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MANAGEMENT OF OCTOPUS FISHERY OFF SOUTH WEST MADAGASCAR

Tantely Andriamaharo Ny Aina
Ministry of Fisheries
P.O Box 1699
Antananarivo
Madagascar
tantelyaina02@yahoo.fr

Supervisor:

Professor Ragnar Arnason
University of Iceland
ragnara@hi.is

ABSTRACT

Octopus fisheries are important at the southwest coast of Madagascar. Fishermen traditionally dried and sold octopus in the local market. Recently, an international company has developed a new lucrative market for the octopus. It has led to an increase in the value and exploitation of this species. Increase in fishing intensity has resulted in an over exploitation of the stock. The aim of this study was to find out the current situation of the fishery and the possibilities for economic improvement for the fishery. A bio-economic model developed by Arnason was used to describe the fishery. The model has calculated the profitability of the fishery and the state of the stock. The results from the fishery indicate that actual fishing effort (no. of fishermen) is about three times more than required to earn maximum sustainable economic benefits from the octopus fishery. There is no management in place so this indicates the need of a fisheries management system. Several types of management are proposed to alleviate the fisheries and community fishing right will be likely appropriate to this fishery. This report also will study the possible implementation of this community management.

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1 INTRODUCTION

Southwest Madagascar is quite arid and comparatively infertile. Consequently, this region cannot sustain a large human population The ocean off the coast, however, has large and biologically rich coral reef systems, providing favourable marine habitats for a number of species. Marine resources are is fundamental to the survival of the people who live in this region. The marine environment in this region is facing threats from human exploitation as well as various other exogenous impacts including pollution and possible climate change.

There has been a rapid increase in fishing activity in recent years. Population growth, partly due to a high rate of migration toward the coastal zone has put the marine resources of the region under increased pressure. Agricultural opportunities in this region are very limited on account of the aridity of the land. Therefore, increased population has concentrated on further exploiting the marine resources.

Fishing pressure has also been considerably increased by commercialization of traditional fisheries. Domestic demand for fish has expanded with increased population and urbanization and. over the past one to two decades; the demand of fish products for export has increased dramatically. A number of fish factories operate in the region for export primarily to Japan, and numerous traders travel around to buy fish for these exporters and the domestic demand (Alasdair 2007).

The three most important species caught in the waters off Southwest Madagascar are anchovy (*Stolephorus indicus* Van Hasselt 1823), squid (*Loligo sp.* Lamarck 1798) and octopus (*Octopus cyanea* Gray 1849). Anchovy is destined almost exclusively for the local and national consumption. The cephalopods, i.e. octopus and squid, are primarily destined for the international market, mostly Japan. In recent years, international companies have developed a new lucrative fisheries market for a wide range of seafood products throughout the region. Commercial fishmongers and exporters first arrived in the villages in 2003 making accessible high paying markets for species such as fresh octopus.

Although fishing methods are still traditional, the recent introduction of an export market for fresh seafood products, as opposed to the traditional dried and salted fish market, has led to an increase in the value and exploitation of the key target species, namely octopus. This increase has been accompanied by a change in recent years from a largely barter and subsistence economy to a fisheries-dependent, cash-based economy. The dramatic increase in fishing intensity seen in recent years has raised concerns amongst local communities and conservation groups of reef damage and fish stock overexploitation (Humber *et.al*.,2006).

Currently there are no management measures in place in the octopus fishery. This study addresses this situation by developing guidelines for the community management of the octopus fishery, which hopefully will adopt known strategies for conservation and sustainable use of the octopus resources.

Community fisheries management is a form of fisheries management regime that provides formal management powers to fishing communities (Arnason 1996). There is a theoretical likelihood that under the appropriator set-up of decision making in these communities, their powers will be used to create economic benefits.

2 MADAGASCAR AND ITS FISHERIES

2.1 Geographical information

Situated in the Indian Ocean off the east coast of the southern Africa (Figure 1), Madagascar is among the largest islands in the world. The land area is about 587,041 km^2 and the coastline is about 4,828 km. There is a 1,500 km long barrier reef in the southwest part of the island.. The reef area has been estimated to be 6,000 km². In addition, there are about 20,000 km² of scattered rocky or coralline grounds. Important mangrove areas are found on the west coast which extend in area to about 5,000 km², there are 3,000 km^2 of Mangrove growing. The Exclusive Economic Zone of Madagascar covers an area of 1.140.000 km^2, which represent twice the surface of the island. The western coastline benefits from a large continental plateau covering an area of 117.000 km^2 (Figure 1).

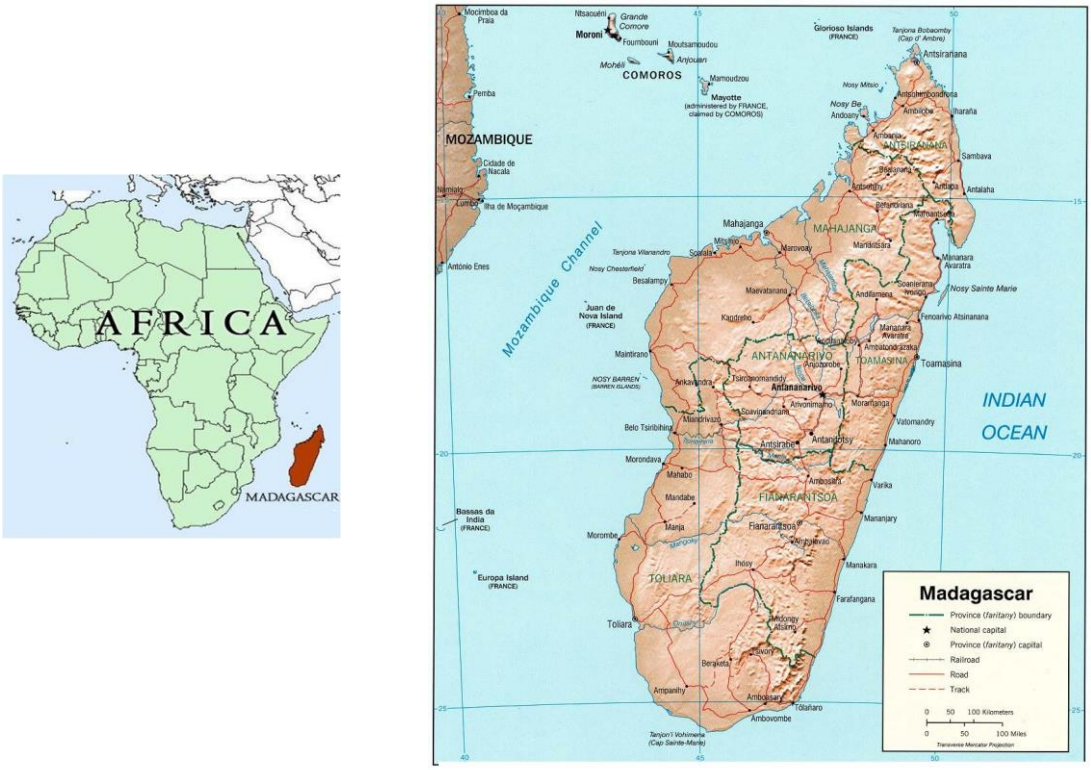

Figure 1: Map illustrating Madagascar on the African continent and their neighbouring countries.

2.2 Madagascar fisheries

Several different types of fisheries are found in Madagascar. There are (i) subsistence fisheries, i.e. fisheries for food for the family, (ii) traditional fisheries using smaller traditional typically non-motorized craft, (iii) artisanal fisheries using small motorized boats fishing in coastal waters (iv) industrial fisheries aimed at the local market and for export, (v) sport fisheries and (vi) exploratory scientific fishing carried out by the authorities. In addition to the type of fisheries, it is useful to divide the fisheries of Madagascar into three subsectors:

- Inland fisheries (freshwater fishing in streams and lakes).
- Marine fisheries.

- Aquaculture (marine aquaculture and freshwater aquaculture).

Marine aquaculture includes shrimp and seaweed culture, and collection of sea cucumber. Freshwater aquaculture is dominated by the culture of tilapia and carp. The marine fishery is the most important than the inland fisheries. They are based on a number of species of which shrimp, lobsters and cephalopods are most important. The estimated potential for marine capture fisheries in Madagascar is 480 000 tons, out of which some 300 000 tons of fish with commercial interest are exploited (FAO 2008).

The marine fisheries sector is structured in three main segments: traditional fisheries, artisanal fisheries and industrial fisheries.

Traditional fishermen use dugout canoes with or without outriggers. Most of the catches (≈ 95%) goes to the local market. Fishing techniques include: various types of nets, baited traps, thin netted with nylon gathered by hand and harpooning with or without diving. The fishery takes place along the coast within a mile or so of the shoreline.

Employment in the traditional fisheries is approximately 60000 fishers using 62000 canoes. The traditional fishing sector is responsible of for 50% of the total marine fish catch. The production from the traditional fishing was about 70,000 tons in 2007 (Madagascar Department of Fisheries 2008).

Artisanal fishing is characterized by the use of motorized boats using engines not over 50 horsepower. This fishery, although still quite primitive is technically more advanced than the traditional fisheries. Fish, crabs and shrimp are the targets of this fishery; the production from this sector was about 460 tons in 2007 (Madagascar Department of Fisheries 2008).

The industrial fishing fleet is made up of boats powered by engines over 50 hp. Industrial fishing commenced in 1963, with the advent of shrimp fishing. For a long time industrial fishing has been a major source of foreign exchange earning in Madagascar with the export of shrimp and tunas. However the last past few years a decline in this fishery has been noted probably due to a combination of increased fee charges and adverse fishing conditions from 24.000 tons in 2001 to 19.000 tons in 2007 (Madagascar Department of Fisheries 2008).

EU has over the years had a fishing agreement with Madagascar. That consist limited numbers of vessels for different type of fisheries. Fishing by the EU fleet is limited to 43 purse seiners and 50 Surface long liners. In 2007, the EU fleet consisted of 97 tuna purse seiners out of which 41 was from France, 48 from Spain, 7 from Portugal and Italy with one fishing vessel. Furthermore, Spain had 24 long liners, Portugal 6, and France with 10 long liners (FAO 2008). Tuna production stood at 10 000 tons per year, and is mainly caught by the EU fleet and Japanese fleet.

