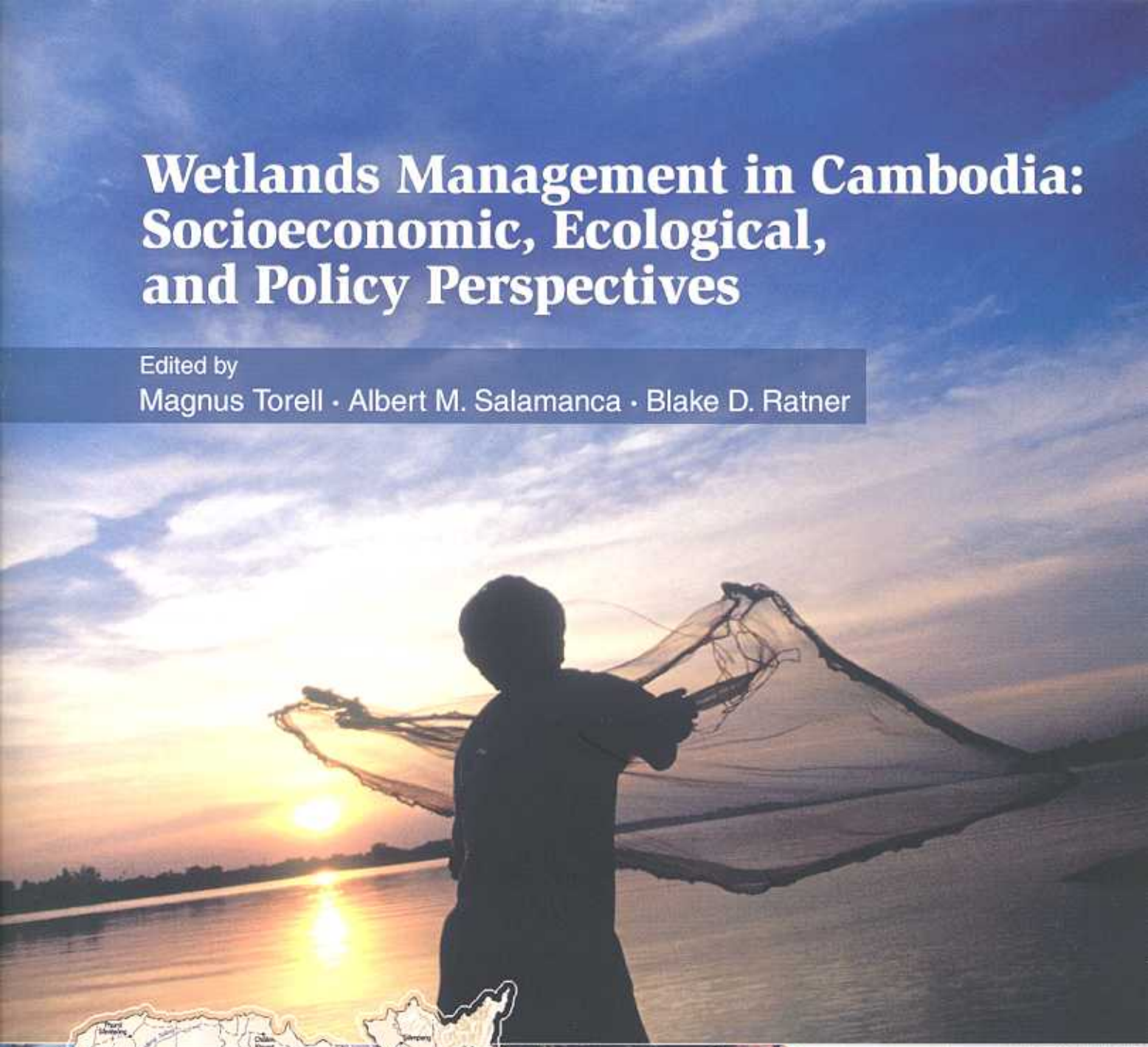
Wetlands Management in Cambodia: Socioeconomic, Ecological, and Policy Perspectives

Edited by
Magnus Torell · Albert M. Salamanca · Blake D. Ratner



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Acknowledgement

This volume is one output of an ongoing collaboration that involves a dedicated core working group and a large number of additional partners in Cambodia (a full list may be found in Appendix 1). Special thanks are due in particular to the Department of Fisheries, which has coordinated project activities in Cambodia, and especially to two members of its staff most directly responsible, Srun Lim Song and Kim Sour. In addition, Harvey Demaine, Siriluck Sirisup, and Eric Meusch of the Asian Institute of Technology's Aqua Outreach Program were essential partners in supporting early project activities in Cambodia. The financial support of the Swedish International Development Cooperation Agency (Sida) is also gratefully acknowledged.

Foreword

The WorldFish Center is committed to improving the lives of poor people who depend upon living aquatic resources for food and livelihood, a commitment reaffirmed through our global Fish for All initiative. Making headway in pursuit of this goal requires a strategic focus on regions where the connection between poverty and aquatic resources management is most pronounced, and where opportunities exist to improve diets and raise incomes through better management. The importance of Cambodia's freshwater fisheries to the food security and the livelihoods of its rural population is globally exceptional.

In many respects, however, the challenges of improving fishery resources management in Cambodia are representative of those throughout the developing world. Faced with a growing population and competing demands on the natural resource base, both the short-term productivity and the long-term sustainability of critical ecosystems are under threat. Effective responses require understanding how the health of living aquatic resources depends upon such diverse factors as land use, pollution control, and forest protection in seasonally inundated zones, as well as how resource exploitation is driven by underlying social, economic, and institutional trends. It is these complexities that a wetlands approach brings into focus.

The contributors to this volume are our partners in an effort to raise awareness of the value of wetlands in Cambodia and to strengthen the legal and institutional frameworks for sustainable management. The project that provides a platform for these discussions is one of a growing number of collaborative initiatives in which the WorldFish Center is engaged in Cambodia and in the Mekong River region. In recognition of the exceptional importance of aquatic resources management to poverty reduction efforts in Cambodia, and as an expression of our commitment to collaborative partnerships in the region, the Center opened its newest research office in Phnom Penh in 2003. We believe it is one of the most important steps we can take in pursuit of our global mission.

Meryl J. Williams
Director General

Introduction: Cambodian Wetlands in Perspective

Magnus Torell
Albert M. Salamanca
Blake D. Ratner
WorldFish Center

Wetlands in Cambodia are much more than places of aesthetic beauty or sites for the conservation of wildlife habitat. They are a lifeline of the rural economy – essential to the livelihoods of millions of Cambodians, the food security of the most vulnerable members of society, and the prospects for national development. Wetlands include not only mangrove forests of the coast and inland marshes and swamps, but also the country's rivers and lakes as well as the zones of forest and agricultural land that they seasonally flood. Thus, many different groups of stakeholders have influence on the ways that wetlands are managed. These range from local fishers and farmers to private businesses and government agencies with diverse mandates including fisheries, agriculture, tourism, the environment, rural development, and public works, along with a host of domestic and international development organizations. Rarely, however, does such a range of actors see themselves as linked together, let alone as sharing responsibility for stewardship of a vital national resource.

Making progress towards the sustainable management of wetlands demands a systematic, holistic perspective, precisely because wetlands defy boundaries. They do not lie within the domain of any one agency's management authority; they are both publicly and privately owned; and their extent fluctuates seasonally. Moreover, resource use decisions in one part of the system directly impact upon other parts, sometimes in complex ways. By presenting perspectives side by side on a number of key facets of the overall challenge of wetlands management in Cambodia, this collection of papers aims to broaden the platform for dialogue and debate about the importance of wetlands, trends affecting their health and productivity, and priority actions in response.

The first three papers provide an essential survey of the importance of wetlands and some of the key trends shaping their management. Kim Sour and Hav Viseth describe the importance of freshwater fisheries and aquaculture and the challenges of improving regulation and management in both domains. Mam Kosal surveys the ecological characteristics of Cambodia's wetlands and the importance of biodiversity conservation, and Hean Vanhan assesses the importance of agriculture in Cambodia's floodplains and the effects of changing land use and agricultural practices on the economy and ecology of wetlands, and on the health of wetland communities.

The next three papers focus on the social, institutional, and legal challenges of wetlands management in the country. Meas Sophal addresses the importance of population growth to the overall challenge of sustainable wetlands management, and identifies the need to address a range of institutional challenges to manage conflicts among competing users of wetland resources, including reform in tenure rights, decentralization of resource management authority, and international cooperation. Mam Kosal reviews key elements of the institutional setting relevant to wetlands management in Cambodia, and describes relevant national legislation and international agreements. The next contribution, by Patrick T. Evans and Vann Sophana, reviews experience from the "Participatory Natural Resource Management in the Tonle Sap Region" project, one of the most promising efforts at transforming the role of provincial and local agencies to support community-based planning and management institutions.

The final three papers address the problems of assessing and enhancing the value of wetlands. Lieng Sopha and colleagues describe the shortcomings of existing data to satisfactorily measure the productivity of wetland ecosystems and their importance to food security and the national economy, leading to a call for improved efforts at wetlands valuation. Responding to this need, Ouch Poeu and Pierre Dubeau present the preliminary results of a pilot study aimed at assessing the value of fisheries production in a representative floodplain zone of the Tonle Sap River. The final contribution, by Ouk Siphan, outlines the need to develop and promote tourism that builds

appreciation of wetlands and generates funds for their protection – one approach to tapping the value of wetlands without degrading them.

The papers in this volume were initially prepared for a workshop organized in April 2001 in Siem Reap, Cambodia, under the auspices of the project, "Legal and Institutional Framework and Economic Valuation of Resources and Environment in the Mekong River Region – A Wetlands Approach."[1] The project, financed by the Swedish International Development Cooperation Agency (Sida) and coordinated by the WorldFish Center, aims to contribute towards environmentally sound development decisions that sustain and improve the livelihoods of those who depend upon wetland resources. Working in the four countries of the Lower Mekong Basin, the project fosters networks of partners engaged in assessing the value of wetlands and analyzing the legal and institutional challenges of improved governance. The network approach builds domestic capacity for such analysis and strengthens the ties among professionals in a range of institutions – government agencies, nongovernmental organizations, and universities – whose collaboration over the long term is essential to institutionalizing new practices. The contributors to this volume represent the Ministry of Agriculture, Forests, and Fisheries (Departments of Fisheries and Agronomy), Ministry of Environment, Ministry of Tourism, the national Senate, as well as the Mekong River Commission, Wetlands International, and the Food and Agriculture Organization of the United Nations. These are just a few of the more than 30 organizations that have participated in project activities in Cambodia (Appendix 1).

Despite the breadth of issues addressed in these papers, the careful reader will surely note many gaps. Official data on fisheries production are unreliable, not only because of the limited numbers and capacity of field staff, but also because the practice of collecting informal fees creates institutionalized incentives to grossly underreport the fish catch (Yim and McKenney 2003). Data on many other wetland products essential to rural livelihoods – such as snails, crabs and fish caught for household consumption – have long been neglected because they are seen to have little commercial importance. Likewise, independent assessment of the legal and institutional framework is still a fairly new concept in a country where departments and ministries typically draft the legislation that governs their own activities. Given this context, we can appreciate that the authors draw from a range of prior studies (even where this reveals inconsistencies in data), and that they are often frank in pointing out institutional shortcomings and the considerable challenges that must be faced.

Improving the governance of Cambodia's wetlands is a mighty task but an important one. We hope that this volume will be appreciated as a modest step in that direction, characterizing the state of knowledge about wetlands management in Cambodia, presenting a range of perspectives on the challenges ahead, and laying the groundwork for more thorough investigation.

[1] The exception is the paper by Kim Sour and Hav Viseth, which was prepared subsequently as a special contribution.

Fisheries and Aquaculture in Cambodia's Wetland Environment

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Introduction

Fisheries in Cambodia play a very important role in the national economy. They provide important sources of protein and employment to millions of Cambodians. However, these valuable resources are threatened by both anthropogenic activities and natural disasters. These resources are being overexploited and natural habitats are being irreversibly destroyed. Inundated areas and mangrove forests are cleared for crop production, rice growing and shrimp farming. Coral reefs are overexploited. Freshwater aquaculture and mariculture are causing harm to the environment. The Department of Fisheries (DOF) has tried its best to manage these resources in a proper manner, but is hampered by a limited budget, lack of skills, human resources and infrastructure.

To respond to the problems in the fisheries sector, whether marine or inland, management tools are needed. First, the DOF should improve the laws relating to fishing and fishery resources as well as to ensure their effective enforcement. Second, an effort should be made to ensure that the management of fisheries is community-based. Third, fish stock assessment needs to be conducted. Fourth, cooperation on research and management of fisheries resources should be encouraged among countries in the Gulf of Thailand. Fifth, marine protected areas (MPAs) should be established.

To anticipate and mitigate environmental impacts related to fishing and other development activities, environmental impact assessment (EIA) should be carried out prior to their implementation. Environmental impacts should be minimized where possible.

Geographic setting

The Kingdom of Cambodia is located in the Indochina peninsula and has a total area of 181 035 km^2. It is bounded by Vietnam in the east and the southeast, Laos in the north and Thailand in the west and the northwest.

The country is generally flat with highlands and mountains found along its borders. The central and eastern parts of the country are rich in inland water systems. The Cambodian section of the Mekong River is 500 km long and flows into four main branches, namely the Great Lake, the Tonle Sap River, the Lower Mekong River and the Bassac River. The four rivers meet at Chaktomuk area or "Quatre Bras". According to the Cambodia National Mekong Committee (CNMC) (2000), the average water flow from the Mekong River into the Tonle Sap River during the wet season is only 11 to 23 per cent, while the Lower Mekong River receives 62 to 68 per cent, and the Bassac River, 12 to 14 per cent. The Great Lake, which is a vast water body in the wet season, is connected to the Mekong River by the Tonle Sap River. During the wet season (May-October), its surface reaches 900 000 to 1 400 000 ha, and covers a large area of flooded forests and some ricefields.

The Mekong River, the Tonle Sap River, and the Great Lake have many estuaries around them. The Mekong River has six estuaries in the form of small rivers and streams. The Tonle Sap has six streams flowing into it and 32 estuaries through which water flows in and out every year depending on seasons. The Great Lake has 10 streams flowing into it, while the Bassac River has 2 streams flowing into it (Seng 1992).

Cambodia has 435 km of coastlines along its southwestern part facing the Gulf of Thailand. The coastlines stretch from Vietnam in the south to Thailand in the west. There are four provinces located along its coastlines: Koh Kong, Sihanoukville, Kampot and Kep. The country's exclusive economic zone (EEZ) covers an area of 55 600 km^2 (World Resources Institute 1994).

Current status of fisheries

According to the latest official data of the DOF, the total commercial fisheries production in 1999 was 284 100 t including small-scale and family-scale freshwater fisheries and aquaculture production

(DOF 2000). Freshwater fisheries account for 82 per cent of the total production, marine capture fisheries account for 13 per cent, and aquaculture 5 per cent. Freshwater fisheries, therefore, are the main fisheries in the country and deserve strong support from the government. However, production from marine capture fisheries and aquaculture is increasing annually, with the exception of shrimp culture.

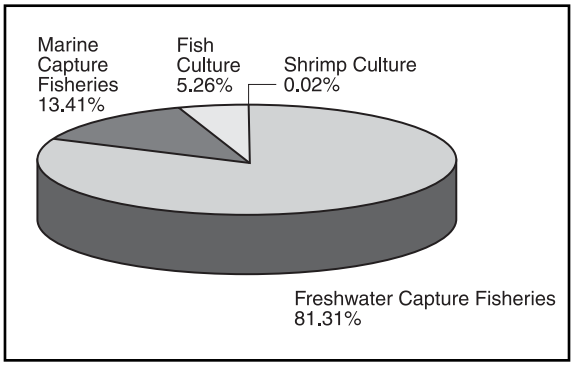

Figure 1. Cambodia's fisheries sector (DOF 2000)

Role of fisheries in the national economy and food security

As already mentioned above, fisheries play a very important role in the national economy and food security, especially among the poorest segment of the population. According to official statistics of the DOF (2000), the total income from the fisheries sector in 1999 was approximately US$ 2.94 million (Table 1), excluding small and family scale fisheries.

In terms of food security, more than 75 per cent of an average Cambodian's total animal protein intake comes from fish (Nao and Ly 1997). Although the rate of fish consumption varies in different areas of the country, the highest rate of consumption is found in or near fishing villages, particularly in fishing households near the Great Lake and Tonle Sap River. The annual per capita fish consumption ranges from 13.5 to 80 kg. At the national level, this translates into an average of 25 to 30 kg per capita (Table 2).

Cambodian people consume not only fresh fish but processed fishery products as well. According

Table 1. Fisheries income in Riel between 1998 and 1999 (DOF 2000)

Income sources	1998	1999
Fishing lot fee	6 581 405 836	4 784 297 000
Medium scale fishing fee	154 513 260	218 842 100
Final deposit money (1998-2000)	652 060 000	3 138 206 000
Confiscated goods and fines	91 736 000	148 622 100
Marine fishing ground fee	287 802 750	844 628 800
Last year debt	23 620 000	155 720 000
Building rentals	529 720 890	698 262 600
Income from KAMFIMEX	910 000 000	1 214 843 500
Income from towns/provincial fisheries	215 881 150	255 159 500
Total Income	**9 446 739 886**	**11 458 581 600**

Table 2. Fish consumption pattern per capita by region

Regions	Amount (Kg)	References
National Rate (average)	25 - 30	(MRC/DOF 1998)
	25	(Touch 1993)
Southeastern Cambodia	13.5	(Csavas 1994)
Southern Cambodia	40	(CIAP unpublished)
Southwestern Cambodia	38	(APHEDA 1997)
Tonle Sap Region (Floating village)	71	(Hong 1995)
Tonle Sap (up-land area of Siem Reap)	32	(Hong 1995)
Fishing households	80	(Ahmed et al. 1998)
Non-fishing households	67	(Ahmed et al. 1998)
Fishing dependent communes (excluding fish sauce)	71	(Ahmed et al. 1998)
Fishing dependent communes (including fish sauce)	75.5	(Ahmed et al. 1998)

to Ahmed et al. (1998), consumption in eight central fishing provinces is as follows:

- Fresh fish: 43.5 kg per capita per year is consumed by households around fishing districts and 39.9 kg per capita annually by non-fishing households.

