IMPROVING INLAND FISHERIES MANAGEMENT IN CAMBODIA

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By

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ABSTRACT

Since the inland fishery is the backbone of the Cambodian fishery sector a study on how to improve inland fisheries management and development is required. The study is divided into four aspects: A description of the present status of the fishery sector; an examination of environmental considerations, in terms of natural and man made impacts on inland fisheries; education, training, and extension in the fisheries sector; and an evaluation of the current state of fisheries management including fisheries legislation, policies, administration, and human resources development. Monitoring, control, and surveillance, vital elements of fisheries management and development are also considered in the context of inland commercial fisheries management.

Major fisheries policies, constraints, and strategies are indicated and conclusions drawn with respect to the improvement of inland fishery management and development in Cambodia.

The paper concludes that development of the capacity for effective and even implementation of policy and laws at Department of Fisheries (DOF) level is essential. Rapid reform resulting from decentralized decisions will fail if capacity at Department of Fisheries level does not exist.

Provincial, municipal and department of fisheries reform of policy and its implementation is necessary along with more sophisticate strategic planning. This must be anchored in effective legislation. New fisheries laws must be harmonized with that of other sectors.

And recommends that an intensive training programme of DOF staff must be undertaken. This should start immediately and be designed to facilitate the uniform implementation of fisheries policy at all levels-particularly at provincial and municipal levels-and to assist in developing the capacity of local communities to participate effectively in decision-making and management of the resource. DOF must work to ensure the uniform application of laws and controls at all levels-and ensure that the local communities receive equitable consideration.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIT: Asian Institute of Technology

AUCC: Association of Universities and Colleges of Canada

BFSPRC: Bati Fisheries Seed Production and Research Centre

CCAM: The Central Company of Agriculture Material

CIDA: Canadian International Development Agency

CPUE: Catch Per Unit Effort

CS: Chrang Cham Res Inland Research Station

DDT: Dichloro Diphenyl Trichloro Ethane

DOF: Cambodia's Department of Fisheries

ESCAP: Economic and Social Commission for Asia and The Pacific

FAO: United Nation Food Agriculture Organization

FIMS: Fisheries Information Management System

FOF: Faculty of Fisheries Science, Royal University of Agriculture

GDP: Gross Domestic Product

ha: Hectare

hp: Horse Power

KAMFIMEX: Kampuchea Fishery Import Export Company

Km h: Kilometre Per Hour

Km^2: Square Kilometre

m^2: Square Metre

m^3: Cubic Metre

MCS: Monitoring, Control and Surveillance

MEYS: The Ministry of Education Youth and Sport

MI: Marine Institute

mm: Millimetre

MAFF: Ministry of Agriculture, Forestry, and Fishery

MRC: Mekong River Commission

MSY: Maximum Sustainable Yield

NGO's: Non-Government Organizations

IO: International Organization

PADEK: Partnership for Development in Kampuchea

SAO: Southeast Asian Outreach

SAR: Search and Rescue

SIDA: Swedish International Development Assistance

t: Tons

TKS: Toul Kro Sang Station

UNDP: United Nations Development Programs

US$: United State Currency

The challenge for fisheries resource managers is to overcome harvesting, environmental and ecological problems, and ensure maximum economic returns from the fisheries resource. As the inland fisheries of Mekong, Basac, Tonle Sap, and Great Lake region rebuilds, attention has to be paid to the human resource development, legislation, and administration to ensure the past problems are overcome. An analysis of the current situation is significant to achieve better inland fisheries management and development in the future.

1.1 Purpose

The purpose of this paper is to identify problems and make conclusions with respect to necessary ways and means to better address the development of inland fisheries management, especially as it relates to the Department of Fisheries in Cambodia. Fisheries management, in the context of this paper, is taken to comprise all the different principles and actions associated with the management, use and protection of the natural resources. It includes biological, economic, socio-economic, technological, political, and social dimensions. Fisheries management is taken to cover all sectors and sub-sectors of fisheries and fisheries systems.

According to FAO, (1994) the future success and continued growth of the total inland fisheries production in Cambodia depends on enhancing and improving the management of inland fisheries.

1.2 Scope of study

The study area for this paper is concentrated on the Great Lake region (Boeung Tonle Sap) and includes the provinces of Pursat, Battam Bang, Siem Reap, Kompong Thom, and Kompong Chhnang. A quarter of the total population of the country lives in this region and the total commercial fish productions dominated in this five provinces has been decreased from 1.76 in 1998 to 1.63 in 1999.

The study deals with natural resources, ecosystems, economics, legislation, administration, education and training, environment, etc., and the effects of human activities and developments around the study areas that are affecting, or will potentially affect the Great Lake environmental resources within the study areas. In addition, the study considers some of the environmental and social effect of developments occurring within the study areas, wherever these effects may manifest themselves.

1.3 Methodology

The study is a combination of personal knowledge and experiences, as well as information from existing literature produced by a variety of Non-Government Organizations (NGOs), International Organizations (IOs), Department of Fisheries (DOF), and other institutions during the last decade.

Data used in this paper is extracted from official sources. In some instances they are supplemented by information provided by fishers and fisheries officers from the central and provincial fisheries administrations. However, it is recognized that some of the data

are limited, unreliable and otherwise deficient and where estimates are made by the Department of Fisheries (DOF) and provincial fisheries, such estimates are often based on the outdated assumptions and methodologies. However, in the absence of the comprehensive alternative data sources, and since the data are official and used within the administration for planning and policy formulation, they have been used with caution in this paper.

CHAPTER II: CAMBODIA'S PHYSICAL CHARACTERISTICS

2.1 Geography

Cambodia is a country located in Southeast Asia between 8° and 12° North latitude and 102° and 108° East longitude. It covers a surface area of approximately 181,035 km^2 (Figure 1). Cambodia is a graphically compact country comprised of 21 provinces and 3 cities. Thirteen of the 24 Cambodian provinces and cities are considered freshwater fishing provinces with numerous fishing grounds. Five of these provinces border the Great Lake (Kompong Thom, Siem Reap, Battam Bang, Pursat, and Kompong Chhang), and the total population of these five provinces is 3 million people.

Cambodia is located in the tropical monsoon area of Southeast Asia. Rainfall is abundant with an average annual rainfall of 1,000 – 3,000 mm. Based on FAO, 1994 and fisher's experience, high annual rainfall is extremely seasonal, and together with the dry and flood periods, it significantly affects fishing activities in the country. The seasonal rise and fall of inland waters determine resource availability and production capacity.

In Cambodia there are two main seasons: The dry season is from November to May and rainy season is from June to October. During the dry season the average temperature is 35°C while it drops to 27°C during the rainy months. The lowest value of 19°C is usually recorded during December and January. In the hottest period of the year (April-May) the highest value ever was 40°C (Ministry of Environment, 1994).

The Mekong River is Cambodia's largest river. It dominates the hydrology of the country and therefore has a significant influence on the inland fisheries. The Mekong River's average annual flow of 441 km^3 is estimated as 93 percent (%) of the total Mekong run-off discharge into the South China Sea. The flow at Kratie ranges from a minimum of 1, 250 m^3 s to a maximum 66, 700m^3 s (FAO, 1994). The Mekong is the world's tenth largest river. Its originates in China at an elevation of 5,000 m and totals 795, 000 km^2, encompassing parts of China and Myanmar, one third of Thailand, the whole of Laos and Cambodia, and one fifth of Vietnam before reaching the South China Sea.

At the capital city, Phnom Penh, the Mekong River receives the waters of a major tributary, the Tonle Sap, which is fed by the streams that drain into the Great Lake in Western Cambodia. The flow of the Tonle Sap changes direction in the rainy season when part of the flood waters of the Mekong River flows into the natural storage basin provided by the Great Lake. The direction reverses in October when the level of the Mekong drops and water flows out of the Great Lake. The seasonal flow of water into and out of the Great Lake is the most important phenomenon in the Cambodian inland fishery. During the rainy season, the flood transfers suspended and dissolved solids onto the floodplains. Flooding also releases nutrients from the soil, vegetation, and inundated organic debris, which in turn support an expansion of fish stock (FAO, 1994).

Immediately downstream of the Mekong-Tonle Sap confluence, the Mekong River divides to form the Mekong and Basac Rivers. The Great Lake occupying nearly 6% of the total land area of the country in the flood season, is the largest and most productive freshwater lake in Southeast Asia (Bardach, 1959)

