Thesis for the Degree of Master of Fisheries Science

Policy Evaluation of Marine Fisheries System; a multi-criteria participatory approach with the case of Sri Lanka

by

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KOICA-PKNU International Graduate Program of Fisheries Science

The Graduate School

Pukyong National University

February 2012

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다중접근법 어업정책평가 시스템에 관한 연구

– 스리랑카 어업정책을 중심으로 –

Advisor: Prof. Sang-Go LEE

by

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A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Fisheries Science

in KOICA-PKNU International Graduate Program of Fisheries Science,

The Graduate School,

Pukyong National University

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February 24, 2012

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Policy Evaluation of Marine Fisheries System; a multi-criteria participatory approach with the case of Sri Lanka

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Abstract

The process of policy formulation, dissemination and implementation needs effective strategies and management structures to maximize the utilization of scare resources for human well being together with environmental well being. Fisheries are living natural resources. Therefore policy initiatives require comprehensive information as well as appropriate evaluations in different dimensions with country's requirement. In this manner this study was carried out to appraise current status of Sri Lankan marine fisheries considering five evaluation fields with regard to fisheries policy evaluation. Moreover Rapfish technique was adapted to compare the status (ecological,

economic, social, technological, and administrative) of both principal fisheries (coastal and off shore fishery) with reflecting the impact of current marine policies. The study revealed that both fisheries were still not bad in ecological perspective than result of other fields' evaluations. But, in the same time system of current fisheries management regime was evaluated as weak and ineffective even though it was the policy formation body. Here it is distinguished that formation and implementation of policies take minimum consideration of available decision support tools and also careless policies to improve the robustness of decision support tools vice versa.

Introduction

Marine Fisheries in Sri Lanka

Sri Lanka is an island state in the Indian Ocean, located south-east of the Indian sub-continent between latitudes 5^{o} 30'-10^{o} 00' North and longitudes 70^{o} 30'-82^{o} 00 East. The island is approximately 65,610 km^2 in area with 1817.5 km (MFAR, 2007) long coastline (Samaranayake, 2003). Sri Lanka claims sovereign rights over 517,000 km^2 of Exclusive Economic Zone (EEZ) of the Indian Ocean including 21 500 Km^2 territorial sea. The country has a narrow continental shelf with an average width of 22km and its extent is 30 000km^2 which is 5.8 percent of the country's ocean area (FAO, 2007).

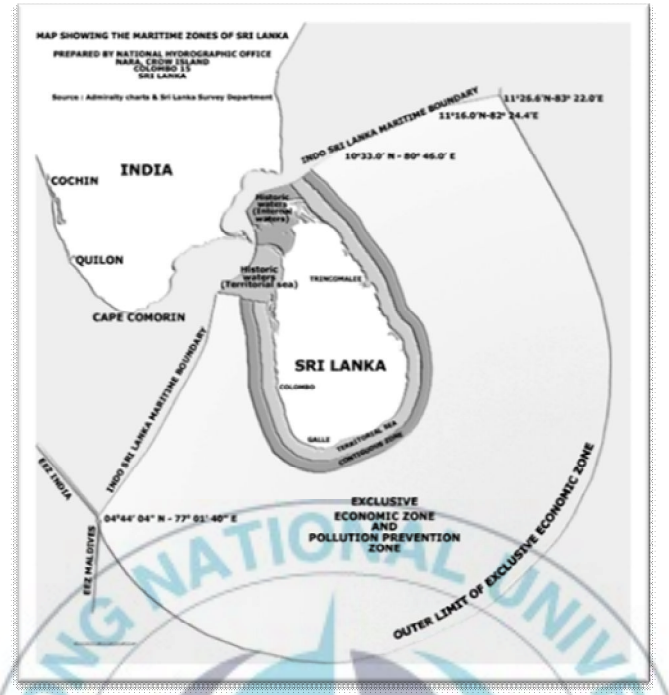

Figure 1: Sri Lanka's maritime waters

Fishing remains the key livelihood activity for the coastal population of Sri Lanka. The coastal zone consist 25 percent of the land area of the country, 25 percent of the total population of the country, 70 percent of hotels and 70 percent of industrial units (FAO, 2007). More importantly it contains a variety of coastal habitats that includes estuaries, lagoons, mangroves, coral reef and large extent of beaches and dunes that are vital to ecological functioning and maintenance to bio-diversity. Sri Lankan fisheries can be divided in to three subsectors as coastal fisheries, off shore /deep sea

fisheries and inland and aquaculture fisheries (Ten Year Development Plan, 2007-2016, MFAR). Both coastal and off shore fisheries (marine fisheries) contributed 86.29 percent for the national fish production amount of 293 170MT in 2009. The operated total number of crafts was 48 274 and 32 778 operation licenses had been issued by DFAR for exploitation of marine fisheries in the same year(Fisheries Statistics,2009,MFAR).

Total fishing households accounted 139 630 and total active fishers comprised 175 223 of both 139 630 fishermen and 10 353 fisherwomen in 2009. As per census of fishing boats (2006/2007) 1 337 fishing villages involve in marine fisheries and 664 820 population represent those fishing households. Fisheries sector created variety direct and indirect of employment nearly 475 000 comprising fishing, associated service activities, fish trade and also 2.5 million fishing and related livelihoods including inland and aquaculture. Number of fisheries cooperative societies has increased up to 568 in 2009 than previous with reactivated program conducted by MFAR. There are 91 095 member consist of both male and female. Fisheries pension scheme is also one kind of social welfare system which support to fishers and their family members and there are 61 163

fishermen already have taken part of the scheme getting benefits someone among them (Fisheries Statistics, 2007, 2009, MFAR).

On 26 December, 2004 the fisheries sector was severely affected by tsunami tidal causing widespread destruction and killing over 31 000 people, 4 870 fishers, destroying 16 434 fishers homes and damaging natural ecosystems, and coastal infrastructure in East, South and South Western coast (FAO, 2007). Of the 12 major fishing harbors 10 were severely damaged. Immediate after tsunami Government started the rehabilitation program with assistance from different donor agencies in short term as well as long term. At present there are 16 major fishery harbors, 40 anchorages and 785 minor fish landing centers functioning entire coast of the country. Also 75 active fishing plants give their contribution to fisheries sector with capacity of ice production 1 059 ton per day. Addition to those 26 of cool room, 29 of boat manufacturing yards and 6 fishing gear factories currently contribute to increase the infrastructure facilities throughout the country (Fisheries Statistics, 2009, MFAR).

Institutional Arrangement

The Ministry of Fisheries and Aquatic Resources Development (MFAR) is a cabinet ministry which is the responsible for fisheries policy, management, development and conservation of fisheries resources in Sri Lanka. The MFAR, formerly the MFOR (The Ministry of Fisheries and Ocean Resources) was established in 1970, having previously been part of the Ministry of Agriculture (FAO, 2007). There are one department, two agencies and three co operations under the current Ministry (Figure 2).

Department of Fisheries and Aquatic Resources (DFAR) act as an implementation directorate. National Aquatic Resources Research and Development Agency (NARA), and National Aquaculture Development Authority (NAQDA) both are responsible for research, development and extension of fisheries resources. Ceylon Fisheries Cooperation (CFC), Ceylon Fishery Harbour Cooperation (CFHC) and Cey-Nor Foundation Ltd provide services for the sector such as fish distribution, harbor management, fishing vessel design and fishing gear supplying respectively.

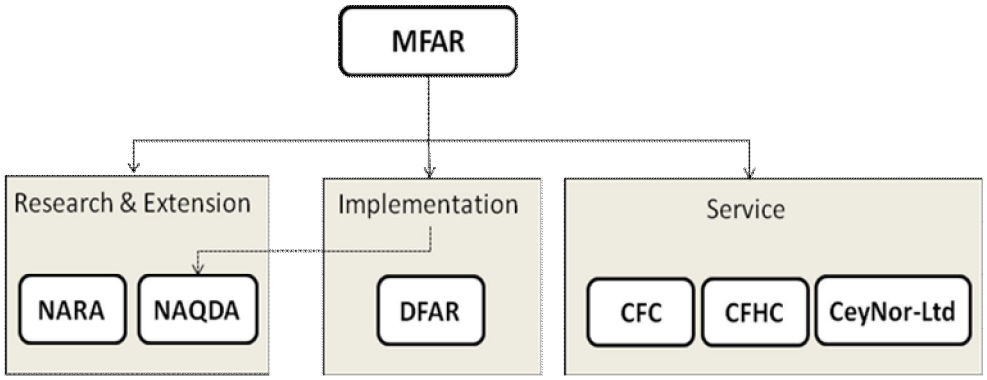

Figure 2: Institutional arrangement of MFAR

Except those six directorates there are other two key institutions directly involved with the sector. Coast Conservation Department (CCD) conserve, protect develop and regulate the coastal zone and National Institute of Fisheries and Nautical Engineering (NIFNE) provide education and training on fisheries. Previously CCD and NIFNE both were under the MFAR and in 2009 they had been moved under the Ministry of Defence and Ministry of Education respectively.

Additions to those there are other government organizations pertain to the fisheries sector from different Ministries. Department of Wildlife, Department of Coast Guard, Department of Co-operatives are some of among them. District Agents/ Secretaries and Divisional Secretaries, Provincial Fisheries Ministers and Department Provincial Councils

established as per the 13th amendment of the constitution Municipal, Urban Councils and village level Pradeeshiya Saba which are involved the sector in different ways (Wijayaratne, 2001).

Research and effective management both are essential when marine resources are to be utilized in a sustainable and responsible manner. Usually management measures depend on best scientific information available and also it rely on proper data collection system and appropriate research vice versa. DFAR and NARA are the key institutes which are mainly responsible for those implementation and research activities for marine fisheries in Sri Lanka.

NARA

NARA is the principal national institute charged with the responsibility for carrying out and coordinating research activities on aquatic resources. It is the main research body of the MFAR. NARA was established in 1981 (Act number 54) as a responsible to the implementation of Sri Lankan's EEZ and It provides scientific and technology expertise and advice for the development and the management of the fishing sector. It has organized its activities into nine divisions (FAO, 2007).

Objectives

- Application and utilization of scientific and technological expertise for the implementation of the national development program on the subject of living and non-living aquatic resources.

- Promote and conduct research activities directed towards identification, assessment, management, conservation and development of aquatic resources in following fields.

    - Oceanography and Hydro graphic
    - Fishing gear, fishing craft, equipment and fishing method
    - Social and economic aspect of the fishing industry and welfare of the fishermen and their dependants
    - Processing, prevention and marketing of fish and aquatic products and,
    - Development, management, conservation of aquatic resources in the inland waters, coastal wetlands and coastal and off shore waters.

DFAR

The DFAR is responsible for the management, regulation, conservation and development of fisheries and aquatic resources in the Sri Lanka. The legal basis for DFAR activities is the Fisheries and Aquatic Resources Act No 2 of 1996. Principally, DFAR is responsible for the administration and enforcement of the fisheries act and regulations (FAO, 2007).

The Fisheries and Aquatic resources Act No 2 of 1996 and Amendment No 4 of 2004 determine the role of fisheries and aquatic resources advisory council, prescribing the management areas and implementation of limited input controls through fisheries committees, establishing a system of registration and licensing including provisions for registration of local fishing boats, licensing of fishing operations, settlement of fishing disputes, powers of authorized officers, offences, penalties and other provision for open access.

DFAR acts to fulfil leading six objectives under given mandate by Fisheries and Aquatic Resources Act No 2 of 1996.

Objectives

- To manage, regulate, conserve and develop fisheries activities in sustainable manner in conformity with national and international laws and conservation.

- To promote local and foreign investment in the fishing sector

- To introduce new technology for the expansion of fishery resources in national and international waters.

- To ensure quality and safety of fish and fishery product exports in conformity with international standards.

- To uplift the socio-economic status of the fishing communities and

- To minimize post-harvest losses and improve the quality of local fish production.

DFAR is organized dividing in to six divisions and those divisions responsible for different tasks to accomplish above objectives. There are

fifteen District Fisheries Offices have been established in coastal districts around the country to carry out activities of DFAR. Those fisheries districts have been also broken up in to Fisheries Inspection Divisions and it is the bottom level management body where the officers and community meet together directly.

Addition to Fisheries and Aquatic Resources Act No.2 of 1996 there are some other government agencies legally involve managing and conserving the sector directly and indirectly. These authorities mandated by giving provisions through their acts.

Coast Conservation Act No. 57 of 1981 and Amendment No 64 of 1998 makes provisions to conduct research, formulate coastal zone management plan(CZMP), regulate, control activities in the coastal zone and to formulate and execute coastal protection.

Coast Guard Act No. 41 of 2009 is responsible to protect the coastal belt around the country and maritime zone considering non military enterprise, committed to enforcing law ensuring safety, security and cleanness in Sri Lankan waters. It has empowered to the arrest the persons, vessels, and ship which engaging in illegal fishing and assist Sri Lankan fishermen in distress while fishing in the deep sea.

The Fauna and Flora Protection (Amendment) Act 1949(No. 38), 1964(No. 44), 1970(No. 1) and 1993(No.49) indicate the protected fish species and provisions for the establishment of natural reserves, nature reserves and sanctuaries within which no person shall take fish or other aquatic animals without a permit issued by the director of Department of Wild Life.

The National Environment Act No. 47 Amended by No. 56 of 1988 makes provisions for the protection, management and enhancement of the environment and for the regulation, maintenance and control of the quality of the environment and to prevent abetment and control pollution.

The Forest Act 34 of 1951 Amended in 1954, 1966 and 1979 covers the large extent of mangrove forest and some of the inland water bodies with the forest forests fall within the control of this Act executed by the forest conservation.

Marine Pollution Prevention Act Provides for the prevention, reduction and control of pollution in Sri Lankan waters and is in part to comply with international conservations to prevent pollution of the sea.

Coastal Fisheries

The coastal fisheries are confined to waters of the relatively narrow continental shelf and its slope area that is 22km wide on average and rarely exceeds 40 km (Wijayaratne, 2001) where the fishing crafts do single day operations (FAO, 2007). After establishment of The Department of Fisheries in1940s, the Sri Lankan fishery was confirmed to inshore waters. The traditional crafts are made out of timber and use gear such as beach seines and stake nets made out of coir. The fish production in the 1950 was approximately 40 000MT of which 40 percent was caught with beach seine (Wijayaratne, 2001). The rapid development of coastal fishery began in 1960 mainly due to motorization and introduction of new crafts, fishing gear made of synthetic material. The coastal fish production increased from 38 760MT in 1957 to 114 870MT in 1975 and 183 280MT in 2000 (Wijayaratne, 2001).