- Processed fish: This consists of fish paste, fermented fish, salt-dried fish, dried fish and smoked fish. On average, 14 kg per capita per year of processed fish is consumed by households. Based on available information on conversion rate, the 14 kg of processed fish consumed is roughly equivalent to 27.5 kg of fresh fish.

- Fish sauce consumption per capita ranged from as low as 3 liters per year for non-fishing households in Siem Reap to as high as 10 liters per year for fishing households in Kampong Chhnang, which translates into about 4.5 kg of fresh fish.

Inland capture fisheries

The extensive capture fisheries in Cambodia are based on two systems: the Mekong River and the Tonle Sap Great Lake (Mekong River Commission 1997). While admitting that the statistics of the 1950s are not very reliable, Bardach (1959) estimated that the production was 130 000 t in 1957. In 1970, the University of Michigan made indirect evaluations based on average fish yield per hectare for the overall inundated area and on the fish consumption per capita and came up with an annual estimate ranging from 125 000 to 160 000 t. Of this, 50 000 to 80 000 t came from the Great Lake. The annual commercial fish production during the period 1980[2] to 1998 fluctuated between 18 400 to 75 000 t. But the figure in 1999 jumped to 231 000 t (Figure 2). This is due to the inclusion of catch from ricefield fisheries and family fisheries during the year. In 1999-2000, family fisheries produced 115 000 t and the ricefield fisheries contributed 45 000 t (DOF 2000). This figure is smaller than what was estimated by Ahmed et al. (1998) at 300 000 to 400 000 t.

Around the Tonle Sap Lake, seven provinces/towns are considered to be commercial fishing areas, namely Phnom Penh, Kandal, Kampong Cham, Kampong Chhnang, Pursat, Battambang and Kampong Thom. Other provinces have only small-scale family and ricefield fisheries.

Large-scale fisheries

There are two types of large-scale fisheries in Cambodia: the fishing lot system and the *dai* fishery. The fishing lot (*loh nessart*) system accounts for the largest freshwater fishing industry in Cambodia. Fishing lots are auctioned to stakeholders or bidders. The concession for each lot is given to the highest bidder for exclusive exploitation over a two-year period (DOF 1987) and these lots provide an important source of revenue to the national government. There are 167 fishing lots comprised of lakes,

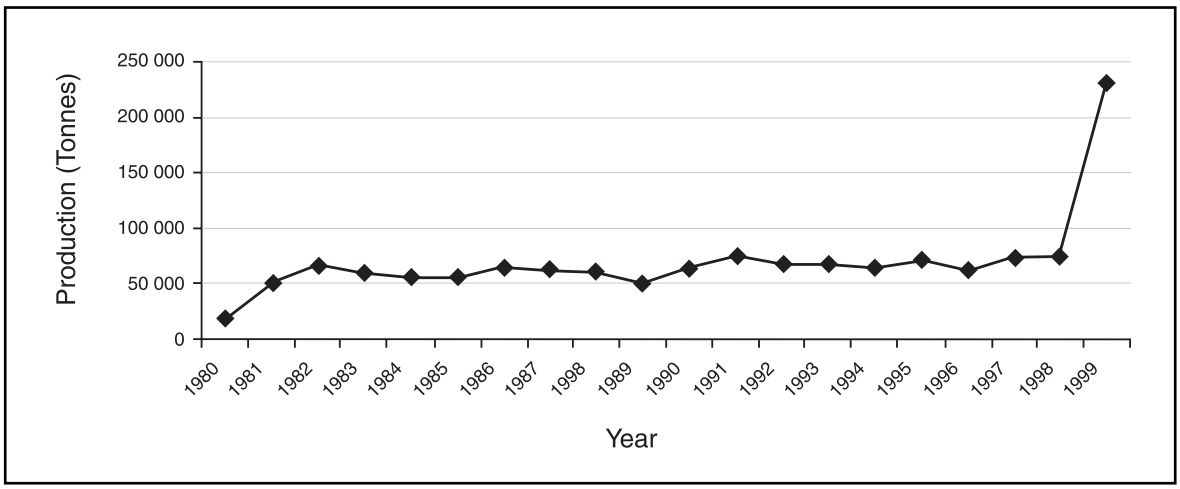

Figure 2. Inland capture fisheries production , 1980-99, according to DOF records
(Note: The figure for 1999 includes family and ricefield fisheries.)

[2] Date prior to 1980 are not available as recording of catch was only started from this year onwards.

sand banks and riverine lots, which together cover a total area of 852 900 ha. Among these, 93 fishing lots (477 925 ha) and all 84 bagnet (*dai*) lots are located in the Mekong River. According to the fisheries law, lot owners are allowed to operate from October to June, but in the Great Lake they tend to start in January.

Figure 3 shows one of the fishing lots with a barrage and rectangular trap in Kandal province during the fishing season. The barrage and trap catches fish that migrate downstream from a lake to the Bassac River during the dry season.

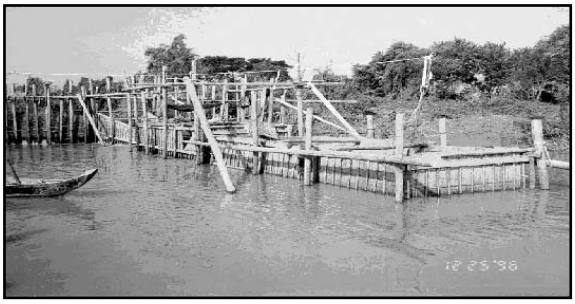

Figure 3. A freshwater estuary barrage and rectangular trap in Kandal Province

A *dai* is a kind of bagnet or stationary trawl net positioned across the river to capture fish migrating downstream. The legal set-up of *dai* is like that of a fishing lot, but instead of a piece of land and water, an anchoring portion of river is auctioned. *Dai* lots tend to be much cheaper on average than other lots. Most of the auctioned *dai* locations are along the Tonle Sap River, which during the 2000-2001 biennium included 63 lots (38 in Kandal Province and 25 in Phnom Penh); they are operated from October through March (Nao et al. 2000). There are 13 freshwater lobster bag nets all located in Prey Veng Province of the Mekong Delta. When the dry season begins, fish (especially *trey riel*) start leaving the submerged lands for the rivers and lakes and eventually for the Mekong River. Migration usually happens during the six days before the full moon. More than half of the catch is made during the January season. The bulk of the catch is used for fish paste (*prahoc*), fish sauce, oil, salted and dried fish (van Zalinge et al. 1998).

Presently, the *dai* fishery for *Pangasianodon hypothalmus* fry, which employs a different technique from a normal *dai*, uses smaller nets and operates during a different season. In 1998, more than 650 sets of such gear were operated. Billions of fry of this species as well as others were caught in the Mekong River from May to August. However, only *Pangasianodon* fries are kept alive to be sold to cage farms mainly in Viet Nam (Ngor 1999).

Medium-scale fisheries

Licenses are required to operate this type of fishery in Cambodia. Fishing gears of different kinds and dimensions are used. These gears are larger than small-scale or family-scale fishing gears, but are smaller than large-scale fishing gears. This open-access fishery is performed outside the fishing lots. Middle-scale fisheries are widespread and catch more fish than the large-scale fisheries, but less than the family and ricefield fisheries.

Figure 4. Cast net, a medium-scale fishing gear

The most common medium-scale fishing gears used in Cambodia, especially in the Mekong River, the Tonle Sap River and the Great Lake, are seine nets, small river trawl nets, beach seines, gillnets, traps, cast-nets, scoop-nets, hooks and lines, and brush-parks. Apart from the fishing lots, full-time and part-time fishers operate these kinds of fishing gears in permitted freshwater fishing areas.

Figure 4 illustrates a typical medium-scale cast net that is longer than 5 m (from the top of cone to the end of the net). If the net is shorter than 5 m, it is considered a small-scale family fishing gear (Ly 1990). This gear consists of a cone-shape net and small chains attached to the bottom of the net as sinker. It is used to fish in many water systems such as lakes, rivers, streams, and canals.

Small-scale fisheries or family and ricefield fisheries

Access to this fishery is open and does not require a license to operate. Fishing is done in floodplain areas, in fishing lots during the closed season

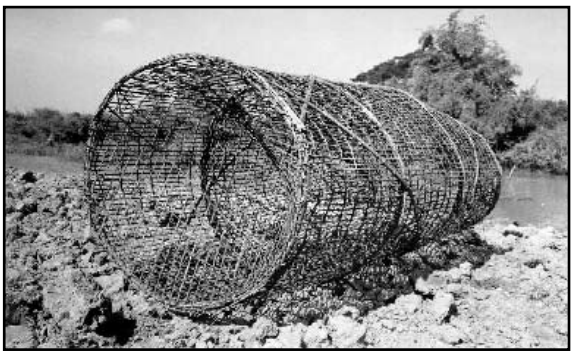

Figure 5. Cylindrical drum trap, a small-scale fishing gear

and in ricefields during the rainy season. Family fisheries in Cambodia are estimated to produce 160 000 to 250 000 t annually (Deap et al. 1998).

Figure 5 shows a cylindrical drum trap. It is considered a small-scale fishing gear because it is smaller than 0.80 m in length and 0.30 m in diameter. If it is larger than this, it is classified as a medium-scale fishing gear. The gear is made of bamboo sticks.

The Mekong River system is rich in biodiversity, particularly in fish. Rainboth (1996) recorded about 500 species of fish within the system. However, fewer than 100 species are caught and recorded around the Tonle Sap - Great Lake by large- and medium-scale fishing gears, although Nao et al. (1996) noted that approximately 280 fish species migrate to the productive floodplains.

Apart from fisheries, the Mekong River system has other resources such as inundated forests, which host many species (Table 3). Permanent water bodies and flooded forests, which are used as spawning and nursing grounds by many fish species, decreased dramatically from 567 100 ha and 795 400 ha in 1985-87 to 411 100 ha and 370 700 ha in 1992-93, respectively. This was largely due to the conversion of flooded areas to ricefields, dry-season farms and seasonally flooded crop fields, with the result that areas of ricefields and seasonally flooded crop fields increased noticeably from 17 500 ha and 366 800 ha in 1985-87 to 29 300 ha and 529 900 ha in 1992-93, respectively (Table 3). The loss of permanent water bodies and flooded forests may have caused the decline of fish stocks.

Marine capture fisheries

Apart from freshwater fisheries, marine living resources in Cambodia also play a very important role in the national economy. These resources include coral reefs, mangrove forests, and many more. Mangrove forests are important ecosystems in tropical areas. They perform important ecological functions such as being the feeding and nursery grounds of commercially important species. They also play an important role in the prevention of coastal erosion (Munoz 1995). There are extensive mangrove stands in Cambodia's coastal zone but these are threatened by shrimp pond conversion and collection of firewood.

The list of important ecosystems in the coastal areas will not be complete without mentioning coral reefs. They constitute major ecosystems that maintain the livelihood of coastal communities around the world. It is estimated that coral reefs support one-third of the world's fisheries, and possibly as many as half a million different animal species altogether (Luck et al. 1998). This is as much the case in Cambodia. But sadly, most of the reefs in this part of the world are severely threatened by sedimentation, coral mining, pollution, destructive fishing practices, and a host of anthropogenic factors (Sebens 1994; Chansang et al. 1981; Hutchings and Wu 1987; Wilkinson et al. 1993).

Table 3. Areas of floodplains and other water resources (Ahmed et al. 1996)

Type of Floodplain and Water resources	Area 1985/87 (ha)	Area 1992/93 (ha)
Permanent water (river, lake, pond, etc.)	567 100	411 100
Flooded forest	795 400	370 100
Flooded secondary forest	28 200	259 800
Flooded grassland	80 800	84 900
Flooded ricefield (receding & floating ricefield)	17 500	29 300
Seasonally flooded crop fields	366 800	529 900
Swamp	12 200	1 400
Total	**1 868 000**	**1 687 000**

Table 4. Marine fishing gears used by province in 1999 (DOF 2000)

Province/ Town	Trawl Net (Set)	Anchovy Seine (set)	Purse Seine (Set)	Seine Net (Set)	Gill Net (m)	Lift Net (Set)	Hook/ Line (# Hooks)	Trap (#)
Kep	4			3	12 000			500
Kampot	22			13	52 355	965		1 745
Sihanoukville	283	1	8	3	593 300	1 500	7 500	2 300
Koh Kong	342	2	1	4	1 451 275		1 100	29 415
Total	**651**	**3**	**9**	**23**	**2 108 930**	**2 465**	**8 600**	**33 960**

Knowledge on the true state of Cambodia's fisheries is limited at this stage due to problems with data collection and the reliability of available data. Catches from subsistence fishing are largely unrecorded. However, information is available on the number of different kinds of gears used such as trawl nets, drag nets, purse seines, gill nets, traps and hook and line (Table 4).

The fleet of Cambodia's marine fisheries is composed of non-motorized and motorized vessels. The non-motorized fishing vessels are used by many small-scale fishers who carry out subsistence fishing. This type of vessel, popular in 1996, accounted for 3 312 boats operating within Cambodia's coastal zone without paying taxes or fees to the government. Since then, the figure dropped dramatically to only 227 boats in 1999 (Figure 6). On the other hand, motorized fishing vessels increased noticeably from 1 017 boats in 1997 to 3 785 boats in 1999. Most of the motorized fishing vessels with large fishing gears are required to have licenses to operate.

Just as the number of motorized fishing vessels increased, the number of fishers also increased as shown in Figure 7. In 1999, there were 13 920 fishers and fish processors, compared with 8 488 in 1995. The increase in both fleet capacity and number of resource users indicate an increase in effort, which may have implications on the sustainability of the resource.

The rise in capacity has brought about an increase in production. Fish constitute the largest portion of overall production (Figure 8). Official data show an increase in fish production from 1 200 t in 1980 to 38 100 t in 1999 (Figure 9). Efficiency in effort provides a likely explanation to the increase in production as motorized vessels are more efficient in catching fish than non-motorized ones due to the speed and the size of gear that can be installed on board. Understanding the catch per unit effort (CPUE) may shed new light on the level of exploitation of Cambodia's fishery resources and how they can be sustained.

Regulation, control and management of capture fishing activities

In order to ensure the sustainable use of fishery resources, the Department of Fisheries

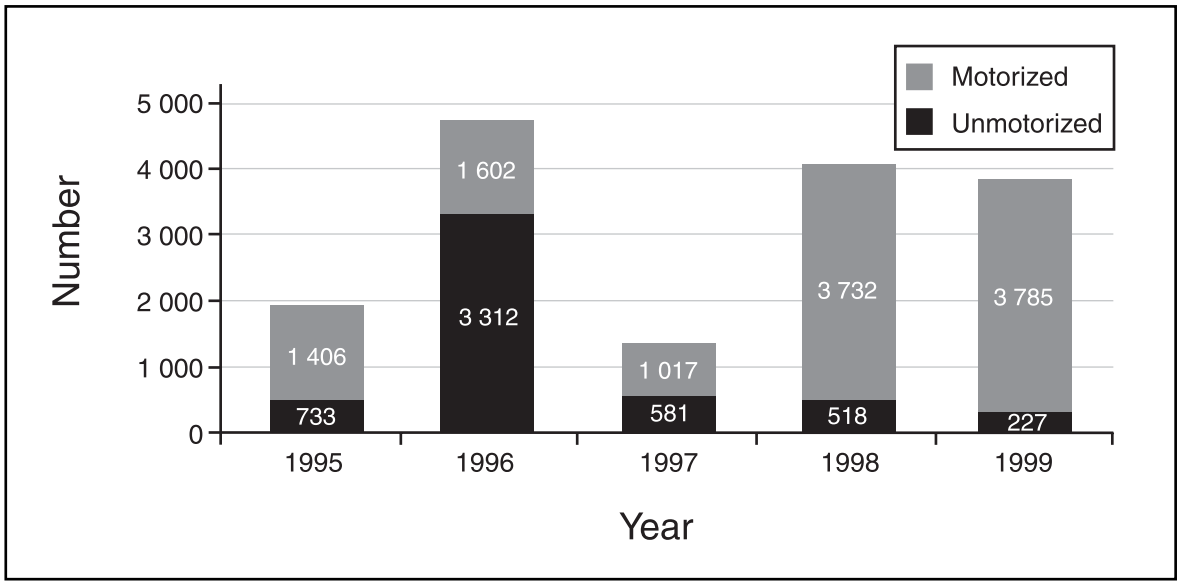

Figure 6. Number of marine fishing boats recorded (DOF 1996-2000)

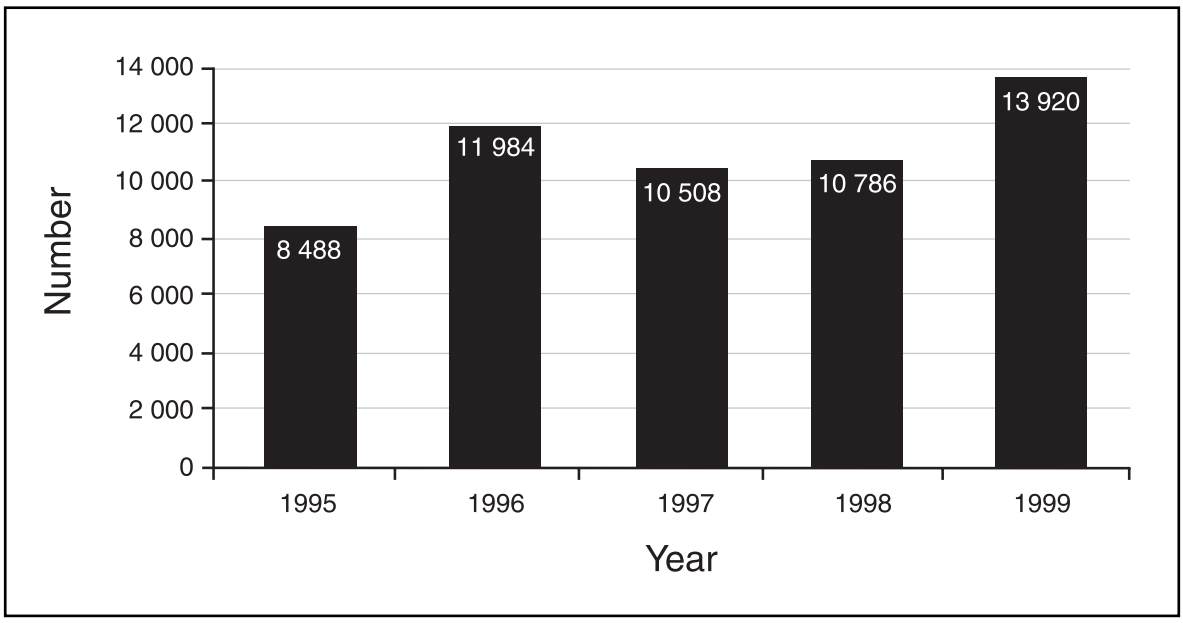

Figure 7. Number of marine fishers and fish processors (DOF 1996-2000)