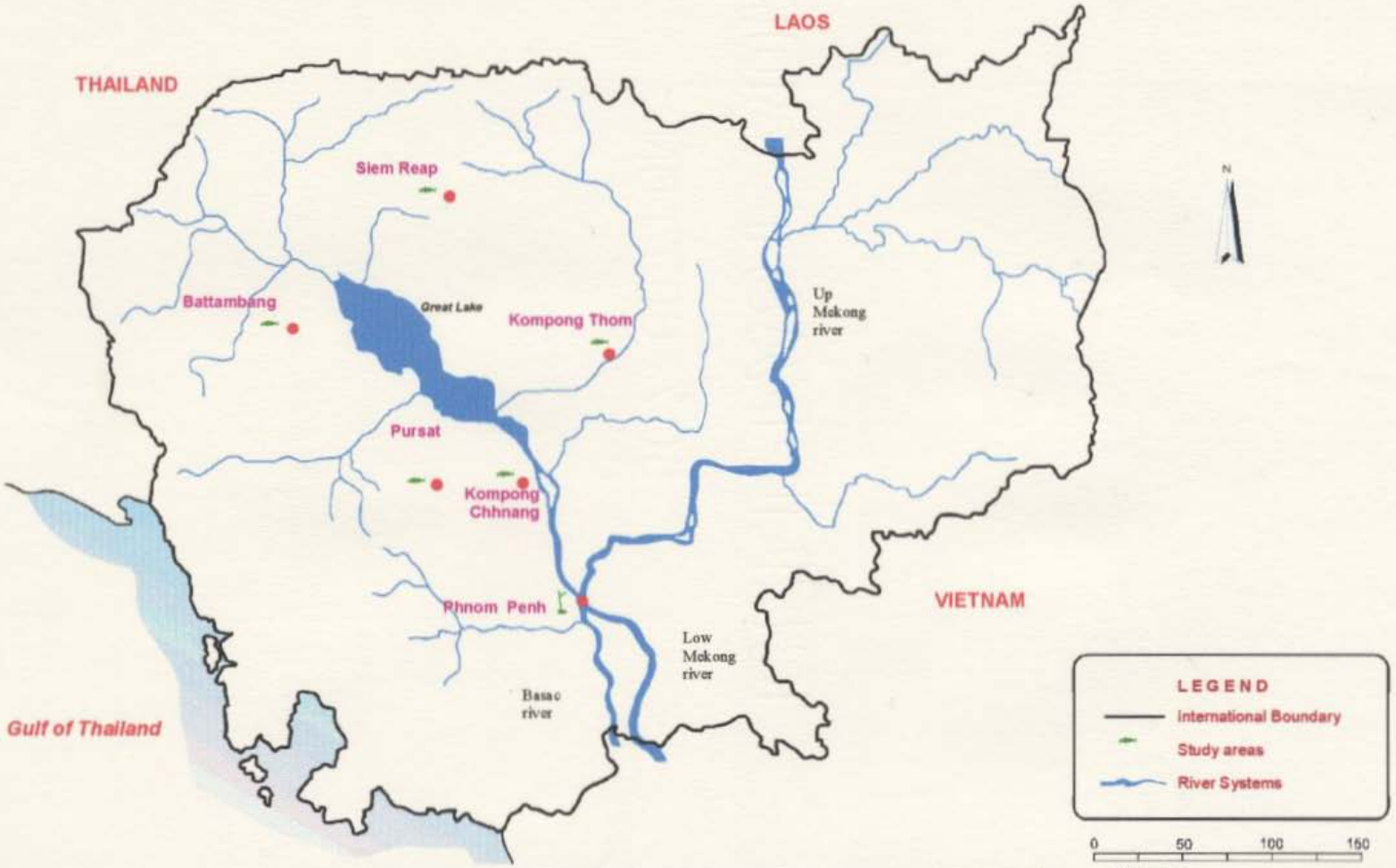

Figure 1. Map of Cambodia, 5 Fisheries Provinces around Great Lake

Under the impact of the inflowing Mekong River waters, the water level in the Great Lake rises by between 7 and 14 m, and its surface area increases from 3,000 km^2 to10,000 km^2, and in exceptional circumstances to 13,000 km^2 (FAO, 1994). The Great Lake then acts as a natural flood retention basin. By the time the lake water level drops to its minimum surface size, a band 20-30 km wide of inundated forests is left dry. This forest, which is of great significance for fish, is under pressure from deforestation and is greatly reduced in size.

2.2 Population characteristic

In 1998 the population of Cambodia was 11.4 million (52 % women) of which 84% were living in rural areas and 16% in urban areas, with a national average population density of 64 per km^2. The densities in the different natural regions are as follows: Plain region: 235; Tonle Sap region: 52; Coastal region: 49; Plateau and mountain region: 17; The rate of population growth is 2.49 percent per annum (National Institute of Statistics, 1998).

Cambodia's urban population represents 16% of the total population. Phnom Penh has a recorded population of 999,804, comprising 517,893 (51.8 %) female. The population of this municipality constitutes 8.7 % of Cambodia's population. The average density is 3,448 per km^2 in the capital city of Phnom Penh.

2.3 Economic structure

The Cambodian economy measured by Gross Domestic Product (GDP) at constant prices had been growing from 1993 to 1995. In 1996 however, an economic slow down started

to decelerate the economy from a 6.7 % growth rate in 1995 to 5.5 % in 1996. Further slowing down of the economy's growth was registered at 2.6% and 1.3% in 1997 and 1998 respectively. The increase in GDP from 1993-98 was largely influenced by significant increases in the value added of the industrial sectors such as textile, wearing apparel, wood and wood products (Ministry of Planning 1998 and 1999).

In 1998 the agriculture sector contributed 38.8% to GDP, industry and services contributed 18.3% and 38.1%, and taxes on products 4.8% respectively. Within the agriculture sector the fisheries sub-sector is relatively small contributing 6.9% to the agriculture sector output in 1998 (Ministry of Planning, 1999).

The increasing depreciation of the Riels (Riels US$) from 1996 to 1998 greatly affected the levels of GDP and per capita GDP expressed in US$. From 1996-1998, both per capita GDP at constant 1993 prices expressed in US$ had been rapidly decreasing every year, from -4.9% in 1996 to -22.6% in 1998. While the overall trend in per capita GDP in Riels is still increasing, that of per capita GDP expressed in US$ had been going down.

CHAPTER III: PRESENT STATUS OF INLAND FISHERIES

3.1 Fisheries resource

In Cambodia there are two mains fresh water river systems: the Great Lake and Tonle Sap system, and the Mekong and Basac river system. The inundated forest of the Great Lake, and to a lesser extent the inundated forests of the Tonle Sap and Mekong River, are considered to be essential for maintaining the current level of inland fishery production (FAO, 1994). The Great Lake Tonle Sap contributed about 61% of the total commercial production from inland fisheries in 1999. Approximately 90% of the total freshwater fish stocks follow the inundation spawning pattern and many fish species breed in the inundated forests. The dominant species of the Great Lake in terms of catch, are carp (cyprinids) (45%), catfish (19%), murrel (9%). A wide variety of other species make up the remaining 27% (FAO, 1994).

For the period from 1980-98, documented annual commercial catch had probability fluctuated in the vicinity of 60,000 tons (Table 1), of this total about 30% came from the Great Lake, 30% from the Tonle Sap River, and 40 % from all the other rivers and their floodplains. Economically, carp is the most important species in Cambodian inland fisheries. Both the DOF and fishers believe that there has been a general decline in inland commercial fisheries products (Table 3). However, this is not substantiated by the official statistics (DOF's staff (Table 6). In other words, the Maximum Sustainable Yield (MSY) of the total commercial catch may be at 60,000 tons. In 1999, the total catch from fresh water increased to 231, 000 tons, 71, 000 tons from commercial and 160,000 tons from

subsistence (family) harvesting (Table 1). Until 1999 the production from subsistence harvesting was not recorded and is not considered in most calculations.

Table 1. Fish Production (tons) by Major Fisheries, 1980-1999

Year	Total	Commercial inland	Subsistence(family)	Marine	Aquaculture
1980	19.600	18.400	-	1.200	-
1981	51.594	50.780	-	814	-
1982	68.715	65.700	-	3.015	-
1983	68.161	58.717	-	9.444	-
1984	64.424	55.093	-	7.721	1.610
1985	70.578	56.400	-	11.178	3.000
1986	73.628	64.181	-	7.247	2.200
1987	82.071	62.154	-	17.417	2.500
1988	86.800	61.200	-	21.000	4.600
1989	82.088	50.500	-	26.050	5.538
1990	111.400	65.100	-	39.900	6.400
1991	117.800	74.700	-	36.400	6.700
1992	111.150	68.900	-	33.700	8.550
1993	108.900	67.900	-	33.100	7.900
1994	103.200	65.000	-	30.000	8.200
1995	112.510	72.500	-	30.500	9.510
1996	104.310	63.510	-	31.200	9.600
1997	114.600	73.000	-	29.800	11.800
1998	122.000	75.700	-	32.200	14.100
1999	284.100	71.000	160.000	38.100	15.000

Source: DOF, 1999.

3.1.1 Natural resources

The inland capture fisheries in Cambodia are governed by the annual cycle of hydrological events such as the filling up and draining of the Great Lake by the Tonle Sap river and the annual flooding of the plains around and downstream of Phnom Penh. The hydrological cycles determine longitudinal and lateral migration of most of the fish species. The inland fisheries are unique in a number of respects: they exploit a large

diversity of water bodies (i.e., a natural lake, rivers with their floodplains with a high inherent productivity based on a relatively high organic carbon content). The inundated forest zone provides the spawning and nursery grounds which supply the bulk of the young fish to repopulate most of the water bodies in the basin.

In addition, to the numerous marine water fish species found in Cambodia, there are around 800 species of fresh water fish, most of which are captured and used as food. According to Walter Rainboth, 1996 a taxonomist who worked for a joint FAO/MRC and University of Wisconsin Oshkosh, U.S.A., there are in fact more than 500 species. Most fish species in the river systems are well adapted to widely fluctuating water levels, changing pH, and have a wide tolerance for temperature, dissolved oxygen and other environment parameters.

Cambodia has a large variety of freshwater bodies, which are exploited both for capture and culture fisheries. The largest freshwater capture fisheries by far take place in the Great Lake, Tonle Sap, Mekong and Basac Rivers. Capture fisheries are practised all over this large region dividing into three types: subsistence, artisanal and commercial. The subsistence fishery is not regulated and is permitted year round. Prior to 1998 no data on subsistence fisheries is available in any statistics compiled by the relevant authorities. The subsistence fisheries take place out side of the fishing lots, reservoir, and protected areas. Fish captured from subsistence fishery is for sale for local consumption only.
Under Cambodian fishery law (DOF, 1987), a bag net unit is classified as a fishing lot. Fishing lots are concessions auctioned by the government to the highest bidder for

exclusive exploitation over a 2-year period. It is one of the government's instruments for extracting a resource rent from fisheries. The lots are located at the periphery of the Great Lake and along the Tonle Sap and Mekong Basac rivers. In 1988, there were 307 fishing lots and 11 reserved fishing lots. This decreased to 239 fishing lots in 1999, of which 135 were for lake-stream fishing, 63 for bag net fishing, 8 for white lady bag net lots, 13 for fishing prawn, 20 for sever sandbank. In addition there are 13 reserved lots.