The coastal fisheries in Sri Lanka are multiple species and multi gear with high species diversity. About 610 of coastal fish species have been reported from Sri Lankan water (Country Profile, FAO) and mainly consist of small and large pelagic fish, dermersal fish, coral reef fish, invertebrates, shrimp and crabs (Samaranayake, 2003). Small pelagic are accounted for about 40

percent of coastal fish production (Haputhanthri, 2004). There are about 100 species of small pelagic around Sri Lanka, of which not more than 25 contribute significantly to the commercial production (Samaranayake, 2003). Of the variety of gear used, small - mesh gill nets and beach seines are the main methods used for exploitation of small pelagic fish and diving for collecting sea cucumber, chank and ornamental fish species in the island. Gill nets contributed over 80 percent of the landings while beach seines accounted for most of the reminder (Maldeniya, 1997). Tuna and bill fish are the dominated large pelagic species in the coastal water and highest catches have been seen in Eastern zones (Large Pelagic Database, NARA, 2006).The large mesh nets and ring nets are the main methods used for exploitation of large pelagic fish in the coastal waters of the island. Two types of gillnets are used for catching for tuna varieties. The large mesh gill nets (5" - 7" mesh size) mainly target on large tuna but considerable amount of small tuna varieties are also landed in this fishery. Medium mesh gill nets (2.5" – 3.5" mesh size) are exclusively used to targeted small tuna (Wijayaratne, 2001). Besides gill nets, a number of other important gears include troll lines, trammel nets, bottom long lines, bottom trawls, and hand line are also used in coastal fisheries (Premawardana, 2009). However, the

long line is the most popular gear in coastal waters for large pelagic presently, but gill nets and hand line combination can be seen very frequently. Only gill nets can be seen in Eastern statistical zone as the fishing gear for large pelagic (Large Pelagic Database, NARA, 2006).

Coastal Fish Production and Fishing Fleet

Boats which are operated in Sri Lankan waters can be categorized in to six types according the Fisheries and Aquatic Resources Act No 2 of 1996 (Premawardana, 2009). Addition to that there can be seen other type of vessel classification based on purpose of data collection on large pelagic fish species in marine waters. It was introduced by FAO/TCP data collection program mainly considering size, length and construction of the vessel. More over it was decided to use the same the vessel classification for the IOTC/OFCF data collection system (Large Pelagic Database, NARA, 2006). Those two type vessel classification summarized in table 1 and table 2.

Table 1: Fishing vessel classification by Fisheries Act, No.2 of 1996

Description	Code	Fishery
Off-shore multi-day boat	IMUL	Off-shore
Day boat with inboard engine	IDAY	Coastal & Lagoon
FRP boat with outboard engine	OFRP	Coastal & Lagoon
Traditional boat with outboard engine	MTRB	Coastal & Lagoon
Beach seine boat (non motorized)	NBSB	Coastal
Traditional boat (non motorized)	NTRB	Coastal & Lagoon
Fishing without craft	FWCR	Coastal & Lagoon

Table 2: Fishing vessels classification by large pelagic data base, NARA, 2006.

Boat Code	Boat type and description	Fishery
TR2	Traditional Mechanized oru - wallam	Coastal Fishery
TR5	Mechanized Traditional oru	Coastal Fishery
UN1	5.5 -7.2 m (17' -21') FRP dinghy. Outboard engine - 8 - 40 HP (usually 15 - 25 HP).	Coastal Fishery
UN2A	8.8 - 9.8 m (28' - 34'). FRP or wooden. Inboard engine (single) - 40 HP. No ice box or insulated fish hold, no gear hauler, navigational or acoustic equipments.	Coastal Fishery
UN2B	8.8 - 9.8 m (28' - 34'). FRP wooden. Inboard engine (single) - 40 HP. Insulated fish hold, no gear hauler, may have GSP/ sounder/ fish finder.	Off Shore Fishery
UN3A	9.8 - 12.2 m (34' - 40'). FRP wooden. Inboard engine (single) - 60 HP - (includes Abu Dhabi vessels). Insulated fish hold and may have gear hauler/ GSP/ sounder/ fish finder.	Off Shore Fishery
UN3B	12.2 - 15.2 m (40' - 50'). FRP or wooden. Inboard engine (single) - 60 + HP. Insulated fish hold and may have freezer facilities. Gear hauler/ GSP/ sounder/ fish finder.	Off Shore Fishery
UN4	Reserved for vessel category e.g. 15.2 - 18.3 m (50' - 60'). Few in numbers.	Off Shore Fishery

There are five different type of crafts use in coastal waters with one operating system without craft (Diving). From the day marine fisheries started coastal fisheries have been taking part as the major contributor for

national fish production up to now. Table 3 shows that total fish production and number of different type of crafts engaged in coastal fishing fleets. It distinguishes while the total number of crafts was increasing from 26 165 to 39 495, the production was fluctuated during last ten years (2000-2009). The production 176 250MT in 2002 was surpassed in 2009 (180 410MT) for the last decade. But number of craft addition to coastal fishing fleet was continuously increased.

Table 3: Current and targeted (2016) coastal fish production and number of crafts by type (source: Fisheries Statistics, MFAR, 2009)

Year	Capture fish Production	IDAY	OFRP	MTRB	NTRB	NBSB	Total Fishing fleet
1995	157,500	1,357	8,564	1,060	14,649	-	25,630
2000	175,280	1,170	8,690	1,205	15,100	-	26,165
2001	167,530	993	8,744	640	15,200	-	25,577
2002	176,250	1,112	9,033	776	15,600	-	26,521
2003	163,850	1,486	11,020	618	15,040	-	28,164
2004	154,470	1,493	11,559	674	15,260	1,052	30,038
2005	63,690	1,164	11,010	1,660	14,739	-	28,573
2006	121,360	907	13,860	1,842	16,347	-	32,956
2007	150,110	1,060	15,200	1,680	16,640	1,008	35,588
2008	165,320	1,140	15,847	1,959	17,178	932	37,056
2009	180,410	958	17,193	2,126	18,243	975	39,495
2016	236,132	1,310	15,766	2,413	16,000	990	36,479

The prolonged civil war situation for last three decades (up to 2008) the Northern and Eastern parts of country had adversely affected. It was severely affected the coastal fisheries and was a major reason to reduce its contribution to national marine fish production. The Northern and Eastern coastal belt covered nearly 60 percent of the Sri Lankan coastal line (USAD, 2008). Due to the conflict disturbance directly affected both marine fisheries and production had declined to 68 percent by 2000 (Wijayaratne, 2001). This is a one reason for increased pressure on coastal fisheries in other parts of country with migrated fishermen. Sudden reduction of production can be seen in 2005 as result of tsunami tidal waves in 2004.

Current status of Coastal Fisheries

"The Dr. Fridtjof Nansen" Survey in 1978 – 80 estimated the total bio mass on the West South and east shelf to be 400 000MT - 500 500MT with seasonal variation. Of these demersal and semidemersal fish were estimated at 250 000MT – 350 000MT consisting of emperors, snappers, groupers, sweet lips, carangids etc. The potential yield from coastal fish resources within the continental shelf was estimated to be 250 000MT per year of pelagic and demersal fish species. Coastal pelagic fish were estimated to

have a maximum sustainable yield (MSY) of 170 000MT per year and demersal species 80 000MT (Wijayaratne, 2001). According to the table 3 current total productions for both pelagic and demersal fish was 180 410MT in 2009. When it compares with total MSY for coastal fisheries (250 000MT); it is quantitatively under exploitation. But the survey was carried out in Northwest coast, Southwest coast, Hambanthota bank, East coast, Northwest coast and Pedro bank which was covered almost all around the coastal belt of country (FAO, 1999). As a result of Northeast conflict, present total production of marine fisheries was unable to represent whole marine production of the country. In this manner it is difficult to narrate current exploitation level is under exploitation without comprehensive scientific research. Moreover, the fishermen who lost their livelihood in Northeast parts; they migrated to other parts of the country. The result of this was addition more pressure to coastal fisheries and it could be proved by increased number of crafts year by year (Table 3).

In 2001, Wijayaratne calculated the MSY for coastal fisheries using the Gordon Schaefer bio economic model. As to his explanation the MSY level was 165 235MT and it implied that the coastal fisheries in Sri Lanka were fully exploited. Further exploitation would cause a decrease in catch which

in turn reduce the profit for coastal fisheries for Sri Lanka. According to this estimation prevailing exploitation level is not sustainable. Even though it is not a sound analysis with a limited set of data as his mentioned, it is a considerable explanation if compare with current production and effort level (Table 3). Because addition of fishing crafts to the coastal fishing fleet has gradually increased trough out the past years with fluctuation of coastal fish production. Addition to this Dayaratne in 1996 explicated that according to available information the coastal fisheries had reached optimum exploitation levels.

Recently, The NARA conducted a survey (CENARA, 2008/2009) on five coastal fisheries (Shrimp, Lobster, Sea cucumber, Chank, and Ornamental fisheries) in East coast, North West coast and Southern coast in Sri Lanka. The study was revealed that the most of fish species from those five fisheries already had over exploited and necessity of immediate action to manage (CENARA Project, 2010).

Off Shore Fisheries

Off shore fisheries take place outside of continental shelf and beyond, extending up to the edge of the Exclusive Economic Zone and in the high seas by multiday boats (FAO, 2007). As the production of fish resources from the coastal sector reached optimum unless, many attempts were made to expand the fishing range more towards the off shore areas to exploit tuna and other large pelagic resources. Although there had been many attempts to develop off shore fisheries since mid 1960s, the most effective phase of fleet development began in the early 1980 under the North West Coast Development Project, with the introduction of 80 34" boats from Abu Dhabi to conduct multiday fishing operations in offshore waters. Hereafter multiday fishing operations developed in Sri Lankan off shore waters (Maldeniya, R, and D, Amarasooriya, 1998).

The catch of off shore fishery mainly consist of several group of fish including tuna, seer fish, bill fish, shark, rays and other bony fish species. Tuna is the most dominant group and it consists of highly migratory skipjack and yellow fin tunas (Large pelagic database, NARA, 2006).

Usually various types and sizes of fishing gears are used in off shore fishery. But it depends on size of boats operating. Drift nets and long line basically

used; but combination of both has become very popular. Even though gill nets are the prominent fishing gear in the off shore fishery, long line is also carried out most cases with the combination with gill nets. Addition to that, the troll lines, hand lines, and purse seines are the other combinations can be seen in frequently carried out with gill nets cum long line operations (Dissanayake, 2005).

Off Shore fish production and fishing fleet

As to "The Fridtjof Nansen" survey, preliminary estimated that Sri Lankan's off shore fisheries could be taken 50 000MT – 90 000MT per year without the risk of over exploitation (Ganapatiraju and Pitcher, 2007). But, the possible annual yield vary from 90 000MT – 150 000 MT as total yield from off shore fishery (Ten Year Development Plan, 2007 – 2016). Therefore maximum contribution of off shore fishery is 37.5 percent for national marine fish production. Collection of statistics recorded from 1972 on off shore fisheries (Wijayaratne, 2001) and it shows considerable incensement of exploitation of off shore fisheries for past two three decades. Table 4 shows that off shore production for last ten years and it has almost

reached to maximum exploitation level as to estimate of Fridtjof Nansen survey.

Table 4: Current and targeted (2016) off shore fish production and number of crafts by type (source: Fisheries Statistics, DFAR, 2009)

Year	Capture fish Production	IMUL
1995	60,000	1,639
2000	88,400	1,430
2001	87,360	1,572
2002	98,510	1,614
2003	90,830	1,530
2004	98,720	1,581
2005	66,710	1,328
2006	94,620	2,394
2007	102,560	2,460
2008	109,310	2,809
2009	112,760	2,934
2016	156,450	3,129

Boats used in off shore waters categorized under one group in DFAR as IMUL boats (Act No 2 of 1996). But these boats differ from length, engine horse power and facilities they have (Table 2). Effort for the off shore fisheries had increased continuously as well as production but with fluctuation in some years and 2 934 of boats were registered as operating multi day boats in 2009 (Table 4). During the war it was unable carry out of

multiday fishing operations and also Government didn't allow fishing operation in North and East parts because of security issues. The average number of days per fishing trip per multi day boats varies with size, power, facilities of boat and targeted fishery. It was 5.8 days per boat which length was 35" for tuna fishery in 1996 (Maldeniya, R, and D, Amarasooriya, 1998). But with length, capacity of boat and engine, fishing trip can be more than two months (Amarasingha, O, 2001).

Current status of off shore fisheries

Multi day fishing has become the fastest growing fishing activity in marine fisheries sector during recent past in Sri Lanka with increased demand for tuna species nationally and internationally. Ten Years Fisheries Development Plan (2007- 2016, MFAR,) notifies that need to be expanded with introduction of slightly bigger sized boats with better storage facilities, safety, communication equipment and net/line haulers. Further it has planned to increase the fishing fleet up to 3 129 and production up to 156 450MT by 2016. But current fishing fleet consists 2 934 boats and it is very close to the target of 2016. Therefore those things imply that necessity of more scientific studies and information to take decisions regarding off shore

fisheries before increasing the fishing fleet. Because the surface fishery in the off shore area has already reached its economic maximum and the catch rates reported by the industrial fishing fleet have shown a decline trend for past years, indicating a need for a cautious approach in fleet development (Maldeniya, R, and D, Amarasooriya, 1998).

NARA emphasis to exploit the off shore fishery resources more efficiently, fishers need to use state of the art technology such as fishery forecasting system and knowledge on the resource and handling of the modern marine equipments as well. Addition to that MFAR encourage the fishermen transfer to their fisheries from gill nets to long line providing awareness and subsidies. Recent records of exports indicate that the tuna fish species have been dominating than other fish species for recent years (Fisheries Statistics, 2009, MFAR).

Fisheries Development Plan

MFAR has the responsibility to implement laws, policies, plans and programs for the development of the fisheries and ocean resources and also direct all the directorates under MFAR to implement its policies. MFAR has highlighted its vision as to "Sri Lanka become a leader in the South Asian Region in sustainable utilization of fisheries and aquatic resources" and mission as to "Directing the utilization of fisheries and aquatic resources for the benefit of the current and future generations". Policy objectives of the MFAR has mentioned as follows.

- To improve the nutritional status and food security of the people by increasing the national fish production.
- To minimize post-harvest losses and improve quality and safety of fish products to acceptable standards.
- To increase employment opportunities in fisheries and related industries and improve the socio-economic status the fisher community.
- To increase foreign exchange earnings from fish products.

- To conserve the coastal and aquatic environment.

Up to 1999, there were seven fisheries development plans. But with lack of quality, reliable statistics and initial stages of management and policy implementation were badly affected for those development plans. After 1999 MFAR was implemented a six years fisheries development program (1999-2004) to overcome these weakness and to up lift the strength of institutional efficiencies to meet the better fisheries management. And also it emphasized that need of especial attention to manage over exploitation of fisheries resources and to ensure the sustainability of resources utilization (Wijayaratne, 2001).

Ten Years Development Policy Framework

After the tsunami hit it was badly affected to fisheries sector. Almost 80 percent of fishermen lost their livelihood damaging 75 percent of fishing fleet and also coastal zone infrastructures. Immediate after tsunami there was an urgent need to restore coastal livelihoods, reconstructions of coastal environment and as well as rebuild the fishing fleet. As a result of immediate assistance it was effect to increase the size of current fishing fleet

than before tsunami. It was revealed by post-tsunami census conducted by MFAR. Those reasons stressed the necessity of a long term development strategy to rebuild, manage and develop the whole fisheries sector for present and future generation. With these purposes, MFAR implemented a ten years fisheries development poly framework (2007-2016) early in 2007. The policy frame work was designed to increase domestic fish production expanding standards of fish export to international markets, increase employment opportunities with better socio economic status and enhance the conservation coastal and aquatic resources through better management. Furthermore the plan has explicated its strategies and actions need to be implemented with some indicators to evaluate. Some strategies are

- Conduct a comprehensive marine fish resources survey on selected fisheries
- Increase off shore fishing capacity (750 additional IMUL boats)
- Implement co-management program under principle of responsible fisheries
- Reduction of post harvest losses

- Fleet development plan for high sea fishing
- Increase aquaculture production
- Introduce new technology for multi day boats
- Set up three fish canaries
- Set up new infrastructure facilities
- And implement effective conservation, management and socio-economic activities.

