Bombay are dangerously polluted from heavy metals. Cadmium levels in the water column are among the highest ever recorded (80 microgrammes per litre). There are widespread fears that as the region develops its industrial infrastructure, industrial pollution will accelerate, compounding the problems posed by raw municipal wastes.

The sub-continent's rivers, especially the Ganges, Brahmaputra and Indus bring in millions of tonnes of sewage and industrial wastes. The Ganges in particular is full of toxics, including decomposing bodies tossed into it along most of its length: chronic fuelwood

shortages that afflict most of India mean that wood to burn bodies is expensive and hard to get. The poor simply cannot afford it. At just one Indian city, Varanasi, about 10,000 half-burned bodies are pushed into the river each year, along with 60,000 carcasses of cows, dogs and buffaloes. Downstream, the river's waters contain a frightening assortment of toxins and disease organisms.

In a bid to clean up the Ganges, the Indian government has allocated $195 million over the next five years. Sewage treatment plants will be built, along with industrial-waste treatment facilities. The carcasses of animals will not be allowed to be dumped in the river at all and proper cremation of bodies will be mandatory. In urban areas large cattle sheds will be built and the dung collected for use in local biogas plants and as fertilizer. Comprehensive as the clean-up programme is, it will take some years before any change is noted in the river's water quality.

Oil pollution

South Asia lives on the same oil highway that passes through South-east Asian waters. In 1985, around 232 million tonnes of Middle East crude were transported along the main tanker route, which stretches across the Arabian Sea, through the Maldives and into East Asian waters.

Oil spills occur, but the real problem, as elsewhere, is the routine discharge of dirty ballast waters, bilge slops and tank washings from oil tankers and other ships plying the shipping lanes in the Indian Ocean. It has been estimated that roughly five million tonnes of oil is slopped into the Arabian Sea every year, while the Bay of Bengal gets 400,000 tonnes.

As a consequence of this practice, tar-balls and oily residues are a common sight on most beaches bordering the Indian Ocean. Some of south India's beaches are permanently littered with tar. Although some 5,000 tankers pass within five km of Sri Lanka's coast every year, so far no serious accidents have occurred – but time is not on Sri Lanka's side. Coral reefs have been covered with oil residues in the Andaman and Nicobar island archipelagos in the Andaman Sea, reducing income from tourism. So far, there is no region-wide mechanism in place to deal with oil spills and the routine discharge of oily wastes by ships sailing through the Indian Ocean.

Coastal sedimentation

Most of the region's rivers run brown sediment from agricultural lands and denuded watersheds. Much of this sediment ends up being dumped into coastal waters. The Brahmaputra River alone carries roughly 500 million tonnes of sediment a year into the Bay of Bengal. Bound to these sediments are heavy metals and chemical residues from industrial, mining and agricultural activities.

Coastal waters are often muddied by all this debris from the land, reducing fish stocks by soiling breeding habitats. Upland soil erosion in Sri Lanka has resulted in the siltation of important lagoonal areas. In some cases, silt has built up across the mouths of lagoons, cutting them off from the sea and destroying breeding and nursery areas for fish and shellfish.

In those areas where mangroves stabilize some of the sediment and filter out pollutants, the problems caused by sediment overloading are greatly minimized. But aside from the Sundarbans (at the mouth of the Ganges and Brahmaputra), the largest tract of mangroves in South Asia, much of the region's coasts have been denuded of their protective mangrove barriers. And once the mangroves are gone, coasts are ravaged by storms and coastal land is lost to the sea.

Siltation of coastal areas does have a positive aspect: it builds up land. The extensive mangroves of the Sundarbans are a product of this natural process. Normally, mangrove forests would spread seaward, colonizing many of the new islands currently being built up by erosion sediment dumped into the Bay of Bengal by the Brahmaputra and Ganges Rivers. Between 1972 and 1977, 3,600 hectares of land were added to the Bay. Unfortunately, pressure for coastal land has reached crisis proportions in Bangladesh and India. Tens of thousands of poor landless fishermen and peasants are forced onto any new spits of sand, known as *chars*, that appear above the sea. Mangroves do not have a chance to extend their reach and stabilize the land. The absence of mangroves on these newly-formed islands translates directly into human tragedy when tens of thousands of people are swept away by tropical storms. In some cases even the islands themselves disappear.

Mangroves and coral reefs at risk

Healthy mangroves and coral reefs are essential components of coastal ecosystems in the Indian Ocean. If managed properly they

provide employment as well as food, fibre, fodder and building materials.

The Sundarbans, that vast mangrove swamp sprawling between the deltas of the Hooghly and Ganges/Brahmaputra Rivers, covers around 6,000 sq km. It is one of the largest mangrove areas in the world, and has been worked for decades by coastal peoples in both India and Bangladesh. Currently, this vast forest supports around 300,000 people who make their living by selectively harvesting mangrove timber and raising fish and shrimp in pond cultures. In recent years, however, excessive harvesting of mangrove wood and conversion to fish ponds has degraded parts of the Sundarbans. The area is now more at risk from storm surges and tidal floods.

India may have upwards of 700,000 hectares of mangrove swamps along its 7,000 km of coastline. But their status remains uncertain, as no real inventories have been conducted. And thousands of hectares have already been converted into brackish-water shrimp and fish ponds, agricultural land, industrial estates and housing units.

Extensive deforestation of mangroves in the Gulf of Kutch has resulted in the sedimentation of nearby coral reefs. Mangroves have also been cleared around Bombay and the Cochin Backwaters.

Pakistan's mangroves occupy a fraction of their former range. The only undisturbed stand is at the mouth of the Indus River. Sri Lanka has perhaps 6,000 hectares of mangroves left, but they are being exploited on a large scale for fuelwood and fish ponds.

In addition to their value as fish-breeding centres, coral reefs perform other important functions. Like mangroves, they reduce wave action and help prevent shoreline and beach erosion. If coral communities are destroyed, the consequences can be as bad for the land as they are for fisheries. On the south-west coast of Sri Lanka, near the town of Hikkaduwa, coral mining for construction purposes (for lime, calcium carbide and cement) has removed some 75,000 tonnes of coral a year. As a result, the "beach" has moved 300 metres inland, whittled away by direct wave action over a 50-year period.

The best reefs are found around the Maldive Islands, hundreds of which are uninhabited. Remoteness has saved many of them. The coral reefs near inhabited islands, particularly around the main island of Male, have been destroyed by coral collectors and mined for the building industry.

The one reef off Bangladesh has been blasted apart by dynamite fishermen. The coral islands and atolls of the Andaman and Nicobar archipelagos are relatively free from exploitation, except for coral

collection for the tourist trade. However, they lie close to shipping lanes and some of the fringing reefs are routinely covered with oil pollution. These reefs have also been invaded by the destructive crown-of-thorns starfish.

Because the Indian Ocean has areas of nutrient-rich upwellings where fish congregate, coral-reef fisheries are very localized, contributing little to the commercial catch.

Fisheries

The coastal waters of the Arabian Sea and the Bay of Bengal are rich in fish and shellfish, thanks to upwellings and favourable currents. The countries of the region collectively gather 2.4 million tonnes of fish and shellfish a year from this part of the Indian Ocean.

India and Pakistan both have deep water fishing fleets. But thousands of tonnes of fish are taken by small-scale commercial and artisanal fishermen in each country. In many areas, particularly off India's south coast, conflicts have erupted between subsistence fishermen and trawlermen. Several hundred have been injured in these confrontations. As near-shore fish catches continue to decline – due in large measure to over-fishing and pollution – such conflicts will likely continue. Trawlers also continue to fish within three miles of the shore, angering subsistence fishermen, who lack motors and bigger boats which would allow them to go further off-shore to fish.

India has around 20,000 mechanized trawlers, in addition to 75 deep sea fishing vessels. Another 200 trawlers will be added to the fleet over the course of the next few years. But little is being done to help small-scale, artisanal fishermen upgrade their equipment and skills. For the 10 million or so subsistence fishermen along India's coastline, making a living from the sea is becoming more difficult every year.

Yields from cultivated fish and shellfish continue to expand. India harvests around 40,000 tonnes of pond-raised fish and shrimp a year; Sri Lanka close to 100,000 tonnes. More mangroves in the Sundarbans are being cleared for fish ponds, a development that could bring decreased off-shore fish catches, particularly prawns and shrimp, which are dependent on mangroves for critical stages in their life cycles.

Few studies of sustainable yields in the north-central Indian Ocean have been carried out, so it is difficult to tell if over-fishing of

commercial stocks is a problem. Certainly many near-shore fisheries are chronically over-harvested. The governments of Pakistan, India and Bangladesh will have to come to terms with the needs of small-scale commercial fishermen if they want to implement realistic coastal-management plans.

Marine protected areas

The region has done little to conserve marine resources. Only India has an established system of marine parks and protected areas that qualify as something more than "paper parks". So far, 21 different sites have been set aside, most of them on the relatively unspoiled islands of the Andaman and Nicobar archipelagos.

Pakistan has granted some protection to the mangrove swamps of the Indus Delta. Sri Lanka has had little success in establishing marine reserves. The Hikkaduwa Marine Sanctuary was established in 1979, but has received no enforcement or management. Meanwhile, coral mining has eroded shorelines in the immediate vicinity of the sanctuary. The Maldives, which draw most of their income from fishing and tourism, have yet to establish any conservation areas. Since many of their coral islands are uninhabited and remote, a number of them could be made into sanctuaries and reserves. But as yet no studies have been carried out to assess their potential as protected areas.

