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Master Plan for the Rehabilitation and Revitalisation of the Ex-Mega Rice Project Area in Central Kalimantan






FISHERIES AND AQUACULTURE IN THE EX-MEGA RICE PROJECT AREA IN CENTRAL KALIMANTAN

Technical Report No. 7

OCTOBER 2008

Euroconsult Mott MacDonald and Deltares | Delft Hydraulics
in association with
DHV, Wageningen UR, Witteveen+Bos, PT MLD and PT INDEC

Master Plan for the Rehabilitation and Rehabilitation of the Ex-Mega Rice Project Area in Central Kalimantan

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Fisheries and Aquaculture in the Ex-Mega Rice Project Area in Central Kalimantan

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Summary

Fisheries and aquaculture, play an important role in Central Kalimantan providing a source of food and protein to the local communities, generating employment and house hold income, providing trade and economic well-being. The average annual fish consumption of 45 kg per person in Central Kalimantan in 2001 almost doubled the average annual national figure of 26.5 kg per person emphasising the importance of the sector to local communities in terms of animal protein.

Capture fisheries in the EMRP area can be classified as small-scale fisheries and takes place in the main rivers Barito, Kapuas Kahayan, their tributaries, peat and freshwater swamps, lakes, estuaries, the mangrove and coastal areas. Inland capture fisheries use a broad range of active and passive fishing gear and target both riverine and swamp species including amongst others glass catfish (Lais kaca, *Kryptopterus hexapterus*), croaker (Gulama, *Sciaena ruselli*), giant snakehead (toman), climbing perch (Papuyu, *Anabas testudineus*), gouramy (sepat rawa, *Trichogaster trichopterus*), Rasbora (Saluang, *Rasbora paciperforata)*, blackskin catfish (pentet, *Clarias sp.*). The traditional fisheries system beje providing an important source of income to the Dayak communities can be found in the tributaries of Kapuas river and targets similar swamp species. Capture fisheries provides employment for people directly engaged in fishing activities and for others working in fisheries-related activities such as fish processing and marketing, boat building and net making. Most fish products, whether fresh or processed are distributed through intermediaries controlling the traditional marketing and are sold at the local markets. In the remote areas were access to fresh fish distribution channels is limited, fish is often processed before it is marketed. The role of women is particularly important in this.

Aquaculture in the EMRP area is practiced in brackish water ponds in coastal lowlands (*tambaks*), freshwater ponds *(kolam*) and cages (*karamba*) located in the rivers.. Culture systems range from extensive to semi-intensive depending on the seed stocking density, the level of inputs and the degree of management. Freshwater aquaculture in the project area is done traditionally in village ponds. The most common species cultured are Nile tilapia (*Oreochromis niloticus*) and catfish (*Pangasius* sp.). Brackish water ponds can be found at the coast in *kecamatan* Kahayan Kuala in Pulang Pisau district. The main species cultured in tambaks are milkfish (*Chanos chanos*), mullet (*Mugil* spp.) and shrimp species (*Penaeus sp*). Cages are located in Kapuas and Barito river and near Palangkaraya in the Kahayan river. Cage culture is mainly done as an additional livelihood. Floating structures are used to grow catfish (*Pangasius* sp.) and Nile tilapia (*Oreochromis niloticus*). Private traders, collectors or agents market most of the aquaculture products. Fish fry or fingerlings are produced privately are at the hatchery of the Department of Marine Affairs and Fisheries in Pulang Pisau district. The species cultured in small aquaculture ponds and cages are sold at the local and national markets or used for household consumption. Shrimp famers often sell to collectors transporting the products from production site to processing plants and export companies. Hygiene and sanitation in the fresh or wet supply of fish is not always up to the food safety standards which has strong consequences for export to international markets.

Over the years, human intervention such as canal construction for agriculture development, logging and mining and pond construction in mangrove areas have destroyed and degraded ecosystems in the EMRP area that are critical to the survival and growth of fish species. Changes in water quality, turbidity and sedimentation have led to deterioration of fish habitats leading to the disappearance of certain species,

changes in species composition and a decreased aquaculture and fisheries production, in particular of the traditional *beje* fisheries. Development of structures such as dams and gates in the drainage canals limit the seasonal movement and migration of fish species from peat swamp areas to rivers and back. Conversion of mangroves to aquaculture ponds translates to biodiversity loss, impacting the coastal and marine fisheries depending on mangroves for feeding and breeding ground. Illegal fishing activities and overfishing of certain fish species also threaten the ecosystem and impact the sustainability of the fisheries resources and the livelihood of fishing communities.

The different types of fisheries in the EMRP project area require specific management approaches that can not always explicitly be linked to the proposed Management Units in the Master Plan. The long-term strategies for development of *capture fisheries* in the EMRP area should aim at sustainability and balance fishing effort with resource availability. *Freshwater aquaculture* in and along rivers require a management approach that includes the river basin as human activities upstream impact on downstream fish farming practices. In *peatswamp areas*, fisheries and aquaculture can provide a source of livelihood to local communities provided appropriate laws and regulations are at place to support this. Such socio-economic development should be based with a long term view on sustainability and be carefully balanced with conservation and rehabilitation efforts. *Brackish water aquaculture* should be managed according to the specific characteristics of the coastal ecosystem. It is evident a long-term integrated management plan for the EMRP area should represent the interests of all involved in the fisheries and aquaculture sector. An improved dialogue on water resources allocation, water use and water quality management is key to the success of such integrated management approaches.

Opportunities to improve the livelihoods and alleviate poverty of the local fishing communities in the EMRP area include: (a) expansion freshwater aquaculture production, (b) development of cage culture in the rivers, (c) rehabilitation of beje fisheries and (d) marketing of ornamental fisheries. The introduction and/or further development of these fisheries and aquaculture activities depends strongly on the condition and carrying capacity of the ecosystem. Appropriate data on existing fisheries resources, exploitation figures but also environmental data such as water quality are needed to support decision making to better manage the fisheries resources and to avoid further resource depletion. In addition, adaptive management and the livelihood approach could be leading strategies to offer promising solutions to both wise use of fisheries resources and poverty alleviation in the project area.

The sustainable development of the fisheries and aquaculture sector entails knowledge and skill development in fisheries practices and innovative pond and cage culture techniques. Access to credit and input supplies and the marketing infrastructure needs to be improved and facilitated and links with commercial national and international ventures should be explored. Demonstration, research and extension services should be made more relevant to the fish farmers' needs and situation supporting them to invest in innovative technologies and increase their production. The success or failure of interventions and experiences need to be carefully monitored and documented to allow for better sharing and internalising of lessons learned.

1 Introduction

This technical report is prepared as part of the development of an integrated Master Plan for the Ex-Mega Rice Project (EMRP) in Central Kalimantan. The purpose of the Master Plan is to *"lay out a comprehensive plan addressing technical, environmental, socio-economic, cultural and institutional issues related to and impacting on the long term sustainable rehabilitation of the Ex-Mega Rice Project area".*[1]

Capture fisheries and aquaculture play an important role in the Ex-Mega Rice Project (EMRP) area providing nutrition, income and employment to local communities. This report describes the existing fisheries and aquaculture systems in the EMRP area and their potential and constraints. Recommendations are given based on the bio-physical and socio-economic conditions and available knowledge and capacities of the stakeholders involved in fisheries and aquaculture development and management. The analysis of the fisheries systems is based on field visits, analysis of secondary information, literature review and stakeholders interviews. Although this report does include data on marine fisheries the main focus is on inland capture fisheries, including peat swamp fisheries and aquaculture. Aquaculture includes brackish and fresh water farming, cage culture and aquaculture in rice fields. Marine capture fisheries data is included to provide the overall production figures of Central Kalimantan province and the EMRP area. It also meant to emphasise the importance of conservation of coastal habitats such as mangroves which support marine fisheries production.

Besides this introductory chapter 1, the report contains four more chapters. Chapter 2 describes briefly the existing conditions of the Central Kalimantan Peatlands Development Area including the role of fisheries and aquaculture in the regional economy and existing socio-economic conditions. A more detailed general description of the conditions can be found in the Master Plan Synthesis Report. Chapter 3 describes the different types of fisheries and aquaculture systems that can be found in the EMRP area, their production and constraints faced. Chapter 4 reviews the challenges and opportunities in fisheries and aquaculture. Finally chapter 5 presents the strategy for aquaculture and fisheries management, conservation and development in the proposed Management Zones and Units.

[1] Royal Netherlands Embassy – Government of Indonesia (2007) Terms of reference for services in the field of conservation and sustainable development of peatlands in Central Kalimantan, Indonesia

2 Existing conditions of the EMRP area

2.1 Background

The Ex-Mega Rice Project area is located in the south-eastern part of Central Kalimantan province, Indonesia and covers an area of 1,462,296 hectares of degraded peat and other land.[2] The area is bounded by the Sebangau River in the west, the Java Sea in the south, the Barito River in the east and the Palangka Raya – Buntok road in the north. Since the Mega-Rice Project, the project area is divided into five blocks (Figure 2.1).

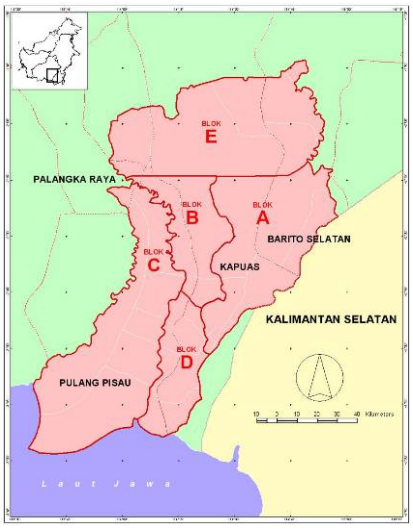


Figure 2.1: Ex-Mega Rice Project Area

The EMRP area falls within the administrative boundaries of the provincial capital Palangka Raya City and the districts of Kapuas, Pulang Pisau and Barito Selatan. Within the boundaries of the area, there are 187 villages divided among 20 sub-districts with a total population in 2005 of 352,103 persons and 88,414 households. Out of this total number of households, 28% live at the riverbanks. The Dayaks, the indigenous and predominant ethnic group, consist of many sub-ethnic groups, each having its own language and traditions. The EMRP area covers almost 10% of the area of Central Kalimantan but is home to almost one-quarter of its population. The future of the EMRP area is therefore of great importance to the future of the province (Table 2.1).

Table 2.1: Area, Population and Administration within the EMRP Area.

District/City	Area of EMRP (ha)	# Sub-districts	# Villages	Population	Households
Palangka Raya	16,324	2	8	11,303	2,879
Kapuas	629,827	8	108	206,908	51,647
Barito Selatan	197,601	3	18	34,691	8,852
Pulang Pisau	618,543	7	53	99,201	25,036
Total	**1,462,296**	**20**	**187**	**352,103**	**88,414**

Source: Own calculation (area of EMRP) and PODES 2005.

[2] The size of the area and sub-units is taken directly from the GIS data and differs from previous data. The differences in total area and block areas for EMRP are caused by the inconsistencies in mapping and assignment of the surface area of large rivers to one or another defined region (such as a block).

2.2 Bio-physical conditions

The area is predominantly flat and characterized by a humid tropical climate with mean daily temperatures varying from 25 to 33°C at sea level, high humidity (85-90%) and a mean annual precipitation of approximately 2,400 mm. Normal dry seasons last from May/June to September. During El Niño-Southern Oscillation (ENSO) years, the dry season may begin as early as March and last until December.

There are basically four main land systems in the EMRP area, each having a different landscape setting and with very different usage options and management requirements:

1. Riverbanks and Levees – Traditional settlements are found along side the rivers. In parts with strong riverine influence well-drained, coarse textured river banks or levees are formed. Downstream, near the coast, these levees are less pronounced or even absent but are still well drained, compared to the hinterland, and provide favorable conditions for housing.

2. Swamps - The swamps are the low lying areas between the riverbanks, often flooded and water logged for longer periods. Soils are of riverine and marine origin and have a high horizontal and vertical spatial variability, containing (shallow) organic soils, muck soils, and (potentially) acid-sulphate soils. In slightly elevated marine terraces some podsolidation may have taken place in acid sulphate clays, resulting in highly infertile white loamy and silty topsoils.

3. Peat Soils - With the accumulation of peat in the swamps, the surface level rises gradually reducing the river influence. After some time peat growth fully depends on rainfall resulting in the typical dome-shaped peat lands. Three continuous deep peat areas are found in the area (Figure 2.2): one between Sebangau and Kahayan Rivers (Block C), one between the Kahayan and Kapuas Rivers (Block B and the Western part of Block E) and one between the Kapuas and Barito Rivers (the northern part of Block A and eastern part of Block E). Patches of shallow to medium peat are found in the south of Block A and Block D. Peat of more than 0.5 m depth covers 927,000 ha or 63.5% of the EMRP area (Table 2.2)[3].

4. Coastal Soils - The coastal zone is mostly defined by alternating sandy beach ridges and swales with clayey and organic soils.

[3] The map of peat extent and depth shown in Figure 2.2 is based on all available peat data (Pulitanak, Restorpeat, Yayasan BOS) and survey work conducted under CKPP (see Annex x). While discussions on the precise depth of deep peat deposits are possible due to data imperfections, the position of the 3m and 1m peat depth lines are now relatively well-established for most of the area with the exception of block E, which has few data points.

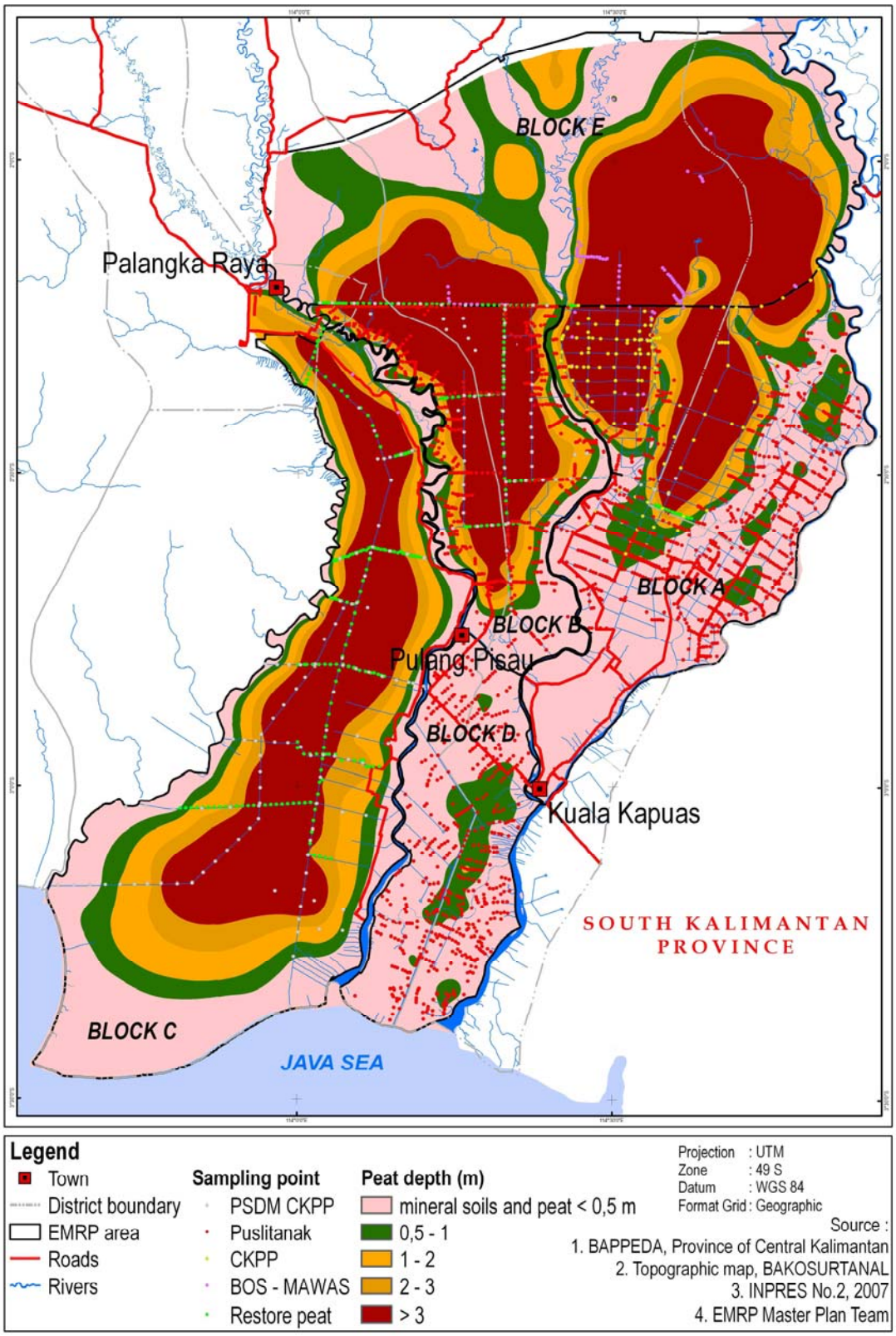


Figure 2.2: Peat depth map with sampling locations for the EMRP area.
The map shows peat >3m deep (red area) with peat depth zones of 2-3m, 1-2m and 0.5-1m. The pink area represents mineral soils and shallow peat <0.5m. Data for block E are approximate.

