# FUEL SUBSIDY IN SRI LANKA FISHERIES: DATA ANALYSIS AND POSSIBLE IMPROVEMENTS

Ragavan Nadarajah
University of Jaffna
Sri Lanka
ragavansms@gmail.com

Supervisors:
Hörður Sævaldsson: hordurs@unak.is
Daði Már Kristófersson: dmk@hi.is

## ABSTRACT

Fisheries subsidy is defined as direct or indirect financial assistance to the fishing sector from the government or public organisations. In 2012 and 2013, the Sri Lankan government issued fuel subsidy to motorised fishing vessels due to high fuel prices. Non-motorized fishing vessels owners did not receive the subsidy. This study covers the impacts of fuel subsidy in Sri Lanka coastal fishery, no previous study were found with similar analyses. This project aims to provide such study, the paper is divided into three parts: Firstly, evaluation of the impact of fuel subsidy on fishing effort and vessels profit in Jaffna coastal fisheries in Sri Lanka. Secondly, asses quality of Sri Lanka coastal fisheries data as input to fuel subsidy methods. Thirdly, identify suitable ways to improve data quality and estimate the cost of modification. Six different types of fishing vessels are engaged in fishing activities in Sri Lanka marine fisheries sector; four types of motorised fishing vessels and two types of non-motorized fishing vessels. For the evaluation, monthly coastal fisheries data were collected from three landing sites from the Department of Fisheries in Jaffna. Suitable methods for the evaluation were obtained by reviewing the literature of fuel subsidy in the fisheries sector. Analyses of available data in Sri Lanka coastal fisheries reveal the current data not to be sufficient as input to fuel subsidy methods. The number of vessel groups was skewed from one period to another (shifted), the catch by landing sites could not be separated by fishing vessels, and the data of fishing cost was missing (i.e. fishing hours and amount of fuel consumption). As a recommendation, the author suggests three data collection methods to improve the data quality as a base to the scientific decision in the coastal fisheries. Recommended methods were grouped by the technology needed. The advanced complete enumeration is the most technological method, it is designed to monitor the fishing vessels, fishing activities and landing sites with 24 hours surveillance. The complete enumeration data collection method is designed to monitor the landing site only with 24 hours of surveillance. In both methods, data will be collected from all the fishing boats in the landing site. The stratified sampling method is designed to collect a number of fishing vessels from a landing site. These three methods vary in human resources, financial resources and technologies facilities. High quality data can be obtained from complete enumeration and lower quality data from the stratified sampling method. The complete enumeration methods are not economically feasible due to a large number of landing sites and lack of infrastructure in Sri Lanka coastal fisheries. The author recommends the data collection methods in Sri Lanka coastal fisheries to be reinforced to fully evaluate the effects of governmental support to the fishing sector. The stratified sampling method was seen to be the most likely collection method, as it is most suitable to current infrastructure in Sri Lanka coastal fisheries.

# TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES



## LIST OF APPENDICES

Table 1: List of Acronyms

| | |
|---|---|
| AD | Assistant Director |
| CBSL | Central Bank of Sri Lanka |
| CPC | Ceylon Petroleum Cooperation |
| DFAR | Department of Fisheries and Aquatic Resources, Sri Lanka |
| EEZ | Exclusive Economic Zone |
| FAO | Food and Agriculture Organization (United Nations) |
| FARA | Fisheries and Aquatic Resources Act |
| FI | Fisheries Inspection |
| FO | Fisheries Officers |
| GDP | Gross Domestic Production |
| GPS | Global Positioning System |
| IDAY | In boat motor day fishing boats |
| IMUL | In boat motor Multiday Fishing Boats |
| ITDG | Intermediate Technology Development Group |
| Kg | Kilogram |
| LKR | Sri Lankan Rupees |
| LIOC | Lankan Indian Oil Company |
| LTTE | Liberation Tigers of Tamil Eelam |
| MEY | Maximum Economic Yield |
| MFARD | Ministry of Fisheries and Aquatic Resources Development |
| MSY | Maximum Sustainable Yield |
| Mt | Metric tons |
| MTRB | Motorized Traditional Fishing Boats |
| NARA | National Aquatic Resources Research and Development Agency |
| NBSB | Non-Mechanised Beach Seine Boat |
| NGO | Non-Government Organisations |
| NTRB | Non- Mechanised Traditional Fishing Boats |
| OEDC | Organisation for Economic Co-operation and Development |
| OFRP | Out boat motor, fibreglass reinforced plastic boat |
| SU | Statistical Unit |
| TAC | Total Allowable Catch |
| USD | United States dollar |
| VDR | Voyage Data Recorders |
| VMS | Vessel Monitoring System |
| WTO | World Trade Organization |

# 1 INTRODUCTION

Sri Lanka is an island, located in the Bay of Bengal, southeast of the Indian subcontinent with the land area of 65,610 $km^2$ and 517,000 $km^2$ area of the EEZ (FAO, 2006) (Figure 1). The total population is around 21 million.

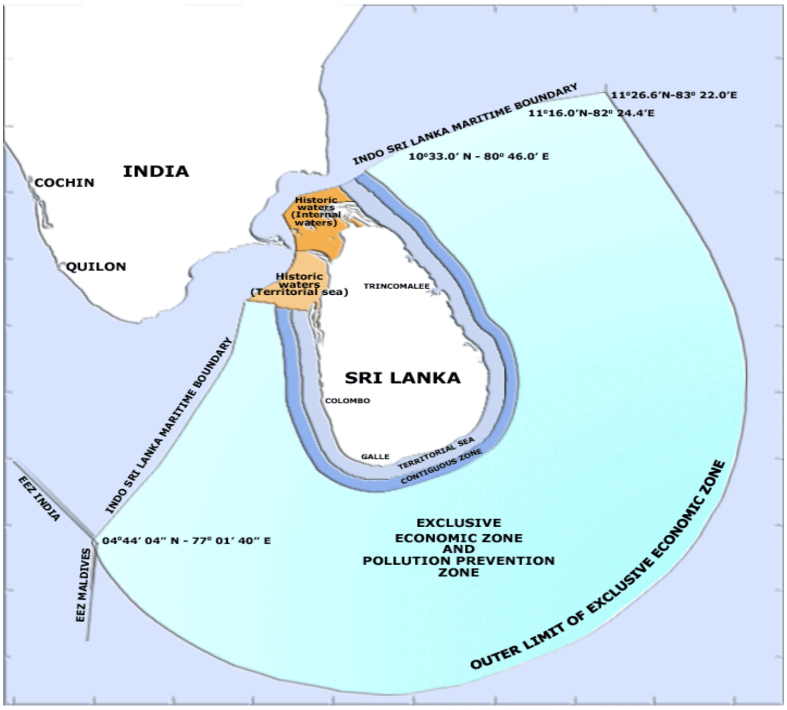


Figure 1. Sri Lankan Exclusive Economic Zone
(Source: http://sarathjaya.blogspot.com/p/policy.html)

The fisheries sector contributes significantly to the national economy; around 1.3 % of the country's GDP in 2016 (CBSL, 2018). The sector also provides important employment opportunities to local people. Almost 560,000 direct and indirect jobs are provided in the whole fisheries sector (NARA, 2016). The total labour force in Sri Lanka was 8,310,000 in 2016. The labour force comprises all persons above age 15 who were either employed and unemployed during the survey (Department of Census and Statistics, 2016). About 7% of the labour force depends mainly on the fisheries sector as their livelihood. Fish accounted for more than 60 % of Sri Lanka animal protein consumption in 2016 (NARA, 2016).

The fisheries sector is mainly divided into two sectors, marine fisheries and inland and aquaculture sector. Marine sector is the dominant sector and it is divided into three subdivision; coastal fisheries, offshore and deep-sea fishing. The coastal fishing activities are carried out from the shore to the edge of the continental shelf, while offshore, and deep-sea fishing activities are operated beyond the continental shelf. In 2016, the total fish production was about 530,000 Mt. The total fish production consists of marine capture fish production, inland capture fish production and aquaculture. The marine capture fisheries (457,000 Mt) contributed to 81% to the total fish production in 2016 (NARA, 2016). The remaining quantity then from inland and aquaculture sectors. The coastal fisheries sector (274,000Mt) contributed to 60% of the total marine fish production in 2016. Marine fishing activities are carried out in entire coast of Sri Lanka with the support of 21 fishing harbours, 46 anchorage points and about 950 landings sites. Coastal areas are divided as 15 fisheries districts for fisheries administration purposes (DFAR, 2016).

Fishery products are both exported and imported in Sri Lanka. The export quantity in 2016 was 17,593 Mt of seafood products with export value USD 183.5 million. The total export quantity was about 4 % of Sri Lanka total fish production in 2016. Major export products include prawns, fish fresh or chilled, aquarium fish, frozen fish, lobsters, crabs, shark fin and other edible fish. The dominant composition in 2016 were chilled and fresh seafood (63 %), followed by crabs (12 %). Aw well, a substantial amount of seafood is imported to Sri Lanka to sustain excess demand in the country. In 2016 the quantity of imported products was 115,693 Mt and the value USD 241 Million (NARA, 2016).

Fishing was fully open access except stake net fishing and beach seine fisheries before 1996. Fisheries and Aquatic Resources act was passed year 1996, to manage, conserve and develop the fisheries sector. Registration of fishing vessel and operation licences were made compulsory with the 1996 regulation (Atapattu, 1994). Based on the regulation, Sri Lankan marine fishing crafts are categorised into six major types (Table 2): In boat engine Multiday fishing boat (IMUL), In boat engine Day Fishing boats, outboard motor FRP boat (OFRP), Motorized Traditional Fishing Boats (MTRB), Non-Mechanised Traditional Fishing Boats (NTRB) and Non- Mechanised Beach Seine Boats (NBSB) (FARA act, 1996). However, some fishing activities are carried out without fishing crafts such as cast net fishing and handline fishing.

Table 2. Characteristic features of different types of fishing vessels in Sri Lanka (Wijayaratne, 2001; DFAR, 2018) (Jaffna district fisheries officers estimated the average values in 2018, they vary from one year to another, seasons and districts***)

| Code | Place of operation | Length (Feet) | Hull material | Horsepower | Common fishing methods | Fishing days per Month*** | Active fishing hours *** | Average catch per trip *** | Number of crafts in 2016 |
|---|---|---|---|---|---|---|---|---|---|
| IMUL | Offshore | Above 45 | Fibreglass | In boat motor (180Hp-250 Hp) | Longline, Driftnets, Purse seine | 5-10 days | 3 - 4 days | 1000-1500 Kg | 3,996 |
| IDAY | Offshore | 28-32 | Fibreglass | In boat motor (39 Hp-45Hp) | Trawling, Longline, Drift nets | 12 days | 18 Hours | Prawn- 50 - 70 Kg<br>Fishes 100-200 Kg | 786 |
| OFRP | Coastal | 18-24 | Fibreglass | Outboard motor (9.9 Hp- 40 Hp) | Gill nets, hand collection | 22-25 days | 16 Hours | 30 -40 Kg | 24,282 |
| MTRB | Lagoon and Coastal | 21-34 | Fibreglass / Timber | Outboard motor (8Hp to 25Hp) | Stake nets, Gillnets | 15-22 days | 8 -12 Hours | 20 - 30 Kg | 1,839 |
| NTRB | Lagoon and Coastal | 21-34 | Fibreglass / Timber | Non-Motorized | Stake nets, Traps, Handlines, Gillnets | 15-22 days | less than 8 hours | 15- 20 Kg | 17,853 |
| NBSB | Coastal | 20-24 | Timber | Non-Motorized | Beach seine | | | | 1,913 |
| | | | | | | | | **Total operating fishing crafts in 2016** | 50,669 |

In paper by Wimalasena & Rupamoorthy (2000) fishing vessels were categorised into two groups based on the fishing days and the labour force; small scale and large-scale fishing vessels. The small-scale vessels usually have single day fishing trips within the coastal regions of Sri Lanka. This group consists of non-mechanised (NBSB and NTRB) and mechanised fishing crafts (MTRB and OFRP). The large-scale vessels have multiday fishing activities in the offshore and high sea fishing grounds. This group consist of IMUL and IDAY fishing boats. In a report from NARA around 50,000 fishing vessels were found to be in the Sri Lanka marine fisheries sector in 2016 (NARA, 2016); 9% large scale fishing vessels and 91% of small-scale fishing vessels.

Two stock assessment survey have been performed in the Sri Lankan marine waters, the former in 1978 with results published 1979 and the latter in 2018. The first stock assessment survey was carried the help of Dr. Fridtjof Nansen research vessel from Norway. In the survey 400,000 to 500,000 Mt of the aquatic organism's biomass were found of in the west, east and south shelf region. The survey estimated maximum sustainable yield (MSY) of the continental shelf as 250,000 Mt per year (Blindheim & Foyn, 1980). Same research vessel did the second stock assessment survey in 2018. Some part of the northern province including Jaffna were also covered in the 2018 survey. The survey results have not yet been published.

Wijayaratne (2001) estimated the maximum sustainable level of coastal fisheries through bioeconomic models as 165,000 Mt per year. As shown in figure 2 the number of fishing vessels has increased from 30,000 in 2005 to about 51,000 vessels in 2016. The coastal fisheries production increased by five fold from 2005 to 2016. Sri Lanka's average coastal fisheries production from 2012 to 2016 was about 270,000 Mt. Current coastal fish production is higher than MSY values estimated by Wijayaratne (2001) and Dr. Fridtjof Nansen Survey (1979) (Figure 2). These statistical data indicates that coastal fishing activities are beyond the sustainable level.

