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NATIONAL REPORT

on

Coral Reefs in the Coatal Waters of the South China Sea

CAMBODIA

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INTRODUCTION

Marine habitats in Cambodia play a very important role in the national economy and the balance of regional and global environment ecosystems. Marine habitats include coral reefs, inundated forests (mangrove forests), and seagrass. In Cambodia, these habitats primarily fall under the management of the Department of Fisheries with Article 1 of the Fishery Law stating that "*Fishery resources comprise of live animal and vegetable reproduced itself and abided in the fishery domain*", and that the "*Marine fishery domain extends from the coastline to the seaward border of the outer economic zone of the People's Republic of Kampuchea*" (DoF, 1990). This coastal zone is 55,600sq. km and includes 69 islands and 28.065sq. km of coral reefs (DoF, 2004). Administratively, the coastal zone includes the two provinces of Koh Kong and Kampot, and the two municipalities of Sihanoukville and Kep.

From a functional perspective, Cambodia's coastal zone can be conceptualised as being made up of two inter-related systems - ecological and socio-economic systems. The ecological system includes the physical, chemical and biological environmental parameters that provide natural resources, sequesters pollutants, and offers fundamental life-support functions (e.g. clean air and water) for humans and other living organisms. The socio-economic system depends upon many functions and products of complex ecological systems. Cambodia's marine ecosystems are abundant in living resources, but have limited capacity to provide fish, timber, coral reefs, seagrasses, clean water and other goods and services to meet the demands of socio-economic development. Given that the production capacity of the ecological systems is limited, it is not surprising that the final demands by society, and new opportunities for multiple uses, are the source of increasing conflicts arising within Cambodia's coastal zone.

Coral reefs, in particular, are critical habitats for a diverse range of resident and migratory species, especially endangered and vulnerable species. The structure of a reef provides shelter and food for many types of plants, fish and invertebrates (Nelson 1999). Many Cambodians are also reliant on coral reefs for livelihood and nutrition, with much demand placed on the many commercially valuable species dependent on these habitats. Additionally, these areas provide much potential for the development of eco-tourism in the future. Until recently, little was known about the status of Cambodia's coral reefs due to minimal research and lack of monitoring in this region. However, our knowledge is now increasing with studies carried out by the Danida funded project on Environmental Coastal Zone Management in Cambodia implemented in the Provinces and Municipalities of Kep, Sihanoukville, and Koh Kong Province (Nelson 1999), the National University of Singapore (Chou *et al.* 2003), and through the UNEP/GEF South China Sea Project.

PHYSICAL FEATURES

Due to limited research resources, information about the physical characteristics of Cambodia's marine environment is almost completely lacking. However, some general parameters have been recorded such as sea surface and air temperature, depth, turbidity and/or visibility. Usually, visibility is very low near the mainland and high adjacent to offshore islands. Visibility can reach up to 20m in waters surrounding the offshore islands.

CORAL REEF DISTRIBUTION

Coral reefs in Cambodia are mostly distributed as fringing reefs along parts of the mainland, particularly headlands, and around many islands (Figure 1). Corals near to shore are those adapted to living in turbid environments, while further offshore a wider diversity of species is found (Nelson, 1999).

BIODIVERSITY

Coral reefs are some of the most biologically rich ecosystems on earth, however the exact number of species found in Cambodian waters is yet to be determined due to limited research in this region. To date, at least 70 species of corals in 33 genera and 11 families have been identified during a brief

survey at Koh Tang near Sihanoukville (Nelson, 1999). A review conducted by the Fisheries Component of the UNEP/GEF South China Sea Project found 520 marine fish species from 202 genera and 97 families, with an estimated total stock of marine fish of 50,000 metric tonnes (Ing, 2003). The total number of coral reef associated species in Cambodia is largely unknown (Table 1).