The development plan has spread over three distinct phases as short term over three years (2007-2009), medium term over four years (2010-1013) and long term over three years (2014-2016). It implies that there is a best opportunity to evaluate the progress and weakness during the policy implementation of each stage and take precautionary action for next stage. The implementation is not the final step in the policy process.

The effectiveness of the policy needs to be assessed after certain period of time, and steps must be taken to ensure that there are resources and means to maintain the successful policy. Ongoing program evaluation is thus central

to the maintenance policy and it benefits for performance of management and data requirements. Without evaluation the result may be that policy in place frequently conflict with each other in terms of goals and implementation measures. (Brian Slack, 2009).

Objectives of the study

1. Principal objective is evaluation the performance of current policy process of Sri Lankan marine fisheries sector in broad range with five different evaluation fields.
    i. Ecological evaluation
    ii. Economic evaluation
    iii. Social evaluation
    iv. Technological evaluation
    v. Administrative evaluation
2. Secondly, identification of trade-off among evaluation fields and some pragmatic recommendations for future policy measures.

Literature Review

Evaluation

Evaluation is the process of determining significance or worth, usually by careful appraisal and study. It is the analysis and comparison of actual progress verses prior plans, oriented toward improving plans for future implementation. Evaluation is a factor of a continuing management process consisting of planning, implementation and evaluation; ideally with each following the other in a continuous cycle until successful completion of the activity. Moreover it is the process of determining the worth or value of something. This involves assigning value to the thing or person being evaluated (SIL, 1999). Most frequently given definition is “Evaluation is the systematic assessment of the worth or merit of some subject”. But many types of evaluation can be seen without considering assessment of worth or merit as a necessary result (descriptive studies, implementation analyses, formative evaluations etc.). Therefore, there is a definition that “The evaluation is the systematic acquisition and assessment of information to provide useful feedback about some object” which consider the information processing feedback functions of evaluation. Because all evaluation work

involves collecting and shifting through data, making judgments about the validity of the information and of inferences we derive from it, whether or not an assessment of work or merit results (Research method, 2006).

The goal of most evaluations is to provide useful feedback to variety of audiences including sponsors, donors, client groups, policy makers, administrators, staff and other relevant constituencies. Most of feedback is perceived as useful if it aids in decision making. In addition there is a broad consensus that the major goal of evaluation should be influence decision making or policy formulation through the provision of empirically driven feedback.

There are many definitions, guide lines, studies, and administrative procedures on modern evaluation theory. Scriven and Fournier have expressed in a sequence of four stages for fundamental decision logic of evaluation.

1. Establishing evaluation criteria related dimension.

2. Setting standards of performance, i,e. levels that must be exceeded for to be evaluand (generic term for whatever is being evaluated) to obtain a criterion value term, “good” verses “bad”.

3. Collecting data pertaining to the evaluand's performance on the criteria relative to the standards.

4. Integrating results in to final value judgment. (Nielsen and Holm., 2007, Descy and Tessaring, 2004)

Scriven explains that two types of evaluation as summative and formative considering relationship between evaluation and action or change.

Summative evaluation

"The summative evaluation can be performed when the evaluand is already standardized and the relevant value matrix and measurement standards self-evident and agreed-upon. The evaluation then takes the form of a score count. In such cases, the evaluation process is primarily descriptive. The evaluand has a stable identity and the purpose of the evaluation is to measure it such that an accurate value judgment becomes possible. An example of summative evaluation would be national league football, where matches are standardized by reference to FIFA's rules of the game, and count of "goals" decides the winner" (Nielsen and Holm, 2007). Simply summative evaluation can be explained that it is a method judging the worth

of program at the end of the program activities with focusing on the outcomes (Descy and Tessaring, 2004).

Formative evaluation

"A formative evaluation, in contrast is part of the process that constitutes the object under consideration. As a farming device, the evaluation define the measurement system by which an object is described and the value matrix by which it shall be judged. To the extent such a definition is accepted by authoritative, the evaluation confers agreement on the identity and worth of the evaluand. How consensual and binding a given evaluation will be on relevant audiences in particular causes is of course an empirical question and cannot be answered in general. When it is consensual and binding, however, it transfers status onto the object, which becomes reconstituted in that process. In such case the evaluation the evaluation is formative. Instead of reading the evaluands identity off from the object of question, the formative evaluation is a process by which a specific identity is impose of the object. In foot ball, formative evaluation can be located in process where "the rules of the game" are adopted and changed" (Nielsen and Holm, 2007).In generally formative evaluation is a method of judging the worth of

program while the program activities are forming or happening with focusing on the process. Additionally formative evaluation strength or improve the object being evaluated. They help form it by examining the delivery of the program or technology, the quality of the implementation, and the assessment of the organizational context, personal, procedures, inputs and so on. In practically those both of evaluations are not always separable. The one will follow often another depending on the purpose of evaluation (Research method, 2006).

Table 5: correlation between purposes and methodology as to type of evaluation

Purposes	**Methodology**		
	Criteria and standards	Causal inference	Change orientation
Accountability	Outcome and Impact evaluations. Mainly summative		
Development			Formative evaluation of programs
Knowledge production		'What works' – improving Future policy/practice	
Social improvement			Empowerment and participative evaluations

Moreover, above major arguments the types of evaluation can be explained with coherent of methodology and purposes. The correlation between purposes and methodology axes show the table 5 (Descy and Tessaring, 2004).

As to the table it can be seen three distinguish methodological positions with different approaches to evaluation discussed above.

i. The criteria or standards based position, which is concerned with judging success and performance by the applications standards.

ii. The causal inference position, which is confirmed with explaining program impact and success.

iii. The formative or change oriented position, which seeks to bring about improvements both for programs and for those who participate in them.

The evaluation purposes can be distinguished between following purposes.

i. Accountability, where the intention is to give and account to sponsors and policy makaers of the achievements of program or policy.

ii. Development, where the intention is to improve the delivery or management of a program during its term.

iii. Knowledge production, where the intention is to develop new knowledge and understanding.

iv. Social improvement, where the intention is to improve the situation of the presumed beneficiaries of public interventions.

Evaluation of fisheries

Evaluation on fisheries always gives the priority for biological aspects. Because fisheries stock assessment is the main process to determine the stock status relevant to biological reference points. It provides early status of fisheries exploitation. These biological reference points can be target reference points, limit reference points, or precautionary reference points for any type of fisheries (FAO, 2003). In practice management measures (precautionary principles) implement through the establishment of biological target and limit reference points that are occasionally associated with harvest control rules (Quentin Grafton et al,2005). But the stock assessment depends on many stock parameters, best scientific information available (current and historic data) and from independent biomass survey to measure levels of fishing mortality, spawning biomass or age structure. There is a mismatch between the complexity of these stock assessment models and the high degree of uncertainty inherent in fisheries research (Pitcher and Preikshot, 2001).

If the stock assessment modals are used to create precautionary reference points then they will need to be continuously updated which involves myriad of decisions about model assumptions and the data to use. It will be more difficult if the reference point based on data levels of absolute abundance. At that time the great deal of discretion is required as to what data, such as catch rates at particular location and times and what point trends in the data indicate the precautionary reference is reached (Quentin Grafton et al, 2005). Moreover conventional stock assessment relates to ecological or rarely the economic sphere (Pitcher and Preikshot, 2001).

From this point fishery science are moving from single species to ecosystem approach, from micro to macro perspectives, increasing the need for measuring the impact of fishing on natural and manmade system (L. Adrinato et al, 2005).

"Fisheries are complex non-standard entities. Since fisheries and their management come in many shapes and will fail in different ways, we cannot respect automatic convergence regarding the appropriate standards for evaluating their performance. In addition, the position from which to perform and authoritative evaluation of fisheries cannot be easily claimed by a single discipline. Since fisheries comprise cultural, social and political

elements as well as natural and technological ones, a range of perspectives are relevant their evaluation" (Nielsen and Holm, 2007).

Meanwhile Cochrane introduced four alarms which are biological, ecological, economic and social crisis that should consider as a challenge for fisheries management (L. Adrinato et al, 2005). Biologically most of the stocks of the ten fish species which contributes for 30 percent of world marine capture fisheries are already fully exploited. Almost 85 percent of stock either (53%) fully or (28%), over exploited (3%) depleted or (1%) recovering (FAO, 2010). In an economic perspective, fisheries actually exit to meet social and economical demands, but unfortunately some evidences suggest that the expected benefits have not been in the form of economic gains. In social aspects fisheries consider as a simple tool for generating economic returns and also most of employment restrict to rural and remote areas (L. Adrinato et al., 2005).

Sustainable development and sustainability evaluation of fisheries

Concept of sustainable development emerged as a result of inadequacies of early economic development models and various policies which were focused short term gain at the expense of long term aspiration. FAO council in 1988 defined sustainable development as

> "The management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Such sustainable development conserves (land), water, plants and (animal) genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable".

The SCOPE (Scientific Committee on Problem of Environment) discovered that the present status of resources (often bad), social and economic constraint (generally serious), institutional failure (resulting from ineffective laws and organization), and relative adequacy of information base and analytical capacity available to support decision making. Insufficient

information always attenuates effectiveness of implementation of management measures. As to definition of sustainable development it indicate that the necessity of simple and carefully selected indicators which can be used available information to improve the effectiveness of decision process (S.Garcia, 1996).

As mentioned earlier, current fisheries and its contribution challenges to sustainable development because depletion of fish stock and irreversible changes of marine ecosystem due to present unsustainable practices. Uncertainties of fisheries emphasize the necessity of better management practices and consideration of multidimensional nature of fishery to ensure the sustainability of fisheries in the long term. At the European level, “The Green Paper on a reform of the Common Fisheries Policy (CFP)” was adopted in 2009 with the aim of defining, in a clear and prioritized manner, the objective regarding ecological, economic and social sustainability (E. Garmendia et al, 2010).

There are many method and theories have been developed by many scientists and economists which can be used, how to define sustainability and how to measures progress towards it. These methods have been highlighted in order to assess the sustainability of fisheries, necessity of

interaction of data from various disciplines such as ecology, economics, sociology, technology, ethical and administration. These data can be both quantitative and qualitative (A. Murillas et al, 2008; E. Garmendia et al, 2010). FAO in 1999 introduced several frame work to evaluate the sustainability of fisheries assessing different dimensions of fisheries. Moreover, these dimensions clarify in to different criteria which can be organized conveniently and identified indicators easily in relation to sustainability. Even though many indicators have been taken into account by these frame works, there is a lack of explicit analysis with regard to the issue of sustainability (E. Garmendia et al, 2010).

Another multidisciplinary approach is the Rapfish which use non parametric evaluation methodology to evaluate sustainability, developed by the Fisheries Centre at the University of British Columbia, Canada.

Rapfish

Rapfish is a new multi-disciplinary rapid appraisal technique for evaluating the sustainability of fisheries. The technique employs simple, easily scored attributes to provide a rapid, cost effective, and multi-disciplinary appraisal of a fishery, in terms of sustainability. Fisheries may be defined flexibly, from a broad scope such as all the fisheries in a country or lake, down to the narrow scope such as a single jurisdiction, as a target species, a gear type or even individual vessels. A set of fisheries may be compared, or the time trajectories of individual fisheries may be plotted. The technique is still under developing (Pitcher and Preikshot, 2001).

Rapfish uses non parametric ordination technique (Multi-dimensional scaling – MDS) to provide values that indicate the relative sustainability of fisheries in relation to some fixed extremes. Rapfish doesn't require quantities of bio mass or effort data which is usually expensive and difficult to obtain in countries which have limited resources for fisheries research, but, instead relies on easily obtained field indicators or expert opinion with defined uncertainties of scores (D.Tesfamichael, T.J.Pitcher, 2006).

Currently the analyses consist of five evaluation fields such as ecological, technological, economic, social and ethical status. Attributes for these disciplines revised by Rapfish group and finally in 2006 they introduced the latest attributes and scoring system for good and bad in relation to sustainability (Table 6, 7, 8, 9, 10).

Scores of attributes for each fishery are determined from both peer-reviewed and grey literature or from correspondence with experts on each fishery. Most attributes are scored on a 0-10 point ranked scale that makes it relatively easy both to obtain value in the absence of precise surveys and interviews, and for a group a group of experts to give on a score. These scores are standardized and distances between entities (fisheries) in multi-dimensional space are calculated before ordination. Ordination are bounded by reference points that simulate the best and worst possible fisheries using score 0 (0%) and 10 (100%) for all attributes and these hypothetical "good" and "bad" fisheries provide extreme reference points for comparing the sustainability scores (Pitcher and Preikshot, 2001).

Attributes used for different dimension for Rapfish analysis

Ecological Analysis

Ecological attributes reflect how the fishery impacts sustainability in terms of the ecology of the exploited fish and their ecosystem. Fisheries management practices that increase the risk of overexploitation, quickly change trophic levels etc are scored towards the 'bad' end of the scale while fisheries management practices that protect the species or ecosystem score towards the 'good' end of the scale.

Table 6: List of attributes and definitions in ecological perspective

# = 10	Killers	Good	Bad	Notes
Exploitation status	K	0	10	FAO-like scale: under-(0-1); fully - (2-4); heavily-(5-6): or over-exploited (7-8); completely collapsed (9-10) [consult FAO website for status, except level 9-10]
Recruitment variability		0	10	COV [coefficient variability]: low<20% (0-1)medium 20-60% (2-5); high 60-100% (6-8); very high > 200% (9-10)
Change in trophic level		0	10	Is the trophic level of the catch in the ecosystem which this fishery is embedded, decreasing; no (0-2); somewhat, slowly (3-5); rapidly (6-10) [See Fish Base]
Migratory range		0	10	Number of jurisdictions encountered during life history (includes international waters): 1-2 (0-2); 304 (3-5); 4-7 (6-8); > 7 (9-10).
Range collapse	K	0	10	Is there evidence of geographic range reduction: no or very little (0-2); some, slow (3-5); a lot, fast (6-8); very great, rapid (9-10).
Size of fish		0	10	Has average fish size landed changed in past 5-10 years: no or very little (0-1); yes, a grdual change (2-5); yes a rapid large change (6-8); major rapid reduction (9-10).
Catch before maturity		0	10	Percentage caught before size/age of maturity: none (0-1); some >30%; lots >60% (6-8); a lot > 80% (9-10).
Discards		0	10	Percentage of target catch (target species juveniles plus other species): low 0-10% (0-1); medium 10-40% (2-5); high > 40% (6-8); very high > 100% (9-10).
Species caught		0	10	Number species caught (retained and discarded): low 1-10 (0-1); medium 10-100(2-5); high > (6-8); very high (9-10).
Bycatch		0	10	Percentage of target catch (target species juvenile plus other species): low 0-10% (0-1); medium 10-40% (2-5); high >40% (6-8); very high > 100% (9-10).