Waiting for an action plan

An action plan for this region has been drafted and is now under consideration by South Asian governments. UNEP officials hope that it will be formally adopted in 1991, along with a convention and associated protocols combating oil spills.

"In addition to UNEP's catalytic role in getting these countries together, we have also initiated a number of preliminary programmes," points out Dr Reza Amini, former Programme Officer for UNEP's Oceans and Coastal Areas Programme Activity Centre in Nairobi. "IUCN will be investigating suitable sites for marine parks, and there is a public awareness campaign in the works as well." So far UNEP has invested half a million dollars into the region in an effort to get the action plan started.

It is obvious that these five countries desperately need a plan. Legislation controlling pollution from towns and cities and curbing

harmful industrial effluents is badly needed. But even more important, coastal land-use strategies have to be worked out with the co-operation of local communities. Without effective management of coastal areas, resource conflicts will escalate and there will be fewer resources to sustain increasing numbers of people, millions of whom are poor.

10. Eastern Africa

The countries of Eastern Africa include the mainland nations of Somalia, Kenya, Tanzania, and Mozambique, and the islands of Madagascar (the Malagasy Republic), Mauritius, the Comoros, Réunion, and the Seychelles. With the exception of Réunion, which is part of France, all of these nations have foreign debts. Collectively, these countries owe $14 billion to foreign banks and development agencies. Although this sum is not nearly as much as Asian countries owe, servicing these debts is a severe drain on their economies. Tanzania's long-term public debt constitutes a full 85 per cent of its GNP; for Madagascar the figure is 106 per cent; for Somalia 75 per cent; and for Kenya 52 per cent.

One result of debt is shifting government priorities and unplanned development. Coastal development in all of these nations is accelerating, particularly in Kenya and Tanzania, as people move to the coast from the impoverished uplands. Kenya's coast from Diani north to Malindi is also being developed for tourism, displacing fishing villages.

As coastal crowding continues, land is degraded and mis-used. Coral reefs are damaged from blast fishing and sediment run-off from the land. Deforestation along the coasts, including mangrove forests, is a problem in some areas, as fuelwood becomes scarce and harder to find. Pollution around cities and industrial zones is on the increase. Behind the postcard facade of pristine lagoons, sheltered coves, and dazzling white-sand beaches, East Africa's coasts are threatened.

The region's colonial past is partly to blame. During long years of colonial exploitation, little was done to protect the environment or conserve resources. Somalia was occupied by the Italians, then the British, finally gaining independence in 1960. Kenya was a British colony until 1963. Tanzania was taken over by the Germans under Bismarck in 1898 in order to secure trade concessions, but after World War I the British took over until 1961. Mozambique was

Portugese until 1975. All of the island states were initially colonized by the French, but most of them were also British at some time during the last century. The French annexed Madagascar in 1896, with the connivance of the British, remaining in control until the country became independent in 1960. The Comoros became independent from France only in 1975. The English ended up with the Seychelles, finally allowing the creation of an independent state in 1976.

Most of the mainland countries have had independence now for more than 30 years. But the economic crisis means that resource and conservation issues are placed after development on the political agenda. Not one East African country has implemented comprehensive land-use policies. "And real planning capability simply doesn't exist," complains one Kenyan scientist. "In our rush to develop, we have forgotten resource management completely."

The long history of domination by foreign powers has left the countries of East Africa with some bitter legacies, but it has also provided them with a common ground. Realizing that a regional programme was necessary to come to terms with the growing problems of their coastal areas, they joined together in 1985 to endorse the Eastern African Action Plan.

A geography of poverty

As the travel guides state, Eastern Africa is a region of contrasts. Living amidst some of the most spectacular geography found anywhere are some of the world's poorest people. Stunning scenery abounds, from Kenya's Rift Valley to Mount Kilimanjaro in Tanzania to the lush flood plains of Mozambique. But it is the struggling poor of the region who will determine how that geography will look in ten years' time and beyond.

The narrow coastal plains contain some of East Africa's most fertile land and receive the most rainfall. The land here is green and richly productive. But much of the best land along the coast is worked by large-scale agricultural plantations growing only one or two crops, like sisal, sugar cane, pineapples, coffee, cotton, coconuts, or bananas. Smaller family-owned farms, which traditionally grow cassava, maize, cashews, coconuts and spices, are being pushed aside.

The cruel irony is that despite ample land for farming and grazing, East Africans have trouble feeding themselves. Much of what is

grown is exported. And for many reasons – mostly political – the prices paid to peasant farmers are kept artificially low. The "pauperization of peasant farmers" has driven many of them from the land. Often men have migrated to cities and towns to find wage employment, leaving women and children to tend the family farm. "Not only have we squandered natural resources but we are squandering our human resources as well," notes one Tanzanian scientist.

Throughout the entire region, the coastal plain is only 10–20 km wide. This means that people and pollution are concentrated in narrow coastal strips. Except for arid Somalia, the coastline has many towns and fishing villages, industries, farms and tourist resorts.

Shallow continental shelves extend for only a few kilometres offshore before plunging down to 2,000 metres. These deep basins eventually taper off to 4,000 metres, the same average depth as the Pacific Ocean. Upwellings are seasonal with the monsoons. The rainy season, which lasts from April to August, is the prime fishing time, since the Somali Current flows counter-clockwise back towards the coast. With it come tropical cyclones, but also large quantities of nutrients and fish.

The island states of Madagascar and the Seychelles are remnants of the ancient super-continent known as Gondwanaland. The other islands – Comoros, Mauritius and Réunion – are all products of volcanic activity and are much younger.

Most of the islands are surrounded by fringing reefs, which create beautiful, shallow lagoons, ideal for tourism. Coral reefs are also land-builders. Without them, the Seychelles would lack 47 per cent of their total area, as well as about half of their 48,334 sq km of submarine banks. But the region's reefs are suffering from the pressures of exploitation for cement production, coral collection and fishing. And tourist developments more often than not ruin the resource which originally makes them attractive.

The fastest growing populations in the world

The sustainable management of resources is not helped by rapid population growth rates. Officially the population of the region is no more than around 60 million (as of 1985). But it could very well be double that figure – in many countries a proper census hasn't been carried out in years. All of the region's

mainland populations (and Madagascar) are growing at nearly three per cent a year; Kenya's birth rate remains among the highest in the world, doubling the population of the country every 15 years.

Although the majority of Somalis, Kenyans and Tanzanians live in the uplands, a full 75 per cent of Mozambique's population lives along its 2,400 km of coastline. Similarly, most Malagasys live along the coast, as do the populations of the small island states.

The weight of agricultural and grazing pressures on fragile uplands throughout the region has contributed to land degradation and widespread soil erosion. As populations grow, good agricultural land shrinks. The best land in Kenya, for example, has been sub-divided again and again. The amount of land available per person has fallen from 0.40 hectares in 1969 to 0.20 hectares today. Poor farmers are forced to use marginal land, which swiftly deteriorates, or else move to cities and towns. Kenya's capital, Nairobi, grew 600 per cent between 1950 and 1979, and most of that growth was concentrated in slums and squatter settlements around the fringes of the city. Not surprisingly, one of Kenya's immediate development priorities is slowing population growth.

With the uplands incapable of supporting growing numbers of people, many migrate to urban areas along the coast. Since there are few other opportunities for employment, they turn to the sea in an effort to make a living.

This trend is painfully visible along Kenya's coast, both north and south of Mombasa. As more people move to the coast, they are forced to squat on whatever land they can find. This often brings them into direct conflict with land developers and the government.

During April 1989, 500 people squatting near the fishing village of Shariani, in Kilifi District north of Mombasa, were evicted from land they had been living on for over 30 years. Their houses were pulverized by bulldozers. In another incident the same month, squatters, angry at being forcibly evicted from their land, attacked police in the village of Diani, south of Mombasa. At least nine people were seriously injured in the ensuing riots. Kenya's coastal lands are in a state of crisis as squatters and the government continue to clash over land rights. Similar problems confront Tanzania as the country struggles with problems of coastal development.

The staggering growth of coastal cities and towns is one result

of the failure of agrarian policies and the inability of East African governments to come to terms with the crisis of their agricultural lands. Dar es Salaam (Tanzania), Maputo (Mozambique), and Mogadishu (Somalia) have all witnessed extremely rapid and unplanned urban growth. Most of the new arrivals, forced off their land, end up in dismal disease-ridden slums or squatter settlements lacking clean water and sanitation.

Unfortunately, government planners, anxious only for development, have not yet made the connection between degraded uplands and over-populated, degraded coasts.

In some countries, such as Tanzania, government resettlement schemes have back-fired. The creation of *ujamaa* ("working together") villages has created chaos, rather than stability. In many cases these villages were not sited properly to begin with, so their new inhabitants could not make a living from the poor soils. Necessities like potable water and sanitation facilities were often overlooked. Dissatisfied with the arrangements in these *ujamaa*, many peasants simply migrated to coastal cities like the capital Dar es Salaam. Huge urban squatter settlements soon sprang up around the fringes of the city, prompting a crisis in municipal services. When authorities forcibly evicted thousands of squatters in the early 1980s, and sent them back to the interior, more displaced peasants took their place.