Table 2. Fishing Lots and Reserved Fishing Lots

Year	Total	Type of fishing lots					Reserved
		Lake stream	Bag net	White lady bag net	Prawn bag net	Server sandbank	
1980-88	307	143	96	-	13	55	11
1989-90	271	141	76	7	13	34	13
1991-92	270	141	76	8	13	32	15
1993-94	267	141	74	8	13	31	15
1995-98	248	141	63	8	13	23	15
1999	239	135	63	8	13	20	13

Source: DOF, 1999.

3.1.2 Methods and gears

A diversity of fixed and mobile gears is used in the inland fisheries. Currently trawling, trapping, purse seining, lift netting, gill netting, and long lining are the main techniques used. In the Great Lake Tonle Sap and Mekong Basac rivers systems a variety of fixed fishing gears are in use, however, only a few are employed for large commercial fishing. Fixed gears are constructed from the locally available materials (e.g. bamboo and wooden stakes) however, those materials are becoming more difficult to obtain. Such materials are recycled, and can be used for up to five fishing seasons (a season is a year). Fixed gears (e.g., traps, barrages and pots) must be dismantled in the off-season.

One type of gear is the fixed set bag net, which is widely used in all the waterways in the river systems. The size of these nets varies considerably depending on the size of the waterway and water current. Smaller units are often observed further up the river while large installations are placed in the lower reaches of the river branches. These nets function basically like stationary trawls that filter the water by means of the water current. Large bag nets (Dai units) may be as long as 20-40 m with a mouth and vertical opening ranging between 15-25 m and 5-10 m, respectively. The mouth of each bag is firmly fixed to two large poles. The catch from these nets is usually harvested during the low tide. This kind of fishing gear is usually operated in fishing lots (Figure.2). There are few restriction placed on the legal use of gear in terms of catch (i.e., fish size, total catch, etc.). However, some endangered species are protected and must be returned to the wild, if caught.

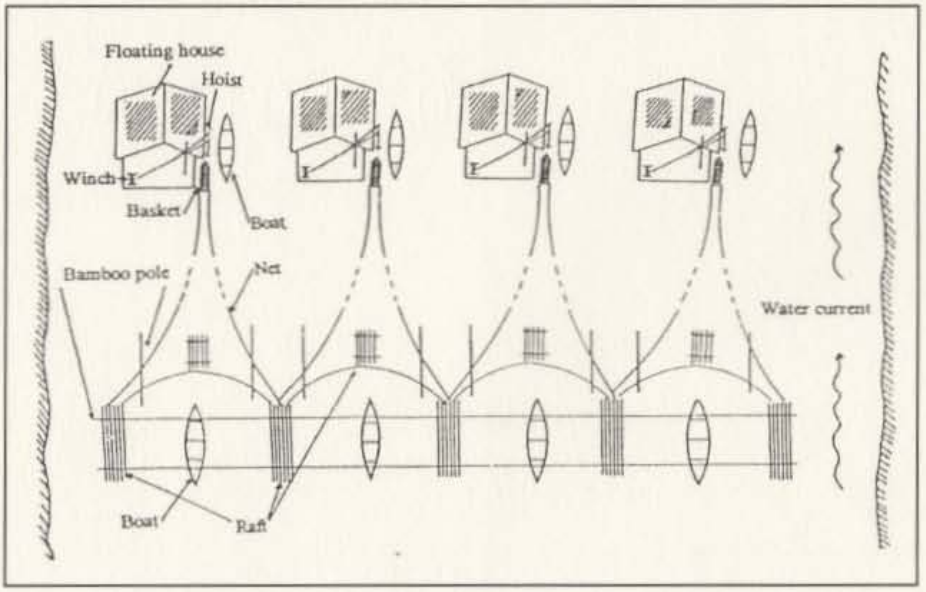

Figure 2: Diagram of a row of four bag net units in the fishing lots

Source: S.LIEN, C.YIM and N.P.VAN ZALINGE, 1995

The incidence of illegal fishing reported by the DOF has increased from 1,120 to 1,990 cases in 1996 and 1999 respectively (DOF's annual report, 1999). Illegal activities include the use of electro-fishing, poison, explosives (especially popular with demobilized soldiers), trawling with nets that have very small mesh size, and the use of motor-powered craft to tow or push mobile gears is illegal in Cambodia.

The use of explosives for fishing is also affecting fish production. Bomb fishing is practiced in many fresh water bodies and even in the reservoirs and irrigation canals. Apart from its adverse effects on the aquatic environment and fisheries, it can also be highly destructive to aquatic resources in general. Existing levels of fishing effort in the inland fisheries indicate heavy fishing pressure on resources, through this conclusion cannot be substantiated by empirical evidence.

A robust market for fresh inland fish and processed products provides a strong incentive for fish harvesters to increase their fishing effort (e.g. the use of bag nets with mosquito netting-sized mesh on barrages) in the face of declining availability of the commercial production (Table 1) and fish that appear, on average, to be declining in size (Table 3). The multiple harvesting of species would also be affected this. The principle associated with the current harvesting technique is that it catches a high amount of small fish during a relatively short season. This seasonal nature has historically generated lower returns per pound to the fish harvester and to the total national catch. Such fishing methods and the large number of them in use provide little escapement for juvenile fish.

Table 3. Grades of Fish (tons) From The Inland Commercial Fishery

Fishing period	Grade 1	Grade 2	Grade3	Total
1988-89	10,200	13,200	27,100	50,500
1989-90	9,600	15,643	39,778	65,081
1998-99	8,449	12,631	49,920	71,000

Source: DOF, 1999.

Criteria for grading based on the size are used e.g. grade1 fish are 1 kg or over in weight, grade2 are fish between 0.5-1 kg in weight, and grade3 less than 0.5 kg. However, in some cases small fish may also be classified as grade1. According to Table 2 grade 1 fish are becoming less abundant, being replaced by the grade 3 fish from year to year.

In 1999 57% of fisheries vessel were motorized. The total number of motorized fishing vessels was reported at 13,037 units with a total engine capacity of 205, 590 hp of which 149, 180 hp are operated in fresh water. 57% of vessels have engines. Approximately 53% of the vessels operating in fresh water are fitted with engine smaller than 10 hp, while 17% have engines ranging between 10-30 hp, about 3.4% have engine range from 30-50 hp, and about 0.6% have engines above 50 hp (DOF, 1999). About 40% of the motorized vessels are operated in the Great Lake region (Table 4). The significant increase in the size of the fishing fleet since 1996, especially in the inland fishery, is a cause for fisheries management concern.

Table 4. Statistics of Fishing Vessels with Engines in the Great Lake Region

Provinces	Less than 10 hp	10-30 hp	30-50 hp	Over 50 hp	Total
Kompong Thom	105	105	150	-	360
Kompong Chhnang	450	300	70	65	885
Pursat	333	353	58	10	754
Battom Bang	216	215	126	8	565
Siem Reap	326	1, 185	66	6	1, 583
Total	1,430	2,158	470	89	4,147

Source: DOF, 1999.

It has been shown in Table 3 that the grade1 fish has declined while that of grade 3 has increased. On the other hand, fresh water fishing lots and fishing grounds are limited and becoming fewer, compared to the previous decades (Table 2). However, it should be noted that the number of vessels without engines declined and the vessels with engine from 10-50 hp expanded rapidly. As a result, the fleet composition has changed, its capacity has increased and with it the potential for over-fishing.

3.2 Supply and demand

3.2.1 Present status and projected demand

A FAO report (1999) demonstrated that the relative nutritional importance of fish in Cambodia varies from 40-60% of the total protein intake of the population. However, in the Great Lake region the relative importance of fish as a source of protein is 75% of total protein (FAO, 1999). The total human population of Cambodia has increased from about 10.5 million (estimation) in 1997 to 11.4 million in 1999.

Cambodia's annual per capita consumption of fish was estimated to be in the range of 12-16 kg in 1992 (by calculation and DOF, 1992). However, in 1970's the per capita fish consumption was in the range of 20-25 kg per year (Lagler, 1976). By calculation based on the total production (DOF's annual report, 1999) divided by the total population in the year 1999 (National Institute of Statistics, 1999), Cambodia's annual per capita consumption of fish was at 25 kg in 1999.

Domestic fish consumption projections for Cambodia for the period 1995-2000 according to FAO (1994) are shown in table 5. By calculating per capita consumption and assuming no increase in consumption through out 1999-2005, it is projected that domestics demand for fish in 2005 will be about 320,000 tons. However, if annual per capita consumption decreased to 20 kg, about 256,000 tons of fish would be required in 2005 to satisfy domestic demand. The levels of fish consumption estimated in Table 5 by World Bank, Mekong Secretariat, and DOF are much lower than in reality because the total production estimates does not included small-scale (subsistence) production. This means that total catch estimate is based on the commercial catch only.

Projected demand for fish consumption in Table 5 has important implications for resource management policies, production capacity, aquaculture production strategies, national food security, and fishery research and development. Management policies and strategies in fishery sector over the next decade must be applied to maintain domestic supply at least at current levels of per capita consumption.

Table 5. Current Consumption and Projected Demand at Different Levels of Fish Requirements in Cambodia 1992-2005

Description	year				
	1992	1995	1999	2000	2005
Population (millions)[1]	9.0	9.7		11.1	12.8
Consumption per capita (kg)[2]	13.3	13.3		13.3	13.3
Total production (thousand tons)	119.1	129.0		147.6	170.2
Consumption per capita (kg)[4]	12.3	12.5		13.0	13.0
Total production (thousand tons)	111.1	112.5		143.0	166.4
Consumption per capita (kg)[3]	16.0	16.0		16.0	16.0
Total production (thousand tons)	144.0	155.2		177.6	204.8
Consumption per capita (kg)	20.0	20.0		20.0	20.0
Total production (thousand tons)	180.0	194.0		222.0	256.0
Current Population (millions)			11.4		
Consumption per capita (kg)[4]			25.0		25.0
Total production (thousand tons)			284.1		320.0

Source: [1] From 1992-2000, calculated from World Bank (1992). [2] Mekong Secretariat (1992). [3] Cambodian Department of Fisheries (1992) data. [4 & 4'] Calculated based on current data with a 2.49% annual population growth rate.