2.3 The state of fish stock

Marine production is based on ten types of fish stocks: fish (deep-water, tuna, shark), shrimp, , deep water shrimp, , lobster, , sea cucumber, crabs, and sea weed. The state of these groups of stocks is assessed by the Madagascar Department of Fisheries, which believes most of them to be under-exploited. The exception is shark and sea cucumber whose production fell dramatically in 2007 (Table 1).

Only the shrimp and lobster stocks, representing 5.6 % of the total tonnage of marine fishing in 2007, are thought to be fully exploited (Figure 2).

The shrimp, being the commercially most important species in Madagascar, is the subject of particular attention by the Ministry of Fisheries. The exploitation level of this stock is considered to be close to the maximum (MSY) since 1998. The recent reduction (2006-2007) of the catch in shrimp fishing is thought to be primarily due to reduced profitability of the fishery and temporary adverse marine conditions, but may also be indicative of over-exploitation (Figure 2).

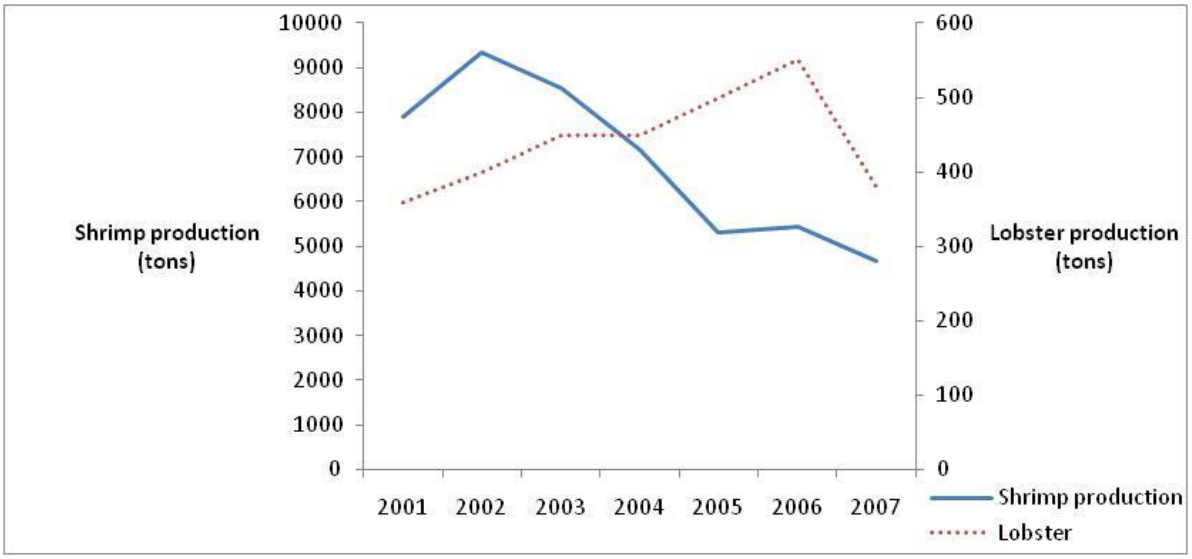

Figure 2: Shrimp and lobster catch (Madagascar Fisheries Department 2008).

2.4 Evolution of fishing level

In Madagascar catch level for different fisheries sector seems to be generally stable (Madagascar Department of Fisheries 2008). Total production has fluctuated between 137.925 tons in 2003 to 130.771 tons in 2007 (Table 1).

2.5 Use of harvest

Fish is utilized in many forms. For the local consumption the main products are found at most market as fresh, frozen, dried, salted and smoked products. Frozen and transformed products are destined for export. Some product is transformed for animal feeds.

2.5.1 Export fish markets

Shrimp export is the major export commodity for Madagascar. The total shrimp output from aquaculture increased from 400 tons in 1994 to 6770 tons in 2006, following an expansion in the industry. (Madagascar Fisheries Department, 2008). The main export markets are Japan, Europe USA, Reunion and Mauritius and these markets are also important for crabs, lobsters, shell fish and octopus. Important markets for other export commodities include China and Singapore (sea cucumber, shark fin and octopus).

Due to the comparatively high shrimp prices, domestic demand for shrimp is very low. Local consumers usually purchase the small and medium-sized dried shrimp originating from the artisanal fisheries sector, which is cheaper.

Table 1: Evolution of the production of fishing and aquaculture (2001-2007).

Production (Tons)	2001	2002	2003	2004	2005	2006	2007
Marine fishing							
Industrial fishing	**24 663**	**24 728**	**23 920**	**23 574**	**20 935**	**21 270**	**19 405**
Shrimp	7 888	9 328	8 545	7 155	5 312	5 442	4 679
Fish	4517	3 050	3 105	4 089	3 273	3 453	2 341
Deep sea shrimp	130	150	-				
Deep sea Fish	2 127	2 200	2 270	2 300	2 350	2 375	2 385
Tuna	10 000*	10 000*	10 000*	10 000*	10 000*	10 000*	10 000*
Artisanal fishing	**620**	**690**	**765**	**599**	**639**	**547**	**459**
Shrimp	437	490	726	590	572	490	401
Fish	183	200	39	9	67	57	58
Traditional fishing	**65 507**	**70 680**	**71 870**	**71 950**	**72 020**	**72 350**	**69 820**
Shrimp	3 450	3 450	3450	3450	3450	3450	3450
Crabs	1 347	1 400	1 500	1 500	1 525	1 600	1 370
Lobster	359	400	450	450	500	550	380
Sea cucumber	851	830	850	850	820	850	470
Fish	55 000*	55 000*	55 000*	55 000*	55 000*	55 000*	55 000*
Sea weed	5 045	5 100	5 170	5 200	5 225	5 300	3 650
Other	4 500	5 500	5 500	5 500	5 600	5 600	5 500
Inland fishing							
Inland fishing	32 350	32 400	32 450	32 550	32 650	32 750	32.630
Aquaculture							
Shrimp aquaculture	5 399	6 628	8 920	6 243	6 404	6 776	8 457
Pond farming	850	900	950	1 000	1 050	1 100	540
Rice field fish farm.	1 500	1 500	1 500	1 550	1 600	1 650	2 090
Total production	**133 583**	**135 126**	**137 925**	**134 916**	**132 648**	**133 693**	**130 771**

*: Estimated value due to lack of data.

3 FISHERIES MANAGEMENT IN MADAGASCAR

In 1993 the Ministry of Fisheries issued an ordinance (93020) on fishing and aquaculture management. It stipulates that the fisheries and aquaculture minister must prepare and implement fisheries management and fish stock conservation plans. These plans are then incorporated into the Fishing and Aquaculture Directing Plan. The main goals of the fisheries plans are to increase export revenues, improve food security, incomes to fishermen and their living conditions and job creation.

Moreover, the constitution of Madagascar stipulates a rational exploitation of fish resources in order to preserve them for future generations. , The Directing Plan must be based on the development and application of good fish and aquaculture resource production management plans and on the other, the development of under-exploited and potential resources. The Directing Plans are put into action through the drafting of Decrees fixing, for example, the number of licenses issued or the level of taxation of a particular fishery.

The Ministry of Fisheries is responsible for the management of the fisheries. Three main institutions for the management and the development of the fisheries sector are connected with the Ministry. They are (Figure 4):

- Fishery monitoring control and surveillance (CSP), whose role is to enforce regulations in fishing and aquaculture.

- Sanitary Competent Authority (VO) to make the quality control of the products from fisheries and to secure hygiene and healthiness of the products to the export.

- National Aquaculture and Fisheries Development Fund (AMPA), resulting from the counterpart of the agreements of fishing or from rent in collection and from licenses.

The Regional Services for Fishing and Fish Production are in charge of the application of the management of the fisheries and of consulting stakeholders in each fishery at a regional level. They collaborate at a local level with the consultative councils for fishing and agriculture of each province. Its different agencies co-ordinate the application of fishing legislation and centralize the information concerning fisheries management, each at their own level of jurisdiction.

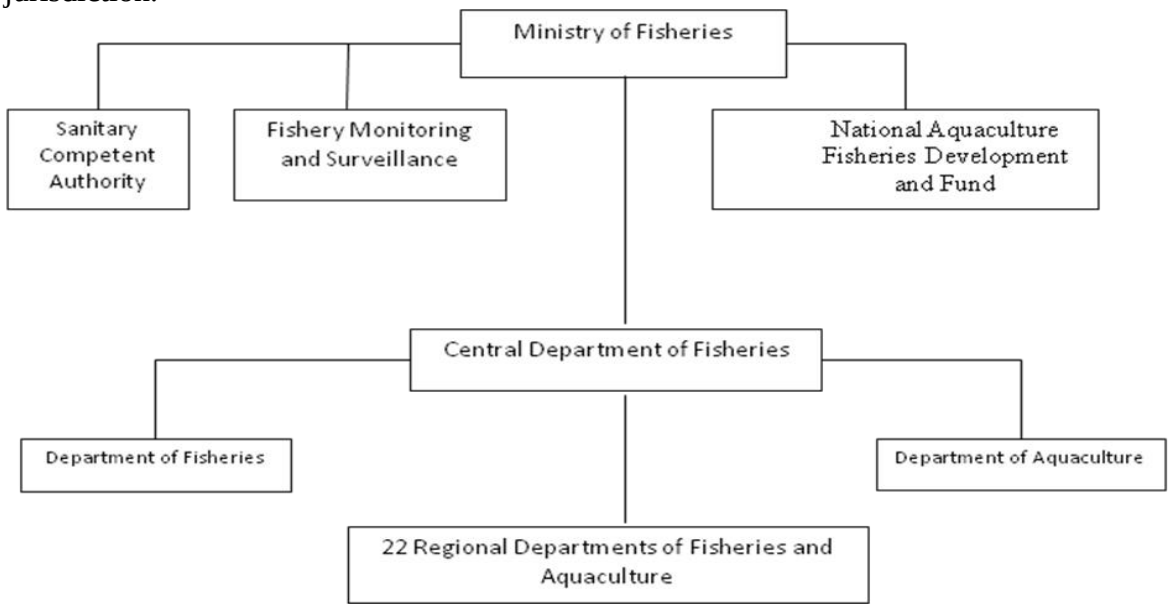

Figure 3: Organizational chart of the Ministry of Fisheries.

The management process is also influenced by the establishment of protected marine zones (marine protected areas) in collaboration with the National Office for the Environment and different organizations acting on environmental issues, like the Wildlife Conservation Society (WCS) and the World Wildlife Fund (WWF). At a local level, these zones can have an important impact on traditional fisheries.