2.3 Water resources

Central Kalimantan has a large network of water resources comprising of rivers, lakes and peat swamps (figure 2.3). The total area of inland water in Central Kalimantan is 22678 km^2, which is the second largest ecosystem after the forests area. The EMRP project area covers a total area of 14622.28 km^2. The inland water bodies including rivers and lakes cover an area of 126.22 km^2. Fresh water and peat swamp areas cover respectively 999 km^2 and 1564 km^2. The total mangrove area is 139.93 km$^{2.}$

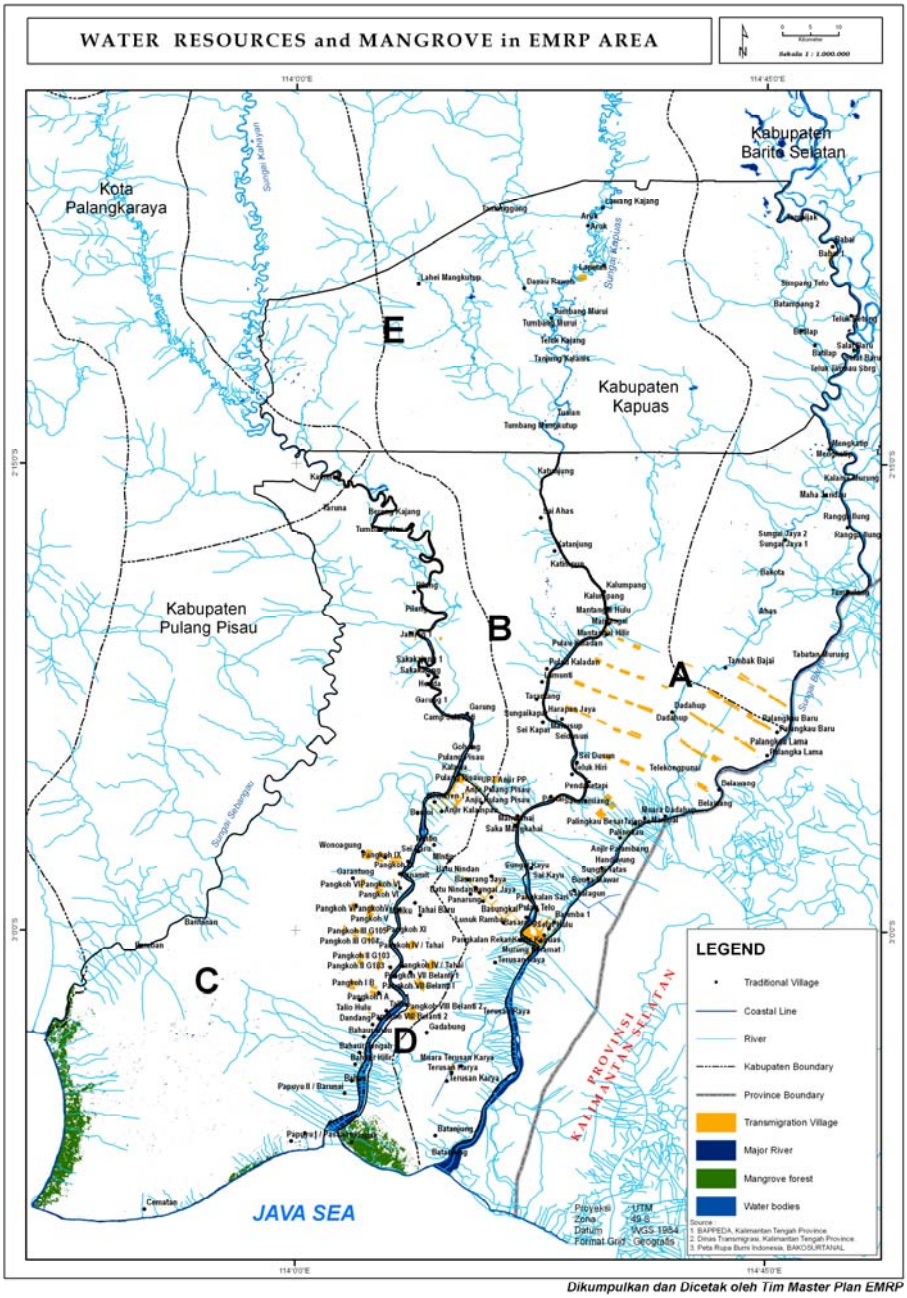


Figure 2.3: Water resources and mangrove map of the Ex Mega Rice Project area

2.3.1 Infrastructure

The main features of the existing water infrastructure can be divided into (i) the traditional *handil* systems of spontaneous and local settlers, developed since early last century, (ii) the *anjirs* and agricultural drainage schemes developed by the Dutch Indies government in the 1920s, (iii) the large-scale government sponsored swamp reclamation schemes developed during the 1970s and 1980s, and (iv) the macro and micro hydraulic infrastructure developed under the MRP during the late 1990s.

During the 1970s and 1980s large-scale government sponsored swamp reclamation schemes were constructed along the downstream parts of the Kahayan and Kapuas Rivers in Blocks C and D. The lay-out followed the typical forked grid and *kolam* design of UGM. These schemes are populated with transmigrants of mainly Javanese and Balinese origin

A pronounced feature of the current water infrastructure is the canal network constructed during the Mega Rice Project (MRP). Construction of the canal system resulted in a 187 km long main canal connecting the Barito River (at Mangkatip) and the Kahayan River (near Palangka Raya) and 958 km of primary canals in Block A, B, C and D. In Block A, an additional 973 km of secondary canals, 900 km of tertiary canals and 1515 km of quaternary canals were constructed. The macro-infrastructure caused severe damage to peat domes resulting in over-drainage, subsidence and was associated with forest clearance as a result of improved access increasing fire risks. After extensive fires during the long El Niño dry season of 1997 and Indonesia's momentous political transition of 1998, the project was abandoned.

Apart from these major features, private sector estates, especially for oil palm, developed some hydraulic infrastructure. Infrastructure for shrimp and fishponds is found in respectively the coastal zone and near villages in block A, B, C and D , where (illegal) loggers often dig channels into the forest.

There are few large roads in the EMRP area as river transportation is an important factor. Many canals do not only serve water management but are also used for regional and local transportation. In the tidal environment, accessibility of these canals is often limited to periods of high water levels during the high tide. Structures in the canals may be perceived as an obstruction and may be demolished by the local communities.

The main road in the EMRP area is the National Road connecting Palangkaraya to the South-East with Kuala Kapuas and Banjarmasin, to the North-West to Sampit, and to the North-East to Puruk Cahu and Muara Teweh. A provincial road connects Kuala Kapuas with Mantangai in Block A. Minor roads are often not all-weather proof or are in poor shape. Improvement of road systems in the project areas and land connections with regional service centres is essential in lifting development in the existing swamp settlements.

2.3.2 Hydrology

The overall hydrology of the project area is characterized by the presence of three major rivers (Kahayan, Kapuas and Barito) with large upland river basins to the North, producing major peak flows, and a strong tidal influence that extends over 100 km inland. The catchment of the Barito is about 40,000km2, roughly twice as large as that of the Kapuas and Kahayan River. The tides are mainly diurnal (one high water and one low water each day) and the tidal range fluctuates from an average of 1.2m during neap-tide to 2.4m

during spring-tide, with only minor variations throughout the year. An 18.6 year cycle determines the maximum tidal water level, which can become as high as 1.55 metres above Mean Sea Level. Upstream of the fully tidal river reaches, the water-levels become more and more determined by the river flow, and seasonal fluctuations become pronounced. Near the upstream boundary of the EMRP area tidal fluctuations are almost entirely absent, and wet season river levels in the Barito and Kahayan Rivers can be 5m above dry season levels for periods, while in the Sebangau and Kapuas the wet-dry season difference is typically 2m. As a result, the area's hydrology sets the boundary conditions for the development of the area and the following hydrological conditions and processes need to be considered in planning and management of the area:

Tidal Flooding - In the downstream part of the area, low-lying lands are subject to flooding by high tides. Flooding depth can be up to several decimeters, and while the duration of high tide is a few hours only, the land may remain flooded for some time after the high water has receded from the river or canal. In areas without salinity intrusion, the tidal flooding is highly beneficial for wetland rice cultivation (tidal irrigation).

River Floods - Upstream of the tidal river reaches, increased river flows during the wet season inundate adjacent lands. These river floods may last for weeks or even months, and flooding depth can be up to several meters depending on the local topography in relation to the river levels. Flooding from rivers is determined by water flows from the upstream river basins of the Barito, Kapuas, Kahayan and Sebangau Rivers. Hydrological model results and field observations show that large-scale and prolonged river flooding presently occurs mostly along the Barito River, affecting parts of Block A and D.

Rainwater Ponding - The flat topography and high groundwater tables can result in rainwater causing local ponding. The water accumulates in depression areas, which then remain inundated for weeks or even months. This type of flooding occurs both in depressional areas in mineral soils and at the footslopes of local peat domes. It is usually shallower and shorter-lived than flooding by rivers, but it is more frequent and affects a larger area[4].

2.4 Regional Economy

The economy of the EMRP area is dominated by agriculture, of which forestry and commercial crops, notably rubber and palm oil, are the most important. In 2006, agriculture accounted for about 50% of GDP. Palangka Raya and nearby Banjarmasin are the most important markets for the agricultural produce of the area. Most commercial crops are exported via the port of Banjarmasin, which is closer to Kuala Kapuas (the main economic centre of the area) than Palangka Raya.

The agricultural sector (including forestry) absorbs by far most of the employment. In 48.3% of the total number of villages the main occupation is farming: 34.3% in plantation sector 0.5% in animal husbandry, 8% in the forestry sector, 6.5% in fishery and 3.7% in other sectors.

2.4.1 Role of fisheries and aquaculture in the economy

The fisheries sector, including aquaculture plays an important role in Central Kalimantan providing a source of food and protein to the local communities, generating employment and household income, providing trade and economic well-being. While the total marine capture fisheries has declined, the inland capture fisheries and aquaculture production has grown over the last years (Figure 3.1) in response to increasing demand, and as a result of improved fishing technology, aquaculture growth, and expansion in

[4] Further details are provided in the Technical Report on the Hydrology of the EMRP area.

areas and species fished. The contribution of fisheries and aquaculture to the Gross Regional Domestic Product (GRDP) is relatively small compared to other sectors such as agriculture, forestry and mining (Table 2.2).

Table 2.2: Gross Domestic Product of Central Kalimantan
IDR billion, constant prices

Sector	2000		2003		2005	
	(IDR billion)	(% of total)	(IDR billion)	(% of total)	(IDR billion)	(% of total)
Agriculture	5,160.35[1]	47.5%[1]	5,230.18	41.0%	5,296.81	37.7%
- Farm food crops			975.86	7.6%	942.32	6.7%
- Farm non food crops			1,977.12	15.5%	2,309.69	16.5%
- Livestock			458.12	3.6%	537.07	3.8%
- Forestry			1,063.31	8.3%	709.41	5.1%
- Fisheries			755.77	5.9%	798.31	5.7%
Mining	412.00	3.8%	400.97	3.1%	926.92	6.6%
Manufacturing	745.57	6.9%	1,139.60	8.9%	1,244.96	8.9%
Construction	489.59	4.5%	572.56	4.5%	646.57	4.6%
Services	4,063.72	37.4%	5,415.96	42.4%	5,919.37	42.2%
TOTAL	**10,871.23**	**100.0%**	**12,759.27**	**100.0%**	**14,034.63**	**100.0%**

Source BPS

[1] The figure of 2000 includes farm food crops, farm non-food crops, livestock, forestry and fishery

The sectoral composition of the economy of Central Kalimantan is markedly different from the national economy (Table 2.2). The agricultural sector accounted for about 38% of provincial GDP in 2006, against less than 15% for Indonesia as a whole (see Master Plan annex on economic development of the ex-mega rice area, 2008). The agricultural sector includes farm food and non food crops, livestock, forestry and fisheries. Food and non-food crops contribute 56% of the total agricultural figure. The share in forestry accounted for 20% in 2003, but this was reduced to 14% in 2005. The fisheries sector (including marine fisheries, inland fisheries, brackish (tambak) and freshwater ponds and cage culture) contribute 6% to the total GDP. Its share of 15% in the agricultural sector remained constant over the last years.

The EMRP area covers about 14,622 km^2 in four districts: Kota Palangka Raya, Kapuas, Pulang Pisau and Barito Selatan. Table 2.3 shows that the EMRP area is slightly more dependent on agriculture than the economy of Central Kalimantan. The agriculture sector dominates the local economy and accounts for about 50% of GDP. The figures in the table are based on the statistical data of three districts, Pulang Pisau, Kapuas and Barito Seletan. Kota Palangkaraya has not been included in the calculations. The three district boundaries go beyond the project boundary but include over 90% of the population living in the project area (Master Plan annex on economic development of the ex-mega rice area, 2008).

Table 2.3: Gross Domestic Product of the EMRP area
IDR billion, constant prices

Sector	2000		2003		2005	
	(IDR billion)	(% of total)	(IDR billion)	(% of total)	(IDR billion)	(% of total)
Agriculture	1,195.74	49.1%	1,386.73	50.6%	1,528.24	51.0%
- Farm food crops	327.66	13.5%	408.45	14.9%	438.36	14.6%
- Farm non food Crops	381.68	15.7%	434.54	15.9%	519.64	17.4%
- Livestock	82.79	3.4%	97.75	3.6%	115.79	3.9%
- Forestry	212.97	8.7%	220.13	8.0%	217.71	7.3%
- Fishery	190.65	7.8%	225.86	8.2%	236.73	7.9%
Mining	8.47	0.3%	9.20	0.3%	10.35	0.3%
Manufacturing	178.00	7.3%	185.99	6.8%	194.51	6.5%
Construction	174.95	7.2%	205.13	7.5%	229.42	7.7%
Services	877.79	36.0%	953.10	34.8%	1,031.66	34.5%
TOTAL	**2,434.97**	**100.0%**	**2,740.15**	**100.0%**	**2,994.18**	**100.0%**

Over the years the share of forestry in the GDP in the EMRP area has declined (Table 2.4). This decline was caused by a growth in non-food farming. The share of food farming, which largely consists of subsistence agriculture, and the share of fisheries remained unchanged. These observations apply to both Kabupaten Kapuas and Kabupaten Pulang Pisau (Table 3.6). In Barito Selatan the share of the fisheries and forestry sector is twice as high as in the other two districts and a slight increase can be seen over the years. Due to ecological and hydrological nature of this area fisheries is expected to contribute considerably to the livelihood of the people. However, only 10% of Barito Selatan district is located within the EMRP area.

Table 2.4: The agricultural sector in Kapuas, Pulang Pisau and Barito Selatan, 2000 and 2005
Percentage of total agricultural sector

Agricultural Sector	Kapuas		Pulang Pisau		Barito Selatan	
	2000	2005	2000	2005	2000	2005
- Farm food crops	32.3	32.9	36.2	36.4	7.2	8.2
- Farm non food Crops	31.9	34.0	27.7	31.0	35.7	37.2
- Livestock	7.3	8.7	6.7	5.9	6.1	6.0
- Forestry	15.5	12.4	13.9	11.2	27.1	22.9
- Fisheries	12.9	12.1	15.6	15.5	23.9	25.8
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: BPS

Although from the figures above it appears that the role fisheries plays in the economy is relatively small, it should be emphasised that the sector is extremely important to the local communities in terms of food and protein. From the year 2002 to 2006, fish was the second most important source of daily protein consumption per capita after cereal (BPS 2007). The average protein consumption per person in Indonesia is highest in North and Southeast Sulawesi followed by Central Kalimantan (BPS, 2007). Animal protein is expensive and is not readily available to all. Fish is an important, more accessible and

cheaper alternative. In 2001 the average fish consumption per person in Central Kalimantan was 45 kg/person/year which was almost double the average amount of fish consumed by the entire nation, 26.5 kg/person/year (Dinas Perikanan dan Kelautan Kalteng, 2007). This indicates the importance of the sector to the population in the province and the EMRP area. The livelihood survey undertaken by CARE in December 2006 supports this. The survey showed that in all of the 5 different areas surveyed, fisheries was found to be an important additional source of income generation.

3 Fisheries & aquaculture

3.1 Fisheries, aquaculture and the environment

The types of ecosystems supporting fisheries and aquaculture in the EMRP area are the inland aquatic ecosystems and the coastal ecosystems. The inland aquatic ecosystems include a variety of natural water bodies such as streams, rivers, floodplains, lakes, peat and freshwater swamps, rice fields and drainage canals. Production cycles in these ecosystems closely follow the seasonal changes in temperature and precipitation in the surrounding terrestrial environment. The inland aquatic ecosystems are linked to the coastal ecosystems which they affect through nutrient inflows that cause the high productivity in many coastal fisheries, but also by pollutants carried by the water, which can impact fisheries production in a negative way.

The coastal ecosystems include the mangroves, the estuaries and the marine environment. The mangrove areas, located in Pulang Pisau and Kapuas districts and the estuaries of Kahayan and Kapuas river, have a high natural productivity and biodiversity. Their influence extends well out into the coastal and marine waters. Mangroves are valued for their protection and stabilisation of coastal wetlands and shorelines by preventing erosion with their root systems. They help protect uplands from storm winds, waves, and floods and serve as feeding and breeding ground for a great number of fish species, crustaceans and invertebrates and support an abundant and productive marine life. Mangroves are essential to fish production and of great importance to the coastal communities and the local and regional economy. They are extraordinarily rich habitats that serve as life support systems to many commercially important species such as barramundi (*Lates calcifer*), mud crab (*Scylla serrata*) and crustaceans. A number of marine fish and crustacean species, e.g. milkfish (*Chanos chanos*) and black tiger shrimp (*Penaeus monodon)*, need inland water ecosystems like estuaries and lagoons to complete their life cycles. There are also freshwater species such as *Macrobrachium* species that breed in the sea. A part of the coastal mangroves in Pulang Pisau district has been converted for brackish water aquaculture. The production in these brackish water ponds (tambaks) but also aquaculture in freshwater ponds and cages very much depends on the environmental conditions and in particular the hydrology of the area and the water quality.

Peat swamps are unique habitats for fauna and flora and therefore important in the EMRP area. They possess an interesting fish fauna, which is diverse and unique, and many of the species occupy narrow habitat, en food niches and restricted ranges. Peat swamps provide a variety of goods and services, both directly and indirectly, in the form of fisheries and forestry products, energy, flood mitigation, water supply and groundwater recharge. Peat swamps play an important part in stabilising the ecosystem, particularly in the purification and soil formation. At a global scale the peat swamp forests contribute to the storage of atmospheric carbon helping to slow down global warming.

3.2 Fisheries and aquaculture production

3.2.1 Central Kalimantan

The total fish production in Central Kalimantan is mainly derived from capture fisheries and aquaculture (Figure 3.1). The capture fisheries production is dominated by marine fisheries with an annual production

of 48401 tons, followed by inland fisheries production of 33573 tons (Dinas Kelautan dan Perikanan Kalimantan Tengah, 2006). At the end of year 2002, the total fisheries production was 95279 tons; 56071 tons produced by marine fisheries and 36376 tons by inland capture fisheries (Dinas Perikanan dan Kelautan Kalteng, 2002).

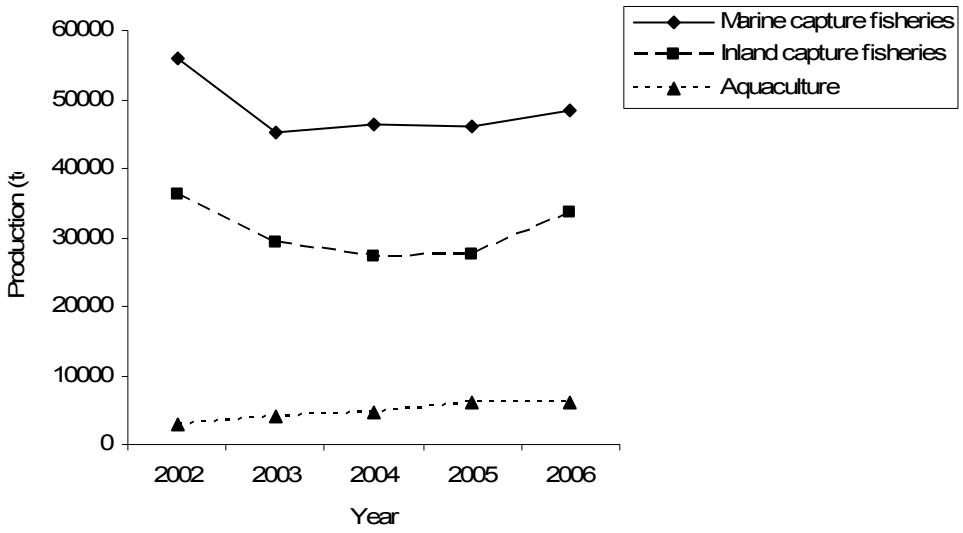


Figure 3.1: Fisheries production of Central Kalimantan province, 2002 - 2006

Source: Laporan Tahunan Statistik Perikanan Tangkap dan Budidaya, Dinas Kelautan dan Perikanan Kalimantan Tengah , 2002 – 2006.

The species caught in the inland water resources of Central Kalimantan province are mainly riverine and swamp species (Table 3.1).