3.2.2 Present status and projected production

In terms of production and value inland fisheries have traditionally been the most important fisheries sector in Cambodia, while marine production ranked second, and aquculture production third. Fish is consumed fresh, or processed in various traditional forms such as dry, smoked, steamed, pho-ork, prohok (fish paste), and fish sauce, or it may be used as feed for animals or for making fertilizer.

In 1997 and 1998 Cambodia's average annual fresh-water fisheries commercial production was estimated at 73,000 to 75,700 tons. By 1999 production had fallen to 71,000 tons (Table 1) due to a number of interrelated factors including a decline of commercial fishing lots and reserved fishing area (Table 2). In general, the commercial fishing water boundary has become smaller and shallower for all the fishing lots.

For food security and welfare reasons, if existing per capita consumption levels are to be maintained at 25 kg, the commercial production from inland fisheries should reach at least 80,000 tons and the subsistence (family) production at least 320,000 tons in 2005. However, to date the production from the natural resource has never reached these values. To achieve these objectives inland capture fisheries will have to be supplemented by inland aquaculture production (pond and pen culture) which has a vital role and continues to require strong extension inputs from DOF and NGOs. This will require the application of new inland and marine aquaculture technologies to supplement and sustain greater production. Development of extension policies and intensification of fish production from Mekong Basac floodplains will also be required.

CHAPTER IV: ENVIRONMENTAL ISSUES

Habitat deterioration and reduction in bio-diversity is a growing threat to the inland fisheries production in Cambodia. The Mekong Basac and Great Lake Tonle Sap river systems have suffered from environmental deterioration since the 1970s. The deterioration is linked to deforestation, increased siltation, development of agriculture, illegal fishing, sluice mining, and over-fishing. The increasing siltation rate, changing patterns of canal drainage, and the construction of new dams and canals during the Khmer Rouge regime (1975-1978) have reduced access by migrating fish to the floodplain for reproduction, feeding and growing. These factors have also resulted in reduction of the seasonal inundation, and reduction in the fishing lot boundaries, reservoir, and protected areas. Illegal fishing has resulted in changes in size of fish and catch composition, and is threatening some species with extinction (FAO, 1994).

4.1 Flooded forest deforestation

The forest around the Great Lake, which is flooded each year, is the spawning and nursery ground for a major part of the Mekong Basin's fish population. In the rainy season the floods transport organic materials, fish fry, and adult fish to these areas. In the dry season the water current flow out of the Great Lake through the lower Mekong Basac to the South China Sea, and fish migrate along with the water current. The Great Lake Tonle Sap river and its fisheries are now threatened by siltation resulting from deforestation in the flooded forest and watershed areas, sluice mining in the upper reaches of the Tonle Sap watershed in Battam Bang and Pursat provinces as well as widespread illegal and over fishing.

According to Ahmed (1996), the total flooded area of forest in Cambodia was 823,600 ha in 1985-1987 and 630,550 ha in 1992-1993. This means that between 1985-1993 the total area of flooded forest declined by approximately 24%. In addition, there are significant changes in the area under other types of land and water resources use. J.Malleux, FAO Chief Technical Advisor, reported in 1997, that the total flooded forest in Cambodia was 481,224.50 ha or 58% of the flooded land in the 1985-1987 period. The change in the area of the flooded forest will result in the loss of primary flooded forest and indigenous fish species in the near future. It also reduces habitat for breeding and feeding, and this leads to a reduction of fish reproduction

Flooded forest of the floodplains of the Great Lake Tonle Sap, Mekong Basac river systems have been under severe pressure from agricultural land development, for the use of branches creating brush ponds the water to attract fish for brush parks (fish attraction devices), and also for charcoal and firewood products. Cutting of flooded forest for the construction of fish traps and for smoking fish has also contributed to the forest decline. There is an urgent need for replanting some of the flooded forest species to rebuild habitats.

4.2 Siltation

FAO (1994) reported that in the Great Lake area, siltation has increased by 20-40 mm per year and this result in shallower water which warms more quickly, leading to increased water temperature during the lowest water levels. Fish mortality has been observed in some cases from increases in water temperatures resulting from the shallower water

(FAO, 1994). Siltation also causes narrowing of the channels and is significantly reducing the depth of the water way systems. This is badly affecting the capacity of the Great Lake Tonle Sap to act as buffer during the wet season and as a main source of fish for the country. This situation is especially apparent at the confluence of the Mekong and Tonle Sap river and at the outflow of the Great Lake, and is having the effect of changing flow patterns, hampering the movement of fry and fingerlings, and reducing the access of migrating fish to floodplain for breeding.

The mining industry in Cambodia is underdeveloped with little resource exploitation (Ministry of Environment, 1994). The exception to this is the uncontrolled gemstones mining in the region of Paillin in Northwest of Great Lake. Excessive mining in this region has seriously degraded the land and is considered the main cause of the increased siltation levels in the river Sangkar in Battam Bang and Great Lake (Ministry of Environment, 1994).

Soil erosion is a significant problem along many roads, rivers, and canals. Soil erosion is also a threat to the roads directly, particularly along riverbanks and in areas prone to annual flooding. Some of the increased siltation from soil erosion might have resulted from deforestation in catchments of several smaller rivers entering the Great Lake in the Northwest. Proper erosion protection should be considered in relation to the planning and design of any rehabilitation activities.

4.3 Agricultural expansion

Agricultural activity significantly impacts the fish species distribution and the ecology and production of individual species. At present time, some fishing lots are use as agricultural land during the dry season. Deforested areas, adjacent to the water bodies are used for rice and other agricultural crops during the low water season. Such areas, when flooded, may release pesticides and herbicides use for crop protection. In addition, the removal of trees and bushes, makes such areas unattractive for fish breeding, because the eggs and juvenile stages are vulnerable to wave action (FAO, 1994).

In Cambodia, 21-22% of the total land area is cultivated. According to recent data, provided by the Central Company of Agriculture Material (CCAM), in 1994, 45,000 tons of inorganic fertilizers were imported and this increased to 60,000 tons in 1996 (Ministry of Environment, 1994). Based on the available data, fertilization of agricultural lands has increased from 1.24 kg to 1.66 kg per m^2. These fertilizers are washed into the Great Lake during the rainy season. These results in algae blooms, depressed oxygen levels and fish kills. These chemical concentrations increase and become more dangerous, during the periods of lowest water level.

One of the greatest sources of pollution is the insecticide that are being used in the agricultural activities in the flooded forest or in the vicinity and from which the runoff enters the water of the Great Lake. The use of Dichloro Diphenyl Trichloro Ethan (DDT) is widespread, and the use of other chemical pesticides has been promoted and they are accumulating in the ecosystem. The chemicals are also contaminating ground and surface

water, harming downstream users of that water and damaging inland fisheries (Ministry of Environment, 1994).

4.4 Damming and water channels

The Mekong Secretariat has proposed a number of hydropower and water control projects on the main stream of the Mekong River, as well as a number of tributary projects for irrigation and hydropower (Ministry of Environment, 1994). The potential impact of dams which may be constructed on the Mekong river is a cause for concern from a fisheries perspective. Feasibility studies for two hydro-electricity dam projects at Stung Treng and the Sambur are in progress. Both locations are on the main stream of the Mekong. A third project, a barrage on the Tonle Sap river, proposes to regulate the seasonal reverse flow between the Great Lake and the Mekong River.

Implementation of the Mekong projects, plus one proposed for Pa Mong in Laos just North of Cambodia, would decrease the Mekong flood discharge at Phnom Penh from 40,000m^3 s to 23,000m^3 s, thereby lowering the high water level at this location by 3 m. It would also result in reduction of the maximum lake surface area by about 3,000 km^2 (Ministry of Environment, 1994).

These hydro-electricity dams will cause a change in the hydrological regime of the Mekong River resulting in diminished flows at certain critical times. If the dams also serve for irrigation, they will result in diminished water availability in dry season for down stream users. Clearly, water use priorities need to be established before any such

projects are undertaken. Apart from the impacts on navigation, fisheries and the ecology of wetlands, there will be negative impacts on the inundated zones estimated at 20% of the total surface areas of Cambodia (Ministry of Environment, 1994).

A reduction in flooded area would reduce the area available for fish breeding and feeding. The impact of the proposed Pa Mong dam in Laos has been expressed in term of the losses to Cambodia fisheries as a 24,000 t reduction in catches from the floodplain, and 1,260 t from the Great Lake area (NEDECO et al., 1988). However, an alternative estimate by the ESCAP (1990) equates a 10% loss in flooded area to a 10% loss of capture fisheries in Cambodia, which, at that average levels of 60,000 t per year from industrial and artisanal fisheries and 30,000 t from family fishing, would equal 9,000 t.

If the proposed dam projects proceed, such fish losses would have to be carefully weighed against the gains from the projects. Regulation of the water level of the Great Lake resulting from the implementation of the barrage proposed for the Tonle Sap river would also certainty result in reduced fish production from the lake and the river.

An existing network of the canals is also believed to hamper the natural propagation of fish. They were constructed in rigid geometric patterns and cut across existing water channels that previously led the migrating fish to the floodplains where they spawn. Construction of roads, dikes, dams, irrigation and drainage schemes have further disturbed the original spread of flooded water and consequently the migration of breeding fish and the fertilized eggs and larvae of riverine fish (FAO, 1991).

Floodplain fisheries on the Mekong Basac have also undergone changes and a decline in catches of some large fish species has been reported. Data to support these conclusions were shown in table 3 chapter III of this report. The major reasons for this development can be seen in the intensive fishing pressure combined with the more difficult access to floodplains for the migrating brood-stock and young fish. Most of the natural connections and colmatage canals, constructed in 1920s for regulating water inflow and outflow from floodplains, have been silted over and now permit floodwater onto floodplains only at very high water levels. This also limits the number of brood-stock fish and the period of time for the entry onto floodplain water bodies for breeding.