If the total score from the two "killer" attributes exceeds 17, then all scores in this ecological evaluation field are set to 'bad'.

Economic Analysis

Economic attributes reflect how fisheries management practices impact the economic sustainability of the fishery and related human communities, as ultimately predicted on ecological sustainability. Therefore in a RAPFIAH analysis scores at ‘good’ end of the scale of an attribute reflect economic sustainability and are not a risk to the fishery or ecosystem, whereas the ‘bad’ end of the scale may be risk. A fishery where the average wage of a fisher is above the average national wage scores towards the ‘good’ end because there is an incentive or likelihood that fishers will manage for sustainability to ensure that their wages remain high or improve.

Table 7: List of attributes and definitions in economic perspective

# = 9	Killers	Good	Bad	Notes
Fisheries GDP		10	0	Importance of fisheries sector in the economy: low (0-3); medium (4-7); high (8-10). In comparison to other industries and economic sectors such as agriculture, tourism etc.
Average wage		10	0	Do fisheries make more or less than the average person? Much less (0-2); less (3-4); the same (5-6); more (7-8); much more (9-10).
Limited entry		10	0	Includes informal limitations: open access (0-2); weak or formal control (3-4); medium control (5-6); strong control (7-8); strictly limited (9-10).
Marketable right		10	0	Marketable wright/quota/share? None or almost none (0-2); some (3-5); mix (6-8); full ITQ, CTQ or other property right (9-10).
Other income		0	10	In this fishery, fishing is mainly: causal (0-2), part time (3-5); seasonal (6-8); full time (9-10).
Sector employment		0	10	Employment in formal sector of this fishery: < 10% (0-3); 10-20% (4-7); > 20% (8-10); > 30% [compared to all the other fisheries at the same scale of analysis]. Note: Employment includes jobs in processing, selling, etc. of the catch from a particular fishery.
Ownership/ Transfer		0	10	Profit from fishery mainly to: locals (0-2); mixed city/local (3-5); a mainly non-locals (6-8); mainly foreigners (9-10).
Market		0	10	Market is principally: local (0-2); regional/local (3-5); national/ regional (6-8); national/international (9-10).
Subsidy	K	0	10	Are subsidies (including hidden subsidies) provide to support the fishery? No (0-2); somewhat (3-4); large subsidies (5-6); heavily reliant (7-8); almost completely reliant on subsidies (9-10).

If the score from the 'killer' attribute equals 9 or 10 then all scores in the economic evaluation field are set to 'bad'.

Ethical Analysis

Ethical analysis within RAPFISH is designed to analyze fisheries for five type if justice; creative, productive, ecosystem, restorative, and distributive. Creative justice includes issues such as fair management of the fishery; productive justice and ecosystem justice consider treatment of and behaviour within the fisheries ecosystem; restorative justice covers the repairing of previous damage; distributive justice deal with how the resource is shared. Where questions arise, ethnicity is not the intended basis of equity in the attributes. The package of ethical attributes assesses fisheries based on these various ethical concerns, and integrates sustainability on many levels, including ecological and social.

Table 8: List of attributes and definitions in ethical perspective

# = 8	Killers	Good	Bad	Notes
Adjacency and reliance		10	0	Geographical proximity and historical connection with resources: not adjacent/no reliance (0-2); not adjacent/some reliance (3-5); adjacent/some reliance (6-8); adjacent/strong reliance (9-10).
Alternatives		10	0	Alternative to the fishery as sources of support within the community: none (0-2); some (3-5); lots (6-8); very many (9-10).
Equity in entry to fish.		10	0	Entry based on traditional/historical access/harvest? Not considered (0-3); considered (4-7); traditional indigenous fishery (8-10).
Just management		10	0	Inclusion of fishers in management: none (0); consultations (0-2); co-management/gov't leading (3-5); co-management/community leading (6-8); genuine co-management with all parties equal (9-10).
Mitigation-habitat destruction		10	0	Attempts to mitigate damage to fish habitat: much damage (0); some damage (1-3); no ongoing damage or mitigation (4-6); some mitigation(7-8); much mitigation (9-10).
Mitigation-ecosystem depletion		10	0	Attempts to mitigate fisheries-induced ecosystem change to predators, prey or competing organisms of fishery targets: much damage (0-2); some damage (3-4); no damage or mitigation (5-6); some mitigation (7-8); much mitigation (9-10).
Illegal fishing IUU		0	10	Illegal and unreported fish catches (poaching trans-shipments etc.: none (8-10); some (3-5); a lot (6-8); great deal (8-10).
Discards and waste		0	10	Discards and waste and/or bycatch of birds, mammals, reptiles, Structural benthic invertebrates: none (0-2); some (3-5); a lot (6-8); a great deal (8-10).

Social Analysis

Social attributes reflect how fisheries management practices impact the sustainability of the society or community associated with the particular fishery, as ultimately predicated on ecological sustainability. In a RAPFISH analysis the 'good' end of the scale of an attribute reflects social sustainability but low risk to the fishery or ecosystem, whereas fishery regulations scores towards the 'good' end of the scale, while a fishery where there is conflict with other fisheries or industries scores towards the 'bad' end of the scale.

Table 9: List of attributes and definitions in social perspective

# = 8	Killers	Good	Bad	Notes
Socialization of fishing		10	0	Fishers work as: individuals (0-3); families (4-6); community groups (7-10). Individuals = working for commercial company; families = direct connections to the fishery (eg. Owner/operator); community groups = social connections (eg. Fishing co-operative).
New entrants into the fishery		0	10	growth over past ten years: < 10% (0-2); 10-20% (3-5); 20-30% (6-8); > 30% (9-10); Increasing numbers of fishers and people involved
Fishing sector		0	10	Household containing fishers in the community: few, < 5% (0-2); some, 5-10% (3-5); many 10-40% (6-8); a great many, > 40% (9-10); Community is defined at the scale of the fishery defined in the analysis, e.g. Landing site, harbor city, state.
Environmental knowledge		10	0	Level of knowledge about the fishery resources and its ecosystem and environment: none (0-2); some (3-5); a lot (6-8); a great deal(9-10).
Conflict status		0	10	Level of conflict with other sectors: almost none (0-2); some (3-5); lots (6-8); a great amount (9-10); includes other fisheries or industries (eg. Oil drilling platforms, catchment runoff).
Fisher influence		10	0	Strength of direct fisher influence on actual fishery regulations: almost
Fishing income		10	0	Fishing income as % of total family income: < 10% (0-2); 10-50% (3-5); 50-80% (6-8); > 80% (9-10).
Kin participation		10	0	Do kin sell and/or process fish? Almost none (0-2); very few relatives (1-2 people) (3-4); a few relatives (5-6); some relatives (7-8); fishery is mainly kin (9-10).

Technological analysis

Technological attributes capture appropriate technologies that minimize risk to sustainability of the fishery. Therefore when devices are used to improve the catching power these fisheries scores towards the ‘bad’ end, while a fishery that uses technology such as ice to prevent waste or reduce by-catch scores towards the ‘good’ end of the scale.

Table 10: List of attributes and definitions in technological perspective

# = 9	Killer	Good	Bad	Notes
Trip length		0	10	Average date at sea per fishing trip: 1 or less(0-1); 2-4 days (2-4); 5-8 days (5-6); 8-10 days (7-8); more than 10 days (9-10).
Landing sites		0	10	Are landing sites: dispersed (0-2); somewhat centralized (3-5); heavily centralized (6-8); distant water fleet with little or no local landings (9-10)
Pre-sale processing		10	0	Processing before sale: [eg., gutting, filtering, salting] none (0-2); some (3-5); a lot (6-8); a great deal (9-10).
Onboard handling		10	0	Almost none (0-2); some (eg. Salting, boiling) (3-5); sophisticated (eg. flash freezing, champagne ice) (6-8); a great amount, tanks (9-10).
Selective gear		10	0	Device(s) and/or handling of gear to increase selectivity and reduce bycatch? Very little (0-2); some (3-5); a lot (6-8); a great amount (9-10).
FADS		0	10	Fish attraction devices: not used (0-2); some, eg., bait is used (3-5); some reliance on FADs (6-8); almost completely reliance on FADs (9-10).
Vessel size		0	10	Average length of vessels: < 5m (0-2); 5-10m (3-4); 10-15m (5-6) 15 20 m (7-8); > 20m (9-10).
Change in catching power		0	10	Have fishers altered gear and vessel to increase catching power over past 5 years? Not much (0-2); a small amount (3-4); somewhat (5-6); a lot (7-8); a great amount, rapid increase (9-10).
Gear side effects	K	0	10	Does gear have undesirable side effects (eg. Cyanide, dynamite, trawl): very few (0-2); some (3-5); a lot (6-8); fishery dominated by destructive fishing practices (9-10).
If the score from the 'killer' attributes equal 9 or 10. then all scores in this technological evaluation field are set to 'bad'				

The method can be used to evaluate the “health” of fishery making comparison, in other words to diagnose emerging problems in fisheries for each of five evaluation fields. The results can also suggest where to emphasis future research, management measures and the wise use of limited resources. Simple kite diagrams may be used to compare the results of alternative fisheries policies. However, Rapfish is not intended to replace conventional stock assessment procedures used to formulate management tools like quotas (Pitcher and Preikshot, 2001; T.J.Pitcher, 1999).

Methodology

For the evaluation of current fisheries policy implementation in the context of coastal and off shore fisheries in Sri Lanka, the Rapfish technique was adapted here. Rapfish is a one kind of rapid appraisal technique can be used to evaluate fisheries using simple and easily scored attributes as to different fields which represent the different dimensions of fisheries sector. Once, D.Leadbitter and T.J.Ward mentioned "None of fishery assessment system we examined, other than Rapfish cover the full range of social and economic matters relevant to fisheries management and sustainability" (D.leadbitter, T.J.Ward, 2007). In this analysis, the method considered five evaluation fields: Ecological, Economic, Social, Technological and Administrative. The field, administrative analysis is a new field included for Rapfish with the purpose of this evaluation which comprises nine attributes (Table 11). Most of these attributes have discussed in technical guide lines for responsible fisheries of FAO, 1999 and article seven in Code of Conduct for Responsible Fisheries, FAO, 1995. Overall 46 attributes have been considered relevant to those five evaluation fields. However, in order to adapt the Rapfish evaluation fields to the fisheries of country, some

attributes were removed from some evaluation fields and some were added (Table 12). All the attributes were scored referring the guide line of Rapfish group, (Fisheries Centre,UBC,2006) and possible combination of scores were located between minimum score of 0 (Bad) and maximum score of 10 (Good) for each. Here, the 'good' and 'bad' are evaluated in terms of current effectiveness of fisheries policy measures within the evaluation fields. In order to explanation of the outcome of analysis was carried out by using simple kite diagram with comparatively on those two principal fisheries.

The scoring system for 'good' and 'bad', some attributes run from low to high and others from high to low (Table 7, 8, 9, 10).Therefore total scores cannot be used directly for a evaluation field (T.J.Pitcher, 1999). In this manner, the scoring system was rearranged to get minimum value for 'bad' and maximum value for 'good' in terms of low to high. Rearrangement was considered only transpose the scores with in an attribute without any modification for basic structure (Annex 2).

Administrative Analysis

Table 11: List of attributes and definitions in administrative perspective

# = 9	Good	Bad	Notes
Institutional framework	10	0	There are several institutions under Ministry of Fisheries Sri Lanka; DFAR, NARA, NAQDA, CFC, CFHC, Cey- Nor. Are they arranged well and horizontal integration? Worst (0-2); somewhat (3-5); good (6-8); very good (9-10).
Scientific studies on fisheries	10	0	On endangered, over exploited /depleted species/stock, MSY: None (0-2); some (3-5); a lot (6-8); a great deal (9-10).
Regulatory compliance	10	0	sufficient of compliance regime, : very little (0-2); some (3-5); a lot (6-8); a great (9-10).
Law enforcement	10	0	Effective implementation of Act and regulations: none (0-2); some (3-5); a lot (6- 8); a great (9-10).
MCS	10	0	Monitoring, control and surveillance: none (0-2); some a great deal (9-10).
Best scientific evidence available	10	0	Timely, complete and reliable statistics: very little (0-2); some a great (9-10).
Consultation of stakeholders	10	0	Stakeholders' contribution for decision - making: very little a lot (6-8); a great (9-10).
Periodic evaluation	10	0	Evaluation of fisheries and management performance coupled with rolling development and management planning process: almost none (0-2); some (3-5); lots (6-8); a great amount (9-10).
Compliance with international law	10	0	FAO Code of Conduct, IOTC, UNCLOS etc : very little (6-8); a great (9-10).

Removed and included attributes

Table 12: Both Removed and included attributes from different evaluation fields

Removed Attributes

Ecological Analysis	Good	Bad	Notes*	Reason
Migratory range	0	10	Number of jurisdictions encountered during life history (Includes international waters): 1-2 (0-2), 3-4 (3-5), 4-7 (6-8), >7 (9-10)	The study consider only coastal and off shore fisheries which consist of number of single fisheries. Attribute, migratory range is applicable for migratory fishspecies and it needs individual studies for relevant species according to notes*.
Economic Analysis				
Marketable right	10	0	Marketable right/quota / share? None or almost none (0-2); some (3-5); mix (6-8); full ITQ,CTQ or other property right (9-10).	There are no any output control system used in Sri Lanka. Only input restriction used except ITQ,CTQ TAC or other property rights (FAO, 2007).

Included Attributes

Ecological Analysis				
Catch composition	0	10	Change in catch composition duringlast five years: No or very little (0-1); yes, a gradual change (2-5); yes, a a rapid large change (6-8); major rapid reduction (9-10).	Coastal and Off shore fisheries are multi species and also very limited studies available on separate species.
Economic Analysis				
Fisheries exports	10	0	Fisheries export value (compared with total value of exports): Low (0-1),Medium (2-5), high (6-8), very high (9-10).	Indicators for sustainable development of marine capture fisheries, FAO, 1999 had considered as a important criteria for economic analysis. It is important to Sri Lanka as a developing country and also As a natural resources exporter.
Social Analysis				
Community based management	10	0	Fishers manage their fisheries by themselves in addition to Act and Regulations: none (0-2); some (3-5);a lot (6-8); a great lot (9-10).	Mainly coastal fishery is multi species, multi gears and multi crafts fishery. Off shore fishery is somewhat different. It is difficult to apply output control and management measures except community participation (FAO,2007).

Data Collection

Data for all the attributes were collected through a questionnaire by using participatory assessment method (Annex 1) which was designed to get scores for each attributes simply and easily. Even though questionnaire was mailed for 47 fisheries experts around the country, finally sample was limited to 23 (response rate 49%) experts with the maximum effort. Usually mail surveys suffered from potential non-response bias and low response rate (N.Hanley and C.L.Spash, 1993). Nonetheless, the limitation of sample, it was consisted of fisheries research officers, (7) fisheries managers (5), fisheries consultants (4), and university professors (7) who were involved in directly to the sector with empirical knowledge. It was asked the experts to define their values on each attribute for five evaluation fields with current state of play in both coastal and off shore fisheries. Information was collected via emails (mail survey).