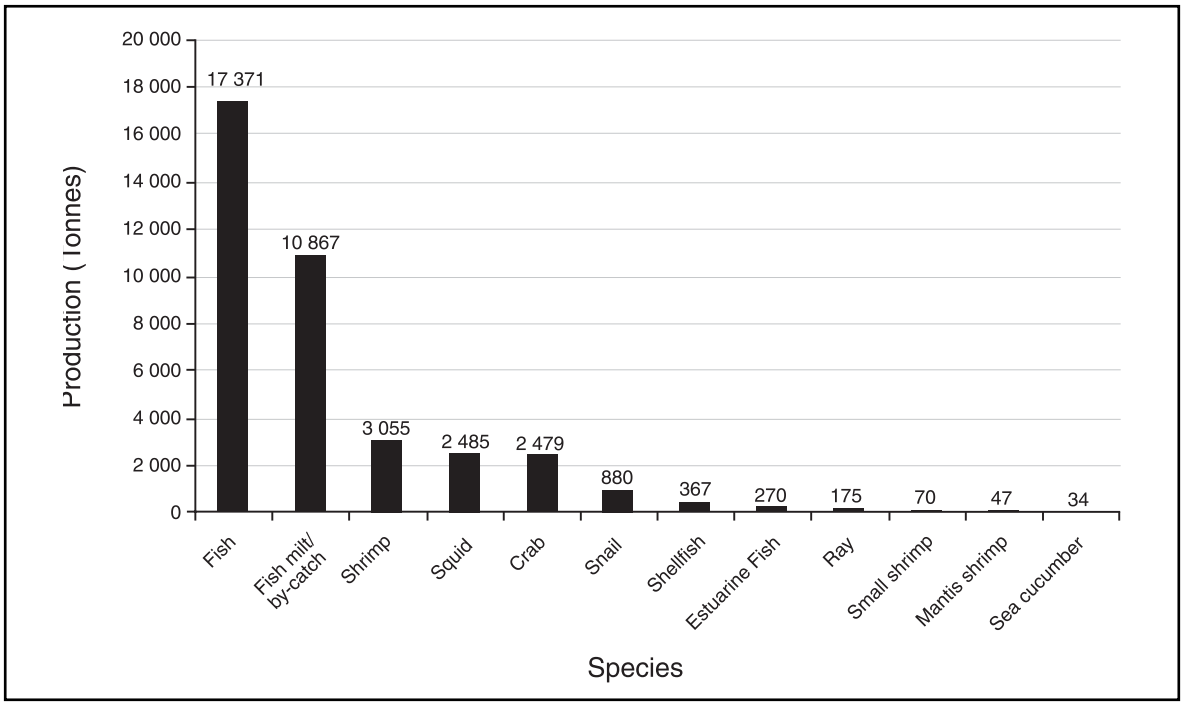

Figure 8. Marine production by species in 1999 (DOF 2000)

has tried its best to manage these resources. A fisheries regulation/law was passed in 1987 to manage these resources for the nation's benefit and the food security of the Cambodian people. The law strongly prohibits all kinds of illegal fishing such as the use of very strong lights, electricity and muro-ami (Ly 1990). It prohibits fishing during the closed season (fish spawning season), and in fish sanctuaries in freshwater systems. The law also prohibits the cutting of trees in mangrove or inundated forest areas and has created its own fisheries inspectors to monitor fishing activities in its coastal waters. Despite these measures, it is reckoned that the law is very weak and passive (Touch 1995).

The agencies looking after the fishery sector in Cambodia are the Department of Fisheries at the national level and the Provincial Fisheries Offices under the Provincial Department of Agriculture at the provincial level. However, such

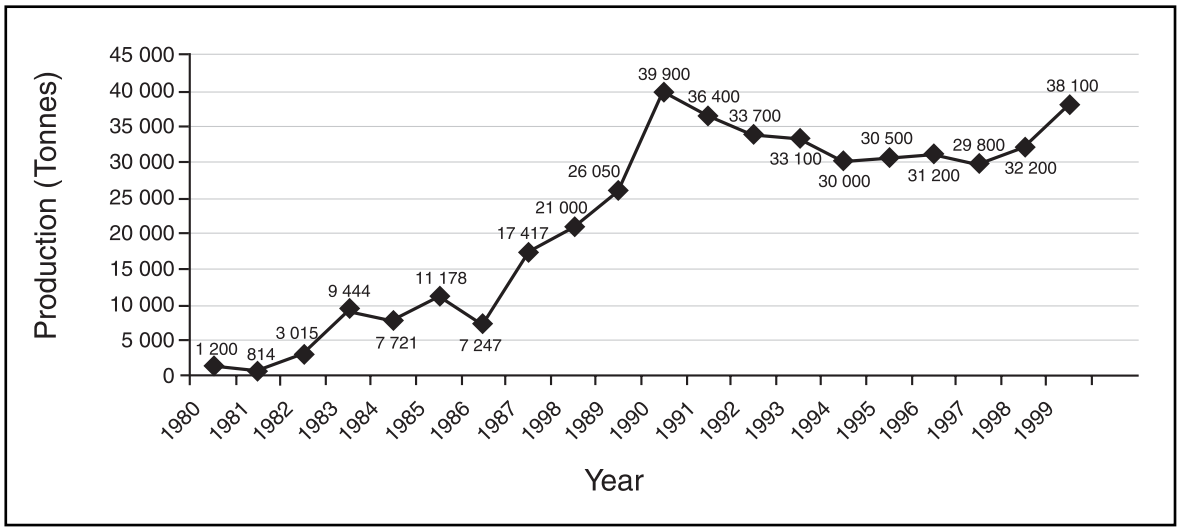

Figure 9. Marine capture production, 1980-99 (DOF 2000)

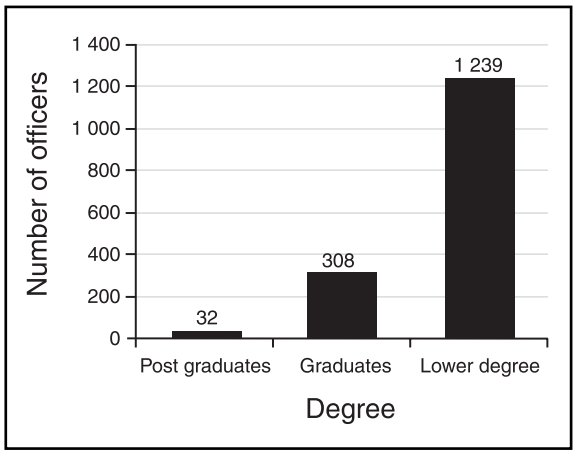

Figure 10. Degrees attained by staff at the DOF (DOF 2000)

an administrative structure is burdensome, non-functional and likely to be inefficient. It may also lead to duplication in services (e.g., fisheries inspection, overlapping zones), non-provision of services, resource wastage and potential rivalry between different levels of administration. In addition, such a structure is not conducive to strong fisheries development and management (Csavas et al. 1993).

The human resources needed to properly manage the fishery is lacking in Cambodia. In 1999, the DOF had 1 579 fisheries officers. A total of 714 officers were attached to the national office while 865 were in the provinces (DOF 2000). Of these fisheries officers, 32 had postgraduate degrees; 308 had university degrees; and the rest had lower educational levels (Figure 10).

The following problems and constraints exist in Cambodia's fisheries:

- **Overfishing, especially in inland capture fisheries**. The Great Lake and the Tonle Sap River are the main freshwater fishing lot areas in Cambodia and are believed to be the most productive in the Lower Mekong Basin. However, it is surmised that fisheries in these areas are in various stages of overexploitation. It is also hypothesized that large and medium sized fish are overexploited, while the small fish are fully exploited (van Zalinge and Nao 1999). On the other hand, some reports have indicated that Cambodia's coastal resources are being exploited close to or slightly above the maximum sustainable yield (Csavas et al. 1994).

- **Lack of adequate human resources to manage the fisheries**. As shown in Figure 10, there is a dearth of trained managers and officers in the DOF. Presently, there is not a single officer with a Ph.D. in the field of fisheries or aquatic science in the DOF.

- **Insufficient scientific data for sound management and decision-making**. Data available at the DOF are not collected in a reliable and scientific manner, which limits their usefulness. Stock assessments of available fishery resources are needed to determine proper levels of exploitation and to institute appropriate management measures to manage them.

- **Lack of monitoring capabilities**. It has been reported that fish caught illegally are easily transported to other countries with the help of high-ranking officers in the military. Monitoring the movement of illegally caught

fish has not been effectively done as the means to do this are lacking. Similarly, Cambodia's exclusive economic zone (EEZ) is not effectively protected from poaching by nationals of other countries due to lack of surveillance infrastructure and mechanisms.

- **Poor enforcement of laws**. Although laws and regulations governing fisheries in Cambodia are not perfect, some legal frameworks are already in place as bases for management. Unfortunately, enforcement is still problematic as the DOF does not have enough financial resources and appropriate tools, such as patrol boats and communication equipment, to carry out the task effectively. Enforcement of fisheries laws, like those for other natural resources in Cambodia, is hampered by corruption.

- **Inefficient administration**. Too much bureaucracy is noted in the DOF and the Ministry of Agriculture Fishery and Forestry (MAFF), causing decision-making to become a lengthy political process, in instances where timely decisions are needed for effective resource management.

- **Increasing conflicts between different types of users**. More conflicts have been observed in the management of natural resources in Cambodia, especially with regard to different uses of these resources. For instance, there are recurring conflicts between the use of land for human settlement and for fishing. People need land for house building while the DOF wants to designate areas as fishing lots and fish sanctuaries. This is a delicate matter and a proper balance should be maintained between these competing uses so as not to create problems. On the one hand, fish production should not be sacrificed for human settlement as food security may be put at risk while, on the other hand, housing is a basic need.

Aquaculture

Aquaculture in Cambodia is believed to have developed in the 10th Century when the major system was cage and fishpen culture. Fishers and fish farmers stocked fish caught from rivers and lakes in cages or fishpens. When they reached a commercial size, they were sold to consumers at a higher price. The cages or fishpens were made of bamboo and kept floating in the Tonle Sap River during the fishing season or dry season (So and Nao 1999).

In the 1960s, Chinese carp and tilapia were introduced in Phnom Penh for pond culture (So and Nao 1999). These were raised in gardens and parks as ornamental fish rather than for food as there were plenty of wild fish to catch at that time. Coastal aquaculture started with shrimp culture using seed collected from the wild. Thailand was the source of the technology. Semi-intensive culture systems were applied in the coastal area near the Thai border using seeds and feeds from Thailand. Cage culture of grouper was started several years ago due to a high demand in the international market.

Inland aquaculture

Small-scale aquaculture has been practiced in Cambodia for a long time. Intensive pond culture and small-scale pond polyculture are promoted by NGOs to improve food security in the rural or isolated areas and fish-scarce regions such as Svay Rieng, Kampong Speu, Takeo and Prey Veng. More cage culture is being carried out in the Mekong River, the Bassac River and the Tonle Sap-Great Lake.

There are two types of cultured species in Cambodia: exotic species and indigenous species. The most common of the former are the hybrid African catfish (*Clarias gariepinus*), common carp (*Cyprinus carpio*), Silver carp (*Hypophthalmichthys molitrix*), big head carp (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*), rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Catla mrigala*), Nile tilapia (*Oreochromis niloticus*), and Java tilapia (*Oreochromis mosambicus*). These exotic fish are raised in ponds and ricefields. Among indigenous species, the most common are: river catfish (*Pangasius* spp.), giant snakehead (*Channa* spp.), small scale mud carp (*Cirrhinus auatus*), walking catfish (*Clarias* spp.), sand goby (*Oxyeleotris marmorata*), and silver barb (*Puntius* spp.). Most of these indigenous species are cultured in cages and /or ponds. The fingerlings used in the culture are caught from the wild during the rainy season. Cage culture is common in Phnom Penh, Kandal, Kampong Cham, Kampong Chhnang and Prey Veng. The common species cultured are snakehead (*Channa* spp.), catfish (*Pangasius* spp.), Barb (*Puntius* spp.), carp (*Cirrhinus* spp.) and sand goby (*Oxyeleotris* spp.).

Inland fish culture production increased remarkably from 1 610 t in 1984 to approximately 15 000 t in 1999 (Figure 11). Freshwater aquaculture contributed about 99 per cent of the total

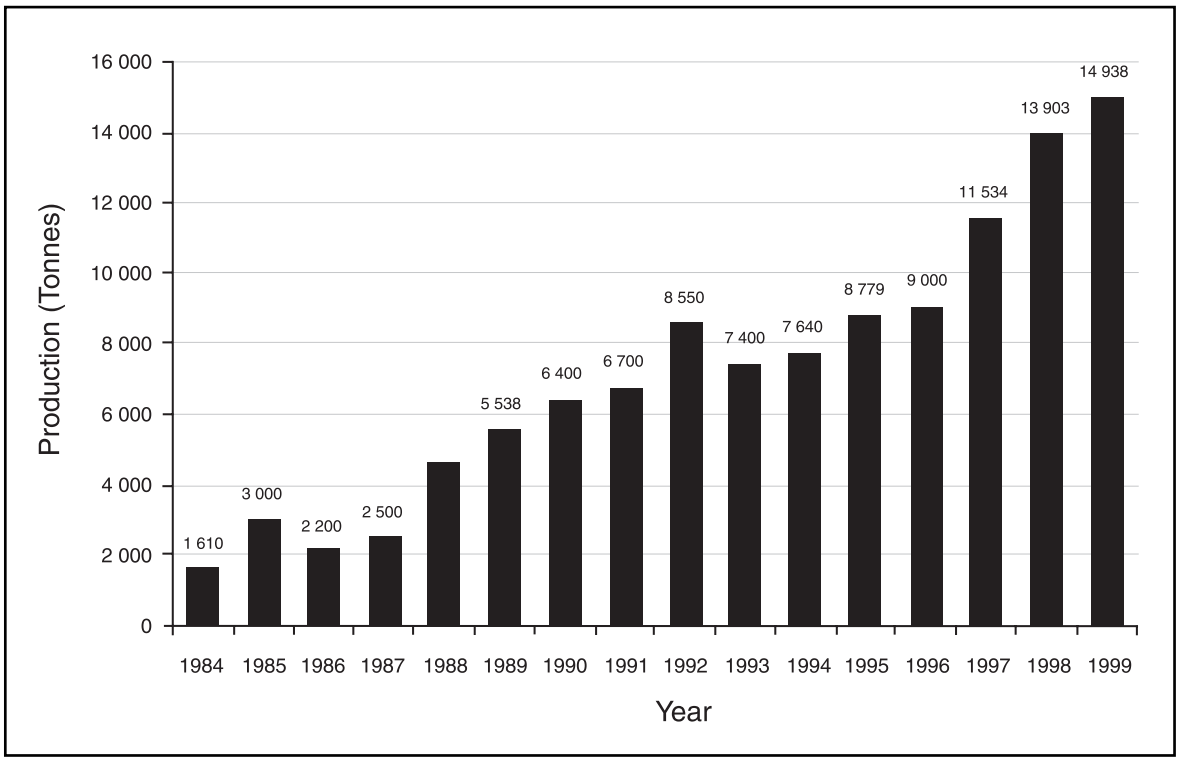

Figure 11. Fish culture production, 1984-99 (DOF 1984-2000)

aquaculture production in 1990, and approximately 87 per cent of the total aquaculture production in 1999. These figures illustrate the importance of aquaculture in increasing fish production and reducing fish caught from the wild.

The supply of fish fry in Cambodia is provided by 12 hatchery stations throughout the country. Most of them receive external funding from organizations such as Southeast Asian Outreach (SAO), the Asian Institute of Technology, Japanese International Cooperation Agency, Partnership for Development of Kampuchea (PADEK), the European Union, Cambodia Area Rehabilitation and Regeneration Project (CARERE), FAO, UNDP, Australian People for Health, Education and Development Abroad (APHEDA), and the Helen Keller Foundation. Most fingerlings of indigenous fish species (e.g. *Chyclocheilichthys enoplos*, *Pangasuis micronemus*, *Leptobarbus hoeveni*) are collected along the Mekong River system during the rainy season. A small mesh-sized *dai* is laid along the downstream area of the Mekong River to trap passing fingerlings. The annual total fingerling production jumped from 148 000 in 1984 to 9 060 000 in 1999 (Table 5).

Apart from freshwater fish culture, crocodile culture has become popular in many provinces of the northern part of the country such as

Table 5. Fingerling production, 1984-99 (DOF 1984-2000)

Year	Number of Fingerlings	Year	Number of Fingerlings
1984	148 000	1992	2 700 000
1985	182 000	1993	990 000
1986	208 000	1994	5 600 000
1987	559 000	1995	5 096 000
1988	1 174 000	1996	5 100 000
1989	2 983 000	1997	4 124 000
1990	3 500 000	1998	5 060 000
1991	2 406 000	1999	9 060 000

Siem Reap, Battambang, Kanpong Thom, and Kandal. The number of crocodiles cultured rose noticeably from 4 372 in 1989 to a peak of 40 700 in 1998, before it dropped to 25 380 in 1999 (Figure 12). The decline in the number in 1999 might be due to loss of foreign markets and decrease in the export price. Another reason might be the shortage of feed for the crocodiles.