Furthermore, during their migration through the canals and water channel, stocks are heavily fished. The suggested measures to remedy this situation include dredging selected canals and some natural water channel connections, and protecting brood-stocks against fishing during their passage through the canal. If successful, such measures will increase the number of fish in the permanent water bodies of the floodplains, which are now subject to over-fishing.

4.5 Reservoirs, national park, and protected areas

In theory, the Department of Fisheries' administration pays significant attention to fish protection. There are 8 fish reservoirs in the Great Lake, the main purpose of which is to protect brood-stocks and for rare fish species. Information on fish species composition in the reserves is not available, as no surveys have been undertaken. The Government proposes (Ministry of Environment, 1994) to maintain reserved fishing lots and national

parks to provide habitat sanctuaries. Selected areas of inundated forest also need to be protected, as they are important feeding habitats of many fish and aquatic animals.

CHAPTER V: INLAND FISHERIES LEGISLATION AND ADMINISTRATION

5.1 Legislation

The legislative hierarchy in Cambodia is attached as annex A. Fiat-law on fishery management and administration of Cambodia fisheries was issued by the council of state in 1987, and together with two sub laws enacted by the council of Ministers of Agriculture Forestry and Fisheries, and Justice Ministry in 1988 and 1989 form the basic legal framework as Cambodian fisheries legislation.

The Fiat-law (1987) is divided into 6 chapters and 44 articles covering definitions, exploitation of inland fisheries, exploitation of marine fisheries, aquaculture and the processing of fisheries product. The two sub laws relate to the transportation of fisheries products and the rental of inland and marine waters for fishery purposes.

A series of measures have been introduced to protect fish stocks, some of these are believed to have contributed to stabilized catches. The closed season (June-September) for the industrial and artisanal fishing, and the 13 reserved fishing lots have been established for conservation purposes. About 8% of the dry season lake areas are placed under fisheries reserves; however, illegal fishing activities still happen in these areas (DOF report, 1999).

The institutional and legal capacity of the Department of Fisheries to manage, monitor, and control-fishing activities is weak. Fisheries databases and information, ranging from simple measures of depth in the Great Lake to the complex interactions between fisheries and ecological change, are unavailable.

By Fisheries Fiat-Law (DOF, 1987) each type of capture fishery has to follow certain regulations regarding the type and size of fishing gear used, the location of fishing, length and wide of nets or fish traps, and number of fish hooks etc.

A fundamental problem relating to the effectiveness of the fisheries legislation is its lack of enforcement. This stems principally from the nature of the legislation itself, a shortage of staff, a lack of training, experience and motivation, and poor employment conditions in the public service. The need to strengthen fisheries control and enforcement has been identified as a main issue for DOF. Although the fisheries legislation is comprehensive and geared primarily towards resource conservation, control, and enforcement, it is not well understood by fishermen and even by some fisheries officials. In addition, the legislation is not consistent with current international law and practices. The DOF has noted that an important shortcoming of the current legislation is its lack of consideration of environmental and ecological issues.

Today, Cambodia's political and economic environment is changing, the fisheries legislation and its regulation should be revised and extended to ensure that the legislation serves to reinforce fisheries policy and management. The revision must be consistent with international law relevant to inland fisheries.

Some constraints that reduce the effectiveness of the fisheries legislation include:

1-The combination of the centralized and decentralized structure of fisheries administration at DOF, and in the provincial and municipal fisheries services. The relationship and responsibilities between these levels of administration are not clearly

identified. Moreover, the legislation does not cater adequately for an inter-jurisdictional system of administration.

2-The effectiveness of enforcement is poor due to a lack of physical means to enforce the legislation. This situation adversely affects the morale of fisheries personnel.

3-Lack of catch, effort and statistical data, and limited research capacity to support the institution of management measures and;

4-Weak management, control and surveillance capacity and ineffective surveillance and enforcement of fishing activities within the inland fisheries and limited ability to ensure fisheries management measures are observed.

It should be noted that, legislation revision alone will not automatically lead to improve enforcement. This will require supporting measures designed to implement and administer the legislation.

5.2 Administration

5.2.1 Department of Fisheries (DOF)

DOF is one of the Departments in the Ministry of Agriculture, Forestry, and Fishery (MAFF) (Figure 3). The political responsibility for the Department lies with the Minister, two Secretaries of State, and various Under Secretaries of state. Fisheries Management responsibility rest with the Director, who is assisted by two Deputy Directors. The structure of the DOF is rather unconventional in that a number of activities report to the Director though the Deputy Directors while other activities report directly to the Director.

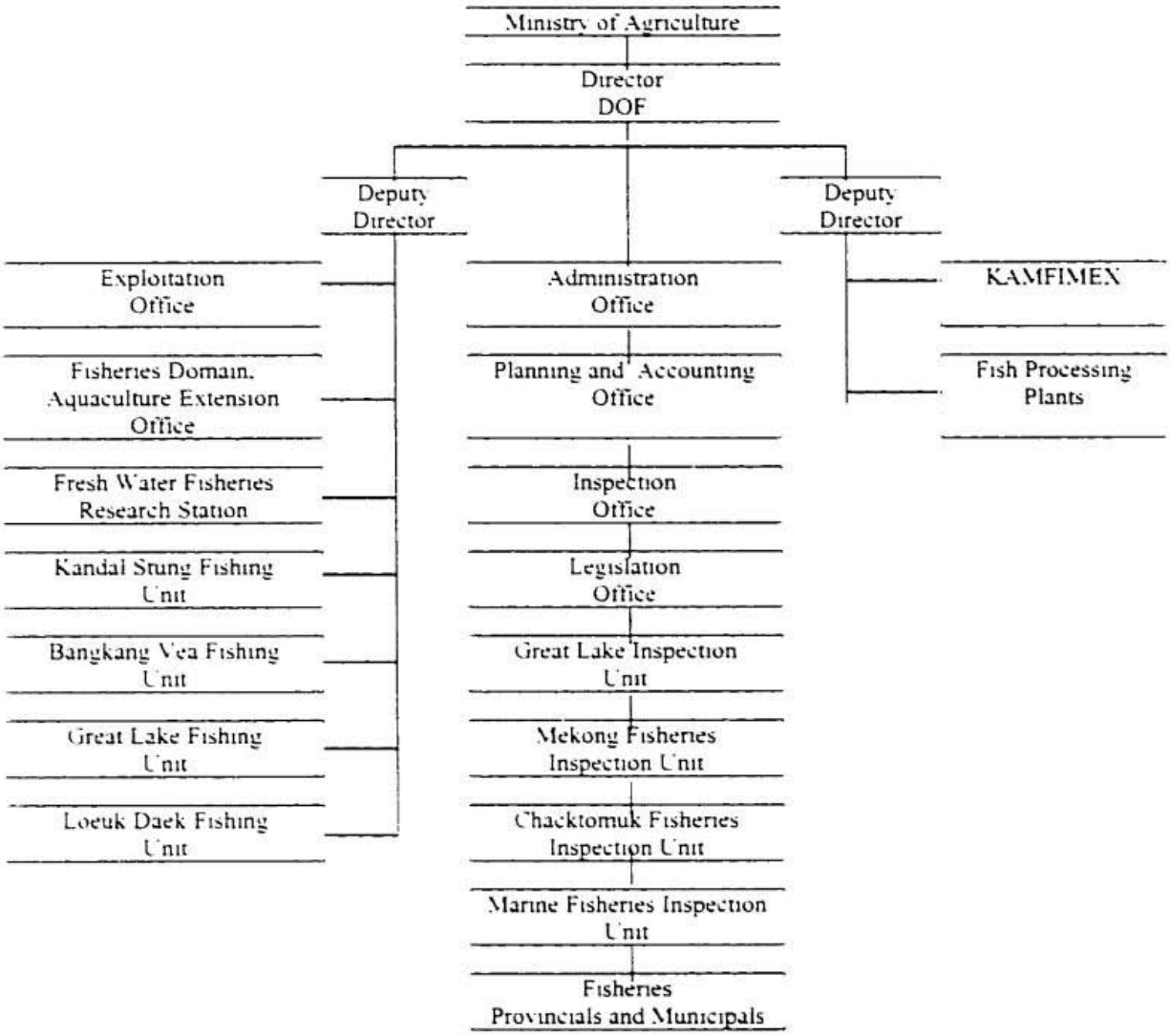

Figure 3. Organization Chart of The Department of Fisheries, 2000

Source DOF, 2000

The rationale for this arrangement is not clear. One Deputy Director is responsible for the DOF's commercial activities (Kampuchea Fishery Import Export Company (KAMFIMEX) and processing plants), while the other Deputy Director is responsible for a range of activities. Reporting directly to the Director is administration, planning and

accounting, legislation, provincial fisheries departments, and inspection activities. A notable feature of current fisheries organizational structure is the lack of coordination of related activities within DOF.

5.2.2 System of administration

The administrative management system of the fisheries sector has evolved over 40 years since the establishment of the Department of Fisheries in the 1960s and has developed both centralized and decentralized systems. The Department of Fisheries is centralized, while the provincial or local authority implements decentralized systems.

There are three levels of fisheries administration: one central (DOF); 13 provincial; and 3 municipal and city (Phnom Penh, Sihanouk Ville, and Kep). Such an administrative structure is burdensome, non-functional and likely to be inefficient. It may also lead to duplication in services (e.g., data collection and fisheries inspection), resource wastage and potential rivalry between different levels of administration. Moreover, such a structure is not conducive to strong fisheries management.

In addition, according to FAO, (1994), communication and coordination between the levels of fisheries administration is weak and erratic. There is a lack definition of roles and responsibility. Moreover, the DOF noted that enforcement of the fisheries legislation is complicated and difficult because of the decentralized system of administration.

Within the bounds of fisheries legislation, provincial and municipal administrations have freedom to determine their own policies and programs, despite limited technical capacities. This administrative situation enables inconsistent fisheries management policies to evolve, even between adjacent provinces and municipalities that have common waterways and resources.