Data Analysis

For data analysis simple rate calculation method was used for all attributes within each evaluation fields separately.

$$P_a = \frac{a_{(ave)}}{a_{(max)}} x\ 100$$

Where $a_{(ave)}$ and $a_{(max)}$ are the given average score by stakeholders and maximum score for the attribute. P_a ,is the percentage contribution of attribute a .Therefore reference points in terms of boundaries which are defined the 'bad' and 'good' for fishery scaled on 0% - 100%. It explains which are provided minimum score to maximum scores on scale that goes from the worst to the best situation. Then overall percentage for each fields were calculated as follows.

$$P_{a1} = \frac{\sum_{a=1}^{n} P_a}{n}$$

Where, the P_{a1} is percentage contribution of the evaluation field and n is the number of attributes comprise in an evaluation field.

For the purpose of comparative evaluation and to report on relative potential of each attributes to be able to make an effective assessment of fisheries, scores range was divided into for quartiles. The variability within each criteria and each evaluation field is represented by above 75% quartile is best (good), below 24% is bad and 2nd and 3rd quartile are moderately good and moderately bad (table 13).

Table 13: Percentage of evaluation dimension

Evaluation Dimensions	
24% - 0%	Bad
49% - 25%	Moderately Bad
74% - 50%	Moderately Good
100% - 75%	Good

Results and Discussion

Ecological Analysis

In order to assess the current ecological condition of both coastal and off shore fisheries, ten attributes were studied. From this result, (Table 14 & Figure 3) it revealed that lowest rate for the attribute “change in tropic level” (37%) for coastal fisheries and the value lay in the range moderately bad. In contrast of offshore fishery it was 64 percent and placed in the range moderately good in terms. From the all criteria; the “level of by catch” recorded the highest rate (85%) for coastal fishery and it explained low level of by catch with multi gear and multi species fisheries in coastal waters. The value judgment of experts evidenced the peak rate (92%) for criteria “discards” and minimum rate (55%) for “size of fish” for off shore fishery. Maximum difference can be seen between coastal and off shore fisheries with attribute “level of exploitation” from the studied attributes for ecological analysis. From all these ten attributes “exploitation status” should be the core characteristic because every other quality is defined and explained by this, and it had been highlighted as a killer attribute by Rapfish analysis. It was valued by experts as 77% for off shore fishery and 45% for

coastal fishery in terms of level of exploitation had gone towards the good situation for off shore fishery and moderately bad for coastal fishery. This result symbolized that the coastal fishery had already surpassed its peak exploitation level even though experts' decision was not hundred percent consensuses (SD – 19.16%).

Furthermore decision on "recruitment variability" makes an argument for coastal fishery. Because, all other attributes (exploitation status, change in trophic level, catch composition.) which were directly correlated with characteristic "recruitment variability" placed in range "moderately bad" and; discussed one showed almost "good" situation. The reason is difficult to explain with limited outcomes and, however it evidenced the minimum standard deviation (16.16%) from all of ecological analysis and nearly same percentage for off shore fishery (16.83%) too. As a whole, from all the characteristics of ecological analysis, for attributes were placed in above 75% (good) and remaining were located in scope "moderately good" for off shore fishery. In comparison, coastal fishery indicated various ambits of rates (table 14) for assessed attributes than off shore fishery.

Table 14: Average scores and standard deviations of each attribute for ecological analysis by principal fisheries coastal and off shore

Ecological Analysis							
		Coastal Fishery			Off Shoe Fishery		
No	Attribute	Average	%	SD	Average	%	SD
1	Exploitation status	4.5	45	19.16	7.7	77	18
2	Recruitment variability	7.3	73	16.16	6.6	66	16.83
3	Change in trophic level	3.7	37	18.69	6.4	64	17.27
4	Catch composition	4.7	47	21.04	6.1	61	22.7
5	Range collapse	5.3	53	20.58	6.0	60	27.38
6	Size of fish	5.0	50	21.5	5.5	55	23.38
7	Catch before maturity	5.2	52	19.04	6.3	63	20.77
8	Discards	8.1	81	19.2	9.2	92	8.9
9	Species caught	7.3	73	24.34	7.7	77	15.44
10	Bycatch	8.5	85	19	7.6	76	28.14
	Total Value	59.6	596		69.0	690	
	Average value	6.0	60		6.9	69	

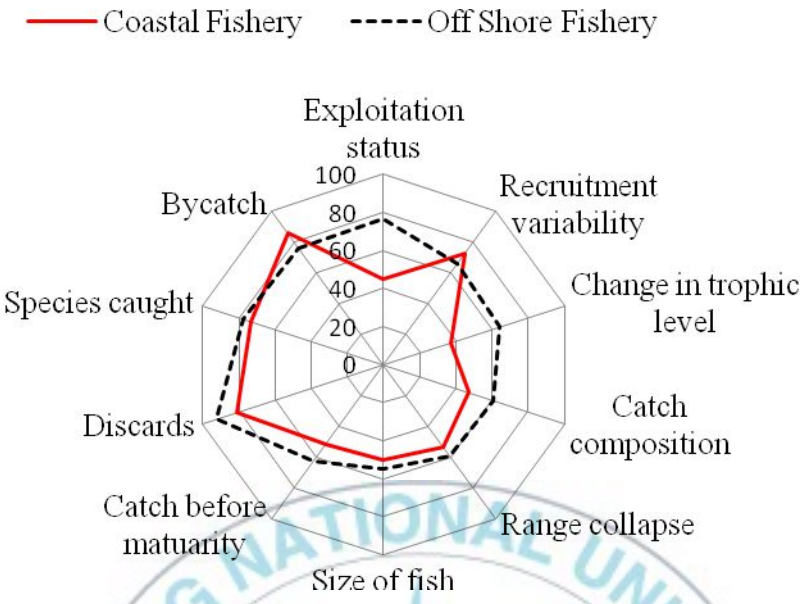

Figure 3: Kite diagram expressing the average scores of sustainable status for each attribute in ecological perspective by principal fisheries coastal and off shore

Economic Analysis

Both social and economic evaluations may involve the analysis of the benefits and costs that are derived by an entity (individual, group or community) from a given resources. Usually economic evaluations focus on "net economic benefits" which describe benefits through the use of prices and markets. This allows relatively straightforward approach to the measurement and comparison of benefits across uses (Simon Vieira et al, 2009). However, in this analysis it considered nine different attributes to evaluate the both major fisheries in economically and how those attributes reflects the risk on ecological sustainability in indirectly. The kite diagram (Figure 4) and table 15 show the highest rate (76%) for "sector employment" in off shore fishery and it betoken less employment relatively which means economically in good than coastal fishery (47%). Higher employment increases the excess pressure on particular fishery and it implies the trend of over exploitation. The attribute "average wage" was rated as 67% (moderately good) for off shore fishery means fishers earned better income than the average wage per person and it was almost normal average wage for coastal fishery (moderately bad). Least rate was indicated (10%) for criteria "market" for off shore fishery, because the attribute

considered that the principally national/international market wasn't favourable towards the good end of economic perspective (SD-10%). If the supply is focused on International market, the common sense, it will encourage more excess pressure and cause the exploitable biomass to be reduced. Bio-economically, entry will cause once vessels find that there is no more profit to be obtained, biomass having adjusted to new (lower) equilibrium in terms of risk on targeted fishery and less income for fishers. On the other hand it is a better opportunity being open the international market to the country which means fishermen can enjoy with better life. In this case, it needs pragmatic management measures and considerations. However, in contrast coastal fishery was rated as 66% (moderately good) for the same criterion which was reflected regional and local market. Attributes "fisheries GDP" and "fisheries exports" express the importance of fisheries sector to the whole economy when it compares with other industries and economic sectors such as agriculture, tourism etc. In comparatively experts judged contribution of the sector to the GDP was "bad" and contribution to the exports was "moderately bad". Meanwhile, analysis revealed that coastal fishery was almost seasonal but some weight towards the full time and off shore fishery was full time (Table 15, Annex 2).

It means fishers almost totally depend on fisheries throughout the year and it implies the risk on resources furthermore negative profits for the fishers in long term. The characteristic “ownership/transfer” appraised the direction of the flow of profits means profits from the fishery to locals, non locals or foreigners. It recorded the peak rate for coastal fishery (78%) and 60% for off shore fishery. Level of subsidy (Killer attribute) lay in range “moderately good” for both fisheries and relatively low rate for off shore fishery (55%) suggested that dependency on subsidies than coastal fishery (67%).

Limited entry is an important concept use to manage fisheries (natural resources) because anyone can access to the fishery (open access) as a common property. According to the FAO definition (Fisheries Glossary) limited entry mean “The fishery where the number of operators (and size of boats) is restricted through license limitation or quota systems, to control the amount of fishing efforts. It frequently involves controls the number and size of vessels, and conditions relating to the transfer of fishing rights or the replacement of vessel”. In the cause of Sri Lanka, all the fishing boats should be registered and all prescribed fishing operations (Fishing operation regulation, 1996, DFAR.) should be licensed under Department of Fisheries

and Aquatic Resources (Fisheries Act, No.2 of 1996). However result of this economic analysis; it was rated as 24% describing ineffective effort control system even though fishing operations were licensed. This response of experts explains significant situation which means without any output limitations such as TAC, ITQ, TCQ or licensed limitation (FAO,2007); only licensed fishery is meaningless as a management measure for Sri Lanka because no way to control the additional number of operations except only licensing.

Table 15: Average scores and standard deviations of each attribute for economic analysis by principal fisheries coastal and off shore

Economic Analysis							
		Coastal Fishery			Off Shoe Fishery		
No	**Attribute**	**Average**	**%**	**SD**	**Average**	**%**	**SD**
1	Fisheries GDP	2.0	20	12.2	1.9	19	9.41
2	Fisheries exports	2.7	27	17.76	3.1	31	17.4
3	Average wage	4.5	45	12.05	6.7	67	14.97
4	Limited entry	2.4	24	17.77	2.4	24	17.36
5	Other income	2.7	27	17.77	1.7	17	21.29
6	Sector employment	4.7	47	25.96	7.6	76	26.49
7	Ownership/Transfer	7.8	78	15.94	6.0	60	14.3
8	Market	6.6	66	21.69	1.0	10	11.07
9	Subsidy	6.7	67	12.87	5.5	55	15.95
	Total Value	40.1	401		35.8	358	
	Average value	4.5	45		4.0	40	

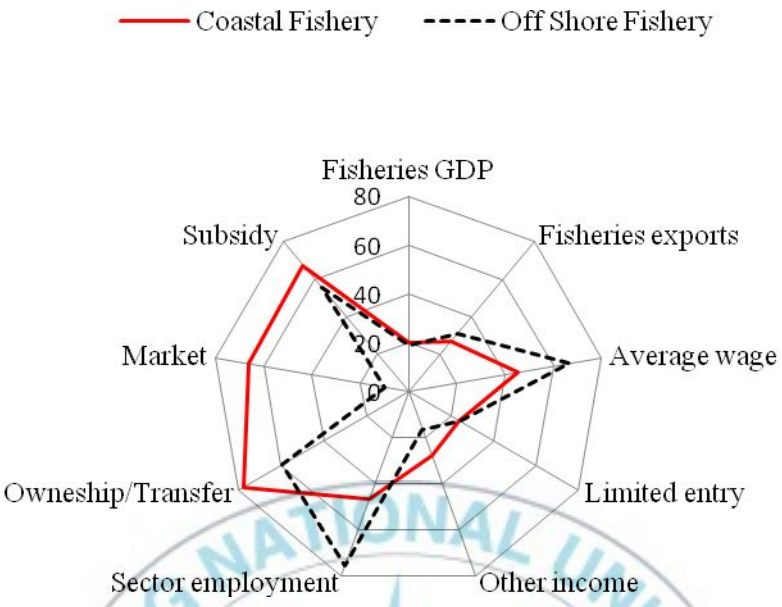

Figure 4: Kite diagram expressing the average scores of sustainable status for each attribute in economic perspective by principal fisheries coastal and off shore

Social Analysis

The social analysis of fisheries had focused on the evaluation of nine attributes which were involved directly and indirectly for fisheries management practices. The obtained results from the analysis (figure 5) recorded maximum rate for “fishing income” for coastal (83%) and off shore (87%) fisheries and it recognized that higher contribution of income from fisheries for fisher families benefited towards the “good” end of the scale in socially. The characteristic “community based management” considered on contribution of the community participation to manage and conserve the fisheries resources. According to the evaluation, it received least scores indicating minimum rate for coastal (28%) and offshore (10%) fisheries which denoted “bad” or “weak” self management mechanism in social perspective. Addition to that decision on “fisheries influence” which was discussed strength of direct fisher influences on actual fishery regulation and management measures, was almost same as “community based management” and reported 30% for coastal and 16% for off shore fishery. In the same time level of “environmental knowledge” of fishers in term of knowledge about the fishery resources, its ecosystem and environment rated as 33% for those two fisheries directing the social

sustainability towards the “bad”. “Socialization of fishing” and “new entrants to the fishery” lie in the range of “moderately good”. In the same time “fishing sector” (households containing fishers in the community) and “conflict status” (level of conflict with other sectors) placed in level of moderately good for off shore fisheries and moderately bad for coastal fishery. Higher rate for “kin participation” benefited towards the “good” end symbolizing better social condition and it claimed 58% for coastal and 22% for off shoe fishery as to Rapfish analysis.

