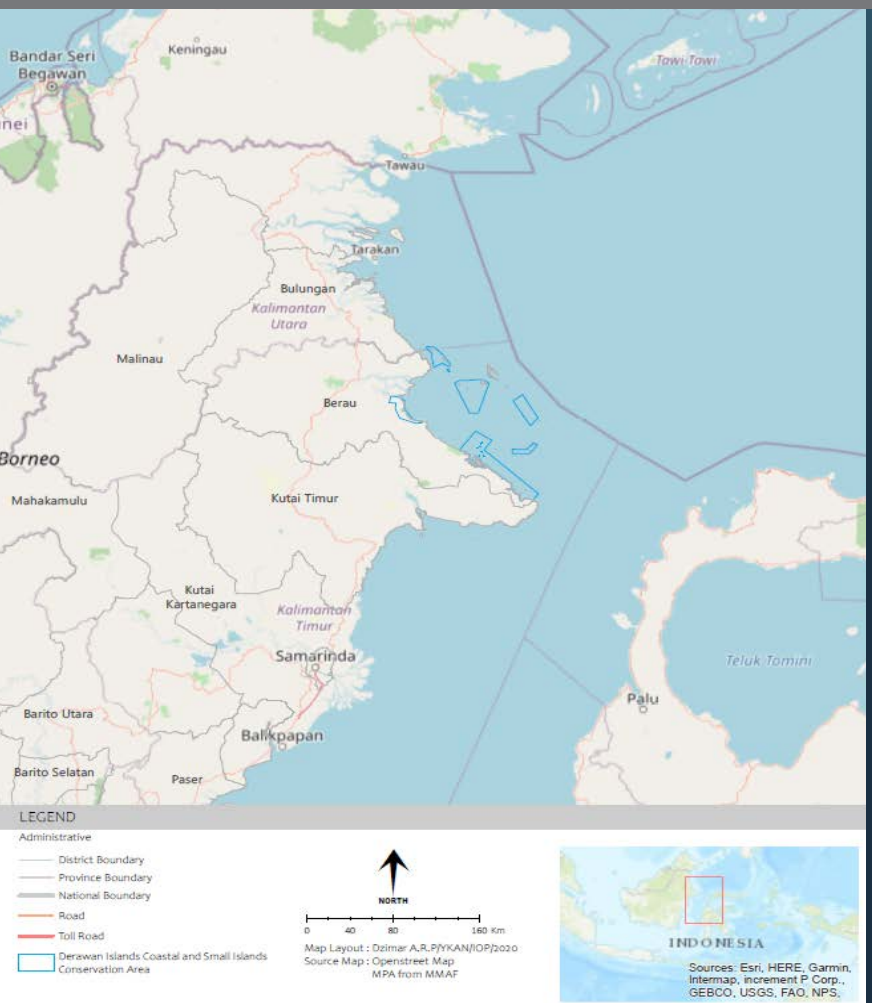
IUCN Aquaculture and Marine Conservation

INDONESIA CASE STUDY
Brackish Water Pond Polyculture in Mangrove Areas in the Marine Protected Area of Derawan Islands and Surrounding Waters



Situation map of the location of Coastal and Small Islands Conservation Area (KKP3K) of the Derawan Islands and Surrounding Waters (KDPS)

Shrimp ponds in Berau regent © YKAN

"This third case study is about brackish water pond culture in mangrove areas and marine protected areas (MPAs). Mangrove ecosystems are key for many species and provide important ecosystem services. Pond aquaculture is a key activity for local communities in terms of sustainable development and food security. For meeting the Convention on Biological Diversity post-2020 global biodiversity framework as well as the Sustainable Development Goals (SDGs) by 2030, it is necessary to identify synergies and opportunities between marine conservation and sustainable local economic activities such as aquaculture. Small scale, extensive, multi-species pond aquaculture is a relevant and robust type of aquaculture for meeting the development needs of local communities while not hampering mangrove, seagrass bed and coral reefs conservation efforts. MPAs are providing natural resources conservation and support sustainable development."

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Contents

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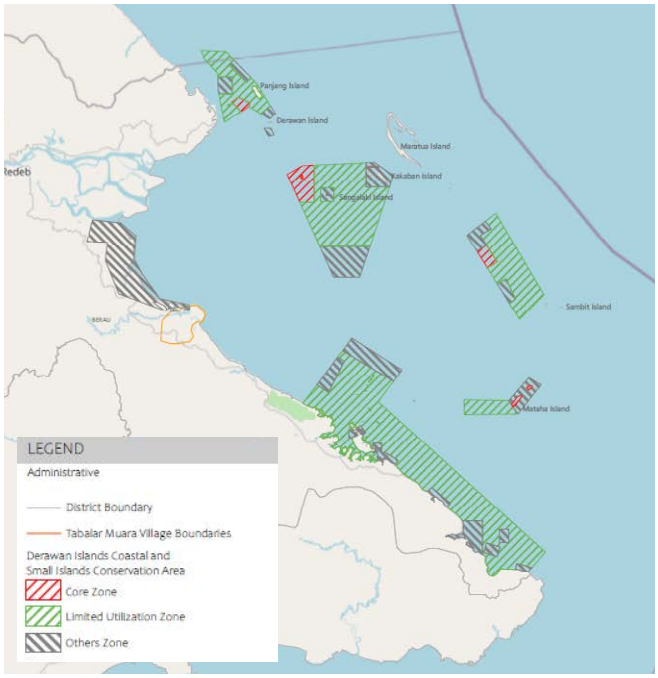
MPA short description

The Marine Protected Area in the Derawan Islands is called the Coastal and Small Islands Conservation Area (KKP3K) of the Derawan Islands and Surrounding Waters (KDPS). It was formerly established on 30 December 2016, by the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia, Susi Pudjiastuti, after a procedure started in 2013 (ref background paper) (Berau Regency, 2014). Administratively, KKP3K KDPS covers an area of about 285,549 hectares located in Berau Regency, East Kalimantan.

KKP3K KDPS was formed with the aim of managing the resources of coastal areas and small islands in a sustainable manner, especially for capture fisheries and the marine tourism sector. In addition, KKP3K KDPS is included in the Government of Indonesia's commitment to reach the target of 30 million hectares of coastal and marine conservation areas by 2030.