Another relocation programme forced people out of the traditional rice-growing region of the Rufiji Flood Plain and into the surrounding hills. The peasants, not used to growing anything in the drier uplands, could barely produce enough food for their own use. Meanwhile, rice production on the flood plain collapsed. Many of the peasants forcibly moved into the uplands eventually abandoned their small parcels of land and migrated to urban slums and squatter settlements in Tanzania's coastal cities and towns.

Rural resettlement schemes in Mozambique have produced similar results. The concentration of rural people into village centres has denuded lands around the villages, creating deserts where once there had been productive soil.

Well-meaning, but wrong-headed, agricultural policies have contributed to the impoverishment of soils and upland watersheds, and hence to Africa's food crisis. Improper grazing practices in the northern areas of Somalia, Kenya and Tanzania have caused the desert to advance.

The debt crisis is cited as a serious problem, but many knowledgeable Africans think it should not be used as an excuse for

failing to manage resources. "We shouldn't confuse debt repayment with environmental deterioration," points out Dr Walter Lusigi, programme specialist for UNESCO's regional office in Nairobi. "We can survive debt, we cannot survive the loss of our environment. Rich or poor alike need to preserve their environment, or we all end up with nothing."

Resource degradation

As their resource base deteriorates, too many people throughout East Africa are ending up with nothing. One of the main threats to coastal resources remains the widespread degradation of uplands. Deforestation, poor farming practices and over-grazing have resulted in the loss of soil cover over much of the region. Barren soil, exposed to wind and torrential rains, quickly erodes. What doesn't erode is baked hard by the sun. The major rivers of East Africa and Madagascar run red with sediment washed out of the watershed. Most of this sediment ends up in shallow coastal waters, where it clogs estuaries, and smothers mangrove forests, seagrasses and coral reefs.

The Galana-Sabaki River in Kenya brings sediment washed out of the uplands into coastal waters near a marine park at Malindi. As a result, during the rainy season the waters around this resort town are choked with sediment. Near-shore waters turn a dark brown, repelling tourists and reducing local income. The beach at Malindi, once a major tourist attraction for Kenya, has expanded seaward by some 500 metres due to sediment deposits.

So much sediment has been dumped at the mouth of the Zambezi River in Mozambique that the delta is shrinking under the weight. The resulting rise in sea-level has caused extensive coastal erosion and salt water is intruding 80 km up the river, altering the entire ecology of the delta.

Madagascar is eroding away. Its denuded uplands are victims of excessive fuelwood-cutting, slash-and-burn agriculture, and over-grazing by sheep and goats. As one flies over the central part of Madagascar, the most notable feature is its barren hills, stripped of vegetation, punctuated by huge craters gouged out by water erosion. Nearly every river on the island is clogged with sediment, turning them a red-orange colour. So much sediment was dumped into the coastal waters of Mahajanga, that the city's port

became completely inoperable. A new one had to be built further down the coast.

In some upland areas of Madagascar, as much as 250 tonnes of soil per hectare are lost every year. Soils there tend to be erosion-prone, a condition aggravated by tropical cyclones which can deluge the island with up to 15 millimetres of rain in 15 minutes. Expressed in monetary terms, the average loss from erosion reaches about $100–150 per hectare per year, the equivalent of 70–100 per cent of the average Malagasy's annual income. The government has counter-attacked with soil conservation programmes, resettlement schemes, and tough legislation, but the problems are far from solved.

The silt-choked Shebelle River transports thousands of tons of Ethiopian sediment to the Somali coast where it ruins beaches and clogs estuaries. Entire marine communities of plants and animals have been wiped out.

Coastal bluffs south of the capital city of Mogadishu were denuded of vegetation because of over-grazing by sheep, goats and cattle. Some 5,000 sq km of shifting dunes were created. To date only around 100 sq km have been stabilized by replanting the slopes with prickly pear cactus.

In addition to the effects of upland degradation on coasts, the direct exploitation of coastal resources – for food, fuelwood, fodder and building materials – has resulted in the loss of habitats and degradation of ecosystems.

Coral reefs have been destroyed in virtually every country of the region. Surveys carried out in the mid-1980s revealed that many reefs had been obliterated by blast fishing and the use of coral for building materials and as tourist trophies. In Tanzania, of eight reefs that were recommended for marine parks in 1968, only two could still be found in 1983. The rest had disappeared from the map, blown to oblivion by dynamite fishermen and removed by coral collectors. Mozambique's few reefs have been over-exploited by fishermen and many corals killed off by siltation.

Perhaps the greatest destruction has occurred on the islands. Comoros, Mauritius, and the Seychelles all have extensive fringing coral reefs; the remote, far-western part of the Seychelles consists entirely of coral islands and atolls. Coral sands and reefs have been excavated for cement production and building materials on all three island nations. The reefs of the Comoros and Mauritius

have been pillaged by tourists and collectors. In some areas, the sea has devoured beaches and coastal lands because the protective coral barrier was removed.

Unfettered tourism has probably had the most negative impact on the coral reefs of Mauritius and Réunion. Tourist resorts, built in coralline areas, have provided reef access to thousands of trophy-hunting tourists, who think nothing of tearing apart live coral looking for shells. At low tide, unthinking tourists tramp across the coral heads, crushing them, in their search for souvenirs. Many visitors to reefs don't even realize the coral is alive, so they see no reason why it shouldn't be collected. There may be more coral from these islands on European and North American coffee-tables than remains in their coastal waters.

Fortunately, the most spectacular reefs in the Seychelles are all so remote from the main, inhabited islands that they are free from exploitation. The magnificent raised coral atoll of Aldabra was made a World Heritage Site in 1983, principally because it is one of the last refuges of the giant land tortoise (*Geochelone gigantea*), similar to the species living on the Galapagos Islands, off the coast of Ecuador. The atoll is also a refuge for thousands of nesting water birds. Coral reefs around the main island of Mahe, however, have been damaged by trophy collectors and covered with sediment from poorly-planned coastal development projects – many of them tourist resorts.

Mangrove forests in East Africa are not extensive; under a million hectares remain in the entire region. The most extensive growth – 320,000 hectares along the north-west coast of Madagascar – supports a thriving shrimp fishery. With few exceptions mangroves are endangered by coastal development, fuelwood collectors and siltation. In Kenya there are large areas of mangroves around the Tana River Delta and north of Lamu, with small pockets found at the mouth of creeks and estuaries. On the south coast there are significant stands at Gazi and Funzi south to Vanga. Tanzania has one major stand in the Rufiji Delta, plus smaller pockets scattered about, and Mozambique's 67,000 hectares are in its central delta region.

Without genuine, active conservation programmes in place to preserve what remains of the region's mangroves and coral reefs, exploitation will continue. By the time some areas are set aside, their value as reserves may be negligible.

Coastal pollution

Most of the municipal and industrial wastes which find their way into the Indian Ocean are untreated. Sewage systems in the region serve a maximum of twenty per cent of the entire population. Some claim even this figure is too high. Even though Kenya has 150 sewage treatment plants throughout the country, less than half the population is covered by them. The sewage treatment plant in Mombasa is constantly over-loaded. Dar es Salaam's sewage treatment network has completely collapsed, necessitating the establishment of a master sewerage plan for the city. To be completed in stages, the system will not be ready until the year 2010. Meanwhile, everything is dumped raw into shallow coastal waters. Somalia has no sewage network at all; relying instead on pit latrines and septic tanks, which pollute groundwater. Only ten per cent of the urban population of Mozambique had access to sanitation facilities by the mid-1980s. A cholera epidemic in Maputo was linked to the sewage-contaminated bathing waters in the Bay of Maputo. Of the island states, Madagascar and the Comoros have no sewage treatment plants. Wastes from both islands are channelled into coastal waters.

More serious, perhaps, is the amount of industrial and agricultural poisons brought into the sea from rivers and streams. All of Nairobi's municipal and industrial wastes are flushed into the Athi River, which exudes such a foul odour that the stench can be detected for kilometres. Some of these poisons eventually reach the sea. Their effects on marine communities are virtually unknown.

Industries in coastal areas dump their wastes directly into the sea untreated, a pattern that show no signs of improvement. Mogadishu's coastal waters are patrolled by huge sharks, attracted to the raw wastes from a slaughter house, which are simply drained into near-shore waters. Unwary swimmers have been snatched by voracious sharks that have even learned to swim on their sides, seizing their victims in waist-deep water.

Coastal industries in Tanzania dump untreated wastes from soap factories, sisal and sugar mills, and plastics, wood-processing and super-phosphate plants into coastal waters. At Dar es Salaam, industrial effluents have turned the waters of the Mzimbazi Creek – which flows through a mangrove swamp – into an anaerobic, stinking cesspool bubbling with sulphide gases.

In Maputo, wastes from the city's cotton and textile factories drain directly into Maputo Bay, parts of which are eutrophic and devoid of marine life.

Another problem which affects coastal waters is pesticide runoff from agricultural lands. Pesticides banned in the West, such as DDT, are still used extensively in East Africa. Residues from these pesticides seep into rivers and coastal waters. Madagascar alone sprays its agricultural fields with 20,000 tonnes of pesticides a year, most of it DDT. Shellfish beds, tainted with pesticide poisons, had to be destroyed in Madagascar and Mozambique.