Coastal aquaculture

Shrimp culture was started extensively in Koh Kong and later expanded to Sihanoukville and Kampot. Finfish culture followed shrimp culture, especially in Koh Kong and Sihanoukville. The main marine culture species in the coastal

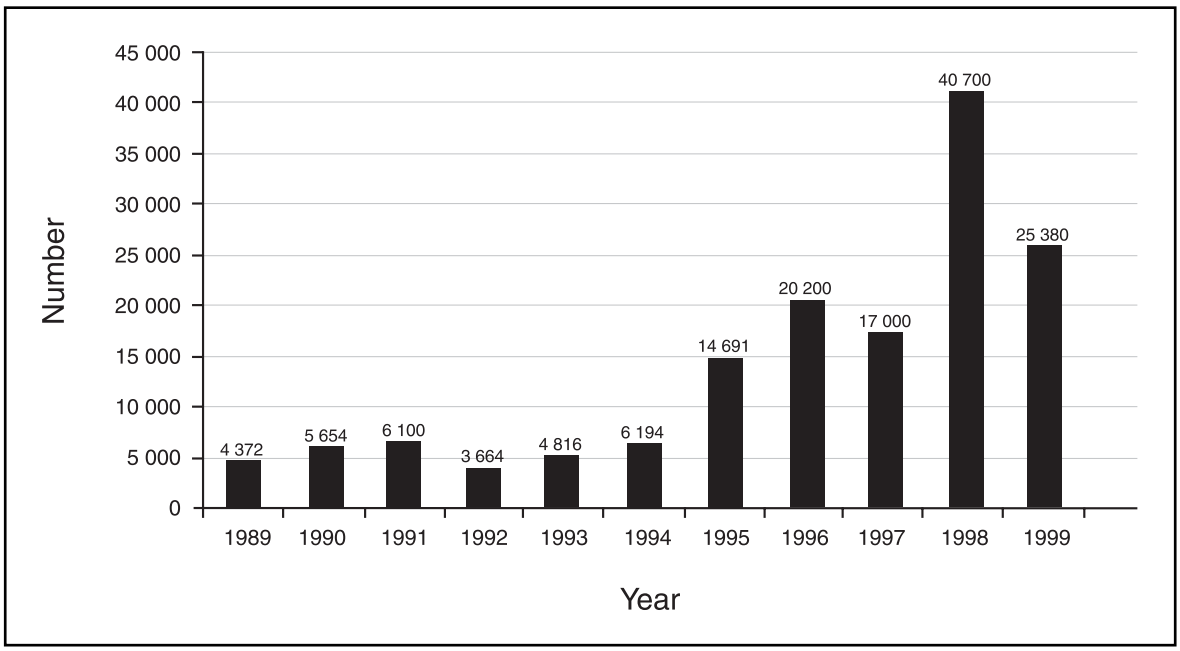

Figure 12. Number of crocodiles cultured in Cambodia (DOF 2000)

area were tiger prawn (*Penaeus monodon*, and *Penaeus merguensis*), seabass (*Lates calcarifer*), grouper, and green mussel. During the early 1990s, *Penaeus monodon* was a popular cultured species, with a rise in production from 500 t in 1993 to 731 t in 1995. But this rise was short-lived as diseases set in and led to a decline in shrimp production. As more farmers abandoned shrimp culture, production was down to only 62 t in 1999 (Figure 13). Many causes of the diseases were mentioned but none of them have been scientifically proven. These include: farm pollution, high acidity in the soil, and viral/ bacterial infections in shrimp.

Regulation, control and management of aquaculture activities

As aquaculture is a new sub-sector in fisheries, specific laws and/or regulations to govern this industry, such as those related to research, environmental impact, development and management, are currently not available. The legal framework for aquaculture comes from the Fiat Law on Fisheries issued by the Council of Ministers on 9 March 1987 concerning the management and allocation of the country's freshwater and marine aquatic resources. Since this law is not specific to aquaculture, certain aspects

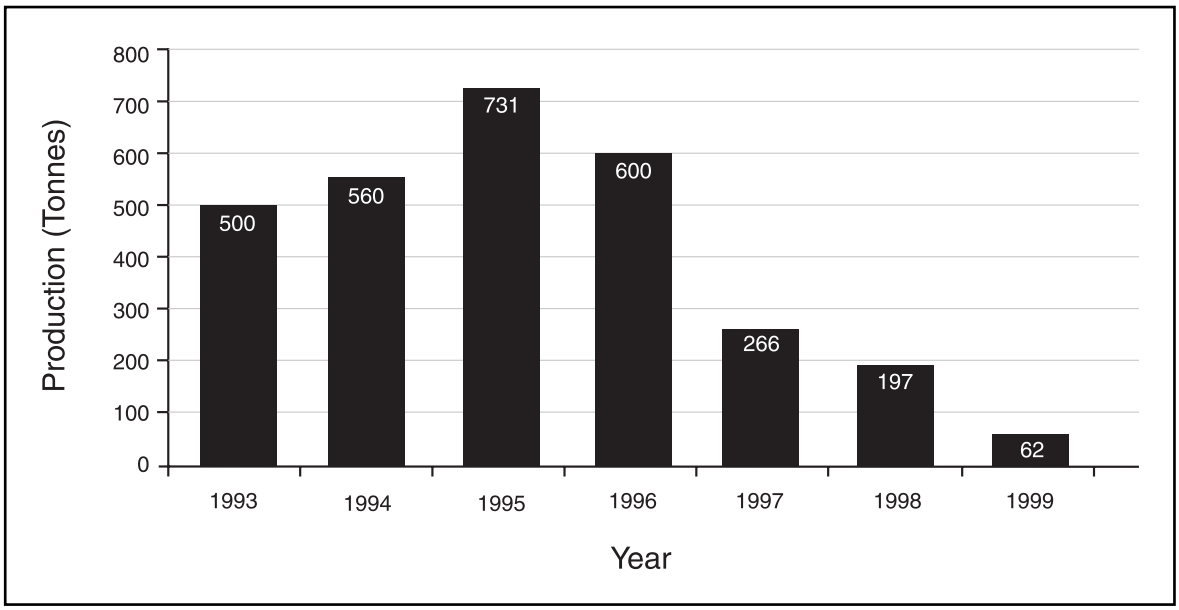

Figure 13. Shrimp culture production, 1993-99 (DOF 2000)

such as the environmental impacts of aquaculture are not mentioned in it. Despite the absence of a specific law, however, aquacultural activities can still be carried out by means of a permit system, especially those practiced on a commercial scale. Aquaculture in ponds or pens larger than 0.5 ha or cages larger than 15 m^2, crocodile farming of more than 5 crocodiles, turtle farming of more than 50 turtles, and farming of more than 20 non-poisonous snakes, for example, can be carried out if a permit is granted by the DOF (DOF 1989).

In view of the absence of rules and regulations governing the aquaculture industry in Cambodia, problems are likely to occur. They are similar to what have been experienced in other countries, notably Bangladesh, India and Thailand (see Bailey and Skladany 1991; Primavera 1991; Stonich 1995; Macintosh 1996; Bailey 1997; Clay 1997; Primavera 1997; Stonich et al. 1997; Boyd and Clay 1998; Boyd et al. 1998; Menasveta and Fast 1998; Paez-Osuna et al. 1998; Primavera 1998; Boyd and Schmittou 1999; Flaherty et al. 1999; Stonich and Bailey 2000; Paez-Osuna 2001; Senarath and Visvanathan 2001; Hein 2002). Some of these problems are mentioned below:

- Effluents of polluted water from aquaculture farms may contain viruses, bacteria, antibiotics and chemicals which may be harmful to the environment and human health.

- The clearance of inundated forests and mangrove areas for aquaculture may lead to the reduction of habitats for commercially important marine species.

- The collection of small fish and fingerlings to feed carnivores such as snakeheads and crocodiles may lead to the overexploitation of these fish species.

- The introduction of exotic species into the Mekong River system may cause negative environmental impacts although the extent of this problem is yet unknown as no studies have been made to date.

- The lack of funds for aquaculture infrastructure and management has hampered the ability of the DOF to improve this sector. So far funds for aquaculture- related activities have largely been provided by donors and NGOs.

- The rise in the incidence of fish diseases has been an increasing concern. For example, in the early 1980s, the epizootic fish disease (EUS) spread across the region from the south to the north/northwest of the country. The disease affected both natural and cultured fish stocks and caused high mortality in most of the fishing grounds (Tonguthai 1985). The affected species were snakeheads and other air-breathing species that inhabit marginal habitats (So and Noa 1999).

The need for environmental impact assessment

Owing to the challenges in the management of fisheries and aquaculture in Cambodia's wetland environments, there is a need for a pro-active protocol that enhances the ability of environmental and fisheries agencies to anticipate and mitigate the negative environmental impacts of development activities including fisheries and aquaculture themselves. Here lies the opportunity proffered by a system of environmental impact assessment (EIA). Since the revitalization of the Ministry of Environment, EIA is increasingly being seen as a potential tool in environmental management. Impact indicators are collected by project proponents to provide baseline information on the likely changes resulting from the project. Impacts, both positive and negative, are anticipated and potential mitigation measures are assessed to provide an overall scenario on the costs and benefits of an undertaking. Regulators would then decide whether to give the green light for the project according to the information given on the positive or negative impacts the project would have on the economy, environment and society. Some of the environmental impacts of capture fisheries and aquaculture requiring EIA are described below.

In capture fisheries, overfishing causes a major impact. There are five types of overfishing: growth overfishing, recruitment overfishing, economic overfishing, ecosystem overfishing and Malthusian overfishing (Russ 1999). Growth overfishing occurs when the size and age structure of fish populations are changed due to fishing, resulting in the reduction of larger and reproductively mature fishes. This is basically a case of catching fish before they have time to grow. Recruitment overfishing results when the production of larvae and recruits are affected because the number of adults in a breeding stock is reduced by fishing. Economic overfishing materializes when more effort is needed for a particular catch while it was possible to have

the same level of catch at lower effort previously. Malthusian overfishing happens when there are too many fishers chasing too few fish. The level of overfishing in Cambodian waters is hard to gauge right now, but there are indications it is heading toward that direction as more and more cases of illegal and destructive fishing, such as dynamite and electric fishing, are recorded and the population of inland communities is increasing.

In aquaculture, the introduction of exotic species such as Chinese carps, tilapia and African walking catfish may have negative environmental impacts. However, these impacts are speculative as no real scientific studies have been carried out in Cambodia to assess their depth. The precautionary principle may be used to make decisions or policies concerning the introduction of exotic species. Another impact of aquaculture stems from the pollution associated with the culture system itself. The introduction of processed feeds, antibiotics and improperly quarantined cultured species and wastewater from ponds has a high potential to cause human health problems and to impact on nearby ecosystems as is the case in other countries. In addition, the reduction of mangrove cover due to the conversion to shrimp farms is a cause for alarm (Primavera 1991, 1995, 1997, 1998).

Conclusion

Wise management of fishery stocks is easier said than done, this is especially so in Cambodia. It includes, among other things, establishment of quotas, restriction on the type of fishing gear, increased livelihood opportunities, policy changes, enforcement of laws and regulations, and political will. In Cambodia, many things are required in order to develop and manage resources in a sustainable way. Firstly, the Department of Fisheries should improve the fisheries laws and their enforcement. Secondly, the government should recognize the key role of communities in natural resources management. Community-based resources management has been shown to be effective in pursuing the goals of an efficient management of resources. The government should provide avenues for these communities to participate in the management activities within their areas as there are many opportunities that this approach provides. Thirdly, fish stock assessment should be conducted to understand the level of exploitation of Cambodia's major fisheries. Finally, all countries in the Gulf of Thailand should collaborate to promote the goals of fisheries conservation and management in their shared waters. The establishment of marine protected areas may be considered as a means to support this effort.

Biodiversity of Cambodia's Wetlands

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Introduction

Wetlands cover more than 30 per cent of Cambodia. In addition to streams, ponds, freshwater swamps and marshes, Cambodia has four internationally significant wetland areas: the Mekong River and its floodplain, the Great Lake (Tonle Sap) and its floodplain, the Stung Sen River and the coastal estuaries of Stung Koh Pao and Stung Kep. The Mekong River is the longest river in Southeast Asia, and about 468 km of its length is in Cambodia. The Mekong River provides a wide range of benefits at both national and community levels. It serves as a migratory channel for fish between rivers, tributaries and lakes. The seasonal relationship between the Tonle Sap and the Mekong River is an interesting aspect of the Mekong River system. The Mekong River swells during the wet season (May to October) and its waters flow into the Tonle Sap River, forcing it to reverse its course and flow back into the Tonle Sap Lake. The lake expands from 2 500 km^2 in the dry season to 13 000 km^2 in the wet season (Ministry of Environment 1999).

The Tonle Sap Lake is a seasonally inundated lake surrounded by a broad belt of freshwater swamp forest about 25 km wide except in Battambang Province where it extends up to 65 km. The Tonle Sap supports important agriculture, fisheries, and aquaculture industry. Cambodia is estimated to have a fish catch of more than 400 000 t per annum (van Zalinge et al. 2000) and average per capita fish consumption of 71 kg per annum (Ahmed et al. 1998).

In the coastal zone, mudflats and estuaries are important wetland environments. The major estuaries and mudflats are found in Koh Kong and Kampot provinces. The Stung Koh Pao and Stung Kep estuaries are recognized as internationally important wetlands. Both rivers originate in the Cardamon range and discharge into Koh Kong Bay. Mudflats are very productive systems and are rich feeding grounds for vertebrates (Ministry of Environment 1999).

Many of the riparian wetland ecosystems in Cambodia are of global significance. Their exploitation, management and conservation are important areas for study.

Freshwater wetlands

Freshwater wetlands in Cambodia represent one of the most diverse ecosystems in the Mekong River Basin. Nearly 500 of the 1 200 fish species found in the Mekong River are in Cambodia. The degree of endemism in the Cambodian section of the Mekong River is high, especially in the upland areas of the northeast and in the mountains bordering Thailand and the Gulf of Thailand (Rainboth 1996). Endangered species include the Giant Catfish (*Pangasianodon gigas*) and Try Trasak (*Probarbus jullieni*) (Ministry of Environment 1999).

Of the 435 bird species in Cambodia, 106 are water birds and the wetlands of the Lower Mekong Basin support 15 globally threatened species including the critically endangered Giant Ibis (*Pseudibis gigantean*), rediscovered in 1993 along the Xe Kong and Mekong Rivers in Lao PDR. Other endangered species include the Sarus Crane (*Grus Antigone*), Greater Adjutant (*Leptoptilos dubius*), White Shouldered Ibis (*Pseudibis davisoni*), White Winged Duck (*Cairina scutulata*), Bengal Florican (*Eupodotis bengalensis*) and Nordmann's Greenshank (*Tringer guttifer*). Vulnerable species include the Spot Billed Pelican (*Pelecanus philippensis*), Lesser Adjutant (*Leptoptilos javanicus*), Milky Stork (*Mycteria cinerea*), Greater Spotted Eagle (*Aquila clangula*), Green Peafowl (*Pavo muticus*), Masked Finfoot (*Heliopais personata*), Blackbellied Tern (*Sterna acuticauda*), and Indian Skimmer (*Rynchops albicollis*).

The Tonle Sap Lake is the largest breeding ground for large water birds in Asia. The Sarus Crane and Grus Antigone are found in Northeast Cambodia and Trapeang Thmar, and Banteay Meanchey provinces (Wetlands International-Asia Pacific 1996).

Other endangered species include the Irrawaddy Dolphin (*Orcaella brevirostris*), of which fewer than 100 individuals are believed to survive in the Mekong today, mostly between Phnom Penh and the Khone Falls in southern Lao PDR. The Siamese Crocodile (*Crocodilius siamensis*) is also critically endangered. It used to be found throughout the Lower Mekong Basin but numbers have declined through excessive hunting and

habitat degradation. Over 20 species of turtles live in the Lower Mekong Basin, 10 of which are listed in the Red Data Book, including the critically endangered Chinese Three Striped Box Turtle (*Cuora trifasciata*).

Limited surveys of mollusks have identified a rich biodiversity with a high degree of endemism. Of the 160 mollusks identified in the Mekong and its Mun tributary, 116 species (73 per cent) are endemic. In a recent survey of the Stung Treng Ramsar site conducted by the Department of Nature Conservation and Protection, 33 species of plants were found in flooded forests. In the Tonle Sap alone, 200 species were identified in 1996 (McDonald et al. 1997).

Threats to freshwater wetlands

Loss of ecosystem integrity

The productivity of the wetland system of the Lower Mekong Basin stems from the differences in the wet and dry season flows. There are a number of proposed developments that may alter the hydrological regime, reducing the peak wet season flow and increasing the dry season flow. The cumulative effects on the biodiversity of the Basin's wetlands are unknown. Such alterations are likely to reduce productivity because some seasonal wetlands do not fill up and others dry out. The rapid industrialization of the Lower Mekong Basin and agricultural runoff are increasing the pollution load and, in the absence of effective measures to control pollution, it will continue to increase. Intensive logging in the Basin is reportedly causing increased sedimentation of rivers resulting in the loss of ecosystem function.

Reduction of species abundance and diversity

Exploitation of wildlife in the region is high, particularly migratory birds, and over-harvesting of plant life is widespread. For example, during the 1995-96 breeding season, collectors and harvesters gathered over 26 000 eggs and 2 559 chicks from colonies in Prek Toal at the western end of the Tonle Sap Lake. The species collected included the endangered Spot Billed Pelican (*Pelicanus philippensis*), Greater Adjutant Stork (*Leptoptilos dubius*), and the White Winged Duck (*Cairina scutulata*). About 3 100 Spot Billed Pelican eggs were harvested during the 1995-96 breeding season. This is from a species whose global population is estimated at 11 500.

Harvesting non-target fish species using destructive methods, tree felling (to remove arboreal wildlife or allow easy gathering of fruit) and illegal shipments of biomaterial for traditional medicine and food are also threatening the ecosystem. Loss of ecosystem integrity is further brought about by the introduction and spread of alien species such as the Giant Mimosa (*Mimosa pigra*) and Golden Apple Snail (*Pomacea canaliculata*).

Coastal wetlands

Biodiversity

The 435 km Cambodian coastline is comprised of beaches and 60 000 ha of some 30 species of mangroves. The most pristine mangrove forests are found in Koh Kong Province. In addition to mangroves, seagrass beds extend throughout the coastal areas, especially in Kampot Province, the Prek Kompong Bay Delta and Kep municipal waters. Extensive seagrass meadows exist along the mainland and patches of seagrass intermingled with coral reefs may be seen around islands. Eight species of seagrass have been identified to date: *Enhalus acoroides*, *Cymodocea serrulata*, *Halodule pinifolia*, *Halodule uninervis*, *Halophila decipiens*, *Halophila ovalis*, *Syringodium isoetifolium*, and *Thalassia hemprichii*.