KKP3K KDPS has a Management and Zoning Plan that has been in effect for 20 years, defining various zones with different protection status and allowed activities (link Table in background document). The present Zoning Management Plan (2019-2039) is enforced by the Governor of East Kalimantan. KKP3K KDPS zoning consists of a "Core Zone" (3.4%), a "Limited use zone" (28.2%) and an "Other zone" (64.9%).



Zone mapping in the Marine Protected Area in the Derawan Islands, called the Coastal and Small Islands Conservation Area (KKP3K) of the Derawan Islands and Surrounding Waters (KDPS)

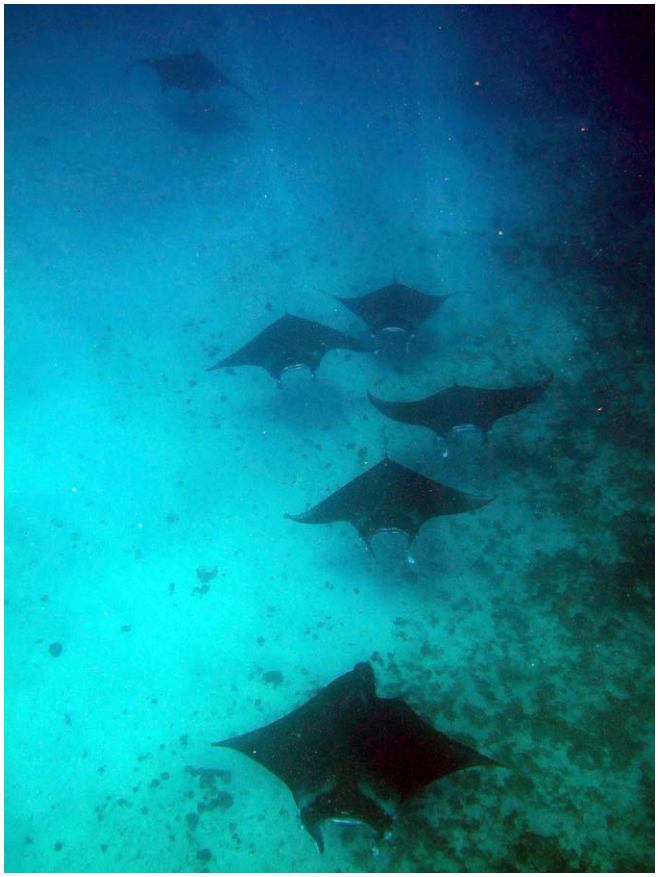
Main MPA and aquaculture facts

MPA	**Type (IUCN[1] category)**	Three main zones in % of total surface: Core zone (3.4%, IUCN Cat. I), Limited use zone (28.2%, IUCN Cat. V and VI) and Other zone (64.9% IUCN Cat. VI).
	Surface area	About 285,549 ha
	Creation date	30 December 2016
	National status	Public
Aquaculture	**Type**	Traditional (monoculture and polyculture in brackish water earthen ponds), extensive type, unfed, various species of shrimp, including tiger shrimp (*Peneus monodon*), milkfish (*Chanos chanos*), mud crabs and mullets. One or two cycles/year.
	Surface	About 522 ha in the MPA (YKAN GIS Analysis, 2020).
	Creation date	Start in 1982, then abandoned, and re-started in 2013.
	Organization type Investors, ownership, capital, shareholders	Local communities: 34 farmers, mostly operating under the group named "Rantau Tarik", in the vicinity of Tabalar Muara, Berau regency. Investors from other provinces: around 10%; financial and technical regional support. Shrimps mainly to export markets, other species for local markets and households.
	Production	In 2020, tiger shrimp: 52 tonnes for almost 5,978 million Indonesian Rupiah (US$ 427,143), milkfish: 261 tonnes almost 3,653 million Indonesian Rupiah (US$ 260,960).

1 IUCN uses seven MPA categories:

Protected area category and International name	Management objectives	
Ia - Strict Nature Reserve	Managed mainly	for science
Ib - Wilderness Area		to protect wilderness qualities
II - National Park		for ecosystem protection and recreation
III - Natural Monument		for conservation of specific natural/cultural features
IV - Habitat / Species Management Area		for conservation through management intervention
V - Protected Landscape / Seascape		for conservation and recreation
VI - Managed Resource Protected Area		for the sustainable use of natural ecosystem

Surveys conducted in 2005 identified 872 species of reef fish from 287 genera and 77 families (Wiryawan et al, 2005). In these waters, the presence was observed of several remarkable rare species such as pygmy seahorse (*Hyppocampus bargibanti*) and giant manta rays (*Manta birostris*). In addition, eight marine mammal species and eight seagrass species were also described.



Manta ray (*Manta birostris*) in Berau © YKAN

Coral Reefs

The types of coral reefs in the coastal areas and small islands of Berau Regency consist of fringing reefs, barrier reefs and atolls. Some atolls have formed into islands and some have formed into saltwater lakes. Studies confirmed the exceptional biodiversity of hard, soft, and fungal corals in this area (Hoeksema, 2004; Ofwegen et al., 2004; Wiryawan et al., 2005). For instance, the waters of Berau Regency are among the richest areas for soft coral species in the western Indo-Pacific (Ofwegen et al., 2004). The corals are exhibiting various degrees of damage due to bad fishing practices such as bombs and poisons, which are prohibited but still recorded. Irresponsible tourism practices also induce significant impacts to coral reefs. In addition, the impact of global warming is a threat factor that has started to cause coral bleaching (Chumkiew et al., 2011).

Coral reefs in Sankgalaki © YKAN

Seagrass

Seagrass beds are found throughout the KDPS KKP3K under different conditions, with an average cover of 10-80% in the area (Kuriandewa et al., 2003; Wiryawan et al., 2005). Seagrass beds are more abundant in shallow, well-flooded and protected waters around the islands (high cover area of 20-80%), as compared to mainland, characterized by more turbid and disturbed coastal waters (low cover <10%). Major threats on seagrass beds in the KKP3K KDPS are associated to a sedimentation process due to land clearing from the upstream rivers. In addition, the construction of jetties and homestays in the seagrass area, as well as effluents and domestic waste pollution from the settlements of island residents that flow into the seagrass ecosystem, are major contributors to water quality degradation impacting seagrass beds. Although seagrass habitats are recognized as essential for numerous ecosystems services (Nordlunda et al., 2018), seagrass restoration and conservation efforts have not (yet) been carried out in this MPA.