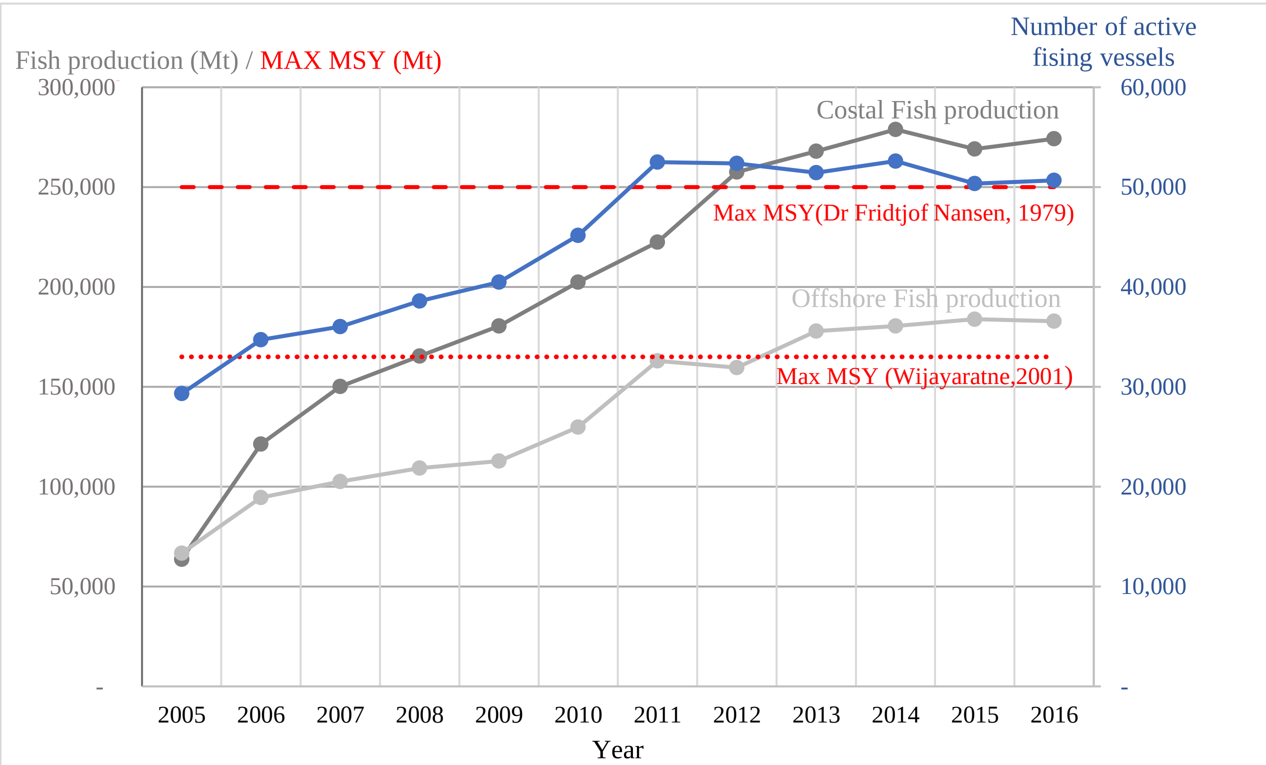


Figure 2. Marine fish production and the number of active fishing vessels in Sri Lanka from 2005 to 2016 (NARA, 2016). The graph shows that coastal fish production increased from 2005 to 2014 and the number of active fishing boats increased from 2005 to 2011.

## 1.1 Jaffna fisheries district

The Jaffna district is situated in the northern province of Sri Lanka with an area of about 1000 $km^2$, the shoreline is 292.2 km and the continental shelf area 3,360 square miles (Piratheepa, Chitravadivelu, & Edrisinghe, 2016). The total population of the Jaffna is 610,640 thereof 186,681 families (Jaffna District Secretariat, 2019). Jaffna population depends on Agriculture, animal husbandry, fisheries and self-employment for their livelihood (Jaffna District Secretariat, 2017). The Fisheries Sector is an important sector in Jaffna District and major economic activity and the source of livelihood for 20,699 families comprising of 88,286 persons thereof 21,852 persons as active fisherman (DFAR, 2018).

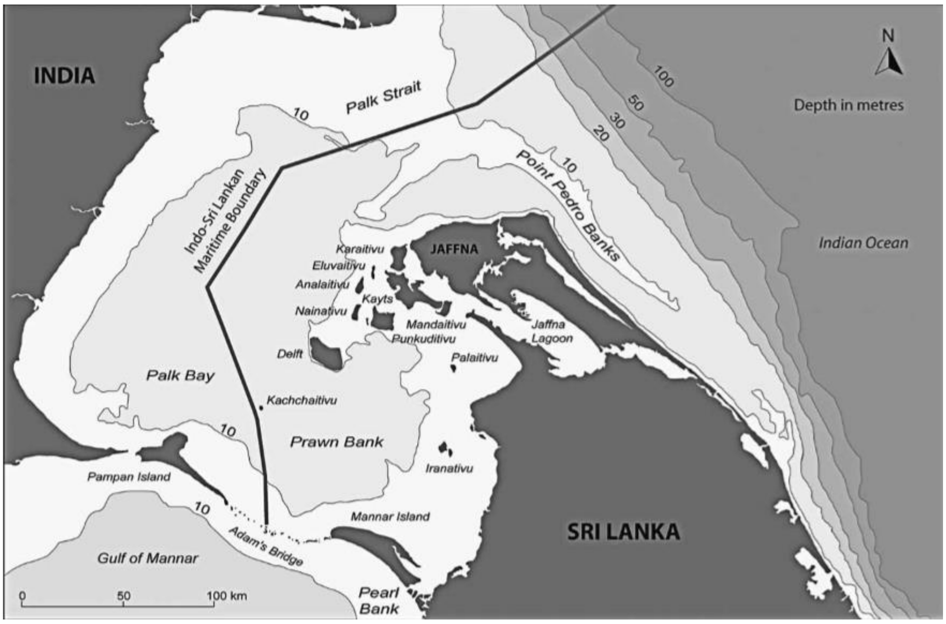


Figure 3. Fishing grounds around the Jaffna district (Siluvaithasan & Stokke, 2006)

The Jaffna peninsula is surrounded by good fishing grounds (Figure 3). Shallow continental shelf region with the two different fishing banks (Point Petro bank and prawn bank) are supported to the coastal fishing activities (Siluvaithasan & Stokke, 2006). Fishers also engage the fishing activities in the Jaffna lagoon, Thondamanaru lagoon and some part of the Chundikkulam lagoon.

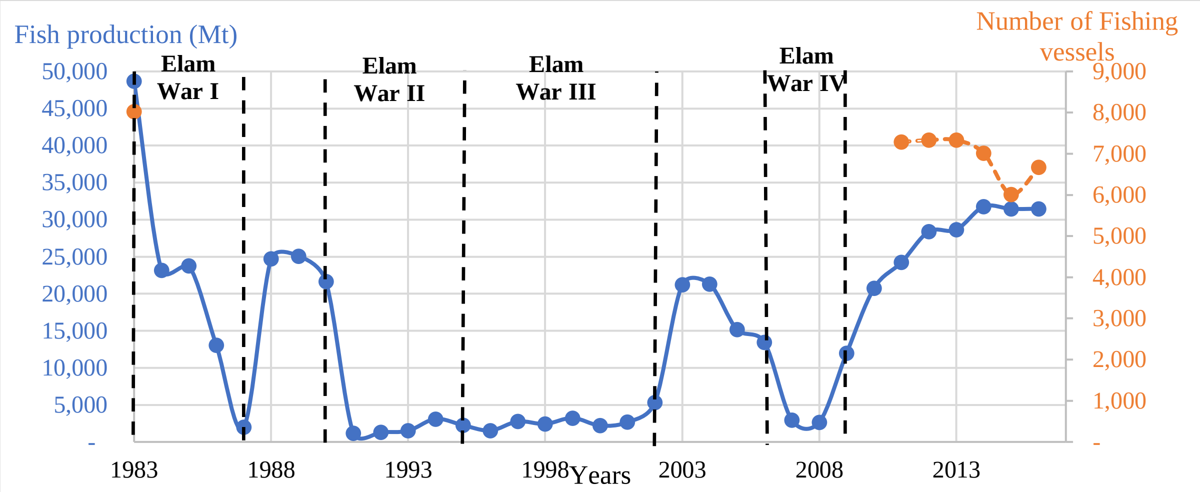


Figure 4. Annual fish production (Mt) of the Jaffna District from 1983 to 2016 (DFAR, 2018). Civil war affected Jaffna fish production from 1983 to 2009.

Siluvaithasan & Stokke (2006) indicated that Jaffna district fish production grew at a higher rate until the year 1983. Jaffna had solely contributed 26% (48,776 Mt) of fish to the national fish production of Sri Lanka in 1983. Then 22,563 people lived in 106 fishing villages in the Jaffna area. Myliddy fishing harbour (marked in Figure 5) played a significant role in the fisheries. The local civil war after 1983 had an adverse impact on the fisheries and other sectors in the northern part of Sri Lanka, including Jaffna (Figure 4). The civil war occurred from 1983 to 2009 in the North and Eastern part of the country. As the war got more severe in 1990 many people from the fishing villages and other villages migrated to some other parts of the country and some even migrated to India. This was a pathetic era in the Sri Lanka economy, in, 1999 only 10,688 fishing families were registered in the Jaffna district. However, during that time most of the coastal villages of the northern part of Sri Lanka has been dominated and ruled by the civil security department forces of Sri Lanka and those areas were considered as High-Security Zone, the general public did not have any access these areas. Fishing activities on most of the coastal areas were banned during that time. In very few coastal areas, the fishing activities were permitted with restrictions on selected days with permission from the security forces. Average annual fish production was about 4000 Mt from 1990 to 2002. The restriction for the fishing activities in the coastal regions of Northern part of the island was reduced considerably after 2002 when the cease-fire agreement prevailed between government and Liberation Tigers of Tamil Eelam (LTTE). Fortunately, some fishing community members were allowed to settle in their own villages during that time, yet some of the coastal villages were known as the high security zones (Figure 4). The fishing activities during the agreement period resulted in high fishing harvest in that time. (Siluvaithasan & Stokke, 2006).

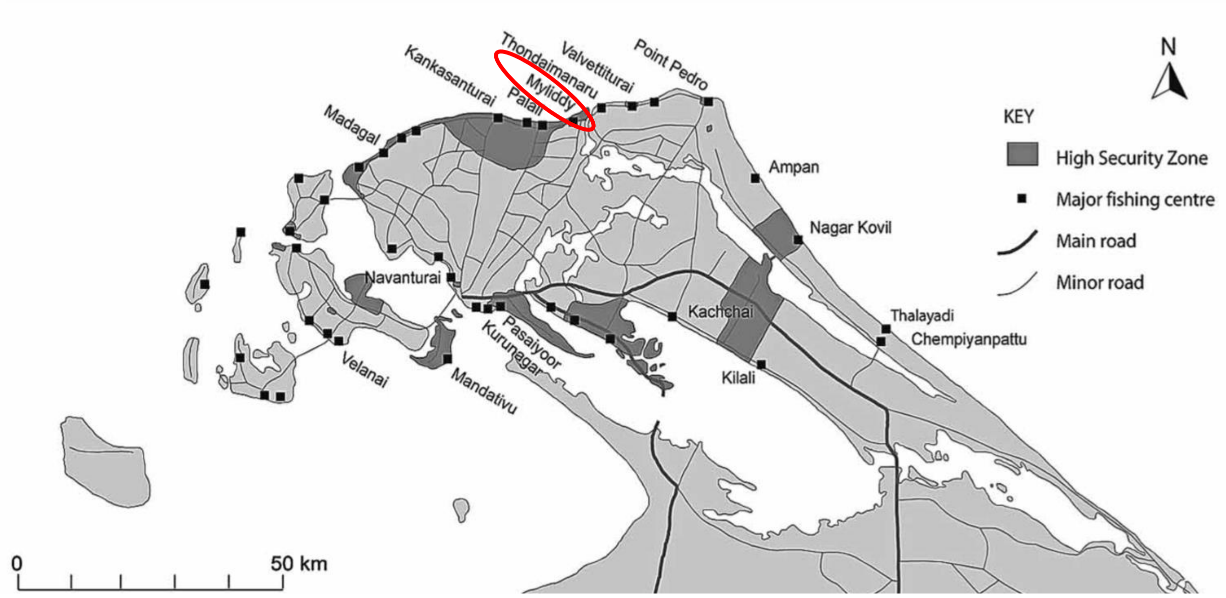


Figure 5. Major fish landing sites and High-Security zones in 2004 (Siluvaithasan & Stokke, 2006)

The increase in the fishing activity was not sustained, due to the Tsunami disaster in 2004 and reactivate of the civil war in 2006. Many fishing communities heavily suffered from the Tsunami disaster, about 650 fishermen died, and around 3000 fishing boats got lost. (NACA, FAO, SEAFDEC, & BOBP-IGO, 2005). The security forces again implemented the fishing restriction in 2006. Finally, in 2009 the local war ended, then people from the restricted areas started to resettle in their own places restrictions in high security zones were released. Fishing boats, houses and requested infrastructure developing facilities were provided by Government and Non-Government Organisations (NGOs). Hence, fishing productivity increased from the year 2009 onwards. After 2009, invade of Indian trawlers became a big threat to Jaffna fishery (Bavinck, 2015). Every month more than 300kg per boat were recorded to be lost in some part of Jaffna District (Mathagal and Point Petro) due to Indian pouching (Vithursha, Shivashanthini, & Gunaalan, 2018).