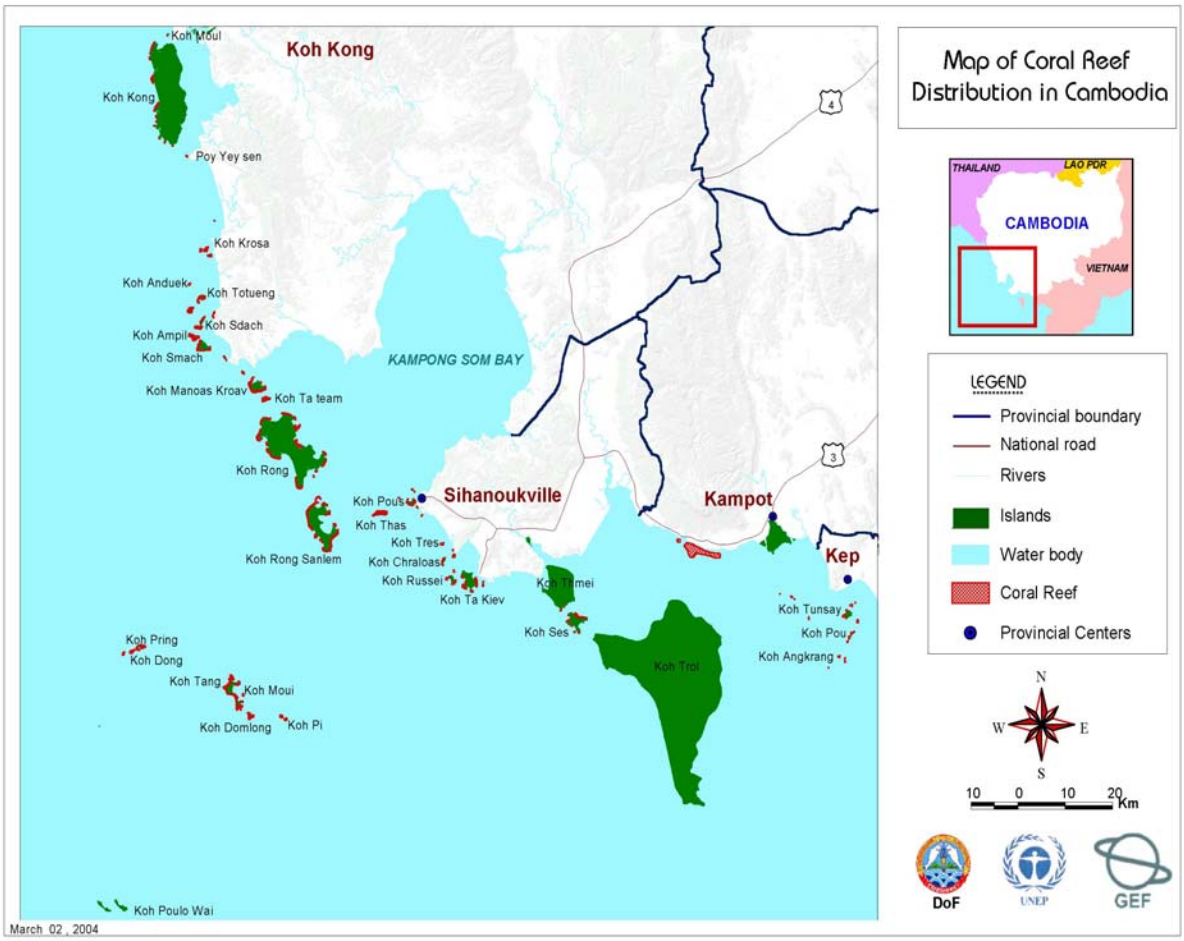

Figure 1 Map of Reef Distribution in Cambodia.

Table 1 Estimated Number of Species for Major Groups of Marine Biota.

Marine Biota	Number of Species	References
Hard Corals	70	Nelson, 1999
Soft Corals	17	Nelson, 1999
Marine Fish	520	Ing, 2003
Echinoderms	21	Ing, 2003
Crustaceans	50	Ing, 2003
Molluscs	250	Ing, 2003
Marine Turtles	5	Ing, 2003
Marine Mammals	12	Ing, 2003
Seaweeds	16	Ing, 2003
Seagrass	9	CZM, 2002

STATUS OF CORAL REEFS

In 2003, the Department of Fisheries conducted a coral reef baseline survey in Cambodia using standard methodologies as outlined by two global coral reef monitoring agencies, the Global Coral Reef Monitoring Network (GCRMN) (http://www.gcrmn.org) and Reef Check (http://www.reefcheck.org.). These methods employ rapid assessment techniques, which enable quick and reliable assessment of coral reef health. Reef Check was used for the survey of reef fish, invertebrates, and general reef condition. The GCRMN Line Intercept Transect Method, which has been widely used within the Asia-Pacific region to survey coral reefs, was used to provide detailed quantitative benthos assessment. Seven sites including the Koh Kong Islands, Koh Sdach Islands (Koh Kong Province); Koh Rong, Koh Rong Sanleom, and Koh Takiev Koh Tang island groups (Sihanoukville); and the Koh Tunsay island group (Kampot Province and Kep Municipality) were selected as monitoring sites. The data collected by monitoring activities provided a figure on coral reef status in the coastal waters of Cambodia.

Status of Reef Benthos (especially corals)
Based on the GCRMN range, Cambodia's coral reefs are in fair to good condition, with coral cover ranging from 23.1% in the Koh Sdach island group of Koh Kong Province to 58.1% at Koh Takiev island group of Sihanoukville. Dead coral was observed to range from 0% in Prek Ampil to 44.9% per square meter at Koh Rong. However, this may not be a reflection of the status of all reefs in Cambodia, as surveys were not carried out in areas of intensive seaweed farming. Reports from the Koh Pouh area indicate that coral reefs have been heavily impacted on by seaweed farming activities in that area, leaving most reefs in very poor condition (Mam 2001). Little other benthos was observed at most of the sites, accounting for only 2.2% of total cover at the Koh Sdach island group. The highest percentage of other benthos was observed in the Prek Ampil area of Kampot Province, accounting for approximately 5.6% of total cover (Table 2).

Algal cover was not very dominant at most sites, and no algae was observed on the reefs of Koh Takiev. The highest percentage cover of algae (17.5%) was observed on the reefs of the Koh Sdach island group of Koh Kong Province. The coverage of sand and rock is considered high, accounting for 15.4% of total cover at the Koh Sdach island group and 40% at Prek Ampil (Table 2).

Table 2 Percentage cover of benthos types on selected coral reefs in Cambodia.