Mangrove

A 2018 study measured the area of mangroves in Berau Regency at 86,087 ha, located in coastal and small islands (Agus et al., 2019). The mangrove ecosystems in KKP3K KDPS covers 22,213 ha, representing about 25% of the mangrove area in Berau Regency. This area is the largest mangrove in East Kalimantan Province. The distribution of the mangrove genus in Berau Regency is categorized into five main groups. The largest genus distribution is obtained from the Rhizophora class (21,406 ha) (Agus et al., 2019), followed by mixed mangrove types (21,303 ha).

Mangrove forests in Berau Regency are still mostly in natural condition. However, in some locations, mangrove zones were transformed into other uses such as shrimp ponds or other activities, construction of road infrastructure, settlements, rice fields, and ports. Other threats on mangrove are associated with pollution from domestic and palm oil industrial wastes. However, in some places where the activity was abandoned (for instance, shrimp ponds), a natural regeneration of mangrove was observed (Agus et al., 2019).

Turtle, jellyfish and mammals

The Berau coastal region is a major green turtle nesting site (*Chelonia mydas*) (Reischig, 2012), threatened by egg vandalism and illegal sea turtle capture for scales trading and meat consumption. The KKP3K KDPS area includes a very unique salt lake on Kakaban Island, habitat for four species of endemic jellyfish, jeopardized by irresponsible tourism practices. KKP3 KDPS is also a migration corridor for at least ten species of marine mammals in the Berau watershed, consisting of five species of whales and five dolphin species. But intentional and unintentional capture also occurs in manta rays, sharks and marine mammals.

Green Turtle (*Chelonia mydas*) nesting © YKAN

MPA management

In 2018, the East Kalimantan Provincial Government created a transitional management institution called the KKP3K KDPS Task Force[2]. The Task Force is led *ex officio* by the Head of the Marine Spatial Administration of the East Kalimantan Marine and Fisheries Agency, with members consisting of representatives from the Berau District Government, Universities, and Non-Government Organizations (NGO). Local communities (fishers, villagers) are not part of the Task Force, but they are consulted for the elaboration of the programme.

Apart from being an organization that assumes management responsibilities during the transitional period, the Task Force has the main task of encouraging the establishment of a definitive management agency at the level of a Regional Technical Implementation Unit under the East Kalimantan Marine and Fisheries Agency. Since the Task Force was formed, various activities have been carried out, including the KKP3K KDPS Management and Zoning Plan, compiling academic texts and consulting with the Ministry of Domestic Affairs, which has the authority to grant permits for the formation of the Regional Technical Implementation Unit.

2 Through the Governor of East Kalimantan Regulation No.523.13 / K.103 / 2018, dated February 28, 2018

The source of funding for the Task Force's activities comes from the East Kalimantan Province Regional Budget and contributions from the NGO, The Nature Conservancy, as a member of the Task Force. Currently, no taxes or entrance fees are applied in the MPA, which is mostly financed with the East Kalimantan provincial budget supplemented with a national budget and NGO funds. The Provincial Government of East Kalimantan is preparing an Operational Standard for a management institution, as a requirement for proposing the formation of a Regional Technical Implementation Unit for the KKP3K KDPS, and which is still under consultation and should be released in the near future.

The Provincial Government of East Kalimantan has shown its commitment to managing KKP3K KDPS through the Regional Technical Implementation Unit by building a Regional Technical Implementation Unit office in Tanjung Batu Village, Pulau Derawan District, Berau Regency. In addition to building an office, the East Kalimantan Provincial Marine and Fisheries Office has assigned one contract employee for office operational work. There are no specific rangers and guards for the MPA. The sea area is controlled through routine patrols by the Marine and Fisheries Resource Surveillance Directorate of Marine and Fisheries Ministry (MMAF), the Marine and Fisheries Agency of East Kalimantan, the Navy and the Police. There are also fishers' community initiatives to report destructive fishing and other illegal practices to the patrols. At present, the establishment of an MPA management unit is still pending. The government is anticipating finalizing it in 2021.

Activities and resource use in the MPA

The KDPS KKP3K is administratively located in and around the village areas. There are at least 18 villages around the KKP3K KDPS area, organized under six sub-regencies (sub-districts), a total of 72,600 inhabitants (Table 2).

Most people in the villages are active in KKP3K KDPS as fishers (69%), shrimp pond farmers (19-20%) and tour guides and boat drivers. Agricultural production mainly involves growing rice.

Table 2: Numbers of people/household base on livelihood per sub regency around KKP3K KDPS

Sub Regency	Villagers	Fishermen	Shrimp farmers	Restaurants	Accommodations	Speed boats
Tabalar	7,300	380	35	2	2	
Pulau Derawan	9,200	580	520	10	130	60
Maratua	4,000	280		5	110	30
Biduk-Biduk	6,700	680		3	24	
Batu Putih	8,600	300		2	2	
Sambaliung	36,800	170	80	6	2	20
Talisayan	12,000	250		7	2	
Biatan	8,000	160	10	5	3	
Total	72,600	2,800	635	28	275	110

Source: Berau Tourism Agency, 2018; Berau Fisheries Agency, 2019 and Statistic Agency, 2020.

Capture Fisheries

Capture fisheries in the conservation area are dominated by small-scale and artisanal fisheries operating with boats and fishing rods, traps, and gill nets. The government only regulates large fishing boat operations (more than 10 gross ton). Small fishing boats (less than 10 gross ton) are considered as traditional fishing, thus, not regulated. There is an indication that

overexploitation of the fish stocks is occurring, but statistics are not sufficient to determine the status of the stocks. Fishers operating in the KKP3K KDPS catch fish (barramundi, treadfin beams, yellow tail, gulamah, croakers, black pomfret, white pomfret, great barracuda, rays), shrimp and crabs (Berau Fisheries Agency, 2019). At least 50% of the total fishers carry out fishing activities in the KKP3K KDPS "Limited use zone" and "Other use" zones.