Table 16: Average scores and standard deviations of each attribute for social analysis by principal fisheries coastal and off shore

Social Analysis							
		Coastal Fishery			Off Shoe Fishery		
No	**Attribute**	**Average**	**%**	**SD**	**Average**	**%**	**SD**
1	Socialization of fishing	5.9	59	16.56	6.7	67	28.63
2	New entrants into the fishery	6.7	67	27.86	5.7	57	15.79
3	Fishing sector	4.5	45	26.02	6.0	60	15.95
4	Environmental knowledge	3.3	33	12.51	3.3	33	13.01
5	Conflict status	4.8	48	15.36	6.9	69	14.24
6	Fisher influence	3.0	30	14.14	1.6	16	11.96
7	Fishing income	8.3	83	16.64	8.7	87	13.77
8	Kin participation	5.8	58	12.12	2.2	22	18.69
9	Community based management	2.8	28	15.65	1.0	10	3.67
	Total Value	45.0	450		42.1	421	
	Average value	5.0	50		4.7	47	

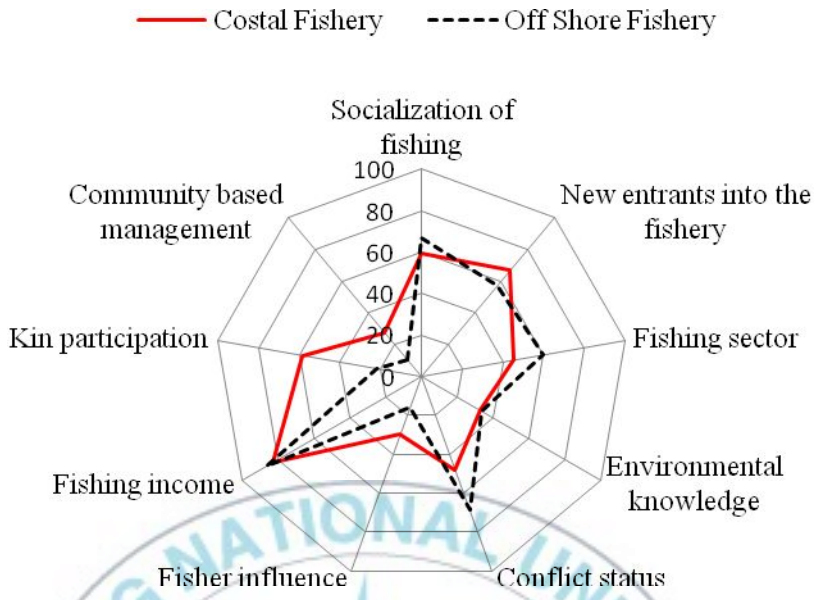

Figure 5: Kite diagram expressing the average scores of sustainable status for each attribute in social perspective by principal fisheries coastal and off shore

Technological Analysis

In the technological dimension, evaluation has been considered by nine attributes which were technologically benefits to minimize the risk on sustainable fisheries. Average day at sea per fishing trip was analyzed by attribute “trip length” and, when days surpassed more than ten days scores towards the “bad” end of scale(0%) and vice versa days less than one towards the end of ‘good” (100%). Addition to that, due to depression of “landing sites” around the coastal belt reflects the technological stability and centralization shows technological instability. From the analysis, results shows (figure 6 and table 17) that both attributes have been recorded the greatest rate for coastal fisheries placing the range in “good” and in same circumstances off shore fishery rated least (7%) for “trip length” and “moderately bad” for “landing sites”. However, these two results are contradictorily characteristic for both principal marine fisheries in Sri Lanka, because it depends on mainly type of the vessels and the fishery. More over “vessel size” also other characteristic attribute for marine fisheries depend on type of vessels and obtained results “good” for coastal and “moderately bad” for offshore means same as above. Therefore, in this analysis it makes doubtful comparison between coastal and off shore fisheries with these three

attributes in technological perspectives; because Rapfish analysis usually compares single fisheries with each other taking in to account all the fisheries separately and in this cause all single fisheries represent only two characteristic fisheries as coastal and off shore. “Pre sale processing”, “onboard handling” and “selective gear” were rated as “bad” for coastal fisheries. Except “selective gear” judgment on other two attributes can be described because the coastal fishery is single day fishing operation and it focused mainly local or regional market (economic analysis) due to small scale fishery. In contrast off shore fishery is a multiday (more than 10 days) and national or international market targeted fishery means it needs more processing and on board handling as a large scale than coastal fishery. However obtained result shows that “presale processing” lay on the lower end of “moderately good” and “onboard handling” was in “moderately bad” and it evidenced that the quality of fish landings is generally poor and fish spoilage is as high as 40% reducing the potential for value added in the sector (FAO, 2007).

In technologically, “change in catching power” (increase) and use of “FAD”s (fish attraction devices) implies the additional pressure on fish resources in terms of risk on ecological perspective. Therefore, Rapfish

method emphasized that minimum influenced technological changes would be favourable for resources and also result of analysis illustrated that both attributes lying in range "moderately good" for both fisheries ('change in catching power" for off shore fishery was 43%) in technological dimension. Finally the attribute "gear side effect" categorized as a killer attribute by Rapfish group, means if score equal to 1 or 2 technological analyses filed is completely set to "bad". In here, experts' value represents "good" and "moderately good" for off shore and coastal fishery respectively.

Table 17: Average scores and standard deviations of each attribute for technological analysis by principal fisheries coastal and off shore

Technological Analysis							
		Coastal Fishery			Off Shoe Fishery		
No	**Attribute**	**Average**	**%**	**SD**	**Average**	**%**	**SD**
1	Trip length	9.0	90	0	0.7	7	6.55
2	Landing sites	8.0	80	17.06	3.8	38	15.51
3	Pre-sale processing	1.4	14	9.41	5.1	51	21.96
4	Onboard handling	1.5	15	11.23	3.7	37	17.64
5	Selective gear	1.3	13	9.35	4.1	41	20.87
6	FADS	5.6	56	22.1	5.5	55	19.97
7	Vessel size	7.6	76	12.03	4.1	41	10.76
8	Change in catching power	5.9	59	20.47	4.3	43	9.97
9	Gear side effects	6.7	67	8.06	7.7	77	19.06
	Total Value	47.0	470		39.1	391	
	Average value	5.2	52		4.4	43	

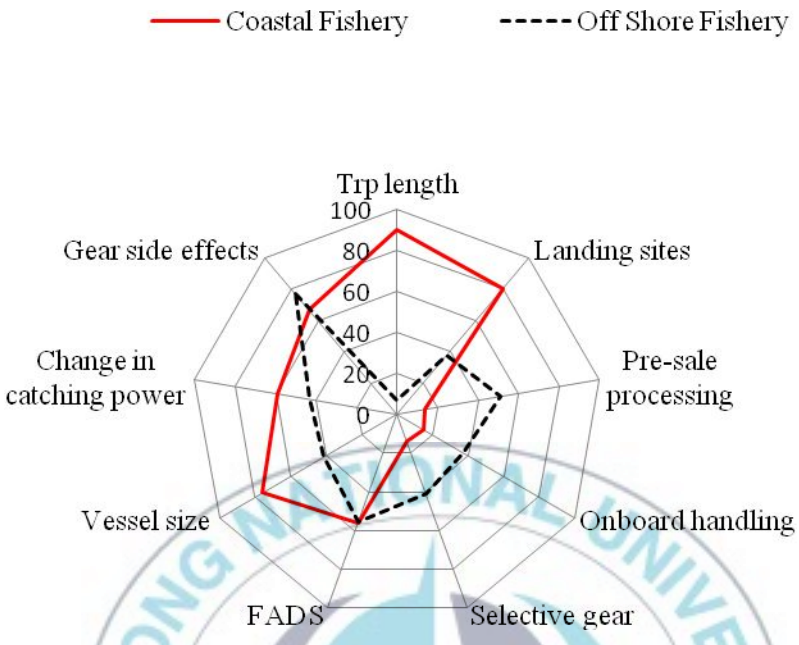

Figure 6: Kite diagram expressing the average scores of sustainable status for each attribute in technological perspective by principal fisheries coastal and off shore

Administrative Analysis

Administrative analysis reflect action and progress of current fisheries management regeme. Therefore analysis forcused nine attributes(table 18 and figure 7) which were directly involved to conserve and manage the fisheries resources. As to result, least rate was recorded the characteristic "periodic evaluation" for coastal (11%) and off shore (13%) fisheries and, that evinced almost zero evaluation on fisheries and management performance. "regulatory compliance" reported maximum scores for both fisheries in administratively rating 66% (coastal) and 80% (off shore) which means current regulatory compleance system was adequate to mange and conserve the sector as to experts perspective. Even so evaluation implies the enough rules, laws and regulation(regulatory compliance) to mange the sector; attributes "low enforcement" "MCS" amd "compliance with international" were rated in the range of "moderately bad". Furthermore "scientific studies on fisheries" and "best scientific evidence available" are most important chatacteristics for decition making and policy implementation of any type of fisheries. But, experts judgement lay in the range "moderately bad" and comparatively less standard deviation stressed almost same decition of experts (table 18). Mean while second least rate was

accounted (coastal-23%, offshore-17%) criteria "consultation of stake holders" implying reare consultation of stake holders for management and policy making of the sector. Finally, the criteria "institutional framework" took cognizance of arrangement and intergaration among directorates which were responsible for fisheries management regeme and same as other attributes it was also rated by experts "moderately bad" for both fisheries.

Table 18: Average scores and standard deviations of each attribute for Administrative analysis by principal fisheries coastal and off shore

Administrative Analysis							
		Coastal Fishery			Off Shoe Fishery		
No	**Attribute**	**Average**	**%**	**SD**	**Average**	**%**	**SD**
1	Institutional framework	4.2	42	16.78	3.3	33	16.63
2	Scientific studies on fisheries	3.6	36	8.91	3.3	33	12.95
3	Regulatory compliance	6.6	66	21.26	8.0	80	17.18
4	MCS	3.3	33	11.85	3.3	33	17.74
5	Law enforcement	4.2	42	14.13	3.7	37	16.95
6	Best scientific evidence available	3.4	34	11.58	3.8	38	9.51
7	Consultation of stakeholders	2.3	23	19.87	1.7	17	16.08
8	Periodic evaluation	1.1	11	9.68	1.3	13	12.22
9	Compliance with international law	3.0	30	17.45	3.7	37	17.48
	Total Value	31.7	317		32.0	320	
	Average value	3.5	35		3.6	36	

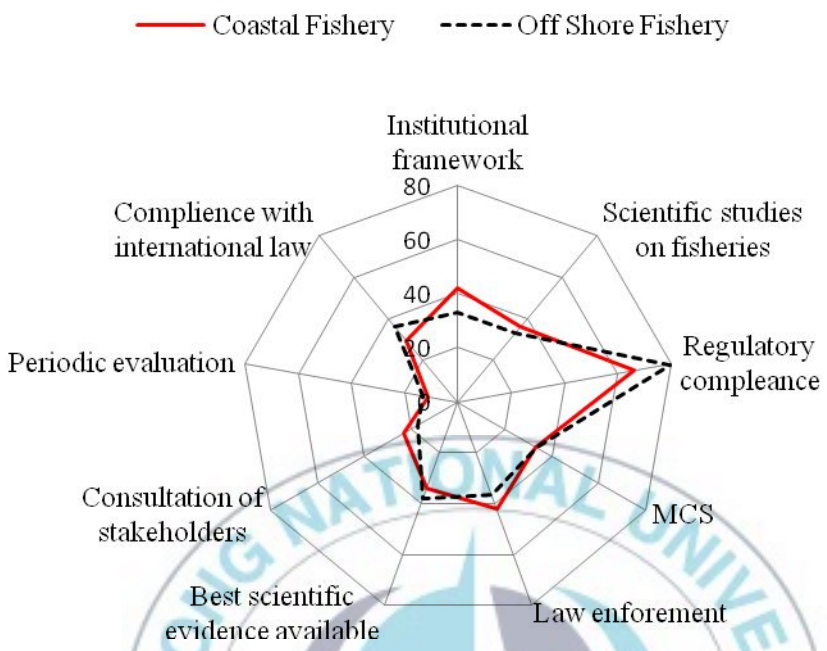

Figure 7: Kite diagram expressing the average scores of sustainable status for each attribute in administrative perspective by principal fisheries coastal and off shore

Overall discussion on evaluation fields

In order to run the "bad" or "good" state of analysis, here all rates of selected attributes were merged in a single composite and calculated average percentage for each field with in each fishery. This means, it indicates the percentage contribution of each discipline (field) for both fisheries according to average judgment of experts for evaluated attributes. Results of this approach are shown in figure 8. On the other hand, as to Rapfish illustration this participatory approach system adequately reflect contemporary view of fisheries sustainability in different direction in terms of "good" or "bad" or "moderate" fishery. From all of five evaluation fields, ecological status accounted the highest rate falling in the third quartile as "moderately good" and comparatively off shore fishery was better (69%) than coastal (60%). The experts interest on three attributes "discards", "species caught" and "bycatch" were highly weighted (above 75%) in the ecological perspective. These particular emphases make doubtful impression in contrast with the score of attribute "selective gear" in technological orientation. Because in the same time receiving minimum scores for criteria "selective gears" (coastal - 13%, off shore – 41%) emerge contradictory conception means with minimum selective gears how it can be

minimized those side effects (discards, bycatch, number of species). Mean while studies carried out on marine fisheries had been revealed that marine fisheries of Sri Lanka was as multi species and multi gears (NARA, 2006; Dissanayake, D.T.C., 2005; Wijayaratne, B., 2001; Haputhantri, S., 2007; FAO, 2007.) and also zero output control system (FAO,2007). Addition to that the approach assessed both of major fisheries in general perspective, including all single fisheries as a whole. Therefore such reasons might have influenced on expert decision for those attributes in ecologically to be on the safe side.

Table 19: Average scores of five evaluation fields by coastal and off shore fishery

Evaluation Fields	**Coastal Fishery**	**Off Shore Fishery**
Ecological	60	69
Economic	45	40
Social	50	47
Technological	52	43
Administrative	35	36

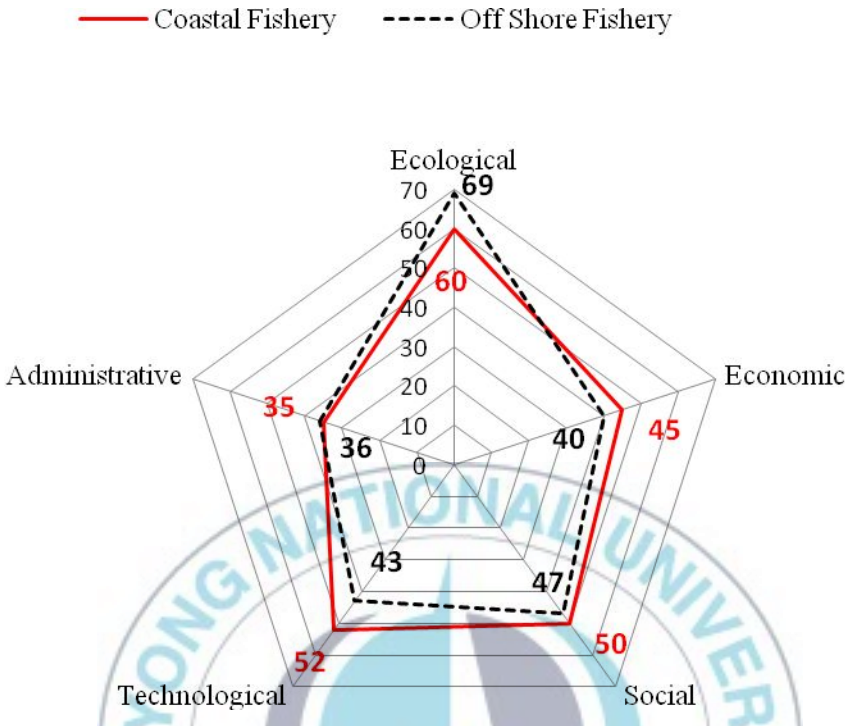

Figure 8: Composite kite diagram of the average scores in each evaluation fields by coastal and off shore fishery

Economic and social analyses reflect intensity of impact of current fisheries management practices on the sustainability of economy and society or community associated with particular fishery. As stated by Rapfish, evaluation considered grater rates for socio-economic status towards the

“good” end and sector would be strong in economically and socially as well as ultimately it would be reflected the ecological sustainability. Even though overall analysis demonstrated the marine sector was “moderately good” in ecological dimension, it was “moderately bad” in social (coastal-50% just on the line of moderately good; off shore-47%) and economical (coastal-45%; off shore-40%) dimension.