Benthos	Koh Kong	Koh Sdach	Koh Rong	Koh Takiev	Koh Tang	Prek Ampil	Koh Pouh
Live Coral (%)	47.4	29.3	23.1	58.1	38.3	53.8	41.0
Dead Coral (%)	29.6	35.6	44.9	0.6	13.1	0.0	19.2
Other Benthos (%)	4.2	2.2	5.1	3.1	4.2	5.6	2.4
Algae (%)	1.6	17.5	0.6	0.0	0.6	0.6	10.1
Abiotic (%)	17.2	15.4	26.4	38.1	43.8	40.0	27.4

Only Koh Rong and Rong Sanleom of Sihanoukville have been monitored over time. The first survey was conducted in 1998 by the Daninda funded Environmental Coastal Zone Management (CZM) project (Nelson 1999). In 2001, the site was surveyed by Wetlands International and the CZM project (Mam 2001). The two final surveys were conducted by the Department of Fisheries with the support of the UNEP EAS/RCU[3] in 2002 and 2003 for trainings on diving, reef check, and the GCRMN Line Intercept Transect (LIT).). Although no exact positions of the transects were plotted by GPS for the last two monitoring programmes, it is believed that all surveys, including the last two, were conducted at very similar locations, although at different times of the year.

The percentage of live coral cover did not change significantly from 1998 to 2003 (Figure 2). The initial survey in 1998 found that live coral accounted for 20% of the total reef cover at this site. The percentage cover was observed to increase slightly to 26.25% in 2002, before dropping to 23.12% in 2003. However, regular annual monitoring is needed in order to detect any trends over a larger temporal scale.

[3] *East Asian Sea Regional Coordinating Unit.*

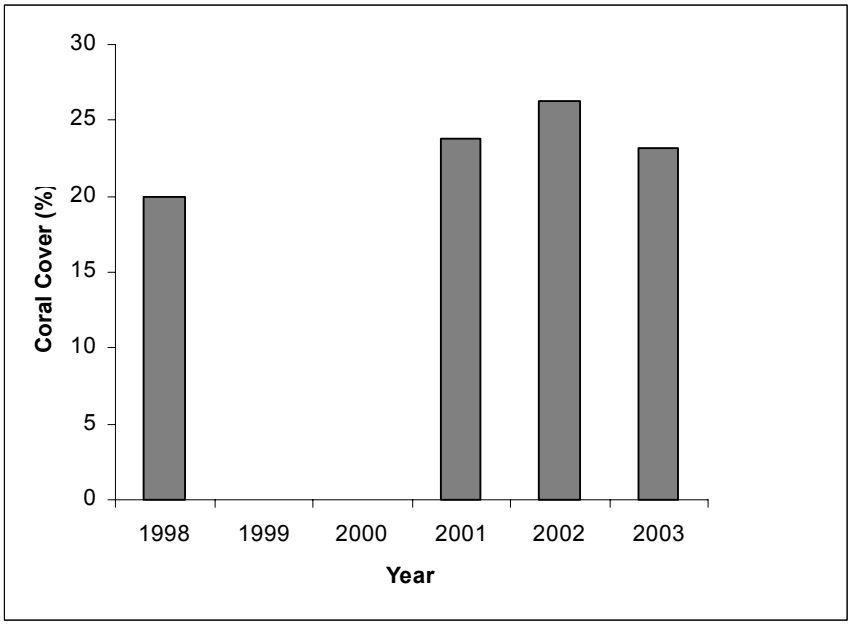

Figure 2 Trend of Live Coral Cover in Koh Kok (Koh Rong and Rong Sanleom) of Sihanoukville.

Status of Reef Fish

Based on the ReefCheck method, about 17 groups of reef fishes and invertebrates have been recorded at seven locations. They include butterfly fish, sweetlip, snapper, barramundi cod, grouper, humphead wrasse, bumphead parrotfish, other parrotfish, moray eel, banded coral shrimp, pencil urchin, sea urchin, sea cucumber, crown-of-thorn star fish, giant clam, triton shell, and lobster. The following table shows the number of each animal group per 100 square metres. Reef fish indocators are found at nearly all sites except Koh Pouh of Kep Municipality. Sweetlip, barramundi cod, moray eels, lobster, triton shell, and banded coral shrimp were rarely present at any of the sites. The lack of banded coral shrimp may not be a true reflection of their actual numbers, but a consequence of their small body not seen by researchers (Table 3).

Table 3 Site Summaries of Major Fish Groups per 100m^2.

Major Fish Group	Koh Kong	Koh Sdach	Koh Rong	Koh Takiev	Koh Tang	Prek Ampil	Koh Pouh
Butterflyfish	1.63	0.47	1.75	0.75	1.25	7.00	0
Sweetlips (Haemulidae)	0	0.33	0	0	0	0	0
Snapper (Lutjanidae)	0.13	0.10	6.50	1.75	0.42	0	0
Barramundi Cod (*Cromileptes*)	0	0.07	0	0	0	0	0
Grouper	2.63	0.23	2.25	0.25	1.67	0	0
Humphead Wrasse		0.47			0.33	0	0
Bumphead Parrotfish	0.13	0.07		1.25		0	0
Other Parrotfish	4.38	2.37	0.75	2.00	15.33	0	0
Moray Eel					0.08	0	0
Banded coral shrimp (*Stenopus hispidus*)	0	0	0	0	0	0	0
Diadema urchins	*5.0*	17.0	213.0	17.0	129.8	7.0	4.3
Pencil urchin (*Heterocentrotus mammilatus*)	0	0.4	0	0	0.1	0	0
Sea cucumber (edible only)	0	0.1	0	0	0	0	0
Crown-of-thorns star (*Acanthaster*)		0.1	0.8				
Giant clam (*Tridacna*)	2.0	1.2	0.3		0.3		
Triton shell (*Charonia tritonis*)		0.2					
Lobster							

THREATS

There are many anthropogenic impacts causing damage to the coral reefs of Cambodia. These include destruction of coral from anchors, dynamite fishing, discarded fishing gear, and seaweed farming. Monitoring data indicates the status of damage to coral reefs at the site level (Table 4).