Solid wastes are often dumped into coastal lagoons and mangrove swamps. On the main island of Mahe in the Seychelles, solid wastes are dumped into a lagoon, known as "stinking corner". Next to this eyesore and health menace is a marine park. Efforts to clean it up have failed, as the authorities don't know where else they can dump their municipal garbage.

As cities and towns expand, treating and disposing of municipal and industrial wastes will become major environmental issues. So far, little has been done in the East African region to tackle either the causes or effects of unsupervised waste disposal.

Oil pollution

East Africa lies on the other half of the world's major oil highway – the branch which flows out of the Arabian Gulf west to markets in Europe and North America. Approximately 475 million tonnes of oil are transported through the region every year. About half of it is carried by Very Large Crude Carriers (VLCCs), averaging about 200,000 dead weight tonnes apiece. On any given day there are about two hundred oil tankers in East African waters, going to and from the Gulf.

With this much oil being transported through the area, oil spills are inevitable, but so far no catastrophic accidents have occurred. Most of the oil pollution is due to the routine cleaning of tanks, and the discharge of dirty ballast waters and bilge slops. Captain James Ferrari, former Principal Secretary in the Ministry of Transport for the Seychelles, estimates that, on average, about 35,000 tonnes of oil are spilled into the eastern Indian Ocean every year through normal shipping operations. The actual figure could be considerably higher.

Despite the dangers, the countries of East Africa have not yet developed contingency plans for combating oil spills. And even if

they had a plan of action, there is practically no equipment to use in such emergencies.

Fisheries

Most fish are landed by small-scale commercial and artisanal fishermen. For the most part, fishing takes place in shallow lagoons and on reefs. On the mainland many fishermen simply wade out to the reef, and encircle fish with simple hand-nets. Those with boats – usually outrigger canoes – stay within five kilometres of shore near coral reefs and mangrove estuaries. On the Comoros, some 4,000 outrigger canoes fish within a couple of kilometres of the coast, using hand-lines. Madagascar's 4,000 artisanal boats, mostly outriggers, are found on the calmer, western side of the island; they use hooks and lines and gill-nets. Trawling is limited to a few offshore areas, where tuna, sardines, anchovies, Indian mackerel and billfishes are caught.

In the early 1980s, fish catches in East African waters, including the islands, amounted to no more than 170,000 tonnes. Most of the harvest was taken by artisanal fishermen.

There is one exception. Shrimping is big business in Madagascar, where some 40 trawlers haul in $50 million worth of the crustaceans a year. On the continent shrimp catches are confined to a few important mangrove areas in Kenya, Tanzania and Mozambique.

Fishing is not highly developed, mainly because access to better techniques and fishing gear is severely limited. Most Kenyan and Tanzanian fishermen, for example, are confined to coral lagoons where they fish on foot during low tide. Because nylon nets are expensive, they mend their nets constantly and use them until they fall apart. Throughout the region, cold storage facilities are lacking and road networks primitive. Fish and shellfish must be sold the same day in village markets or to middlemen who pack the fish in ice and deliver them to buyers in nearby towns and cities.

The other factor limiting fish consumption is local tastes. Somalians, with their nomadic tradition, consume only 0.7 kilogrammes of fish per person a year, while the people of the Seychelles rely on the sea for most of their animal protein; the average Seychellois consumes 70 kilogrammes of fish a year. With transport networks already over-taxed on the continent, the demand for seafood is likely to remain coastal.

Despite all the evidence against the non-sustainable harvesting of fishery resources, over-fishing is becoming a serious problem along much of the coast of Kenya and Tanzania. As increasing numbers of people are pushed off upland farms, many migrate to the coast in search of employment. Even though they use primitive gear, so many people are fishing that fish stocks are becoming depleted in lagoonal areas. Inappropriate fishing practices abound as well. Many of the newcomers, lacking traditional knowledge of the sea and its creatures, harvest fish and crustaceans bulging with eggs, or take fish before they have matured. Others use destructive equipment, such as overly fine-meshed nets which collect everything, even fish eggs. Whether out of greed, ignorance or desperation, increasing numbers of subsistence fishermen are resorting to dynamite, particulary in Tanzania, which not only kills indiscriminately but destroys the reef upon which their livelihoods depend.

The two sides of Mombasa

Akida Abushiri's greatest fear is that he will have to give up the sea. He has been fishing in the clear coralline waters north of Mombasa for over 45 years. But his fishing days may be coming to an end. Over the past decade, many people, unable to find employment on the land, have turned to the sea for a living. This has meant that edible fish are now harder to find and catch.

Akida lives in the village of Shariani, in a small traditional hut made from mud and wattle, with a palm-thatched roof, called *nyumba ya kiswahili* in Swahili. There is no running water and no sanitation facilities. Pit latrines are dug whenever necessary and fresh water is taken from shallow wells or bought from vendors. He has lived on this same plot of land for 50 years. Like all of his neighbours, however, he does not own the land; the government has allowed the people of Shariani to squat here because its sandy soil, filled with pieces of ancient coral reefs, is poor for agriculture.

It is an unsettling existence. "The government could always come in here and tell us to move somewhere else," points out one of Akida's relatives. "We have nothing to fall back onto, but the sea."

"The sea," insists Akida, "is just as productive as before. But now more people are fishing, so there is less to go around. When I started fishing in this area 45 years ago, there were only five other fishermen. Today, about 40 people fish regularly in this part of the reef."

Increased numbers of fishermen are only part of the problem facing Akida and his neighbours. The poor fishermen of Shariani have no boats, not even simple dugouts. Without boats, they cannot fish outside the reef, where fish are more plentiful. Like most of the other older fishermen from the village, Akida uses a simple net, made from nylon or cotton fibre, to catch fish – a technique that has been used along this part of the Kenyan coast for decades. With two of his comrades, Akida wades out to the reef at low tide. When they find a likely spot, usually up to their necks in water, the net is spread out and readied. While one fishermen beats the water with his hands, the other two guide frightened fish towards their net. Any fish taken are quickly placed in fish bags, woven from the leaves of the screw pine (a large plant). There are no cold storage facilities in the village, so fish must be sold the same day in the local market, or to fish vendors from nearby villages.

At the best of times it is back-breaking, dangerous work. Wading out to the reef, fishermen have to take care not to step on poisonous sting rays and stone fish. Once near the reef, they must be on the lookout for big waves which can crash over them unexpectedly, pounding them into the jagged edges of the coral. During the first half of 1989, two fishermen from this village were killed on the reef, both victims of freak waves which crushed them against the coral. Their bodies were not recovered for days. Anyone who survives being dragged over the coral reef faces treacherous surface currents which can sweep someone far offshore in minutes.

Like many other fishermen in Shariani, Akida must support his family on a meagre income. He averages about 1,000 Kenyan shillings a month ($55). From this he supports two wives and ten children. Four children have already left home and have families of their own. Since his land is too poor to grow vegetables, maize, rice and other staples must be bought.

The good times are not as good as they once were, and the lean times are leaner. "Twenty years ago, I could save some money in the bank," says Akida, "but not today. One good week is usually followed by several bad ones. So any surplus is quickly used up."

Sometimes it is difficult for Akida and his neighbours to afford new nets. They are expensive – 1,300 shillings each – and must be bought in Mombasa, a 45-minute bus ride to the south. "We should buy new nets twice a year," points out Akida, "sometimes we just don't have the money."

Although there are no reserves or protected areas in this part of the fringing reef, which stretches for several hundred kilometres along the Kenyan coast from Mombasa northwards, the older fishermen of Shariani and other villages are natural conservationists. They don't use destructive fishing gear, like dynamite and poisons. They are careful not to harvest fish with eggs, and when net fishing they treat the coral as if it were rare porcelain.

Many of the newcomers to the coast are not so careful about what techniques they use to catch fish. Some of the younger fishermen are using "juya nets", with very small holes. "This is a dangerous net, since it takes everything, even fish eggs," explains Akida.

The other scourge afflicting Akida's village is spear-fishermen. Within the last several years, Shariani and other nearby fishing villages have seen an influx of "school leavers". Unable to find suitable employment, they have taken to the sea to make money by spear-fishing at night and collecting corals and shells for the tourist trade during the day.

Akida claims they are interfering with his subsistence fishing by taking everything they can get. "The government should clamp down on this form of fishing. Spear-fishermen spare nothing and they damage the coral when they miss their mark."

Twenty-six year old Jackson is one of the spear-fishermen Akida is complaining about. He left school and could not find anything worthwhile to do, so he has turned to spear-fishing on the reef at night using a water-proof flashlight to blind the fish.

He justifies his methods because they work. "We can get 20 kilos of fish a night," says Jackson. "We only go out for about three hours a night. Day fishing is too much work and there are too many guys doing it."

Usually, Jackson fishes with nine other young spear-fishermen. They all use crudely-fashioned home-made spear-guns. "But night fishing is really easy," he adds. "The fish are resting and don't expect to be taken at night. You can swim right up to them and almost grab them with your hands."

Jackson and his friends each make about 4,000 shillings a month from night fishing, four times the amount Akida brings in. And they do not have families to support.

Although Jackson insists that he does not take shells for the tourist trade, many young men in the area do. Because trochus and triton shells have been pillaged, the reef is suffering from plagues of the

crown-of-thorns starfish and sea urchins. The natural balance has been upset.