About 6,880 fishing crafts operate in the Jaffna district, thereof 2,000 non-mechanised fishing boats which are 29% percentages of the Jaffna fleet. The average annual catch from 2012 to 2016 in the district was around 30,000 Mt, nearly 7% of Sri Lanka total catch in 2016.

Overfishing of blue swimming crab (BSC) was recorded in the Jaffna district survey. The overfishing resulting from bottom trawling, illegal fishing activities, Indian trawler invasion and by-catches in the fyke net operation (BOBLME, 2015). Fyke net is a fishing trap used in the lagoon fisheries. Some studies revealed that other shelf fish organism also has a potential threat for overfishing in Jaffna (National Water Supply and Drainage Board, 2017).


Figure 6. Jaffna west fisheries inspection division (Source: Google map)

Jaffna fisheries district is divided into fourteen Fisheries Inspection (FI) division. Jaffna west FI division is one of the most important FI division in Jaffna District. This division consists of three major landing sites including Kurunagar, Navanthurai and Koddadi (Figure 6). The fish catch was around 6500 Mt in 2016 and 15% of Jaffna fish production (DFAR, 2018). Demographic factors and fishing vessels detail of Jaffna west FI division is shown in Table 3.

Table 3. Jaffna west FI division Demographic and fishing vessel details in 2017 (DFAR, 2018)

| FI DIVISION | FISHING POPULATION | ACTIVE FISHERMEN | FISHING FAMILIES | NO. OF BOATS IN THE DIVISION | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | IMUL | IDAY | OFRP | MTRB | NTRB | NBSB | Total |
| JAFFNA WEST | 11882 | 3780 | 2872 | 47 | 285 | 408 | 100 | 94 | 0 | 934 |

Jaffna west FI division fishermen engage in fishing activities in Jaffna lagoon and coastal regions. They use different types of fishing vessels (shown in Table 3) and fishing gears. MTRB and NTRB fishermen use stake nets and fyke net when fishing in the Jaffna lagoon. OFRP boat fishermen fish in the coastal regions with gill nets and trammel nets. IDAY and IMUL fishing boats operate in coastal water, they target shrimps and sea cucumber with bottom trawls (Thivviyan & Jayakody, 2016). Usually the fishing boats land in the morning around 7 am to 12 pm. The majority of the catch are shrimps; Carangidae, Mugilidae, Siganidae, Portunidae, Loligolidae, along with other small schooling fishes (Thivviyan & Jayakody, 2016). The amount of catch depends on the monsoon pattern and the lunar cycle. The catch is brought to markets in plastic baskets. Landing sites markets are divided as auction market and retailers' market. Most retailers purchase fishes from the auction markets. Then they sell it by kilogram-based price in retail markets. Seafood companies directly buy and collect the graded shrimps and crabs from the fishermen.

Marine fishing activities are regulated by Department of Fisheries and Aquatic Resources. The fisheries officers are responsible for regulating and monitoring fishing activities, as well they collect fisheries data from the landing sites. The officers visit each landing sites once a week. Then they inspect the fishing boat registration, operational licences, fishing gears and the catch They have authority to take legal action against illegal fishing and unregulated fishing activities. The weekly catch data collection from the landing is performed by visual inspection on the auction fish markets and with interviews with the fishermen. These inspection and data collection activities are normally carried out from, 8 to 11 a.m. Rest of the time, they work in their FI division office. The office is not situated close to the landing sites. The office is easily accessed in all fishing villages and landing sites in the division.

## 1.2 **Fuel subsidy**

In 2012, fuel prices increased sharply in Sri Lanka which caused problems for motorised fishing boat owners. The Government of Sri Lanka granted monthly fuel subsidy through the Ministry of Fisheries and Aquatic Resources Development to the owners of mechanised fishing crafts and those who are actively engaging in fishing operations and registered with the Department of Fisheries and Aquatic Resources. Fuel subsidy was provided to fishers to enhance their revenue. The total fuel subsidy was estimated to be USD 34.9 million (LKR 4.5 billion) in fifteen months period in 2012 and 2013. The beneficiaries payments vary from one month to another; the average monthly values displayed in table 4. About 4000 large scale fishing boats (3608 IMUL + 289 IDAY) and around 20,000 small scale fishing boats (17702 OFRP + 1523 MTRB) received fuel subsidy in Sri Lanka, including the Jaffna district.

Table 4: The monthly amount of fuel subsidy and the number of beneficiaries in Sri Lanka in 2012 and 2013.

| **Type of fishing boat** | **Average number of beneficiaries** | **Monthly subsidy (in USD) per boat** | **Monthly subsidy (in LKR) per boat** |
|---|---|---|---|
| In boat Motor Multiday Fishing Boats (IMUL) | 3608 | 243 | 31,200 |
| In boat Motor day fishing boats (IDAY) | 289 | 150 | 19,200 |
| Out boat Motor FRP boat (OFRP) | 17702 | 73 | 9,375 |
| Motorized Traditional Fishing Boats (MTRB) | 1523 | 73 | 9,375 |

At the end of 2013, the government decided to discontinue the fuel subsidy and introduced new technologies as a more effective approach for the development of the fisheries. Some of the technologies from the government included Global Positioning System (GPS), life safety jackets and fishing nets to fishers instead of the fuel subsidy scheme in 2014.

Till today, only a few studies have been done on the effect of fuel subsidies on Sri Lanka fisheries sector. Fuel subsidy is not known to be efficient in all instances, some beneficiaries could opt to sell the oil to unrelated person when fuel prices are rising. Meanwhile, it is important to note that the non-motorised fisher did not receive any subsidy. Furthermore, there is a need to concentrate on how do fuel subsidy beneficiaries utilise the fuel subsidy. Therefore, it is important to analyse the impacts of fuel subsidy on fishing effort and vessels' profits by using available data from the Sri Lankan coastal fisheries sector.

## 1.3 Research Question

This research attempt to evaluate the limitations of existing coastal fisheries data for analysis of fuel subsidy in Sri Lanka coastal fisheries and provide guidelines for the improvements in data quality in order to analyse the fuel subsidy impacts on fishing efforts and vessels profits.

## 1.4 Goal

The main goal of the study is to evaluate the impacts of fuel subsidy in terms of fishing effort and vessel profit (fishermen income) by using the available data from Sri Lankan coastal fisheries and provide guidelines for improving the data quality.

## 1.5 Objectives

- To identify suitable methods to evaluate the impacts of fuel subsidy on fishing effort and vessel profit.
- To find the limitations of Sri Lanka existing coastal data as input to selected fuel subsidy methods
- Identify suitable ways to improve data quality and estimate the cost.

# 2 METHODOLOGY

This part describes the study area, suitable methods to analyse the impacts of fuel subsidy in Sri Lankan coastal fisheries. It also aims to find out the possibilities for available Sri Lanka coastal fisheries data as input to selected methods.

## 2.1 **Purpose of this study**

This research is carried out part of a fellowship of the six months training programme in Iceland under the United Nations University Fisheries Training Programme (UNU-FTP) from September 2018 to March 2019. The topic criteria was to be on issues found in fisheries in the home country.

## 2.2 **Study area and data**

Jaffna west FI division was selected as study area. Their fishing activities have been carried out past the civil war, or from 2008 to present. The highest percentage of fishing vessels in Jaffna district operates in the division (15%), and they contributed as well 15% to Jaffna fish catch in 2016. Jaffna district fishermen received USD 2.7 million fuel subsidy in 2012 and 2013, while Jaffna west FI division received USD 0.2 million. It was about 10% to Jaffna fuel subsidy. All the fisheries statistical data (from 1983 to 2016) was collected from the Department of Fisheries and Aquatic Resources.

Table 5. List of data collected for the studies

| **Type of Data** | **Period** | **Source** |
|---|---|---|
| Fisheries statistics of Jaffna west FI division (Number of fishing boats, harvest, fish prices and other) | January 2009 to December 2016 | Department of Fisheries and Aquatic Resources, Jaffna District |
| Fuel subsidy Data | 2012 and 2013 | Department of Fisheries and Aquatic Resources, Jaffna District |
| Annual fish production of Jaffna district | 1983 to 2016 | Department of Fisheries and Aquatic Resources, Jaffna District |

## 2.3 **Methods for analysing the impacts of fuel subsidy**

Several studies have been done by some researchers and policymakers to evaluate the fishing efforts and vessels profits incorporated into the fuel subsidy in various countries. But the inputs for the analysis of fishing efforts and vessels profits might differ from each other. However, the most suitable methods were selected by reviewing scientific articles and reports. These scientific articles were found from the science direct database and google scholar.

## 2.4 **Propose solutions**

If the collected data will not be good enough as input for the analysis, a suggestion of data improvement will be given. Good quality data as socioeconomic data are important to understand the status and trends of capture fisheries, better decision making, and responsible fisheries management (Graaf, et al., 2011).

The above selected methods were applied for available data from Sri Lanka coastal fisheries to evaluate impacts of fuel subsidy and access the quality of data. Three data method were proposed to overcome the limitation and gaps in Sri Lanka coastal fisheries data.

The solutions include,

a. What data are needed to include?
b. What is the strategy used to collect the data and estimate the production?
c. What capacity building is needed?

## 2.5 Cost of solutions

The suggested changes in the data collection methods, strategy, infrastructure facilities, human resources, and capacity development programmes will be covered. Inputs to cost calculation were collected from Technical officers at University of Jaffna, Fisheries officers at DFARand a construction company in Jaffna. Current price indexes (08-02- 2019) were used to calculate the costs. The LKR to USD currency exchange rate based on the 08-02-2019 exchange rate (1 USD = 177.72 LKR). The expenditures are divided into two categories. They are capital cost and operational cost. The capital cost includes building expenses, assets cost, equipment cost, and training programme costs. Officers' salaries, transportation and maintenance cost are included in the operational expenses. Also, all these expenses are estimated at average cost. Cost should be considered when selecting a feasible and effective method for data quality improvement.

# 3 THEORY AND LITERATURE REVIEW

This chapter covers the theory of fuel subsidy and its impacts in other countries. It also includes the information on impacts of high fuel prices in Sri Lankan fisheries and data collection methods of the Sri Lankan coastal fisheries sector.

## 3.1 Global Fisheries Subsidies

Fisheries subsidy is defined as direct or indirect financial assistance to the fishing sector from the government or any public organisations (OEDC, 1997) including grants, loans and loan guarantees, equity infusion, tax exemption and income support programme (WTO, 1994). FAO categorises the incentives into five major categories; 1) direct government payments to the industry, 2) tax waivers and deferrals, 3) government loans and loan guarantees, and insurance, 4) implicit payments to or charges against the industry and 5) general programmes that affect fisheries (FAO, 2003).

Based on their impacts, fisheries subsidy can be classified as beneficial, capacity-enhancing and ambiguous. Beneficial fisheries subsidies promote investments to enhance the resource allocation and maximisation of social welfare; i.e., fisheries management programme and services and fishery research and development. Capacity-enhancing subsidies are defined as assistance programs that lead to disinvestments in natural capital assets once the fishing capacity has reached to a point where resource exploitation exceeds the maximum economic yield. Boat construction, renewal and modernisation programs, tax exemption programs, and fuel subsidy are the examples for the bad subsidies. Ambiguous subsidies are defined as programs that have the potential to lead to either investment or disinvestment in the fishery resource such as Fisher assistance programs, Vessel buybacks programs and Rural fishers' community development programs (Khan, Sumaila, Watson, Munro, & Pauly, 2006). Global fisheries subsidies were estimated at USD 35 billion in 2009. Almost 60 % of the fisheries subsidies were the capacity enhancing, while fuel subsidy contributed to the highest part (22%) of the total fisheries subsidies. (Sumaila, Lam, Manach, Swartz, & Pauly, 2013).

## 3.2 Crude oil prices and fishing activity in Sri Lanka

Sri Lanka imports 100% of its crude oil, in 2016 the quantity was around 1,685 Mt of crude oil with a value of USD 595 million (Central Bank of Sri Lanka, 2017). Electricity generation, transport, industrial, agriculture, fisheries and household are the main sectors that depend on the fuel. Global crude oil price depends on the supply constraints, geopolitical uncertainties, refinery capacity constraints, wars and demand growth fluctuations (Kesicki, 2010). Sri Lankan government set petroleum products prices through Ceylon Petroleum Cooperation (CPC). CPC was the only organisation to import the crude oil and petroleum products and distribute all over the country at uniform prices until 2002. In 2002, the Lanka Indian oil company (LIOC) entered as another major supplier. LIOC prices are determined independently. However, CPC is the leading petroleum distributor in Sri Lanka. Both organisations prices are based on world fuel market prices. The government increased the prices of in February 2012; gasoline by 9%, Kerosene by 49%, fuel oil by 80% and diesel oil by 37%, see figure 7. Several sectors suffered due to high fuel prices. Therefore, the government decided to offer fuel subsidy to the transport sector, electricity and fisheries. The government also raised the Samurthi monthly allowance in order to purchase the fuel for their household consumption. Samurthi is a national poverty alleviation programme in Sri Lanka.