Table 4 Anthropogenic damages to the coral reefs in Cambodia.
(General reef condition: None=0, Low=1, Medium=2, High=3)

Location	Koh Kong	Koh Sdach	Koh Rong	Koh Takiev	Koh Tang	Prek Ampil	Koh Pouh
Coral damage: Anchor	0.9	0.2	0.0	0.0	1.4	0.0	0.3
Coral damage: Dynamite	1.8	0.7	0.0	0.0	2.4	0.0	1.3
Coral damage: Others	0.5	0.7	0.0	0.3	1.2	0.0	0.3
Trash: Fishing gear	0.4	0.3	0.0	0.0	0.7	0.0	0.8
Trash: Others	0.0	0.3	0.0	0.0	0.2	0.0	0.3

Destructive Fishing Methods

There is little data on over-fishing and destructive fishing practices. Data from ReefCheck surveys and other studies indicate however, that dynamite fishing is a major threat to coral reefs in Cambodia (CZM 1999). Only one interviewee admitted to using dynamite, and claimed that a profit of up to 14.7 million riel per day was possible (CZM 1999). Information about cyanide fishing is equally lacking but thought to be practiced using cheap chemicals from Viet Nam (US$36/kg). It has been reported that groupers and cod are caught using this method for grow-out in cages at Tumnup Rolork and Stoeng Hav (CZM 1999).

Coral collection, an important threat from 1995 to 1997, is declining because the Fisheries Department has tightened controls and confiscated coral from vendors. More recently, there has been a reduction in the collection of coral due to the prohibition of this activity by the Provincial Government and the declining value of coral for use in the curio trade.

Anchor and Trawler Damage, Others Kind of Damage (divers, trampling, etc)

Anchor damage is apparent on most reefs in Cambodia, largely as a consequence of a lack of mooring buoys and low-level awareness amongst fishermen of the damage boat anchors do to reefs. Tourism based on Cambodia's coral reefs is limited, such that the impacts from tourist boats, divers and trampling are limited. However, this could be a potential threat in the future with the development of the tourism industry.

The introduction of seaweed cultivation to Cambodia in 1999 is also contributing to the destruction of once healthy corals. Seaweed cultivation is a lucrative business attracting significant foreign investment in Cambodia. This activity is particularly prevalent in Kampot Province. The destruction of corals associated with seaweed culture is a consequence of local people cultivating seaweed directly on reefs, with damage caused by trampling or discarded trash. In some areas, corals are now under severe threat from seaweed farming and are disappearing from many sites. The majority of coral communities on Koh Pouh where intensive seaweed farming takes place have been converted to rubble due to unsustainable farming practices (Mam 2001).

Development Impacts (ports, airports, dredging, etc)

There are many construction activities taking place in the coastal areas of Cambodia, but their impacts on coral reefs are largely unknown. Construction activities, including commercial port expansion, five-star hotel construction, and golf course development are particularly prevalent in Sihanoukville municipality. Even with the Government's policy of conducting Environmental Impact Assessments (EIAs), no EIAs were conducted prior to recent development activities in this important coastal municipality.

Coastal agriculture and development have contributed to the damage of coral reefs in Cambodia as a result of increased sedimentation and land-based pollution. Without any prompt mitigation, large quantities of agricultural run-off and soil will continue to be discharged from coastal rivers to areas of Cambodia's coral reefs each year. The sediment and nutrient loads of Cambodia's coastal rivers are largely unknown, but increased turbidity has been reported for most coastal water areas.

Coral Bleaching
There is little data available on coral bleaching in Cambodian waters. However, similar to other places in the region, coral bleaching did occur in 1998. Bleaching from the 1997-1998 event affected Cambodian reefs, with one survey indicating that 80% of corals in Sihanoukville bleached during 1998 (Burke *et al.* 2002). Nelson (1999) also noted that bleaching occurred elsewhere in Cambodia, including other sites on Koh Rong Sanleom, Koh Rong, Koh Tang, Koh Damlong, and Koh Thas.

Outbreaking or Invasive Organisms
Crown-of-thorns starfish were abundant in 1998. At one site on Koh Tang, crown-of-thorns starfish were abundant, with more than 20 large starfish observed per $100m^2$ (CZM, 1999). However, recent surveys have reported low densities, with only one animal observed at some sites and none found in others. Of more concern are the numbers of *Diadema setosum*, with 218 observed per $100m^2$ in Koh Rong and Rong Sanleom.

Potential threats to coral reefs
There are many potential threats to coral reefs in Cambodia. *Reefs at Risk in Southeast Asia* indicated that the main threats are from coastal development, marine-based pollution, sedimentation, over-fishing, and destructive fishing (Burke *et al.* 2002). Over-fishing is major threat to all reefs in Cambodia, and while destructive fishing is also a potential threat, it is unknown how many reefs are at risk.

Coastal Development
At present, coastal development is only a high threat to a relatively small percentage of reefs in Cambodia. However, in the future, as the amount of development along the coastline increases, the percentage of reefs at risk from this potential threat will also increase if strict environmental impact assessments and mitigation are not carried out.