3.1 Management of traditional fishing

Traditional fisheries are not under strict management regime. The fishery is open access but subject to general regulation such as a ban on use of toxic substances, explosives and electrical devices to stun the fish as well as any equipment to prolong a dive above the person's physical ability. In order to collect the catches from traditional fishing, collecting firms must seek the authorization of the Province Executive Committee President.

Lobster, crab, sea invertebrate such as sea cucumber and algae fisheries, although traditional in fishing operations, is subject to additional controls. An authorization from the Province's Executive President is necessary for the creation or the establishment of a fishing enterprise, or the sale and collection of its product. The firm is obliged to technically assist fishermen in its area and help them purchase materials and fishing vessels. The enterprise must also on a monthly basis to provide fishing, collection and sales statistics to .the local fishing administration

Moreover, holothurians (sea cucumber) and lobster fisheries are subject to restrictions on the minimum size of the catch (minimum of 11 cm fresh and 8 cm dry for holothurians and 20 cm for lobster) but the restrictions concerning lobster are not enforced. Lobster fishing is also banned each year from the 1st of January to the 31st of March.

3.2 Management of artisanal and industrial fishing

The management of the artisanal and industrial fishing is basically similar, with the only difference being the license fees. As mentioned in the chapter 2.2 the vessels are categorized by engine power. This also forms the basis for license fees.

Shrimp is by far the most important industrial and artisanal fishery in terms of tonnage and value. It is also the primary source of foreign exchange for the national economy.

Practiced since 1967, industrial shrimp fishing has constantly been the object of studies by the Fisheries Ministry and international organizations (FAO, World Bank, AFD, IRD, and EU). Formal and documented management plans have been put in place in the last ten years. Management of the fisheries is well established and is based on licenses, fixed since 1999 and defined in zones, of tax on these licenses and a period during which fishing is closed every year. Stakeholders (Association of shrimp farmers and fishers of Madagascar) participate actively to the management of their industry.

In order to contribute to the local market, the Ministry of Fisheries decided in 1998 to impose the requirement that for each kg of shrimp harvested, the local market should be supplied with 0.5 kg of fish as considerable amounts of fish are caught in the shrimp fishery as by-catch. This measure was taken due to the fact that the industrial shrimp fishery discarded a lot of by-catch and because the industrial fish production was initially destined entirely to the export market. Even though there are no stipulations stopping the export of such fish, the latter are often small fish of little value not suitable for the export market.

Industrial shrimp fishing is associated with high levels of by-catch, which use up space in the boats, which could be used for high value shrimp. Utilizing of the by catch calls for extra effort in terms of selection, transport, off-loading and distribution. By taking up valuable space, by-catch also increases fuel costs. Nonetheless, the measures taken have been beneficial to the local population and have had relatively little impact on the profitability of the shrimp fishing sector (Andrianaivojaona *et al.* 2003).

Deep water fishing has only been authorized since 2001. Little information on this fishery is available. The landing reached 2127 tons during 2002, the first year of full operation and has gradually rise to 2385 tons in 2007 (Table1).

Deep water fishing is subject to a regime of licenses and tax. Fishing zones are regulated (two miles from the shoreline of the West coast and eight miles of the East coast), smallest mesh size must be at least 45 mm wide and ship-owners have to provide the Fishing Ministry with statistics.

In addition, a VMS put in place since 2002. All artisanal and industrial fishing vessels are fitted with the Immarsat C global positioning system and must transmit their location to a surveillance centre every hour (24 positions daily). Qualified observers, paid by the ship owners are working on each boat.

3.3 Revenues from fisheries management

State revenue is generated from the following:

- Revenue of financial compensation for the right of access to Madagascar's waters.
- Revenue from the sale of confiscated catch or equipment.
- License fees.
- Revenue from fines and transactions.

The Madagascar treasury collects about 80% of these incomes. Approximately 20% of the taxation on license from the shrimp fishing is transferred to the National Aquaculture and Fisheries Development Fund (AMPA) which was created to allow the Department of Fisheries to help and promote the aquaculture and fisheries sector. The main domains of intervention of the AMPA are:

- Fisheries management and stock conservation.
- Promotion of artisanal and traditional fishing.
- Development of aquaculture.
- The promotion of the local fish commercialization and establishment of the necessary infrastructure.
- Control and surveillance operations of the exploitation and commercialization of aquaculture and fishing resources.
- Research and development towards better identification and active exploitation in aquaculture and fishing.
- Any operation judged by the Ministry of Fisheries and Aquaculture to be compatible with and complementary to the good execution of the activities listed above.

4 THE OCTOPUS FISHERIES

Octopuses are widespread across the world's oceans and support a global fishery that has grown significantly in recent decades. The most important commercial species include *Octopus vulgaris, O maya, O. tetricus, O. dolfeini,* and *O cyanea*.

Morocco leads the world in octopus export, capturing as much as 44% of the global market in 2002 (FAO 2003, FAO 2005). China, Spain, Senegal and Mauritania are also large producers (FAO 2003, FAO 2004, FAO 2005). Markets are mainly in Asia and Europe with Japan being the largest in the world and Italy being the largest in Europe (FAO 2004, 2005). In 2004 Japan imported 53.000 metric ton (MT) of octopus while Italy imported 44.000 tons

(FAO 2004). While the global market for octopus continues to grow, export from the major producer has either levelled off or decreased in recent years.

Many African nations now supply a large proportion of their octopus to the European Union and Japan, but their fisheries have peaked and are starting to decline (Humber *et.al.*,2006).

4.1 Octopus fishery in Madagascar

Three species of octopus are found in the waters of Madagascar: *O cyanea, O aegina,* and *O macropus*. *O cyanea* or day octopus is most abundant and the primary specie caught in Madagascar water (Figure 4).

Figure 4: Day octopus hiding in rocks and imitating his environment colour.

4.1.1 Biology of Octopus cyanea

O cyanea or day octupus is the common reef-dwelling octopus in the Indo-west-Pacific (Roper *et al.* 1984) and occurs along the northeast and southwest coast of Madagascar. *O cyanea* resides in holes and crevices found in coral reefs and rocky areas. During the day it hunts on the reef sea grass beds, and across rocky, sandy or muddy bottoms. It is thought to be the most common octopus on reefs and occurs from the water surface to a depth of at least 150 m across tropical and temperate coastal waters and continental shelves.

The day octopus is a comparatively large species, with a body length up to 16 cm and arms up to 80 cm. It is typically brown in colour but with the ability to rapidly change colour and skin texture. This octopus is characterized by dark oval false eyespots with no iridescent rings commonly present at the base of its arms and the dark brown colouring on the tips of the arms along with two rows of lighter spots. The dark eyespots are only sometimes visible and depend upon the patterns being displayed by individual octopuses.

The day octopus, unlike other cephalopods, feeds during the daylight hours. Its prey includes various bivalves, fishes, crabs and shrimps. Because this species feeds during daylight hours, its ability to camouflage is exceptional. The day octopus can produce a variety of color patterns and elaborate skin textures that resemble the ocean substrate around them making them virtually invisible to predators. Their complex brain sends nervous impulses to their muscles causing them to change almost appearance instantly as they move over sand, coral, rubble and other surfaces (Humber *et.al.*,2006).

Males are thought to mature at body size of approximately 320 g and females at approximately 600 g. However, sexual maturities can be attained at a wide range of body

sizes and many are much bigger before they become sexually mature. The number of eggs a female produces is proportional to its body size. Fertilization is achieved through direct mating. Females who guard the eggs until they hatch die shortly thereafter. The males die soon after mating although they may reproduce with multiple partners. Hatched larvae have a 4 to 8 weeks pelagic stage before settling on the bottom (Humber *et.al*.,2006).

The lifecycle of the day octopus is characterized by an exponential growth. It grows very rapidly and can increase in size by as 200 g in only 15 days. They seemingly follow the "live fast and die young" principle and have a total estimated lifespan of between 9-18 months after settlement. Water temperature, light, diet and feeding rate seem to influence growth and maturation (Humber *et.al*.,2006).

4.1.2 The main octopus fishing grounds

The decline in reef fish catches, and the low price of fish, has encouraged traditional fishermen in Madagascar to look for alternatives. In the northern part of the island and especially the southwest part, these alternatives have largely consisted of invertebrate stocks, especially octopuses. The main octopus fishing grounds in Madagascar are indicated in Figure 5.

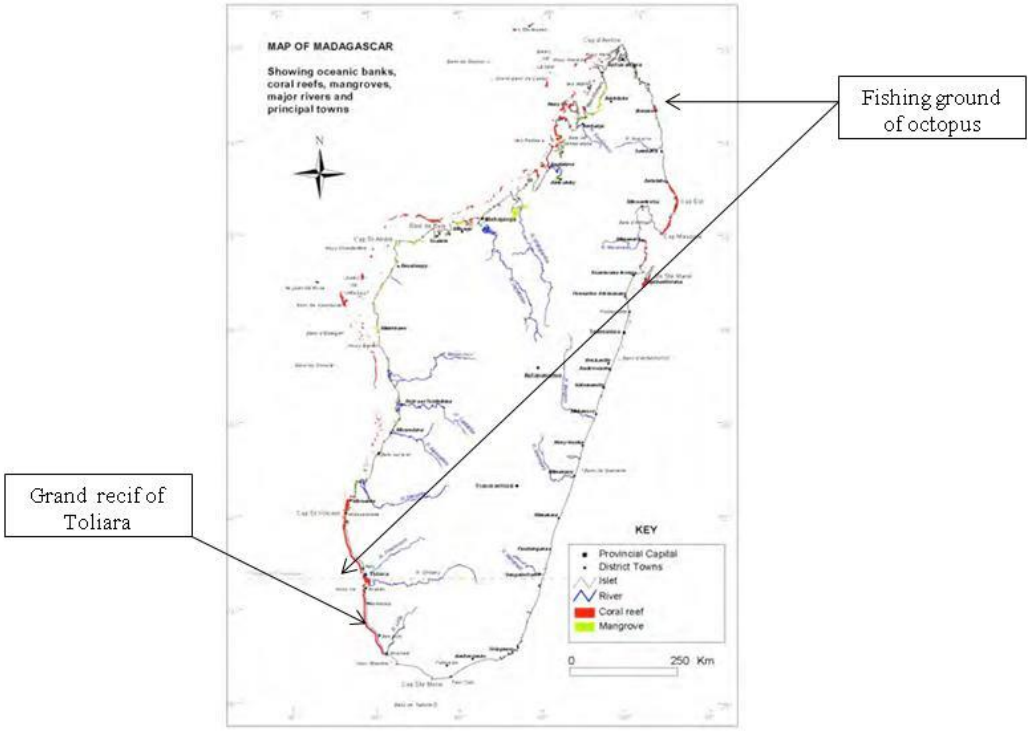

Figure 5: Main fishing areas of octopus in Madagascar

The traditional octopus fishery in the north part of Madagascar is an alternative subsistence fishery because almost the whole population is employed in agriculture and exploit marine resources only occasionally. By contrast, in the southwest part of Madagascar, the octopus fishery is an important economic activity.