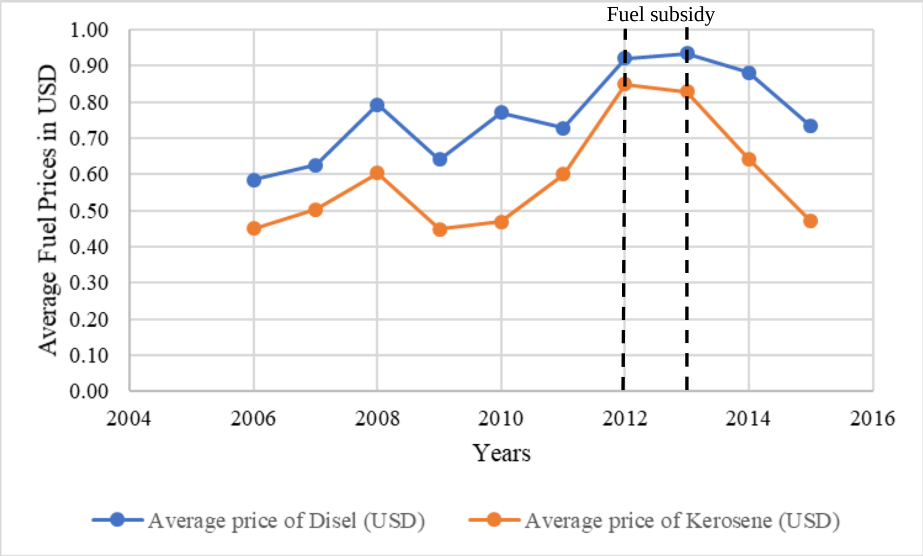


Figure 7. Sri Lanka fuel prices per litre (Source: CPC). It shows a sharp increase in fuel prices in 2012.

Wimalasena, Maheepala, & Amaralal (2014) carried out studies on the impact of higher fuel prices on marine fisheries in Sri Lanka. They estimated about 70% of marine productions in 2010 from the mechanised fishing boats. They recorded 4,523 large scale fishing boats and 21,450 smallscale motorised fishing boats to be in the marine fisheries sector. They calculated the average fuel consumption and fuel cost of each type of vessel. Average fuel consumption for small-scale fishing boats was 45 litre per trip, and these boats use kerosene as their fuel. Large scale fishing boats consumed 91 litres of diesel per trip. The results indicate that fuel cost contributed differently to small scale and large scale fishing activity. Fuel cost accounted for more than 90% of the operational cost in the coastal fisheries and about 65% in largescale fishing vessels. In 2012, kerosene and diesel prices were raised by 49% and 37% respectively. Motorised fishermen had a negative impact on their fishing profitability due to high fuel prices. They found that decline catch per unit effort in the small-scale fisheries and high fuel prices were reasons for adverse impacts on fishing profitability of the small-scale fishermen. Because of negative profitability, Government provided fuel subsidy to mechanised fishing boats in 2012 and 2013.

## 3.3 **Fuel subsidy theory**

Theoretical framework and models, which are used to evaluate the fuel subsidy impacts, are adapted to Gordon-Schaefer models (Sumaila, Teh, Watson, Tyedmers, & Pauly, 2008; Guillen, et al., 2016; Martini, 2012). Fishing vessel profit (π) is calculated by the difference between total revenue (TR) and total cost ($TC_0$). Total revenue depends on the price of the unit catch (P) and the amount of harvest (H). Amount of harvest is determined by the size of fish stock (x) and fishing effort (e). Meanwhile, the total cost is explained by the function of fishing efforts, which include the fuel cost (*f*) and other costs (*o*) such as labour cost (Sumaila, Teh, Watson, Tyedmers, & Pauly, 2008).

$\pi = TR - TC$
$\pi = PH(e,x) - C\ \{e\ (f,o)\}$

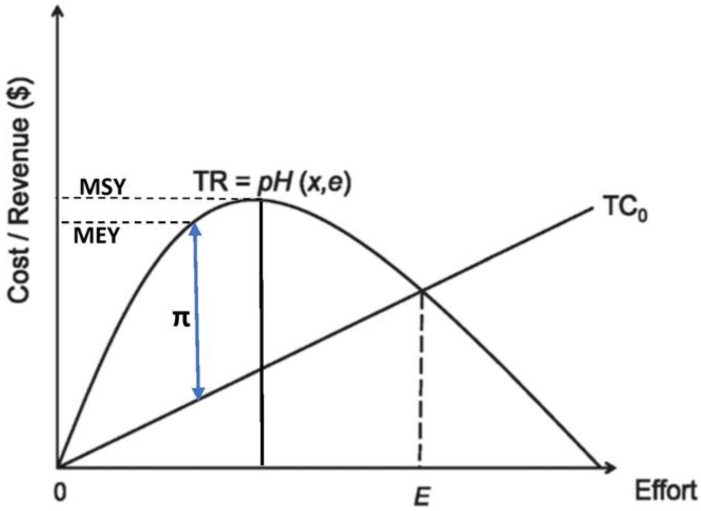


Figure 8. Bioeconomic model (Gordon-Schaefer Model) (Sumaila et al., 2008)

The bioeconomic models is used to predict the resource use strategy and net economic benefits through time. Maximum Sustainable yield (MSY) is a fundamental biological reference point for the fisheries management to set limits for the harvest rate. The fishermen gain the highest profit in the Maximum economic yield (MEY). Total fishing cost and fishing revenue are equal to the 'E' fishing effort, which point is known as the breakeven point (Figure 8). If the fishing effort moves beyond the breakeven point, fishing activities are not profitable.

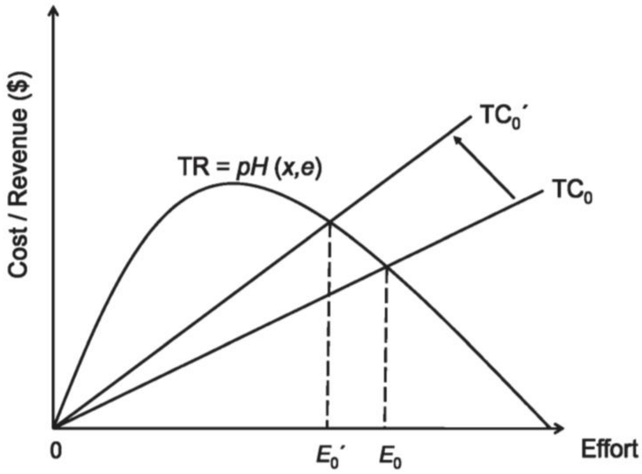


Figure 9. Bioeconomic model in high fuel prices (Sumaila et al., 2008)

When the fuel price increased, total cost increased from $TC_0$ to $TC_0^1$. As a result of increment in the total cost, fishing profit is reduced. In an open-access fisheries sector, the fishing effort for the breakeven point is reduced ($E_0$ to $E_0^1$) (Figure 9). High fuel cost reduce fishing pressure and have a positive effect on resource sustainability and stock biomass increasing and by removing fuel inefficient fishing vessels (Tyedmers, Watson, & Pauly, 2005). However, the government provide fuel subsidy to maintain fishing efforts during the high fuel price (Sumaila, Teh, Watson, Tyedmers, & Pauly, 2008).

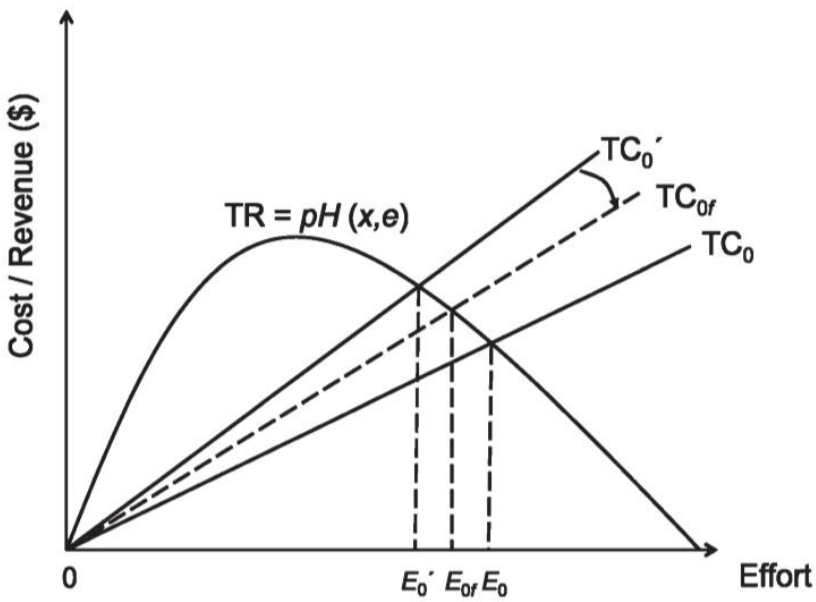


Figure 10. Bioeconomic model during the fuel subsidy (Sumaila et al., 2008)

Government provide fuel subsidy in order to increase fishing profits in high fuel price situation and may lead to an increase in fishing effort in an open access fishery (Figure 10). When fishing effort is beyond the Maximum Economic Yield (MEY) fishing profit start to decrease and becomes non-profitable beyond the breakeven point fisheries (Martini, 2012). In catch control with effort control management regime, total allowable catch (TAC) and fishing effort are effectively controlled. Therefore, there are no possible chances to increase the fishing effort and harvest of fish species. In this management regimes, fuel subsidy gives a positive profit increment in their fishing trips (Arnason, 1998). The Fuel subsidy is not useful for overfished fish stock. Because fishing activities are unprofitable when the resources are overfished. Sri Lankan marine fishing activities are open access fisheries. However, the number of fishermen and fishing vessels are controlled by boat registrations and operational licences. But number of operation licence and boat registration are not limited, and anyone can obtain fishing operation licence.

## 3.4 **Empirical studies from other countries**

Several types of research have been done in various countries to evaluate the impacts of fuel subsidy in the fisheries sector. However, most of the studies mainly rely on the principle and theory of the fuel subsidy and limited empirical studies have been done to evaluate the impacts of fuel subsidy.

The Malaysian Government introduced fisheries subsidies in the early 1970s. They provide direct financial assistance to enhance the livelihood of small-scale fishermen. Moreover, the Malaysian Government introduced the fuel subsidy to licensed fishers in 2008. Islam, Ali, Zamhuri, Viswanathan, & Abdullah (2016) did a questionnaire survey to evaluate the impacts of subsidies on the small-scale fisheries sector in Malaysia. They considered fishermen who engaged fishing activities with tradition fishing gears within five nautical from shore as small-scale fishermen. They found that commercial fisher’s fishing effort and catch were higher than the artisanal fishers. The results indicate that the subsidies programme led to the increased fishing effort because of the reduction of operational cost. Excess fishing pressure was created on the fishery resources because of the increasing fishing effort. They conclude that fisheries subsidies may not lead to sustainable fisheries.

Pham, Hsiao, & Chuang (2010) carried out a study on the fuel subsidy programme in Taiwan and Vietnam. Fuel subsidy was introduced in Taiwan in 1960. Global fuel prices determined the amount of fuel subsidy. The study reveals that the amount of fuel consumption and fishing boats increased from the 1960s to 2004. Fuel consumption increased from 20 million litres to 160 million litres during the period, while fishing boats increased by 2.5 factor. In the early stages (the 1960s to 1976), global fuel prices determined the amount of fuel subsidy. Amount of fuel subsidy increased with international market fuel prices increments. Though several plans were implemented to control fuel consumption, they were not successful. In 2005, the government introduced a new policy to control fuel consumption. Based on the newly introduced policy in 2005, all the fishing vessels installed the voyage data recorders (VDRs) in order to obtain the fuel subsidy. Fuel subsidy was issued based on their fishing routes which are recorded by VDR. As a result of the new policy, fuel consumption was significantly reduced.

In 1997 fisheries subsidies program initiated in Vietnam, then later fuel subsidy program was issued for nine months in 2008. Amount of fuel subsidy determined by the size of vessels. Resulting, a significant increase in the number of fishing vessels (42%) and total capacity (8%) compared to 2007. However, fish production was not increased during the time. Therefore, they concluded that the fuel subsidy programme was not useful for the fishermen (Pham, Hsiao, & Chuang, 2010).

In Senegal, fuel subsidy encouraged the use of powerful motors and extended the fishing hours in order to exploit the new fishing areas. Meanwhile, some small-scale fishermen fishing effort was shifted from domestic market-oriented species to export-oriented species (UNEP, 2002). Lee & Midani (2013) attempted to evaluate the impacts of fuel subsidy on levels of fishing effort in South Korea. The results revealed that fuel subsidy would have an adverse effect by increasing fishing effort in the inshore and offshore fishery in South Korea. It is resulting in economic overfishing in South Korea.

Statistical data suggested overfishing to be observable in Sri Lanka fisheries past 2012. Most of the Northern province fishing grounds of Sri Lanka were unexploited fishing ground in 2009 due to war restriction (The Ceylon Chamber of Commerce, 2010). Some studies revealed that shellfish organism had faced a considerable threat from overfishing in Jaffna in 2014. Fuel subsidy was provided in 2012 and 2013, it might be one of the reasons for overfishing. Both small scale fishing vessels and large-scale fishing vessels received fuel subsidy in Sri Lanka. The number of active fishing boats increased by 100 in Jaffna district during the 2012 and 2013 fuel subsidy months. One year later, the numbers of active fishing vessels dropped by 300 in 2014 and by 1000 in 2015 (Figure 4) in the Jaffna district. Fuel subsidy can be a plausible reason for the increase the fishing vessels in 2012 and 2013 and removal of fishing vessels in 2014 and 2015. The Jaffna district seems to have faced similar impacts like the countries mentioned in the literature review.