Table 3.1: List of main fish species caught in inland water of Central Kalimantan

Local name	Common name	Scientific name	Habitat
Betok, papuyu	Climbing perch	*Anabas testudineus*	S
Baung	Asian redtail catfish	*Mystus sp*	R, S
Sepat rawa	Three spot gouramy	*Trichogaster trichopterus*	S
Sepat siam	snake skin gouramy	*Trichogaster pectoralis*	S
Gabus, haruan	Snake head	*Ophiocephalus striatus*	S,R
Toman	Giant snake head	*Ophiocephalus micropeltes*	S,R
Lele, pentet	Blackskin catfish	*Clarias batrachus*	S
Hampal			R
Salab		*Pontioplites falcifer*	R
Jelawat	Hoven's carp	*Leptobarbus hoevenii*	R
Lampan			R
Seluang	Greater scissortail	*Rasbora sp*	S, R
Tawes		*Ostechulis microcephalus*	S, R
Betutu	Marbled goby	*Oxyeleotris marmorata*	R
Tambakan	Kissing gouramy	*Osphronemous gouramy*	S
Belida	Giant featherback	*Chitala lopis*	R, S
Gurame			S

Patin Jambal			R
Lais		*Kryptopterus sp*	R
Udang galah	Giant freshwater prawn	*Macrobrachium rosenbergii*	R

R = river; S = swamp

Source: Adapted from Laporan Tahunan Dinas Kelautan dan Perikanan, 2006

Aquaculture production has strongly increased in Central Kalimantan in recent years (Figure 3.2). The total aquaculture production (including fresh and brackish water ponds, cage culture and fish production in rice fields) almost quadrupled from about 1900 tons in 2000 to about 6000 tons in 2006. Brackish water ponds composing the smallest part of the total production in 2000, less than 2% has grown to the second most important aquaculture practice in 2006, composing 21% of the total production. Cage culture production in that same year amounted to 3750 tons contributing the largest part of the total production, almost 63%. The cage culture production increased over five year from about 1650 tons in 2000 to 3750 tons in 2006. Although freshwater aquaculture production has grown over the last 5 years from 255 tons in 2000 to 857 tons in 2006, it does not constitute a large part of the total production. Fish production in rice field has remained quite low over the years. In 2006 it even declined together with brackish water pond production (Laporan Tahunan Dinas Kelautan dan Perikanan, 2000-2006).

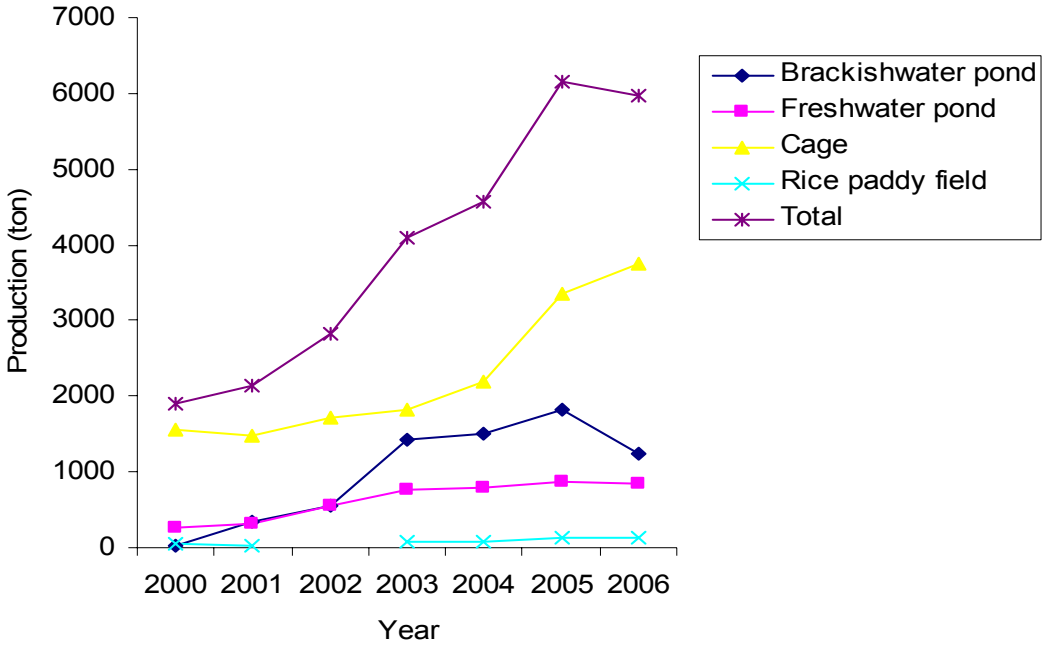


Figure 3.2: Aquaculture production of Central Kalimantan province, 2000 - 2006

Source: Laporan Tahunan Statistik Perikanan Tangkap dan Budidaya, Dinas Kelautan dan Perikanan Kalimantan Tengah , 2000 – 2006.

The total number of households engaged in marine capture fisheries over five years increased from 6319 households to 8129 households (Table 3.2). At the same period, the number of households engaged in inland capture fisheries increased from 7459 to 13414 households in 2003. After that the number decreased to 11812 households in 2006. Although the households declined, the total inland fisheries production over the last years has increased which could be realized by more effective fishing practices. The total number of households engaged in aquaculture has also increased from 8256 in 2002 to about 11812 households in 2006.

Table 3.2: The number of households engaged in marine, inland fisheries and aquaculture of Central Kalimantan province from 2002 to 2006

Fisheries system	2002	2003	2004	2005	2006
Marine capture fisheries	6319	7200	7240	8685	8129
Inland capture fisheries	7459	13414	11987	11921	11812
Aquaculture	8256	No data	10681	9233	11243
Total	**22034**	**20614**	**29908**	**29839**	**31184**

Source: Laporan Tahunan Statistik Perikanan Tangkap dan Budidaya, Dinas Kelautan dan Perikanan Kalimantan Tengah , 2002 – 2006

3.2.2 EMRP area

The fisheries system that can be found in the EMRP area consists of marine and inland capture fisheries and aquaculture. Capture fisheries can be found in the main rivers Barito, Kahayan and Kapuas, their tributaries, peat and freshwater swamp areas, lakes, estuaries, the mangrove and coastal areas. Aquaculture is practiced in brackish water ponds in coastal lowlands (*tambaks*), freshwater ponds *(kolam*) and cages (*karamba*) located in the rivers in the EMRP area. Marine capture fisheries and brackish water aquaculture is only taking place in Pulang Pisau and Kapuas district having a coastline. Inland capture fisheries, freshwater fish farming and aquaculture activities can be found in the entire project area[5].

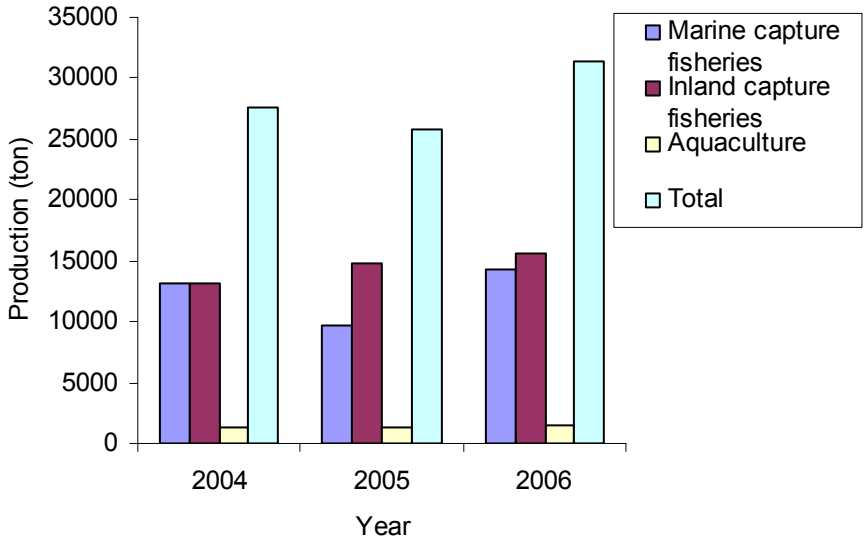


Figure 3.3: Total fisheries production of EMRP area, 2004 – 2006

Source: Laporan Tahunan Statistik Perikanan Tangkap dan Budidaya, Dinas Kelautan dan Perikanan Kalimantan Tengah , 2004 – 2006.

[5] The tables and figures on fisheries and aquaculture production in the EMRP project area in this report are based on the statistical data collected in three districts, Pulang Pisau, Kapuas and Barito Seletan. The three district boundaries go beyond the project boundary but include over 90% of the population living in the project area. Although Barito Kuala district is contributing the largest percentage of the total capture fisheries and aquaculture production, these figures should be interpreted carefully since only a small area of the district is located within the EMRP area.

The total fisheries production in the project area increased from 27637 tons in 2003 to 31433 tons in 2006 (Figure 3.3). Inland capture fisheries is the most important fisheries in the EMRP area contributing about 48% (13161 tons) of the total inland capture fisheries production in the project area over the period 2003-2005 (Table 3.3). The project capture fisheries composed about 45%-48% of the provincial total inland fisheries production in the same years. The marine capture fisheries production decreased in 2005 but increased again to 14300 tons in 2006, composing 46% of the total marine capture fisheries production in the EMRP area. The marine capture fisheries contributed between 21-30% of the Central Kalimantan production from 2004 to 2006. Aquaculture constitutes the smallest production (about 4.5% of the total EMRP production) and showed a slight growth from 1270 tons to 1514 tons over the period 2003-2005. It is expected that with an increasing demand for fish in the future when the population continues to grow, the role of aquaculture will become more and more important in the project area. Simultaneously the growth in aquaculture production will strongly depend on the availability of land and water resources and skills and expertise of local communities to be involved in the farming practices. The production in 2006 contributed 25% to the total aquaculture provincial production.

Table 3.3: Contribution of fisheries system (%) to the total production of fisheries in EMRP area, 2004 - 2006

Fisheries system	2004		2005		2006	
	Total	%EMRP	Total	%EMRP	Total	%EMRP
Marine capture fisheries	13208.3	47.8	9678.9	37.5	14329.2	45.6
Inland capture fisheries	13160.8	47.6	14839.7	57.5	15589.8	49.6
Aquaculture	1267.2	4.6	1301.7	5.0	1513.79	4.8
Total	**27636.3**	**100**	**25820.3**	**100**	**31432.8**	**100**

Source: Laporan Tahunan Statistik Perikanan Tangkap dan Budidaya, Dinas Kelautan dan Perikanan Kalimantan Tengah , 2004 – 2006.

A total of about 3300 households are involved in inland capture fisheries in the three districts in 2006. This does not include the temporary and recreational fishermen. Kapuas and Pulang Pisau district show similar number of households involved in marine capture fisheries over the years (Table 3.4).

The highest number of households involved in fresh water fisheries and the highest inland capture fisheries production can be found in Barito Selatan district, a district located far from the coast (Table 3.6). Kapuas district has the highest number of households engaged in aquaculture, followed by Barito Selatan district. The highest aquaculture production is however found in Barito Selatan where fish is mainly produced by cages (Tables 3.10 and 3.11).

Table 3.4: Number of households (HH) engaged in marine and inland capture fisheries and aquaculture, 2004 – 2006

		2004			2005			2006	
District	Marine capture fisheries	Inland capture fisheries	Aqua-culture	Marine capture fisheries	Inland capture fisheries	Aqua-culture	Marine capture fisheries	Inland capture fisheries	Aqua-culture
Kapuas	1275	1150	n.a	1161	717	2012	1161	717	2128
Barito Selatan	n.a	2046	n.a	n.a	2206	1641	n.a	2206	2165
Pulang Pisau	1404	558	n.a	1247	329	258	1247	329	253
Total HH	**2679**	**3754**	**n.a**	**2408**	**3252**	**3911**	**2408**	**3252**	**4546**

Source: Laporan Tahunan Statistik Perikanan Tangkap dan Budidaya, Dinas Kelautan dan Perikanan Kalimantan Tengah , 2004 – 2006

3.2.3 Inland capture fisheries

Inland capture fisheries activities play an important role in the project area providing a source of food and protein to the local communities, generating employment and household income, trade and economic well-being. Capture fisheries can be found in the main rivers Barito, Kahayan and Kapuas, their tributaries, peat and freshwater swamp areas, lakes, estuaries, the mangrove and coastal areas.

The capture fisheries in the EMRP area can be classified as an open access small-scale or artisanal fisheries, making it an attractive livelihood for the rural communities. This type of fisheries is labour-intensive, uses relatively small boats with a low fuel consumption and involves small capital investment. Most small-scale fishing families have a comparatively low standard of living and high poverty. Pure subsistence fisheries, where the fish caught are shared and consumed directly by the households, is however rare in the project area. Part of the products are often sold or exchanged for other goods or services.

Fishing is done on a full time basis as the main source of livelihood to some of the communities or is a part time activity and combined with agricultural activities. During the dry season a considerable number of people from Palangkaraya and Banjarmasin fish around Dadahup. This recreational fishing is done for personal consumption and leisure and part or all of this catch is traded or sold.

The inland capture fisheries provides employment for about 3300 households directly engaged in fishing activities in the EMRP area (Table 3.7), and for many more working in fisheries-related activities such as fish processing and marketing, boat building and net making. The total numbers of recreational fishermen is not known. The role of women is particularly important in the areas of fish and shrimp processing (e.g. krupuk) and marketing. In this way processing and marketing activities can contribute substantially to the basic needs of the poor households. Intermediaries play a major role in this type of fisheries as they traditionally control the market outlets and often represent the only source of credit available for the fishers.

Table 3.5: Fishing gears used to catch the fish in Central Kalimantan province and the project area

Local name	Common name
Jaring insang hanyut	Drift gill nets
Jaring insang tetap	Set gill nets
Anco	Lift net
Serok	Scoop net
Rawai	Long line
Pancing	Hand line
Sero	Guiding barrier
Jermal	Stow net
Bubu	Cylindrical bamboo trap
Jala tebar	Cast net

Inland capture fisheries in the project area like in the rest of Central Kalimantan, targets a very wide range of species. The catch is composed of both riverine and swamp species and include amongst others glass catfish (Lais kaca, *Kryptopterus hexapterus*), croaker (Gulama, *Sciaena ruselli*), giant snakehead (toman), climbing perch (Papuyu, *Anabas testudineus*), gouramy (sepat rawa, *Trichogaster trichopterus*), Rasbora (Saluang, *Rasbora paciperforata)*, blackskin catfish (pentet, *Clarias sp.*) (interview stakedolders, 2008). Some blackwater species are confined to narrow niches but most swamp species migrate from rivers to

swamp during the rainy season. Typical black water species inhabit peat swamp areas in both the dry and the rainy season.

A broad range of fishing gears is being used. Fishing is done with traditional types of gear, both active and passive such as gillnets, hook and line, lift nets, scoop and cast nets. Traditional fishing traps made of bamboo, wood and nets are also used (Table 3.5). The fishing strategies are adapted to the seasonal variability. In the transmigration area in Block A in Dadahup A1 to A5, local communities fish the canals with rod and line and scoop net. The fish species caught were climbing perch (papuyu, *Anabas testudineus)*, scissortail carp (saluang, *Rasbora pauciforata),* lined or zebra Barb (Kapar, Puntius Lineatus) and Betta (Kelatau, *Betta* sp.) and are used for local consumption only. Fisheries in this area suffers greatly from the acid soils and resulting low pH of the water. Although most endemic species can survive these harsh environmental conditions with a pH of the water being as low as 2.7 but they show an extremely low growth and remain small (2-3 cm). Fishing around Katunjung village is done in Kapuas river, the swamps and drainage canals with tangguk (scoop net) and pancing (hook and line). The majority of the catch during field visits at the beginning of 2008 was composed of climbing perch (*Anabas testudineus*) and snake head (*Ophiocephalus striatus*).

Most small-scale fisheries are exploited under an open access regime, even though traditional community controlled mechanisms exist to restrict access during certain seasons or to certain fishing grounds. In Mengkatip for example, the communities have introduced a regulation on mesh size (interview key informants, 2008).

Production

The total inland capture fisheries production of the EMRP area, increased from 14000 metric tons in 2003 to about 16000 tons in 2006 (Table 3.6). South Barito produced about 50% of this total in 2003 but this share declined with 15% in 2006. The largest part of this district is located outside the EMRP area so it is not entirely clear how high the production in the EMRP really is. In Kapuas district the capture fisheries production slightly decreased from 3830 tons in 2003 to 3293 tons in 2006. Note that over the same period the capture fisheries production in Pulang Pisau district more than doubled: from 3011 tons in 2003 to 6665 tons in 2005, contributing respectively 21% and 43% to the total production of EMRP.

Table 3.6: Inland capture fisheries production (in tons) in the districts located in EMRP

	2003	2004	2005	2006
District	**Production (in tons)**	**Production (in tons)**	**Production (in tons)**	**Production (in tons)**
Kapuas	3830	3392	3415	3293
South Barito	7187	6464	5740	5632
Pulang Pisau	3011	3305	5685	6665
Total production EMRP area	**14028**	**13161**	**14840**	**15590**
Total production in Central Kalimantan	*29360*	*27306*	*32660*	*33573*

Source: Modified from Laporan Tahunan Dinas Perikanan dan Kelautan 2003 – 2006

The EMRP inland capture fisheries production composed 48% (14028 tons) in 2003 and 46% (15590 tons) of the total inland fisheries production in Central Kalimantan in 2006.

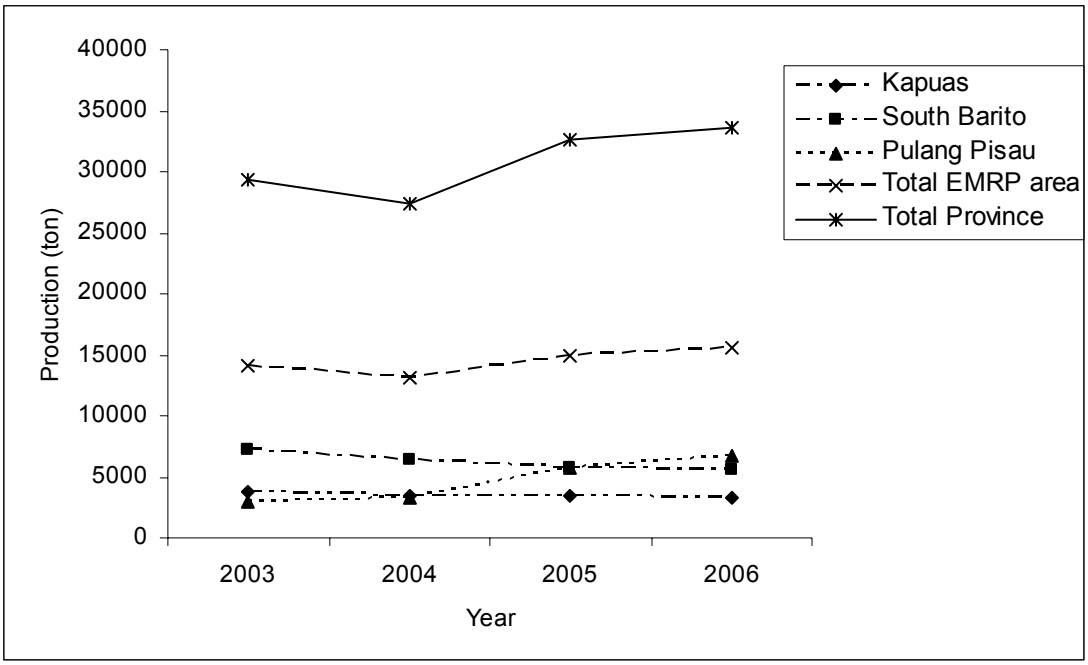


Figure 3.4 Inland fisheries production within EMRP area, 2003 – 2006
Source: Modified from Laporan Tahunan Dinas Perikanan dan Kelautan 2003 – 2006

The total number of households involved in inland capture fisheries in the three districts decreased from about 3800 in 2004 to 3300 in 2006 (Table 3.7). This number does not include the temporary and recreational fishermen. The highest number of households, around 2000, can be found in South Barito district which also explains the highest capture fisheries production in this district. Over the years the total number of household involved in fisheries in this district has however decreased with a corresponding decline in production rates. In Kapuas and Pulang Pisau district the total number of households involved in fishing shows a strong decline while the fisheries production figures increased. This is most prominent in Pulang Pisau district. This could imply that fish stocks have been abundant and effectiveness of the fishing activity has increased. After south Barito, Kapuas district has the highest number of households involved in inland capture fisheries. This number almost halved to 717 over the period 2003-2006.