The experts’ decision on several attributes discovered existent common case of both coastal and off shoe fisheries in comparatively when it could be comparatively discussed with socio-economic ecological perspectives. “Heavy exploitation” of coastal fishery (table 14) has reduced the strength of “new entrants” to fishery because it has dropped down the “average income” of fishers in terms of declining the yield of catch. Results of those key attributes illustrate feeble health of resources and unsustainable socio-economic status of coastal fishery. In contrast higher average wage and under or fully exploitation level has almost increased the new entrants to the off shore fishery alarming towards the unsustainable socio-economic and ecological status. Reasons exemplify by ineffective entry limitations (figure 4) and poor management measure implementations (figure 7) increasing the potential of risk on fisheries vice versa on fishers excluding the objectives

of Rapfish. Because Rapfish method addresses that an average wage above the national is an intensive for fishers to support and obey management directives to ensure that their wages remain high or improve.

Meanwhile both fisheries are almost full time (attribute – "other income") means method considers it is badly affected to economic sustainability (Table 15) and fisheries being the major income contributor to fishers' family means improvement of sustainability in social perspective; because of more dependence on fisheries as a primary income for subsistence of householders will manage to ensure that their resources in good enough with regards to sustain health of fishery. On the other hand the number of fishermen in a context of high dependency on fishery resources is a factor to determine high resource exploitation and also limited access to alternative incomes. Here, it implies a basic economic concept that; if there are no or limited alternative sources of employment that the opportunity cost of fishers (labour) will be low or almost zero. Therefore that will be a critical condition for policy makers in economical, social and ecological view and more over politically too.

In social dimension it has recognized that when fisher work an organized and cooperative way there are more opportunities to settle common rules

that help the regulation and sustainable management of resources (E.Garmendia et al., 2010). On this basis results described that both fisheries were as more socialized (work as community group) in contrast to individual (unsocialize). But, in the same time outcome has revealed that current management regime has neglected this best opportunity to manage common resources (fisheries) with consultation of stakeholders and direct fisher influence on actual fishery regulations and implementation (table 16 and 18). Under these circumstances distinctive effect is poor community based management system (table 16) and characteristic top-down fisheries management intervention through spiralling regulations. When the common resources (fisheries) manage, such pragmatic management needs to consider fishers' influence which means those "non scientific information" and active participation of them for long term resilience and effectiveness. But, particularly such matters as stakeholders, co-management, and collective decision making are still well not implemented in most fisheries management systems (D.Leadbitter, T.J. Ward., 2007).

In technological dimension, evaluation was carried out to determine how technologies used to minimize risk on sustainability of fisheries and also how it engage to lower the losses or make economic optimization. Figure 8

shows that off shore fishery was “moderately bad and coastal fishery was “moderately good” lying on the line towards the bad in view of technological evaluation from both principal fisheries. Adverse effects such as long trip length, use of FADs, size of vessels and positive change of catching power should be controlled to reduce risk on fish resources for long run. Because long term sustainability of exploited fish stock can be achieved only if strategic parameters influencing technological changes are kept under strict control (F.Dercole et al, 2010). On the other hand innovative technologies to reduce post harvest losses and to maximize usage of environmental friendly fishing methods (selective gears) need take an immediate action in technologically (table 17.).But lack of proper understanding of these reasons and ineffective enforcement of available strategies by fisheries directorates (table 18) evinced that worst and moderately bad state of most characteristics which represented the technological dimension of marine fisheries (table 17) in Sri Lanka.

Fisheries governance involves two key challenges. The first one is to understand the prevailing situation of world (or country) and especially feed backs of fishers and ecosystem dynamics. The second one is the necessity to validate this knowledge in to effective governance to achieve biological,

social and economic goals (R.Quentin Grafton et al, 2007). Under this elucidation considered all attributes of administrative analysis except available rules, laws and regulations (regulatory compliance) have gathered the other side of good and resulting “moderately bad” condition of administrative dimension at last. Receiving minimum rate for the administration of the government from all five evaluation fields evince that progressively more restrictive fisheries management regime. Under these circumstances the weak environment of administration generates many challenges of concerns for policy makers, because performances of other four fields extremely depend on the best management measures and implementations keeping alive.

Conclusions

In conclusion, using Rapfish technique here it is illustrated as a practical approach is able to evaluate the status of fisheries comparatively for countries where the reliable and scientific information are less available. It encompasses and systematizes wide scope of evaluation field than conventional stock assessment, reflecting realistic policy choices and trade off that have to be made especially among ecological, economic, social, ethical and technological (T.J.Pitcher, D.Preikshot, 2001).

As to conducted study, it seems that the marine fishery is still not bad in ecological aspect in Sri Lanka and , however off shore fishery is better than coastal fishery comparatively in the same perspective. On the other hand recording poor rates for three other assessed fields which are economic, social and technological dimensions suggest two judgments. One is visual angle of policy formulation and also implementations are less sufficient and ineffective within those dimensions (Economically, socially and technologically). Other one is inferior results of those three fields (table 19) infers the increasing risk on ecological features. Those risks on resources are little bit higher on off shore than coastal fishery, it means policy

implications has paid little attention regarding coastal resources than off shore due to differences of ecological stability.

From the administration point of view, evaluation confirms that exist designed policies are not well planned because lack of reliable information, scientific studies, consultation and periodic evaluations of performance, in terms of without decision support tools. Under these conditions it can be concluded that established fisheries policy can be good (with high score in ecologically) or has ignored (with lowest score in administratively) the ecological features. Usually most fisheries management system in many tropical developing courtiers pay less attention to biological, technical and social aspects because poor understanding of biological relationship and political and social reasons. (M.G.Bhat, R.Bhatta, 2006).

If all the things take in to an umbrella it reflects that current poor marine policy system is unfavourable for long term sustainability in ecological dimension because those policies are ineffective for other four evaluations in terms of reasoning to increase additional pressure on resources. An important question is whether these reasons could be diagnosed early, to take precautionary actions by current conventional fisheries management regime (Table 18). If not one of major risk of management failure in

fisheries is the conflict between ecological constraints and socio-economic priorities, and ultimately be more complicated in (politically, administratively) the future than present.

Finally, the work of world commission on sustainable development Brundlandt Report has explained “the issue of using information for more informed planning and decision making has been central to development debate for all sectors, and particularly those exploiting natural renewable resources. Moreover it explains assessing the status of the resources (often bad), addressing social and economic constraints (generally serous) and discovering the relative in adequacy information and analytical capacity available to support the decision making. Information available is very rarely sufficient for informed decision making and simple and carefully selected indicators could improve the effectiveness of decision process” (S.Garcia, 1996). Results of this analysis on Sri Lanka fisheries are a typical example to substantiate the above statement perfectly. More over studies like this can be gear up the understanding of the dynamic among socio-economic, technological, governance and ecological conditions simply and easily.

Recommendations

1. Sufficient information is a key factor for the best decision making. It needs many studies and researches on fisheries science with proper data collection system from deferent dimensions (Ecological, economic, social, technological and administrative etc.). The study exposed that precise information and scientific researches available were greatly insufficient for well formulated decision process (Policies, development plan) of Sri Lankan marine sector at present. Because, directives for managing fisheries are often dependant on the "scientific advice" above all other considerations in the decision making exercise (D.E.Lanes, R.L.Stepheson, 2000). Therefore analysis confirms that to switch current policy measures focusing on these objectives as a primary concern is to improve the effectiveness of decision making.

2. Studies and evaluations will be able to suggest appropriate and applicable management measures to the sector. In this sense all the directorates should consider that information together (institutional arrangement is moderately bad) to make development plan and

policy measures with endless evaluation process for long-term responsible fisheries. Because separate management process for fisheries science and fisheries management with in government agencies, and noted that the lack of an appropriate context for the management of fisheries reasoning the lack of an integrated approach to fisheries management (D.E.Lanes, R.L.Stepheson, 2000).

3. Sri Lankan marine fisheries have defined as a multi efforts (gears and crafts), multi species (FAO, 2007) and socialized (table 16) fishery, in other way can be defined as a complex fishery. Therefore it emphasize that the realistic formation and application of management measures together with the fishing community is essential to overcome the complexity. Fisheries management usually flow from high level national policies or strategies and national agreement. As consequence, there is a gap between broad statements and practical use in management plan. Therefore policy measures should be and frequently applicable. It is in this context that it is necessary to introduce consultation with the fishing community to

use bottom-up style fisheries management (M.De.Lara, V.Martinet, 2009). That is an absolute responsibility of fisheries management regime which means how the fishing communities/organizations are placed to minimize those impediments to make better cooperation and partnership with fishers for long term sustainability.

4. Technological innovations are associated with changes in the technical level for exploitation of involved products (resources). With higher exploitation pressure (Table 14) additional technology (catching power, FADs, Vessel size etc.) can be triggered harvesting intensity on resources than previous resulting unsustainable fishery. In these circumstances innovations should be carefully considered the way to apply such as to reduce post harvest losses (table 17) in terms of increase the production or income of the fishers indirectly rather than surplus tensions over the resources. More over new technologies needs to reduce adverse affect on marine environment (bycatch, physical damage, ghost fishing etc.) by poor fishing gears. Policy priorities should be weighted up these changes with current

issues for long term sustainability of exploited fish stock and also better socio-economic status of community in Sri Lanka.

5. Study revealed that all fishing communities almost were highly dependent on marine resources as primary income for their subsistence which means 80% from total family income (table 16). This appears to indicate risk on fisheries resources and goal of socio-economic efficiency. This follows that necessity to ensure; first sustainable and efficient fisheries and second riskless system to enhance income of fishing families to improve their living standards. Policy makers needs to know these ecological and economic realities and it is a accountability of them to create alternative employment opportunities to the sector increasing opportunity cost of labour (crew) and system to take family members part in the income generation to make sure safety of both resources and uses.

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Acknowledgement

I am grateful to my supervisor professor Sang-Go LEE whose encouragement and guidance and support from the initial to the final level enabled me to develop an understanding of my subject.

I would like to show my gratitude to my Pukyong National University and all the professors who helped me to complete my Master thesis successfully.

I owe sincere and earnest thankfulness to KOICA because this master thesis would not have been possible unless KOICA wouldn't grant this fellowship to me as a graduate student. In the same time I would to like to thank my department (DFAR) and ministry (MFAR) too.

Finally it is pleasure to thanks fisheries experts who made this thesis possible giving information through the questionnaire with encouragement in Sri Lanka.

Appendices

Appendix 1: Data collected questionnaire from fisheries experts

Ecological Analysis

Ecological attributes reflect how the fishery impacts sustainability in terms of the ecology of the exploited fish and their ecosystem. Fisheries management practices that increase the risk of overexploitation, quickly change trophic levels etc. are scored towards the 'bad' end of the scale while fisheries management practices that protect the species or ecosystem score towards the 'good' end of the scale.

No	Attributes	Description	Situation	Score Range	Fisheries Sector	
					Coastal	Offshore
1	Exploitation status	FAO like scale	Under	(0 - 1)		
			fully	(2 - 4)		
			heavily	(5 - 6)		
			Over Exploited	(7 - 8)		
			Completely Collapsed	(9 - 10)		
2	Recruitment Variability	Coefficient of variability (Variation of no. of fish Enter to the fishery)	Low < 20%	(0 - 1)		
			Medium 20% - 60%	(2 - 5)		
			High 60% - 100%	(6 - 8)		
			Very high >200%	(9 - 10)		
3	Change in trophic level	Is the trophic level of the catch in the ecosystem in which this fishery is Embedded, decreasing? (Fishing down the food web)	No	(0 - 2)		
			Somewhat, slowly	(3 - 5)		
			Rapidly	(6 - 10)		
4	Catch Composition	Change in catch composition During past five years	No or very little	(0 - 1)		
			Yes, a gradual change	(2 - 5)		
			Yes, a rapid large change	(6 - 8)		
			Major rapid reduction	(9 - 10)		

5	Range collapse	Is there evidence of geographic range reduction	No or very little	(0 - 2)		
			Some, slow	(3 - 5)		
			A lot, fast	(6 - 8)		
			Very great, rapid	(9 - 10)		
6	Size of fish	Has average fish size Landing past 5 - 10 years	No or very little	(0 - 1)		
			Yes, a gradual change	(2 - 5)		
			Yes, a rapid large change	(6 - 8)		
			Major rapid reduction	(9 - 10)		
7	Catch before maturity	Percentage change before size/age of maturity.	None	(0 - 1)		
			Some > 30%	(2 - 5)		
			Lots >60%	(6 - 8)		
			A lot > 80%	(9 - 10)		
8	Discards	Percentage of target catch (target species juveniles plus other species)	Low 0 - 10%	(0 - 1)		
			Medium - 10 - 40%	(2 - 5)		
			High >40%	(6 - 8)		
			Very high > 100%	(9 - 10)		
9	Species caught	Number species caught (Retained and discarded)	Law 1 - 10	(0 - 1)		
			Medium 10 -100	(2 - 5)		
			High > 100	(6 - 8)		
			Very high	(9 - 10)		
10	Bycatch	Percentage of target catch (target species juveniles plus other species)	Low 0 - 10%	(0 - 1)		
			Medium - 10 - 40%	(2 - 5)		
			High >40%	(6 - 8)		
			Very high > 100%	(9 - 10)		

Economic Analysis

Economic attributes reflect how fisheries management practices impact the economic sustainability of the fishery and related human communities, as ultimately predicted on ecological sustainability.

No	Attributes	Description	Situation	Score Range	Fisheries Sector	
					Coastal	Offshore
1	Fisheries in GDP	Importance of fisheries sector in the economy (in comparison to other industries and economic sectors such as Agriculture, Tourism.)	Low	(0 - 3)		
			Medium	(4 - 7)		
			High	(8 - 10)		
2	Fisheries Export	Importance of fisheries Exports compared with total exports (Export/Total exports)	Low	(0 - 1)		
			Medium	(2 - 5)		
			High	(6 - 8)		
			Very high	(9 - 10)		
3	Average wage	Do fishers make more or less than the average person?	Much less	(0 - 2)		
			Less	(3 - 4)		
			The same	(5 - 6)		
			More	(7 - 8)		
			Much more	(9 - 10)		
4	Limited entry	Includes informal limitations	Open access	(0 - 2)		
			Weak or informal control	(3 - 4)		
			Medium control	(5 - 6)		
			Strong control	(7 - 8)		
			Strictly limited	(9 - 10)		
5	Other income	In this fishery , fishing is mainly	Causal	(0 - 2)		
			Part time	(3 - 5)		
			Seasonal	(6 - 8)		
			Full time	(9 - 10)		

6	Sector Employment	Employment is formal sector of this fishery (Compared to all the other fisheries at the same scale of analysis)	10% - 30%	(0 - 2)		
			30% - 60%	(3 - 5)		
			60% - 80%	(6 - 8)		
			80% - 100%	(9 - 10)		
7	Ownership/ Transfer	Profit from fishery mainly to	Locals	(0 - 2)		
			Mixed city/local	(3 - 5)		
			A mainly non locals	(6 - 8)		
			Mainly foreigners	(9 - 10)		
8	Market	Market is principally	Local	(0 - 2)		
			Regional/local	(3 - 5)		
			National/regional	(6 - 8)		
			National/international	(9 - 10)		
9	Subsidy	Are subsidies(Including hidden subsidies) provided to support the fishery ?	No	(0 - 2)		
			Somewhat	(3 - 4)		
			Large subsidies	(5 - 6)		
			Heavily reliant	(7 - 8)		
			Almost completely reliant on subsidies	(9 - 10)		

Social Analysis

Social attributes reflect how fisheries management practices impact the sustainability of the society or community associated with that particular fishery, as ultimately predicated on ecological sustainability.