Octopus represents approximately 12 % by wet weight of marine resources captured on the reef flat of the Grand Recif of Toliara in the southwest coast. This represents almost 19 tons.km^{-2}.year^{-1}, which is greater than the finfish catch from pirogues (dugout canoes) (Humber *et.al*.,2006).

Traditionally, fishermen dried the octopus catch, and traded to regional inland markets. More recently, foreign-owned seafood trading and collection companies purchase most of the catch, resulting in a change in recent years from barter and subsistence economy to a market-driven cash based economy. The change to an international market for octopus has increased both the value of octopus and the quantity harvested.

4.2 Octopus fishery in southwest of Madagascar

In the southwest of Madagascar, about 80 % of the population is employed in agriculture. The regional economy thus is based mainly on the farming sector, accompanied with the development of the social sector (education, hygiene and health).

Fishing, however, constitutes the main activity in the coastal villages. The limited opportunities in agriculture, an arid climate in the region and better marketing opportunities for marine produce especially octopus have encouraged people to turn to fishing. For the majority of the cases, this activity still stays at the traditional or family level, usually with family members migrating to the coast to do the fishing while still maintaining ties with their farming village inland. Almost all of the fishing in this area is centred on the reef exploitation.

Octopus fishing in general is carried out using pirogues (dugout canoe) as shown in the Figure 6 or simply wading onto the reef areas. This simple technology has limited most fishing effort to the nearby reef systems.

Figure 6: Traditional pirogue with sail.

The main fishing tool used is the harpoon. Although the same fishing gear is used, the fishermen approach the fishing in three different ways:

- The fishing on foot (“Mihaky’’), practised by women and children who use the pirogue only to cross the lagoon if it necessary.
- The fishing by diving (“Maniriky’’) specially practised by the men using masks and air tube
- The fishing in pirogue (‘’Mitino’’), practised by the men. They don’t dive that if individuals are targeted well.

A wide range of fish, not only octopus, is targeted. However, the octopus remains the primary catch as it fetches good price in the market for export.

Since 1994, when the octopus fishing started at commercial level, both catch and effort (number of fishermen) has fluctuated considerably. From 1996-1999 the catch was rather stable around 700 tons, but jumped to around 1400 tons from 2000 to 2003 and then fell to

about 600 tons (Figure 7). The fishing effort rose steadily from 1994 to 2001 from about 800 fishermen to about 1300, but then the effort reduced sharply to about 900 in 2002. Since then the effort has increased gradually to about 1400 in 2006.

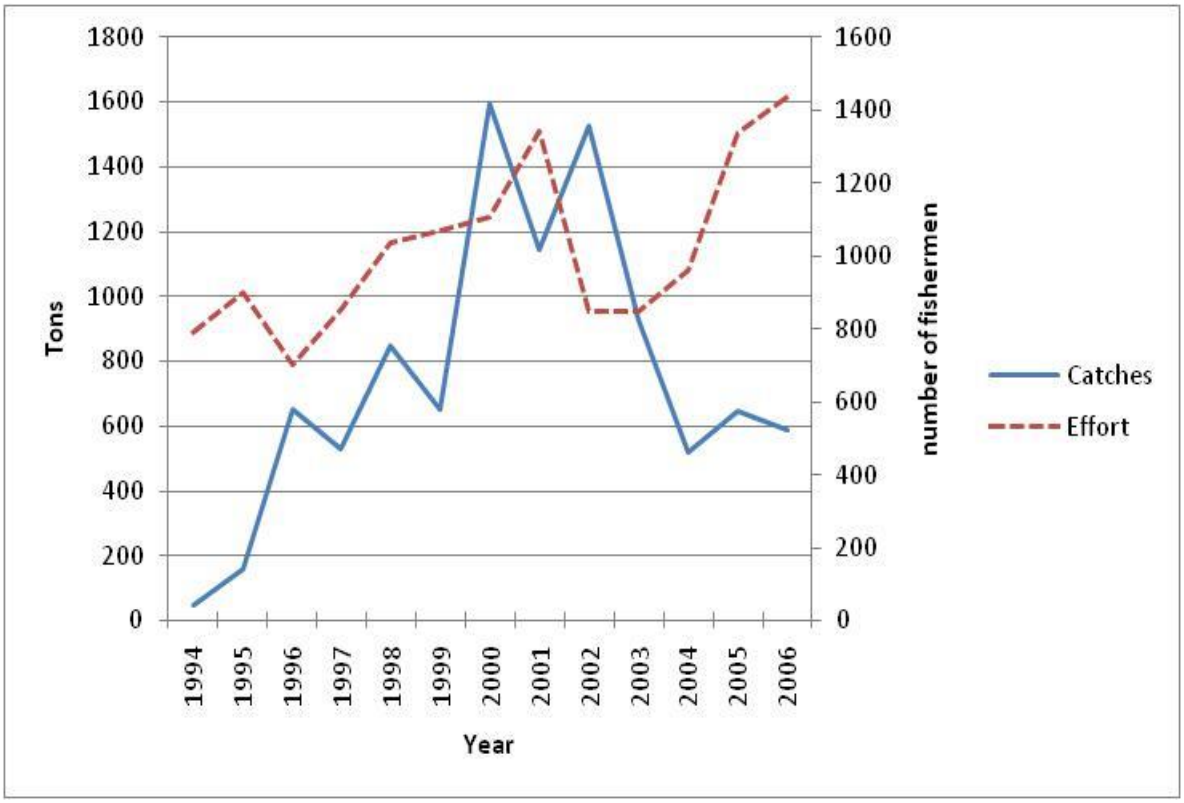

Figure 7: Octopus annual catches and effort (Regional Fisheries Department 2007)

Thus, in Figure 8, the catch per unit effort (CPUE) has been quite variable. Until 2002, the CPUE seems to have increased greatly. Since 2002 the CPUE seems to have has decreased dramatically (Figure 8). It should be recognized that the catch and effort data are probably not very accurate. Nevertheless, it probably reflects important real trends. The initial rise in CPUE may be due to a learning process by the fishermen and expansion of the fishing range as new fishing grounds were discovered. The decline since 2002 may well reflect a drop in the stock size due to overexploitation.

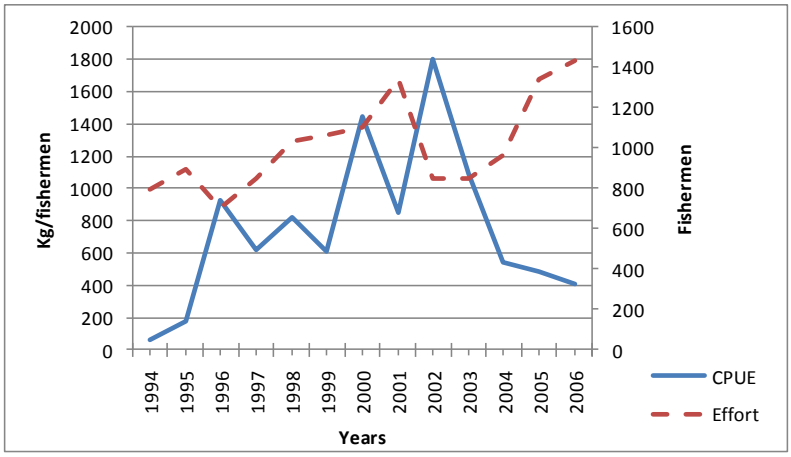

Figure 8: Fishing effort and CPUE of octopus fisheries (Regional Fisheries Department 2007)

The region's marine resources were largely unexploited, apart from limited local subsistence fisheries, until the arrival of commercial fisheries collection companies in 2002, which provided communities with ready market access for marine resources. Prior to the commercial exploitation of local fisheries, there was little need for the creation of rules and regulations to aid fisheries management. The traditional subsistence fishing of Vezo tribe (fishing people who inhabit a coastal belt of southwest of Madagascar) communities in the Southwest of Madagascar does not have to been endangering the health of local marine resources.

Anecdotal evidence gathered during the discussion with the fishers from this region suggests that the arrival of export market in 2002 considerably increased the fishing pressure for octopus and that the catch has fallen in recent year. Available statistics support this and provide evidence of overfishing after 2002 (Figure 8). The need for fisheries laws arose once the value of commercial fishing for export was realised.

4.2.1 Management of the fishery

The coastal zone fisheries management in Madagascar is focused on industrial fisheries such as shrimp and tuna. This has left limited capacity for fisheries management in traditional and artisanal fisheries such as those found in the southwest region. This lack of formal regulation could potentially cause problems for the local fish stocks. It is important to realize however that in the absence of government regulations, locally implemented fisheries regulations often associated with spiritual beliefs was in place. In the communities who live in southwest Madagascar fishers adhere to traditional local laws, known as *dina*, which are recognised by the government and seem to represent valid and viable fisheries management system (Alasdair 2007).

Since 2003, Andavadoaka, a fishing village in the Southwest of Madagascar and surrounding communities have worked with conservation organisations such as Blue Ventures (BV) and the Wildlife Conservation Society (WCS) to develop plans and strategies for marine resource management for the first time in the region. The development of a new fishing cooperative in Andavadoaka and plans for the establishment of a regional area management committee, have created opportunities for structural and functional interactions in the community. The planned establishment of a network of community-managed marine and coastal protected areas represent an important step for Vezo communities in the region in creating a new coastal regulatory framework directly affecting traditional livelihoods (Alasdair 2007).

In addition to this, a variety of marine resource management initiatives are being implemented by the fisheries department and NGOs in the south west region of Madagascar where the main source of income comes from fish- and fisheries-related produce and over 80% of households engage in fishing (Alasdair 2007).