A total of 70 species of hard corals belonging to 33 genera and 11 families have been identified in Cambodia's coastal waters. *Acropora* and *Montipora* are two of the most common ones. Among reptiles, four species of marine turtles are reported to be present in Cambodia's waters: Hawksbill turtles (*Eretmochelys imbricata*), Green turtles (*Chelonia mydas*), Olive Ridley (*Lepidochelys olivacea*) and Leatherback (*Dermochelys coriacea*). Crocodile sightings, (probably the Saltwater Crocodile *Crocodylus porosus*), have been reported by fishermen in the Koh Kong estuary mangroves and Prek Toek Sap.

The coastal waters host about 435 fish species from 97 families. Marine mammals (*Dugon dugon*) and marine dolphins are found, including the endangered Irrawaddy Dolphin (*Orcaella brevirostris*). Other species of cetaceans known to occur in Cambodia's coastal waters are the Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Common Dolphin (*Delphinus delphis*), Bottle-nosed Dolphin (*Tursiops truncatus*), Shinner Dolphin (*Stenella longirostris*), and Finless Porpoise (*Neophocaena phocaenoides*).

Threats to biodiversity

While there are laws protecting mangrove forests, (cutting mangroves has been made illegal since 1994) threats remain. Mangrove loss occurs as a result of charcoal production and shrimp farming. A large portion of the Peam Krasop Wildlife Sanctuary was cleared at the end of 1998 even though the Department of Environment routinely destroyed the charcoal kilns to prevent further production. In Koh Kong and Kampot provinces, 1 272 ha of mangroves was cleared for shrimp farming but the shrimp ponds were later abandoned as unprofitable. Trawling and motorized push nets in shallow waters destroy seagrass leading to a reduction in fish catch and threaten the species which are dependent on them. Coral reefs in near shore areas are reported to be in poor condition due to sedimentation and the use of destructive fishing practices. The *Dugon dugon* is endangered by floating and fixed gill nets, especially in Kampong Som Bay.

Conservation approach

In 1993, the King designated 23 areas as protected. Four categories were created: national park, wildlife sanctuary, protected landscape, and multiple use areas. The Tonle Sap, Dong Peng (multiple use areas) and Peam Krasop (wildlife sanctuary) were designated as protected wetland areas. Three wetlands (Boeng Chmar in the Tonle Sap-Great Lake, Stoeng Treng and Koh Kapi in Koh Kong Province) were identified as sites of international importance. Stoeng Treng was designated by the Ministry of Environment as a demonstration site for the 'Mekong River Wetlands Biodiversity Conservation and Sustainable Use Project' that will run from 2003 to 2007. The Boeng Tonle Chmar Ramsar site has been designated as the core zone of the Biosphere Reserve. A number of sites in the Tonle Sap area are designated as fish reserves or fish sanctuaries. Most of the open waters bordering the flooded forests are allocated for fishing by the Department of Fisheries.

The Participatory Mangrove Management Resource Project is being implemented in the Peam Krasop Wildlife Sanctuary. This sanctuary is an important migration route for birds in the region.

Recommendations

Local communities and other stakeholders need to be involved in managing the wetlands. An economic valuation of wetlands should be undertaken to confirm the benefits of biodiversity. The approval of the Wetland Action Plan and the establishment of the National Wetlands Committee are necessary for integrated wetlands planning. A wetlands biological assessment should be conducted to provide a basis for wetland policy, planning and management. There need to be human and technical resources development and a review of alternative uses of wetland natural resources.

Agriculture in the Wetlands of Cambodia

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Introduction

Covering an area of 181 035 km^2, the Kingdom of Cambodia has a tropical monsoon climate comprising a dry season (November to April), and a rainy season (May to October). Average annual rainfall is between 1 200 to 1 400 mm in the central lowlands, 2 000 mm in the highland regions, and up to 3 000 mm in the coastal areas. The relative humidity varies between 65 and 90 per cent. The average temperature is around 27 °C. The Mekong River and its tributaries dominate the hydrology of the Kingdom. Cambodia's population density (59 people per km^2) is low compared to other Southeast Asian countries but the concentration is high in some areas of the Mekong River (up to 500 people per km^2). This paper surveys a number of issues relating to agriculture in Cambodia's wetlands, including the impacts of agriculture on wetland ecosystems and trends in pesticide and fertilizer use.

Land use

In 1999, the total crop production area was around 2.45 million ha. Rice farming accounted for 89 per cent of this area (Ouk Makara and Srun Sokhom 2001). At present, up to 40 per cent of land potentially suitable for agriculture is not used due to undetonated land mines, poor roads and other infrastructure deficiencies. Around 90 per cent of the rice area under cultivation is rainfed. The majority of fields in the rainfed lowlands are not very productive because of poor soil quality and uneven rainfall. Yields are 1.2 to 1.3 t per hectare, while the average yield in flood recession ecosystems is between 2.5 to 2.7 t per hectare. Other important crops cultivated are maize, rubber, vegetables, mungbean, soybean, cassava, tobacco, groundnuts, sesame and sugar cane. Oil palms and coffee are increasingly being cultivated in the northeastern highland regions.

Farms are characterized as low input and low output systems. However, this is changing as farmers in some regions adopt groundwater irrigation and more chemicals are being used in agriculture. No accurate data exist, however, as there are no regulations covering their use and reports on pesticide poisoning are anecdotal.

The most important environmental issue is deforestation. Deforestation and soil erosion are the leading causes of topsoil loss. This increases sedimentation in rivers and lakebeds, changes the flooding patterns, and disturbs aquatic life. There is now concern about the survival of the Tonle Sap Lake which has been the main rice growing and fish producing area in Cambodia for centuries. Other constraints to agricultural development are shortage of credit for rural farmers and poor irrigation systems. The government's agriculture policy, therefore, has three objectives: promote the cultivation of improved rice varieties; develop irrigation and infrastructure; and introduce modern agriculture technologies.

Impact of agricultural activities

Deforestation

In 1962, Cambodia reportedly had a forest cover of 13.2 million ha or 73 per cent of the country (Tichit 1981). Although official sources indicate that the cover is currently between 40 to 60 per cent, Global Witness, an active critic of logging practices in Cambodia, claimed the cover was halved to 35 per cent in the 1960s and a recent study claimed it was as low as 28 per cent (Global Witness 1997a). Deforestation in Cambodia is caused by logging, firewood collection, expansion of cultivated land and shrimp farming.

Coastal areas

The coastal areas of Cambodia contain important natural resources including beaches, river deltas, harbors, marine fisheries, and mangrove forests. Development in these areas must undergo much closer scrutiny to avoid environmental degradation. Mangroves and marshlands provide protection against wave actions, negative impacts of siltation and pollutants. They are also valuable for wood, fish and shellfish resources, wildlife, and recreational uses.

In the coastal areas of Koh Kong Province, aquaculture ponds degrade the ecology by the use of pesticides to disinfect the ponds before the release of fingerlings, as well as the use of lime to control the pH of the pond water.

Expansion of cultivated land

Agricultural production has increased by expanding areas for cultivation, introducing improved plant varieties, and investments in irrigation, fertilizer and pesticides. As a result of regular flooding, farmers around the Tonle Sap and those living along the Mekong and Bassac Rivers in Takeo, Prey Veng, and Kandal grow mainly deepwater rice (DWR). Since 1983, DWR has covered an average of 7.5 per cent of the total cultivated wet season rice lands (Table 6).

Low yield DWR has become a target for conversion or elimination and is forbidden in some parts of the country. Farmers have been encouraged to build elaborate waterworks - canals, dams and reservoirs - to make it possible to convert to irrigated dry season rice growing (Pijpers 1989). DWR cultivation has been drastically reduced and the seeds of most traditional varieties (TVs) lost.

Forest clearance for the growing of cash crops such as mungbean, cucumber, maize, bottle gourd, squash, sesame, and other vegetables is increasing. Cash crop production is also expanding in rainfed lowland rice (RLR) areas. The crops are grown from late April through May and are harvested from July to August before RLR is transplanted.

Soil erosion and sedimentation

Agricultural production in Cambodia is threatened by erosion and the sedimentation of riverbeds and lakes. Sixty-three per cent of the forests in Cambodia are located in the mountainous watersheds (MOE 1994) where the average yearly rainfall is as high as 2 000 mm or more. In the uplands, farming is generally practiced along slopes without any soil conservation measures where the erosion potential is high. Three months after clearing, one to 1.5 cm of the topsoil is typically lost (Yang Saing Koma 1997).

Available data on sedimentation reveal that rivers and lakes are gradually becoming shallower. In 1996, the maximum sediment load in the Tonle Sap River was 3 000 g/m^3, twice what it was in 1994 (PPWSA unpublished). In the Stung Sangker River, the sediment load measured in October 1963 was 63 mg/l, but it was 288 mg/l in October 1995. According to a measurement in 1963, the average yearly siltation rate of the Great Lake was 0.4 mm (Carbonnel 1963). Today, the aggradation of the lake is estimated at 2 to 5 cm/year (MOE 1994). The average depth of the lake has decreased from 4.5 m in January 1979

Table 6. Deepwater rice area in Cambodia as a percentage of the total area planted, 1949-89

Year	Deepwater Rice (ha)	Total Rice Area (ha)	DWR percentage of total rice area
1947 - 1949[a]	60 000 - 120 000	1 000 000 - 1 110 000	6.0 - 10.8
1958 [b,c]	85 000	2 030 000	4.2
1965 - 1966[d]	376 700	2 398 000	16.7
1966 - 1967[d]	390 300	2 479 100	15.7
1967 - 1968[d]	371 800	2 506 800	14.8
1983[e]	127 700	1 739 861	7.3
1984[e]	111 993	1 416 781	7.9
1985[e]	97 993	1 516 000	6.5
1986[e]	120 914	1 618 143	7.5
1987[e]	125 041	1 428 103	8.8
1988[e]	119 127	1 641 105	7.3
1989[e]	108 652	1 489 780	7.3

[a] Coyaud (1950)
[b] Delvert (1961) citation in Delvert for Bulletin statistique agricole 31 Janvier 1958 with no explanation for differing figures for cultivation areas from other sources, or definition other than floating rice.
[c] Tichit (1981)
[d] Hellei (1970)
[e] Ministry of Agriculture, Phnom Penh, unpublished data

to 3.5 m in January 1994 (Global Witness 1997). People living along the Tonle Sap have also reported increased sedimentation and siltation (Shams and Ahmed 1996 and CEDAC 1997).

Although there are insufficient data to support the lake drying up, the situation is very serious. Mottet (1997) claimed that if the present pace of deforestation remained unabated, the Tonle Sap Basin would very soon stop producing rice and fish. According to a study cited by Global Witness, there are two possible scenarios for the siltation of the Tonle Sap Lake as a result of deforestation. If no additional deforestation occurs, it will take around 935 years for the Tonle Sap to dry up from siltation. If logging continues at the current rate of 1.5 million m^3 per year, the Tonle Sap will be totally silted up by 2023. The exploitation of forests has led to reduced availability of resources to local communities; increased run off and siltation from commercial logging; reduced soil fertility (Shams and Ahmed 1996; CEDAC 1997); and changed flood patterns leading to food shortages in some parts of the country.

Use of pesticides and fertilizers

The use of pesticides and fertilizers in Cambodia is covered by Sub-Decree No. 69, Agricultural Material Standards, which was enacted by the government at the end of 1998. The Bureau of Agricultural Material Standards (BAMS), under the Ministry of Agriculture, Forestry and Fisheries, was established in 1999 to implement the sub-decree. Pesticides and fertilizers (except phosphate) are not produced in Cambodia. Almost 98 per cent of pesticides and 60 per cent of fertilizers are illegally imported from Vietnam and Thailand. Previously, during 1985 to 1992, pesticides and fertilizers were imported and distributed by the Central Company of Agricultural Materials (COCMA) of the former Soviet Union and other Eastern European countries (see Tables 7 and 8). Comparing the imports against rice cultivation (1 378 ha in 1987-88, and 1 932 ha in 1989-90) indicates a rate of 9.2 to 29.5 kg/ha.

In 1996-98, brown plant hoppers, armyworms, grasshoppers (*Locusta* sp.) and rats were reported to have infested rice and vegetables. Recently, a new pest, the Golden Apple snail (*Pomacea* sp.), has been recorded. In a few provinces it was being raised in ponds for commercial purposes. The Plant Protection Service is now promoting measures for their eradication. The use of pesticides is a common measure used by farmers to combat pests; however, their use can be potentially harmful to the environment and public health.

Based on information of the World Health Organization (1999), 76 per cent of pesticides available in Cambodia belong to class Ia (extremely hazardous), 16 per cent belong to class Ib (highly hazardous) and the others belong to class II (moderately hazardous). The most commonly used pesticides in Cambodia are Carbofuran, Parathion, Methyl Parathion, Mevinphos and Monocrotophos (Bal and Polo 1994). A survey indicates that farmers growing vegetables in some areas commonly use Folidol (Methyl-parathion) and Mevinphos (CEDAC 1997).

Pesticide use depends on the crop but is heavily concentrated in commercial vegetable production and dry season rice that together make up about 10 per cent of the total cultivated land. A Food and Nutrition Survey conducted in 1993-94 indicated that only 5 per cent of the 585 households interviewed used pesticide (UNICEF 1994). A national survey led by Cambodia-IRRI Australia Project (CIAP) showed that 8 to 50 per cent of wet season rice farmers used pesticides, while 40 to 100 per cent of dry season farmers applied pesticides (Jahn 1996). This survey also

Table 7. Fertilizers imported from the former Soviet Union, 1985-92

Year	Kinds and quantity of fertilizer (in thousand tonnes)					
	Ammophos	**16-20-0**	**Urea**	**15-15-15**	**18-46-0**	**TOTAL**
1985	10.205	6.304	12.778	0.059	-	29.346
1986	13.242	2.558	18.342	0.379	-	34.521
1987	0.180	11.559	20.914	0.067	-	32.720
1988	18.003	2.436	35.379	0.211	-	**56.029**
1989	13.701	1.705	15.740	0.093	-	31.239
1990	6.672	4.163	2.413	0.029	-	13.277
1991	-	11.377	4	0.001	-	15.378
1992	-	6.543	4.478	-	3.171	14.192

Table 8. Pesticide imported from the former Soviet Union, 1985-92

Pesticide Powder (PP) & Liquid Pesticide (LP)	Kind and quantity of pesticide imported by years (in tonnes for PP and in thousand liters for LP)							
	1985	1986	1987	1988	1989	1990	1991	1992
Endrin	1.898	0.024						
DDT	0.233	0.135	0.065	0.6		0.175		
Zinc phosphide	11.227	4.300	5.490	4.123	5.949	2.134		
Copper II Sulphade-5H2O			3.694	2.900	3.020			
Zineb			3.010	2.900	3.000		7.068	
Trichlofon				24.023	14.538	5.270	2.655	0.005
Gaxtoxin							2.000	13.372
Total Of PP	**13.358**	**4.459**	**12.259**	**34.546**	**26.507**	**7.579**	**11.723**	**13.377**
Malathion	7.043	0.431						
Metaphos	24.990	43.626	35.279	21.044	6.767			
Meliphos			2.050					
Dichlorvos			9.027		8.989			0.800
Azodrin			4.291	21.072	16.544	21.451	1.827	0.410
Filitox						11.705	2.820	
Wofatox							6.758	
Diazinon [j]								1.000
Sumicidin [j]								2.565
Fenvalerate [j]								4.000
Cypeffnhrin								8.226
Total of LP	**32.033**	**44.057**	**50.647**	**42.116**	**32.300**	**33.156**	**11.405**	**16.730**

Source: COCMA

[j] Japanese pesticide

claimed that wet season rice farmers generally apply insecticides during one or two crop stages, while dry season rice farmers generally apply insecticides during three or four crop stages. The quantity of pesticides per application is reportedly about half a liter per hectare.

Today, Cambodia still lacks regulation on pesticide and fertilizer management and on agricultural materials imported and distributed by the private sector. Limited information is available on the quantity and quality of pesticide use and its impacts. However, the Plant Protection and Phytosanitary Inspection Office of the Department of Agronomy (MAFF) is attempting to survey the pesticides available in the local market, farmer knowledge of pesticide safety, and the rate of pesticide use on different crops.

In 1993, the Department of Agronomy, with support from the Food and Agriculture Organization, established the National Integrated Pest Management Program to reduce the risks associated with pesticide use. An integrated pest management program for rice and vegetables has been implemented in 11 provinces and groups of trainers are available. A commitment to expand the program has been made and a number of institutions and NGOs have expressed their willingness to cooperate.

In 1995, the Department of Agronomy established the Pesticide Safe Use Program to address the lack of control on the importation, distribution and use of pesticides by farmers. The program was supported by the Japan International Cooperation Agency. Although abandoned in 1998, a proposal to renew this program has been submitted to the government by the Department of Agronomy and Agricultural Land Improvement (DAALI).

While limited information is available on the impact of pesticide use by farmers, development workers and research workers have reported cases of pesticide poisoning (Specht 1996). A study conducted by a Japanese researcher suggested a discernible level of residual toxicity in soil, water and vegetables (Bal and Polo 1994). Another study found the concentration of toxic substances such as dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyl (PCB) in fish tissue to be low and did not exceed the acceptable limits

defined by the World Health Organization (JSRC 1996). As these studies are nearly a decade old, however, new research is required to assess the current risks.

Some concerns have been raised about the effect of fertilizer use on soil fertility. Most of the fertilizers available in the local market, namely, urea, di-ammonium phosphate (DAP), 16-20-0, 15-15-15 and 16-16-8-13S are illegally imported from Vietnam and Thailand. It is believed that farmers do not use these fertilizers correctly. The use of 16-16-8-13S on high acid soils (as found in Svay Rieng Province) will increase soil acidity. The application of fertilizer on the sandy soil of the rainfed lowlands brings small benefits due to the soil's low exchange capacity. There is anecdotal evidence that after using fertilizers this kind of soil becomes harder.

Inorganic fertilizer consumption in Cambodia was estimated to be 80 000 t in 1995 and 100 000 t in 1996 and projected to increase to 200 000 t in 2000. In comparison to 1965, fertilizer consumption is 10 to 12 times higher now. Chemical fertilizer is mostly applied to flood recession and irrigated rice, commercial vegetables and other cash crops. The application of 200 to 300 kg/ha is common in dry season rice growing areas. In the rainfed lowlands, fertilizer is not applied to all fields and the common application is less than 100 kg/ha. One survey indicated that 35 per cent to 78 per cent of wet season rice farmers apply inorganic fertilizers. Another study indicated that 39 per cent to 58 per cent of the households surveyed used a combination of manure and chemical fertilizer while 8.5 per cent used chemical fertilizer only (UNICEF 1994).