### 3.5 Data quality and availability in Sri Lanka Coastal Fisheries

Statistical Unit (SU) of the Ministry of Fisheries and Aquatic Resources Development (MFARD) is responsible for the collection, analyses and report of Sri Lanka fisheries statistical information (Premawardana, 2010). Presently, two different institutions of MFARD are involved in data collection from marine fisheries. A) Department of Fisheries and Aquatic Resources (DFAR) and B) National Aquatic Resources Research and Development Agency (NARA). NARA is exclusively engaged in collecting statistics from large pelagic fisheries, and DFAR is responsible for gathering landing sites data from all landing sites and harbours (Maldeniya, Perera, Premawardane, & Anupam, 2013).

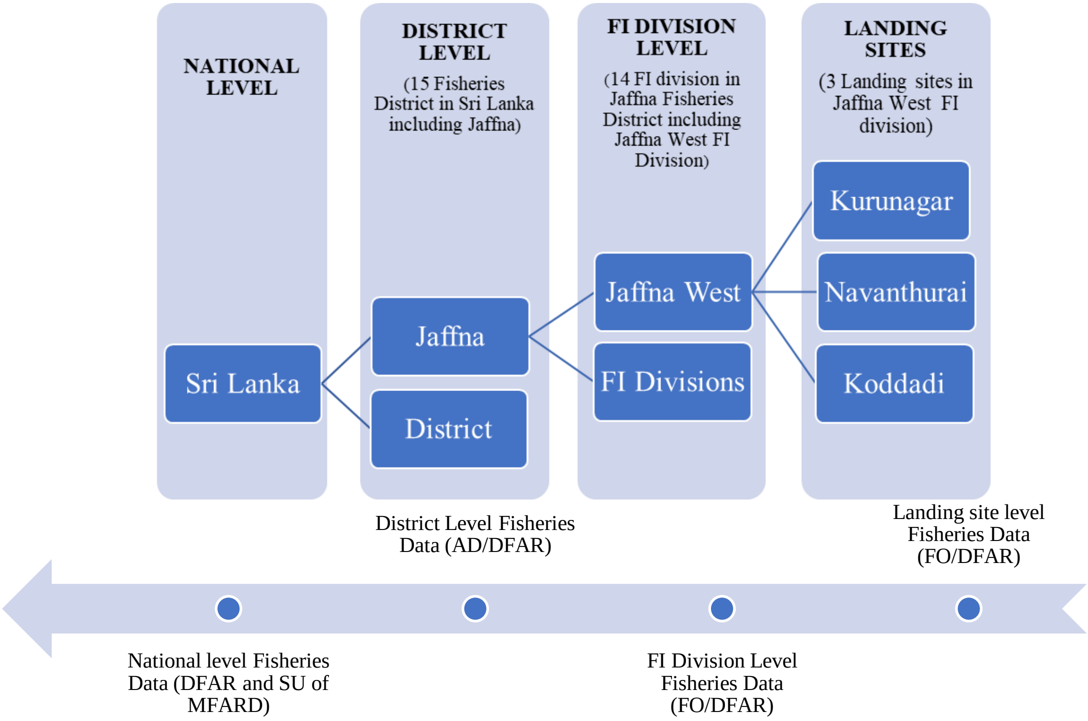


Figure 11. The administrative structure of Sri Lanka Fisheries Department and data flow path of Sri Lanka coastal fisheries data (Created by author)

Fisheries officers (FO) work for DFAR. One fisheries officer is responsible for one FI division. One FI division includes more than two landing sites (shown in Figure 11). Fourteen fisheries officers manage the 120 fish landing sites in Jaffna district. Fisheries officers are responsible for the collection of data from each landing sites. In addition, they have enormous responsibilities; including implementing government policies and regulations, legal action works against the illegal and unregulated fishing activities, fishing boat registrations and issuing operation licences, monitoring the fishermen organisations activities, supporting to fisheries sector development projects and extension works. Because of the enormous responsibilities, data collection from landing sites become less priority to them (Maldeniya, 1996). All fisheries officer's activities are monitored by District fisheries officers and Assistant Director (AD) at a district level.

Fisheries officers collect the data to fill out the standard monthly progress and data collection form (Appendix 1). The data collection form includes information on the number of active fishing vessels, total fishing landing in each landing sites, estimation of landing for a limited number of species and prices of fish species. Apart from landing sites data, boat registration details, issued operational licence details, seaworthiness report, fishing boat insurance data, legal activities, fishers identification card issuing details etc are used to submit with their progress report (Jayasooriya, Gunawardane, & Jayasinghe, 2010). They visit each landing sites once a week and make an estimation of fish landing and species composition by observing landing and interview with the fishermen (Maldeniya, Perera, Premawardane, & Anupam, 2013). They do not take direct weight measurement from the catch. Fisheries officers do not follow scientific and standardised methods in data collection, because of lack of training, instruction and guidelines (Jayasooriya, Gunawardane, & Jayasinghe, 2010). The officers estimate the total catch based on their observations and interview with the fishermen. Final monthly reports are submitted as a printed document to District fisheries office. District level fisheries report have been prepared based on the FI divisional reports.

# 4 RESULTS

## 4.1 Existing Data quality of Sri Lanka coastal fisheries

Department of Fisheries and Aquatic Resources department (DFAR) in Jaffna district collects the fisheries data from all landing sites in Jaffna. They maintain fourteen fisheries divisions' statistics as the printed documents. 2009 to 2017 Jaffna west FI division monthly progress data are collected as paper documents in DFAR. A person in DFAR then registers the data in Microsoft Excel data sheets manually, the author received the Excel data through email for analysis. The initial data analysis was performed with authors supervisors.

Analyses of available data in Jaffna district landing sites reveal the data not to be sufficient as input to fuel subsidy methods. The number of vessel groups was skewed from one period to another (shifted); until November 2010 there were 130 IMUL, 325 IDAY and null OFRP fishing boats recorded. Then in December 2010, there were 3 IMUL boats, 130 IDAY boats 325 OFRP boats reported. The number of active fishermen did not change from January 2010 to December 2017, see figure 6. As well, the catch by landing sites could not be separated by fishing vessels, and the data of fishing cost was missing (i.e. fishing hours and amount of fuel consumption).

Table 6. Coastal fisheries monthly statistics shows unreliable data (created by author)

| Month | Active fishermen | Active Total fishing vessels | | | | | Total Fish catch |
|---|---|---|---|---|---|---|---|
| | | IMUL | IDAY | OFRP | MTRB | NTRB | |
| Mar-10 | 3100 | 120 | 325 | 0 | 0 | 70 | 424540 |
| Apr-10 | 3100 | 120 | 325 | 0 | 0 | 70 | 409115 |
| May-10 | 3100 | 120 | 325 | 0 | 0 | 70 | 367900 |
| Jun-10 | 3100 | 130 | 325 | 0 | 0 | 70 | 202500 |
| Jul-10 | 3100 | 130 | 325 | 0 | 0 | 70 | 208250 |
| Aug-10 | 3100 | 130 | 325 | 0 | 0 | 70 | 222400 |
| Sep-10 | 3100 | 133 | 325 | 0 | 0 | 70 | 361880 |
| Oct-10 | 3100 | 133 | 325 | 0 | 0 | 70 | 329410 |
| Nov-10 | 3100 | 130 | 325 | 0 | 0 | 76 | 428200 |
| Dec-10 | 3100 | 3 | 130 | 325 | 70 | 155 | 391200 |
| Jan-11 | 3100 | 3 | 130 | 374 | 70 | 155 | 291850 |
| Feb-11 | 3100 | 3 | 130 | 374 | 70 | 155 | 371400 |
| Mar-11 | 3100 | 3 | 60 | 374 | 70 | 155 | 462200 |
| Apr-11 | 3100 | 3 | 65 | 374 | 70 | 155 | 473450 |
| May-11 | 3100 | 0 | 30 | 376 | 70 | 155 | 246000 |
| Jun-11 | 3100 | 3 | 137 | 376 | 70 | 155 | 302000 |

## 4.2 Limitations of Sri Lankan coastal fisheries data as input to fuel subsidy methods

Various techniques and methods have been used to evaluate the impacts of the fuel subsidy. The researchers have used the amount of fuel consumption, fishing hours, number of fishing vessels and total engine horsepower to estimate the fishing efforts (Islam, Ali, Zamhuri, Viswanathan, & Abdullah, 2016; Pham, Hsiao, & Chuang, 2010; UNEP, 2002; Lee & Midani, 2013). In Sri Lanka, six different types of fishing crafts are operated in marine fisheries sector (NARA, 2016) including four different types of motorised fishing vessels (IMUL, IDAY, OFRP and MTRB) and two different types of non-motorised fishing vessels (NTRB and NBSB). These fishing vessels vary in characters as noticed in their; motorisation, engine horsepower, number of fishing trips, fishing duration, fishing method and vessel size (Wijayaratne, 2001). Moreover, the operational method of each type of fishing vessel can be changed in terms of fishing distance and fishing duration during the fuel subsidy. Fuel subsidy may have boosted some types of fishing vessels efforts and may have reduced the other types of vessel’s effort. Because of these reasons, the fishing effort cannot be calculated by using the total number of fishing vessels in Sri Lanka. The amount of fuel consumption and engine horsepower can be used to estimate the effort of motorised fishing vessels. Fishing hours is one suitable factor to estimate efforts of six different types of fishing vessels in Sri Lanka. However, there is no time series data available fishing hours and amount of fuel consumption. Therefore, the data are not good enough to estimate the fishing effort.

Profits out of fuel subsidy have been calculated through a simple method (Lee & Midani, 2013; Ramírez-Rodríguez & Almendárez-Hernández, 2013). In the methods, revenue had been calculated by the total fish harvest and unit fish price. Further, the total fishing cost including fuel cost has been documented in verbal communications. However, fish landings by species and price of each fish species are available in Sri Lanka statistical report. These landings are represented from all fishing gear, and fishing craft catches in the landing sites. These data are not good enough to calculate the revenue of different types of fishing vessels, and there is no data available on fishing cost in statistical reports. Therefore, fishing vessels profits cannot be calculated by the data from the statistical report.

### 4.3 Guidelines for improving the data collection method

Fishing effort and fishing vessels profits could not be estimated due to unreliable and low resolution data in Sri Lanka coastal fisheries. Therefore, the author suggests three possible methods to improve data quality in Sri Lanka coastal fisheries. The proposed methods are complete enumeration by advanced technology, complete enumeration and stratified sampling.

#### *4.3.1 Complete enumeration by advanced technology*

In this method, data will be gathered from all fishing fleets in the landing sites. Fishing vessels and landing sites will be monitored 24 hours the whole year. Vessel Monitoring System (VMS) and electronic logbook (e-logbook) will be used to collect data from fishing vessels. In addition to that, biological sampling will be performed for economic importance species.

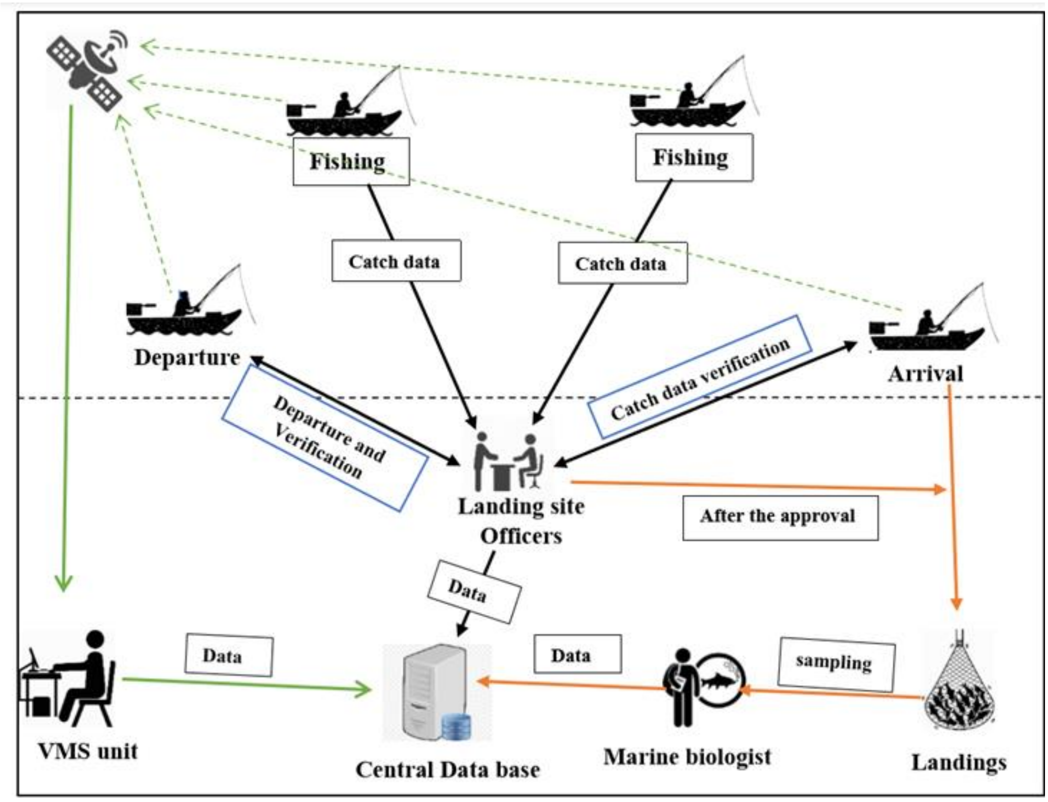


Figure 12. Complete enumeration by advanced technology (Diagrams by author)

Three different units of officers will work together in this data collection method (Figure 12). They are landing site officers, VMS officers and marine biologist. Landing site officers will be a responsible person to collect catch and effort data from fishing vessels. The officer will verify e-logbook data during landing. The VMS officers will monitor the fishing vessel's navigations. And marine biologist will do biological sampling for the commercially important species in order to analyse the gear selectivity, stock health and abundance.