In November 2004, a pilot seven-month octopus no take zone (NTZ) was implemented as an attempt to preserve the valuable fishery (octopus). The result for this pilot project showed that the number and the average weight of octopus harvested was significantly greater compared to another site where are NTZ was not implemented (Alasdair 2007). This success led to the implementation of new national fisheries regulations on octopus fishing in 2005, after consultation of all the actors in this activity (fishermen, Regional Department of Fisheries, and conservation NGOs). This regulation includes a specified minimum catch size

and a regional closure season in southwest Madagascar between 15th December and 31st January each year. The text regulating the octopus fishery in octopus is not yet put into effect.

Following the initial co-operation between international conservation NGOs and local people and the success of the octopus NTZs, discussions have been ongoing between NGOs and the people in Andavadoaka and surrounding villages regarding the creation of permanent marine protected areas in the region. The aim is the establishment of a series of protected areas in the Andavadoaka region, the first community-run Marine Protected Area (MPA) network in Madagascar. The proposed MPA has been named 'Velondriake' which means 'to live with the sea' in the local Vezo dialect. An elected management committee consisting of representatives of every village within the proposed MPA has been formed to ensure that communities would reap the benefits of an MPA network in the Andavadoaka region. Velondriake committee members are responsible for raising awareness within their community regarding the benefits of protected areas. They will act to inform communities of the local *dina* and other laws developed as part of proposed protected area plans, as well as to enforce the local regulations (Alasdair 2007).

The community-based MPA project "Velondriake" is already making headway by changing the perception and behaviour of the local communities in and around Andavadoaka. There is now a sense of support for marine and coastal conservation initiatives (Alasdair 2007).

5 FISHERIES MANAGEMENT REGIME THEORY

To set the stage for the later discussion, an overview of the fisheries management theory suitable for the octopus fisheries is useful for later comparison with different fisheries management systems.

The Fisheries management regime is the institutional framework under which the fishing industry operates. It has three main components: Fisheries Management System (FMS), Monitoring Control and Surveillance (MCS) and Fisheries Judicial System (FJS).

FMS is concerned with setting the appropriate rules for fishing and the two others are concerned with enforcing these rules.

5.1 The basic problem of common property

Fishing industry exploit stocks of fish in their natural environment and it is important to develop an appropriate fisheries management regime to exploit these stocks sustainable, biologically, and economically optimally in most countries. This means that common property is still the most common fisheries management system around the world.

Figure 9 shows the revenues, costs and biomass as a function of fishing effort according to the sustainable fisheries model (reference). Maximum profits are reached at fishing effort e^*. Under the common property arrangement, the fisheries will find equilibrium at fishing effort level e_c, where costs equal revenue and the profit is zero.

When fishermen share ownership in common fish stock, they become aware of the benefits being gained. With no fisheries management in place to limit entries, new fishermen will enter in this fishery stock will to decline and the benefits from the fishery will decrease. As

long as each fisherman thinks that he can harvest more than the others, he will continue to increase the effort. But as there are no indications to show that the stock is at a critical level because of lack of mechanism in place, the fishermen may leave with debts due to their investment in time or equipment for fisheries and biological loss due to the decreasing of the biomass.

The economic waste associated with the common property problem is the reason why management of fisheries is needed.

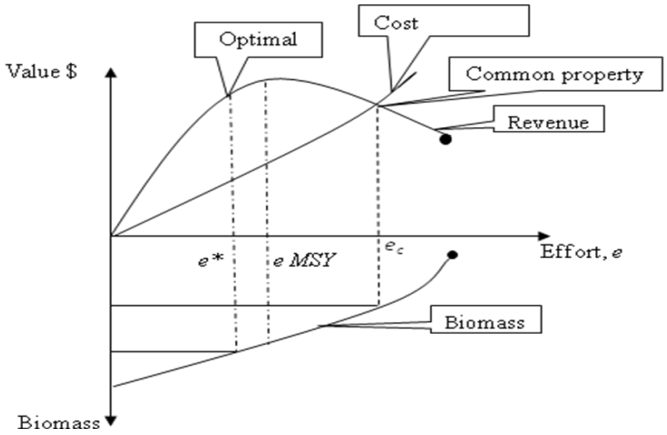

Figure 9: The sustainable fisheries model (Arnason 2009).

5.2 Element of property right, theory

To understand Common Property and effective Fisheries Management, it is necessary to understand basic Property Right theory and the concept of Property Right quality.

Property is referred to an object that a person or group owns and rights are the responsibilities provided to the property's owner. Property rights in Fisheries give incentives to the fishers, to behave economically. Property right is necessary for economic optimum:

a) Without Property Right, there is no accumulation (capital, resources).
b) No specialization and trade without Property Right.

So, it means that poor Property Right lead to a low economic efficiency, accumulation and little net economical benefit building up of capital and expertise.

Traditionally, fish stock has been arranged as common property resources. According to Gordon (1954), common property resources are subject to fundamental economic problems of over-exploitation and economic waste. In fisheries, the common property problem manifest itself in (i) excessive fishing effort, (ii) too small fish stocks, (iii) little or no profitability and unnecessarily low personal income, (iv) unnecessarily low contribution of the fishing industry to the GDP, (v) a threat to the sustainability of the fishermen and the human habitation.

Strong Property Right leads to an economic growth. So the quality of the Property Right is crucial.

a) The property right as a bundle of right

Firstly, the relationship linking the property with the individual can be seen as a bundle of right. The property is determined by the characteristics of the right. Those characteristics are security of the title, exclusivity of use, duration (permanence) of property right and transferability. The quality of the property may be judged by these four characteristics (Figure 10) (Arnason 1996).

b) The property right as a bundle of characteristics

From these characteristics, the quality of the right will be determined. Security is related to quality of ownership. If the right can be taken easily away under certain conditions, then the quality of the security is low. Exclusivity is the right to exclude others from using the property. The permanency is the duration that allows the right holder to use the right provided and the transferability is that the right holder can transfer the rights to someone else if he wants to.

Characteristic of property right is measured along four-dimensional axes. According to Scott (1988), they can be measured on a scale from 0 to 1.A measure of 1 for the four characteristics means that the property right is perfect (Figure 10).

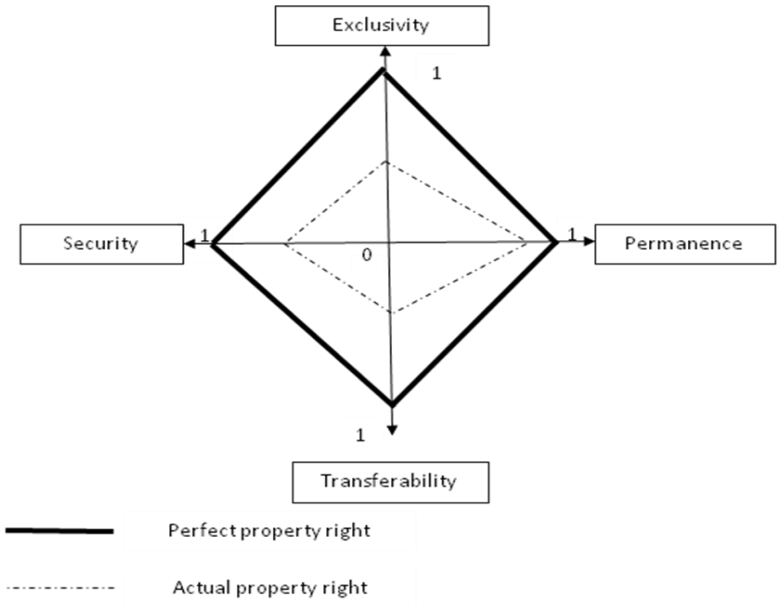

Figure 10: Four-dimensional axes showing the perfect characteristic and the actual world situation (Arnason 2009).

5.3 Fisheries management systems

Different fisheries management systems have been developed and adopted to deal with the problem of common property in fishery. Arnason (1994) has reviewed several fisheries management system. They can be grouped in two broad classes: biological fisheries management and economic fisheries management measures. Economic fisheries management may be divided into direct and indirect economic management (Figure 11).

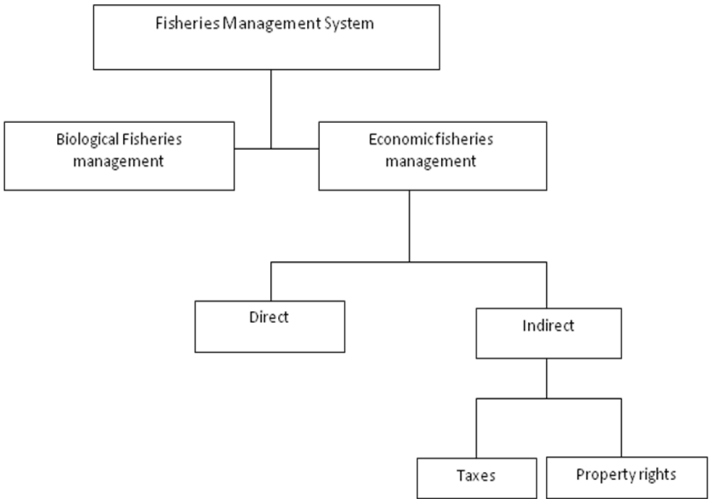

Figure 11: Classification of fisheries management (Arnason 1993).

5.3.1 Biological fisheries management

According to Arnason (2001), Biological Fisheries Management such as Total Allowable Catch, closed fishing areas, mesh size regulation etc. may enhance and conserve the fish stock. But these regulations fail to generate benefit because they do not remove the common property nature, which is source of fishery problem.

In addition, formulating and enforcing biological fisheries restrictions is always costly. Therefore, fisheries management entirely based on biological conservation measures generate negative economic return (Arnason 1993).

5.3.2 Economic fisheries management

Direct measures

Direct economic fisheries management are concerned with controlling fishing effort and capital investment in fishing. It means that it tries to bring the fishing effort down to the optimal sustainable yield level. These measures are consequently ineffective because they fail to eliminate the basic common property nature of the fisheries resources (Arnason 2003). Fishermen can always find ways to invest in uncontrolled fishing effort to escape these restrictions. Therefore direct economic fisheries management is unlikely to generate long-term benefits from the fishery Arnason (1993).

Indirect measures

Taxes and property right such as access licenses and individual quotas are included in the indirect fisheries management methods. They are theoretically capable to generate lasting economic efficiency in fisheries.

Taxes on fisheries inputs will lead to substitution away from taxed inputs to those not taxed. To realize potential economic benefit of a fishery, taxes on catch are more effective, but it makes fishery less profitable. However, in practice this system is faced with socio- political problems.