Capture fisheries production amounted to 20,500 tonnes in 2019 with an economic value of 1,025 billion Indonesian Rupiah (US$ 73 million). The production has been steadily increasing since 2012, except in 2015. Most of the captured fish within the area are sold on local markets either for coastal communities, tourists or for export (Malaysia). Fish are landed in official Government Fishing Ports (two auction markets, Sambaliung and Talisayan). But almost 70% of the captured fish is landed and sold in private middleman fishing ports.

Trammel net for shrimp fishing in Tabalar Muara © YKAN

Although most fishers use environmentally friendly fishing gears (fishing road, fish trap *Bubu* and gill net), destructive fishing practices are still encountered, such as the use of bombs, poison and mini trawling (tribune news 2019). Fishers from outside the Berau area are also catching fish in the KKP3K KDPS area, which may lead to conflicts with fisher communities in the Berau area. The prohibition of fishing at dive or snorkelling sites is problematic for fisher communities. On the other hand, destructive fishing practices in coral reef spots famous for diving or snorkelling, are detrimental to the reputation of these tourist sites, and tend to decrease their economic tourist attractivity.

Tourism

The KKP3K KDPS area and its surroundings are a major tourist destination for the Berau Regency. Several snorkelling and diving centres are operating in the KKP3K KDPS "Limited use zone". The Kakaban Island located in the KKP3K KDPS "Limited use zone" is an attraction for foreign and domestic tourists for its unique saltwater lake and stingless jellyfish. Apart from Kakaban, a popular tourist attraction at KKP3K KDPS is Labuan Cermin, a site resembling a lake, because of its salinity stratification, the upper surface consists of fresh water, and lower depths consist of salt water.

Tourist swimming with a stingless jellyfish (*Mastigias papua*) in the saltwater lake Kakaban © YKAN

The latest data from the Culture and Tourism Office of Berau Regency in 2018 showed that the number of tourists continues to increase from year to year. There were 286,000 tourists visiting Berau, a total number multiplied per a factor of 2.7 in four years. Whereas 94-99% are Indonesian tourists. About 50% of these tourists visit tourist destinations in KKP3K KDPS "Limited use zone" or "Other use zone". With the increase in tourist visits to the KKP3K KDPS and its surroundings, hotels, inns, and homestays have also grown, reaching a total of 220, e.g. 75% of all hotels, inns

and homestays in the region. Apart from hotels, inns and homestays, water transportation activities for tourists are also growing.

Hotel in Derawan Island © YKAN

With the high tourism activity in KKP3K KDPS and its surroundings, the potential for damage to coral reef ecosystems and rare species such as stingless jellyfish is also getting higher. In addition, speed boat oil spillages, and household wastes of hotels, inns and homestays that are not managed properly, cause damage to the ecosystem in the KKP3K KDPS area. The use of lotion, sun block, or swimming with fins in the Kakaban saltwater lake, is a serious threat to the stingless jellyfish. Various sustainable tourism education programmes are frequently carried out by the Government and NGOs to reduce the impact of damage to ecosystems and important species. No MPA specific tax or entrance fee is requested from the MPA visitors.

Research and monitoring programs

Research activities[3] at the KKP3K KDPS are generally carried out in coral reef ecosystem areas located in the “Core zone”. In addition, research in mangrove ecosystem areas and seagrass beds is conducted in the KDPS KKP3 “Limited use zone”. Apart from monitoring ecological health and damage extent, research in mangrove ecosystems and seagrass beds is focusing on sequestration of blue carbon. Another study conducted in the KKP3K KDPS is bioprospecting mangroves for anti-cancer and anti-oxidizing drugs. An assessment of the suitability of land-based ponds in the mangrove area has also been carried out. Besides research on ecosystems, regular data collection for endangered and protected species such as turtles is carried out at KKP3K KDPS by NGOs. Apart from biophysical research activities, socio-economic research activities in villages included in KKP3K KDPS are also ongoing, either by universities or NGOs, and thus, providing assistance to these villages.

Seagrass beds and mangrove ecosystems in Sigending @ YKAN

Research at KKP3K KDPS is beneficial to the scientific community, the MPA management team and other stakeholders. The recommendations from the research results can be a reference for better KDPS KKP3K management decisions. Furthermore, joint research at KKP3K KDPS needs to be encouraged, further involving local stakeholders, and enhancing transfer of knowledge, capacity building and local empowerment.