Marine-Based Pollution
The majority of reefs are considered to be only at medium to low threat from marine-based pollution. However, many reefs would be at high risk in the case of a catastrophic event such as an oil spill, as the government is insufficiently prepared for such events.

Sedimentation and Nutrient Inputs
Burke *et al* (2002) considered the threat to coral reefs from sedimentation to be low. However, much land clearing, for both timber and agricultural purposes, occurs upstream of rivers and estuaries, and as this continues in the future, the threat of sedimentation to coral reefs may increase.

Over-fishing
Over-fishing is considered one of the greatest threats to coral reefs in Cambodia, with all reefs at high risk. It is thought some reef fish and invertebrates are now locally extinct, while populations of others have been reduced significantly. While exact figures are unavailable, it is certain that increasing populations in coastal areas are placing increasing demand on fisheries resources, due to a high level dependence on them for food and income.

SOCIO-ECONOMY AND RESOURCE USES

Socio-economic status
Population
A population census conducted in March 1998 showed a population of 11.4 million, with approximately 85% living in rural areas. In coastal areas, populations ranged from 28,677 in Kep to 527,904 in Kampot Province (Table 5). The average household size ranged from 5.0 people in Kampot province to 5.5 people in Sihanoukville, with females heading 24.8% of households in coastal areas (Ministry of Planning 1999).

Table 5 Population size and density of Cambodia and its coastal areas.

Location	Areas (km^2)	Population	Women (% total)	Density ($/km^2$)
Cambodia	181,035	11,426,223	51.8	64
Kampot	4873	527,904	52.1	108
Koh Kong	11160	131,912	48.7	12
Sihanoukville	868	155,376	50.5	179
Kep	336	28,677	51.0	85

Source: *Ministry of Planning - General Population Census of Cambodia, 1999.*

Cambodia's population is growing at an estimated annual rate of 2.4% (Ministry of Planning 1999). The population is mostly comprised of people of Khmer decent (90%). The main ethnic groups are the Cham, Vietnamese, Chinese (also sometimes called Khmer-Chinese), and others from different hill tribe groups. It is estimated that 95% of the population speak the Khmer language. The main religion in Cambodia is Theravada Buddhism, while the Cham are Muslims. There are no estimates of the distribution of ethnic groups in coastal areas, however, the proportion of Cham people on at least part of the coastline is relatively high (Ministry of Planning 1999).

Occupations

There is a scarcity of clear information about the occupations of Cambodia's coastal people. However, studies suggest that while most households depend on several occupations and sources of income, fishing is dominant, being the main occupation in six villages of Sihanoukville, six villages of Kampot, five villages of Koh Kong, and three villages of Kep. (Carl Bro International a/s 1999).

Migration

There was considerable rural to urban migration in the years immediately following the 1993 elections, as villagers searched for better employment opportunities in the largely urban private sector generated by the influx of international development assistance (UNICEF 1996). Coastal migration is still occurring with 29.6% of men and 15.6% of women relocating in search of employment (Table 6). There has been substantial migration into the coastal areas, particularly Koh Kong province, over the last 20 years. Table 6 highlights the percentage of distribution of migrants by reason for migration and gender.

Table 6 Migration into Cambodia's coastal zone by reason and gender.

Reason for migration	Both Sex (%)	Males (%)	Females (%)
Total	100	100	100
Transfer work	11.0	15.2	3.2
To search for employment	31.0	29.6	15.6
Education	2.5	2.8	1.6
Married	11.4	12.2	9.3
Family moved	53.9	28.9	56.2
Natural calamities	2.7	2.6	3.0
Return after replacement	6.0	5.3	6.1
Other reasons	5.2	3.6	5.1

Source: *Ministry of Planning (1999*).

Education

According to the 1998 Census, 61.2% of Cambodia's literate population had not completed the primary level of education. In Kampot, Koh Kong, Sihanoukville, and Kep, the percentage of the population yet to have completed education at a primary level was 65.9%, 58%, 56% and 68%, respectively. A small percentage (1.45%) of Cambodia's literate coastal population had acquired literacy without passing any grade or class (Ministry of Planning 1999).

Gender disparity is greatest among the poor, but it is also significant among the richest 20% of the population. Boys and girls have fairly similar school enrolment rates until the age of 10. By 15 years of age, male enrolment is 50% greater than that of girls, and by 18 years of age, male enrolment rates are nearly three times as large as female enrolment rates. This means that initially, parents send both their sons and daughters to school, but take the girls out of school after a couple of years. Household survey data suggest that more than 60% of children drop out of school because they have to help the family with household and market work. Furthermore, parents are often reluctant to send their girls to secondary school as they would be required to travel long distances or stay away from home (Ministry of Planning 1999).

Income level

The average per capita income of Cambodia in 1998 was 79,355 Riels or US$20.80 per month. In coastal zones it is slightly less, with the average income per person per month reported at US$19.50. This level was higher than that in the Tonle Sap zone (US$17.80) and mountain zone (US$18.21), but

lower than in the plain (US$23.09) (Ministry of Planning 1999). General problems faced by some local communities include lack of rice and food, lack of water during dry season, lack of schools and health facilities, lack of capital for productive use, and decline in fish catch.