The aims of the property based rights management is to eliminate the common property problem by establishing private property right over the fish stock (as explained earlier). To improve the socio-economic benefit from the fisheries, property rights management has been developed. It minimizes conflicts over access to resources and provides incentives for the owner of the resources to make them as productive as possible.

Sole ownership, access licenses, territorial user rights in fisheries (TURFs), individual quotas (IQs), individual transferable quotas (ITQs) and community fisheries management (CFM) are key modes of property right-based fisheries management.

5.3.3 Sole ownership

Scott (1955) described sole ownership as the complete appropriation of natural resources in particular areas. It could either plan to economize the use of fishing effort by adopting labour-saving techniques. If the sole ownership expects to have permanent tenure, then the fisheries would be quite different from competitive fishery in short time. The sole owner tries to keep the future return from the fisheries as high as possible. This can work if other enterprises in the economy are run by a purely free market economy. However, most of socio-political policies in many countries don't support sole ownership of the fisheries resources.

5.3.4 Licenses

Access license does not eliminate the problem of common property among the license holders. It may reduce the problem, only if the number of license holder is low and held for some years (Arnason 2001).

5.3.5 Individual quotas

According to Arnason (2001), IQs offer the most promising general approach to the management of fisheries resources. They can be monitored and enforced. Economically, IQ systems appear to be better than other systems and are widely and increasingly employed. IQs and ITQs generate sustainable economic benefits and capable of bringing fisheries reasonably close to the optimal point with limitations. These measures have been found economically ineffective, taking into account the cost of enforcement.

5.3.6 Territorial user right in fisheries

Territorial user right in fisheries (TURFs) is the exclusive right to engage in fishing within a certain specified geographical location (Charles 2000). The holders of TURFs have an incentive to control and conserve their environment. It works well for relatively sedentary fish stocks. For the stocks that periodically migrate in and out of the TURF-area, the effectiveness of TURF is much reduced.

5.3.7 Community fishing rights

Community Fishing Right is another form of property rights. It does not constitute a fisheries management system. Community Right represents the devolution of power from central government to a smaller community of fishers. Community Fishing Right does not eliminate the Common Property Problem. The community will still have to deal with the problem of designing and implementing a good Fisheries Management Regime. The community

members share rights and responsibilities to the resources. Figure 12 shows the possible power sharing responsibility between the government and the communities in the management of fisheries resources.

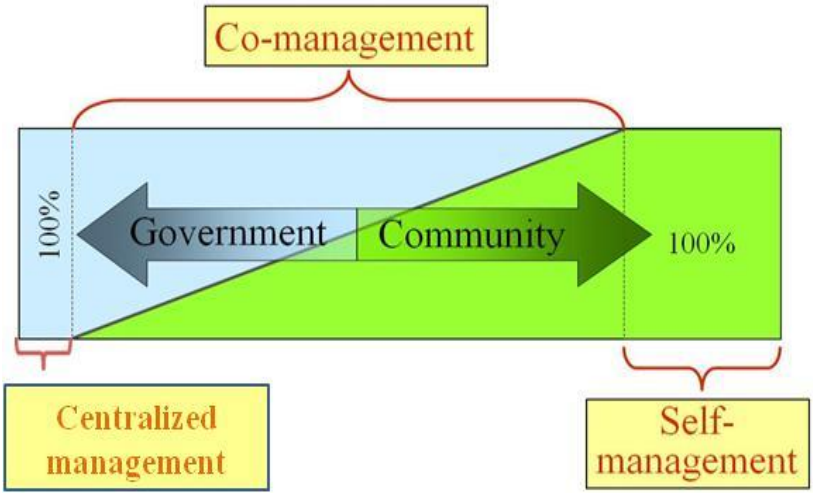

Figure 12: Power sharing responsibility between government and community in fisheries resources (Arnason 2009).

To the left, the government commands more power and responsibility and at the end of the diagram it has full power and management responsibility. To the right, the community has more power and responsibility in the management of their fisheries resources, and in the end of the diagram it leads to self-management.

Rationale for Community Fishing Right

The fundamental rationale for a CFR is that such option would possibly improve the coastal fisheries management with reduced cost of enforcement, and CFR could reduce the social and political problem in fisheries. Apart, the CFR has certain inherent advantages compared to the centralized management. These advantages are in collecting information, incentives and responsibilities.

Information sharing:

The responsibility for managing the resources should be borne by the communities and their involvement in the process would provide valuable knowledge to supplement research based scientific knowledge to improve management decisions.Information from the community is important for the management. It is often acknowledged that the local communities possess the most complete information and understand the environment of fisheries better than a central authority. A centralized authority often neglects the community's traditional knowledge, although it lacks financial resources to carry out research. International donors kick-start the community developments and they encourage the community involvement; little attention is has been given to the specific culture of the community. Sometime, donors expect the community to change their behaviour from their point of view, but they ignore the fundamental traditional value and this lead sometime to unsuccessful management measures (Pomeroy 1995, Arnason 2003).

Incentives:

Collecting data is difficult for the centralized authority. But if the collected data and the gathered information are inappropriate, these do not have effect on the remuneration of people in the government; on the contrary, in a CFR the effectiveness of the collected data and its processing is an incentive for the fishermen. Because, if they draw conclusion from wrong data, they risk losing their own money (Arnason 2003).

Responsibility:

In a CFR, communities realize that they own the fishery and they are the first to benefit from utilizing the fisheries. Therefore, the first responsibility for the management of the fisheries is also theirs.

Arnason (2003: 79) said: "*Community fishery management puts the responsibility for management squarely on the shoulders of the fisheries community itself. If the community fails in this management, it is unlikely that social safety nets will be as easily forthcoming as when central authority fails in its fisheries management function. Hence, this added responsibility contributes to even greater effort by the community members to conduct their fisheries management effectively"*

5.4 Community Fisheries management (CFM)

Community fisheries management is the management regime adopted by the community to achieve their collective goals and objectives. For Community Fisheries Management to be possible, the community must have substantial power to manage its own fisheries. Basically, the members of the fishing community find themselves in a situation where they have to play a bargaining game. The outcomes of the game depend on the collective decision made and group dynamics in the community and must be uncertain.

Arnason (2003) has established certain design principles for community fisheries management (CFM) namely *"Arnason design principles"*. These principles follow the probability that the CFM will generate lasting economic efficiency in fisheries. Community fisheries management (CFM) represents the devolution of power from the central government to a much smaller community of fishers, and have become seen as a viable alternative to the centralized fisheries management regime.

Arnason (2003) compares the rules of the fisheries management to that of game where players are community members. They will decide which rules to adopt and the process of adopting those rules to achieve goals and objectives of their fisheries. The outcomes of this game depend on the collective decision (level of coherence and cohesion) and the group dynamics in the community. This in turn is influenced by several sociological, political, cultural and economical factors. If the group is well organized and the group cohesion is high for division of labour, adherence to rules and distribution of benefits then it is likely that the behaviour and the decision of the group could be predictable. If the community members have different preferences and expectations so the outcome of decision is uncertain. Through their social relations, the right holders know much better about their individual and collective needs and preferences (Willmann 2000).

Right holders can, through their direct participation make a management decision based on their knowledge of the environment of their fisheries activities (abundance of resources, catches, economic returns etc.) and the community members may have different opinions on how to manage of the fisheries or on an optimal fishery policy. How the game is played depends on rules. The game is a positive sum game where all members can reach a solution and where all can benefit (Arnason, 2007).

In the bargaining game, the ideal policy of each member of the community is maximizing the aggregate profit. Rules of the game are to apply to the management regime as well as management measures.

According to Arnason (2007) the results are still the same, where pay-offs are shares in the aggregate profits. Each member's pay off is increases in the aggregate pay off independently of what the others members do.

Community may face certain restriction (limitation on effort and catch) due to an introduction of new management measures. From this in term of benefit, some member may gain and some may lose. Thus the policy should incorporate means of compensation for the loser so that there is overall net benefit.

The Arnason design principles attempt to increase the probability that fisheries management will be economically efficient. These principles may be regarded as design principles for organization the community fishing rights. These principles are referred to as such:

- The right allocated to the communities (property right) should be as high of a quality as possible.
- Communities consist of as homogenous group as possible.
- The decision-making rules of the community should be clear and effective.
- Communities should, if possible be set-up so that each member's pay-off is an increasing function of the aggregate pay-off.

5.4.1 The property right should be as high of a quality as possible

Property is commonly referred to an object that a person or group owns. Rights are the legal responsibilities provided to the owner of the property. The allocated property right should be of high quality, according to Scott (1996), the most crucial components of a property rights are the security, exclusivity, permanence, and transferability. As discussed in Arnason (2000), it is convenient to measure their properties on a scale from 0 to 1. Property right is perfect when the value of each of its components is in a measure of 1 (Figure 10).

Security

Full security means that the rights cannot be challenged (measure of 1) and the right holder will maintain his property. If they are challenged, the right holder can withstand to maintain his property.

Exclusivity

Exclusivity means that others cannot infringe on the rights. It means too that the right holders can utilize the subject of the right any way they wish. In ocean fisheries where fish are mobile, full exclusivity is hard to ensure. Enforcement plays critical part in exclusivity. For

total exclusivity, the right holder must ensure effective enforcement (Arnason 2000, Arnason 2003).

Permanence

Permanence is the right that allows the holder a time span to use the rights provided. Law should protect these rights. It doesn't mean that the community holds these rights forever, if the rights are to be withdrawn or transferred; compensation has to be paid to the right holders.

Transferability

Transferability means that the right holder can transfer the rights to another community if it wants to. If the right holders are not able to use the right due to technological reason, they may wish to transfer this right to others that could use of it to ensure maximum economic benefits (Arnason 2000, Arnason 2003).

5.4.2 The communities should consist of as homogeneous a group as possible

It is important for an efficient CFM that the community consists of a homogeneous group. It is preferable that the group is composed of fishermen because they share the common interest in fisheries. If the group consists only of fishermen, they will want to implement many fisheries management policy, which will maximize their profits. So the bargaining game will result in policies, which converge to a point that ensures maximum profits at the optimal sustainable yield (Arnason 2003).

5.4.3 The decision making rules from the community should be clear and effective

It is an important aspect of ensuring an efficient community fisheries management. The community should be set-up according to certain pre-assigned rules for decision making within the community. According to Arnason (2003) transaction costs will be reduced as the process of attaining a path towards bargaining equilibrium is increased.