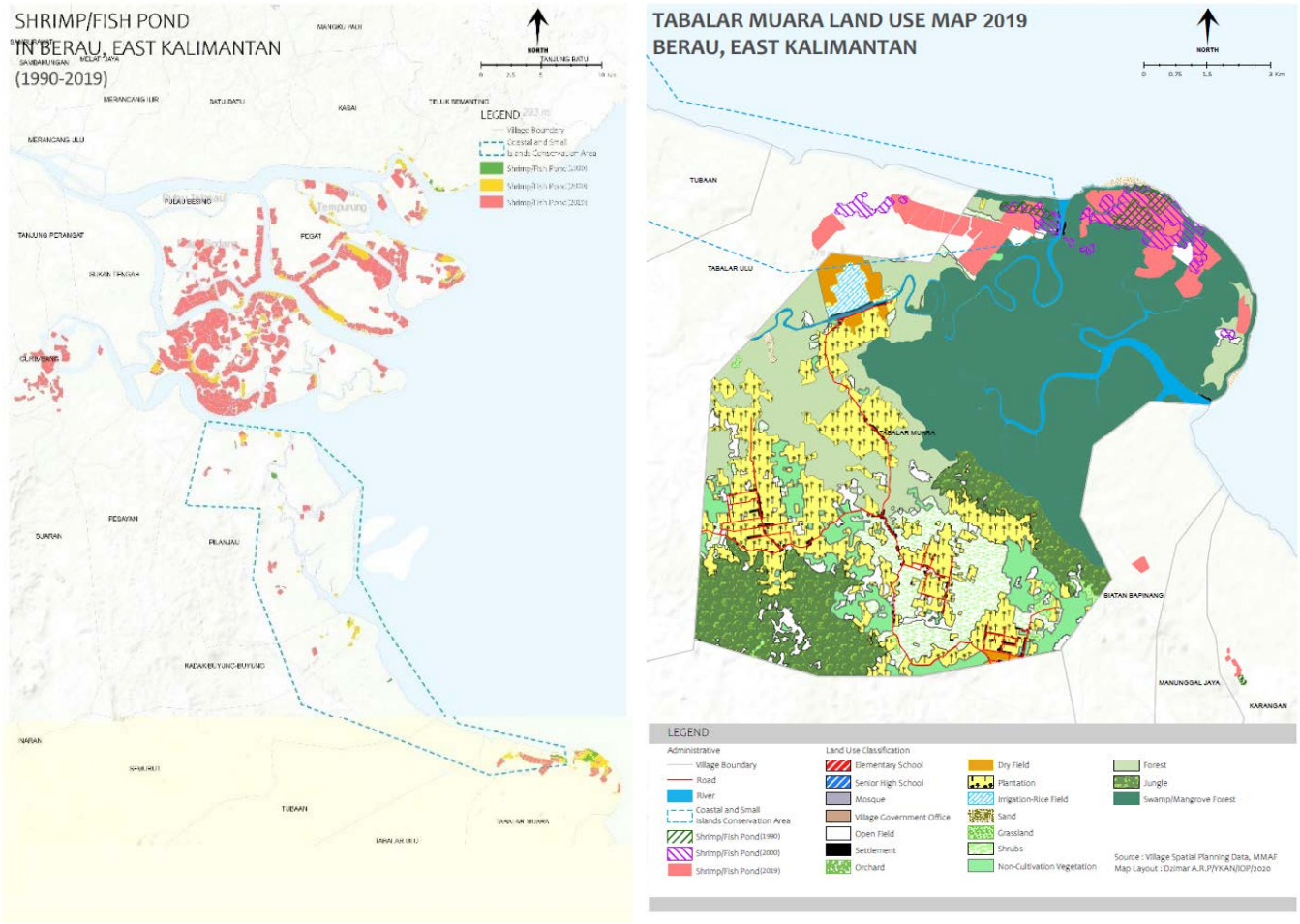
3 Research institutions and universities that conduct research at KKP3K KDPS include Mulawarman University, Bogor Agricultural Institute, Bandung Institute of Technology, Indonesian Institute of Sciences (LIPI), Centre for Marine Research and Research Institute for Brackish Water Fisheries and Fisheries Extension, Ministry of Marine Affairs and Fisheries. Republic of Indonesia, and the Southeast Asian Regional Centre for Tropical Biology (SEAMEO BIOTROP).

Aquaculture activities within the MPA

Aquaculture production is practiced in brackish water areas. The 2018 Berau Fisheries Office noted that brackish water aquaculture production in Berau Regency has increased since 2015. In 2018, pond production in Berau reached 1,843 tonnes. The aquaculture commodities at KKP3K KDPS are mainly tiger prawns (*Peneus monodon*) and milkfish (*Chanos chanos*). The brackish water aquaculture located in the KKP3K KDPS area is mostly managed by pond farmers within 34 households of the local communities of Tabalar Muara Village (Figure 3a and b). Based on data from The Nature Conservancy (Yuliantri, 2017), and Mulawarman University (Erwiantono, 2018), there are about 140-150 ha active shrimp ponds in Non-forest Estate, Conversion Production Forests, and Limited-use zones in KKP3K KDPS.

Indeed, whether these shrimp ponds are settled and managed in respect of the KKP3K KDPS MPA rules, and are environmentally friendly, are central key and sensitive questions of this document.

Shrimp farming in Tabalar Muara started in 1982 on one individual private initiative. It expanded and was gradually abandoned by 2002, for reasons linked to poor management practices and disease outbreaks causing major crop losses. In 2013, the Tabalar Muara community started a new initiative for shrimp farming, under a farmer group named “Rantau Tarik”. They were able to restore the ponds with government donations and technical supports.



Shrimp pond area, land use in the KKP3K KDPS area, and in the Berau, and in Tabalar Muara village, East Kalimantan

Production system

When the growing season starts, shrimp farmers used to spread out a pesticide (organochloride) to kill all the predators within the ponds filled with water (Box). But this practice is now illegal, and farmers are encouraged to use a natural compound, the plant-derived chemical saponin. The pond water is then fully renewed. If financially possible, farmers may buy shrimp post larvae *Penaeus monodon* and cultivate them with a stocking density of about 1-2 shrimp Post-Larvae/m^2. However, most of the time, farmers rely on natural shrimp seed from the mangrove area that is flowing freely into the pond during high tide. Milkfish fry must be purchased as it is not as abundant as shrimp natural seed.

After stocking, the next step in pond preparation is fertilization, which is optional, and usually made with urea or phosphate in liquid or solid ingredients. Farmers may also use probiotics in shrimp ponds. No extra feeds are introduced into the pond system. Partial water renewal is made every high tide. After one and a half months from the start of the growing season, the farmer may conduct partial intermediate harvests of wild shrimps, mud crabs and mullet fish. The tiger shrimp and milkfish production are harvested after three and six months, respectively. A second production cycle may be implemented during the year.

@ YKAN

All shrimp ponds in Tabalar Muara are traditionally operated, extensive, and artisanal systems, earthen ponds, wide pond embankments, natural water renewal using gravitation through a gate, both functioning as inlet and outlet. The construction of the pond and inlet/outlet system was done through a collective work of the community, the *Mappadajo*. *Mappadajo* means that the community works together to build water gates one at a time for shrimp ponds belonging to individual farmers. *Mappadajo* is one of the local customs that has been operational for decades. Ponds were generally constructed manually so that the embankments were relatively thin and low. Since 2015, the pond has been reopened again due to the availability of heavy equipment (excavators) which allow for higher, thicker, and stronger embankments. When farmers build the pond, they usually leave a central islet of mangrove trees in the middle of the shrimp pond, but these mangrove trees tend to die for the most part, due to disruption of the natural hydrology.