Fishing conflicts

Small-scale, trawl, and motorised push-net fishers are in conflict over access to inshore areas and fish resources. Trawls often destroy small-scale fishing gear and large commercial operators typically do not pay compensation to local fishers. Small-scale fishers cannot claim compensation as trawling is banned in most inshore areas and the crews of such vessels are usually under the protection of high-ranking military, police, or government officials. There have also been reports of significant variations in the types and levels of taxes and other fees paid by local fishermen. In Koh Kong it has been reported that many fishermen had to pay a monthly fee ranging from R50,000 – 80,000 to the police, army, fisheries officers and village guard, in addition to the annual tax to the Fisheries Office. There are also reports of fishing equipment being confiscated if fishermen did not pay around R50,000 per month to people whose task it was to prevent violation of fishing regulations (Carl Bros International A/S 1999).

Resource uses

The development of Cambodia's coastal zone continues to occur at a rapid pace. While the coastal areas of Cambodia are a prime location for foreign and domestic tourism investment, due to pristine beaches along the coastline and the offshore islands, the primary economic benefit comes from extractive use of its resources. As a consequence, the coastal area is experiencing high immigration rates, second only to Phnom Penh. Concern exists about the unsustainable use of natural resources, particularly those located near the coastline, and the detrimental effect that loss of value would have on many local communities.

Marine resources are vital to the livelihood of many inhabitants of coastal villages, with many people reliant on fishing for their primary source of income. Most fishermen catch fish, shrimp, crab and squid around different islands and headlands, some fishing up to 15km from the village. Much shrimp, crab, crab meat and expensive fish is sold to traders both locally and internationally, with villagers in Koh Kong selling most of the sea products in Thailand. There is seasonal variation in prices which traders are willing to pay for the products, with villagers having no other option but to sell their products to the traders (Carl Bros International A/S 1999).

Many people feel there has been a decline in their standard of living over recent years, with loss of value of marine resources due to significant reduction in fish stocks and declines in fish catch. Many fishermen are dissatisfied or angry about the use of trawling and pushing nets and boats using lights in shallow water because it can damage local fishermen's equipment and also takes away all the small fish and other marine resources (Carl Bros International A/S 1999).

Reef Fish and Fisheries

The most direct use of the coral reef ecosystem is marine fisheries with the Department of Fisheries reporting 42,000 to 45,000 metric tons of non-reef fish and reef fish collected every year (Ing 2003). However, these figures are unreliable and it has been estimated that it could be much larger than the official figure. It is also hard to determine how much of these resources have come from coral reefs. With increasing population growth in coastal areas, increasing demands are being placed on this resource with more people dependent on fish for their livelihoods and nutrition. Reef fish are the most valuable species in both domestic and international markets, and therefore the most targeted species by both legal and illegal fishers.

Reef fish, such as Sweetlips (Haemulidae), Snapper (Lutjanidae), Barramundi Cod (*Cromileptes*), Grouper, Humphead Wrasse and Parrotfish, are the most valuable and targeted marine species. Though, at present, there are no statistical records of these fish. Traditionally fishers catch these species by using trap, gillnet, and hook and lines. These species are collected in all sizes including juveniles. The juveniles and pre-adult fish are collected and ranched in cages along the coast, to be then sold alive to both local restaurants and international markets in Hong Kong, China and Taiwan when they reached commercial sizes.

Tourism
Tourism related to coral reefs seems is limited in terms of infrastructure and activities. Cambodia has very limited resources to develop the marine tourism sector. However, compared to the last few years, more and more tourists are coming to Sihanoukville to see the coral reefs of Koh Thas, Koh Rong and Rong Salem, and even Koh Tang. Diving and snorkelling by foreign tourists in Sihanoukville is also becoming more popular and expected to increase in the future with much potential for further development of eco-tourism in the region. Currently there are three private SCUBA diving centers in Sihanoukville, namely, ECO-SEA, Chez Claude, and SCUBA NATION. Each centre brings about 30-40 divers per month. It is anticipated that the number of divers will increase in the near future when infrastructure and equipment are put in place.

Other Uses
Apart from fisheries and tourism, coral reef resources may play another very important role in scientific research for medical purposes and socio-economic use. However, in Cambodia very limited scientific research has been carried out for medicines or other purposes. In terms of socio-economic use however, most local people who live nearby the reef areas are making their living from the reefs. Most of them are fishers, but some are gaining indirect benefits from the reefs by selling fishing gear and fishing boats.

Collection of corals for souvenirs has also been popular for many years, and even now, though illegal, is still continuing. The main types of corals collected include table corals (*Acropora* spp.), elephant ear corals (*Turbinaria* spp.), deer horn corals (*Porites* spp.). Previously, large amounts of dead corals were collected by high rank military officers for use in the construction of their homes.

MANAGEMENT

Legislations
Existing laws and regulations for coral reef management in Cambodia are insufficient, especially considering the increasing threats to coral reefs in the country. There is no law that explicitly relates to coral reef management, although Cambodia's fisheries law notes the requirement to protect Cambodia's rich marine living resources. Most laws relate to the protection of fisheries rather than coral reefs and there is still a lack of clear policies and regulations for the management of these important resources. The weaknesses in the current system need to be identified and laws amended to provide a sound legislative basis for the protection of coral reefs, while facilitating the development of a transparent legal framework and procedures. Transparency is imperative to reducing the current levels of misuse of authority within the system and ensuring the protection of coral reefs.

Currently, two new legislative tools are being proposed by the Department of Fisheries. These are:

- Royal Decree on the establishment of protected aresa and the conservation of coral reefs and seagrass in Koh Rong and Koh Sdach Group of Islands.
- Sub-Decree on the management of Marine Protected Areas covering coral reefs and seagrass areas.