Table 3.7: Number of Households (HH) involved in of inland capture fisheries

	2004		2005		2006	
	Number of HH	*% of total HH*	*Number of HH*	*% of total HH*	*Number of HH*	*% of total HH*
Kapuas	1150	30.6	717	22.1	717	22.1
South Barito	2046	54.5	2206	67.8	2206	67.8
Pulang Pisau	558	14.9	329	10.1	329	10.1
Total of EMRP area	**3754**	**100**	**3252**	**100**	**3252**	**100**

Source: Modified from Laporan Tahunan Dinas Perikanan dan Kelautan 2004 – 2006

Constraints

Ecosystems important for the survival and growth of fish species are strongly affected by land use practices and human activities in the EMRP area. Land-based sources of degradation such as logging, mining and agricultural development and pollution are among the main factors influencing fisheries resources and production. Logging and forest fires have greatly reduced the vegetation cover in the project area, creating a pre-condition for the increase of surface runoff and soil erosion rates and sedimentation during high rainfall. A direct impact of sedimentation is the filling of waterbodies and estuaries in the downstream of the rivers. Suspended sediments can influence the growth of aquatic plants by reducing light penetration (through increased turbidity) and damage the gills of aquatic insects and fish. Sedimentation changes the water flow pattern and the characteristics of river bed that function as fish habitats. Increased sedimentation can decrease the success of fish spawning by covering the eggs thereby reducing oxygen supplies and interfering with the flushing of metabolic wastes and by impeding the emergence of young fish. Sedimentation also changes the community structure of aquatic plants and insects causing a loss in food supply of different fish species and reducing the habitat used for cover (W.F. Megahan, undated). Although no studies have been done to look at the impact of fires and logging on fish stocks and habitat in the project area it can be expected that the extensive logging and forest fires have strongly affected its fisheries resources and the supporting habitats.

Mining activities have a similar effect on water turbidity as logging activities. In the EMRP area illegal gold mining is carried out in Kahayan, Kapuas and Barito rivers. Heavy metals such as mercury are used to extract the gold from the soil. Although Mercury is ubiquitous in the environment and can be found in soil, rocks and also in lakes, streams and oceans, mercury is also released into the environment by human activities such as pulp and paper processing, mining operations, and through the burning of garbage and fossil fuels (Eisler, 2004). In the project area the mercury used in the mining process is directly flushed into the river. These practices cause deterioration of the water quality and accumulation of mercury in the food web.

The inorganic mercury in the aquatic environment (e.g., lakes, streams and oceans) can be transformed by bacteria to organic mercury, such as methyl mercury. Methyl mercury binds tightly to the proteins in fish tissue and tends to concentrate or accumulate in the food chain so most human exposure to mercury is through the consumption of fish. Therefore, predatory fish species that are higher in the food chain tend to have higher levels of methyl mercury than fish species that are lower in the food chain. Children and pregnant women are particularly sensitive to the known neurotoxic effects of methyl mercury (Eisler, 2004). It is debated whether wild riverine fish species in the EMRP area contain mercury levels above internationally set standards. No study is available in Central Kalimantan yet providing valuable data on residue levels of mercury in fish tissue to support this. Water quality data collected in Kapuas and Kahayan river (Badan Pengelola Pelestarian Lingkungan Hidup Daerah, 2007) kantoor in Palangka Raya) however show higher levels of mercury close to locations were gold mining is being carried. These data are however only collected for a short period of time at irregular intervals.

The canal development has impacted the soil and water quality. Leaching from the open acid soil lowered the water pH to approximately 3, impacting fisheries (Anonymous, 1999). Certain fish species can not tolerate such poor aquatic conditions resulting either in a declined productivity or in the loss of fish species. Water quality of rivers is further compromised by the use of fertilisers and chemicals and an increased release of human effluents into surface waters. Development of structures such as dams and gates in drainage canals of agricultural schemes also limit the seasonal movement and migration of fish species from peat swamp areas to rivers and back.

Around Katunjung village located in block A, fishing takes place in Kapuas river, swamps and drainage canals. Besides the common types of gear, fishing in Kapuas river is also done with the use of electricity at night time. The species caught are lais (*Kryptopterus* sp), belida (*Giant featherback*) and patin (*Pangasius* sp). This type of fisheries is particularly damaging because of its non-selective effects. This fishing method does not only affect the riverine fish population but also the long-term sustainability of the fisheries by killing the fry and fingerlings as well. This fishing method is illegal but regulations are generally not enforced.

The lack of alternative livelihoods in the project area and an increase in fish demand has led to increase in fishing effort and resource depletion. Sustainability of the fisheries resource is threatened especially since access regulations to the aquatic resources do not exist.

3.2.3.1 Capture fisheries in the peat swamp areas

Peat swamp forests compose 1564 km^2 of the total EMRP area. Peatlands over 3m deep cover most of Block C and E, and much of Block A and B (figure 2.2). Shallow peat areas can primarily be found in the east and south of Block A and in Block D.

Peat swamps are unique habitats that support a diverse and unique fish fauna. These freshwater fish species often only survive in narrow niches and have restricted ranges. A study has been conducted in 2007 under the CKPP project to identify the biodiversity (including fish biodiversity) of black water ecosystems in Sebangau National Park and Block A and E the project area. This study has shown that the EMRP area has a high fish biodiversity. Some examples of fish species identified include O*steochilus Spilurus, Rasbora sp, Puntius lineatus*, *Ttrichogaster sp, Cyckocheilichtys armatus, Channa lucius*, *Betta sp* (CKKP, 2007).

Studies conducted in Peninsular Malaysia have shown a similar rich fish biodiversity in peat swamps. Some 55 species of peat swamp fish, of which about 60% are stenotopic (having a narrow range of adaptability to changes in environmental conditions) are known. In the North Selangor peat swamp forest, the most well studied area, 48 peat swamp fishes have been recorded (Ng *et al*., 1992, 1994).

There is a marked seasonal migration of fish to and from the river, and an annual cycle in the relative abundance of herbaceous and predatory fishes. CIMTROP (2006) conducted a study to identify fish species in Kalampangan village which is located in block C of the EMRP area. The fish species found in the peat swamps could be distinguished into two groups, the native peat swamp and the temporary species. The native species inhabit the swamps during the dry and the rainy season. Examples of these species are *Anabas testudineus, Belontia hasselti, Channa lucius*, *Clarias* sp, *Osteochilus spilurus, Hemirhamphodon* sp*, Luciocephalus pulcher, Pristolepis grooti*, and *Wallago leeri* (Table 3.8). They are hardy species that can withstand unfavourable water quality conditions (low pH, low oxygen levels, high temperature) during the dry season. On the other hand, the temporary species such as *Mystus nemurus, Barbodes schwanenfeldii, Macrognathus* sp, *Pangasius* sp, *Kryptopterus* sp, and *Macrobrachium* can only be found in peat swamps during rainy season when the water quality has been improved following the rise of the water level.

Table 3.8: Fish species occurred in peat swamp of Kelampangan village (block C) during dry and rainy season

	Family	Species	Dry Season	Wet Season
1.	Anabantidae	*Anabas testudineus*	+	+
2.	Bagridae	*Mystus micracanthus*	+	+
		Mystus nemurus	-	+
3.	Belontiidae	*Belontia hasselti*	+	+
		Betta anabatoides	+	+
		Sphaerichthys osphromenoides	+	+
4.	Channidae	*Channa lucius*	+	+
		Channa pleuropthalmus	+	+
5.	Clariidae	*Clarias* sp.	+	+
6.	Cyprinidae	*Barbodes schwanenfeldii*	-	+
		Osteochilus schlegelii	+	-
		Osteochilus spilurus	+	+
		Puntius lineatus	+	-
		Rasbora pauciperforata	+	+
7.	Hemiramphidae	*Hemirhamphodon* sp.	+	+
8.	Luciocephalidae	*Luciocephalus pulcher*	+	+
9.	Mastacembelidae	*Macrognathus* sp.	-	+
10.	Nandidae	*Pristolepis grooti*	+	+
11.	Pangasius	*Pangasius* sp.	-	+
12.	Siluridae	*Wallago leeri*	+	+
		Kryptopterus sp1.	-	+
		Kryptopterus sp2.	-	+
13.	Grapsidae	*Hemigrapsus*	+	-
14.	Palaemonidae	*Macrobrachium*	-	+

Source: CIMTROP, 2006

One of the most desirable and rare aquarium fish, the arowana (*Scleropages formosus*), is found in deep pools in peat swamp rivers (Giesen 1987). Other ornamental fish species with a potentially high export value also inhabit peat swamp areas, such as *Betta sp, Rasbora sp, Trichogaster leeri, Mastacembelus cf. unicolor, Chaca bankanensis* (CKPP, 2007).

Production

In all blocks in the EMRP where peat swamps are located, fishing is taking place. Similar fishing gear as in fresh water capture fisheries are used such as gill net (salanbao), scoop net (salawit) and fish traps. Fisheries production data of peat swamp areas are only available from stakeholder interviews and from a few studies that have specifically looked at fish biodiversity of peat swamps in Central Kalimantan. Muslim (1997) reported that in the peat swamp of Bakung Merang village the fish production ranged from 20 to 300 kg/month depending on the fishing season. Although no hard data are available about the importance of fisheries to the well-being and livelihood of the local communities living in and near swamps in the EMRP area it became apparent from interactions with local community members that fisheries is one of the most important sources of livelihood and protein to them (key informants, village workshops, March 2008).

Constraints

Many black water fish species are confined to specific conditions in the peat swamp forest. This makes them very vulnerable to changes in water quality and to human activities. Destruction of habitats due to logging and conversion to agricultural use, especially oil palm plantations, jeopardises the survival of these species.

Canal construction for agriculture development has changed the hydrology of the peat swamps, reducing the water quality and impacted the survival, growth and productivity of fish species. Development of structures and dams in these canals limits the seasonal movement and migration of fish species to and from habitats important for feeding and breeding.

The populations of all the highly endemic and stenotopic miniature fishes (*Paedocypris species) of* peat swamps in Borneo have decreased or even collapsed as a result of extensive forest fires. Miniature fishes need shallow pools or burrows of other animals to survive droughts. Even in very dry periods, the peat acts as a buffer and retains isolated pools of clean and cold water. In high domes, the waterlogged peat often functions as permanent creeks. Fires destroy the peat swamp habitat directly impacting the survival of the *Paedocypris* species (Kottelat et al., 2006). It is expected that human interventions in the EMRP area also have had similar impact on the survival and growth of fish species endemic to the peat swamps of Central Kalimantan.

3.2.4 Beje fisheries

Hamid (1981) describes beje as a ditch connecting the swamp areas to the main river, constructed to retain fish during the rainy season when the water level rises. The Dayak communities have used this traditional fisheries system or capture method for years and it still provides a very important source of income to the local communities. Beje fisheries is taking place at the shores of the tributaries of the Kapuas river north east of Dadahup (Block A), around Jenamas and Mengkatip (Block A) and around Timpa (Block E) (field visit, 2008). Beje are rectangular ponds which are constructed in shallow peat (<1 meter thick). Sites are selected based on the slope of the terrain, the ponds are build in a traditional way and naturally stocked with various swamp fish (pentet, biawan, sasapat, etc) species during the rainy season. In the dry season the fish is harvested. The Dayak communities have developed customary rules and operational procedures for the development of the beje system. The canals and beje also serve as a fire wall during the dry season and water is used for agriculture.

Beje is the main fisheries system in block A. In Dadahup village alone, almost all of the 800 households own a number of beje. Beje fisheries and agriculture (rattan, rubber, poran) contribute equally to the household income of the Dayak communities living in this community. Rattan takes 2-3 years to grow before it can be harvested so the regular income provided by fisheries is important to the community. The beje are located about 2-15 km north of Dadahup along both sides of the Mengkatip river. A total of 3-4 individual beje form one system and are connected by a small canal. The size of each individual beje is around 10 meter x 3 meter or 15 meter x 3 meter with an average depth of 0.5 -1 meter. It takes about 7-10 days for two people to build a system of canals and ponds. The total cost of the construction of one system is approximately IRD 15 million (interview key informants, 2008).

Beje are naturally stocked with various swamp fish species during the floods in the rainy season from September to April. When the water recedes the fish remain in the beje and are left to grow naturally. At the end of the dry season in August and September the fish is harvested with a salawit (scoop net) or

other types of gear. Fish species harvested are: Papuyu (climbing perch, *Anabas testudineus*), Pentet (catfish, *Clarias Batrachus*), Sasapat (Three spot gourami, *Trichogaster trichopterus*), Kapar (Zebra Barb, *Puntius Lineatus*). Epriyeni (1998) reported that fish caught with beje in Dadahup village during dry season are dominated by black fish species such as snake head (*Chana striatus*), climbing perch (*Anabas testudineus*), sepat rawa (*Trichogaster trichopterus*), tambakan (*Helostoma teminckii*), saluang (*Rasbora paciperforata*), catfish (*Clarias batrachus*) and eel (*Fluta alba*).

Every dry season the ponds, canals and surrounding area are cleaned. The cut grass is left and provides food for the fish when the area floods again. During field visits to the beje system close to Dadahup, the pH in the beje system and canals measured between 5.1 and 5.3 but the pH in the EMRP drainage canal of 2.8 was much lower.

Production

A beje system can provide a good income for the local households according to the Dayak fishermen of Dadahup village (interviews key stakeholders, 2008). Depending on the size of the beje, the average yield of a beje of 10 x 3 x 1 meter is about 500 kg of fish/beje/year. This provides an income ranging from IDR 800.000 – 2 million, sometimes even up to IDR 5 million. Epriyeni (1998) reported that the beje with a size of 17.0 x 1.70 m can produce 500 to 800 kg fish/beje/year, generating an income ranging from IDR 2 to 2.5 million beje/year. Similarly, Sulmin *et al*. (2005) reported that without applying any treatment, the beje with a size of 50 x 2.0 x 1.5 m can generate an income of IDR 1-2 million per year. The average market price in the rainy season is IDR 8000/kg but drops in the dry season when large numbers of fish are being caught and marketed.

Constraints

Due to the construction of the drainage canals during the Mega Rice Project in 1995, water management in Block A changed (interview Kepala Adat and fishermen, Dadahup village, 2008). Epriyeni (1998) reported that in Dadahup village, Kuala Kapuas Regency, the construction of drainage canals disconnected the beje from the main rivers. As a result the rivers did not inundate the beje during the rainy season and the fish production from the area decreased significantly. Only 300 units of the originally 1000 units are still operational (interview key stakeholders, Dadahup, 2008). It now depends on the intensity of flooding whether the ponds will fill up and naturally stock with swamp fish during the rainy season.

Following the impact of the drainage canal development, beje are now being constructed more up north, sometimes a 2 hour boat drive away. This is not only costly in terms of fuel but also increases the risk for theft. During the dry season most beje now are guarded (interviews key stakeholders, Dadahup village, 2008).

The Department of Fisheries is committed to construct and rehabilitate a large number of beje in Kapuas district. The Ministry of Public Works is expected to support infrastructure development. The aim is to introduce beje to local transmigrants and develop approximately 5 beje per household. The beje are expected to produce an average of 100-300 kg of fish per individual beje. The total number of units that were proposed to be developed and/or rehabilitated in 2007 can be found in table 3.9.

Table 3.9: The total number of beje to be developed per sub-district in Kapuas district

Dadahup	Muara Dadahup and Telekung Punei	Palingkau and Palingkau Baru	Tambak Bajai	Batanjung	Jumlah
1114	1110	463	360	294	3341

Source; Department of Fisheries in Kapuas district

In 2007, 36 units of beje were already rehabilitated. The Department of Fisheries received support from the province to rehabilitate another 100 beje in 2008 (pers. comm. Field visit 2008). However none of these plans have been supported by an assessment of the carrying capacity of the ecosystem. Accurate information about stocks is not available so it will be difficult to determine how many beje can be constructed without over exploitation of the natural resources. Large scale infrastructure development when not properly planned and managed can also hugely impact the habitat and its biodiversity.

Agricultural production and beje fisheries, equally important to the livelihoods of the local communities have conflicting demands in water level management. Agriculture requires lower water levels while beje fisheries requires flooding. Agriculture development and its required water management schemes can therefore strongly impact existing fisheries production.

3.2.5 Aquaculture

With the growing demand for fish, and the overexploitation of the natural fisheries resources, aquaculture development has grown fast and is considered an important sector for supporting rural economic development in Indonesia. Aquaculture development is strongly supported by the Ministry of Marine Affairs and Fisheries in response to the greater demand for food-fish and the imposition of a ban on trawl fishing in 1980, which has recently been lifted again. Aquaculture in the EMRP area is practiced in brackish water ponds in coastal lowlands (*tambaks*), freshwater ponds *(kolam*) and cages (*karamba*) located in the rivers. The main species cultured in tambaks are milkfish (*Chanos chanos*), mullet (*Mugil* spp.) and shrimp species (*Penaeus sp*). Freshwater aquaculture in the project area is done traditionally in village ponds. The most common species cultured are Nile tilapia (*Oreochromis niloticus*) and catfish (*Pangasius* sp.). Cage culture is mainly done as an additional livelihood. Floating structures are used which are placed in rivers. Mainly catfish (*Pangasius* sp.) and Nile tilapia (*Oreochromis niloticus*) are grown in cages.

Production

The total aquaculture production in the project area has gradually increased to about 6000 tons in 2006. Kapuas and particularly Pulang Pisau district show a strong increase in production from 2004 till 2006 (Table 3.10). In South Barito the production slightly declined over these years. However the contribution of Barito Kuala to the total EMRP aquaculture production remains high, 66% in 2006. Kapuas and Pulang Pisau contribute respectively 19% and 15% to the total EMRP aquaculture production of 1515 tons.

South Barito produces a total of 17% of the provincial aquaculture production in 2006, and the other two districts both about 4% of the provincial total of 5968 tons. The three districts together contribute 25% to the provincial total aquaculture production.