Sustainable Use and Management of Cambodian Wetlands: Social and Institutional Challenges

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Introduction

Wetlands cover a sizeable portion of Cambodia. Hydrologically, wetlands provide flood mitigation, prevent salt-water intrusion, and recharge aquifers. Geomorphologically, they contribute to sediment trapping, reduction of soil erosion, removal of toxic substances and provide for waste recycling. Ecologically, wetlands are important habitats for birds and other important wildlife. Economically and socially, wetlands are important sources for livelihoods of rural communities.

Cambodia's wetlands are threatened by various activities such as drainage to create agricultural land, reclamation to create embankments and port facilities, dam construction, pollution and nutrient inputs from urban, agricultural, industrial and mining sources, over-fishing, illegal harvest of forest products and the introduction of exotic species. Other factors that contribute to wetland degradation include lack of legislation promoting sustainable use of wetlands, increasing population, privatization of communal marshes, and ineffective enforcement of existing legislation. The complex interaction of such factors is illustrated by an analysis of the sources of fisheries decline in Boeung Thom, Kampong Cham Province (Figure 14), a product of the "Inventory and Management of Cambodia's Wetlands Project."

In order to accommodate the needs of various stakeholders, to resolve conflicts and to provide for the sustainable development of Cambodia's wetlands, a number of social and institutional challenges must be addressed. This paper identifies some of the priorities.

Issues to address

Population pressure

The pressure from an increasing population exploiting wetland resources is a factor in the degradation of wetlands. To address this, it is imperative that:

- Resettlement plans should be reviewed with consideration given to conservation issues;
- Priority should be given to effective family planning including incentives to have smaller families; and
- Public awareness programs should be undertaken to improve understanding of the importance of wetlands.

Wetlands inventory and valuation

Long-term planning for resource exploitation relies on knowing the extent and status of the resources available. A national wetlands inventory should be compiled that would include biological and hydrological data as well as data on the socioeconomic value of wetlands. This inventory would act as a management tool to set priorities. Thus far, a geographic information system (GIS) survey of wetlands including fish spawning and migration sites, wildlife sites, and catchments has been completed. Work should continue on the collection of biological, hydrological and socioeconomic data. A review should be made of the information available for management planning to identify gaps and deficiencies and allow research priorities to be set. Monitoring changes to the character of wetlands should be an integral part of any inventory project.

On-site management issues

Coordination among agencies involved in the management of wetlands is important for their sustainability. There is a need to develop and implement integrated management plans that include input from local communities. It is recommended that such plans be developed and implemented on a regional basis.

Land ownership and resource rights

Local people must be given responsibility for the long-term sustainable management of wetlands and their resources. It is recommended that land

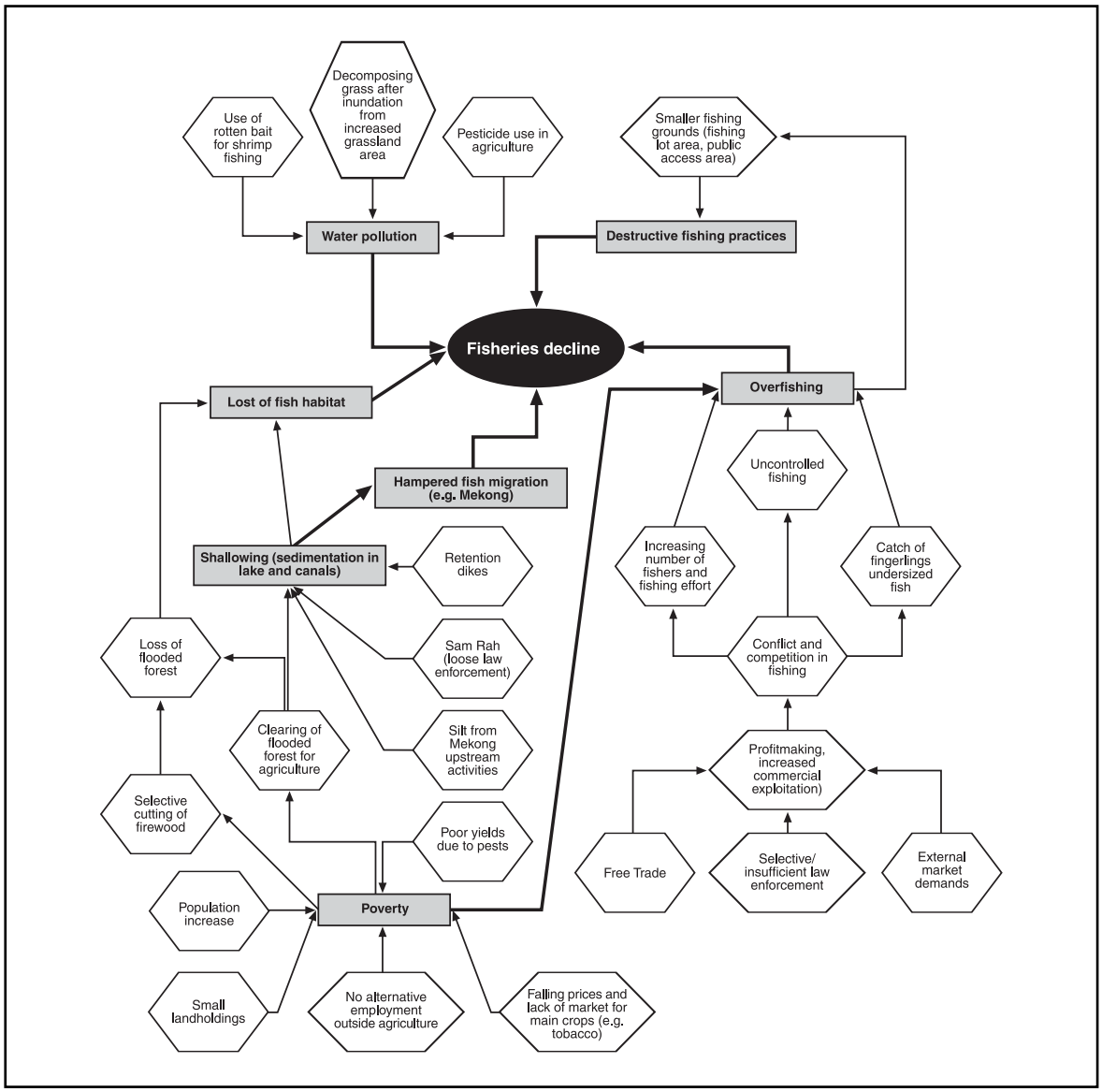

Figure 14. Problems in the Boeung Thom system

reform be carried out to ensure that those who use resources have a long-term incentive to do so in a sustainable manner. Where governments own land, there should be some form of stewardship whereby local communities are given rights over resources for periods of 25 years or more. For example, local communities may be given the right to harvest timber as long as it is done in a sustainable manner and reforestation is carried out. Methods by which commercial enterprises can be provided with long-term stewardship of resources should be identified as a model to encourage sustainable use and development.

Strategic zoning

In order to manage and protect wetlands, a number of zones should be established:

- A Conservation Zone to preserve the structure and function of ecosystems for sustainable biodiversity;
- A Buffer Zone to prevent residential and industrial expansion into conservation zones;
- A Mixed Urban Zone to facilitate integrated economic growth and generate employment; and
- A Residential Zone to facilitate settlement planning and residential development.

Community participation

Community participation in the management of wetlands and their resources is an essential

ingredient for sustainable development. Community-based resource management offers one of the best solutions for more effective conservation of wetlands. To ensure community participation in wetland management, mechanisms must be established that involve the community in all stages of planning and implementation. Development projects must be evaluated against national imperatives and the development needs of the people. Partnerships should be encouraged with local people by providing leadership, guidelines for management policies and legislation, and exploring alternative livelihoods to compensate for lost income and income formerly derived from unsustainable use of the wetlands.

Decentralization

One element in the process of involving communities in natural resources management is to decentralize certain government functions. Applied to the management of natural resources, decentralization implies that certain guidelines are formulated at the national level (legislative framework), and implementation occurs at regional and local levels which can adapt the framework to local circumstances.

Transboundary wetlands conservation and international cooperation

Wetland conservation is a regional issue. Cambodia should promote bilateral or multilateral arrangements with countries where wetlands are situated along migratory paths for fish and wildlife. Information on wetlands and water systems should be shared where such wetlands or water systems cross borders. Transboundary conservation and international cooperation on wetlands management should be promoted in the context of existing multilateral environmental agreements for which Cambodia is a signatory, in particular: The Convention on Biological Diversity (CBD); Convention on International Trade in Endangered Species (CITES); Convention on the Wetlands of International Importance (Ramsar, Iran, 1971); and, Mekong River Commission Agreement on Sustainable Development in the Lower Mekong Basin.

Priorities

Wetlands require coordinated management among stakeholders. A number of priority issues would facilitate such coordination. These actions include the adoption of a Wetland National Action Plan and the establishment of a National Wetland Committee chaired by the Ministry of Environment. The committee would include representatives from all stakeholder groups. Operating at the national, regional and local levels, the committee would work to:

- Create more wetland areas;
- Protect important and threatened wetland areas;
- Review existing legislation pertaining to wetlands;
- Increase public awareness in the importance of wetlands;
- Ensure stakeholder participation in wetland management;
- Encourage more research in wetland areas by allocating additional funding;
- Establish conservation, buffer, mixed urban and residential zones;
- Resolve conflicts among government agencies with respect to their responsibility for wetland protection; and
- Establish National Wetland Working Groups to identify sensitive resources; carry out adaptive resource management; conduct environmental impact assessments; establish environmental and hydrological models; create an information exchange and monitoring network; and complete an inventory of habitat and migratory passages in wetlands and watersheds.

This process should improve knowledge, dialogue and adaptiveness, leading to better long-term decisions affecting wetland biodiversity and sustainable use.

Conclusion

Important wetlands at risk in Cambodia include the Tonle Sap Lake and River, and the Mekong and Bassac Rivers. Their conservation can only be achieved by a coordinated program developed in partnership with all stakeholder groups. Common resources require a common responsibility to ensure their sustainability.

Existing Institutional, Legal and Policy Frameworks for Wetlands Management in Cambodia

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Introduction

Wetlands cover about 30 per cent of the country and 20 per cent of these areas are recognized as wetlands of international importance. Wetlands are important to Cambodia both culturally and economically because most people live in these areas. Given the crucial importance of these areas, a nationally coordinated wetland policy is urgently needed. Such a policy must bring together all the sectors involved in wetland use and management. Thus far, no formal policy on wetland management has been formulated by the Royal Government of Cambodia.

Institutional setting for wetlands management

Management of wetlands in Cambodia lies with a number of sectoral agencies that follow policies and laws specific to their mandates, resulting in poor coordination among agencies. For example, flooded mangroves and forests are presently the responsibility of the Department of Fisheries, but areas beyond tidal influence such as *Melaleuca* forests are under the jurisdiction of the Department of Forestry. In terms of conservation and management of wetland biodiversity, both the Ministry of Environment and the Ministry of Agriculture, Forestry and Fisheries are involved. The Ministry of Environment has a mandate to manage protected areas and is the administrative authority for Cambodia's commitments to the Ramsar Convention and the Convention on Biodiversity. The Ministry of Agriculture, Forestry and Fisheries is the National Management Authority for the Convention on International Trade in Endangered Species (CITES) and, through the Department of Fisheries, is responsible for the fisheries as defined by the Fisheries Law, including concessions, fish sanctuaries, inundated forests, swamps and other fish production areas.

Two intersectoral bodies encourage interagency cooperation: the Council for Development of Cambodia (formed by the Council of Ministers) and the Cambodia National Mekong Committee (CNMC), established in 1957. The former coordinates overall development while the latter oversees water management issues within the Mekong River Basin and is part of the Mekong River Commission (MRC). The CNMC is an intersectoral committee with broad responsibilities for water and wetland issues and is one of the few existing mechanisms that can promote collaboration and intersectoral integration. A working group under the CNMC guides the development of the National Wetland Action Plan.

Since these committees deal with development issues and not specifically with coastal and marine issues, the government established the National Coastal Steering Committee comprised of undersecretaries of state from relevant ministries and the governors of the four coastal provinces. The committee was established with the assistance of Danida's Coastal Management Project. Although its initial objectives were to coordinate and guide environmental initiatives in the coastal areas; it has no legal standing.

Legal and policy frameworks

Owing to the absence of a national coordinating body for wetlands, management issues are dealt with sectorally where legal and institutional mandates exist. This results in a situation whereby wetland-related issues are handled in a piecemeal and indirect fashion. Cambodia needs a national wetland policy that can coordinate wetland development to ensure sustainable use.

The Law on Environmental Protection and Natural Resource Management recognizes the need for cooperation among agencies and the public for the management of natural resources, and requires that environmental impact assessments be conducted for all private and public projects. However, the Ministry of Environment has no comprehensive regulations on resource extraction, management of fisheries, forestry and mining; nor does it have any standards for waste management practices. Only a few isolated laws exist on environment protection; these are drawn from provisions made

during the French colonial period, provisions in contractual agreements between the State and commercial interests, statements of intent within the mandates of individual ministries, and in some cases, decrees.

While there is no legislation specific to wetlands, a number of ministries and departments have regulations pertaining to various sectoral uses of wetlands, mostly in the form of fisheries laws. Some of these laws are conflicting and could promote activities that result in the loss of wetlands. They should be reviewed to determine potential conflicts. Some of the major legal frameworks related to wetlands include:

- **Law on Environmental Protection and Natural Resource Management**
  The objectives of this law, approved by the National Assembly in 1996, are to protect, manage, and enhance the environment and to promote sustainable socioeconomic development. It places responsibility for environmental planning, protected area management, environmental impact assessment, environmental monitoring, pollution control and inspection, and public participation under the Ministry of Environment.

- **Royal Decree on the Creation and Designation of Protected Areas**
  This legislation forms the basis for the protected area program in Cambodia and designates the Ministry of Environment as the agency responsible for planning for and development in the protected areas system.

- **National Forest Law**
  Promulgated in 1988, this law underwent extensive review. Efforts to strengthen forest policy have been supported by the World Bank. The new Forest Law was recently adopted by the national assembly.

- **Fisheries Law**
  Fisheries conservation, management and development are the responsibilities of the Department of Fisheries. The new fisheries law, which is still in draft form, encourages integration of fisheries management with rural development by extending responsibilities for fisheries management to fishing communities and increasing the protection and sustainable use of fishery resources. The management of mangrove and flooded forests is included in the draft and it is expected that other aspects of wetland use will similarly be included.

Some of the major international agreements having implications for wetland management to which Cambodia is a party include:

- **United Nations Convention on the Law of the Sea (UNCLOS)**
  As a signatory, Cambodia is committed to the provisions of UNCLOS, specifically those pertaining to: conservation and preservation of the marine environment (Part XII Section 1, Articles 192, 197, 199, and 200), monitoring and environmental assessment (Article 4), prevention, reduction, and control of pollution (Articles 207 and 208), and sustainable exploitation of marine resources (Article 62).

- **Convention on Biological Diversity**
  Cambodia acceded to this Convention on 9 February 1995. This convention calls on all countries to develop and implement national plans to ensure biological diversity.

- **Convention on Wetlands (Ramsar, Iran, 1971)**
  Cambodia acceded to the Convention on Wetlands on 23 October 1999. The Convention calls on all countries to set aside wetlands of international importance, especially those important to migratory waterfowl and waders. Designated Ramsar sites in Cambodia include the Koh Kapik area, Boeng Chhmar and its associated creek systems, and the middle stretch of the Mekong River north of Stung Treng.

- **UNESCO Man and Biosphere Reserve Program**
  Cambodia has designated the Tonle Sap Lake as its first biosphere reserve. Since its designation and approval by UNESCO in 1997, there has been no agreement on how the reserve is to be managed. The most contentious issue lies with the three core areas that, according to the guidelines, should be free from extractive uses. Efforts are being made to resolve this issue by reshaping the core areas and mandating less stringent management regulations governing them.

- **Convention on International Trade in Endangered Species (CITES)**
  Cambodia became a signatory on 2 October 1997. The Ministry of Agriculture, Forestry and Fisheries is designated as the CITES national management authority secretariat. The scientific responsibility lies with the Department of Forestry and the Department of Fisheries. The Convention establishes mechanisms that facilitate international cooperation on the regulation of wildlife trade.

Lessons from the "Participatory Natural Resource Management in the Tonle Sap Region" Project

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Introduction

At the heart of Cambodia lies the *Tonle Sap Great Lake* with its slow annual pulse of rise and fall. During the dry season the lake covers some 250 000 ha, but as the Mekong River rises at the start of the monsoon, the drainage of the lake reverses direction and flows back into the lake until some 1.25 million ha are underwater several months later. This unique annual cycle has created an exceptionally productive ecosystem for fish and wildlife. The productivity was central to the development of the Angkor Empire a millennium ago and today still serves as the foundation for development in the region.

Central to the productivity of the Great Lake is the extensive forest and associated vegetation surrounding the lake. This unique seasonally flooded forest provides habitat and food for numerous fish species and supplies the nutrients that support an exceptionally high fish population within the lake. Extensive clearing of this unique flood forest vegetation, and the associated threat to fish productivity in the lake, led the Government of Cambodia in 1992 to seek donor support to investigate and develop management options. In 1993, the Government of Belgium, through the Food and Agriculture Organization of the United Nations (FAO), implemented a project called "*Restoration and Preservation of the Inundated Forest Ecosystems of the Tonle Sap and Downstream Areas*." This initial project was a preparatory phase of 12 months duration and resulted in the formulation of the project "*Participatory Natural Resource Management in the Tonle Sap Region*."

The *first phase* of the project was begun on 1 January 1995 for a three-year duration until 31 December 1997, which was eventually extended until 31 August 1998. The overall objective of the first phase was "*to introduce and promote environmentally sustainable integrated natural resource management strategies which aim to improve the socioeconomic well being of the inhabitants of the Tonle Sap inundated forest ecosystem.*" The project was implemented through the provincial departments of forestry, fisheries and environment within the province of Siem Reap. Baseline studies were conducted on the socioeconomic status of fishing and agriculture-based communities living near the Great Lake. Basic data were collected on the flora and fauna of the lake and studies were conducted on fish-habitat relationships. Numerous trials were conducted on reforestation and income generating activities. In late 1997, initial work on participatory natural resource management was undertaken at a pilot site of some 2 600 ha within the flood forest ecosystem. The overall emphasis in Phase 1 was on data collection, field trials and capacity building of local staff. The results of Phase 1 provided a solid foundation on which a second phase focused on *field implementation* of community-based natural resource management was carried out.