At the time of writing, the Royal Decree had been submitted to the Consul Minister and was awaiting approval, while the Sub-Decree submitted to the Ministry of Agriculture, Forestry and Fisheries is still in draft form. It is uncertain as to when these legislative tools will be implemented.

It must be recognised that these amendments will remain ineffective unless qualified law enforcement officials, at the local and national level, ensure compliance. Ultimate success is dependent on the awareness of local communities and resource users of laws and regulations and their compliance to the system. Only then will coral reefs be effectively protected by law.

Institutional framework
The institutional framework for the conservation of coral reefs in Cambodia is still rudimentary, possibly as a consequence of little understanding and awareness of the significance and benefits of this habitat amongst stakeholders. Day-to-day management of natural resources and resource use on the coast is primarily the responsibility of the Ministry of Agriculture, Forestry and Fisheries (MAFF), particularly the Department of Fisheries. There are fisheries staff at district and provincial levels responsible for the patrolling and management of commercial and medium-scale marine fisheries, and the protections of critical fisheries habitats such as mangroves, seagrass and coral reefs.

However, there are overlaps of responsibilities among concerned government agencies, particularly Ministry of Environment and Department of Fisheries of the Ministry of Agriculture, Forestry and Fisheries, and between the national and provincial level agencies and departments. The Ministry of Environment is responsible for the management of protected areas and for overseeing environmental protection. This includes the protection of coral reefs, seagrass and mangroves, particularly when they are in a protected area. This overlap does not seem to be problematic for managers on the ground, but needs to be clarified legally. As coral reef management is a shared responsibility between many departments, including the Department of Fisheries, the Provincial Government, and District Government, there are many potential sources of institutional conflict (Chou *et al*. 2002).

Existing institutional frameworks for coral reef management in Cambodia should be reformed to ensure the protection of coral reefs from the national down to the local level. In compliance with the *Fisheries Master Plan*, empowerment of local communities is required to enable community participation in management. Providing resource users with an opportunity to contribute to management decisions, gives the community greater ownership over, and responsibility for, marine areas and resources. With the rapid development of most coastal areas, it is important that local communities have a sound knowledge of the importance of coral reef areas and the potential impacts of economic activities, particularly tourism.

Marine Protected Areas (MPAs)
Legally, only one marine protected area has been established, namely the Ream National Park. Originally, it was designed to protect mangrove forests, with no consideration of adjacent coral reef areas. However, the park was later extended to include some coral reef area. The first project was community-based fisheries management at Ream National Park, which was a demonstration project funded by ADB in 1999. This project involved the development of community participation in fisheries resources management at the site. Regulations at the community level were developed, and participatory enforcement was initiated.

Currently, the Department of Fisheries is proposing to establish another MPA around two groups of islands, specifically the Koh Kong island group and Koh Sdach. The area of this proposed MPA is 712 km^2. The Department of Fisheries realises the importance of establishing these areas and their significance to the sustainable management of marine fisheries in Cambodia.

Monitoring
The Government of Cambodia is committed to ensuring the effective management and conservation of the countries marine resources. Therefore, information on the extent and present health of coastal and marine ecosystems, including coral reefs, is needed to provide the basis for a long-term management strategy. Monitoring and assessment is a critical element of marine resource management aimed at achieving the sustainable use of Cambodia's coral reefs and associated resources. In the past there has been no coral reef monitoring programmes in Cambodia due to a lack of funding and resources. However, several organisations/programmess have supported coral reef survey activities in Cambodia since 1998. These include:

- *Environmental Coastal Zone of Cambodia (CZM)*
  This programme, financially supported by DANIDA, focused on coastal zone and resource management and conservation. The project started in November 1998, undertaking the first coral reef baseline surveys in some areas, particularly around Sihanoukville.

- *Wetland International Asia-Pacific and Lower Mekong Basin Programme*
  In 2001, a team from the Ministry of Environment, Wetlands International Asia-Pacific, and Lower Mekong Basin Programme conducted field surveys of Cambodia's coral reefs and seagrass areas.

- *National University of Singapore (NUS) Project*
  In 2002, The National University of Singapore, with support from the Singapore International Foundation (SIF) and Youth Expeditions Projects (YEP), organised three expeditions to assess the marine biodiversity of the reefs off Koh Kong Province, Cambodia. Data was collected from the Koh Sdach group of islands, using the methods of Reef Check and Line Intercept Transect (LIT).

- *United Nations Environment Programme (UNEP)/International Coral Reef Action Network (ICRAN)*
  In 2002, UNEP/ICRAN supported staff from the Department of Fisheries in SCUBA diving, Reefcheck and LIT Training courses through the implementation of the project entitled "Proposed Marine Protected Areas in Koh Rong and Rong Sanleom".

- *United Nations Environment Programme/Global Environment Facility/South China Sea Project (UNEP/GEF/SCS)*
  The Department of Fisheries is currently implementing the coral reef and seagrass component of the UNEP/GEF project entitled "*Reversing Environmental Degradation Trends in the Gulf of Thailand and South China Sea*". This project determined the general distribution of coral reefs within Cambodia's marine waters, and conducted baseline surveys to determine the abundance and distribution of coral reef benthos, reef fish, and invertebrates. The general condition of coral reefs was investigated by identifying visible impacts. The project also supports the development of the National Action Plan for Coral Reef and Seagrass Management in Cambodia.