Table 3.10: Aquaculture production of EMRP area by district, 2004 – 2006

	2004	2005	2006
District	**Production (in ton)**	**Production (in ton)**	**Production (in ton)**
Kapuas	145	213	293
South Barito	1035	872	995
Pulang Pisau	88	217	227
Total EMRP	**1268**	**1302**	**1515**
Total Central Kalimantan Province	*4575*	*6152*	*5968*

Source: Modified from Laporan Tahunan Dinas Perikanan dan Kelautan 2004 – 2006

In table 3.11 the production of the different culture systems in 2004 is shown. The highest production is derived from freshwater ponds and cages and can be found in Barito Selatan district. Only in Kapuas district is rice farming combined with fish farming. The highest production of brackish water ponds can be found in Kapuas district but the production area is located outside the project area (Figure 2.3).

Table 3.11: Production by culture system in 2004

	Freshwater ponds	Cages	Rice paddy field	Brackish water ponds
District	**Production (in ton)**	**Production (in ton)**	**Production (in ton)**	**Production (in ton)**
Kapuas	46	12	80	7
Barito Selatan	98	937	n.a	n.a
Pulang Pisau	70	12	n.a	5
Total EMRP	**214**	**961**	**80.**	**12**

Source: Modified from Laporan Tahunan Dinas Perikanan dan Kelautan 2004

3.2.5.1 Tambak

The brackish water ponds (tambaks) in the ERMP area are located in Block D near Papuyu III village in *kecamatan* Kahayan Kuala, Pulang Pisau district. The tambaks in Kapuas district are situated outside the project boundary. Coastal mangroves have been converted for the development of tambak by transmigrants from Makasar (South Sulawesi) and the Department of Fisheries in Pulang Pisau. A narrow mangrove green belt has been left following national regulations. The main species cultured are milkfish (*Chanos chanos*) and shrimp species (*Penaeus sp*). The latter contributes the largest percentage of the total brackish water production. The salinity of the water in the tambaks in February 2008, ranged between 16 to 20 ppt which is suitable for both species being euryhaline (able to adapt to a wide range of salinities).

According to the Department of Fisheries in Pulang Pisau the potential area for tambak development at the coast is 2000 ha (interview key stakeholder, 2008). Starting 2005, transmigrants from Makasar have developed a total area of 100 ha which is being operated by about 10 households. These ponds are managed in an extensive traditional way; they are large in size, have not been completely cleared of all vegetation and no fertiliser and lime are applied to increase their productivity. During the culture period the shrimp and fish are not being fed but depend on natural food supply for their growth and survival. When farming in an extensive way, low numbers of shrimp and milkfish are being stocked, a total of 30000 and 50000 respectively for a pond with a size of 10 ha. Fry are bought from Surabaya (Easy Java). The price for tiger prawns fry is IDR 35000 per 1000 fry and for milk fish IDR 40000 per 1000 fry.

The Department of Fisheries started with the construction of 200 hectares of tambaks in Kahayan Kuala sub-district on the east side of Kahayan river to be managed in a semi-intensive way. About 60 households each operate 2 hectares of the semi-intensive tambaks. The fisheries department aims to develop another 400 ha of semi-intensive brackish water ponds in the area. Information on stocking densities and day-to-day management practices were not available during the field visits.

The transmigrants managing the extensive farms have expressed not to be interested to become involved in the semi-intensive farming. They have experienced problems with disease and growth in the past when trying to farm in a more intensive way in other locations. Also the higher costs of investment and operation does not attract them. They are however interested to improve production rates by clearing the land more effectively, applying lime to counteract the effects of low pH during heavy rain and to make use of fertiliser to stimulate natural food production.

Production

After 4 months, the milkfish and shrimps are harvested. Production rates vary considerably. Stakeholders mentioned production rates of 600 kg of milkfish and 100 kg of tiger shrimp per 10 ha of extensively managed ponds. Others talked about production figures of 2 tons of milkfish and 700 kg of tiger shrimp per 10 ha extensive ponds. This implies that the total productivity of the extensive fish farms is low ranging between 70-270 kg/ha (stakeholder interviews, 2008). This figure is based on limited data available about extensive fish farming. No data were available on the semi-intensive farming systems. The market price of shrimp depends on its size and whether they are processed or not. The price of headless shrimp is IDR 150000/kg while the price of unprocessed shrimp ranges between IDR 52000 and IDR 75000. One kg of milkfish includes 2 to 3 individual fish. The market price of milkfish is IDR 8000/kg. The products are sold to fish collectors from Banjar Masin (South Kalimantan) who come to the area to buy. Shrimp are then often exported to international markets. Milkfish is marketed locally or nationally. The Ministry of Marine Affairs and Fisheries estimated the total brackish water aquaculture in Pulang Pisau district in 2004 to be 5 tons which is less than 1% of the total aquaculture production in the project area (Table 3.11).

Kapetsky (1985) estimated that the average yield of fish and shellfish in undisturbed mangrove areas is about 90 kg/ha, with maximum yield being up to 225 kg/ha. Melana (2000) provided an overview of fish productivity in intact mangroves to be between 150 and 260 kg/ha/yr. A total economic valuation study in Indonesia shows that the archipelago's mangroves and their biodiversity is worth over US$350 billion, or US$110 000 per hectare if all benefits are included. Fisheries are often the most valuable extracted products and of prime importance to coastal communities and local and regional economies, followed by timber products. The economic value of Penaeid shrimp in mangroves is 13-756 kg/ha/year or 91-5292 U$/ha/year; mud crabs yield to 13-64 kg/ha/year (39-352 U$/ha/year) and fish value 257-713 kg/ha/year (475-713 $/ha/year). Molluscs have an economic value of 500-979 kg/ha/year, being worth 140-274 U$/ha/year (Giesen et al., 2006). These figures are much higher than the productivity of mangrove areas that have been converted to brackish water ponds.

Constraints

The presidential Instruction No 2/2007 (Inpres) allocated the west side of the Kahayan river to mangrove conservation area and planned tambak development on the east side of the Kahayan river along the coast near Pantai Kiapak village, although this area still has a large diverse mangrove stand with a high biodiversity and a potential for eco-tourism. It is not clear whether an environmental impact assessment has been conducted before introducing this farming practice into the project area and deciding on the location and the size of the area to be developed.

Recently the Department of Marine Affairs & Fisheries of Pulang Pisau started the construction of another 200 ha semi-intensive fish ponds, primary, secondary and tertiary canals and wants to extend this to 600 ha. Local community members of Bahaur village interested to be involved in this new intervention lack the skills, knowledge and experience in brackish water aquaculture practices. Transmigrants with knowledge and experience about tambak farming practices are not involved in knowledge transfer. The Department of Marine Affairs & Fisheries does not build on their experiences and lesson learned in other areas in Indonesia. Semi-intensive and extensive aquaculture practices are not being monitored on a daily basis which makes it difficult to make proper management decisions.

After heavy rains the mortality of the shrimp and fish can be high. This is caused by the acidic soils causing a low pH of the water which is impacting growth and survival of the species reared. Access to input supplies for farming such as lime to counteract the effects of the low pH before stocking the ponds is limited.

A problem faced by the communities living in the coastal area is the drinking water shortage during the dry season. Consequently farmers have to buy the drinking water from Bahaur village for a price of IDR 30 000,- per 200 litre.

3.2.5.2 Cage culture

Cage culture (karamba) is mainly done as an additional livelihood. Cage culture is a family owned and operated business in the EMRP area. Cages can be found in Kapuas & Barito river and near Palangakaraya in the Kahayan river. Floating structures are used and placed in rivers or canals. Mainly catfish (*Pangasius* sp.) and Nile tilapia (*Oreochromis niloticus*) are grown. The harvest is sold via the traditional marketing channels at the local markets or used for household consumption.

Production

Cage culture has been introduced by the Department of Fisheries in the EMRP. The cage culture production in the three districts in 2004 totaled 961 tons in 2004 which is about 76% of the total aquaculture production that year (Table 3.11). The highest production can be found in Barito Selatan district of which the largest part is located outside the project area. The other two districts had an equally high production of about 12 tons in 2004.

CARE International supported by the Department of Fisheries introduced cage culture in Timpah and very recently in Mantangai and Katunjung village. In *desa* Timpah, community groups of 12 people manage a total of 5 cages each with a size of 4 x 2 x 1 meter. The cages cost about IDR 300.000 each and are constructed by the community group. CARE provides the community group with this starting capital but the group has to provide feed for 3 months and buy the fingerlings. The fish were initially fed with artificial feed which costs IDR 5000 per kg. The Department of Fisheries of Kapuas conducted training in feed preparation. Local feed can now be produced using local materials such as corn (carbohydrates), dry fish (protein), egg (calcium) and various vegetables like cabbage, spinach and *kankung* for vitamins at a much reduced price of IDR 2400 per kg. Growth rates appear to be similar between fish being fed with artificial feed and fish given local feed. No cost analysis has been made yet between using corn for human consumption or for preparation of fish feed.

Each cage was stocked with 500 fingerling of Pangasius. One month before stocking the bamboo cages (karamba) were submerged in water in Kapuas river. The pH of the water that time was measured to be around 5. After 7 months a total of 400 fish were harvested. The mortality of 10% was caused by the low

water quality as a result of mining activities up river (personal communication, 2008). Each harvested fish weighed between 500 -1000 grams and is sold at the local market or directly to restaurants in Timpah for IDR 18.000-20.000/kg. When sold a local markets located further away such as Pujon village the price increases to IDR 25.000/kg.

Cage culture practices in rivers near agricultural development areas (e.g. Katunjung) is problematic. The species (Pangasius) suffer from the low pH of 4 of the water in Kapuas river due to flushing of the agricultural areas and die on mass. Communities have now stocked the cages with local endemic species such as *Anabas*. The outcome of these trials although not known yet is expected to give better production results; endemic species are well adapted to local conditions and can endure lower pH. Communities also keep *Pangasius* in cages (20 in total) in Pulang Pisau next to the bridge. Fingerlings are bought from the hatchery of the Department of Fisheries. Culture here is more successful due to the improved water quality.

Constraints

Throughout the EMRP project area problems with water quality, due to human induced activities such as logging, mining and agricultural development, impact cage culture practices by lowering production rates and causing mortality of the species stocked. Water quality is further affected by agricultural use of fertilisers and chemicals and an increased release of human effluents into surface waters, all having a negative effect on fish growth and survival.

During the rainy season the river flow also increases in volume which can strongly impact the tidal fluctuations even at more inland locations. As a result flushing and drainability of these areas is limited during that period. The resulting low pH of the water is not favourable for fisheries and aquaculture. During the dry season, tidal fluctuations are more pronounced allowing better flushing and drainage.

The common constraints faced by fish and cage farmers are lack of skills, technical know-how and credit facilities, theft, low quality of the seed supply and inadequate marketing opportunities. Input supplies such as materials to construct the cages, fingerlings and feed are expensive.

The local Department of Fisheries & Marine Affairs does not have the manpower or capacity to provide the support required. Demonstration, extension and research are often not relevant to the farmers' needs and situation.

The Ministry of Fisheries and Marine Affairs is interested to further develop aquaculture practices and cage culture. Unfortunately plans at national and local level have different priorities and institutional arrangements are inadequate to implement such plans. Often the local governments, not having enough capacity, financial resources and man power have to implement the plans in the districts. Implementation of activities is very often project and budget driven.

3.2.5.3 Freshwater aquaculture

Freshwater aquaculture in the EMRP area is usually done traditionally in village ponds. The most common species cultured are common carp (*Cyprinus carpio*), Nile tilapia (*Oreochromis niloticus*) and catfish (*Pangasius* sp.). Total production of freshwater pond aquaculture in 2004 was 46 tons in Kapuas district, 98 tons in Barito district and 70 tons in Pulang Pisau district (Table 3.11). The freshwater aquaculture production of 214 tons, which equals 17% of the total aquaculture production of 1268 tons in the project area in 2004. Species are cultured for local markets and/or household consumption.

Communities grow *Pangasius* in freshwater ponds in the area around Pulang Pisau and the Department of Marine Affairs and Fisheries is aiming to further develop this area. They also established a fish farm and hatchery with a total area of 10 ha In Pulang Pisau district. The ponds are fed with water from river Kahayan which is located at about 200 meter from the furthest pond in the hatchery (close to the road to Kapuas) and are not aerated. Water influx occurs automatically when the water level in the river rises due to tidal movements or rainfall. Monitoring of the water quality (pH, Dissolved Oxygen, temperature and transparency) in the ponds is done. The pH of the water is around 6. The temperature of the water is 28 C^0. The aquaria and tanks are filled with river water which is pumped into settling ponds and then pumped into tanks with a coral and charcoal filter before it is used in the tanks and aquaria in the hatchery. The hatchery contains a total of 43 aquaria and 2 tanks (field visit February 2008).

Three 3 species are cultured, *Pangasius* (patin), African catfish (pentet) and Nile tilapia (nila) mainly to breeding purposes. Different sizes of fish can be found in one pond. Brood stock of *Pangasius* is bought in South Kalimantan. A total of 200 fish (1 female : 3 males) have been stocked in one pond with an area of 20*40 meter and a depth of ½ meter. The fish are bred during the rainy season from November till May when enough fresh water can enter the ponds. The pH of the water is mostly around 6. If it becomes lower than 4 the *Pangasius* species will get stressed. For reproduction, the females and males are injected with hormones and stripped. The fertilized eggs are put in an aquarium in a hatchery and hatch within 24-36 hours. Over 1000 eggs are placed in one aquarium and about 700 fry survive. The fry are fed for 10 days with artemia which is imported from Java. After 20 days the fingerlings are transferred to an aerated stocking tank with a size of 2 * 4 meter and a depth of 2 meter. The food given to the fingerlings costs IDR 10.000/kg. The brood stock is fed with artificial food at 7 am and 4 pm. No feeding scheme or feed management plan is followed. The feed is imported from Java and costs IDR 200.000 for 30 kg. The Department of Fisheries tried to prepare feed themselves but did not succeed due to lack of input supplies. The fingerlings (5-20 cm) are sold at Palangkaraya market or people buy them directly of the hatchery at a price of IDR 500/fry. Some fingerlings are left in the ponds to be used as future brood stock. It takes about 6-7 months to grow the fish to market size with a weight of 800 grams/fish. The adult fish are sold on the market in Pulau Pisang for IDR 10000/kg.

African catfish are bred all year round. The Department of Fisheries stocked 70 catfish (1 male: 1 female). The brood stock is bought in South Kalimantan (Mandiangin). For breeding the females are injected with hormones and put together with a male in a tank lined with breeding mats made of Nipa palm. The eggs attach to the mats and the broodstock is moved back to the pond. The eggs hatch within 24 hours and the fry is fed for 1 week with artemia before they are moved to the fry pond (about 7000 fry) for one month. In the fry pond no feeding takes place for the initial two weeks but after that artificial feed is given. Feeding is done at the same hours and in the same manner as the *Pangasius* species. When the fry has grown to fingerlings with a size of about 8-10 cm they are sold. The market price of an adult catfish is IDR 5000/kg. This fish is not very much liked since it is a scavenger.

Tilapia (Nila*, Oreochromis* Niloticus) breed naturally in the ponds and are the easiest of the three species to grow. They are grown all year round. The fry surface in the pond and are put in a separate net inside the pond. Tilapia are also fed with artificial feed like the African catfish and *Pangasius*. Tilapia broodstock cost about IDR 10.000/kg. Fingerlings (5-8 cm) are sold for IDR 200-250 /fingerling. The price of market size tilapia is IDR 15.000/kg. Although tilapia fetches a higher market price than *Pangasius*, the latter one is preferred due its larger size per individual fish. The demand for *Pangasius* is also higher.

In response to political pressure, the Department of Marine Affairs & Fisheries has built a number of ponds in the peat swamp area close to the transmigration villages A0-A5 in Block A near Dadahup. A consultant from Banjarmasin was hired to look into possibilities to introduce fish farming into the area. Due to the low pH which is unfavourable for the culture of most commercial exotic fish species all pond were lined with thick plastic to prevent the influence of the acidic soils. A total of three ponds with an average size of 15 * 15 meter and depth of 70 cm were constructed. The ponds were filled with water from the surrounding drainage canals and were limed to counteract the extreme low pH of the water (25 kg lime/pond for IDR 500/kg). Water hyacinth was used to cover part of the pond to reduce the water temperature. After filling the ponds no extra water was added during the production cycle and the ponds were not aerated. The ponds were stocked with 15.000-25.000fry (2-3 inch) of *Pangasius* (Patin).

The fish were fed for the first 3 month only. During a visit in the field in February 2008 only 7 months after construction of the pond, the fish were still alive in the ponds but no real monitoring had taken place so little could be said about mortality and growth rate, feed conversion rates etc. The plastic covering the ponds was ruptured and the water level in the pond was reduced by half. The pH in the ponds was 6.5. From the beginning the Department of Marine Affairs & Fisheries in Kapuas district being very familiar with the area, had reservations about the project. Observations made by them throughout the implementation of the pilot project were: 1) the investments needed to build the ponds (plastic, pond construction, lime, feed etc) is too high for local communities for it to be an economically interesting additional or alternative livelihood, 2) no economic analysis about the farming practice was conducted by the consultant only technical pond construction details were looked into, 3) the production cycle has not been properly monitored. It can be concluded that the experiment was unsuccessful and introduction of aquaculture with exotic species in shallow peatswamp areas close to agricultural development schemes proves extremely difficult if not impossible.

Constraints
Besides the production of fry, fingerlings and marketable size fish, the Department of Marine Affairs & Fisheries is not involved in information and knowledge transfer about fish farming to local communities.

Production in freshwater ponds located close to the drainage canals suffer from high acidity, causing slow growth and low production of the cultured species. To counteract the low pH, famers need to lime their ponds before stocking them with fry or fingerlings.

Introducing aquaculture in transmigration villages close to the agricultural scheme development areas is complicated due to specific ecological conditions and high acidity which is not suitable for most freshwater species not indigenous to the area. Even local species suffer low growth rates and higher mortality rates when the pH drops below a certain level (3.5).

3.3 Marketing and processing

Most fish products are distributed through the traditional marketing channels at the local or national market or used for household consumption. In the traditional fish marketing system, fish products change hands several times until the point of last sale. The market chain involves fishermen or fish farmers, collectors, distributors and consumers. Intermediaries play a major role in small scale fisheries as they traditionally control the market outlets and often represent the only source of credit available for the fishers. In remote areas were access to fresh fish distribution channels is limited, fish is often processed before it is

marketed. Women play an important though often an unrecognized role in processing, marketing and day to day management of fish ponds.

Private traders, collectors or agents market most of the aquaculture products, including fish fry or fingerlings. The species cultured in small aquaculture ponds and cages are sold via the traditional marketing channels at the local and national markets or used for household consumption. Fish collectors also provide fingerlings, fish feed, fishing gears and aquaculture equipment to the fishermen or fish farmer.

Producers for export have links to larger scale, industrial-type seafood companies. Shrimp famers sell to collectors transporting the products from production site to processing plants and export companies. Hygiene and sanitation in the fresh or wet supply of fish is not always up to the food safety standards which has strong consequences for export to international markets.