The *second phase* of the project represented the *implementation phase*. The emphasis was on development and implementation of community-based natural resource management over a wide area and within a variety of environments and/or jurisdictions, i.e. Forest Department Land, Fishery Domain, and National Parks. The staff went to the field to *learn by doing* with the local communities. *Community fisheries* were initiated within the inundated forest and *community forestry* was conducted in the upland forests and within Angkor Park and Phnom Kulen National Park. At the start of the second phase, the project was assisting six villages with the management of the 2 642 ha Pilot Unit. By the end of the second phase, some *70 000 ha* of inundated forest and *20 000 ha* of upland forests were under community protection and management by some *180 villages* located throughout the province of Siem Reap.

During the second phase, the project became recognized at the national level as a *model project* for community-based natural resource management in the country. Numerous organizations sent their staff to see and learn from what was being done in Siem Reap. Field results from the project have been used to influence both policy and legislation within both the forestry and fishery sectors. Project activities were also instrumental in triggering the *fishery reform process* in late 2000, which resulted in the release of *536 289 ha* from the commercial fishing lot system to local communities for *community fisheries management*.

Current objectives

The project is currently in its third phase of a 30-month duration from 1 November 2001 to 30 April 2004. The overall project objective of the third phase is:
"To establish responsible, productive and sustainable management of forest and fishery resources by local communities to meet local needs, and to stimulate local development within the province of Siem Reap."

Specific immediate objectives are:

1. Development of community fisheries within Siem Reap province;

2. Establishment of community forestry within Siem Reap province;

3. Promotion of private and community-based development activities in support of natural resource management; and

4. Institutional strengthening and local / regional capacity building.

Results

The *third phase* of the project represents the *consolidation phase*. Emphasis is on the establishment of both community fisheries and community forestry within the province of Siem Reap. Standardized guidelines are being prepared for use in other parts of the country and emphasis is on the transfer of knowledge and experience to other provinces.

At this point in time (October 2003), the project is assisting 116 villages organized into 10 *community fisheries organizations* with the protection and management of 110 000 ha of inundated forest / fishery grounds. All sites are officially recognized at the provincial level and management plans have been finalized for two organizations and are in draft form under consultation for the remaining eight organizations[3]. Twelve community-managed fish sanctuaries are established to protect brood stock during the dry season. Emphasis is now on management planning to establish income generation, the control of destructive fishing practices, communication and extension among all primary and secondary users, and the control of access to the resources by secondary users. Participatory monitoring and evaluation of fish harvests is now under development.

Community forestry has gained considerable support among provincial officials and the project has facilitated the establishment of 44 sites with 86 villages. A total of 21 management plans have been finalized and the remaining sites are in various stages of development. Emphasis is on communication/extension, management planning and management plan implementation. The project is now working to establish income generation through community forest management to both support management and contribute to local development.

Other supporting activities include:

1. *Aquaculture* - over 1 000 farmers have been trained and are supported by the development of 2 fish hatcheries and 8 nurseries;

2. *Agroforestry* - roughly 100 000 seedlings are produced and outplanted each year with emphasis on on-farm planting with poor farmers;

3. *Horticulture* - 22 private nurseries established to produce improved fruit trees;

4. *Rural credit* – a total of US$30,000 in revolving funds and low-interest credit has been provided with an emphasis on poor women; and

[3] Both community fisheries and community forestry have integrated into the commune, district and provincial planning frameworks.

5. *Environmental education* - some 5 000 children have been educated in the GECKO Center and in an outreach program with nearby communes. Several thousand people have participated in adult environmental education programs in the villages. Additionally, a new environmental education program has been launched in primary schools utilizing the project's environmental education activities manual.

Conclusions

The project has made significant progress in the development of both community fisheries and community forestry within the province of Siem Reap. Over 130 000 ha of upland forest, inundated forest and fishing grounds are now under community protection and management. The key outstanding issue is whether or not the communities will be granted proper control over their resources through the pending legislation. The interest exists at the community level and there is great potential to protect and conserve extensive areas of natural resources while reducing local poverty and stimulating development, if the political will is there to truly empower the people. To develop community-based natural resource management, minimum inputs are required. The people simply need assistance from well-trained staff who receive sufficient salaries and have means of transportation to enable them to work full time as facilitators in the field.

The Need for Improved Valuation of Cambodia's Wetland Fisheries

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Introduction

Approximately 84 per cent of Cambodia's population (11 million) live in rural areas and depend on farming and fishing for their livelihood (National Institute of Statistics 1998). It is thought that fish resources are declining due to habitat degradation from such activities as water engineering, land clearing, and an increasing population that puts pressure on the fish resource for food and employment. If proper management measures are not taken, fisheries resources will continue to decrease and recovery will become more difficult.

Recent catch statistics

In the years 1994-97, estimates of annual inland fish production ranged from 290 000 t to 430 000 t per year (Table 9). Of the significant sectors, fishing lots represented a catch of 30 000 to 60 000 t, ricefield fisheries contributed 45 000 to 110 000 t while family fisheries ranged between 115 000 to 140 000 t.

Food security

Fish and rice are staples in the Cambodian diet. Fish is inexpensive and a good source of protein. The 2.3 million people living around the Great Lake and along the Mekong and Bassac Rivers consumed 163 000 t of fish or 75.6 kg per capita per annum (Ahmed et al. 1998). This is the highest level of fish consumption among riparian countries in the Lower Mekong Basin. This quantity is comparable to Japan, Norway and some fish-consuming communities in the Pacific Ocean (Jensen 2001). In comparison, beef, pork, chicken and duck are consumed at a rate of 8 kg per capita (Ahmed et al. 1998).

Table 9. Range of annual inland fish production (tonnes), 1994-97 (Ahmed et al. 1998; Diep et al. 1998)

	Range
Fishing lots[1]	30 000 - 60 000
Dai (Bagnet)[2]	15 000 - 20 000
Middle-scale fisheries[3]	85 000 - 100 000
Family fisheries[3]	115 000 - 140 000
Rice field fisheries[4]	45 000 - 110 000
Total	290 000 - 430 000

[1] Range reflects uncertainty in actual catch level
[2] Range shows approximate minimum and maximum values, 1994-98
[3] Based on socioeconomic survey data extrapolated to entire country
[4] Approximately 1.8 million ha x likely range of fish yield = 25 – 62 kg/ha

Employment

About 1 million people make their living by fishing (O'Brien 1999). Eleven per cent of the households in the fishing-dependent communes around the Great Lake and along the Mekong and Bassac Rivers are engaged full-time in fishing and related activities while 35 per cent are part-time. Besides fishing, some people farm, make nets and other gears, and process fish. These fisheries-related businesses can be started up easily with little capital and low risk (Ahmed et al. 1998).

Economy

The annual value of fish landings have been estimated at US$150 to US$250 million. This represents 20 to 30 per cent of the total estimated value of fisheries production in the four countries of the lower Mekong basin. In a study on the collection of ricefield food in three villages (Samakee, Thanal Keng and Thluk Pring in Svay Theap District, Svay Rieng Province), the value

Table 10. Value of fish and other aquatic products in comparison to rice (Gregory et al. 1996)

Village	Average Yield (kg)	Value (USD)	Rice: fish ratio
Samakee	Rice 1 100 Fish/other aquatic products 446	162 357	1:2.3
Thanal Keng	Rice 3 480 Fish/other aquatic products 765	512 611	1:1.2
Thluk Pring	Rice: 3 024 Fish/other aquatic products 953	445 762	1:1.7

of fish and other aquatic products was higher than that of rice (Gregory et al. 1996). This value may be lost if the fisheries are not managed in a sustainable manner (Table 10).

The Great Lake

A unique characteristic of the Cambodian wetlands is the Great Lake system which is estimated to be 5 000 to 6 000 years old (Carbonnel and Guiscafre 1963). The water reverses its flow in the rainy season (Hoskin and Hopkins 1991) enlarging the Lake four to six times of the dry season level (van Zalinge et al. 2000). When the Mekong River flows into the lake, many migratory fish species follow the current to spawn in the lake and its surrounding wetland areas. For most of the wetland species, the spawning season starts with the rainy season. From December to May, the water flows from the Great Lake and the floodplain back through the Tonle Sap River into the Mekong River. During this time, migratory fish become more active and can be caught in great abundance.

Fish yield in the Tonle Sap Lake

The Tonle Sap is known to be highly productive. An estimate from the Project for the Management of Freshwater Capture Fisheries in Cambodia indicated that 164 000 t of fish were caught from fishing lots, middle-scale *dai* fisheries (bagnet) and family fisheries. This accounts for 45 per cent of the total fish catch in the country, or a yield of 112 kg/ha/year. However, this fish yield is lower than the 173 kg/ha/year maximum yield in the Lao PDR and the 175 kg/ha/year in Australia (van Zalinge, personal communication.). While fish caught in Cambodia may be smaller in size, a comparison of ecosystems suggests that the Cambodian fishery should be more productive. This indicates that the fish catch is likely to be significantly underreported.

Conclusion

There is a need to confirm fish yield by habitat to establish sustainable exploitation levels. A full economic valuation of wetlands and wetland fisheries should be carried out to determine development planning.

Value of Floodplain Fisheries in Kompong Traolach District, Kompong Chhnang Province

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Introduction

The high productivity of floodplain fisheries comes from the complex ecosystem created by large expanses of land that are seasonally inundated. This allows a wide range of fish species to exploit diverse habitats, and the people living in the Mekong River Basin exploit these rich aquatic resources to their benefit. While a great deal is known about the commercial fishery in Cambodia, small-scale family fisheries of the Mekong basin have only recently received attention. Researchers believe these fisheries account for an important part of the total production. In an effort to assess this value, a long-term monitoring study (Assessment of Mekong Fisheries Component of the MRC Fisheries Programme) began in mid-September 2000 to estimate the total production yield of small-scale subsistence fisheries in floodplain zones (excluding the fisheries on the main river). A pilot site was selected and a full season study was undertaken including social, biological and economic assessments.

Study area

The selection process

The two main criteria used in selecting the study area were: (1) site location, where the population and the fisheries were representative of other areas in Cambodia, and (2) site demarcation, whose boundaries were clearly defined. The site had to be in an area fished with barrage fences on the Tonle Sap River so that the total catch per unit of area could be estimated. Radarsat imagery, provided and analyzed by Hatfield Consultants Ltd. (Canada), was used to define the extent of flooding and confirm discharge channels and villages. In 1999, a team from the Mekong River Comission's Assessment of Mekong Fisheries Component (AMFC) assisted by Hatfield Consultants Ltd., surveyed areas along the Tonle Sap River. Proximity to Phnom Penh was another consideration.

The location

Covering approximately 82 km^2 of seasonally inundated floodplain, the study area is located in Kampong Chhnang Province, approximately 60 km north of Phnom Penh, with a smaller crescent-shaped section overlapping Kandal Province (Figure 15). Following the Tonle Sap River on Road No. 5, the study area begins where the road bends west before entering Kompong Chhnang Province. The southern and western boundaries follow Road No. 5 for 18 km. The top west corner is at the Salalekpram intersection and a smaller road, connecting Road No. 5 to the Tonle Sap River, forms the north boundary. Farming and fishing dominate in the land where rice paddies and palm trees are widespread; the area is characteristic of the lowland along the Mekong and Tonle Sap floodplains. Land use maps show a band of land, approximately 4 km wide, flanking the Tonle Sap River, which are flooded several months of the year. During the peak of the monsoon season, flooding reaches as far as Road No. 5. The area is moderately populated, comprising 29 villages with a population of 23 902 in 4 676 households.

Village selection

Eight villages were selected with an emphasis on their access to a variety of water bodies. Rapid rural appraisal (RRA) and participatory rural appraisal (PRA) methodologies were used, as well as stratified random sampling for more detail, to create three categories based on the degree of inundation. The first category applied to villages along the Tonle Sap River while villages set apart from the Tonle Sap but having access to a range of fishing areas were in the second category. Villages both far from the Tonle Sap and having limited

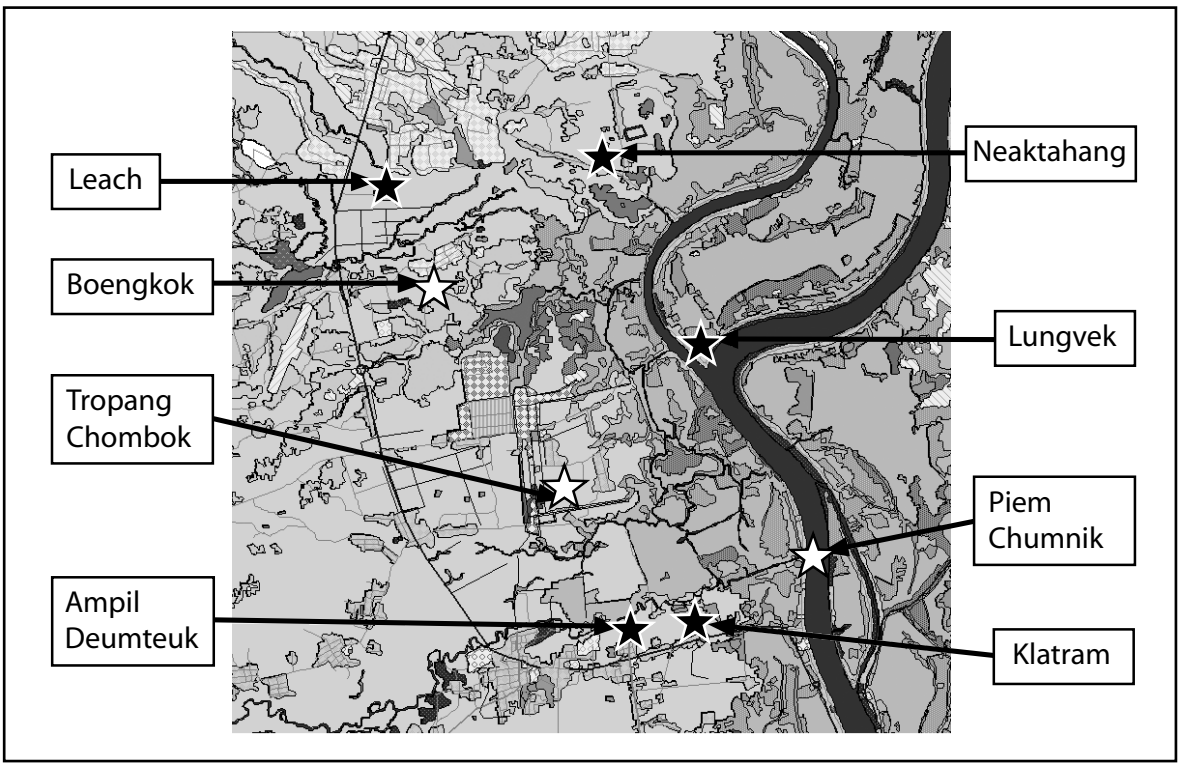

Figure 15. Map of study sites, Kompong Traolach District, Kompong Chhnang Province

access to fishing habitats were considered in the third category. Among the villages selected, 3 have fewer than 100 households, 4 have between 100 and 200, and 1 has more than 200 households.

Selection of monitors

The intention was to select a representative group of villagers based on such criteria as gender, age, literacy and involvement in the fishery. The village head was asked to find a group of eight volunteers willing to participate in the study. Including those who have since dropped out, 111 people have been involved in the study, 96 men and 16 women. Adults made up the largest group (85 per cent), children were 10 per cent (9 boys and 2 girls), and the remaining 5 per cent were mature adults over the age of 45.

Data collection

The volunteers were asked to record (on a daily basis) information about their fishing activities, using a logbook system. There were two main sections in the logbook questionnaire. The first part covered details about the catch such as what was caught, where and how; the second was on how the catch was processed. Additional information on related fishery activities such as boat and gear repairs was also included. Habitats in the study included lakes, reservoirs, streams, canals, ponds, with dry rice and wet rice habitats being the most important.

Summary of results

Aquatic biodiversity in Kompong Traolach wetlands

Fish

At least 75 fish species found in the wetland area are identified as migratory species (Table 11). The species caught in each habitat were recorded, but it was not known by what gear as this was not asked. On occasion, villagers provided the list of habitats, gears, and species without specifying the connection among the three parameters.