Box 1: Shrimp ponds, social, biodiversity and complex issues in practical terms

The past use of pesticide

The pesticide used in the past was Thiodan, a biocide that kills fish predators. But it is highly toxic to the environment, as the main active ingredient is Endosulfan, belonging to the organo-chlorides family. It used to be a "compulsive ingredient" for shrimp farmers in Tabalar Muara. This type of poison is now prohibited in Indonesia, but a few shrimp farmers may still obtain the poison from the black market in Malaysia. The farmers claim that they do not have a choice, although Thiodan is not only prohibited, but also expensive. Tea seed saponin, a natural pesticide, is still difficult to obtain at affordable prices. The government is committed to encouraging farmers to change their practices through education, training, applying the government's best aquaculture practices (Cara Budidaya Ikan yang Baik, CBIB), and via surveillance, in particular in the MPA.

Pond construction cost

Pond excavation represents 81% of the considered investments, sometimes requiring a credit system with the owner of the excavator, the "patron" *punggawa*. Shrimp farmers in Tabalar Muara need to provide a down payment of around 50% to the patron. But in some cases, the down payment can be negotiated. The rest of the excavation fees will be paid in successive payments when shrimp farmers harvest. There is no loan interest for this rental debt. But, as long as the debt is not paid off, the proceeds of the harvest must be paid to the patron. There is no formal letter about this agreement, but shrimp farmers honour it. However, some shrimp farmers complain that, although it is paid off, they still must sell the harvest to the patron as a condition of the loan.

Land tenure related to aquaculture ponds

Most, if not all, of the farmers manage onshore aquaculture ponds on land that officially belongs to the government (forest or non-forest state land). The farmers, however, claimed the ownership of the land based on a permission letter from the village head *Surat Garapan*, allowing them to transform the forest land into a pond in the 1980s, and based on the fact that their families have been the ones who first occupied the land ever since.

The situation becomes problematic, because the government does not recognize the village head permission letter, as a land ownership certificate. In fact, the aquaculture pond farming may be considered as an illegal occupation of government land. As a result, the farmers cannot access bank credits, and are worried about restoring their pond back into mangrove, fearing that the government will take over the pond as it becomes a forest again. To address this acute problem, and to give the farmer assurance of ownership status, the government is in the process of passing a new law, the Agrarian Reform Land Object (TORA). With the new law, farmers could obtain a land certificate from the government if they can prove that they have continuously managed the land for 20 years.

Economic figures

For about 56% of shrimp farmers, the shrimp farming activity is their only source of income. For the others, shrimp farming is combined with a fish trading business, a fishing activity, coconut cultivation, or cattle farming. Most shrimp farmers are now practicing polyculture in their ponds, featuring several species of shrimp alongside milkfish (*Chanos chanos*) mud crabs, and mullets. According to a focus group discussion with shrimp farmers (Yuliantri, 2017), the choice between monoculture and polyculture, and the choice of species is opportunistic, depending on the funds available to buy seed. If the available fund is sufficient to buy tiger shrimp and milkfish seed, farmers will opt for the cultivation of two species at least. Usually, farmers sell shrimp, both tiger and wild shrimp, mud crabs, and milkfish for an income. Often, the lower-quality mud crabs and shrimp, mullet and other wild fish will be for family or neighbouring household consumption.

The most significant investment cost for shrimp farmers is related to the pond construction, particularly if costly excavating equipment must be negotiated, replacing the traditional manual work of the past (Box 1). Operational costs depend on the system in place, whether it is a polyculture or monoculture, including the purchasing costs of seed (46% and 55% of the total costs, for milkfish and tiger shrimp, in monoculture, respectively), pesticides, fuel, pond maintenance, harvest expenses, and miscellaneous costs.

The yearly productivity of shrimp ponds per hectare for all types of shrimp was estimated to be 100 kilograms/ha, earning 8 million Indonesian Rupiah/ha (US$ 570), whereas milkfish production yields 250 kilograms/ha/year. The milkfish kilogram is sold at 15'000 Indonesian Rupiah/kg, therefore, the potential milkfish gross income is 7.5 million Indonesian Rupiah /ha/year (US$ 540).

Gender issue

Aquaculture is a family activity, in which the roles are distributed. Men take care of building and monitoring the ponds, helped by women for managing post-harvest handling, marketing and logistics (feed for pond manager).

At the harvest stage, men and women collect the crops by picking them from the nets, and then put them into containers. In addition, for harvesting tiger prawns, women have a role to separate the head from the body of the shrimp. After that, the shrimp's body parts are put into a cork box filled with ice cubes. The crops are sold by the husband (to the collector/middleman) or by the wife to the local market. The revenues generated from the sales will be handed over to the wife. Apart from pond activities, the wives of the farmers also play a role in finding alternative sources of income, such as post-harvest processing of dried fish and milkfish. Women also harvest various organisms in the neighbouring mangroves (molluscs, crabs) to sell on local markets, and get additional income, which also secures them some independence.

Market Chains

In case of the shrimp value chain (speckled, white and tiger shrimps), there are only two fish buyers in Tabalar Muara. Most farmed shrimp is sold headless to maintain freshness and to distinguish them from wild caught shrimp. The products are exported through Malaysia to the Asian market, but a small volume is introduced into the local market in Tanjung Redeb, especially speckled shrimp (*Matepenaeus monocheros*). Milkfish is mostly marketed on a local basis, through a short supply chain.

Major stakes and challenges associated with aquaculture activities in the MPA

Low productivity figures in shrimp ponds in KKP3K KDPS and its surroundings is caused by

Women supporting harvest and processing of milkfish in Tabalar Muara © YKAN

various factors, which could be explained by the following:

- An excess of acid sulphate was found in the soil and pond sediments, which would need to be corrected by the addition of lime in the ponds, an additional significant cost that seems critical.

- The viral shrimp infectious disease "white spot disease" is prevalent and causing major shrimp harvest failures. Little work is done to prevent the spread of such diseases or improve the health conditions of farmed shrimp and fish.

- Another challenge is linked to the limited supporting facilities and infrastructures, such as electricity. For instance, without electricity, shrimp farmers cannot use surface aerators to increase the dissolved oxygen concentration that would ensure better conditions for the aquatic farmed animals.

- Land-based pollution (oil palm pollutants, domestic waste, and mining) may deteriorate the water quality in the coastal area that is used for aquaculture.

As explained in Box 1, the use of pesticides is prohibited, in theory. Alternative solutions such as the use of natural biodegradable poison (saponins) should be promoted or other techniques to avoid any use of biocides. The issue related to land tenure is also critical.