In the first step of this data collection method, e-logbook and VMS installation will be made as compulsory for all fishing vessels. Non motorized vessels need to utilize battery to operate the electronic equipment. Vessel's details, owner's details, fishing gear details, operation licence and boat registration will be feed on VMS and e-logbook. Therefore, it cannot be exchanged between the vessels. The skipper of the vessels will be a responsible person to operate e-logbook.

Landing sites office will be located close to the landing sites. The office will help to monitor all the boats on the site. Landing site officers will work in three different shifts to monitor the fishing activities 24 hours. All fishing vessels need permission from landing site office, prior to departure as well as arrival approval through the e-logbook. During the departure, the skipper will provide the information on fishing gear details, fishing equipment, crew members details and skipper details through e-logbook. Landing sites officers will verify the information provided by the skipper. The vessels will be allowed to leave the landing sites after the verification. After the departure, fishing vessels will be tracked by VMS until the arrival of vessels. VMS officers receive fishing vessels navigation route and vessels speeds through the VMS satellite data. The VMS unit will be common for a district or more than one district. It depends on the number of fishing boat. However, VMS unit runs all day long at landing site offices.

Detailed data from each voyage will be entered through the e-logbook: date, haul time, fish species, fishing gear and catch weight. Similarly, discard details will be recorded by species and their amount. At the end of the fishing trip, fishing cost details and the amount of fuel consumption will be collected entered to the e-logbook. Landing sites officers will verify all the information provided by fishermen during arrival. They will use a weight scale to measure the weight of fish and verify other voyage details. Unloading will be permitted when the inspector gets approval that catch data has been sent to NARA central database. Furthermore, marine biologist will do biological sampling from markets. They will do their experiments in district marine laboratories. The Markets have to send in daily fish prices by species on a monthly bases, inspectors secure correct procedure at fish markets.

Initially, landing sites officer must be given the knowledge on fish species identification and computer technology. VMS officers will be given training on computer skill and VMS data access method. Marine biologist needs to be trained in terms of calculating the fish age, identify the spawning season and estimate the mortality and recruitment rate.

### *4.3.2 Complete enumeration*

In this method (Figure 13), landing sites will be monitored 24 hours and data collected from all fishing vessels in the site. The paper logbook will be used as a tool for data collection. Landing site officers verify all the data recorded in the logbook. Unloading of the catch will be permitted after the verification.

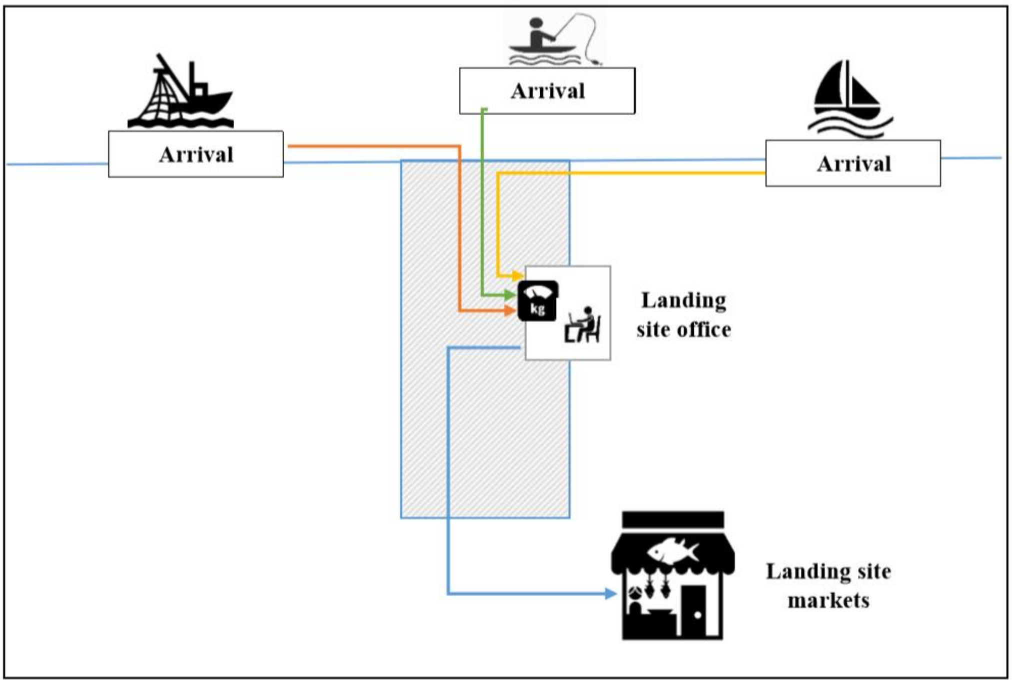


Figure 13. Total enumeration method of data collection method (Diagrams by author)

Only landing sites officers will be involved in the data collection methods (Figure 13). Landing site officers engage in surveillance and data collection 24 hours the whole year. Therefore landing sites officers will have three different shifts. These officers will grant permission for the departure of fishing vessels and unload the harvested fishes.

In this method, paper logbook (Annexure 2) will be made mandatory for all fishing vessels to maintain record of fishing trip. The logbook will have paper sheet in triplicate: original copy for the landing site officer which inputs actual weight of catch, one copy for NARA and one copy onboard the vessel. . Before the departure of a fishing boat, landing site officers inspect the boat and fishing equipment. The fishing vessel will be allowed to leave after the inspection. After the fishing, Fishing ground details, fishing gear details, fishing cost and harvest details will be recorded in the logbook. The weight of catch will be entered separately based on the type of species. Discarded information also will be recorded in the logbook. The logbook will be given to landing site officers to verify the information. They will measure the weight of each fish species and confirm the logbook data..

Also, the landing site office will be close to the landing site. The landing site officer should also be competent in the fish identification, fisheries data collection and verification and computer skills. Proper training should be given to improving the officer's skills.

### *4.3.3 Stratified sampling technique*

In this method, fisheries data will be collected by the sampling technique. Data collection depends on the combinations of the fishing vessel and fishing gear. Fishermen will be divided into several strata (fishing unit) based on the type of fishing vessel and fishing method. For instance, Jaffna west FI division's fishing units can be divided as IDAY-TRAWLER, IMUL-TRAWLER, OFRP-GILLNET, OFRP-TRAMMEL NET, MTRB-STAKE NET, MRTB-FYKE NET, NTRB-STAKE NET, NTRB-FYKE NET. The number of fishermen in each unit will be estimated. A number of fishermen in each unit will be selected for the data collection. The number of samples in a fishing unit will depend on the number of fishermen in the unit and the accuracy level of sampling (Table 7).

Table 7. Accuracy level of sampling in a population (Stamatopoulos, 2002)

| **Accuracy (%)** | **90** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Data Population size** | **Safe sample size** | | | | | | | | | |
| **300** | 29 | 35 | 43 | 54 | 69 | 90 | 120 | 163 | 218 | 274 |
| **400** | 30 | 36 | 44 | 56 | 73 | 97 | 133 | 188 | 267 | 356 |
| **500** | 30 | 37 | 45 | 58 | 75 | 102 | 143 | 208 | 308 | 432 |
| **600** | 30 | 37 | 46 | 59 | 77 | 106 | 150 | 223 | 343 | 505 |
| **700** | 31 | 37 | 47 | 60 | 79 | 108 | 156 | 236 | 373 | 574 |
| **800** | 31 | 38 | 47 | 60 | 80 | 110 | 160 | 246 | 400 | 640 |
| **900** | 31 | 38 | 47 | 61 | 81 | 112 | 164 | 255 | 424 | 703 |
| **1000** | 31 | 38 | 48 | 61 | 82 | 114 | 167 | 262 | 445 | 762 |

The data collecting officers will be recruit by DFAR. These officers conduct daily based data collection from the landing sites from 7 AM to 12 PM. Selected number of samples will be collected from each fishing unit to provide accurate data. The officers measure the weight of the catch and interview the fishermen regarding various information; such as fishing duration, fuel consumption and fishing cost. All these data will be recorded in a data collection book. In the evening, they will enter the data in Excel sheet for DFAR office.

If the data is collected daily basis manner, monthly total fish production, revenue, fishing effort and the fishing cost will be estimated based on collected data. Monthly fish production will be calculated from the following equation. Average harvest ($\bar{H}$)will be calculated from selected samples in a particular fishing unit.

$$\bar{H} = \frac{Total\ Catch\ in\ selected\ samples}{Number\ of\ samples}$$

Total fish landings from a fishing unit will be calculated through the following equations.

$$Total\ Fish\ catch\ in\ fishing\ unit = \bar{H}\ X\ Number\ of fishermen\ in\ the\ fishing\ unit$$

Total fish landing in a landing site can be calculated through summing total catch from all fishing units. The same method can be applied to estimate the amount of fish production by species-wise, total fishing cost, total fishing effort and fishing revenue of a particular fishing unit.

## 4.4 Cost of solutions

Table 8 shows the total annual cost of government for each data collection method. Advanced complete enumeration methods will more expensive, and stratified sampling will require less cost in the proposed method. Advanced complete enumeration method includes the cost of a landing site, a VMS unit and a marine laboratory. The VMS unit and a marine laboratory common for one or more than one districts. In the first year, the government will spend money on infrastructure and human resources development and data collection. Second year onwards, the government will spend money to pay the salaries and allowance of officers and maintenance of offices.

Table 8. List of tentative government annual cost per landing site (Details annual cost are shown in appendix 4 and 5) (estimated by author)

| Cost | | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|
| | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| Total Capital Cost | Per Landing site | $ 20,188 | - | $ 18,288 | - | $ 478 | - |
| | Per VMS unit | $ 23,520 | - | - | - | - | - |
| | Per Marine laboratory | $ 38,752 | - | - | - | - | - |
| | Training programme | $ 4,800 | - | $ 1,400 | - | $ 1,400 | - |
| Total Operational Cost | Per Landing site | $ 18,144 | $ 18,144 | $ 18,144 | $ 18,144 | $ 3,696 | $ 3,696 |
| | Per VMS unit | $ 18,114 | $ 18,114 | - | - | - | - |
| | Per Marine laboratory | $ 31,248 | $ 31,248 | - | - | - | - |

Coastal fishing activities are carried out about 900 landing sites in fifteen coastal districts of Sri Lanka. Annual cost has been calculated for all three methods to implement in all landing sites in Sri Lanka (Table 9). Comparably, the stratified sampling method is cheaper than other methods, while advanced complete enumeration method is too costly. Because minimum of six officers will be working in those methods and a considerable amount will need to run the offices. On the other hand, a data collecting officer will do data collection in a landing site and no cost for constructing the building and its maintenance. The results indicated that the complete enumeration method and advanced complete enumeration method would require operational cost five times larger than the stratified sampling method, while the capital cost nine to ten time larger than the stratified sampling method.

Table 9. List of the tentative annual cost for the government to implement the data collection in all landing sites in Sri Lanka (estimated by author)

| Cost | | Numbers | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|---|
| | | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| Total Capital Cost | Landing sites | 900 | $ 18,169,200 | - | $ 16,459,200 | - | $ 430,200 | - |
| | a VMS unit | 15 | $ 352,800 | - | - | - | - | - |
| | a Marine laboratory | 15 | $ 581,280 | - | - | - | - | - |
| | Training programme | | $ 4,800 | - | $ 1,400 | - | $ 1,400 | - |
| Total Operational Cost | Landing sites | 900 | $ 16,329,600 | $ 16,329,600 | $ 16,329,600 | $ 16,329,600 | $3,326,400 | $ 3,326,400 |
| | a VMS unit | 15 | $ 271,710 | $ 271,710 | - | - | - | - |
| | a Marine laboratory | 15 | $ 468,720 | $ 468,720 | - | - | - | - |
| **Total Annual cost for government** | | | **$ 36,178,110** | **$ 17,070,030** | **$ 32,790,200** | **$16,329,600** | **$3,758,000** | **$ 3,326,400** |

Around 50,000 fishing vessels are operated in about 900 landing sites in Sri Lanka. It shows that an average of 56 fishing vessels are in a landing site. If the Sri Lankan government will decide a landing site for 500 fishing boat, there will be a minimum of 100 landing sites in Sri Lanka. The cost for the 100 landing sites is shown in Table 10.

Table 10. List of the tentative annual cost for the government to implement the data collection in 100 landing sites (estimated by author)

| Cost | | Numbers | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|---|
| | | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| Total Capital Cost | Landing sites | 100 | $ 2,018,800 | - | $ 1,828,800 | - | $ 47,800 | - |
| | a VMS unit | 15 | $ 352,800 | - | - | - | - | - |
| | a Marine laboratory | 15 | $ 581,280 | - | - | - | - | - |
| | Training programme | | $ 4,800 | - | $ 1,400 | - | $ 1,400 | - |
| Total Operational Cost | Landing sites | 100 | $ 1,814,400 | $ 1,814,400 | $ 1,814,400 | $ 1,814,400 | $ 369,600 | $ 369,600 |
| | a VMS unit | 15 | $ 271,710 | $ 271,710 | - | - | - | - |
| | a Marine laboratory | 15 | $ 468,720 | $ 468,720 | - | - | - | - |
| **Total Annual cost for government** | | | **$ 5,512,510** | **$ 2,554,830** | **$ 3,644,600** | **$ 1,814,400** | **$ 418,800** | **$ 369,600** |

Data collection from 100 landing sites will be profit for the government (Table 11). Reduction in the landing sites will help to reduce cost six to nine times than data collection from 900 landing sites.