4 Challenges and opportunities

4.1 Challenges in fisheries and aquaculture

Fish stocks in the inland waters of the EMRP project area are exploited for a range of fisheries and aquaculture related purposes. The same waters are also used for a number of human activities other than fisheries including agriculture, navigation, tourism, water supply and waste disposal. These compete with fisheries by modifying the structure of the environment and the quality and quantity of water. In this way they threaten the sustainability of aquatic ecosystems and the fisheries that depend on them. However many of these alternative demands on water are often seen to be of greater value than fisheries and assigned a higher priority when decisions about the allocation of water are made.

Human interventions in the project area such as agriculture development, logging, mining, and pond construction in mangrove areas have led to changes in fish habitats resulting in the disappearance of certain species and/or changes in species composition and has impacted fisheries and aquaculture production:

- Canal construction during the Mega Rice Project has disrupted not only the hydrology of the area, strongly impacting the effectiveness of traditional fisheries systems such as the *beje* fisheries but also reduced the water quality, in particular the pH, jeopardising the survival, growth and productivity of endemic fish species in (peat) swamp and riverine habitats and impacting aquaculture practices. Heavy rains or flushing also cause the pH to drop to levels unsuitable for fish survival (exotic species) or production (indigenous species). Water quality is further affected by agricultural use of fertilisers and chemicals. An increased release of untreated human effluents into surface waters also has a negative effect on the water quality, fish growth and survival.
- Development of structures such as dams and gates in drainage canals of agricultural schemes limit the seasonal movement and migration of fish species from peat swamp areas to rivers and back, restricting their feeding and breeding patterns.
- Logging and forest fires have greatly reduced the vegetation cover causing erosion and sedimentation. Sedimentation changes the water flow pattern, decreases the success of fish spawning and changes the structure of the aquatic plant community and insects causing a loss in food supply and reducing the habitat used for cover.
- Mining activities have a similar effect on water turbidity as logging activities. They also cause deterioration of the water quality and accumulation of mercury in the food web which can impact human health.

Flushing and drainability decreases during the rainy season due to increased river flow volume which limits tidal fluctuation at more inland locations. The resulting low pH of the water is not favourable for fisheries and aquaculture. During the dry season, tidal fluctuations are more pronounced allowing better flushing and drainage.

Illegal fishing activities such as fishing with electricity create social conflicts, is damaging to the health of the ecosystem because of its non-selective effects, and affects the long-term sustainability of the fisheries resources.

The introduction, intensification and extensification of the fisheries and aquaculture activities, depend on the carrying capacity of the ecosystem. Appropriate data on existing fisheries resources, exploitation figures but also environmental data such as water quality to support such decisions are not available. Data on the importance of fish production for the livelihood of communities are also lacking, are incomplete or collection has only started recently. Few stock assessment studies have been conducted, especially in peat swamp areas.

Aquaculture practices are often unproductive due to the inappropriate selection of sites with unsuitable environmental conditions (low pH). Freshwater ponds located close to agricultural development areas in transmigration schemes suffer from high acidity, causing slow growth and low production of the cultured introduced species. In peat swamp areas farming of exotic fish species require high input supplies and result in low production rates due to the soil and water quality. Conversion of mangrove to brackish water aquaculture ponds (tambaks) for culture of shrimp species and milkfish directly translates to loss of biodiversity and impacts coastal and marine fisheries depending on mangroves for reproduction, growth and shelter. Intensive farming often leads to lasting changes in the soil condition (acid sulphate soils).

The common constraints faced by fish and cage farmers are lack of technical know-how and experience in pond and water management, high costs of low quality of input supplies such as fry, fingerlings and lime, limited access to credit facilities, inadequate marketing opportunities and poor infrastructure. The marketing infrastructure in the EMRP area is poor and inadequate; most fish products are sold locally.

The role and responsibility of the Department of Fisheries in capacity development (knowledge transfer and skill development) in support of newly introduced fisheries and aquaculture technologies such as cage culture and pond development is lacking and extension services are weak. Demonstration, research and extension are often not relevant to the fish farmer's needs and situation.

Appropriate systems to monitor the impact of innovative technologies are not in place. This and the weak documentation of experiences with innovative aquaculture practices makes it difficult to draw on lessons learned internalise them and integrate them in new project designs.

A clear long term integrated framework for fisheries and aquaculture in the EMRP area does not exist and the institutional arrangements for management of the fisheries resources and the conservation of critical fish habitats are inadequate. Capacity and knowledge on integrated sustainable management approaches is lacking and existing policies and strategic plans are all sector based and sometimes conflicting. A good example are water management regimes that are required for agriculture often conflict with needs of fisheries and aquaculture.

4.2 Opportunities in fisheries and aquaculture

In social, economic and ecological terms, small-scale fishers are low-input, low-cost producers. They consume less energy and require less capital per ton of product and are often less ecologically destructive compared to large scale fisheries and other resource users. They contribute to rural development following a unique and highly appropriate livelihood strategy for the communities and contribute effectively, and sometime very significantly, to food security and nutritional balance in the EMRP area.

The sustainable development of small-scale fisheries in the project area is desirable for a balanced social, economic and regional development. This requires:

- increased political and economic attention and support,
- more favourable fisheries development policies and strategies,
- integration of fisheries into rural development and coastal area management,
- strengthening of decentralised, participative management processes,
- identification and allocation of resource rights
- control of fishing capacity and creation of alternative employment
- promotion of technological progress
- reduction of negative impacts on the environment
- improvement of product quality; supporting post-harvest and value-added activities
- better access to credits and inputs and
- improved markets and services

As there is little scope for infinite expansion of capture fisheries in the project area given current levels of exploitation, it is crucial to better manage fish resources to avoid further resource depletion. Even with resources fished close to the maximum it is feasible to reduce fishing costs, improve market value through better processing, value-adding, and marketing. It is also possible to develop complementary or alternative employment through other productive activities, such as aquaculture and eco-tourism. Although aquaculture practices have a good potential in the project area, there might be constraints preventing capture fishers moving into aquaculture in view of high investment costs, lack of suitable sites (land and water) and the lack of access to technical know how and inputs. Communities also need to expand their knowledge and skills in fisheries practices and innovative pond and cage culture techniques. Capacity development and extension services of the Department of Fisheries therefore need to be strengthened. Demonstration, research and extension, relevant to the fish farmers' needs and situation will increase the impact of aquaculture practices and carefully monitoring and documentation of experiences will make it easier to draw on the main lessons learned, internalise them and integrate them in new project designs.

First it is however important that a long-term integrated framework will be developed for the EMRP area which includes fisheries and aquaculture. Community management and co-management (the sharing of power and responsibility between the manager e.g. government, and the resource user e.g. small-scale fishers) could offer promising solutions to poverty alleviation. The livelihoods approach should be leading as this strategy aims to improve the effectiveness not only of the activities of fishing communities, but also of the public policies, institutions and processes that affect the livelihood of fishing communities. To ensure sustainable management of the fisheries resources and the conservation of critical fish habitats the capacity and understanding of the various stakeholders involved on integrated sustainable management approaches needs to be identified and strengthened and conflicting interests should be addressed. It should be kept in mind that collective action and co-management can require many years of capacity-building to be effective.

To improve the livelihood options and alleviate poverty of the local fishing communities specific opportunities in the fisheries sector in the project area for the future include: (a) freshwater aquaculture, (b) cage culture, (c) beje fisheries and (d) ornamental fisheries. These alternative livelihood options were selected based on ecological, hydrological and economical aspects and existing policies and will be described in more detail in Chapter 5.

5 Strategy for development

Strategic planning for the inland fisheries and aquaculture sectors must take part in the wider discussions and decisions concerning future water resources allocation, water use and water quality management. Those responsible for decisions on ground and surface water allocation, use and management at all administrative and technical levels must make adequate water available for maintenance of quality and timing of flows and for rehabilitation and improvement of ecosystems to sustain and enhance valuable subsistence, commercial and recreational fisheries.

Given current levels of demand for land and water, it will not always be possible to protect the environment fully, but environmental appraisal processes must be carried out to properly balance resource priorities, guide decisions on allocation and on any mitigation measures that may be necessary. Current knowledge is sufficient for technical interventions to mitigate continuing damage by other users or to rehabilitate impacted ecosystems. Public capacity to improve the aquatic system lies more in policy making and allocation among different user groups.

There is an increasing need for a better understanding of the different demands placed on the aquatic system and how these demands relate to one another. There is also a need for improved communication and acceptance of how the requirements of one user will modify and compromise those of another. Solutions outside of the fisheries sector can be as important, if not more so, than strategies employed within the sector, and may therefore require action and co-ordination across sectors. Political processes are needed that will facilitate involvement off all stakeholders and support integrated resource management. It is important that concepts of social and economic value and use are developed for inland fisheries so that fisheries interests can be properly represented in the allocation and resource use debate and development plans.

The different types of fisheries in the EMRP project area require specific management approaches that can not always explicitly be linked to the proposed Management Units in the Master Plan. The long-term strategies for development of *capture fisheries* in the EMRP area should be robust to cope with fluctuations in climate and are influenced by the relationship between fishing capacity and resource availability. The aim should be on sustainability and determining a fishing effort that balances the volume of catch with the production of the wild stocks. Any significant reduction of fishing effort will create a large social problem as many fishers in the project area live at the edge of subsistence. The fisheries administrations have few real means to control access. A common policy could be designed to help artisanal and small-scale fishers to reserve areas exclusively for them.

Freshwater aquaculture in and along rivers require a management approach that includes the river basin as human activities upstream impact on downstream fish farming practices. In *peatswamp areas*, fisheries and aquaculture can provide a source of livelihood to local communities provided appropriate laws and regulations are at place to support this. Such socio-economic development should be based with a long term view on sustainability and be carefully balanced with conservation and rehabilitation efforts. *Brackish water aquaculture* should be managed according to the specific characteristics of the coastal ecosystem. In addition, adaptive management should form an important part of the approach to fisheries and aquaculture development in all ecosystems in the project area. Modification of water management will lead

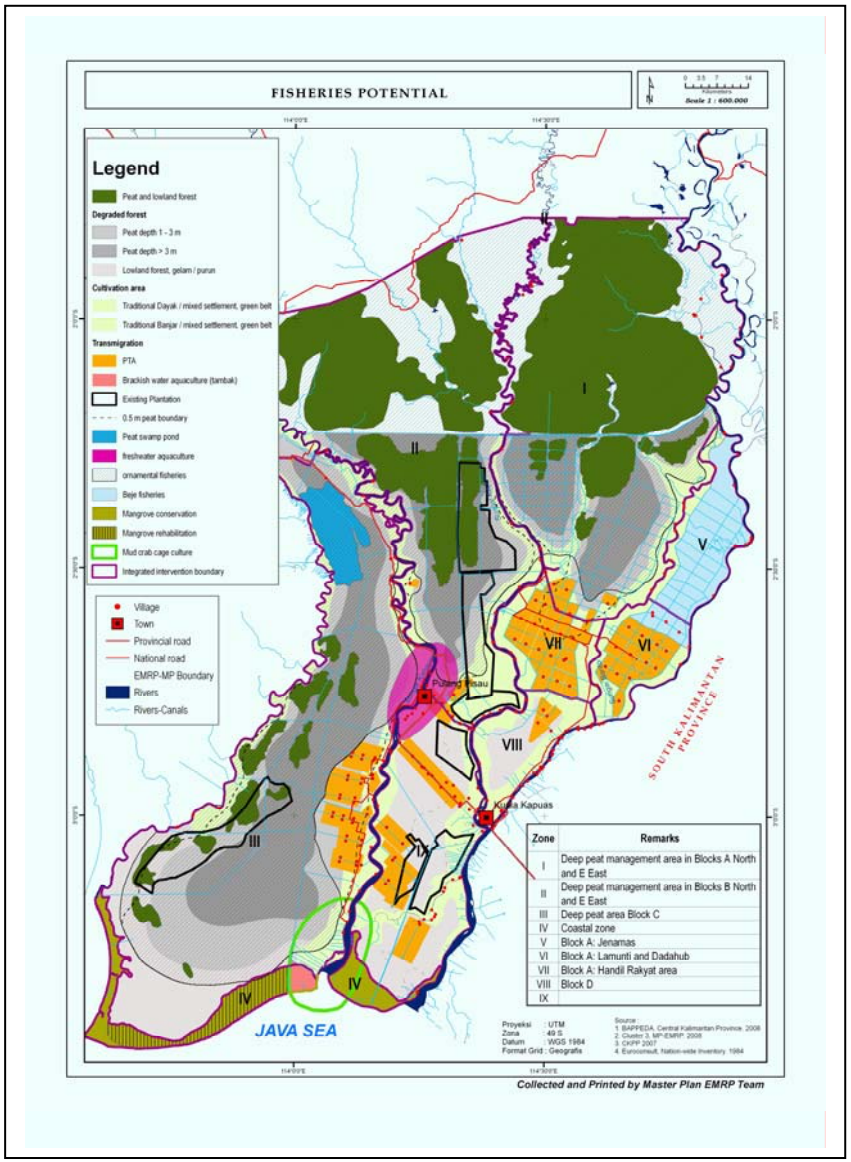
to changes in the environment and therefore the suitability for fisheries and aquaculture development These induced changes should be closely monitored to identify possibilities to bring back old technologies like cage culture and/or to introduce new more appropriate aquaculture interventions to the area. The success of existing interventions should also be monitored carefully to see what works and to try to improve from this. An effective enabling environment for the development of fisheries and aquaculture in the project area include:

- Technical capacity and skills to manage and sustain the interventions
- Supportive institutional arrangements & capacity
- Technical support and adequate extension services of Department of Fisheries
- Access to credit and services
- Enforcement of laws and regulations (including ban on electro-fishing)
- Infrastructure development for marketing & processing
- Multi-sectoral planning in policy and strategy development. Authorities charged with the conservation and management of natural resources and where the prime objectives is other than fisheries, should explicitly include in the protection of aquatic resources for its biodiversity and fisheries.
- Data collection including (a) stock assessment, (b) catch data at landing sites, (c) marketing data, particularly on ornamental fish (d) the impact of changing hydrology and land-use on the fish populations and biodiversity in peat swamp areas.
- The development of a livelihood strategy including the wetland users (communities), the wetland habitat and the dependence on fisheries (home consumption). This strategy should include knowledge and experience of local inhabitants.

The priority interventions for the development of fisheries in the project area involve the following: (i) freshwater aquaculture, (ii) cage/pond culture with indigenous species and mudcrab, (iii) beje fisheries, (iv) ornamental fisheries, and (v) coastal zone management (Figure 4.1). [6]

In table 5.1 an overview of the various strategies to develop fisheries and aquaculture in the EMRP area, which are described in more detail in the remainder of this chapter, can be found.

[6] These maps are based on the four management zones, Peatland Protection and Conservation Zone, Development Zone, Adapted Management Zone and Coastal Zone and the 9 Management Units as proposed by the EMRP project.



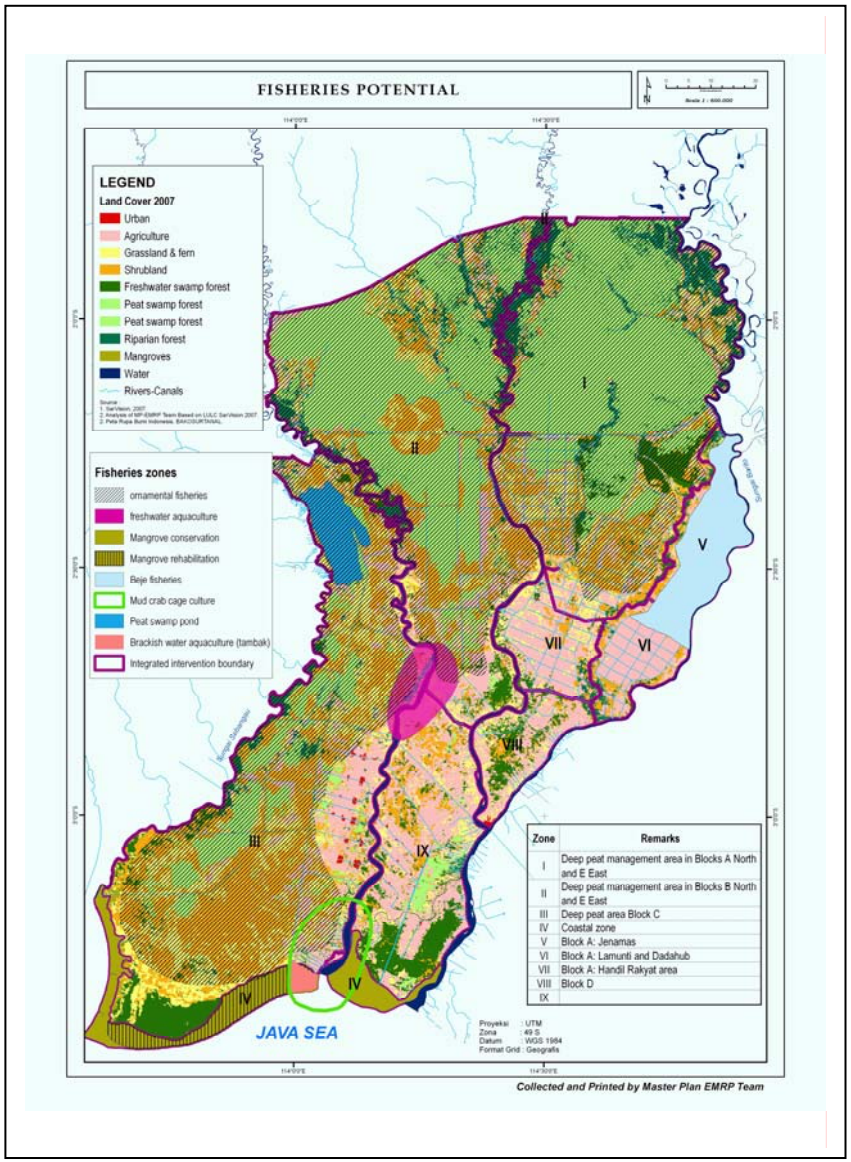


Figure 3.5: Fisheries potential in the EMRP area with (left) EMRP Management Zones and (right) Land use map

Table 5.1: Summary of strategies to develop fisheries and aquaculture in the EMRP area

Objective	Activity	Priority location
Create an enabling environment for fisheries and aquaculture development	• Develop technical capacity and skills • Strengthen and develop supportive institutional arrangements • Strengthen extension services of the Department of Marine Affairs & Fisheries • Improve access to credit and services • Enforce laws and regulations • Develop infrastructure for marketing & processing • Promote multi-sectoral planning in policy and strategy development. • Establish an effective data collection system: (a) stock assessment, (b) catch data (c) marketing data (d) hydrology and land-use • Develop a livelihood strategy including the wetland users, the wetland habitat and the dependence on fisheries.	
Develop freshwater aquaculture while conserving genetic diversity and minimizing impact on wild fish populations	• Develop management plans and policies ensuring fair natural resource allocation to users • Establish procedures for monitoring and assessing environmental impacts of aquaculture activities • Strengthen extension role of the Department of Marine Affairs & Fisheries • Promote good aquaculture practices at small scale farms • Build capacity and develop technical skills of local communities • Provide input supplies for aquaculture • Establish demonstration farms • Conduct trials with culture of endemic peat swamp fish species in deep peat ponds and blocked canals • Establish a monitoring system and document lessons learned for dissemination	*Freshwater ponds:* Adaptive Management Zone Development Zone around Pulang Pisau *Peat swamp ponds:* Peatland Protection and Conservation Zone Adaptive Management Zone

Develop cage culture in freshwater and marine habitats	• Map areas suitable for cage culture • Study and document production requirements and limitation of cage culture of exotic species • Strengthen skills and knowledge of local communities in day to day cage culture management • Provide input supplies for cage culture • Improve infrastructure and marketing channels • Conduct cage culture trials with indigenous species • Conduct a feasibility and marketing study prior to the trials • Conduct stock assessment studies of indigenous species suitable for cage culture • Monitor the impact of cage culture on the environment and its carrying capacity	*Mud crab fattening:* • In the estuaries of Kahayan river *Cage culture of exotic species*: • In rivers but depends strongly on the pH • With improved water management larger areas will be suitable for cage culture *Cage culture of indigenous species:* • Studies and trials will provide more information on suitable species and sites.
Rehabilitate beje fisheries	• Document and disseminate lessons learned with rehabilitation of recently constructed beje • Develop a monitoring plan measuring impact, effectiveness and sustainability of the beje fisheries • Conduct stock assessments and monitor fish landings to support decision making on the total number of beje that can be constructed in view of the carrying capacity of the ecosystem • Put a licensing system in place to ensure sustainable beje development	Management unit V and northern part of management unit VI
Market ornamental fish species	• Explore possibilities to link local initiatives with national commercial ventures • Study condictions for sustainable exploitation of ornamental species • Conduct a marketing study	Peatland Protection and Conservation Zone: Management Unit I, II, III

	• Develop infrastructure and marketing channels • Conduct trials with farming of ornamental fish specie	
Sustainable development of the coastal zone	• Conduct site assessments for semi-intensive tambak development • Restore and conserve mangrove areas at the mouth of Sebangau river and behind Pantai Kiapak village east of Kahayan river • Assess the potential for eco-tourism	Coastal Zone

5.1 Freshwater aquaculture

As a primary goal, aquaculture development should conserve genetic diversity and minimise negative effects of farmed fish on wild fish populations, while increasing supplies of fish for human consumption. The natural resources in the project area are often used by more than one user or have the potential for different uses. To avoid disputes and conflicts between different users of resources policies and plans should be developed that ensure that resources are used and allocated on a fair basis.