With all the new fishing pressures to contend with, Akida wonders how he will manage a year from now. Sitting amidst his children on a palm mat, Akida meticulously repairs his only net. The strain of the last few years shows on his wrinkled brow.

The government has overlooked the north coast of Mombasa. None of the fishing communities here has received training in new techniques, or loans to buy better equipment. Part of the reason lies in their own stubbornness. Distrustful of organizations, they have not been able to form co-operative fishing associations, which might attract government project support, or international aid. An attempt by one young man from the village to form a co-operative came to nothing. The fishermen did not want to put in any of their own money.

"All we really need is a small boat and two new nets," observes Akida. "Then we could fish outside the reef and make a better living."

Until that day comes – if it does – he must catch what he can in the lagoon, and watch as the waters on the other side of the reef fill with fishing boats taking in rock cod, barracuda, groupers, mullet and billfish. And he must watch as younger fishermen, less mindful of the ecology of the reef, take more fish and shellfish than they should. For the poor people of Shariani there is only less of everything.

By contrast, on the south side of Mombasa fishing villages have prospered by forming co-operatives. Mohammed Kitawana is one of the officers of the Mwagugu Fisheries Co-operative Society, set up ten years ago in the fishing village of Vanga, a few kilometres from the Tanzanian border. The extensive growth of mangroves which separates the village from the sea provides a rich and diverse catch including shrimp, prawns, rabbitfish, squid, mullet and many other off-shore species.

Nearly all of the fishermen of Vanga are members of the co-operative. Kitawana counts 179 members and more people are writing to join every month. Unlike Shariani on the north coast, Vanga's fishermen all own their own boats and dugouts. They use a variety of techniques including hooks and lines and different kinds of nets, depending on what type of fish they are after.

"Some of our fishermen specialize in shrimp and lobsters," explains Kitawana. "Others go after mullet and rabbitfish. But most of the fishermen here harvest whatever edible fish they can catch."

Mohammed Kitawana is thirty years old and has a high school education. He was born in Vanga and is happy to be able to contribute to the advancement of his village. He is clearly pleased at the success of the co-operative.

"It took us two to three years to set it up in the beginning," confesses Kitawana. "We had to get government permission and organize all the fishermen. Some were sceptical at first that we could make this work. But today, the co-operative's success is well-known. All our members make a comfortable living from the sea."

The co-operative sells no less than 500 kg of fish and crustaceans a day and often unloads up to 1,000 kg. "On a monthly basis we probably take in 100,000 shillings," says Kitawana. "After all expenses are paid, including the fishermen's share of the profits, we still have around 10,000 shillings left in our reserve fund."

A few years after the fishermen's co-operative was established, the government built the Vanga Fish Depot, where the co-operative sells its fish. They have also built an office. "Once you have an organization, you can get bank loans and assistance from the government," points out Kitawana.

There is no over-harvesting of fish around Vanga and none of the fishermen resorts to illegal techniques, like dynamite fishing. Occasionally, Tanzanian poachers infringe on Kenyan waters, but anyone caught dynamiting is quickly driven off. "If anything, our waters are still under-fished because we don't have big trawlers in these waters," notes Kitawana.

Some of the fishing villages south of Mombasa stand in sharp contrast to the poor, struggling communities north of the city. One of the reasons for the dichotomy is because the mangrove-based fishery here is more productive. But the key ingredient, missing from the north coast, is a fisherman's organization.

"It's not the answer to everything, but forming a co-operative or some kind of organization that represents your interests is one way to protect yourself against outside forces," says one fishermen from Vanga. "We no longer feel that we are out there alone."

Marine conservation

With so many other problems to worry about, government officials in the region have not paid much attention to the conservation of marine areas. Kenya and Tanzania – currently engaged in an escalating bush war with poachers – are more concerned about saving what they can

of their terrestrial animal life. So far, there are only 41 protected marine areas in the entire region, including the islands. And more than half of these are in one country: the Seychelles.

Kenya has designated four marine parks, covering 50,000 hectares, but most of the area protected is coastal land, not nearshore waters. Somalia and Madagascar have no marine parks or protected areas. Tanzania has recently gazetted seven marine reserves. Mozambique has designated two marine reserves, comprising 8,000 hectares; but management is lax. Mauritius has managed to conserve a few marine areas, mostly as tourist attractions. The Seychelles have an impressive record of marine conservation, setting aside 38,000 hectares of coral atolls and islands, with more areas under consideration.

The status of marine mammals is uncertain. Dugongs are extremely rare and those remaining are threatened by poachers and loss of habitat. Sea turtle populations have also been devastated by poaching and destruction of habitats, despite national legislation against harvesting. Dolphins, on the other hand, seem to be in no immediate danger in East African waters.

On the bright side, the Indian Ocean was declared a Whale Sanctuary in 1983 and has remained one since then. No commercial whaling activities are permitted at all in the entire ocean basin, north of the 55° south parallel. Although this caveat exempts Antarctic waters, where many species of whales spend their summers feeding on krill and plankton, it is still a significant breakthrough in global efforts to conserve these vanishing mammals.

East African Action Plan

In 1985 the countries of the region banded together to form the East African Action Plan, under the auspices of UNEP. The first phase, now being implemented, is the formation of scientific contact points within the region. Participating institutes and research centres are working together in efforts to make their methodologies, and results, compatible. Baseline pollution studies are being carried out, in order to pinpoint local problem areas and assign priorities.

The Action Plan calls for the following measures:

- an inventory of ecosystems in the region;
- regional inventory and status report of all existing protected areas;
- documentation of all endangered species;

- facilities made available to train pollution control technicians;
- assessment of socio-economic activities that may have an impact on coastal and marine environments;
- strengthening of oil spill contingency plans;
- studies of ciguatera poisoning, and heavy metal and organo-chlorine contamination of fish and shellfish; *and*
- assessment of the effects of dynamite fishing on coastal habitats and fish stocks.

It has been a slow process, but building institutions takes time. The mainland and island states of East Africa started the programme with few environmental experts and little in the way of institutional support. Building up a research network of institutions and experts consumed the first few years. To this end, UNEP has contributed nearly $1 million to get the programme started. Now that the Action Plan is moving out of its "study phase", the region may begin to see some action designed to solve the problems confronting coastlines.

Many needs have not been met. Public awareness campaigns are critical to the overall success of coastal management plans. But so far, not one African NGO deals with coastal issues and there is little government interest in coasts, other than for agriculture and tourist development.

Resource-use planning must begin to be implemented along the coasts, at least in a few of the priority areas as identified by the Action Plan. "Right now we are doing little more than crisis management," observes one Kenyan biologist. "We need to develop the capacity to plan for people and their needs."

In this context, controlling urban growth must be a top priority. A related issue is dealing directly with the causes and consequences of landlessness. Ways must be found to keep farmers productive and on their land, and employment must be found for urban squatters and slum-dwellers. When the causes of poverty are addressed directly, then coastal-zone problems, which are themselves related to people's poverty, will be easier to resolve.

11. West and Central Africa

This vast region includes 21 coastal states, stretching from Mauritania in the north to Namibia in the south. The economies of the region vary considerably; Nigeria is a rapidly emerging industrial power, while the Gambia and Benin are almost subsistence economies.

Despite the economic, political and social divides separating West Africa, the countries of this region have many resource and environmental problems in common. Nearly all of the countries of West and Central Africa must fight coastal erosion, the most severe environmental problem of the region. Although partly a natural process, the sea is eroding more of the coastline than normal because development along the coast has upset the natural balance between land and sea. Coastal towns and cities sprawl in all directions as their populations continue to expand. As in East Africa, most urban and industrial wastes enter the sea without any kind of treatment. Tropical forests have been decimated and mangroves cleared. Oil pollution is widespread, especially around the coasts of oil-producing nations like Nigeria. And rivers and streams dump toxic residues from pesticides and fertilizers into coastal waters.

For most of these countries, coastal management is barely considered, let alone enacted. Meanwhile, development along this long and varied coastline seems to be divorced from any constraints.

Ironically, one area of "development" has given impetus to the regional approach to environmental protection: the importation of hazardous wastes. With some countries willing to accept the toxic wastes of the First World and others bitterly opposed, the need for a clear set of guidelines and rules governing the transport, storage, treatment and disposal of such wastes became obvious. The Action Plan for the West and Central African region (called WACAF by UNEP) has, on this issue, become a medium of central importance.

Geography of a continent

The 21 countries of West and Central Africa cover 9 million sq km, or nearly thirty per cent of the entire continent. Their collective coastline stretches out over 6,500 km. Coastal shelves extend out only 30–40 km offshore, then slide down to ocean basins. But even the shelf, which averages 100 m in depth, is fractured by deep trenches. Coastal upwellings make the continental shelf a rich fishing ground.

Excluding Arab North Africa, the countries of this region are the most developed on the continent. Nigeria has built its economy on oil and gas, while countries like Senegal, Zaire and Liberia have evolved advanced mining and processing industries. Only a few West African countries are on the United Nations list of the least developed. Most of these nations have an abundance of natural wealth to build on: minerals and hydrocarbons, timber, rich agricultural land and fisheries.

But the real test here, as over much of the rest of Africa, is whether they can continue to develop without ruining their resource base in the process. The task is formidable. Population growth is already making a mockery out of government attempts to manage resources and the environment. Cities are growing especially quickly; and in many parts of the region the coasts are suffering the most from the rapid rise in population.