There is a clear need for an ecosystem approach for the aquacultural system and its full implementation within the MPA area.

Interactions between the aquaculture activities, the MPA and local communities

Negative interactions

- **Impacts on mangrove ecosystems**
  The opening of ponds in coastal conservation areas and small islands of the Derawan Islands and its surroundings has an impact by reducing the extent of the mangrove ecosystem, which serves as a habitat for various species. The loss of the mangrove ecosystem also has an impact on the ability of mangroves to absorb waves and tsunamis. Based on the Berau Regency Spatial Plan 2016-2036, the Berau coastal area is categorised as tsunami- and abrasion- prone. In addition, the conversion of mangrove forests to aquacultural ponds eliminates the function of the mangrove ecosystem as a carbon sink. Clearing mangroves also releases greenhouse gases.

- **Interactions between aquaculture and capture fisheries**
  The threat of expansion of new aquaculture ponds in the KKP3K KDPS mangrove areas is getting bigger, because of the strong demand for shrimp and the availability of heavy machinery for excavation. If ponds are opened in large numbers and exceed the carrying capacity of the ecosystem, the damage to the mangrove ecosystem in Tabalar Sub-district will result in a decrease in the catch of wild fish, wild tiger prawns *Penaeus monodon* and dry skin shrimp *Acetes indicus*, which have been the source of livelihood for fishers in Tabalar Sub-district. Dry skin shrimp is also becoming a main ingredient in shrimp paste, thus contributing to an increase in demand for these wild shrimps. However, fishers and shrimp paste makers have never officially protested the opening of new shrimp ponds

in community deliberation forums. Fishers who catch dry skin shrimp only complain about the opening of the ponds during informal discussions about the relationship between their catch and the presence of mangroves in the conservation area.

Positive interactions

- **The Impact of aquaculture on the economy of local people**
  Even though they do not get a stable income from the ponds, local people rely on this additional revenue from farming activities. Because of this situation, there are efforts made by the Yayasan Konservasi Alam Nusantara in collaboration with the Berau Fisheries Service and the brackish water Aquaculture Research Centre, Ministry of Marine Affairs and Fisheries, to increase pond productivity by reducing the area of ponds from 10 to 2 hectares and improving the farming practices. Despite the smaller pond area (2 ha), it is expected that productivity will equal the one with the original size (10 ha). The remaining 8 ha of ponds will be restored into mangrove forests and used for growing milkfish and crabs. Thus, the strategy is to increase the economic value of an area, by reducing land clearing for ponds.

- **Capture fisheries and tourism**
  Capture fisheries meet the demand for fresh fish intended for consumption by tourists. In addition, an initiative was launched by a middleman, fish trader, UD Mutiara Jaya, to federate some local fishers around better fishing practices, and specifically supply some restaurants that have customers who care about the environment. Environmentally friendly captured fisheries that use fishing rods or traps are thus promoted in several restaurants in Derawan and Maratua Island Sub-Districts.

- **Aquaculture and tourism**
  Shrimps and fish ponds supply the needs of restaurants that serve seafood menus. Although not all restaurants take fish and shrimp from the ponds, pond production is able to overcome the scarcity of fish and shrimp during the bad weather season, when capture fisheries production decreases due to stormy conditions. In addition, a group of women in Tabalar Muara process the milkfish from the pond into boneless milkfish to increase the added value. This boneless milkfish supplies the restaurants as a specialty and increases the attractiveness of Berau as a tourist destination.

Shrimps and mud crabs served in local restaurant © YKAN

Shrimp paste maker in Tabalar Muara © YKAN

Box 2: Impact of the COVID-19 pandemic on the aquaculture sector and the MPA

The Berau Tourism Sector was drastically impacted by the COVID pandemic. Even the local tourism from the Berau regency dropped down because of travel restrictions established by the government policy in the early pandemic. Data from the cultural and tourism Agency of Berau indicate a 57.67% reduction in tourist number in 2020 (301,015 visitors in 2019 and 127,396 in 2020). When the New Normal Policy (limitation in tourist numbers) was implemented in the second half of 2020, local tourists from East Kalimantan started to visit Berau again. However, no return to a normal tourist frequency has been observed yet. Touristic-related activities were also affected such as local guides, boat drivers, speed boat owners, etc., a situation pushing them to fish for income and food security reasons. In reverse, the population increased during the pandemic as some people stayed or came to pass the lockdown in the region, a situation putting more pressure on the local fishing grounds.

In response to the COVID pandemic, the Indonesian national government has established a social fund for six months until December 2020. This financial help was directed to small enterprises, including businesses in tourism, fishing and aquaculture. However, there is no information whether the funding will restart or not. The local government agencies in KKP3K MPA have played a role in helping the communities to access these funds, which seem insufficient to cover all population livelihood needs.

The decline in tourist visitors was beneficial for some marine species that are protected in the MPA. For instance, an apparent higher hatching rate has been observed in sea turtle nests. The stingless jellyfish abundance in the Salt Lake on the Kakaban Island has been benefiting from the lower water pollution and disturbance. However, as the human population living in the islands was locked down and higher than usual, increased vandalism/poaching on sea turtle eggs has been observed, for self-consumption or to be sold on the illegal black market.

The impact of COVID in the aquaculture sector was mainly due to the price decrease of tiger shrimps and mud crabs since March 2020. The buyers or middleman-fishermen stopped buying shrimps or crabs for the export market. Consequently, most shrimp farmers, who had already resumed a growing cycle continued it until the harvest, but got a low profit out of it. Those who planned to start a new aquaculture cycle abandoned the farming. But the situation has gone gradually back to normal although not at the level before pandemic. For milkfish from aquaculture, the prize remained relatively stable, because this fish is sold mostly in domestic markets. Furthermore, the use of pesticide in shrimp farming has significantly decreased during the pandemic, because of the limited export demand, travel restriction, and government law enforcement.