Steps should be taken to ensure that the livelihoods of local communities, including access to, and productivity of, fishing grounds, are not negatively affected by aquaculture developments. Procedures for monitoring and assessing the environmental effects of aquaculture should be established. In addition, care should be taken to give guidelines for types and quantities of feed and fertiliser to be used in farming fish and the monitoring of the follow up. The use of disease-control drugs and chemicals should be minimal because these can have important negative impacts on the environment. It is also important to ensure the safety and quality of aquaculture products.

Indonesia is attempting to introduce quality system certification procedures to certify that aquaculture products are safe to consume and farmed in accordance with certain standards. Such quality system include Good Aquaculture Practices, food safety, social and environmental responsibility, post harvest handling and have so far been developed for shrimp and other aquatic commodities such as tilapias, catfish, gouramy etc. The Indonesian government committed itself to support small-scale farmers with the technical and financial aspects of such system (Made, 2006). Farmers in the project area also need to apply better environmental management practices for aquaculture development.

Depending on suitability of the soil and the water quality of the river (with a pH close to 5), the best sites to be selected for pond development in the EMRP area are located in the Adaptive Management Zone and the Development Zone around Pulang Pisau (Figure 3.5). In Pulang Pisau, the Department of Fisheries has established a fish hatchery that can support the expansion of the freshwater area for aquaculture of Nile tilapia (*Oreochromis niloticus*) and catfish (*Pangasius* sp) and walking catfish (*Clarias Batrachus*) in the area around Pulang Pisau.

CIMTROP recently started trials with the culture of endemic peat swamp fish species in ponds developed in deep peat soils using indigenous species in Management Unit III in Block C. Building on the experiences with these trials the most suitable species can be selected and the production area can - once the intervention proves to be successful - be enlarged to other sites in the Peatland Protection and Conservation Zone and Adapted Management Zone (Figure 3.5).

Stocking of blocked canals with exotic species was tried in Management Unit 1 in block A, during CKPP but proved unsuccessful due to the low pH which caused high mortality (Figure 3.5). Trials could be done to study if indigenous species such as *Anabas* can be grown more successfully. A large market already exists in Banjarmasin and the University of Palangkaraya has conducted a research on the reproduction of *Anabas* species in captivity with some degree of success.

The Department of Fisheries and Marine Affairs should besides providing input supplies for aquaculture, further strengthen its extension role and build technical capacity and skills of local communities in aquaculture & fisheries technologies. Demonstration farms and projects should suit the needs of local farmers and take into account their skills, experience, knowledge and resources available to them to invest

in innovative technologies. A system should be put in place to better monitor the introduction and implementation of new fisheries and aquaculture interventions and document lessons learned for dissemination.

5.2 Cage culture

The areas were cage culture can be practiced depend very much on the water quality. When introducing cage culture, the (fluctuations in) pH and salinity levels in the rivers are important factors to be appraised. Fish species all have their specific range in which they can survive and grow. Success rates with cage culture of *Pangasius* have been low in areas where water pH was low or suddenly dropped. At the coast and the estuaries of Kahayan and Kapuas river mudcrab fattening could provide an additional source of income but also here success rates have been low which was mainly caused by the lack of skills and knowledge of communities regarding mud crab fattening.

Figure 3.6 shows the computed (temporal) variation in salinity at a location approximately 70 km upstream in the Kahayan River is presented as a so-called depth-time diagram. This is done for an average discharge of 300 m3/s in the dry season. This figure indicates that in Kahayan river salinity intrusion can be found up till 70 km inland. The salinity intrusion is confirmed by the *Sonneratia* mangroves species that can be found at the riverside downstream from Buntoi village. There is always a salt wedge, under layer with a higher salinity which is not mixing with the upper layer due to higher density.

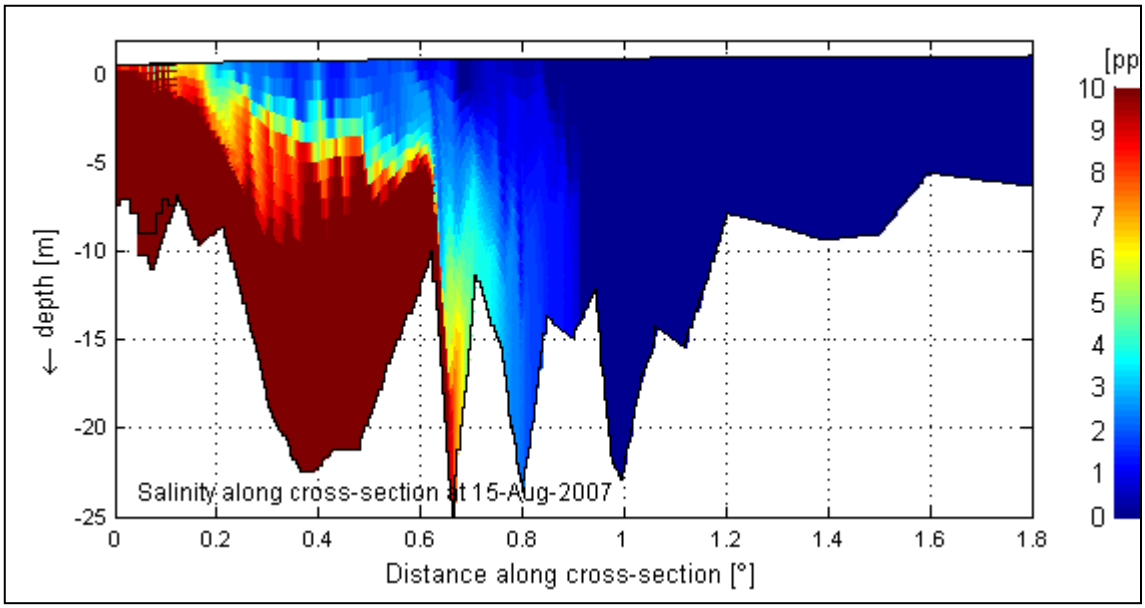


Figure 3.6 Depth-time diagram of variation in salinity at Kahayan river with an average discharge of 300 m3/s in the dry season.[7]

Figure 3.6 indicates that the areas located closer to the coast will be less suitable for the introduction of cage culture with exotic species such as *Pangasius* and common carp (*Cyprinus carpio*) sensitive to high salinity levels. Nile tilapia (*Oreochromis Niloticus*) can however tolerate salinity levels up to 5 ppt and could be cultured closer to the coast. The salt wedge sometimes up to 4-5 meter below the surface can also impact the cage culture production. The saline intrusion in Kapuas river is further inwards up to 100 km which has to be taken into consideration when planning for cage culture development in this river. Based

[7] Further details are provided in the Technical Report on the Hydrology of the EMRP area.

on the water quality, potential areas need to be mapped in more detail and production requirements and limitations further studied and documented.

In the northern part of the EMRP project area (Management Unit I, II and VII) cage culture with fish species in the Kahayan and Kapuas river will only be successful during the dry season. In the rainy season the pH of the water drops considerably due to flushing of the surrounding acid soils in the agricultural development schemes limiting cage culture production. When water management in this area improves, cage culture might be possible all year round.

Culture and fattening of mud crab can be done at locations with high salinity levels at the mouth of Kahayan river and along the coastline in sheltered areas (Figure 3.5). Although cage culture could provide a livelihood to the local communities in the project area, the availability of skills and knowledge in cage management needs to be strengthened. Also input supplies and a market will have to be available and accessible. Day to day management practices have to be further strengthened and marketing infrastructure improved.

All cages in the EMRP area so far have been stocked with exotic species. Alternatively cages could be stocked with local indigenous fish species. Although a market for indigenous species in the province and Banjar Masin exists, care should be taken that the market is not flooded with fish resulting in lower market prices. A feasibility and marketing study should therefore be conducted prior to and during the implementation of the trials. When the culture will entirely depend on natural stocks, it is important to know if the carrying capacity of the ecosystem can sustain the intervention. More study is needed on the available natural stocks and the production and management of indigenous species in cages.

To keep the costs of input supply low the predatory fish species that are often kept, are fed with smaller fish species collected in the areas surrounding the cages. This can potentially lead to overfishing. When the number of cages exceeds the carrying capacity of the system the water quality of the rivers can also be affected by waste and food residues.

5.3 Beje fisheries

The community and Department of Fisheries are interested in rehabilitating the beje fisheries. However, although agricultural production and beje fisheries are equally important to the livelihoods of the local communities in parts of Block A, they have conflicting demands in terms of water level management. Agriculture requires lower water levels while beje fisheries requires flooding. As a consequence, the wetter areas in the north of block A are more suitable for beje fisheries since they are naturally flooded. Beje fisheries could be intensified and extensified in Management Unit V and the northern part of management unit VI (Figure 3.5). Not only are the knowledge and skills already available, the local communities are interested to revive the once successful livelihood and the Department of Fisheries & Marine Affairs is willing to support this development. New beje development should be based on experiences and lessons learned with the rehabilitation of recently constructed beje. A monitoring system measuring impact, effectiveness and sustainability of the beje fisheries should be established; lessons should be documented and disseminated.

The maximum number of beje to be developed and rehabilitated strongly depends on the carrying capacity of the ecosystem. When too many beje will be constructed this will have a negative impact on biodiversity, consequently lowering production rates and decreasing profits. Beje development should be based on

stock assessment and monitoring of the fish landings. Limited data are however available on the existing fisheries resources and exploitation rates to support solid decision making on the number of beje that can be constructed in view of the carrying capacity of the ecosystem. A licensing system could be put in place to limit the maximum number of beje in a certain area. To sustain the brood stock, controlled access could be granted to certain areas or limited in periods such as the dry season and the breeding season.

Care should also be taken that the construction of beje is done in such a way that the conditions that have been created during earlier development of the agricultural drainage canals are not worsened. A proper monitoring plan to appraise the impact of the planned interventions and the need for mitigating measures of the Department of Fisheries should be developed and be put in place.

5.4 Ornamental fisheries

Ornamental fisheries could provide an interesting alternative source of income to local communities in the EMRP area (Figure 3.5). CKPP (2007) has identified ornamental fish species inhabiting peat swamp areas with a potentially high marketing value such as *Betta sp, Rasbora sp, Trichogaster leeri, Mastacembelus cf. unicolor, Chaca bankanensis* (CKPP, 2007). The Department of Marine Affairs & Fisheries contracted a consultancy company to conduct a study to identify the ornamental fish species inhabiting Central Kalimantan Province (2007). This type of fisheries could possibly be introduced and/or intensified in Management Units I, II and III located in the Peatland Protection and Conservation Zone and the Adaptive Management Zone where swamp fish can be found. Investors have also recognised the potential of ornamental fish species. It should be explored whether local initiatives could be linked to such national commercial ventures. Conditions for sustainable exploitation of ornamental species, infrastructure and marketing potential and channels will have to be studied further. Also farming of ornamental species in ponds and cages could be further explored.

Responding to growing opportunities and potentials in Arowana Fish market, PT Inti Kapuas Arowana (IIKP) repositioned its business by focusing on selling and farming of Arowana Fish. Through the company's subsidiary, PT. Istana Bahari, IIKP entered into a partnership with traditional arowana farm in Pontianak, West Kalimantan. In parallel, the company also purchased 24 hectares (62 acres) land. They are both to be developed into a modern fish farming facility.

On the distribution side, IIKP opened its first Jakarta outlet, in July 2005. Besides dealing in direct retail and wholesale, buying and selling, the outlet also provides other services such as Arowana Rental and Arowana Care services. The plan for immediate future will include opening new outlets in major cities throughout Indonesia.

In marketing Super Red Arowana, IIKP develops a brand name "Shelook RED" to represent the high quality standard assurance that IIKP applies in the breeding, selection, and care of its Arowana Fish.

Company's commitment and professionalism in its business operations is reflected by the fact that IIKP is the first Arowana farming and distribution company to be listed in the Jakarta Stock Exchange.

For further information: www.iikp.com

5.5 Coastal zone development

Coastal mangrove areas have been converted for brackish water aquaculture. Although the Department of Marine Affairs and Fisheries aims to expand brackish water aquaculture further development should be limited to the area west of the Kahayan river (figure 3.3). This area has good tambak potential and

mangroves here are already heavily disturbed or have disappeared altogether. In view of the often irreversible impact of tambak cultivation this intervention should be limited to a small area of semi-intensive production.

The mangroves at the east side of Kahayan river Pantai Kiapak village and the mangroves south of the mouth of Sebangau river should be conserved and restored to improve the natural protection function and rehabilitate the degraded coastline. These mangrove areas supporting economic activities based on their diverse flora and fauna and may have a good potential for eco-tourism.

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Annex 1 Species List

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
1	*Achiroides leucorhynchos*		Ikan sebelah, ikan nabi	Lolidah	–	–	–
2	*Acrochordonichthys rugosus*				–	–	–
3	*Ambassis kopsii*	Frekled hawkfish	Serinding	Bebaga, Baga-baga	√	–	–
4	*Ambassis nalua*	Scalloped perchlet	Serinding, Pangkah	Bebaga, Baga-baga	√	–	–
5	*Amblyrhynchichtys truncatus*		Betet	Bilar mata	√	√	√
6	*Anabas testudineus*	Climbing perch	Betok	Papuyu, puyu	√	√	√
7	*Aplocheilus panchax*	Blue panchax	Kepala timah	Banta	–	–	√
8	*Bagarius yarreli*	Goonch		Kupa, Ikan helikopter, Palangaya	√	√	√
9	*Bagrichtys macracanthus*	Black lancer catfish		Pampang, Lahung	–	√	√
10	*Bagrichtys micranodus*			Puntin, Tampalahung	–	√	√
11	*Bagroides melapterus*		Baung tikus	Papuntin, Bapuntin, Puntin, Tabangai	–	√	√
12	*Bagrus docmak*		Semutundu	Pantik	√	√	√
13	*Balanthiocheilus melanopterus*	Three color sharkminnow	Batang, Buro		–	–	√
14	*Barbichthys laevis*	Sucker barb	Santran, Wader	Kumkum	√	√	√
15	*Barbichthys nitidus*			Kumkum	√	√	√
16	*Barbodes balleroides*		Lokas, Wader merah	Betutung	√	√	√
17	*Barbodes collingwoodii*		Salap	Banta batang, Repang	√	√	√
18	*Barbodes platysoma*			Bentutung	√	√	√
19	*Barbodes strigatus*		Tawes		√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
20	*Barbonymus altus*	Red tailed tinfoil		Lampam	√	√	–
21	*Barbonymus gonionotus*	Java barb	Bader putihan, Bader	Benduk	√	√	–
22	*Barbonymus schwanenfeldii*	Tinfoil barb	Ikan lempam, Lampai	Tangara, Salap, Repang, Banta Batang	√	√	√
23	*Barbucca diabolica*			Wakat letek	–	–	–
24	*Belodonthicthys dinema*		Lais tabirin	Lais tabiring, Lais tabing	√	√	√
25	*Belontia hasselti*	Malay combtail	Ketoprak	Kapar	√	√	√
26	*Betta akarensis*	Akar betta	Melantau	Kalatau, Tampaho	√	√	√
27	*Betta anabantoides*	Giant betta	Melantau	Sambaling, Kalatau, Tampaho	√	√	√
28	*Betta dimidiata*		Melantau	Kalatau	√	√	√
29	*Betta edithae*			Tampaho	–	–	√
30	*Betta picta*	Spotted betta	Betah, Tampele	Kalatau	√	√	√
31	*Betta rubra*			Tampalo	–	–	–
32	*Betta unimaculata*	Howong betta	Cupang	Tampalo	–	–	√
33	*Betta waseri*		Cupang	Tampalo	√	√	√
34	*Boraras merah*			Seluang habang	–	–	–
35	*Breitensteinia*			Ikan buta	–	–	–
36	*Ceratoglanis scleronema*		Lais hitam	Katatupung	√	–	√
37	*Chaca bankanensis*	Angler catfish	Tuka	Sampadiung	√	–	√
38	*Channa gachua*	Murrel		Kehung, Ruwan	√	√	√
39	*Channa lucius*	Murrel		Kosok, Mihau	√	√	√
40	*Channa marulioides*			Kemancung	√	√	√
41	*Channa melanoptera*	Murrel	Kehung	Kihung	√	√	√
42	*Channa melasoma*	Black snakehead		Peyang	√	√	√
43	*Channa micropeltes*	Giant snakehead	Toman	Tauman, Ngulur	√	√	√
44	*Channa pleurophthalmus*		Kerandang	Karandang	√	√	√
45	*Channa striata*	Snakehead murrel	Gabus	Haruan, Behau, Urun	√	√	√