The different waterways and bodies fall under the jurisdiction of different provinces. None of the provinces keep records specifically directed towards inland fisheries and simply make estimates of the freshwater fisheries production.

At the present time, a major difficulty for fisheries administration is an almost complete lack of equipment, materials and supplies. This lack of essential office equipment and material adversely affects the administration's capacity to carry out its fisheries mandate. Reorganization of the fisheries administration is required for cost-efficiency reasons. Current duplication associated with the three-tier levels of administration should be revised. Fisheries management must be strengthened and needs strong and consistent policies and strategies at the central level. Restructuring DOF should be pursued within the context of the reorganization of the fisheries administration, with emphasis on functional and size adjustments.

The current situation has led to low morale and lack of responsibilities. As a result, the system of administration at DOF has been faced with some constraints as indicated below:

1- Lack of fisheries data collection and related information, where data collected at the provincial level is often not submitted to DOF administration on time.

Besides that, according to DOF officials, some data collected are not processed and analyzed, and may be eventually discarded or lost.

2- Lack of policy delineation on the roles and responsibilities of all level of administration leads to duplication of duties.

3- Decision-making and responsibility should be out-lined in each level of administration.

4- Weak policy formulation and strategic planning to carry out effective enforcement.

5.2.3 Information systems and services

To place the country's fisheries on a sound scientific basis, a good national library and well functioning fisheries information centre is required. At the present time, there are two small general libraries available at Faculty of Fisheries (FOF) of the Royal University of Agriculture and DOF. Both FOF and DOF lack a specialized fisheries library and there is a marked absence of books and documents related to fisheries information. Among the functions of a centre should be the establishment of data collection based on fresh-water fisheries. The capability to use databases already available for Cambodia, especially on catch species, seasonal fish migration, fish stocks potential of the natural resource, economic importance fish species, and the preparation of reviews on some aspects is required for fisheries planning, conservation, MCS, and policy formulation.

Some computers are available, but data processing is still done manually, and requires significant manpower resources, time and costs to produce reports and information, which often contained errors and inconsistencies. Reports appear one year after the data is collected, thus providing information that is highly out of date and forms a poor basis for management decisions. Computer-based information systems need to be equipped for data analysis. These systems would be useful, allowing the decentralization and streamlining of data collection. The current procedure of boat registration is unclear; it greatly affects the day-to day licensing activities. The offences system can not keep data on offences and prosecutions, and also can not help DOF decide on the action needing to be taken. The logbook systems in capture fisheries data are unclear, and the fishers profile system is not available.

A series of programs is needed to improve the quantity, quality, flow and management of information concerning the fisheries sector between fishers, provincial and municipal fisheries, and DOF.A the Fisheries Information Management System (FIMF) (a fully integrated database, aiming to facilitate improved information flow) should be adopted.

A functional fisheries library and information centre for both DOF and FOF, assisting researchers, students, and administration with the future tasks of developing sustainable fisheries in the country should be established.

5.2.4 Human resources development

The DOF is involved in the fisheries sector at two levels: management and development of the country's resources, and commercial activities relating to the collection, marketing and distribution of fish and fisheries products. In general, public sector terms and conditions of employment are still limited by political and social arrangement. At the present time, public sector terms and conditions of employment are poor and salaries are low, this matter is complicated by the non-payment of salaries on schedule. Fisheries officials indicated that these considerations have a profound impact on incentives to work and perform.

The low remuneration in the public sector therefore has a direct bearing on efficiency of fisheries management and enforcement of legislation. This situation has led to low morale and lack of responsibilities in some areas and overlapping of duties others. More over, public sector employee duties have not really been adequately defined and there is a lack of training in professional skills. Many employees were recruited by political appointment without regard to their qualifications. Policies, systems and procedures for the utilization of public employees are inadequate and unstable. As a result, the systems of administration at DOF have been weakened in terms of staff responsibilities and duplication of duties at all levels.

To strengthen management capacity and development in the fisheries sector, the fundamental consideration must be human resource development. A lack of qualified and experienced staff in DOF is one of the most significant problems facing fisheries

administration in the country. The elimination of educated persons in the late 1970's during the Khmer Rouge regime has created an education and experience vacuum in the administration. DOF rehabilitation and reconstruction are hampered by the availability of human resources (Table 6).

Table 6: Classification of Staff Employed in Cambodia's Fisheries Service

Qualification	Total	DOF	Inspection	Exploitation / research	Business	Provincial/ Municipals
Post Graduated	32	30	0	0	0	2
Under Graduated	308	179	28	3	5	93
Diploma	276	71	57	3	9	136
Certificate	215	20	30	4	5	156
Skilled	879	304	117	10	25	423
Unskilled	724	48	80	65	71	460
Total	2,434	652	312	85	115	1,270

Source: Cambodia DOF, 1999

Note: -Post Graduate: Master degree

-Under Graduate Bachelor degree: Equivalent 4.5 years

- Diploma: Equivalent 2.5 years.

-Certificate: Equivalent 1 year.

-Skilled staff: have no formal qualification but have under taken at least 3 years training abroad.

Comparing DOF's current tasks with the available human resources in table 6 show that management is faced with a number of constraints related to human resource capacity, particularly a lack of qualified and experienced staff to operate in almost all fields and offices.

According to Table 6 in chapter V, "Classification of Staff Employed in Cambodia Fisheries Services", there are 312 persons employed in the inspection units: the one marine inspection unit comprises 64 persons (one female), and the three fresh-water inspections units together comprise 248 persons (all male). Thus, about 10% of DOF's staff are devoted to surveillance and enforcement activities. Comparing the current DOF's task with the human resources employed in inspection units, it is clear that the implementation of surveillance and enforcement faces many constraints.

In addition, education and training is limited and inadequate for current needs because lack of funds to support professional development. Technical foreign language skills are rare and this prevents overseas training. Based on this situation, DOF personnel need " more training at all levels, all types and in all areas" (FAO, 1994).

CHAPTER VI: FISHERIES EDUCATION AND TRAINING

6.1 Fisheries education system

The fisheries education and training system in Cambodia is complex and involves a number of ministries and institutions. The Ministry of Education Youth and Sport (MEYS) controls higher education while the Ministry of Agriculture, Forestry and Fisheries (MAFF) is responsible for technical training and vocational training. On-the-job training is mostly under the supervision of provincial and local authorities. Research and extension service activities are carried out by a relatively large number of NGOs, institutions, and agencies, mostly under the above ministries. There is only one public university providing under graduate degrees in fisheries and two vocational schools providing diplomas and certificates in fisheries.

6.1.1 Fisheries Education

A Faculty of Fisheries Science is located in the Royal University of Agriculture in Chamcar Daung. It offers 4.5 years training courses at the Bachelor's level in Fisheries Science. All post-graduate studies, however, continue to be under taken outside Cambodia (mainly in Asia, Australia, Philippines, Canada, and United States) under scholarships granted by foreign donors.

The Faculty of Fisheries Science (FOF) recently re-evaluated and improved its training curriculum in collaboration with the Asian Institute of Technology (AIT), the Swedish International Development Assistance (SIDA), and the Canadian International Development Agency (CIDA). A series of workshops was held on curriculum

development, short course training and long-term training with the specific aim to improve the technical knowledge and skills of the lecturers and students graduating from the faculty. Although the faculty is facing financial constraints, the collaboration with other training institutions and support from a number of development agencies is undoubtedly assisting it to up-grade skills in teaching and research. In addition, training facilities are improving. However, the faculty still suffers from a lack of well-qualified staff, equipment, and teaching materials.

Given the need for strong and effective fisheries management and for the careful development of inland fisheries to avoid failure and negative effects, curriculum revision for the institute should emphasize applied and practical aspects of fisheries management and sustainable development. Moreover, since the objective of fisheries management is the management of fish harvesters, and not the management of fish, a multi-disciplinary approach should be encouraged. In addition to subjects such as fish biology, fisheries and socio-economics, other subjects such us sociology, business, conservation, processing, fishing and fishing gear technology, aquaculture, basic mechanics and engineering, management, should be included. However, some education specialists, who feel that Cambodia's major need is for people with specialty training rather than generalist qualifications, consider such an approach to fisheries education too general.

Qualified teaching staff should be obtained from other countries to supplement in-country skills. Long-term training in specialty subject areas should be undertaken outside the country.

6.1.2 Fisheries vocational schools

Training in fisheries technical skills is presently provided through two training centres. Prek Leap Agricultural College located in Phnom Penh and Kompong Chham Agricultural College located in the plain region in the south of Cambodia. The minimum requirement for enrolment is completion of primary school. However, it is preferred that applicants have completed secondary school.

The vocational schools offer 3 years diplomas in fisheries and 2 years fisheries certificate programs. These institutions mostly provide fisheries and aquaculture training as well as operating in support of public education programs. They have traditionally had a more applied focus than the Faculty of Fisheries Science at Royal University of Agriculture. The vocational schools suffer from a lack of qualified staff, laboratory equipment, facilities, and teaching materials. A new curriculum for the fisheries courses is also needed. Revision of the fisheries education curriculum has been identified as a matter requiring immediate attention.

6.1.3 Fisheries education and training development

In a rapidly changing social and natural environment, education and training is being called upon to play a varied and complex role in development. In particular, education and training in fisheries faces the challenge of preparing the younger generations for careers in fisheries, especially in sustainable fisheries management and development. No clear path has been identified, but it is obvious that education and training in fisheries will play an important role in preparing farmers, researchers, teachers, managers, extension

staff and members of the fishers and fishing community to help a growing population reach increased levels of food self-sufficiency.

Greater access to electronic databases and resources information, better institutional management, competency-based education and training, and the practical application of improved pedagogical skills and technology are helping students and trainees learn how to solve problems and find answers. This approach is slowly pushing aside a long established traditional of memorizing facts and unrelated bits of information. A critical question is what are the changes and adaptations in structure, strategy and policy that fisheries educators will need to make as they face the challenges of the 21st century? (FAO, 1997).