Table 11. The total annual cost for government in 100 landing sites and 900 landing sites (estimated by author)

| Cost | Numbers of landing site | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|
| | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| Total Annual cost for government | 900 | $ 36,178,110 | $ 17,070,030 | $ 32,790,200 | $ 16,329,600 | $ 3,758,000 | $ 3,326,400 |
| Total Annual cost for government | 100 | $ 5,512,510 | $ 2,554,830 | $ 3,644,600 | $ 1,814,400 | $ 418,800 | $ 369,600 |

As shown in table 12, fishermen will spend money to buy the data collection equipment in Advanced complete enumeration and complete enumeration method. Fishermen will spend about USD 2000 to buy VMS and e-logbook, while they will spend USD 264 as the maintenance cost for the equipment. In the complete enumeration method, fishermen will annually spend USD 28 to obtain a new paper logbook from DFAR. There is no cost for fishermen was recorded in stratified sampling method.

Table 12. List of tentative fishermen annual cost per boat (estimated by author)

| Cost | Details | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|
| | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| Total Capital cost | Appendix 6 | $ 2,016 | - | $ 28 | $ 28 | - | - |
| Operational cost | Appendix 7 | $ 264 | $ 264 | - | - | - | - |
| **Total operational cost** | | **$ 2,280** | **$ 264** | **$ 28** | **$ 28** | **$ -** | **$ -** |

# 5 DISCUSSION

Fisheries data are important tools to evaluate the status of the fish stock, performance of fishing gears and vessels, evaluate the socioeconomic level of fishermen community and performance of the fisheries policies (Maunder & Piner, 2015; Zeller & Pauly, 2005; Ainsworth & Pitcher, 2005; FAO, 1999). The catch data will help to estimate fishable stock in the fishing ground by comparison from stock assessment values. These fisheries data can be obtained from the complete enumeration method and sample-based estimations (FAO, 2000). In the complete enumeration method, data are collected from whole members of fishing vessels. The author split complete enumeration method into two; advance complete enumeration and complete enumeration. In the advanced complete enumeration method, advanced technologies are used to collect the data and paper based logbook are used to collect the data from complete enumeration method. If the complete enumeration is difficult and impossible, sampling approaches are followed by the data collectors. In the sampling approach, accuracy and precision of the data collection determine the quality of data. Sampling precision depends on the variability in the sampling population. The sampling precision is increased with the decreasing variability in the sampling population. Also, Accuracy depends on the sample percentage in the total population. It is directly propositional to the percentage of the sample (Stamatopoulos, 2002).

## 5.1 Quality of data in Sri Lanka coastal fisheries sector

Several studies have been done researches to analyses the impacts of fuel subsidy in the fisheries sector. Most of the studies are depend on the principle and theory of the fuel subsidy. A limited number of empirical studies are available that analyse the impact of fuel subsidy in the fisheries sector, of which a few publications were selected for this research project. The selected studies have been done in developing countries like Sri Lanka such as Malaysia, Vietnam, Taiwan and Senegal. These researchers used a simple method to calculate the fishing vessel's profit and effort. Fishing vessels profit has been estimated by the difference between the fishing revenue (Price* amount of harvest) and fishing cost. The changes in the fishing effort have been evaluated by simple data indicators such as the number of fishing boats, fishing duration, amount of fuel consumption and engine horsepower. Fishing effort can be determined by using one of above mention data indicators. However, the analysis could not be performed by existing Sri Lanka coastal fisheries data due to unreliable and low resolution data.

The results (chapter 4.1) have shown the data from Sri Lanka coastal fisheries sector to be unreliable and skewed from one period to another. Usually, the number of active fishermen will change with number of active fishing vessels. In the data from Sri Lanka coastal fisheries, the number of active fishing boats changed from January 2010 to December 2017, but the number of fishermen remained the same.

Sixteen different types of fishing methods and six different types of fishing boats operate in Sri Lanka marine fisheries (FARA act, 1996). In the study area, six different types of fishing boats operate with various types of fishing gears. The catch amount varies with the type of fishing vessel (shown in table 2). Vessel catch depends on the monsoon pattern and lunar cycle (Thivviyan & Jayakody, 2016). But Fisheries officers have recorded the catch amount for a landing site. They do not show any mathematical formula or methods in their report for the estimation of catch. And fishing costs and fishing hours details have not been recorded by the officers. These data reveal the low resolution of data in the Sri Lanka coastal fisheries.

Moreover, statistical data are maintained as paper documents, therefore it needs to be digitised before analyses. The probability of input error is likely during data entry into databases or Excel sheets, and as well it is time-consuming. If the data will be entered directly into a database or Excel sheets, it will help to handle the data accessible and reduce errors in the analysis.

Results have shown that low resolution and unreliable data in the Sri Lanka coastal fisheries. Further, some studies suggested that low level of sampling frequency and high variability in sampling population is a problem in Sri Lanka coastal fisheries (Jayasooriya, Gunawardane, & Jayasinghe, 2010). These results and fisheries Jayasooriya, Gunawardane, & Jayasinghe (2010) are suggested that Sri Lanka coastal fisheries have a poor quality of data. These are not good enough to manage the fisheries at a sustainable level.

### 5.2 Proposed methods for Sri Lanka coastal fisheries data collection

Three different data collection methods are suggested to improve the data quality in Sri Lanka coastal fisheries in order to take a scientific decision. There are complete enumeration by advanced technologies, complete enumeration and stratified sampling. These three methods are designed to link catch, effort, and fishing cost data with the type of vessel and gear. These kinds of data will help to find the performance of a particular type of fishing gear and fishing vessel in the Sri Lankan coastal fisheries sector. In the complete enumeration by advanced technologies and complete enumeration methods are designed to collect the data from all fishing fleets in the landing site, while a limited number of fishing vessels in a landing site will be selected for the stratified sampling data collection method.

Advanced technologies such as VMS and e-logbook will be used in the complete enumeration by advanced technology method and paper logbook will be used as a data collection tool in complete enumeration data collection method. Functionally, usage of e-logbook and paper logbook are same. Both logbooks will provide the same catch and effort data. But harvest details will be recorded by fishing ground’s GPS points in the e-logbook. The e-logbooks will be easy to handle in the rough sea conditions. But data recording and storage of paper logbook will be difficult in the marine fishing environment. Because there are some possibilities to drench logbook in seawater. Hence, e-logbook is better data collection tool than a paper logbook.

During the arrival of a fishing vessel, landing sites officers will verify the data in the logbook by measuring the weight of fishes in both methods. In addition to that, VMS data will be used to verify the e-logbook data in the complete enumeration by advanced technology method. These cross-checking and verification of e-logbook data will reduce the errors in the data entry. Therefore, the high quality of data can be obtained from complete enumeration by advanced technology method.

Both data collection methods will help to control and eliminate the Illegal Unreported and Unregulated fishing activities by 24 hours landing site monitoring. And the amount of fish harvest data and fishing effort data will be accurately estimated from these both methods. These data from both methods will be used to manage the fishing stocks at a sustainable level. In addition to this, data from the complete enumeration by advanced technology method will be used to manage the fishing grounds at an optimal level by controlling the fishing intensity in the fishing grounds. Moreover, biological sampling method in complete enumeration by advanced technology method will provide the information on gear selectivity, the growth rate of selected species, spawning and reproduction period of the species and stock abundance.

These biological data will use to set the minimum mesh size of fishing nets and fishing close seasons. These results from the biological samples will help to manage the economically important species sustainably.

The government will consider the income of fishermen and available fund for infrastructure development during the implementation of the data collection method. An average annual income of a coastal fisherman is ranged between USD 1,000 and USD 3,336 (Tharmine, Sivashanthini, & Edrisinghe, 2018). In the advanced complete enumeration method, fishermen will need to buy the e-logbook and VMS for USD 2,280, and they will spend USD 264 annually for the equipment maintenance. The government will may arrange three year loan facilities to fishermen for purchasing the equipment. On the other hand, fishermen will spend USD 28 annually in the complete enumeration method. The complete enumeration method will favourable for fishermen when compare to the advanced complete enumeration method. Because advanced complete enumeration will significantly affect the annual income of the fishermen.

The high quality of data for the coastal fisheries management will be obtained from complete enumeration by advanced technology method. While it is comparable required a higher level of human resource, financial resource and technology resource than complete enumeration method. However, complete enumeration by advanced technologies method and complete enumeration method will not be economically feasible to Sri Lanka coastal fisheries data collection due to a large number of landing sites (about 900) in Sri Lankan coastal fisheries. Therefore a massive amount of investment will be required to develop the necessary infrastructure facilities for the data collection.

The third method is stratified sampling data collection method. A limited number of samples will be selected for this data collection method. The number of samples in a landing site will depend on the accuracy level of the data and number of fishermen in a gear and vessel combination. This method is designed to collect the data from fishing gear and vessels combination. It will help to increase the resolution of data and reduce the variability in the sampling population, while the precision of data will increase.

The stratified sampling method is entirely different from the first two methods. In the first two methods, landing sites will be monitored by 24 hours and data will be collected from all the fishing fleets in the landing site. But the stratified sampling method is designed for collecting the data from a limited number of vessels within limited a period. Also, a precise amount of fish production, fishing effort and other details can be estimated by the first two methods. But stratified sampling will provide average fish production level, fishing effort and other data. Therefore, Stratified sampling methods data quality will less than the first two methods. Further, it will require a lower level of human resources, financial resources and technological facilities.

Large numbers of coastal fishing boats and landing sites are available in Sri Lanka. Hence, the stratified sampling method is more appropriate for the present situation to collect data from coastal fisheries. However, there is a potential threat in this method for the future as if the threat is increasing in the coastal fisheries, we need to monitor the landing site and collect associated data. At such situations, previously mentioned first two methods will be selected to monitor the landing sites and collect data from Sri Lanka coastal fisheries.

# 6 CONCLUSION

Sri Lankan government issued the fuel subsidy to motorised fishing boat owners in 2012 and 2013 due to high fuel price. In the first part, an attempt has been made to evaluate the impacts of fuel subsidy in terms of fishing effort and vessel profit in different types of fishing vessels in Jaffna by using the available data from coastal fisheries sector. Results have shown that evaluation could not be performed due to the unreliable and low resolution of coastal fisheries data in Sri Lanka coastal fisheries. In the second part, three different types of data collection method have been proposed to improve the data quality in Sri Lanka coastal fisheries. There are complete enumeration by advanced technology, complete enumeration and stratified sampling. These three methods are proposed based on human resources, technologies and financial resource. However, complete enumeration by advanced technology and complete enumeration methods are economically fewer possibilities to implement in Sri Lanka coastal fisheries sector due to many landing sites. In the present scenario, the stratified sampling method is highly recommended to collect the data from Sri Lanka coastal fisheries sector. If the coastal fisheries face a huge threat in the future, the government will be forced to implement a method like complete enumeration by advanced technology or complete enumeration method in order to manage the resources in an optimum level along with data collection.

# 7 RECOMMENDATION

- Ministry of Fisheries and Aquatic Resources Development (MFARD) and Department of Fisheries and Aquatic Resources (DFAR) should take necessary action to change the coastal fisheries data collection method from existing method to stratified sampling technique. Initially, the government should provide written standard guidelines for the stratified sampling technique to all fisheries officers in order to collect the data weekly basis from all landing sites.

- A detailed study should be carried out in existing fisheries data management in Sri Lanka coastal fisheries sector in order to find out the gaps in the data collection and data indicators, skills of fisheries officers and limitation of existing data collection method. Results from these studies will improve the quality of the proposed method.

- When the government introduce a policy or plan, suitable data indicators should be created in order to analyse the effectiveness of the policy. If the indicators not in existing methods, they should include the data indicator in the data collection method. This will help to evaluate the performance of policies.

- DFAR should more pay attention to collect reliable fisheries data from all landing sites. It should be free from political, governmental and industrial influence. The Assistant Director of the district should supervise these data collection.

- MFARD and DFAR should take the necessary action to reduce the number of landing sites in Sri Lanka. For instance, a major landing site can be established by combining 4 to 5 minor landing sites. It will reduce the effort to collect the data from landing sites and monitor the landing site. Also, it will save a tremendous amount of government investment for infrastructure development.

- The existing data collection method and data indicators are needed to analyse for every two years. It will help to find out the gaps and limitation in the methods and indicator to measure the stock health and fisheries policies. The data collection method and data indicators can be modified based on the analysis.

- The computer connected electronic weight scale in total enumeration method help to save time and reduce error in data entry.

- All the fisheries data should keep in an online database. This will make the transparency of the fisheries data and easy to handle the data for researchers in order to analyse the trends in the fisheries.