No.	*Scientific name*	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
46	*Chela laubuca*	Indian glass barb		Tandrapis, Lalangsi	√	–	√
47	*Chela maassi*			Tandrapis	√	–	–
48	*Chelonodon patoca*	Milkspotted puffer		Buntal merah	–	–	–
49	*Chitala lopis*	Giant featherback	Plasatu, platu	Pipih, Lempor	√	√	√
50	*Chonerhinos modestus*			Buntal	√	–	–
51	*Chonerhinos remotus*			Buntal	√	–	–
52	*Chromobotia macracanthus*	Clown loach	Langli, Botia	Junu, Tangkari, Ikan macan	√	–	√
53	*Cirrhinus chinensis*	Chinese mud carp		Banta	√	–	–
54	*Clarias batrachus*	Black skin catfish	Lele lokal	Pentet pendek, Katoi	√	√	√
55	*Clarias meladerma*	Black skin catfish	Ikan duri, Wais	Pintet	√	√	√
56	*Clarias nieuhoffi*		Lele, Liwes	Pentet	√	√	√
57	*Clupeichthys bleekeri*	Kapuas river sprat		Pelatuk air	√	√	–
58	*Colossoma macropomum*	Tambaqui		Bawal air tawar	√	√	√
59	*Cosmochilus falcifer*			Salop	–	–	–
60	*Crossocheilus cobitis*		Lokas, Pedan laran	Tempujuan	–	–	–
61	*Crossocheilus nigriloba*			Susur	–	–	–
62	*Crossocheilus oblongus*	Siamese flying fox	Lokas, Lukas	Ali biasa, Banta	–	–	–
63	*Cyclocheilichthys apogon*	Beardless barb		Puhing, Kepras, Rangawan, Balam	√	√	√
64	*Cyclocheilichthys armatus*			Puhing	√	–	√
65	*Cyclocheilichthys enoplus*		Tawes	Puhing	√	–	√
66	*Cyclocheilichthys furcatus*			Sababuluh	√	√	√
67	*Cyclocheilichthys janthochir*			Habang-habang, Puhing Kahui	√	–	√
68	*Cyclocheilichthys microlepis*		Jelawat batu	Kelabau	√	–	√
69	*Cyclocheilichthys repasson*			Puhing	√	√	–
70	*Cyclocheilichthys heteronema*			Sabuluh	√	–	–
71	*Cynoglosus bornensis*	Tonguefishes	Ikan lidah	Upak pusu, Kerarau	–	–	√
72	*Cyprinus carpio*	Common carp	Ikan mas, Mas massan	Ikan mas	√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
73	*Datnioides microlepis*	Finescale tigerfish	Ringan	Sasumpit	–	–	–
74	*Dermogenys montana*			Jeluyung, Jejulung	–	–	–
75	*Doiichthys novaeguineae*	Spoon-snouted catfish		Sapapirang	√	–	–
76	*Doryichthys heterosoma*			Tetilo buaya	–	–	–
77	*Elops machnata*	Tenpounder	Menangin	Kakapas, Bandeng sungai	√	√	–
78	*Epalzeorhynchos kalopterus*	Flying fox	Tawes	Banta, Rangkang, Kompas	–	–	–
79	*Gastromyzon borneensis*		Tapa bulu	Kalalam	–	–	–
80	*Gastromyzon contractus*			Kalalam	–	–	–
81	*Gastromyzon ctenocephalus*			Kedompang ari	–	–	–
82	*Gastromyzon fasciatus*			Kedompang somah	–	–	–
83	*Hampala bimaculata*		Dungan	Ampunoang	√	√	√
84	*Hampala macrolepidota*	Hampala barb	Dungan	Manjuhan, Adungan	√	√	√
85	*Helostoma temminckii*	Kissing gourami	Tambakan	Biawan, Tabakang	√	√	√
86	*Hemibagrus nemurus*	Asian redtail catfish	Baung putih, Duri	Baung sungai, Pantik	√	√	√
87	*Hemibagrus wyckii*		Baung	Tingeu, Baung burai	√	√	√
88	*Hemirhamphodon chrysopunctatus*			Luting, Janjau	–	–	–
89	*Hemirhamphodon phaisoma*		Julung-julung	Julung-julung	√	√	√
90	*Hemisilurus heterorhynchus*	Sheatfishs	Jambal	Lais	√	√	√
91	*Himantura signifer*	White-edge freshwater whip	Pari tawar	Pahi	–	–	–
92	*Hippichthys cyanospilos*	Blue-spotted pipefish		Junjuk	–	–	–
93	*Homaloptera ophiolepis*		Selusur		–	–	–
94	*Homaloptera orthogoniata*			Sebayan	–	–	–
95	*Homaloptera stephensoni*	Angler catfishes		Wakat letek	–	–	–
96	*Homaloptera tweediei*			Baung tikus	–	–	–
97	*Homaloptera zollingeri*		Selusur, Selusur	Kelarang mentau	–	–	–
98	*Kryptopterus apogon*		Lais timah	Lais timah, Bentilap	√	√	√
99	*Kryptopterus bicirrhis*	Glass catfish	Lais limpok	Lais kaca	√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
100	*Kryptopterus cryptopterus*		Lais	Lais tunggul	√	√	√
101	*Kryptopterus hexapterus*		Lais putih	Lais	√	√	√
102	*Kryptopterus lais*		Lais	Lais bulu	√	√	√
103	*Kryptopterus limpok*		Lais kerak	Lais kerak	√	√	√
104	*Kryptopterus macrocephalus*	Striped glass catfish	Lais	Lais hitam	√	√	√
105	*Kryptopterus micronema*		Limpok, Lais	Lais jungang	√	√	–
106	*Kryptopterus minor*	Ghost catfish		Lais kaca, Krepesan	√	√	√
107	*Kryptopterus palembangensis*		Lais	Lais baji	√	√	–
108	*Kryptopterus parvanalis*		Lais	Lais bamban	√	√	√
109	*Kryptopterus schilbeides*		Lais kuning	Lais putih	√	√	√
110	*Labiobarbus fasciatus*		Masik	Daun towu, Dawen tebu	√	–	√
111	*Labiobarbus festivus*	Signal barb	Tawes	Masau, Ketulai bunga, Parau sasak	–	–	–
112	*Labiobarbus leptocheila*		Lokas, Wader, Wagat	Ketulai batu	√	–	–
113	*Labiobarbus ocellatus*		Lamba	Gandaria, Masau	√	–	√
114	*Laides hexanema*		Lais jengot	Oyam parei	√	√	√
115	*Leiocassis micropogon*		Tugok	Tongir	–	–	–
116	*Leiocassis fuscus*			Baung kembang	–	–	–
117	*Leiocassis poecilopterus*		Baung duri	Klasso	√	√	√
118	*Leptobarbus hoevenii*	Mad barb	Jelawat	Jelawat	√	√	√
119	*Leptobarbus melanopterus*		Bundung	Jelawat danau	√	–	√
120	*Lobocheilos falcifer*			Puit burei, Pangkulan	√	–	–
121	*Luciocephalus pulcher*	Pikehead	Ikan buaya	Jangjulung, Tumbu ramer	√	√	√
122	*Luciosoma bleekeri*			Juah	√	√	–
123	*Luciosoma pellegrinii*			Juah	√	–	–
124	*Luciosoma setigerum*	Apollo sharkminow	Wader	Juah, Lengkuaran	√	–	–
125	*Luciosoma spilopleura*	Apollo sharkminow		Ruwai, Lanjuar	–	–	–
126	*Luciosoma trinema*		Juajo	Juar, Juwan, Lengkuaran	√	–	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
127	*Macrochirichthys macrochirus*		Timah-timah	Parang-parang, Pamparang, Lalansi	–	–	–
128	*Macrognathus aculeatus*	Lesser spiny eel	Berod	Kili-kili, Cecili	√	√	√
129	*Macrognathus siamensis*	Peacock eel	Berod	Joli	√	√	√
130	*Mastacembelus erythrotaenia*	Fire eel	Kili-kili	Telan patak	√	√	√
131	*Mastacembelus notophthalmus*			Telan patak	√	–	√
132	*Mastacembelus unicolor*		Kili-kili	Leleu, Telan	√	√	–
133	*Micronema micronema*		Lais jungang	Lais jungang	√	√	√
134	*Monopterus albus*	Swamp eel	Belut	Lindung, walut	√	√	√
135	*Mystus albolineatus*		Baung	Sanggiringan	√	√	√
136	*Mystus atrifasciatus*		Baung	Sanggiringan	√	√	√
137	*Mystus bimaculatus*		Baung	Baung	√	√	√
138	*Mystus bocourti*		Baung	Sanggiringan	√	√	√
139	*Mystus gulio*	Long whiskers catfish	Getting, Keting, Lundu	Baung burai	√	√	√
140	*Mystus micracanthus*	Two spotcatfish	Baung	Baung	√	√	√
141	*Mystus mysticetus*		Baung	Sanggiringan	√	√	√
142	*Mystus nigriceps*		Singaringan	Baung Sangiring, Senggiringan	√	√	√
143	*Mystus singaringan*		Baung	Sanggiringan	√	√	√
144	*Nandus nebolusus*	Bornean leaffish	Temburut	Tatawun, Bambuk	–	–	–
145	*Nemacheilus kapuasensis*			Wakat lesek	–	–	–
146	*Nemacheilus lactogeneus*			Joleo	–	–	–
147	*Nemacheilus selangoricus*			Susur batu	–	–	√
148	*Nematbramis borneensis*			Saluang gading	–	–	–
149	*Nematabramis steindachneri*			Saluang	√	√	√
150	*Neolissochilus thienemanni*			Kelabau	√	–	√
151	*Notopterus notopterus*	Bronze featherback	Kapirat	Belida merah	√	√	√
152	*Ompok eugeneiatus*		Lais nipah		√	√	√
153	*Ompok hypothalmus*		Limpok, Lais	Lais bantut	√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
154	*Ompok miostoma*		Wagal	Tapah	√	√	√
155	*Oreochromis mossambicus*	Mozambique tilapia	Mujair	Mujair	√	√	√
156	*Oreochromis niloticus niloticus*	Nile tilapia	Nila	Nila	√	√	√
157	*Osphronemus gouramy*	Giant gouramy	Gurami	Kalui	√	√	√
158	*Osteochilus borneensis*			Paloe, Palau, Parau	√	–	–
159	*Osteochilus chini*			Banta	√	√	√
160	*Osteochilus enneaporus*			Banta	√	√	√
161	*Osteochilus hasseltii*	Silver sharkminnow	Mellem, Wader, Molem	Paloe, Palau, Parau	√	√	√
162	*Osteochilus ingeri*			Banta	√	–	–
163	*Osteochilus kahajanensis*			Banta, Banto	√	√	–
164	*Osteochilus kappenii*		Kelajang	Banta	√	√	√
165	*Osteochilus kelabau*		Kelabau		√	√	√
166	*Osteochilus melanopleurus*		Kelabau padi	Kelabau	√	√	√
167	*Osteochilus microcephalus*		Tawes	Banta, Pahiau batuling	√	√	√
168	*Osteochilus pentalineatus*		Tawes	Tembayuk	√	√	√
169	*Osteochilus repang*		Repang	Repang	–	–	√
170	*Osteochilus schlegelii*		Kenali	Pateno tewu	–	√	√
171	*Osteochilus spilurus*			Banta	–	√	√
172	*Osteochilus triporos*			Pahiau, Banta	√	√	√
173	*Osteochilus vittatus*	Bonylip barb	Menangin	Menangin	√	√	–
174	*Osteochilus waandersii*		Tawes, umpan-umpan	Banta	–	–	–
175	*Oxyeleotris marmorata*	Marbled goby	Betutu	Bakut	√	√	√
176	*Oxyeleotris urophthalmoides*			Tompaho	–	√	√
177	*Oxygaster anomalura*		Seluang	Lauk tipis	–	–	√
178	*Pangasius djambal*	Yellowtail catfish	Jambal	Patin	√	√	√
179	*Pangasius hypopthalmus*	Sutchi catfish	Jambal	Jambal siam	√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
180	*Pangasius lithostoma*			Lawang	√	√	√
181	*Pangasius macronema*		Riu	Riu	√	√	√
182	*Pangasius nasutus*		Patin	Patin	√	√	√
183	*Pangasius polyuranodon*		Sadarin	Sadaring	√	√	√
184	*Pangio semicincta*			Patah golak	–	–	–
185	*Parachela hypophthalmus*			Tandrapis	√	√	√
186	*Parachela maculicauda*			Tarapis	√	–	–
187	*Parachela oxygastroides*	Glass fish	Kelampok, Waderpari	Daun jinggah, Lalang	√	–	–
188	*Parachela siamensis*			Tandrapis	√	√	√
189	*Parailia somalensis*	Somalia glass catfish		Lais riu	√	√	√
190	*Parambassis macrolepis*		Bengak kenari	Babaga	√	√	–
191	*Parambassis siamensis*			Baga-baga	√	√	–
192	*Parambassis wolfi*	Duskyfin glassy perchlet	Serinding	Ikan kaca, Baga-baga, Bambaga	√	√	–
193	*Parapocryptes serperaster*			Sunduk pasir	–	–	–
194	*Parosphromenos linkei*		Melantau	Kelatau	√	√	√
195	*Polymenus melanochir melanochir*	Black hand paradise fish	Kurau	Baruyung	√	√	√
196	*Pristolepis fasciata*	Catopra	Ikan tempeh	Patung, Sepatung	√	√	√
197	*Pristolopis grooti*	Indonesia leaffish		Patung	√	√	√
198	*Pseudeutropius brachypopterus*		Riu	Riu, Nuayang	√	–	√
199	*Pseudeutropius moolenburghae*		Beringit	Riu	√	–	√
200	*Pseudomystus inornatus*				√	–	√
201	*Pseudomystus moeschii*			Rumis kajang	√	√	√
202	*Pseudomystus myersi*			Rumis kajang	√	√	√
203	*Pseudomystus stenomus*		Baung burai		√	√	√
204	*Puntioplites bulu*		Bulu-bulu	Sanggang	√	√	√
205	*Puntioplites falcifer*			Salap	√	–	√
206	*Puntioplites waandersi*		Pahat, Kepiat	Sanggang	√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
207	*Puntius anchisporus*		Berbaju	Banbedang	–	–	–
208	*Puntius bantolanensis*			Adungan	√	√	√
209	*Puntius binolatus*	Spotted barb	Bilak, Klemar	Baan, Paro	–	–	–
210	*Puntius endecanalis*			Mangas	–	–	–
211	*Puntius everetti*	Clown barb			–	–	–
212	*Puntius fasciatus*	Melon barb	Saluang		√	√	√
213	*Puntius foerschi*			Tembalang	–	–	–
214	*Puntius johorensis*	Striped barb	Seluang	Tembayuk	√	–	√
215	*Puntius lateristriga*	Spanner barb	Dokun	Berombang	√	√	√
216	*Puntius lineatus*	Lined barb		Bembayok	√	√	√
217	*Puntius partipentazona*			Lampam	√	√	√
218	*Puntius rhomboocellatus*			Banta	√	–	–
219	*Puntius tetrazona*	Sumatra barb	Ikan baja		–	–	–
220	*Rasbora argyrotaenia*	Silver rasbora	Lunjar pareh, Waderpari	Seluang balu	√	√	√
221	*Rasbora bankanensis*			Seluang sungai	√	√	√
222	*Rasbora borneensis*			Seluang	√	√	√
223	*Rasbora caudimaculata*	Greater scissortail	Rasbora	Seluang	√	√	√
224	*Rasbora cephalotaenia*			Seluang, Bada	√	√	√
225	*Rasbora dorsiocellata*	Eyespot rasbora			√	√	√
226	*Rasbora dusonensis*	Rosefin rasbora	Bilis	Seluang	√	√	√
227	*Rasbora einthovenii*	Brilliant rasbora	Sulir batang	Seluang	√	√	√
228	*Rasbora elegans*	Twospot rasbora		Seluang	√	√	√
229	*Rasbora gracilis*				√	√	√
230	*Rasbora kalochroma*	Clown rasbora			√	√	√
231	*Rasbora pauciperforata*	Redstripe rasbora		Seluang	√	√	√
232	*Rasbora rutteni*				√	√	√

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
233	*Rasbora spilocerca*	Dwarf scissortail rasbora		Seluang	√	√	√
234	*Rasbora trifasciata*			Seluang	√	√	√
235	*Rasbora trilineata*	Three-lined rasbora	Pantau bana, Seluang	Seluang	√	√	√
236	*Rohteichthys microlepis*		Lumbut	Bilap danau	√	√	√
237	*Scleropages formosus*	Asian bonytongue	Arwana, Siluk	Kalikasa, Tangkalasa	√	√	√
238	*Silurichthys hasseltii*			Lier	√	–	√
239	*Silurichthys phaisoma*			Tampahas	√	–	√
240	*Sphaerichthys acrostoma*				√	–	–
241	*Sphaerichthys osphromenoides*	Chocolate gourami		Sasumpit	√	–	√
242	*Sphaerichthys selatanensis*				√	√	–
243	*Sphaerichthys vaillanti*			Sasumpit	√	–	√
244	*Sphoeroides lunaris*			Buntal	√	–	–
245	*Strongylura strongylura*	Spottail needlefish	Jolong-jolong, Ioncong	Julung-julung	–	–	–
246	*Sundadanio axelrodi*				–	–	–
247	*Syncrossus hymenophysa*	Tiger loach	Botia, Langli	Juling, Belukuh, Susur batu laki, Jajiut	√	√	√
248	*Syncrossus reversa*		Langli, Botia	Kangkari, Tangkari, Junu, Ikan macan	√	√	√
249	*Tetraodon biocellatus*	Eyespot pufferfish		Buntal	√	√	√
250	*Tetraodon kretamensis*			Buntal	√	√	√
251	*Tetraodon leiurus*				√	√	–
252	*Tetraodon palembangensis*			Buntal	√	–	–
253	*Thynnichthys polylepis*			Menangin	√	√	√
254	*Thynnichthys thynnoides*		Mentukan, Ringo	Biis	√	√	√
255	*Tor douronensis*	River carp	Kancera	Kumut	–	–	–
256	*Tor soro*			Lumi	–	–	–
257	*Tor tambra*		Sengkareng, Tambera	Somah	–	–	–

No.	Scientific name	Common name	Indonesian name	Local name	Pulang Pisau	Kapuas	Barito Selatan
258	*Tor tambroides*	Thai mahseer	Garing, sengkareng	Sapan, Bungon lataan	–	–	–
259	*Toxotes jaculatrix*	Banded archerfish	Archerfish	Sasumpit	√	–	√
260	*Trichogaster leerii*	Pearl gourami		Sepat hijau	√	√	√
261	*Trichogaster microlepis*	Moonlight gourami		Sepat	√	√	√
262	*Trichogaster pectoralis*	Snakeskin gourami	Sepat siam, Siem	Sepat layang	√	√	√
263	*Trichogaster trichopterus*	Three spot gourami	Sepat jawa, sepat iju	Sepat	√	√	√
264	*Wallago leerii*		Tapah	Tapah	√	√	√
265	*Wallago attu*		Tapah	Tapah	√	√	√
266	*Xenentodon canciloides*		Julung-julung	Isuh, jajulung	√	√	√
267	*Zenarchopterus dispar*	Feathered river-garfish	Kajangan	Julung-julung	√	√	√
	Total species per district				202	162	180

Source: Adapted from Laporan Akhir Jurnal Studi Potensi Ikan Hias Perairan Umum Kalimantan Tengah, Dinas Kelautan dan Perikanan Provinsi Kalimantan Tengah, 2007.

Note: √ = Species is found in the district

− = Species is not found in the district

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