5.4.4 Community should, if possible, be set-up so that each member's pay-off is an increasing function of the aggregate pay-off

This is crucial for an effective CFM. To realize this set-up it is necessary to allocate quotas within the community, and ensure that that all members have their share of property right. Then organize the community as a limited company with members as shareholders (Arnason 2003).

6 FISHERIES MANAGEMENT FOR SOUTHWEST OCTOPUS FISHERY

This section deals with designing a community fisheries management (CFM) structure system for the octopus fishery in the Southwest of Madagascar. In designing this system several aspects are considered. These aspects are the current situation of the octopus fishery, the management system and the profitability of the fisheries. Reasons, why the proposed CFM is appropriate in the octopus fisheries are also given in this section. Finally, the proposed strategies for implementation of the CFM are outlined.

6.1 The bio-economics of the octopus fishery

The need for proper management of the traditional octopus fishery in the Southwest of Madagascar is clear. This is an open access fishery and the experience of fisheries with open access management is very poor (World Bank 2009). The following bio economic analysis quantifies the problem. Using an excel spread sheet program designed by Arnason (Arnason 2008) we can calculate the current state of the fisheries and the equilibrium profit maximizing fisheries policy given the user's specification of a fishery and compares the outcome with the one corresponding to open access or a common pool fishery. Biological data and fisheries data in the base year (2006) are needed for obtaining full results. Biological data are the maximum sustainable yield (MSY), virgin stock equilibrium (or carrying capacity of the biomass) and the schooling parameter.

For the fisheries data in the base year, there are biomass growth in the base year t*, landings, price, profits and fishing effort in the base year t*. The unknown coefficients are estimated with the help of a number of assumptions about the fishery (Table 2).

Table 2: Assumed data for the calculation of the profitability of the octopus fishery.

Variable	Symbol	Value	Units
Maximum sustainable yield	MSY	1.20	1000mt
Virgin stock biomass	XMAS	2.50	1000mt
Landing in base year	X y(t*)	0.59	1000mt
Landing price in base year	p(t*)	1.00	mUS$/1000mt
Net biomass growth in base year	xdot(t*)	0.00	1000mt
Profits in base year	prof(t*)	0.18	m US$
Schooling parameter	b	0.95	No units
Effort (index or real base year effort)			
Actual fishing effort in base year	e(t*)	1437	fishermen
Necessary fishing effort in base year	estar(t^*)	1437	fishermen

The following basic fisheries model is adopted:

(1) $\dot{x} = G(x) - y$ (Biomass growth function).

(2) $y = Y(e, x)$ (Harvesting function).

(3) $\pi = p \cdot Y(e, x) - C(e)$ (Profit function).

(4) $p = P(y)$ (Landings demand function)

Where x dot is the biomass change, G(x) is the biomass growth function ,y is the total harvest, Y(e,x) is the biomass harvesting function, e is effort, C(e) is the harvesting cost function, Π denotes profits and p represent the price of the harvest.

x, y, π, p are endogenous determined within the model. The fishing effort *e* is exogenous, it is a control variable for the fisheries operators. All variable depends on time and can change over time. The following functional specifications, suggested by the available data are employed in implementing the model.

$$x_{t+1} - x_t = G(x_t) = \alpha \cdot x_t - \beta \cdot x_t \cdot \ln(x_t)$$

$$Y(e_t, x_t) = q \cdot e_t \cdot x_t^b$$

$$C(e_t) = c \cdot e_t + fk$$

$$P(y_t) = p$$

α, β, q, b, c, fk and p are constants and t refers to time. The ratio α/β, is the carrying capacity of the biomass (virgin stock equilibrium), fk represents fixed costs, q catchability; f is the elasticity of landings price with respect to the volume of landings. Note that the biomass growth function selected is the Fox function. This is because this function fits the one-time-spawning biology of the octopus better than a symmetric biomass growth function such as the logistic one.

Using the excel spreadsheet designed by Arnason the following coefficient are given in the Table 3 below.

Table 3: Implied Fox coefficients as estimated from the model.

Coefficients	Estimates
α	1.196
β	1.305
q	0.02
c	0.00
fk	0.00
p	1.00

6.2 Result of the model

The following diagram (Figure 13) illustrates the Fox biomass growth function for the coefficients estimated

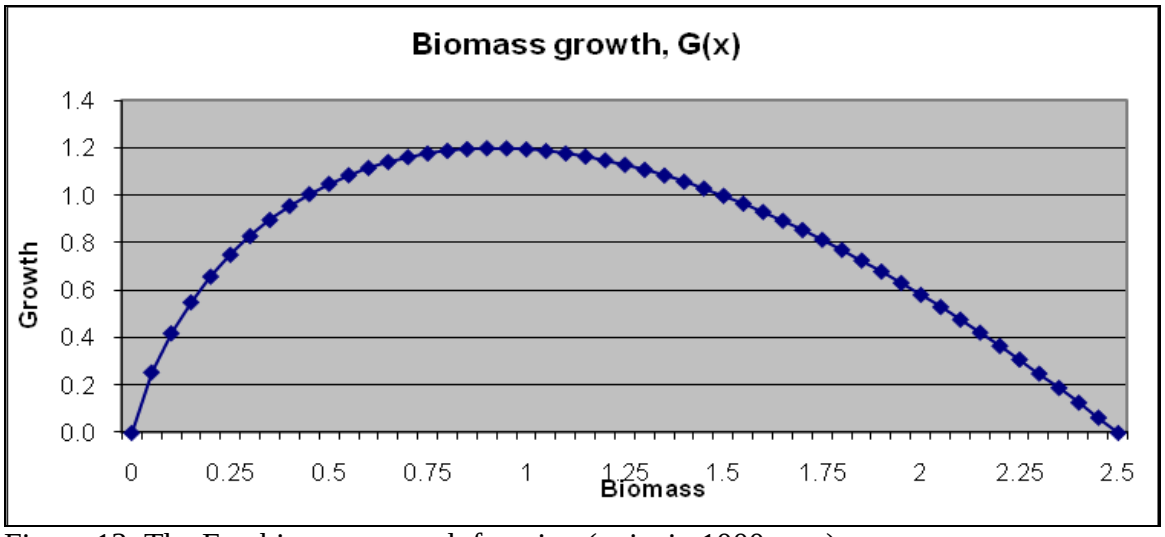

Figure 13: The Fox biomass growth function (units in 1000 tons).

Based on the above estimated coefficients (Table 3), the sustainable fisheries model can be calculated. The corresponding diagram is illustrated in Figure 14.

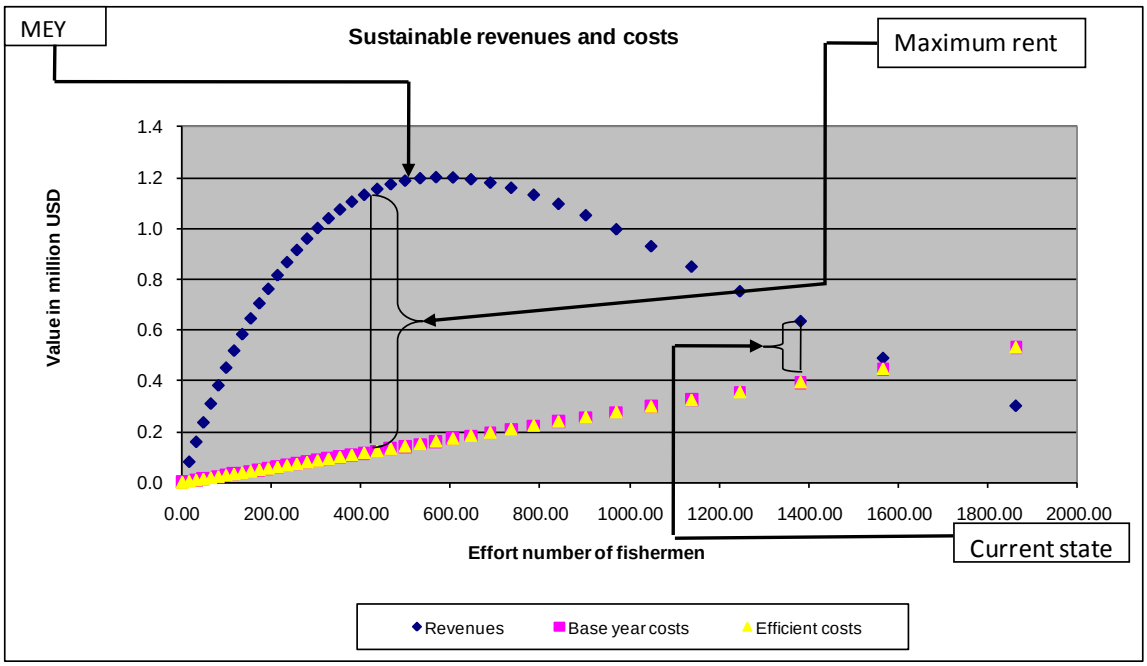

Figure 14: Estimated maximum economic yield (MEY) and rent for the octopus fisheries in 2006.

The maximum economic yield is about 1.2 million US$ (Figure 14.). The maximum rent 1.02 million US$ at is attained effort level of 497 fishermen. This is the point where the difference between revenue and total cost is greatest. Open access equilibrium, however, is determinate at an effort of 1566 fishermen. The current fishing effort is only slightly less than this. Profits are very small and the biomass is much less than would be optimal.

As per the model results it can be concluded that this fishery suffers from excessive fishing effort, low profits and depressed biomass. Moreover, this situation is likely to become even worse in the near future. Therefore, fisheries management is needed.

6.3 Fisheries management options for the octopus fishery

Several types of property right have been proposed to alleviate the fisheries problem. This includes sole ownership; territorial use rights (TURFs), individual quotas (IQs), individual transferable quotas (ITQs), and community rights.

Sole ownership is unlikely to be socially acceptable because putting the resources into sole ownership is making a resource specific to one owner. This may imply unfairness and unequal distribution of the resources, which may be resisted by the rest of the population. So the socio-political policy does not support the sole ownership of the fisheries management.

Individual Territorial use rights (TURFs) divide the fishery into a several plots. Each geographical area is exclusively assigned to a fisher. This system has limitation in management of migratory marine resources, because when the resources move in or out of the TURFs, the quality of the property rights is correspondingly reduced. Octopus does not apparently undertake large migrations but it is quite mobile and certainly does not remain in small TURFs (Humber *et.al*.,2006).