In response to the need to review and adjust teaching, training and educational programs in fisheries at all levels, a parallel strategy should be developed from basic principles, for technical and vocational education and training, and higher fisheries education as follow:

A. Basic principles

1. To promote fisheries education and training programs which are job-oriented and met the actual needs of the fisheries communities, the regions, and the country.

2. To support and promote agreements and cooperation or coordination at inter-institutional and international level, particularly in exchange of faculty members, students, information and experiences.

3. To place a greater emphasis on developing more relevant curriculum, improving the quality of instruction and promoting better institutional management.

B. Higher fisheries education

1. To follow, in matters of higher education, the same general principles: to address local needs and adapt curricula to employment needs, integrate or closely collaborate with research and extension, to be open to the professional environment and make use of resources from the private sector.

2. To organize, as far as possible, an integrated modular structure of teaching, which sub-contracts some subjects to the faculties of general education; offers the students a large range of courses; and open some modules to continuing education.

3. To promote systems and structures which allow staff flexibility among fisheries higher education, research and extension activities.

4. To actively promote participatory teaching methods using case study, problem-solving approaches, group working and interdisciplinary approaches.

5. To promote more relevant and efficient teaching programs through regular reviews of curricula and systematic feedback from employers and former graduates.

6. To promote the adoption of a systems approach in teaching programs enabling graduates to comprehend fisheries as a system comprised of technical, economic, social, and culture elements.

7. To promote projects and actions for training and improvement of teaching staff.

8. To place increased emphasis on the development of distance learning approaches.

9. Electronic information systems and the application of these new systems to different forms of distance learning in fisheries should be given special consideration as a way to improve the effectiveness of pre-service and in-service education.

6.1.4 Research in Fisheries

6.1.4.1 Research and training fund

In theory, the main research budget for the fisheries research comes from the Ministry of Economics and Finance through the Ministry of Agriculture Forestry and Fishery (MAFF). Additional research funds are also available from the state and provincial governments through co-operative projects involving several Ministries and the University of Agriculture. In practice however, almost all of the research and training is being funded by a number of foreign countries through bilateral co-operation projects, managed by NGOs, and international organizations with bases in Cambodia.

6.1.4.2 Research institutions

There are three primary Fresh Water Aquaculture Research Stations in Cambodia, Chrang Cham Res inland research station (CS), Bati Fisheries Seed production and Research centre (BFSPRC), and Toul Kro Sang station (TKS). CS is operated by DOF and located in Phnom Penh, and is the primary aquaculture research and training station in Cambodia. The main duties of the station are to conduct research on fresh water aquaculture

techniques, extension service, and the transfer of aquaculture technologies and know-how to farmers through short-term training courses. CS was established to concentrate on fresh water culture and breeding; and in recent year research and training activities have been carried out in numerous northwest provinces with the collaboration of other institutions and NGOs.

The other two research institutions are associated with Prey Vaeng and Kan Dal Provincial Agriculture Departments in collaboration with PADEX and SAO. Their tasks are the same as CS. These institutions have a certain degree of autonomy and are usually allowed to open their own bank accounts and freely administer the funds allocated to them through the relevant provincial authorities. Each research institution is responsible for developing an annual plan, which is then submitted to the supervising provincial department and steering committee for consideration and approval.

Other institutions and agencies are involved in research related to fresh water capture fisheries and aquaculture are MRC, FAO, SAO, PADEK, AIT, UNDP, and other NGOs.

Cambodia's urgently requires personnel who can operate effectively as fisheries research managers. However, this requires a thorough understanding of field conditions and extensive experience. Officials recognized that fisheries graduates from FOF have little research or field experience and therefore, have difficulty in applying their knowledge after joining the DOF administration.

In addition, education institutions should maintain their own research facilities. The research institutions need to upgrade and improve their human resources capabilities and look for collaborative links with existing, and proposed, fisheries research stations.

6.1.4.3 Research and training

No research is done at the national level but there is some regional activity, inter-alia by NGOs that collaborate with DOF. Planning and co-ordination of all the aquaculture and research activities should be carried out by the research institutes under the responsibility of the DOF. The Department of Fisheries should be involved in the formulation and administration of the MAFF's 5-year research plan as well as reviewing the selection process for all research proposals submitted to the DOF by the research institutes for funding under the 5-year program.

DOF officials indicate that the quality of fisheries researchers is low. This is leading to poor research. Both short-term and long-term training is required for the fisheries research institutions. It is preferable that training be conducted in rural areas in order to reach a large target group in surroundings familiar to trainees. However, out of country training, particularly for more specialization skilled development is likely to be necessary. A wide range of fisheries research training is required to upgrade skills. In term of immediate needs, training at research centres and DOF should focus on short-term skills related to specific specializations and should be conducted through on-the-job training. The enhancement of language skills so that staff can take advantage out of country

training opportunities and be able to review international professional publications. should also be undertaken.

The establishment of a revolving fund for training for staff of the DOF administration and research institutions should be undertaken. A comprehensive program for further training in research should be implemented at national institutions so that they are better able to conduct quality research.

The development of "twinning arrangements" with out of country institutions should be established. Additional support should be given to research facilities for training purposes at the DOF fisheries research stations and fostering of links with existing institutions. A project designed to strengthen researchers development in DOF should be clearly defined and scheduled.

6.1.5 Extension services

Present extension activities are run by different agencies using different systems and approaches. The office of fisheries, aquaculture and extension, within the Department of Fisheries, is responsible for the overall development and monitoring of fisheries and aquaculture extension activities throughout the country.

In land-locked provinces, the services are provided by trained officers working at the provincial agriculture extension office, who are generally under the supervision of the provincial agriculture departments. Virtually no institutional extension is undertaken at

the district or community level. Some research institutions and NGOs also undertake farm level extension but not at a level sufficient to have a major impact on development. Generally, there is a lack of coordination in the fisheries extension program.

The main extension education approach is the use of short training courses (3-5 days), demonstration farms, site visits and study tours for advanced farmers and community leaders. Radio broadcasting, technical booklets, and video films, are widely used as training instruments.

At present the office of fisheries, aquaculture and extension services and some others extension agencies are facing problems of a lack of qualified staff and operating funding. Based on the result of oral interviews with some representatives from DOF, provincial and municipal fisheries authorities, and with some NGOs working on aquaculture and extension service at the provincial level, the fisheries extension services can be evaluated as shown in Table 7:

Table 7: Fisheries Extension Service Evaluation

	Evaluation	Comments
Extension funding	Extremely limited	• The main sources of funds for aquaculture and fisheries extension activities are from the DOF and provincial authority. The extension centres are never granted the full requested budget. • Due to the limited funds available at both the DOF and provincial levels, few annual training courses are organized. Priority is often given to farmers engaged in fresh water aquaculture. • Insufficient budget limits the travel of extension officers to contact the farmers.

		• Low salaries discourage the extension officers to work regularly and effectively.
Technical knowledge of extension officers	Medium	• Although most of the extension workers at the provincial level and some at the district level have received formal education in aquaculture, there are limited possibilities for up-grading their skills. • Inter-regional or inter-provincial information exchange is limited. • Few extension officers have received advanced training in fisheries planning and management. • Few extension workers have received training in extension methodologies. • A large proportion of the extension workers have little practical experience in aquaculture and often tend to relay information from text books which may not be applicable in specific localities.
Number of extension officers	Poor	• The fisheries extension technical personnel work at centres are limited to 2-3 persons. In the majority of the cases, all the technical staff works at the provincial level, very few exceptions at the district level. • Existing extension coverage is rather poor with only a few extension workers to cover large areas.
Extension methods	Inadequate	• The concept of fisheries extension is often not clearly understood by the extension workers. • Limited knowledge on "modern" extension methodologies, with extension largely a top-down exercise, i.e. through the conduct of farmers' training courses rather than an on-going two-way communication process. • Most of the extension programs are focused on fresh water aquaculture, while very little attention has been paid to programs for capture fisheries, conservation and future sustainable development.
Extension equipment and documents	Poor	• Most extension centres are poorly equipped. Most of extension centres have only a small administrative office. Very few have field extension centres where farmers can receive technical advice through practical demonstrations. • An abundance of documents for training in form of booklets or pamphlets available at present are often prepared at the DOF or provincial level. Some have been prepared at the national levels. Distribution, however, appears to be inadequate (few farmers receive

	the materials). • Most farmers are poorly educated and when given documents although they can read the materials, they are not fully understood then without oral explanation.

(Source: The Fisheries Master Plan Project, Sub Project 2, 1996)

CHAPTER VII: MONITORING, CONTROL, AND SURVEILLANCE

Monitoring, control, and surveillance (MCS) is mainly carried out by the Department of Fisheries in Cambodia, with support from other agencies including the Military Police, Army, and local fisheries authorities. Problems in the fisheries sector include the abuse of fishing reserves, destruction of inundated forests in fresh water fisheries and illegal Pangasius fingerling fishing in the closing season.

Enforcement of legislation, regulations and policies is the main fisheries management constraint in Cambodia. Officials at the DOF, provincial and municipal levels identified the lack of enforcement, especially in fresh-water capture fisheries as a major problem. There are four factors that constitute to the deterioration of fresh-water fisheries enforcement: 1) limited training and lack of qualified and experienced staff to implement the system; 2) lack of facilities, particularly fisheries inspection vessels; 3) small operating budgets; and 4) the uncontrolled availability and use of weapons by civilians and militarists. These considerations, combined with poor terms of reference and conditions of employment are contributing to unprofessional conduct by fisheries enforcement officers and lack of interest in executing responsibilities in an effective manner (FAO, 1994). According to the DOF's reports in 1999, illegal-fishing activities increased by 250 percent compared to the same period in 1998. Based on this result, there is a need to review the system of collecting fines levied on fishers for infringements. In addition, better information service systems should be introduced and strengthened. Moreover, fresh-water vessels legislation systems should be reviewed and improved in terms of capacity and numbers to match the potential of the natural resources.