Some of the artisanal fishers had to reduce drastically their activities due to the limitations of seafood exports channels and price fluctuations, as fishing was not cost-effective anymore (e.g. increase in fuel price). On the other hand, in the MPA and its vicinity, local fishers operating in these zones have been able to maintain some activity. As in the marine protected zones, the fish stocks were in better health and lower travel time, their activity has remained profitable (less operational costs per kg of fish captured). The Chief of Biduk-Biduk Sub-District however claimed that the practice of destructive fishing has been ongoing during the pandemic but not by local fishers (http://beraukab.go.id/v2/?p=10239). Consequently, the monitoring strategy was reinforced through the police and the Indonesian army.

Boat of fishermen in KKP3K © KDPS / YKAN.

Conclusion: SWOT matrix[4]

The SWOT analysis presented below shows that there are many synergies and opportunities between aquaculture activities and marine conservation.

The general frame provided by the KKP3K KDPS MPA is offering great opportunities to increase the overall level of education and awareness among the local communities (including the aquaculture farmers), promoting and implementing better practices in all activities within the MPA. This will contribute to increasing the degree of protection of the mangrove ecosystems that are recognized as essential for coastal resilience. To be fully successful, the MPA management team must assure a high level of empowerment and enforcement with local communities, including aquaculture farmers, particularly in providing a clear status of land ownership. The MPA can serve as a test area for innovative solutions applied to these coastal social-ecological systems.

PRESENT

Strengths

Strong institutional support

- MPA plan is under active preparation, and regional support is partly in place.
- TNC/YKAN support to the creation and management of this MPA has been helpful, as well as their experience in managing MPAs.

Aquaculture embedded in village life

- Aquaculture production has been well established and embedded in the villages for many years.
- Most aquaculture production involves non-fed species. The supply chain is rather basic.
- Most of the species are local species (thus removing the issue of invasive species spill in the environment).
- Productive systems are run in a collective way – the whole community is accepting the aquaculture production.
- No real conflict has appeared around these aquaculture activities within the MPA. No real conflict of uses within the MPA.
- For now, no conflict between aquaculture activities and capture fisheries has been recorded. The same community is conducting both activities (aquaculture and capture fisheries).
- Women groups play an active role and contribute to livelihoods of the community collecting mussels and oysters in the mangrove (particularly for families who do not own a pond) / Women bring their own income in addition to the income generated by their husbands).

Weaknesses

MPA management and governance

- No management plan is in place yet. The role of the community will have to be defined at this stage.
- The involvement of the village community in the general management of the MPA is still rather poor. The community representatives are consulted but are still not directly involved in the MPA decision-making process.
- There has been past conflict in defining the MPA boundaries.
- Some legal bases for the management unit activities are lacking, such as standard operating procedures and protocols in managing MPAs.
- Land tenure. There is no clear legal status of a piece of land transformed into an aquaculture pond (see Box 1). If the mangroves are restored on the abandoned ponds, the community fears that these ponds will be considered as a forest area (government land) again. The villagers will not be able to claim it as land and will not be recognized as its owners anymore.

MPA uncertain funding sources

- Only one officer manages the MPA. Staff resources are limited.
- The management of the MPA was transferred to the Province Administration, but the provincial government has not sufficient budget and staff to manage the MPA.
- A problem of funding for the MPA management exists: no clear independent funding source is identified that could provide autonomy to the MPA management unit.

Aquaculture and fisheries poor practices

- Aquaculture productivity in the pond is low, therefore the pressure for keeping the pond area or for opening new ponds is high. This induces a high risk of further mangrove habitat degradation.
- The illegal use of prohibited pesticides is a key issue: remoteness of the place makes it difficult for the government to control the use of the pesticide (farmers got it from Malaysia since the pesticides are banned in Indonesia).
- Government control of the fish captures is limited: lack of data on captured fisheries, no real wild fish stock management.
- There is a low level of awareness, education, and technical support for the farmers.

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FUTURE

Opportunities

Improvements in practice

- The MPA can contribute to improve aquacultural practices: getting rid of bad practices, e.g. use of banned pesticide, etc.
- The MPA can contribute to improving fishing practices: e.g. halt the use of dynamite, cyanides, and improving the fish stocks, their monitoring.
- Research work done around the MPA can support the community to make their activities more sustainable, and organize support services, education. The MPA can serve as a test area for innovative solutions.
- Increasing the productivity of the pond can free space for nature / ecosystem restoration. Reducing the size of the pond while increasing productivity is a promising approach.

Funding diversification

- Government support / commitment is high to protect mangroves.
- Combining improvement of aquaculture activities with blue carbon mitigation with mangroves could be a promising approach and offer additional funding.
- Each village received a village budget as a financial capital for improvement works, e.g. aquaculture investments.
- Potential MPA entrance fees could be created and transferred to the community.

Social innovations and more synergies

Links between MPA/aquaculture and the tourism industry could be improved as follows:

- The potential for premium prices for sustainable/ higher quality and value products should be explored, capitalizing the growing consciousness among tourists for healthy and local seafood.
- Higher quality level products: lesser production volumes but higher incomes for farmers.

Fishing and aquaculture

- The same community is conducting both activities (aquaculture and capture fisheries). There is a potential for good interaction and collaboration.

Women/gender issues

- It is crucial to make sure that women are involved in the post-harvest handling and processing of aquaculture products.

Threats

Excessive pressures

- Uncontrolled tourist and demographic pressures could lead to increased consumption patterns and negative consequences for the environment, loss of mangrove or excessive pollution and wastes, and degradation of the ecosystems.
- Government policies on shrimp production and mangroves may be inconsistent. There is a growing pressure from the government to increase aquaculture production: it could lead to the increase of areas dedicated to ponds, the opening of new canals for aquaculture ponds in the mangrove, hece, decreasing the surface area of mangrove.
- Bad management of the fish stocks and aquaculture development can lead to fish stocks depletion. While uncontrolled aquaculture development will destroy the natural environment and further endanger wild fish stocks. This critical situation may lead to conflicts emerging between fishers and farmers and threaten the whole social-ecological system.

Lack of funds

- The lack of funds for MPA management remains as a major threat because it creates the opportunity of other priorities (due to political choices, crisis, emergency events) that make efficient MPA management difficult to achieve.

Climate change

- Climate change impacts are threatening the whole social-ecological system. The increase of the frequency of extreme events that may greatly impact coastal communities and their activities.

Dolphin swimming in Berau waters © YKAN

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