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# APPENDICES

## Appendix 1. Existing data collection form in Sri Lanka coastal fisheries

**MONTHLY PROGRESS REPORT**

**DISTRICT :-** **MONTH:-** **YEAR :-** **NAME OF FI:-**

**Fishing crafts particulars**

| Fishing Village | IMUL | | | | | IDAY | | | | | OFRP | | | | | MTRB | | | | | RB-Kattuman | | | | | TRB-Vallan | | | | | NBSB | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In the Division | Operating Crafts | Registration upto last month | Registration during the month | Renewal during the month | In the Division | Operating Crafts | Registration upto last month | Registration during the month | Renewal during the month | In the Division | Operating Crafts | Registration upto last month | Registration during the month | Renewal during the month | In the Division | Operating Crafts | Registration upto last month | Registration during the month | Renewal during the month | In the Division | Operating Crafts | Registration upto last month | Registration during the month | Renewal during the month | In the Division | Operating Crafts | Registration upto last month | Registration during the month | Renewal during the month | In the Division (Without Craft) | Operating (Without Crafts) | Registration upto last month | Registration during the month | Renewal during the month |
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| **Total** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Page 1

| Fishing Villages | Total Fresh Fish Production (kg) | Total Dry Fish Production (kg) | Fishing Families | Active Fishermen | Fishing Population | No. of Families Affected due to Ban on Fishing | No of Families getting dry ration |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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| | | | | | | | |
| **Total** | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.00 |

Page 2

**Fish Production**

| Variety of Fish | Fish Production (Kg) | | Fish Production (Kg) | | Fish Production (Kg) | |
|---|---|---|---|---|---|---|
| | Fresh Fish | Dry Fish | Fresh Fish | Dry Fish | Fresh Fish | Dry Fish |
| Seer | | | | | | |
| Paraw | | | | | | |
| Palaya | | | | | | |
| Kelaw | | | | | | |
| Other Blood Fish | | | | | | |
| Shark | | | | | | |
| Rock Fish | | | | | | |
| Shong/v | | | | | | |
| Parwns | | | | | | |
| Lobsters | | | | | | |
| Kumballa | | | | | | |
| Sprate | | | | | | |
| Crabs | | | | | | |
| Beach-de-mer | | | | | | |
| Cuttle Fish | | | | | | |
| Skate | | | | | | |
| Valai | | | | | | |
| Salai | | | | | | |
| Soodai | | | | | | |
| lagoon Fish | | | | | | |
| Others | | | | | | |
| **TOTAL** | **0** | **0** | | | | |

Page 3

# Pension details

| # | Fishing Villages | Total No. Of member enrolled during this month | Total No. Of enrolled upto the end of last month | Total No. Of member full payment (discount) | Total No. Of member instalments basis | Total No. Of member who paid their instalments duly | Total No. Of member defaulted in payment |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
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| | | | | | | | |
| | | | | | | | |
| **TOTAL** | | | **0** | **0** | **0** | **0** | **0** |

Page 4

**Marine Fisheries Statistics - Fish Production (Kilogram)**

Form: Fish Stat MFP /1/2012

Fisheries District:- DS Division:- FI Division: - Month& Year:

| Name of Landing sites | Marine Fish Production (kg) | | | | | | | | | | | | | | | | | | | | | Total Catch |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| | Seer | Paraw | Skipjack tuna | Yellow Fintuna | Frigate & Bullettune | Kawakawa | Other tuna | Sail Fish | Other Blood Fish | Sharks | Skate / Rays | Rock Fish | Shog/v | Prawns | Lobster | Crabs | Cuttle Fish / Squids | Sea Cucumer | Baivalve | Lagoon Fish | Others | |
| Major Harbours ( Multiday) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Miner Landing sites |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Madhal Waraaya |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Lagoons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| TOTAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fish used for dry (Wet Weight - Kg) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |

Reasons for changes of fish production: ..................................................................................................................................
..................................................................................................................................

Name and signature of FI:-

Recommendation of AD :-

Page 5

**OPERATING FISHING BOATS**

FI Division:-

DS D Fisheries District :-

Month:-

| | Harbour/ Thotupola/ Lagoon | Multi Day | One Day | FRP( OB) | OB Traditional | NM Tradational | Total | Beach Seine |
|---|---|---|---|---|---|---|---|---|
| Major Harbours( Multiday) | | | | | | | | |
| 1 | | | | | | | | |
| Minner Landing sites | | | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| Lagoons | | | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| | **Total** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Name and Signature of FI: ...................................................................

Name and Signature of AD: ...................................................................

Page 6

## Appendix 2. Sample logbook sheets

Name of FI division: Name of the landing site:

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FISHING BOAT** | IMUL | | MTRB | | **FISHING GEAR** | Trawlers | | Purse seine | | Fyke net | | Handline | |
| | IDAY | | NTRB | | | Gill nets | | FAD | | Lagoon seine | | Scuba Diving | |
| | OFRP | | NBSB | | | Long line | | Stake net | | Beach Seine | | Cast net | |

Fishing boat Registration number …………………..

Operation license number …………………………..

Departure date ……………………………………..

Departure time ……………………………………..

Skipper signature: ………………………………….

**Office use only**
Landing site officer name: ……………….

Departure: Approved/Denied

Signature: …………………………………
Date: ………………………………………
Time: ………………………………………..

| Date | Location | | Gear | Species | Landed fishes (Kg) (Estimated catch) | Actual weight (By Officers) | Discards fishes (Kg) |
|---|---|---|---|---|---|---|---|
| | Longitude | Latitude | | | | | |
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **Total** | | | | | | | |
| Fishing hours | | | | Amount of fuel consumption | | | |
| Labour cost | | | | fuel cost | | | |
| Ice cost | | | | Other costs | | | |

Departure date:…………………………………..

Departure time: …………………………………..

Special remarks: …………………………………..

Signature of skipper: ……………………………….

**Office use only**
Landing site officer name: ………………….….

Landing: Approved/Denied

Signature: …………………………………
Date: ………………………………………
Time: ………………………………………..

## Appendix 3. A sample sheet of Stratified data collection book

Date:

Name of the FI division:

Name of the Landing site:

Name of the data collector:

| Fishing unit (Stratum) | | | | | |
|---|---|---|---|---|---|
| IMUL-TRAWLER | | OFRP-TRAMMEL NET | | NTRB-STAKE NET | |
| IDAY-TRAWLER | | MTRB-STAKE NET | | NTRB-FYKE NET | |
| OFRP-GILLNET | | MRTB-FYKE NET | | Others | |

Number of active members in this fishing unit: ……………………………….

| Family name | Local Name | 1<br>Landed fishes (Kg) | 2<br>Landed fishes (Kg) | 3<br>Landed fishes (Kg) | 4<br>Landed fishes (Kg) | 5<br>Landed fishes (Kg) | 6<br>Landed fishes (Kg) | 7<br>Landed fishes (Kg) | 8<br>Landed fishes (Kg) | 9<br>Landed fishes (Kg) | 10<br>Landed fishes (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Shrimps | றால் | | | | | | | | | | |
| Squids and cuttlefish | கணவாய் | | | | | | | | | | |
| Crabs | நண்டு | | | | | | | | | | |
| Sharks | சுறா | | | | | | | | | | |
| Ray and skates | திருக்கை | | | | | | | | | | |
| Sea cucumber | கடல் அட்டை | | | | | | | | | | |
| Lobster | சிங்க றால் | | | | | | | | | | |
| Mugilidae | சிரேயா மீன் | | | | | | | | | | |
| Siganidae | ஒட்டி /ஓரா | | | | | | | | | | |
| Chanidae | பால் மீன் | | | | | | | | | | |
| Lethrinidae | வெள்ள மீன் | | | | | | | | | | |
| Gerridae | திரளி | | | | | | | | | | |
| Carangidae | பாரை மீன் | | | | | | | | | | |
| Spyraenidae | | | | | | | | | | | |
| Other | | | | | | | | | | | |
| **Total** | | | | | | | | | | | |
| Fishing hours | | | | | | | | | | | |
| Amount of fuel consumption | | | | | | | | | | | |
| Labour cost | | | | | | | | | | | |
| Ice cost | | | | | | | | | | | |
| Fuel cost | | | | | | | | | | | |
| Other cost | | | | | | | | | | | |

Special remarks: ………………………………………………………………………………………
..........................................................................................................................................
..........................................................................................................................................
..........................................................................................................................................

Signature of data collector:

Date:

## Appendix 4. Tentative government annual capital cost in three different data collection method

| Cost | | Details | Description | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| **Capital cost** | Landing site office (cost per landing site) | Building | (27 feet X 22 feet) | $ 16,800 | - | $ 16,800 | - | - | - |
| | | Computer facilities | (Computer/e-logbook) | $ 2,800 | | $ 900 | - | $ 450 | - |
| | | Office assests | (Table, Chair and other) | $ 560 | - | $ 560 | - | - | - |
| | | Weight Scale | | $ 28 | - | $ 28 | - | $ 28 | - |
| | | **Total** | | **$ 20,188** | **-** | **$ 18,288** | **-** | **$ 478** | **-** |
| | VMS unit ( It will common for one or more district) | Building | (27 feet X 22 feet) | $ 16,800 | - | - | - | - | - |
| | | 5 computers and monitoring facilities | 5 computers and monitoring facilities | $ 5,600 | - | - | - | - | - |
| | | Office assests (tables, chairs and others) | (tables, chairs and others) | $ 1,120 | - | - | - | - | - |
| | | **Total** | | **$ 23,520** | **-** | **-** | **-** | **-** | **-** |
| | Marine biology laboratory (It will common for one or more district) | Building | (50 feet X 22 feet) | $ 28,000 | - | - | - | - | - |
| | | Computer facilities | 3 computers | $ 1,400 | - | - | - | - | - |
| | | Office assests | (Weighting, tables, chairs and others) | $ 1,120 | - | - | - | - | - |
| | | Lab equipments | Microscopes (5) | $ 3,920 | - | - | - | - | - |
| | | | Dissection equipments with board (5) | $ 392 | - | - | - | - | - |
| | | | length and weight measurement equipments (5) | $ 1,680 | - | - | - | - | - |
| | | | Chemicals | $ 280 | - | - | - | - | - |
| | | | Glasswares | $ 280 | - | - | - | - | - |
| | | | Freezers | $ 840 | - | | - | - | - |
| | | | Other lab equipments (masks, gloves, goggles and safety equipment) | $ 840 | - | - | - | - | - |
| | | Total | | **$ 38,752** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** |
| | Training Programme | Data collectors | | | | | | $ 1,400 | |
| | | Marine biologists | | $ 2,000 | | | | | |
| | | VMA unit officers | | $ 1,400 | | | | | |
| | | Landing site officer | | $ 1,400 | | $ 1,400 | | | |
| | | **Total** | | **$ 4,800** | | | | | |
| **Total Capital Cost** | | | | **$ 87,260** | **$ -** | **$ 19,688** | **$ -** | **$ 1,878** | **$ -** |

## Appendix 5. Tentative government annual operational cost in three different data collection method

| Cost | | Details | Description | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| **Operational cost** | Landing site office (cost per landing site) | Landing site officers salaries | ( $ 224 per officer per month) | $ 16,128 (6 Officers X $ 224 X 12 Months) | $ 16,128 | $ 16,128 | $ 16,128 | $ 2,688 | $ 2,688 |
| | | Transport cost | Max. 84 USD per officer | $ - | $ - | $ - | $ - | $ 1,008 | $ 1,008 |
| | | Office maintenance | (Electricity bills, water supply and internet) | $ 2,016 | $ 2,016 | $ 2,016 | $ 2,016 | - | - |
| | | **Total cost** | | **$ 18,144** | **$ 18,144** | **$ 18,144** | **$ 18,144** | **$ 3,696** | **$ 3,696** |
| | Marine biology laboratory ( It will common for one or more district) | Biologist salaries (3 Officers) | (3 Officers X $ 224 X 12 Months) | $ 24,192 | $ 24,192 | - | - | - | - |
| | | Purchasing samples in Markets | Maximum 280 USD per month | $ 3,360 | $ 3,360 | - | - | - | - |
| | | Transport cost | Max. 84 USD per officer | $ 1,008 | $ 1,008 | - | - | - | - |
| | | Monthly other expendtiure | (Electricity bills, water supply and internet) | $ 2,688 | $ 2,688 | - | - | - | - |
| | | **Total cost** | | **$ 31,248** | **$ 31,248** | **$ -** | **$ -** | **$ -** | **$ -** |
| | VMS unit (It will common for one or more district) | Offcers salaries | (6 Officers X $ 224 X 12 Months) | $ 16,128 | $ 16,128 | - | - | - | - |
| | | Office maintenance | (Electricity bills, water supply and internet) | $ 2,016 | $ 2,016 | - | - | - | - |
| | | **Total cost** | | **$ 18,144** | **$ 18,144** | **$ -** | **$ -** | **$ -** | **$ -** |
| **Total Operational Cost** | | | | **$ 67,536** | **$ 67,536** | **$ 18,144** | **$ 18,144** | **$ 3,696** | **$ 3,696** |

**Appendix 6. Tentative fishermen annual capital cost per boat**

| Cost | Details | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|
| | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| **Capital cost** | VMS | $ 1,680 | - | - | | - | - |
| | e-logbook | $ 336 | - | - | | - | - |
| | Paper logbook | - | - | $ 28 | $ 28 | - | - |
| **Total Capital cost** | | **$ 2,016** | - | **$ 28** | **$ 28** | - | - |

**Appendix 7. Tentative fishermen annual operational cost per boat**

| Cost | Details | Advanced complete enumeration | | Complete enumeration | | Stratified sampling | |
|---|---|---|---|---|---|---|---|
| | | 1st Year | 2nd Year | 1st Year | 2nd Year | 1st Year | 2nd Year |
| Operational cost | Mainenance cost | $ 264 | $ 264 | - | - | - | - |
| **Total operational cost** | | **$ 264** | **$ 264** | - | - | - | - |