7.1 Policy and operational responsibility

The MCS system was designed to address fisheries issues as well as coastal, ocean, and inland fisheries concerns. These were not specifically separated from each other. The system can not encompass the gathering of information on fishing effort characteristics and resource yields, the regulatory condition under which exploitation of the resources may be conducted, and the degree and types of observations required to maintain compliance with regulatory controls imposed on fisheries activities. The MCS mechanism and information gathered through the use of its resources can and should be used to benefit other inland sector interests like the environment, inundated forest, food security and sovereignty.

Considering the overlapping jurisdictions among the various institutions and stakeholders with the interest in the sector, an integrated, multi-sector approach at both the national and local levels is deemed necessary to effectively implement MCS. The MCS's policy and responsibility for implementation must be clearly defined and set forth in the national legislation. Although the decentralization of MCS activities had had a degree of political appeal and support, in practice such sharing of responsibility is inefficient and impractical. The main issue concerning MCS is the lack of delineation of responsibility at all levels in the fisheries sector i.e. DOF, provincial, and municipal fisheries administrations.

7.2 Inland capture fisheries

There are three inspection units and an inspection office administrated by the DOF: the Great lake inspection unit, the Mekong fisheries inspection unit, and the Chacktomuk fisheries inspection unit, and the DOF's inland fisheries inspection office is based in Phnom Penh (Figure2). These are logical and central locations and should be maintained. The office and units have prime waterfront land with a rudimentary wharf and office accommodation. These facilities would be inadequate for a more sophisticated MCS operation and would therefore require upgrading. There is no security for DOF patrol vessels and officials noted that fishermen, for this reason, always have advance warning of MCS sortie planning and operations.

These inspections unit operate their own vessels for inland surveillance and enforcement, all of which are constructed of wood. The vessels are about 10-15 m in length and have maximum speeds of about 40-50 km.h. Such vessels are aging and although reasonably well maintained, are run down. They are not designed for MCS purposes but rather are multi-purpose fishing vessels and transport craft. The only equipment visible on board is a compass, one pair of binoculars, a radio, and guns. These vessels do not have navigation aids and secure communication systems necessary for MCS's operations nor cameras for recording purposes. Such equipment is essential and required for the preparation, documentation, reporting and prosecution of fisheries violations (FAO, 1994). Moreover, it is unlikely that the design and construction standards of the vessels comply with minimum international standards. The vessels do not have life support equipment of any

type, even though the MSC unit is required periodically to undertake search and rescue (SAR) activities during the flooded season.

Despite its inadequate MCS facilities, the inland inspection unit, to its credit, secured fines from 1,990 cases of fishing violation in 1999 totaling 149 million Riels. Most of the violations in 1999 involved small-scale fishers (mainly using mosquito nets in prohibited areas during the closed season). The high proportion of small-scale vessel violations is to be expected, given the lack of MCS capacity to patrol offshore areas where industrial activities normally operate. From observations and oral interviews with DOF inland inspection unit personnel and staff from the local inspection units, it was concluded that it was not operationally or technically possible, under current circumstances, for the unit to fully enforce fisheries legislation and policy within the fresh-water boundary.

To achieve the goal of improved fisheries management the following suggestions are offered for the development of policy for the inland fishery:

1- To promote the economic growth of the inland fisheries sector and services, which in turn will ensure political, economic and social stability.

2- To enhance the administrative capacity of provincial fisheries through human resources development and financial support.

3- To encourage the development and strengthening of the legislative hierarchy (see Annex A), or other legal requirements pertaining to inland fisheries management (ICLARM, 1999).

4- To ensure compliance with laws, sub-decrees, or other requirements through capacity building;

5- To protect the natural resources, the environment, the national parks, and others protected areas of the inland zone; and

6- To enhance and develop the inland fisheries, especially the floodplain fisheries, the claims of competing societal objects (fish production, income, nutrition, equity, bio-diversity, government revenue) must be balanced within the physical, biological and socio-economic constrains imposed by the system. Management plans design must cover a hierarchy of issues from the institutional (organizations institutions involved, responsibilities, participation of beneficiaries etc) to the technical (species stocks, densities, timing of release, fingerling size, management of exploitation, etc.).

CHAPTER VIII: CONCLUSIONS

Given that the scarcity of inland fisheries resources resulted from environmental issues and the continued growth of population, there is no alternative but to continue intensifying inland aquaculture production in Cambodia. Furthermore, the fisheries management system currently practiced is degrading the fisheries resource base and posing a substantial threat to sustainability. Change will be necessary to ensure that self-sufficiency is maintained. Environmentally, the destruction practiced appears to pose much less of a threat than is sometimes feared, with the important exception of the inundated forest.

The problem of Inland captures fisheries experienced in Cambodia is cause by distortions of bio-diversity and inappropriate management behavior, as well as from difficulties in learning how to manage complex new fishing gears and fishing methods. The switch from traditional fishing gears into modern fishing gears is much more than a change in amount of inland fisheries production. It is a change from a low input, low output management system to a high input, high output management system. These problems, therefore, are not amenable to traditional forms of intervention through manipulation of the management structure. Nor do rules and regulations on appropriate resources use appropriately address the current problems in Cambodian fisheries. Fishers must have an incentive and the will to respond to degradation problems, if supporting infrastructure is established.

There is considerable scope for fisheries research and extension services to assist DOF

leaders in developing appropriate respond to degradation of fisheries effort problems. This will require a reorientation of research efforts towards on increased focus on site specific conditions, on long-term research, and on fishing systems and practices. The days of "blanket" messages which are unequally applicable to all DOF leaders are over; what DOF leaders need is assistance in fine-tuning their management practices to improve skill and avoid degradation, these are not fundamental qualitative changes. This effort will also require much improved administration system, which must not only deliver information to a lower level of fishery administration but also convey information back to the research system on DOF leaders need and constraints.

For the DOF leaders to be able to increase the efficiency of their management practices, they will also need reliable and timely access to inputs, including monitoring, control and surveillance (MCS). To strengthen MCS in Cambodia, one should take advantage of the lessons learn from the current effort in developing a community-based management system in the Asian countries, in addition to lessons from Canada. Technology advances in computer- and satellite-based communication will increase the efficiency of MCS and at same time reduce the cost. Prospects for achieving conservation and management objectives will be limited in the absence of an effective MCS.

A good MCS system will enhance fisheries management systems, while a poor fisheries management plan will be a disincentive for any effort directed to strengthening of MCS. It is thus of high priority for Cambodia to address the strengthening of fisheries management in an effort to counter the increasing trend towards resource overexploitation

and over-capacity of the commercial fishing.

Although the threat to resource management posed by over-fishing practices appears to be high, several relatively simple (total fish production and fish grading from the inland commercial fishery) can help ensure that the over-exploitation natural resources does not continue. The most pressing need for action to prevent future resource problems is the lost of the inundated forest and reserved fishing lots, which pose a high risk of damage to bio-diversity and fish habitat. Research is urgently needed to determine the magnitude and exact nature of problems, including threat to fish migration and spawning grounds, of pollution of water-bodies, of pesticide residues on fish, of fertilizer effects on the fresh water environment.

The reform of the fisheries regulation system will help to ensure that over-fishing and illegal fishing activities are reduced. The current regulation system is slow, excessively concerned with fisheries regulation effectiveness rather than resource stability, and consumes valuable research resources. In many instances, it has resulted in the continued use of illegal fishing gears and fishing methods, and over-fishing continuing even though more environmental friendly fishing gears are available and in wide spread use in the country.

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ANNEX A

LEGISLATIVE HIERARCHY

1. The Constitution

The Constitution is the Supreme Law of the Kingdom of Cambodia. All other laws must strictly conform to the Constitution. An initiative to review or to amend the Constitution is the prerogative of the King, the Prime Minister and the Chairman of the National Assembly at the suggestion of one-fourth of all the assembly members. A constitutional law passed by the assembly with a two-thirds majority vote for revision or amendment can enact revisions or amendments.

2. Law (Cbbab)

The national assembly determines law by third vote. The law is called an organic law if it refers to the creation or the organization of the state institution and its structures. For example, article 127 of the Constitution provides that provinces, municipalities, districts and communes shall be governed in accordance with organic law.

3. Kram

This is the Royal Promulgation by the King.

4. Royal Degree (Reach Kret)

Royal Degree are used by the King in the exercise of his constitutional power, i.e., power of appointment upon proposals by the Council of Ministers, or by the Supreme Council of the Magistracy.

5. Degree (Kret)

The King upon proposals of the Prime Minister signs degrees.

6. Sub-degree (Anu-kret)

Sub-degree are signed by the Prime Ministers and countersigned by the Ministers in charge of their execution after adoption by the Council of Minister. The Prime Minister, based on his executive regulatory power can also issue sub-degree.

7. Declaration (Ministerial Prakas)

Ministries in the framework of their own regulatory powers use declarations.

8. Decision (Sechkdei Samrech)

Decision is an individual decision of Prime Ministers, a minister or a governor within the framework of their own regulatory powers.

9. Circular (Sarachor)

Circulars are used in general by the Prime Ministers, by ministers as officials of the ministry either to explain or clarify the legality of regulatory measures of to provide instructions.

10. Arete (Provincial Deka)

Provincial governors within the geographical limit of their provinces use provincial Aretes.

11. Customary Law

Customary Law or Khmer customs may sometimes be a basis for judicial decisions. Cambodia is an ancient country in which Buddhist and Khmer beliefs, traditions and customs influence law. Some constitutional references to Khmer tradition illustrate how Khmer regulates behavior and serves as a source of law.

12. Treaties and conventions

International law, if considered part of Cambodian law, may also be enforced by judges

in Cambodia courts. International law is a combination of the laws of individual nations, customs developed in the course of international business transactions, treaties (agreements between two or more independent nations) and declarations and resolutions of international organizations. Cambodia may become a party to the international treaties and conventions whenever the National Assembly approves them. According to Article 26 of the constitution, the King is empowered to ratify an international treaty after approval by the national Assembly.