CONCLUSIONS AND RECOMMENDATIONS

Due to the fact that Cambodia had a very long period of civil war, limited research has been carried out on coral reefs and the marine environment. As a result, information regarding the status of coral reefs is scarce. Recent surveys indicate that coral reefs cover a total area of 28.065km^2, including 70 species of coral in 33 genera and 11 families. Live coral cover at coral reef sites in Cambodia has been observed to range mainly from 23%-58%. However, there have been reports of much damage and destruction of reefs as a result of destructive fishing methods and seaweed farming. In general, near shore reefs are in poor condition with turbid conditions, while healthy reefs are found further offshore, away from human impacts.

Policies and plans for the long-term management of coral reefs in Cambodia are not yet in place. Existing laws focus on fisheries only. This situation, in conjunction with ineffective law enforcement, is not conducive for the effective management of coral reefs and their resources. There are also overlaps in responsibilities among concerned government agencies, which have the potential for conflict in the future. In addition, the Cambodian government has limited capacity, infrastructure, and finances to conduct regular scientific research and monitoring. Greater awareness of the ecological and economical value of coral reefs is needed from all stakeholders at all levels to promote the protection of these areas. With the increase in demand for these resources, increasing populations in coastal areas, as well as the potential for development in the future, there is a need to establish effective management strategies for the long-term sustainable use of coral reefs in Cambodia.

Therefore the development of a National Action Plan for coral reef management in Cambodia, coupled with: improvements to legislation, administrative frameworks and enforcement; establishment of management models; research and regular monitoring; capacity building and maintenance; increasing public awareness and participation; and financial sustainability, is urgently needed to ensure sustainable use and reduce the degradation of this important resource.

Recommendations:

- Implement a National Action Plan for coral reef management to ensure conservation and sustainable use of coral reef ecosystems.
- Implement a national policy, legal and administrative framework applicable to coral reef management and conservation with the aim of reducing the degradation of coral reefs and maintaining their multiple benefits and uses.
- Establish management models to ensure sustainable use of coral reefs according to their different ecological and economic values in order to maintain a balance of uses.
- Establish research and monitoring facilities to monitor the status of coral reefs and to support conservation and management.
- Build cross-sectorial capacity for sustainable coral reef management at national and local levels.

- Increase awareness of managers and communities on the ecological roles and economic values of coral reefs to promote the balance between utilisation and conservation of these resources.
- Create financial sustainability and improve economic status of coastal communities.

REFERENCES

Burke, L., Selig, E., Spalding, M. (2002). *Reefs at Risk in South East Asia.* World Resource Institute. 10 Street, NE Washington, DC 20002, USA.

Carl Bro International a/s (1999*). Cambodian Socio-economist and International Sociologist: Socio-economic and Natural resources studies in three villages in Koh Kong Province*. DANIDA Ref. No.104.Camb.1.MIKA.3. Cambodia.

Chou, L.M., Loh, T.L., Tun, K.P.P., (2003). *Status of Coral Reef of the Koh Sdach Group of Islands, Koh Kong Province, Cambodia, Part II.* Marine Biology Laboratory, Department of Biological Sciences. National University of Singapore. Blk S1, 14 Science Drive 4. Singapore 1175 43.

Chou, L.M., Tun, K.P.P., Chan, T.C., (2002). *Status of Coral Reef and Socio-economic Evaluation of the Koh Sdach Group of Islands, Koh Kong Province, Cambodia.* Marine Biology Laboratory, Department of Biological Sciences. National University of Singapore. Blk S1, 14 Science Drive 4. Singapore 1175 43.

CZM (2002). *National Report of Coastal Resources in Cambodia.* Environmental Coastal Zone Management in Cambodia*.* Danida/Ministry of Environment. Phnom Penh, Cambodia.

CZM, (1999). *Case Study: Coral Reefs of Sihanoukville, Destruction by Dynamite and Coral Collection.* Environmental Coastal Zone in Cambodia*.* Danida/Ministry of Environment. Phnom Penh, Cambodia.

DoF (1990). *Compiled Theme of Fishery Laws.* Department of Fisheries. Phnom Penh.

DoF (2004). *Map of Seagrass Distribution in Cambodia*. Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia.

Ing, T. (2003). *National Report on Fish Stocks and Habitats of Regional, Global and Transboundary Significance in the South China Sea, Cambodia. The Cambodian Fishery Component of* Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand. Department of Fisheries. Phnom Penh, Cambodia.

Mam, K. (2001). *Coral Reef and Seagrass Survey in Cambodia*. Lower Mekong Basin Program of Wetlands International Asia Pacific. Ministry of Environment. Phnom Penh.

Ministry of Planning (1999) *General Population Census of Cambodia 1998. Final Census Results. National Institutes of Statistics*. Ministry of Planning, Phnom Penh.

Nelson, V. (1999). *State of Coral Reefs Cambodia.* Environment Coastal Zone Project, MoE/Danida, Phnom Penh, Cambodia.

UNEP, (2003). Report of the Training Programme in SCUBA Diving and ReefCheck Technique in Cambodia (30 pages), and Report of the Training Programme in Coral Reef Survey Using Line Intercept Transect (LIT) Method (24 pages). United Nations Environmental Program, UN Building, 9th Floor Block A, Rajdamnern Avenue, Bangkok 10200, Thailand.

UNICEF (1996). *Towards a Better Future: An Analysis of Situation of Children and Women in Cambodia.* UNICEF, Phnom Penh, Cambodia.