Population growth

The average rate of growth for the entire region is close to three per cent a year, one of the highest in the world, doubling human numbers every 23 years.

As of the late 1980s, the countries of West and Central Africa contained nearly 200 million people. At least a quarter of these are thought to reside in coastal areas. Indeed, with a few exceptions, such as Kinshasa, Zaire, the capitals and major industrial areas are all coastal.

Coastal capitals and other urban areas are growing at more rapid rates than towns in the interior. In some cases, such as Lagos, Nigeria, land is at a premium. In 1985, for example, Lagos was ranked as the world's twenty-fourth largest city with an official population of 6.1 million. But in terms of population density, the city came in second place after Hong Kong, with nearly

42,000 people per sq km. The city's growth rate is already outstripping public services. Planners pale at predictions that Lagos is expected to have ten million residents by the turn of the century – although some claim this figure has been reached already. Much of the city's expansion is taking place around its sheltered lagoon.

In efforts to stem population growth, many West African governments have instituted family planning programmes. However, since most West African cultures view big families as a form of social security, little progress has been made in bringing down birth rates.

Major urban centres in West Africa, as elsewhere, also concentrate manpower, skills, industries and commerce. The capital of the Ivory Coast, Abidjan, contains 20 per cent of the population of the country and accounts for more than 70 per cent of all economic and commercial transactions. Similarly, Lagos – with a tenth of Nigeria's population – accounts for nearly 60 per cent of total value added in manufacturing and has 40 per cent of the nation's highly-skilled labour force. Such trends are region-wide. The effects of urbanization and the concentration of industrial and commercial activities along coasts has not been fully taken into account by government planners. If unchecked, coastal resources could be critically depleted by this centralization of activity.

Coastal pollution

As on the east coast, West Africa pumps most of its municipal and industrial effluents directly into coastal waters without any form of pre-treatment. Raw sewage from roughly fifty million people is channelled into shallow coastal waters, bays and lagoons. In some areas high concentrations of bacteria pose a clear threat to human health. Lagoonal waters around Lagos receive more than sixty million litres of sewage water a year. Typhoid fever and infectious hepatitis are rampant, caused by the consumption of shellfish tainted with sewage.

The coastal waters of virtually every major urban centre are clogged with a vile assortment of municipal and industrial wastes – everything from sewage to heavy metals and chemical poisons. West African waters are more severely affected by industrial wastes, perhaps, than any other part of the continent. Over sixty per cent of all industries in the region are coastal. Untreated effluents from petrochemical refineries, mining and metal smelting operations, and

food processing, chemical and textile plants all discharge their wastes into coastal waters.

The cement industry in Gabon and Togo contaminates near-shore waters with suspended solids, turning estuaries a pallid grey. Wastes from textile manufacturing in Ghana, Benin and Nigeria go directly into coastal lagoons, creating locally high concentrations of phenols and chrome. Heavy metals from mining and metal smelting ruin shellfish beds along the coasts of Liberia, Senegal, Guinea and Sierra Leone.

The other affliction of river basins and estuaries is the great quantities of pesticides sprayed on agricultural lands throughout West Africa. Since agricultural exports are still the basis of many of the region's economies, West and Central African states consume around ten per cent of all pesticides produced in the world every year. "Practically all the fish, crabs, and shrimp in the coastal areas are exposed to pesticides," states one UNEP report on the coastal health of the region. Once pesticides infiltrate coastal ecosystems, they tend to accumulate in the fatty tissues of marine organisms. High levels have been detected in crustaceans and shellfish. The effects on human health of pesticide accumulation in marine life have not yet been studied sufficiently.

"One of the top priorities of our Action Plan is to control the discharge of municipal, industrial, and agricultural wastes into the coastal waters of the region," points out Dr A. Chidi Ibe, Head of the Physical and Chemical Oceanography section of the Nigerian Institute for Oceanography and Marine Research in Lagos. "But so far we are still in the evaluation stage."

Oil pollution

With most oil in the region being pumped from offshore platforms in the Gulf of Guinea, particularly off the coast of Nigeria, it is not surprising that the coastal waters of the entire Gulf are contaminated with oily wastes and tar balls. The worst oil spill occured in Nigerian waters, when an offshore oil well blew out; some 421,000 barrels were sprayed into the Gulf, killing mangrove forests and fouling beaches.

The entire delta of the Niger River – Africa's third largest, which drains a huge section of West Africa – is polluted with oil residues from offshore drilling and transport.

Oil reserves in West Africa total 2.4 billion tons with 80 per cent of it belonging to Nigeria. At current rates of extraction, these reserves

will last another two decades, perhaps longer. Oil-spill contingency planning, although still unfinished, is high on the list of priorities for the regional action plan.

Forest loss

West African tropical forests and mangrove swamps have been devastated in the name of development. The survival of the region's forests beyond another 50–100 years is doubtful. Forests throughout West Africa are being cleared for urban expansion and the production of food and cash crops, and exploited for timber and fuelwood. Both Nigeria and the Ivory Coast are losing over five per cent of their forests every year.

Scientists fear the loss of tree cover will mean less rainfall and increasing temperatures in some areas. If such delicate balances are upset, the consequences for agricultural production could be catastrophic.

At the same time, mangroves are being cleared to make room for the expansion of towns and cities, industrial estates, and fish and shrimp ponds. Now, the last major stand of mangroves in West Africa – the 900,000 hectares at the delta of the Niger River in Nigeria – is threatened. Seaward, these mangroves are victims of chronic oil pollution and beset by coastal erosion. On land they are exploited for timber, tannin, fuelwood, fodder and fish ponds.

Coastal erosion

"Coastal erosion is probably the most serious environmental problem facing West Africa," says Dr Ibe. The reasons are due to a complex assortment of ocean–land interactions. But in plain terms the ocean here acts like a huge scoop, gouging the land and depositing the debris in deep trenches which knife across the continental shelf fairly close to shore.

The effects are obvious. Hundreds of coastal villages have been moved further inland, as the sea reclaimed their land. In the Gulf of Guinea river deltas had helped build new land by depositing silt from the watershed. Many of these sand spits were occupied by small fishing communities who now have to evacuate their islands as the sea advances.

Up and down the coast, agricultural lands are being washed out to sea. The twisted trunks of palm trees and mangroves sticking up out

of silt-laden coastal waters are a common sight. Sand banks designed to hold back the sea have been battered down. Coastal cities have been forced to reinforce tidal barriers and jetties.

Coastal erosion has reached such proportions in land-short countries like Togo and Benin that they have asked the French Ministry for Co-operation for help in combating it. Off the western pier of Lomé Harbour (Togo), the sea has advanced 380 m in 15 years. The entire eastern portion of the harbour itself is being lost at the rate of 20 m a year.

The great mangrove forest of the Niger Delta are being pushed back towards land by the sea. Scientists estimate they are losing ground at rates reaching tens of metres a year. The huge amounts of sediment transported into the delta by the river is swept away by the currents.

To what extent human interference has contributed to the process of coastal erosion is unknown. But unplanned coastal development is most certainly a factor in some areas. "This problem is receiving a great deal of attention by scientists in the region," asserts Dr Ibe. Unfortunately, the costs of doing something about it are often prohibitive.

Fisheries

Despite a relatively narrow continental shelf, upwellings of nutrient-rich waters are found in certain areas along West Africa's coastline. The region has no fringing coral reefs, but mangrove-based fisheries abound in the north-central regions. The cool Benguela Current which flows north off the coasts of Namibia and Angola supports an annual catch of 1.5 million tonnes (mostly pilchards). Altogether, about 3.5 million tonnes of fish and shellfish are caught in the region every year. The largest catches are taken by Namibia, followed by Nigeria, Senegal, Ghana and Angola.

Fishing is an important source of revenue for West and Central African states. Mauritania's exports of seafood rank second to iron ore. Senegal is the region's leading producer of shrimp, which are taken by trawlers in the mangrove delta of the Saloum and Sine Rivers. About seventy per cent of the catch is exported. The Gambia has developed an export industry based on crabs, oysters and lobsters.

Liberia, Ghana, Togo and Benin have thousands of fishing communities. Most fishing is confined to near-shore waters. In

Ghana, fish consumption exceeds that of meat and the industry is credited with about 1.2 per cent of the country's total GNP.

Nigeria's fisheries are also lucrative, amounting to around 200,000 tonnes a year. Much of the catch is taken by artisanal fishermen with motorized dugouts using simple hook-and-line techniques and gill nets. Still, demand is so great that three-quarters of Nigeria's fish is imported.

Large processing ships from the Soviet Union, Spain, Japan and Norway trawl off the continental shelf. These fleets can catch, process and freeze great quantities of fish before returning to shore. Most tuna taken in West African waters are caught by these foreign "process fleets".

The primitive state of the fishing industry in many West African countries means they do not get a large slice of the offshore resource. The UN Food and Agriculture Organization has long been active in West Africa in efforts to help upgrade fishermen's skills and equipment. FAO reckons that the commercial-fishing potential of the region is immense, amounting to perhaps six million tonnes a year.