No	Attributes	Description	Situation	Score Range	Fisheries Sector	
					Coastal	Offshore
1	Socialization of fishing	Fishers work as (Individuals= Working for commercial company, Families=direct connection to the fishery -eg. Owner, operator, community groups= social connections (fishing co-operatives)	Individuals	(0 - 3)		
			Families	(4 - 6)		
			Community groups	(7 - 10)		
2	New entrants into the fishery	Growth over past ten years (Increasing number of fishers and people involved)	Few < 5%	(0 - 2)		
			Some 5 - 10%	(3 - 5)		
			Many 10 - 40%	(6 - 8)		
			A great many > 40%	(9 - 10)		
3	Fishing sector (Capitalization)	Households containing fishers in the community (Community is define at the scale of the fishery defined in the analysis Eg. landing site,harbor city, state	Few < 5%	(0 - 2)		
			Some 5 - 10%	(3 - 5)		
			Many 10 - 40%	(6 - 8)		
			A great many > 40%	(9 - 10)		
4	Environmental Knowledge	Level of knowledge about the fishery resources and its ecosystem and environment	None	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		
5	Conflict status	Level of conflict with other sectors (includes other fisheries or Industries - Eg. Migratory fishermen, catchment runoff, Beach seine fishery)	Almost none	(0 - 2)		
			Some	(3 - 5)		
			Lots	(6 - 8)		
			A great amount	(9 - 10)		

6	Fisher influence	Strength of direct fisher influence of actual fishery regulations	Almost none	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		
7	Fishing income	Fishing income as % of total family income	< 10%	(0 - 2)		
			10 - 50%	(3 - 5)		
			50 - 80%	(6 - 8)		
			> 80%	(9 - 10)		
8	Kin participation	Do kin sell and/or process fish	Almost none	(0 - 2)		
			Very few relatives (1-2 people.	(3 - 4)		
			A few relatives	(5 - 6)		
			Some relatives	(7 - 8)		
			Fishery is mainly kin	(9 - 10)		
9	Community Based Management system	Fisher mange their fisheries By themselves in addition to Act and Regulations. (Societies, agreements etc)	None	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		

Technological Analysis

Technological attributes capture appropriate technologies that minimize risk to sustainability of the fishery. Therefore when devices are used to improve the catching power these fisheries score towards the 'bad' end, while a fishery that uses technology such as ice to prevent waste or reduce by-catch scores towards the 'good' end of the scale.

No	Attributes	Description	Situation	Score Range	Fisheries Sector	
					Coastal	Offshore
1	Trip length	Average days at sea per fishing trip	1 or less	(0 - 1)		
			2-4 days	(2 - 4)		
			5-8 days	(5 - 6)		
			8-10 days	(7 - 8)		
			More than 10 days	(9 - 10)		
2	Landing sites	Are landing sites	Dispersed	(0 - 2)		
			Somewhat centralized	(3 - 5)		
			Heavily centralized	(6 - 8)		
			Distant water fleet with little or no local landings	(9 - 10)		
3	Pre - sale processing	Processing before sail (eg. Gutting, filtering, salting)	None	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		
4	Onboard handling		Almost none	(0 - 2)		
			Some (eg. salting, boiling)	(3 - 5)		
			Sophisticated (eg. Flash freezing, champagne ice)	(6 - 8)		
			A great amount, such as live tank	(9 - 10)		

5	Selective gear	Device(s) and/ or handling of gear to increase selectivity and reduce bycatch	Very little	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great amount	(9 - 10)		
6	FADS	Fish attraction devices	Not used	(0 - 2)		
			Some, eg bait is used	(3 - 5)		
			Some reliance on FADs	(6 - 8)		
			Almost completely reliant on FADs.	(9 - 10)		
7	Vessel size	Average length of vessels	< 5m	(0 - 2)		
			5 - 10m	(3 - 4)		
			10 - 15m	(5 - 6)		
			15 - 20m	(7 - 8)		
			> 20 m	(9 - 10)		
8	Change in catching power	Have fishers altered gear and vessel to increase catching power over past 5 years ?	Not much	(0 - 2)		
			A small amount	(3 - 4)		
			Somewhat	(5 - 6)		
			A lot	(7 - 8)		
			A great amount(Rapid inc.	(9 - 10)		
9	Gear side effects	Does gears have undesirable side effects (eg. Cyanide, dynamite, trawl , ghost Fishing)	Very few	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			Fishery dominated by destructive fishing practices	(9 - 10)		

Administrative Analysis

Administrative attributes directly explain how the fisheries management measures influence for sustainable fisheries management. It plays the key role for decision making and policy making.

No	Attributes	Description	Situation	Score Range	Fisheries Sector	
					Coastal	Offshore
1	Institutional arrangement & horizontal integration	There are several institution under Ministry of Fisheries DFAR, NARA, NAQDA, CFC, CFHC, Cey-Nor	worst	(0 - 2)		
			some what	(3 - 5)		
			good	(6 - 8)		
			very good	(9 - 10)		
2	Scientific studies on fisheries	on endangered/over Exploited/depleted spp/stock , MSY for fisheries	None	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		
3	Regulatory compliance	Contribution for Sri Lankan Fisheries Management (Boat registration, Operation License, regulations, etc.)	Very little	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great	(9 - 10)		
4	MCS system	Monitoring controlling and surveillance	None	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		
5	Effectiveness of law enforcement	Fisheries Act and regulations	None	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great deal	(9 - 10)		
6	Ongoing collection & availability of data	Efficiency and accuracy of data collection system and Quality of the statistics	Very little	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great	(9 - 10)		

7	Improvement of management system	The establishment of mechanism to ensure effective people's participation	Very little	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great	(9 - 10)		
8	Periodic evaluation	Evaluation of fisheries and management performance coupled with rolling development & management planning process	Almost none	(0 - 2)		
			Some	(3 - 5)		
			Lots	(6 - 8)		
			A great amount	(9 - 10)		
9	Compliance with international law	Compliance with international law, regulation & management measures(FAO Code of Conduct, UNCLOS)	Very little	(0 - 2)		
			Some	(3 - 5)		
			A lot	(6 - 8)		
			A great	(9 - 10)		

Appendix 2: Rearranged scoring system to get minimum value for 'bad' and maximum value for 'good' in terms of low to high

Ecological Analysis

No	Attributes	Situation	Rapfish Scores Range	Re arranged scores
1	Exploitation status	Under	(0 - 1)	(9 – 10)
		fully	(2 - 4)	(6 – 8)
		heavily	(5 - 6)	(4 – 5)
		Over Exploited	(7 - 8)	(2 – 3)
		Completely Collapsed	(9 - 10)	(0 – 1)
2	Recruitment Variability	Low < 20%	(0 - 1)	(9- 10)
		Medium 20% - 60%	(2 - 5)	(5-8))
		High 60% - 100%	(6 - 8)	(2-4)
		Very high >200%	(9 - 10)	(0 -1)
3	Change in trophic level	No	(0 - 2)	(8-10)
		Somewhat, slowly	(3 - 5)	(5-7)
		Rapidly	(6 - 10)	(0-4)
4	Catch Composition	No or very little	(0 - 1)	(9-10)
		Yes, a gradual change	(2 - 5)	(5-8)
		Yes, a rapid large change	(6 - 8)	(2-4)
		Major rapid reduction	(9 - 10)	(0-1)
5	Range collapse	No or very little	(0 - 2)	(8-10)
		Some, slow	(3 - 5)	(5-7)
		A lot, fast	(6 - 8)	(2-4)
		Very great, rapid	(9 - 10)	(0-1)
6	Size of fish	No or very little	(0 - 1)	(9-10)
		Yes, a gradual change	(2 - 5)	(5-8)
		Yes, a rapid large change	(6 - 8)	(2-4)
		Major rapid reduction	(9 - 10)	(0-1)
7	Catch before maturity	None	(0 - 1)	(9-10)
		Some > 30%	(2 - 5)	(5-8)
		Lots >60%	(6 - 8)	(2-4)
		A lot > 80%	(9 - 10)	(0-1)

8	Discards	Low 0 - 10%	(0 - 1)	(9-10)
		Medium - 10 - 40%	(2 - 5)	(5-8)
		High >40%	(6 - 8)	(2-4)
		Very high > 100%	(9 - 10)	(0-1)
9	Species caught	Law 1 - 10	(0 - 1)	(9-10)
		Medium 10 -100	(2 - 5)	(5-8)
		High > 100	(6 - 8)	(2-4)
		Very high	(9 - 10)	(0-1)
10	Bycatch	Low 0 - 10%	(0 - 1)	(9-10)
		Medium - 10 - 40%	(2 - 5)	(5-8)
		High >40%	(6 - 8)	(2-4)
		Very high > 100%	(9 - 10)	(0-1)

Economic Analysis

No	Attributes	Situation	Rapfish Scores Range	Re arranged scores
1	Fisheries in GDP	Low	(0 - 3)	
		Medium	(4 - 7)	
		High	(8 - 10)	
2	Fisheries Exports and Imports	Low	(0 - 1)	
		Medium	(2 - 5)	
		High	(6 - 8)	
		Very high	(9 - 10)	
3	Average wage	Much less	(0 - 2)	
		Less	(3 - 4)	
		The same	(5 - 6)	
		More	(7 - 8)	
		Much more	(9 - 10)	
4	Limited entry	Open access	(0 - 2)	
		Weak or informal control	(3 - 4)	
		Medium control	(5 - 6)	
		Strong control	(7 - 8)	
		Strictly limited	(9 - 10)	
5	Other income	Causal	(0 - 2)	(8-10)
		Part time	(3 - 5)	(5-7)
		Seasonal	(6 - 8)	(2-4)
		Full time	(9 - 10)	(0-1)

6	Sector Employment	10% - 30%	(0 - 2)	(8-10)
		30% - 60%	(3 - 5)	(5-7)
		60% - 80%	(6 - 8)	(2-4)
		80% - 100%	(9 - 10)	(0-1)
7	Ownership/ Transfer	Locals	(0 - 2)	(8-10)
		Mixed city/local	(3 - 5)	(5-7)
		A mainly non locals	(6 - 8)	(2-4)
		Mainly foreigners	(9 - 10)	(0-1)
8	Market	Local	(0 - 2)	(8-10)
		Regional/local	(3 - 5)	(5-7)
		National/regional	(6 - 8)	(2-4)
		National/international	(9 - 10)	(0-1)
9	Subsidy	No	(0 - 2)	(8-10)
		Somewhat	(3 - 4)	(6-7)
		Large subsidies	(5 - 6)	(4-5)
		Heavily reliant	(7 - 8)	(2-3)
		Almost completely reliant on subsidies	(9 - 10)	(0-1)

Social Analysis

No	Attributes	Situation	Rapfish Scores Range	Rearranged scores
1	Socialization of fishing	Individuals	(0 - 3)	
		Families	(4 - 6)	
		Community groups	(7 - 10)	
2	New entrants into the fishery	Few < 5%	(0 - 2)	(8-10)
		Some 5 - 10%	(3 - 5)	(5-7)
		Many 10 - 40%	(6 - 8)	(2-4)
		A great many > 40%	(9 - 10)	(0-1)
3	Fishing sector (Capitalization)	Few < 5%	(0 - 2)	(8-10)
		Some 5 - 10%	(3 - 5)	(5-7)
		Many 10 - 40%	(6 - 8)	(2-4)
		A great many > 40%	(9 - 10)	(0-1)

4	Environmental Knowledge	None	(0 - 2)	
		Some	(3 - 5)	
		A lot	(6 - 8)	
		A great deal	(9 - 10)	
5	Conflict status	Almost none	(0 - 2)	(8-10)
		Some	(3 - 5)	(5-7)
		Lots	(6 - 8)	(2-4)
		A great amount	(9 - 10)	(0-1)
6	Fisher influence	Almost none	(0 - 2)	
		Some	(3 - 5)	
		A lot	(6 - 8)	
		A great deal	(9 - 10)	
7	Fishing income	< 10%	(0 - 2)	
		10 - 50%	(3 - 5)	
		50 - 80%	(6 - 8)	
		> 80%	(9 - 10)	
8	Kin participation	Almost none	(0 - 2)	
		Very few relatives (1-2 people.	(3 - 4)	
		A few relatives	(5 - 6)	
		Some relatives	(7 - 8)	
		Fishery is mainly kin	(9 - 10)	
9	Community Based Management system	None	(0 - 2)	
		Some	(3 - 5)	
		A lot	(6 - 8)	
		A great deal	(9 - 10)	

Technological Analysis

No	Attributes	Situation	Rapfish Scores Range	Rearranged scores
1	Trip length	1 or less	(0 - 1)	(9-10)
		2-4 days	(2 - 4)	(6-8)
		5-8 days	(5 - 6)	(4-5)
		8-10 days	(7 - 8)	(2-3)
		More than 10 days	(9 - 10)	(0-1)
2	Landing sites	Dispersed	(0 - 2)	(8-10)
		Somewhat centralized	(3 - 5)	(5-7)
		Heavily centralized	(6 - 8)	(2-4)
		Distant water fleet with little or no local landings	(9 - 10)	(0-1)
3	Pre - sale processing	None	(0 - 2)	
		Some	(3 - 5)	
		A lot	(6 - 8)	
		A great deal	(9 - 10)	
4	Onboard handling	Almost none	(0 - 2)	
		Some (eg. salting, boiling)	(3 - 5)	
		Sophisticated (eg. Flash freezing, champagne ice)	(6 - 8)	
		A great amount, such as live tank	(9 - 10)	
5	Selective gear	Very little	(0 - 2)	
		Some	(3 - 5)	
		A lot	(6 - 8)	
		A great amount	(9 - 10)	
6	FADS	Not used	(0 - 2)	(8-10)
		Some, eg bait is used	(3 - 5)	(5-7)
		Some reliance on FADs	(6 - 8)	(2-4)
		Almost completely reliant on FADs.	(9 - 10)	(0-1)
7	Vessel size	< 5m	(0 - 2)	(8-10)
		5 - 10m	(3 - 4)	(6-7)
		10 - 15m	(5 - 6)	(4-5)
		15 - 20m	(7 - 8)	(2-3)
		> 20 m	(9 - 10)	(0-1)
8	Change in catching power	Not much	(0 - 2)	(8-10)
		A small amount	(3 - 4)	(6-7)
		Somewhat	(5 - 6)	(4-5)
		A lot	(7 - 8)	(2-3)
		A great amount(Rapid increase.	(9 - 10)	(0-1)

9	Gear side effects	Very few	(0 - 2)	(8-10)
		Some	(3 - 5)	(5-7)
		A lot	(6 - 8)	(2-4)
		Fishery dominated by destructive fishing practices	(9 - 10)	(0-1)