Individual Quotas (IQs) and Individual Transferable Quotas (ITQs) is a measure, which will reduce fishing effort. ITQs are economically superior to IQs and are widely used with generally good results (World Bank 2009). However ITQs and IQs require strict monitoring of harvest, which is often difficult, especially in small-scale traditional fishery such as the octopus fishery in the Southwest of Madagascar and cost of the monitoring and the enforcement are high.

Community property right is not a management system as such. It provides the community with collective property in the fishery (for example communal quota) that allows the community to run its own fisheries management. Community Fishing Rights (CFR) is in many respects suitable for this fishery:

- Fisheries in Madagascar are characterized by poor infrastructure, communication facilities and technical support. These characteristics impede the implementation of fisheries management through the top-down approach such as ITQs or individual TURFs. Decentralised management is suggested as an alternative approach.
- The fishing communities who live in the southwest of Madagascar have managed their fisheries resources through traditional arrangements. All fishers adhere to a traditional local law namely "dina", which is recognised by the government.
  Therefore introduction of a management system such as Community Fisheries Management where government and communities share the responsibilities in management of resources will fit into an existing functioning structure and is likely to be welcomed by the local communities.

CFRs are likely to improve fisheries management and Monitoring, Control and Surveillance by generating the proper incentives to the users of the resources. When exclusive rights to the resources have been given to the fishing communities, and they have opportunity to manage the resources themselves, they will have incentives to manage the resources in a sustainable way.

6.4 The recommended community arrangement

The recommended community arrangement will consist of two partners: the government and the fishing communities.

The communities will be organised into community management units according their geographical location. There are fourteen major villages in the coastal part of the southwest of Madagascar, each constituting a point of collection of the catches (L'Haridon 2006). These will be formed into community management organisations called Village Fisheries Management Units (VFMUs). These organisations will be the basic units of fisheries management at the community level.

It is expected that the community fishing rights will be based upon community TURFs for the more sedentary species

The government and the community share the right and the obligation to manage the resources. This is called co-management. A key issue of the co-management arrangement is to identify which fisheries management aspects have to be retained by the government, which can be delegated to the fishing communities and which should be taken care of jointly by the government and the communities.

The proposed tasks for the government are:

1. The setting of law or rules to legalise community fisheries management.
2. The setting of rules for decision making within the communities
3. Demarcation of the fishing grounds in the case of community TURFs.
4. Setting community fishing quotas in the case of community quota rights.
5. Setting some general fishing gear regulations
6. Conducting research through National Fisheries Institute of Marine Science and providing technical assistance and training to the communities.

The proposed tasks to be handled by the fishing communities are:

1. The formulation of community by-laws
2. The management of the fishery within the bounds set by the government. This includes selecting a fisheries management system within the community and the formulation of a fisheries management plan for the community.
3. Enforcing the fisheries management rules
4. Collecting data to for research and to submit to the government.
5. Dealing with matters concerning other fisheries communities

Given its TURF and quota rights, each VFMU will develop a general management plan. It is regarded as guidelines for a fisheries management at the village level and will describe strategy for implementation of fisheries management activities. This general management plan will contain also basic information for each village such as geographical parameters, demographic and livelihood data, socio-economic status of their respective village and the traditional knowledge of the resources and its environment. This general management plan will be effective once the government represented by the fisheries department will do certification.

For this to work well, effective communication between the government and the communities is required. Currently, the Ministry of Fisheries in Madagascar and the Regional Department of Fisheries, which represent the government at the regional level, have mandates to communicate, coordinate and to oversee the development of fisheries activities. These and other existing communication channels should be improved and formalized. New ones should be set up as needed. During the initial stages of this process several meetings and workshops are foreseeably needed.

6.5 The design of the Community Fishing Right (CFR) for the Community Fisheries Management (CFM) for the fishery

The set-up for the CFR in the octopus fisheries in the Southwest of Madagascar should be according the following principles:

1. CFR should be high quality as possible, in term of security, the duration of the right (long term), exclusivity and transferability between communities. In term of transferability it is proposed that the community have to keep the right ten years without transferability, to avoid the problem due to the lack of experiences on using these rights.

2. The members of the communities should be as homogenous as possible. The community consists of fishermen, collectors, and the owner of the fish collection facility or its representative. It means that communities should not be large neither geographically nor socially. To base the communities on the already existing village structure is in accordance with this principle.

3. In order to receive individual fishing rights, fishermen must be included in a fisheries community and abide by its rules.

4. To the extent possible, the fishing communities should adopt rules about the allocation of benefits. In these rules, individual benefits should depend positively on the collective benefits. As an example of this kind of an arrangement is a limited company with the members as shareholders.

5. The government represented by the Fisheries Department in the granting of communal fishing right should follow certain procedures such as:

   (i) Establishing basic rules for structures and decision making within communities.
   (ii) Signing contract of rights 'obligations with the communities.
   (iii) Offering advice (biological, managerial, economic) on running the communities and the fisheries.
   (iv) Including fishing communities in the decision of centralized fisheries management including the setting of overall total allowable catches (TACs), total allowable effort (TAE) etc.

6.6 Implementation of the Community Fishing Right system

The implementation of the system will consist of three major phases:
(i) Preparatory phase,
(ii) Implementation phase and
(iii) Monitoring and evaluation phase.

The preparatory phase includes informing and consulting with the communities. Community fisheries management will not be successful unless the communities want it and understand the implications. In case of the octopus fisheries in the southwest of Madagascar, community fishing rights are not currently in place and individual rights are extremely weak due to the common property problem. Thus, there may be a desire to obtain some form of community rights over the fishing.

Once the government has formulated its community fishing rights policy, it should announce it at the national level through the media (newspaper, TV radio). At this stage, requests from interested communities should be invited.

Then, technicians from the Ministry of Fisheries should travel to the interested and other communities to inform and discuss with key community leaders (village authority, elders of the village, the fishermen leaders). The objectives of the consultations are first to explain to these key leaders the nature and benefits of these rights to them. These benefits will be of social, economic, environmental and political nature. The second objective is to get their

inputs as to the proper organization of the rights. The third objective is to obtain their support for the implementation of the community right.

It should be emphasized, however, that there is no need for every community to be interested in the community fishing right system Interest from just a few communities is required for this project. If community fisheries management is beneficial in the way expected, the other communities will undoubtedly follow later.

If the key leaders support the program, the next meetings will be organized with individual fishing communities. The objectives of these meetings are to generate public awareness of the CFR system and to seek the support from the fishing community (all fishermen and other stakeholders).

Following the successful completion of these meetings and discussions, the next step is the organization of the community fisheries management group that will oversee the implementation of the CFR.

Once the government has recognized the community management group, a co-management agreement will be signed for a specified period of time, which clearly establishes the roles and the responsibilities of the community and those of the government. In this agreement the community will be have the obligation to implement the CFR and manage their own fisheries and the government will be responsible of providing general oversight, technical support and some funding.

The implementation will be the following stage. It has various components such as to:

- Identify of the potential site under jurisdiction of the village community.
- Develop of guidelines of resources use, methods of fishing respecting the environment and ensuring the conservation and sustainable use of the resources.
- Conduct assessment of potential stock size of the resources through assistance of experts, gathering information about traditional fishing practice, locate heavily fished areas, the busiest season of fishing and others relevant socio-economic data.
- Develop the rules which will guide the general operation of the fishing community such as individual or group fishing areas, fishing periods, closed seasons, quotas etc.

The community will implement the plan of the CFR system and will be responsible for enforcing the fisheries management rules. The government will conduct the monitoring and the evaluation of the success or failure of the implementation. Depending on the result of the implementation, the government will decide whether to continue the program or to seek alternative management interventions.

6.7 Estimated cost and time frames

It is important to implement the concept as a pilot project. At the beginning of the project, four communities will be selected according their proximity to the nearest major city or other relevant criteria. Implementation of CFR is costly. A rough estimate of the costs for implementation for a pilot project CFR in the southwest of Madagascar is indicated in Table 4

Table 4: Rough estimated cost in USD of implementation of pilot CFR in the southwest of Madagascar:

Activity	Time scale	Level	Number	Cost per unit	Total cost
1. Preparatory phase	12-18 months				
Informing stage			1	**4000**	**4000**
Consultation with the community			1	**10000**	**10000**
Consultancy			**1**	**20000**	**20000**
2. Implementation	12-36 months				
Training and awareness program		**community**	**4**	**5000**	**20000**
Meeting with the community		**community**	**4**	**2000**	**8000**
Management cost		**community**	**4**	**2000**	**8000**
Legal processes			**1**	**20000**	**20000**
Setting up MCS-system		**community**	**4**	**5000**	**20000**
3. Monitoring and evaluation		**community**	**4**	**3000**	**12000**
	Total				**122000**

The total cost of the implementation of CFR in the southwest of Madagascar is estimated at approximately 122,000 US$. As we mentioned before, the role of the government is not only to provide technical support to the community but provide some funding.

It is estimated that the preparatory phase for the implementation of the CFR will take 12 to 18 months. Considerable time is necessary to consult, explain and convince the government authority and the local authorities of the importance and the benefits of the allocated right to the fishing community. The time needed for the consultation of the community will be much less because they have already worked with conservation organisations to develop plans and strategies for marine resource management, and are already aware on the problem facing the fishery of the southwest of Madagascar.

Taking these situations into account, 12 to 18 months may be required to set up and start the implementation of the CFR. It will require one to two years for the CFR to be operational and 36 months before the four selected communities are fully covered.

7 CONCLUSION

This project paper has reviewed the actual situation of the octopus fishery in the southwest of Madagascar and identified the exploitation level of the octopus. The result of the study indicates that the profits (or economic rents) from the fishery are decreasing due to an increasing numbers of fishermen. To resolve this situation, fisheries management is needed. Several options of property right are discussed to alleviate the fishing problem. Among those property rights, Community Fishing Rights are likely to improve the fisheries management and monitoring, control and surveillance by creating incentive to the users of the resources.

The purpose of fisheries management is to increase economic return from the fisheries to the fishermen and ensure sustainability of the resource. By allocating fishing rights to the fishing communities in their respective villages, the common property problem will likely be reduced. Theoretical and practical evidence indicate that the tragedy of common can be avoided through community property right where community control the access right to the resource and protect the resource against the fishermen from other areas.

This system will give the fishermen an incentive to apply an appropriate fishing effort and monitoring and control the fishery. Therefore, in the long run, total catch and catch per unit effort should increase and the economic benefits from the fishery improve.

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