Hazardous wastes

The West African region clearly has been targeted by international waste-handling firms and chemical companies as a possible repository for a frightening variety of hazardous industrial and municipal wastes. In 1988 the small coastal town of Koko in Nigeria made headlines when local residents suddenly developed unexplained skin rashes and suffered bouts of vomiting, diarrhoea and headaches. The symptoms were traced to a dump site where investigators discovered that 4,000 tonnes of toxic chemical wastes, left there by an Italian waste company, were leaking poisons into the air and water. Outraged, the Nigerian government impounded Italian ships and arrested Italian businessmen, until the Italian government agreed to remove the dangerous wastes. But the final chapter was a grisly one: Nigerian dock workers who loaded the wastes onto an Italian ship did not have protective masks; many of them began coughing up blood.

Greenpeace International, which has been monitoring the shipment of hazardous wastes from the developed North to the developing South, claims that such waste shipments are increasing in frequency. Between 1986 and 1988, say Greenpeace monitors,

industrialized countries have shipped around 3.7 million tonnes of all kinds of wastes to the developing world. Much is thought to be highly toxic PCBs, pesticide residues, solvents and incinerator ash.

A Greenpeace review of shipments, or attempted shipments, to West Africa include the following examples:

- Guinea-Bissau recently cancelled a five-year contract to take 15 million tonnes of pharmaceutical and tanning wastes from Europe.
- When Guinea discovered that 15,000 tonnes of toxic flyash had been dumped on Kassa Island by an American waste firm, the government filed an official protest with the State Department and the wastes were eventually returned to sender.
- Sierra Leone has accepted toxic incinerator ash from the US containing cadmium and mercury.
- The government of Benin has agreed to take 5 million tonnes of industrial waste each year from the US and Europe.
- Liberia is considering offers to take hazardous wastes, including contaminated earth, from West Germany.
- Gabon has agreed to accept radioactive waste from uranium mining in Colorado, USA.
- The Congo cancelled a deal to accept one million tonnes of chemical wastes from Europe and the US.
- Angola has agreed to dispose of unspecified quantities of toxic waste from Europe.

West Africa seems to be a popular target for such arrangements because the governments are thought to be cash-short and unconcerned about the health of their environment. Nigeria's reaction has ended that myth. But the region is still bombarded with proposals to take toxic wastes off the hands of Northern producers. It is an issue that will certainly require a regional approach for its resolution.

The Action Plan for West and Central Africa

The Action Plan for WACAF contains three main areas: pollution control; fighting coastal erosion; and developing a contingency plan for combating oil spills.

Although the WACAF countries met for the first time in 1981 to discuss the establishment of a West African Action Plan for protecting and managing their coastal environments, the Abidjan

Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region did not come into force until 1984.

Meanwhile a number of important baseline studies were carried out in an effort to determine what major environmental problems confront the region and to make recommendations for their control. Now pollution monitoring is being carried out throughout West Africa by a network of interconnected research institutes. Masses of data have been collected on the region's major problem areas. A Trust Fund was also established to pay for the programme. As of 1989 it contained only $387,000, but more money is expected.

Still, with so little funding it is hard to see how WACAF can achieve much in their fight to conserve resources and protect their eroding coastlines. One West African scientist says that "the time for talking is over, we need action to deal with these problems." The epidemic of toxic waste dumping in the region may be the one issue capable of galvanizing West African governments into collective action.

12. The Red Sea and Gulf of Aden

Nine countries border the Red Sea and Gulf of Aden, but only seven are presently participating in the Regional Convention for the Conservation of the Red Sea and Gulf of Aden: Jordan, Saudi Arabia, Sudan, Somalia, the Popular Democratic Republic of Yemen (South Yemen) and the Arabic Republic of Yemen (North Yemen). The Palestine Liberation Organization (PLO), representing Palestine, is also a member.

The region, surrounded by dry and arid country, is not developed, except for Egypt, Jordan, and Saudi Arabia. Most of the countries are relatively poor, with few resources other than oil.

In this case, poverty, combined with a lack of polluting industries, has saved the Red Sea from the depredations inflicted on the Arabian Gulf. The sea is pollution-free, except around major urban centres and the offshore oil fields in the Gulf of Suez.

Divers who have visited the Red Sea claim that its coral reefs are among the most outstanding in the world. But other than Jordan and Egypt, none of the countries of the region has developed tourism. If developed with sensitivity, tourism could bring needed foreign currency to their economies.

The Red Sea as history

With the opening of the Suez Canal in 1869, the Red Sea was transformed into an important commercial crossroads: the canal provided access into the Mediterranean and European markets. Some 20,000 merchant ships and smaller tankers sail its waters, going to and from the Persian Gulf and Asia every year – a full 15 per cent of all international shipping.

With the ships have come fish as well, migrating from the Red Sea into the Mediterranean. Since the canal opened, over forty different species of Red Sea fish have taken up residence in the eastern Mediterranean. There is even a special name for these

fish: Lessepsian migrants, after Ferdinand de Lesseps, the French engineer who built the canal.

The Red Sea is long, narrow and deep. The sea, one of the warmest and saltiest on earth, is 2,000 km long and averages 2,000 m in depth. There are practically no continental shelves; its shallow coastal-waters drop off steeply. Fishing is limited to coral reef areas, intertidal flats and islands.

The Red Sea, however, has inestimable value as a research laboratory for marine science. It is, as one researcher put it, "an ocean in the making". It is one of the youngest sea systems on earth and of immense interest to marine biologists and geologists. "Physical oceanographers also consider the Red Sea Basin, with its peculiar physiographic and boundary conditions, to be unique," explains Makram Gerges, Programme Officer for UNEP. "With these features – a semi-enclosed sea with deep basins and steep slopes – we consider it an excellent natural physical model for geophysical fluid-dynamic studies." Due to the semi-isolation of its bottom waters, the sea is filled with unique and endemic species of fish and plants. Because the sea's coastlines have not been developed and urban centres are few, most of the region's marine communities are intact and undisturbed.

Population

The number of people living along the shore of the Red Sea is not known. But rough estimates put it at no more than five million. Urban centres are scattered, with hundreds of kilometres of barren sand-dunes between them. Still, there are some important urban areas on the sea: Port Sudan and Jiddah in the south, and Ghardaqa and Suez in the north. Along the Gulf of Aden three more urban centres are found: Djibouti, Aden, and Al-Mukalla.

The main reason the area has been avoided by development is an acute lack of fresh water. Saudi Arabia now extracts its drinking and municipal water from the sea with the help of giant desalination plants, and Jiddah is growing and prospering as a centre for commerce and government, one of the few cities along the sea to do so. Most of the towns found along the Red Sea are little more than outposts in a sea of sand.

Resources

Resource exploitation is not a widespread problem, for the simple reason that there are few people around to exploit anything. Coral reefs are undamaged except in the oil fields of the Gulf of Suez in the north. Mangroves – pushing their northern-most limits – are troubled more by grazing camels than people. In a few areas, mangroves are a valuable source of building materials, fodder and fuelwood. But exploitation is local and limited. Only one stand of mangroves, along the southern Saudi Arabia coast, has been severely damaged. These were simply over-grazed by camels and goats.

The nine species of seagrasses found in the Red Sea are in relatively healthy condition. Coastal dredging along the Saudi and Egyptian coastlines has ruined seagrass habitat, but again, the effects are localized.

Coral reefs flourish in the Red Sea. There are over 150 species of coral in the northern and central sections of the sea. It has been estimated that the standing crop of fish on Red Sea reefs is 10–15 times as productive as the North Atlantic. Most reefs are in good condition, thanks again to low population densities and the mostly artisanal nature of Red Sea fisheries.

Metalliferous muds, rich with metals, are found on the deep seabed, midway between Saudi Arabia and the Sudan. When geologists estimated that the muds could contain two million tonnes of zinc, 500,000 tonnes of copper, 80 tonnes of gold and 4,000 tonnes of silver, these two countries formed the Saudi–Sudanese Red Sea Commission in 1974, in a bid to exploit the mineral resources of the seabed. Despite research investments of over $100 million, mining has still not commenced. The technology needed to extract valuable metals from such depths has not developed as fast, nor proved as economic, as previously thought. The Commission, however, insists that commercial mining operations should begin in the early 1990s.

Pollution

With only a handful of cities of any size along the sea, municipal and industrial wastes pose few problems to the Red Sea's ecology. Jiddah has a sewage treatment network, so wastes are not dumped raw into coastal waters. Port Sudan lacks any real treatment, but sewage is swept away by currents and dispersed. Most of the other small

towns have no sewage treatment plants; wastes are dumped into coastal waters. However, the effects of municipal wastes on coastal ecosystems are thought to be minimal. Except for petrochemicals, there are few industries along the entire coastline.

The one blot on the Red Sea is oil pollution. Nearly 100 million tonnes of crude oil are transported through the Gulf of Aden and Red Sea every year. But most of the oil pollution is concentrated around the oil fields in the Gulf of Suez, in Egyptian waters. Tarballs and floating slicks are common in this part of the region. How much oil is spilled into the Gulf of Suez from offshore drilling is not known, but fouling of beaches is extensive. "Some beaches along the Gulf of Suez and its islands are already oiled beyond recovery," states Dr Youssef Halim, of the Department of Oceanography at the University of Alexandria in Egypt. Reefs in this region have been damaged from oil pollution, as have seagrass beds.