Aquatic animals

A number of bivalves were recorded such as *Pila ampullacea* and *Sinotatis ingallsiana*. They are not as economically significant as fish, but they are important (Baird et al. 1998). A number of crustacean species were also found, including many kinds of shrimp (*Macrobrachium lanchesteri*) and crabs (*Somannia thetpurabrandti*). Detailed taxonomic investigations have not yet been conducted locally. Shrimp may not appear to be an important food source; however, during the rainy season, shrimp are commonly caught

Table 11. A sampling of fish species recorded in the study area

Local name	Scientific Name
Bobele	*Dasyatis laosensis*
Antong Tunleir	*Anguilla marmorata*
Kray/kaey	*Chitala ornata*
Slat	*Notopterus notopterus*
Kbork	*Tenualosa thibaudeaui*
Chhmar	*Lycothrissa crocodilus*
Korntors Plukh/Sleok Rusey	*Paralaubuca typus*
Dangkhteng/Dangdao	*Macrochirichthys macrochirus*
Chroleong/Prolung	*Leptobarbus hoevenii*
Keatsrong	*Cyprinus carpio*
Kamput Chramos	*Amblyrhynchichthys truncatus*
Kampoul Bai	*Cosmochilus harmandi*
Sraka Kdam	*Cyclocheilichthys armatus*
Cha Keng	*Puntioplites proctozysron*
Kulprich	*Systomus binotatus (Puntius binotatus)*
Ampil Tum	*Systomus orphoides (Puntius orphoides)*
Keat Srong	*Poropuntius deauratus*
LoLoksor	*Hypsibarbus malcolmi*
Kanh Chrea	*Systomus partipentazona*
Ankat Prak	*Scaphognathops bandanensis*
Kulreang/Kahor	*Catlocarpio siamensis*
Linh	*Thynnichthys thynnoides*
Phkarkor	*Barbichthys nitidus*
Kaek	*Morulius chrysophekadion*
Kroleng / Pruol	*Cirrhinus microlepis*
Krom	*Osteochilus melanopleurus*
Seis / Chungchuk	*Gyrinocheilus pennocki*
Chhar	*Hemibagrus wyckioides (Mystus wyckioides)*
Khlang hai	*Belodontichthys dinema*
Ta Aun	*Hemisilurus mekongensis*
Kromom	*Ompok krattensis*
Chhke Nhy / Kropaut / Sandai	*Wallago attu*
Keir	*Pangasius bocourti*
Ses/Tro Ses/ Iveir	*Pangasius krempfi*
Andeng	*Clarias batrachus*
Phtong	*Xenentodon cancila*
Kchung	*Mastacembelus armatus*
Chhlong	*Macrognathus siamensis*
Andtong Beng	*Monopterus albus*
Proma	*Boesemania microlepis*
Kantrorp	*Pristolepis fasciata*
Kranh	*Anabas testudineus*
Kanthor	*Trichogaster pectoralis*
Ros / Phtok	*Channa striata*
Chhdor / Diep	*Channa micropeltes*
Kachtoncheiy	*Channa grandinosa*
Damrey	*Oxyeleotris marmorata*
Khane	*Glossogobius giurus*
Klar	*Coius undecemradiatus*
Kanhchea Sla	*Toxotes chatareus*
Kantrang Preng	*Parambassis siamensis*
Andat Chhke	*Cynoglossus microlepis*
Bondol Ampov	*Clupeichthys aesarnensis*
Ach Kok	*Dangila sp.cf. lineata*
Kanchanhchras	*Parambassis wolffi*

continue ➡

in scoop nets for subsistence. The habitats in the study area also support a variety of frogs, water snakes, and aquatic turtles (Table 12). Although these animals are consumed in relatively small quantities, they seem to be significant to the local people. Frogs are also known to be important indicators of environmental health and biodiversity (Kottelat and Whitten 1996).

Table 12. Aquatic animals found in the study area

Lacal Name	Scientific Name
Kadam	*Somanniathelpusa brandti*
Kaong	*Pila ampullacea*
Kchao	*Sinotaia ingallsiana*
Kankeb	*Ranatigrina*
Kampeus	*Macrobrachium lanchesteri*
Pours	Snake (Scientific name unidentified)
Andeuk	Tortoise (Scientific name unidentified)

Fish productivity and yields

The total fish catch of the participants during the 13-month study period was 35 378 kg. Monthly village catches are listed in Table 13.

In Table 14, column N represents the number of records for each habitat. Mean values are calculated from individual daily catch and total hours spent fishing. The column (% of Sum) is calculated using the sum of the total for each parameter. Mean and standard deviations of CPUE are calculated from individual daily values (kg of fish and other aquatic animals combined) divided by total daily effort (in hours).

Table 13. Monthly fish catch of study participants, by village (kg)

Year	Month	Village Name								Total
		Ampil Deumteuk	Boengkok	Klatram	Leach	Lungvek	Neaktahang	Piem Chumnik	Tropang Chombok	
1999	Sep	212.50	366.90	341.30	80.10	292.00	202.70	790.50	196.90	2 482.90
1999	Oct	615.50	620.60	525.40	213.50	488.40	365.80	1 191.00	336.00	4 356.20
1999	Nov	647.60	502.30	387.10	219.30	641.60	406.30	1 042.20	373.60	4 220.00
1999	Dec	698.20	465.00	375.80	172.40	550.30	397.40	1 320.80	523.40	4 503.30
2000	Jan	717.70	506.50	441.30	189.80	212.40	373.10	378.50	698.20	3 517.50
2000	Feb	472.60	330.60	332.20	139.70		399.70	166.00	487.20	2 328.00
2000	Mar	407.50	233.00	379.30	92.80		348.80	136.00	351.00	1 948.40
2000	Apr	487.50	278.60	193.30	65.90		309.00	13.50	286.20	1 634.00
2000	May	731.30	259.60	290.90	91.20		363.60		417.20	2 153.80
2000	Jun	873.00	507.70	250.10	69.10		357.90		742.10	2 799.90
2000	Jul	641.20	404.40	437.40	57.10		446.40		510.20	2 496.70
2000	Aug	553.60	361.30	385.90	91.40		432.90		333.60	2 158.70
2000	Sep	187.10	148.80	112.50	27.80		164.90		138.00	779.10
Total by village		7 245.30	4 985.30	4 452.50	1 510.10	2 184.70	4 568.50	5 038.50	5 393.60	35 378.50

Table 14. Daily effort, catch size and CPUE by habitat type

Habitat	Catch (kg)					Other animals (kg)				Effort (ha)				CPUE (kg)	
	Sum	N	Mean	Std. Deviation	% Total Sum	Sum	Mean	Std. Deviation	% Total Sum	Sum	Mean	Std. Deviation	% Total Sum	Mean	Std. Deviation
Dry rice	17 150.60	6 030	2.8	2.2	50.79	1 203.90	0.2	1	35.16	25 993.45	4.31	2.66	50.22	0.83	0.67
Canal	4 981.10	1 755	2.8	2	14.75	213.9	0.12	0.7	6.25	6 213.20	3.54	2.48	12	1.07	1.04
Reservoir	4 135.10	2 052	2	1.9	12.25	384.2	0.19	0.9	11.22	5 895.20	2.87	1.86	11.39	0.85	0.67
Lake	3 439.20	1 645	2.1	2.8	10.19	229.5	0.14	0.6	6.7	5 984.54	3.64	2.48	11.56	0.65	0.64
Stream	2 085.70	1 126	1.9	1.6	6.18	356.5	0.32	1.4	10.41	3 354.00	2.98	1.87	6.48	0.87	0.75
Wet rice	1 647.40	1 408	1.2	1.5	4.88	967.2	0.69	1.3	28.25	3 806.98	2.7	1.99	7.35	0.85	0.77
Pond	322	264	1.2	1.3	0.95	68.7	0.26	0.9	2.01	502.7	1.9	1.32	0.97	0.91	0.83
Other	5.5	4	1.4	1.1	0.02	0	0	0	0	10.7	2.67	2.24	0.02	0.53	0.03
Total	**33 766.60**	**14 284**	**2.4**	**2.2**	**100**	**3 423.90**	**0.24**	**1**	**100**	**51 760.77**	**3.62**	**2.47**	**100**	**0.85**	**0.75**

Table 15. Catch disposal by village (%)

Village	Eat	Sell	Gift	Process	Other
Ampil Deumteuk	26	71	1	2	0
Boengkok	40	54	5	1	0
Klatram	33	65	1	1	0
Leach	63	16	6	14	0
Lungvek	24	73	1	1	1
Neaktahang	41	50	1	7	1
Piem Chumnik	17	79	1	1	2
Tropang Chombok	45	40	4	11	1
Average	34	60	2	4	0

The average daily fish catch is 2.4 kg per fisher. The average CPUE for the main habitat types is 0.85 kg per hour.

Catch disposal

Volunteers sold about 60 per cent of their catch while the rest was consumed, either fresh or processed. The disposal of catch differed between Piem Chumnik and Leach. In Piem Chumnik, a larger proportion of fish was sold, indicating a higher yield. Leach villagers caught the least amount of fish although the proportion of fish eaten was similar to other villages (Table 15).

Conclusion

Although analysis of the data is still ongoing, the study is already helping to clarify the relationship between fisheries and wetlands and confirms that wetland fisheries have to be managed in order to maintain their productivity.

Ecotourism in the Wetlands of Cambodia

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The present tourism situation

Tourism is one of the world's fastest growing economic sectors. Tourism is considered a major vehicle for Cambodia's economic development due to its vast historical, cultural and natural assets. However, if Cambodia is to reach its tourism potential, rehabilitation of tourism infrastructure is required, including airport passenger facilities, port facilities for cruise ships, roads to sites of historical and cultural interest, improvements of water and power systems, and lodgings. The number of hotels, rooms and beds available for tourists in 2000 is shown in Table 16.

Among the developments planned for the next three years are the upgrading of Pochentong and Siem Reap airports, construction of airports in Sihanoukville, Koh Kong and Rattanakiri, access roads to important tourism sites, and the construction of ports and railways.

Despite a serious reduction in tourist arrivals in 1997 and 1998, the number of visitors rebounded in 1999 and is likely to rise in 2001 (Table 17). The total number of tourists visiting Cambodia from January to June (2000) was 166 920. More than half of these came from ASEAN countries.

Tourism assets

There are 1 305 tourist sites in Cambodia consisting of 1 161 cultural and historical sites, 40 recreation sites, and 104 natural areas which contain features requiring special intervention to maintain their integrity. The natural areas are divided into national parks, wildlife sanctuaries, protected landscapes, and multiple use management areas. There are seven national parks with a total area of 742 250 ha and the wildlife sanctuaries totaling 2 030 000 ha (Table 18).

There are three protected landscapes in Cambodia covering 97 000 ha. Multiple use areas are designated to ensure the sustainable use of resources such as water, timber, wildlife, fish, and pasture land; these areas cover 403 950 ha (Table 19).

Ecotourism and wetlands in Cambodia

Ecotourism generally refers to tourism geared to raise ecological and environmental awareness, and includes cultural and historical sites that are closely related to the ecosystem and provide opportunities for learning about the environment. At the management level, issues involve ensuring responsible travel that has low impact on the environment and addressing conservation,

Table 16. Number of hotels, rooms and beds in Cambodia, first semester 2000

Place	Guest-houses	Hotels	Rooms	Beds
Phnom Penh		113	5 841	9 459
Siem Reap	54	32	1 400	2 527
Sihanoukville		36	982	1 768
Other provinces		48	1 317	1 891
Total	**54**	**229**	**9 540**	**15 645**

Table 17. Tourist arrivals to Cambodia, by continent, 1995-2000

Year	Arrivals by Continent				Total
	Asia & Pacific	Europe	Americas	Africa & Middle East	
1995	156 978	37 907	21 538	3 257	**219 680**
1996	178 015	53 761	27 812	901	**260 489**
1997	150 205	43 331	24 561	746	**218 843**
1998	107 421	46 165	21 773	551	**186 333**
1999	137 054	60 031	36 233	1 064	**262 907**
2000*	78 095	32 963	20 760	35 102	**166 920**

*January to June only

Table 18. National parks and wildlife sanctuaries in Cambodia

National Parks	
Kirirom in Kampong Speu, Koh Kong	35 000 ha
Phnom Bokor in Kampo	140 000 ha
Kep in Kampot	5 000 ha
Ream in Sihanoukville	21 000 ha
Botum Sakor in Koh Laong	171 250 ha
Phnom Koulen in Siem Reap	37 500 ha
Virachey in Stung Treng and Rattanakiri	332 500 ha
Wildlife Sanctuaries	
Aural in Koh Kong	253 750 ha
Peam Krasop in Koh Kong	23 750 ha
Phnom Samkos in Koh Kong	333 750 ha
Roniem Daun Sam in Battambang	178 750 ha
Koulen Promtep in Siem Reap-Preah Vihear	402 500 ha
Boeung Per in Kampong Thom	242 500 ha
Lum Phat in Rattanakiri-Mondulkiri	250 000 ha
Phnom Prich in Mondulkiri-Kratie	222 500 ha
Phnom Nam Lyr in Mondulkiri	47 500 ha
Snoul in Kratie	75 000 ha

Table 19. Protected landscapes and multiple use areas of Cambodia

Protected Landscape	
Angkor in Siem Reap	10 800 ha
Banteay Chhmar in Banteay Mean Chey	81 200 ha
Preah Vihear in Preah Vihear	5 000 ha
Multiple Use Areas	
Dang Peng in Koh Kong	27 700 ha
Samlot in Battambang	60 000 ha
Tonle Sap	316 250 ha

pollution control and waste disposal. Ecotourism emphasizes community involvement in the organization and management of programs. The benefits include income generation, quality of life improvement, and sustainable development. An ecotourist is one who demands activities that provide new intellectual experiences through learning about conservation and natural resources.

Ecotourism potential in Cambodia

Cambodia has a high potential for ecotourism. The Angkor Temple complex and national parks have the highest tourism value, followed by the scenic sites along the coast. Potential ecotourism sites in the Tonle Sap Lake area include Prek Toal, Kampong Kleang, Boeung Toule Chhmar, Stoeung Sen and the area along the Mekong River between Kratie Province and Sambor District. Ecotourism can be divided into intensive and semi-intensive markets depending on the activities in which tourists engage. Intensive activities include nature study, forest trekking, forest touring, bird-watching, cave exploring, coral viewing, rafting, canoeing and camping. Semi-intensive activities include astronomical study, mountain climbing, mountain biking, safari touring and fishing. The government should undertake to develop a national ecotourism policy and encourage the participation of the private sector in its development. Ecotourism presents a possible approach to wetland management since the success of ecotourism depends on environmental quality and there is a strong incentive for environmental protection.

Cambodia's wetlands

Cambodia is rich in wetland environments. Wetlands cover over 30 per cent of the country, and about 5 per cent of Asia's total wetlands of international importance are found in Cambodia. Cambodia's internationally significant wetlands include the Mekong River and its floodplain, the Great Lake (Tonle Sap) and its floodplain, the Stung Sen, and the coastal estuaries of Stung Koh Pao and Stung Kep.

The people of Cambodia are closely linked to wetlands, both culturally and economically. Resources harvested from wetlands by local communities include food, water, medicine, and fuel wood. Wetlands also provide nutrient rich and sheltered habitats for a wide range of wildlife species and serve a variety of ecological functions that support important economic activities including rice production, the maintenance of water cycles, erosion reduction, and flood control. Many wetlands are important as filtering systems for pollution and silt.

The wetlands in Cambodia are threatened by a number of activities including agricultural runoff, deforestation, domestic waste and mining activities. Although industrial pollution does not pose a major problem at the present time, it is expected to increase with the development of paper and textile mills, chemical factories and food processing plants.

Role of ecotourism in wetland protection and management

Ecotourism is an attractive approach to wetland management in that it provides an economic rationale for conservation and can develop a

sense of stewardship among local communities benefiting from tourism. The environmental costs of tourism include pollution, increased demands on fresh water, and the displacement of local wetland users. Guidelines should be adopted to ensure that ecotourism is practiced in a sustainable manner. This could be carried out by issuing concessions (licenses and permits) to responsible operators, with the funds generated used to support the management and protection of wetland areas. To develop ecotourism, human resources training, infrastructure, cooperation between the public and private sectors, and promotional budgets need to be addressed and developed.

Conclusion and recommendations

Given the crucial importance of wetland areas for sustained development, a coordinated national wetland policy is urgently required. In support of such a policy, the following recommendations are offered:

- Promote ecotourism nationally and internationally;
- Develop guidelines for sustainable ecotourism practices;
- Ensure that all large-scale tourism developments are subjected to a rigorous EIA; and,
- Ensure local communities are involved in the development, design and management of ecotourism projects.

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Appendix 1

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Organizations represented in project workshops and meetings in Cambodia

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AIT-AARM Cambodia
Cambodian National Mekong Committee
Department of Fisheries
Department of Agriculture
Department of Agronomy and Agricultural Land Improvement
Department of Environment
Department of Natural Resources Assessment and Environmental Data Management
Department of Nature Conservation and Protection
Department of Planning
Department of Public Works and Transport
Department of Rural Development
Department of Tourism
Department of Water Resource and Meteorology
Department of Women's Affairs
Environment and Natural Resources Planning, Ministry of Environment
General Maritime Administration and Environment Protection
IUCN-Cambodia
Mekong River Commission
Mekong River Commission, Assessment of Mekong Fisheries Component
Mekong River Commission, Project for the Management of Freshwater Capture Fisheries of Cambodia
Military Department
Military Police Department
Ministry of Environment
Ministry of Rural Development
Ministry of Tourism
FAO-Siem Reap Participatory Natural Resources Management Project
Provincial Departments of Agriculture, Forestry and Fishery
Support Programme for the Agricultural Sector in Cambodia (PRASAC)
Wetlands International

Acronyms

AARM	Aquaculture and Aquatic Resources Management (AIT)
AIT	Asian Institute of Technology
AMFC	The Mekong River Comission's Assessment of Mekong Fisheries Component
AOP	Aqua Outreach Program (AIT)
APHEDA	Australian People for Health, Education and Development Abroad
AQIP	Agriculture Quality Improvement Project
BAMS	Bureau of Agricultural Material Standard
CARERE	Cambodia Area Rehabilitation and Regeneration Project
CBD	Convention on Biological Diversity
CEDAC	Centre d'Etude et de Developpement Agricole Cambodgien
CIAP	Cambodia-IRRI Australia Project
CITES	Convention on International Trade in Endangered Species
CNMC	Cambodia National Mekong Committee
COCMA	Central Company of Agricultural Materials
CONCERN	An NGO based in Ireland
CPUE	Catch per unit effort
DAALI	Department of Agronomy and Agricultural Land Improvement
DAP	Di-ammonium phosphate
DDT	Dichlorodiphenyltrichloroethane
DOF	Department of Fisheries
DWR	Deep water rice
EEZ	Exclusive economic zone
EIA	Environmental impact assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GECKO	Greater Environment Chong Khneas Office
GIS	Geographic information system
IFAD	International Fund for Agricultural Development
IMCWP	Inventory and Management of Cambodia's Wetland Project
IPM	Integrated pest management
IUCN	The World Conservation Union
JICA	Japanese International Cooperation Agency
JSRC	Japan Sotoshu Relief Committee
LP	Liquid pesticide
MAFF	Ministry of Agriculture Fishery and Forestry
MARPOL	International Convention on the Prevention of Marine Pollution from Ships
MEA	Multilateral environmental agreements
MPAs	Marine protected areas
MRC	Mekong River Commission
PADEK	Partnership for the Development of Kampuchea
PCB	Polychlorinated biphenyl
PFD	Partnership for Development
PP	Pesticide power
PRA	Participatory rural appraisal
PRASAC	Support Programme for the Agricultural Sector in Cambodia
RLR	Rainfed lowland rice
RRA	Rapid rural appraisal
SAO	Southeast Asian Outreach
Sida	Swedish International Development Cooperation Agency
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCC	United Nation Framework Convention on Climate Change
UNICEF	United Nations Children Emergency Fund
WWF	World Wildlife Fund