There is tarring of Saudi beaches, since prevailing winds and currents sweep some oil down the coast. Oil pollution is also present in the Gulf of Aden, as ships de-ballast and clean tanks before entering the Red Sea.

There is another potential source of pollution to the Red Sea: the possible Saudi–Sudanese exploitation of metalliferous muds on the sea bottom. If mining commences in the early 1990s, the disposal of sludges and muds from this massive operation could pose real problems, especially if the wastes are merely dumped into coastal waters or spread out over the open sea. The Red Sea Commission claims that waste disposal from the mining has been considered and no serious damage will be done to the sea's near-shore ecology. There are plans that the worst of the wastes will be landfilled in specially-prepared desert repositories.

Fisheries

Fishing in the Red Sea is mainly still a small-scale, artisanal activity. South Yemen's fishing fleet, for example, consists of 1,000 small *sambuks* with outboard motors. A beach seine fishery also exists for immature sardines and anchovy. Ethiopia's fleet, at last count, contained 130 boats, but only 22 were motorized, and more than half were not sea-worthy. Sudanese fishermen operate out of small dugouts or canoes and use hand lines to catch reef fish like rock cod, red snapper, coral trout and emperors.

Saudi Arabia's Red Sea fishery is not nearly as developed as its Arabian Gulf operations. Artisanal fishermen use small dugouts or planked canoes and fish close to shore. However, the government recently formed a company aimed principally at exploiting the shrimp fishery for export to Japan. New fishing harbours are also being built along the Saudi coastline.

Egypt operates around 75 trawlers in the Gulf of Suez, harvesting mostly horse mackerel, Indian mackerel, round herring, sardines and shrimp. In the Gulf of Aden, Somalia and North Yemen have instituted small-scale trawling operations.

According to the FAO, the total take of fish and shellfish from the Red Sea and Gulf of Aden is small – amounting to only 145,000 tonnes in 1981 (about average for the past decade). Tuna are not exploited much, but estimates of their potential annual yield have been set at 20,000 tonnes.

South Yemen has developed a deep-sea lobster fishery over the last decade and now yields about 300 tonnes of lobster tails a year for the export market. But recently, catches have fallen dramatically and government officials fear over-harvesting may be the cause. In an effort to give stocks a chance to recover, South Yemen has limited the number of lobster boats to four during the season and no fishing of egg-bearing females is permitted.

Conservation

With limited human impact in the southern part of the Red Sea, it is not surprising to learn that marine turtles are thriving there. Researchers along the Sudanese coast report the highest hawksbill turtle nesting densities ever observed. Thousands of them are also found on Saudi Arabia's deserted offshore islands.

Hawksbill and green turtles nest on deserted beaches along the coast of South Yemen. Ithmun and Sharma beaches are counted among the most important nesting sites in the world for green turtles.

Exploitation of turtles is very low, and there are plenty of good nesting beaches along the southern part of the Red Sea and the Gulf of Aden. Still, no conservation legislation exists to protect these important nesting sites.

Parks and protected areas are now being set up in the region. For example, Egypt has designated the exquisite coral reefs of Raas Mohammed, at the lower tip of the Sinai Peninsula, as a

protected area. Surveys are being carried out in efforts to establish a network of protected parks and reserves in other countries as well. It is hoped that Sudan's first marine national park will be set up on the Sanganeb atoll, northeast of Port Sudan. Saudi Arabia has undertaken a survey of important shallow-water marine habitats in co-operation with IUCN, the Red Sea and Gulf of Aden Environment Programme (PERSGA), and UNEP. As the Action Plan evolves, more marine conservation work will be possible.

The Red Sea and Gulf of Aden Environment Programme (PERSGA)

After several preliminary meetings the governments of the region met in Jiddah in January 1981 to approve the Action Plan for the Conservation of the Marine Environment and Coastal Areas of the Red Sea and the Gulf of Aden. The Regional Convention was adopted a year later by six of the region's states, along with a protocol to combat pollution from oil spills and other harmful substances.

Since many of these countries were starting virtually without any relevant institutional contact points, one of the first priorities was getting the member countries to set up a network of scientific institutions capable of co-ordinating the work. A Secretariat for PERSEA was established in Jiddah, under the auspices of the Arab League Educational, Cultural and Scientific Organization (ALESCO).

Building institutional support for the Action Plan was not easy. South Yemen, for example, did not have a marine research centre until 1983, when one was built with assistance from UNESCO and the Islamic Development Bank. North Yemen still does not have a functional marine laboratory, but intends to establish one.

Meanwhile, as part of the Action Plan, Djibouti, Somalia and South Yemen have agreed to establish a "sub-regional response centre" for combating oil spill emergencies in the Gulf. The centre is being set up with financial assistance from IMO and other donors.

ALESCO will also convene intergovernmental expert groups to draw up additional protocols aimed at controlling pollution from land-based sources, limiting pollution from the exploration and exploitation of the seabed, forging scientific and technical co-operation in the field of marine science, and promoting the sustainable utilization of the marine environment.

So far, baseline studies of pollution sources to the marine environment have been carried out and inventories of marine resources completed. There is a wealth of basic oceanographic data on the Red Sea; Egypt has been studying the physical and chemical properties of the sea since the 1930s. As more data accumulate, the countries of the region will be better prepared to implement coastal zone management plans. More through fortune than planning, the Red Sea has been spared from much of the coastal pollution inflicted on other seas. Hopefully, the Action Plan will help the countries of the region to keep it that way.

13. What Future for Regional Seas?

With coastal resources over-exploited and more people pressing along the coastlines in the developing world, we are courting disaster on a monumental scale. Although some fifty countries now have coastal-zone management plans, only a handful actually have management regimes that are in place and working. The majority of developing countries, however, have not even got to the planning stage. For instance in Kenya, of all the NGOs and community organizations formed in the country over the past several decades to combat environmental and resource degradation, not one exists which deals with coastal-resource problems and the needs of poor fishing communities.

This largely unnoticed crisis must begin to receive the same kind of attention accorded the loss of tropical rainforests and agricultural land, and the problems of desertification. Even some of UNEP's regional-seas programmes are in danger of neglect, as other, more immediate economic concerns head government agenda.

Resource management in general seems to be regarded as an issue secondary to economic development. This must change. Integrated planning of resource use and the implementation of viable coastal-zone management programmes are absolutely fundamental if we are to be able to preserve even a fraction of the rich diversity of plants and animals found in estuaries, mangrove forests, seagrasses and coral reefs. And most importantly, workable management regimes for critical coastal-zones, which involve the integration of land and sea concerns, will help provide the world's poorest billion people with sustainable livelihoods.

In order to ensure that coastal people are able to make a living from the sea, land management must merge with coastal-zone management strategies. The two must be seen as integral parts of one system. This is one of the main lessons that can be learned from UNEP's regional-seas programmes over the past 15 years.

Throughout much of the developing world, efforts at managing resources often have to contend with continually-expanding populations. The tension between human numbers and the resources needed to sustain them will become more acute in the remaining years of the twentieth century, and beyond. At current growth rates, one billion people are added to the world's population every 11 years: sometime during 1998 there will be six billion people in the world. Though fertility rates are declining slowly, the momentum of population growth ensures that at least another 2.2 billion people will be added to the planet between 1988 and 2025. The figure could be as high as 4 billion. If current trends are not reversed or at least slowed down, global population could be close to 14 billion by the year 2100.

Over 90 per cent of this growth is taking place in the developing world. Between now and the turn of the century, the population of industrialized countries will grow by only 56 million, or 5.2 per cent, while that of developing countries will grow by over 900 million, or 24.6 per cent.

It is the failure to deal with population growth, together with resource depletion, that is the underlying cause of the malaise that affects coastal areas throughout the developing South. Until the realities of population growth, uneven distribution and resource management are addressed appropriately and with vigour coastal resources will continue to deteriorate.

Although much remedial work is going on, most of it is local and small-scale. Still, UNEP's regional-seas framework offers one of the best opportunities for participating governments to forge national, as well as regional, coastal-zone management regimes. Within this framework, it is imperative that the following measures be taken during the 1990s and beyond:

1 Third World countries bordering on seas must begin to develop national strategies which integrate population policies with resource management. The two issues are inextricably linked and it makes little sense to separate them.
2 The governments which have joined together in regional-seas programmes under UNEP should devote much more attention, personnel and money to coastal-zone management.
3 Coastal-zone management must be integrated with land management if any progress is to be made in solving the coastal

effects of the following poor land-use practices: uncontrolled logging of watersheds, stripping coastal areas of vegetation for establishment of agricultural land, mining in coastal zones.
4 Within the context of coastal management, it is important that local communities and NGOs be given a strategic role in conserving resources and carrying out management programmes. Without active local support for conservation and management plans, they will never succeed.
5 Environmental education must include coastal zone problems and concerns. Without building up commitment to conservation through basic education, future generations may well repeat the mistakes of the past.

The extent to which these measures are undertaken during the next decade will determine, to a great extent, the kind of world future generations will live in. We have the chance to make a crucial difference in the quality of life for billions of people born next century. The consequences of our failure could be unimaginable.

More immediately, corrective steps must be taken now to halt population growth and coastal-resource loss so that millions of poor people will have the ability to live "sustainably", that is to say, in harmony with their environment to the extent that they do not destroy the resources future generations require. The aim of coastal management should be to give people dependent on the sea a "sustainable present". Future needs will then be easier to meet.

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