# Ecological and Energy Foot Print of Fish Processing in the Southern Coast of Sri Lanka

Elapata, Maheshwari ,Sangeetha [1];De Silva, Achini[2]

[1,]Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya

maheshwari.elapata@gmail.com

[2]Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya

## Abstract

The fisheries sector faces the challenge of determining effective management, in an ecosystem perspective in order to mitigate the Global Warming Potential (GWP).The main focus of the study was to analyze the resource utilization in the value chain of Maldives fish processing and the environmental performances of the steps involved. The study has attempted to calculate the carbon foot print and the water foot print during the Maldive fish processing. Rapid market chain analysis employed to collect the data. The sample composed of a case study of Kudawella fishing community of the southern coast of Sri Lanka. The estimation methods were based on the guidelines published by the Intergovernmental Panel on Climate Change for the preparation of Greenhouse gas inventory. The study revealed that 5kg of raw fish were required to produce 1kg of Maldives Fish. The waste produced were dumped into the sea. Energy source used for processing was combustion of firewood. The requirement per one kg of Maldives fish was 4kg of coconut husks. Thus resulting 4.4MT CO 2e per MT of Maldive Fish. The transportation of raw fish from offshores to the point of processing estimated a value of 70.484MT CO2 e/MT of Maldives Fish. The estimated water requirement of processing Maldive fish ranges from 2.5-3 litres/kg of Maldive fish. The study revealed that Diesel was one of the major contributor of Carbon-dioxide in the Maldive fish value chain and add extra points to carbon foot print. Proper Post Harvest Management practices will thereby help to mitigate the GWP.

Keywords: Carbon Foot Print, Maldives Fish, GWP

## Introduction

**F**isheries sector as a vital segment that serves the mankind by providing the basic nutritional requirement. Apart from the role of providing food security, the small scale fisheries sector is considered as an important sector especially for developing countries. It plays a key role in contributing in securing the livelihood security, alleviating poverty, wealth creation, foreign exchange earnings and rural development (Akande & Diei-Ouadi, 2010).According to Akande et al., 2010 the Small-scale fisheries provide employment for over 90% of the fishermen in the world and also provide other job opportunities associated with fish processing, distribution and marketing.

Fish and fish products are widely consumed alternative food that satisfies the protein requirements of people. Fish contributes to 17 percent of the global animal protein intake (Ahmed, 2008). Thus, consumption of fish has grown rapidly ever since. The study by Leo et al., 2014 reveals that the global fish food supply had shown a significant growth rate of 3.2 percent annually within the period of 1961 to 2009. As a result of the increased demand for the fish products, it urges the need of increasing the supply of fish. This had led to improvements in fishing activities from capturing, storing and transporting. These improvements have facilitated to increase the supply of fish and also to strengthen the distribution of quality fish products all over the world. (Leo, Miglietta, & Slađana, 2014).

Despite the social, economic and nutritional benefits derived from the fishery sector, issues had been raised due to the threat it cause on sustainability. The extensive capture of fish had also led to other adverse impacts to the ecosystem. It was recorded that a higher rate of the ecological footprint of fishing is concentrated on the waters off the industrialized countries of North America and Europe, and off Japan in 1950.This has also expanded and widespread on world's productive waters by year 2005 (Swartz, Sala, Tracey, Watson, & Pauly, 2010).

The rigorous capture of the fish also lead to the decline of fish, and fishermen then expend more effort and energy to capture fish which in turn lead to higher emission of greenhouse gases. This naturally creates a vicious cycle as illustrated in Figure 1 (Tan & Culaba, 2009).

A study carried out in Norway revealed that the carbon foot print of sea food products are significantly high ranging from 0.7 to 14.0 kg CO2e per kilogram edible product. These high values are due to the carbon emissions during production, use of refrigerants for storage in fishing vessels, fuel consumption of the fishing vessels and other modes of distribution (Madin & Macreadie, 2015).


*Figure 1: Climate change as part of a vicious cycle for commercial fisheries*

Source: (Tan & Culaba, 2009)

## Significance of the study

Food production is a precursor for the anthropogenic greenhouse gas (GHG) emissions globally (Ganegama Arachchi, et al., 2000).The primary production of food to humans are served through the three main sectors which includes Agriculture, forestry, and fishing (Kroodsma, et al., 2018). It was revealed that GHG emissions generated by the entire offshore fisheries increased from

1,442,975 tCO2e/year in 2011 to 1,477,279 tCO2e/year in 2013in Republic of Korea (Park, Gardner, Chang, Kim, & Jang, 2015).However marine food production is typically neglected and dis regarded from global assessments.

Tuna fish is a high regarded as a valued and popular food among the Sri Lankans (Ganegama Arachchi, et al., 2000). Tuna is one of the main fish resources from coastal area of-shore areas of Sri Lanka .Furthermore Tuna is the main ingredient of Maldive Fish production in Sri Lanka. There is very a dearth of published information directed at aspects concerning post-harvest loss reduction of Tuna Fish, the carbon foot print associated in production of Maldive Fish. Thus the fisheries sector faces the challenge of determining effective management, in an ecosystem perspective in order to mitigate the Global Warming Potential (GWP). These consequences of loss are need to be analyzed as thoroughly as possible.

## Research Objectives

The main focus of the study was to analyze the resource utilization in the value chain of Maldives fish processing and the environmental performances of the steps involved. It specifically calculates the post-harvest losses of tuna fish, carbon foot print and the water foot print of the activities associated in the production of Maldives fish. The figure 2 describes the conceptual framework of the study.

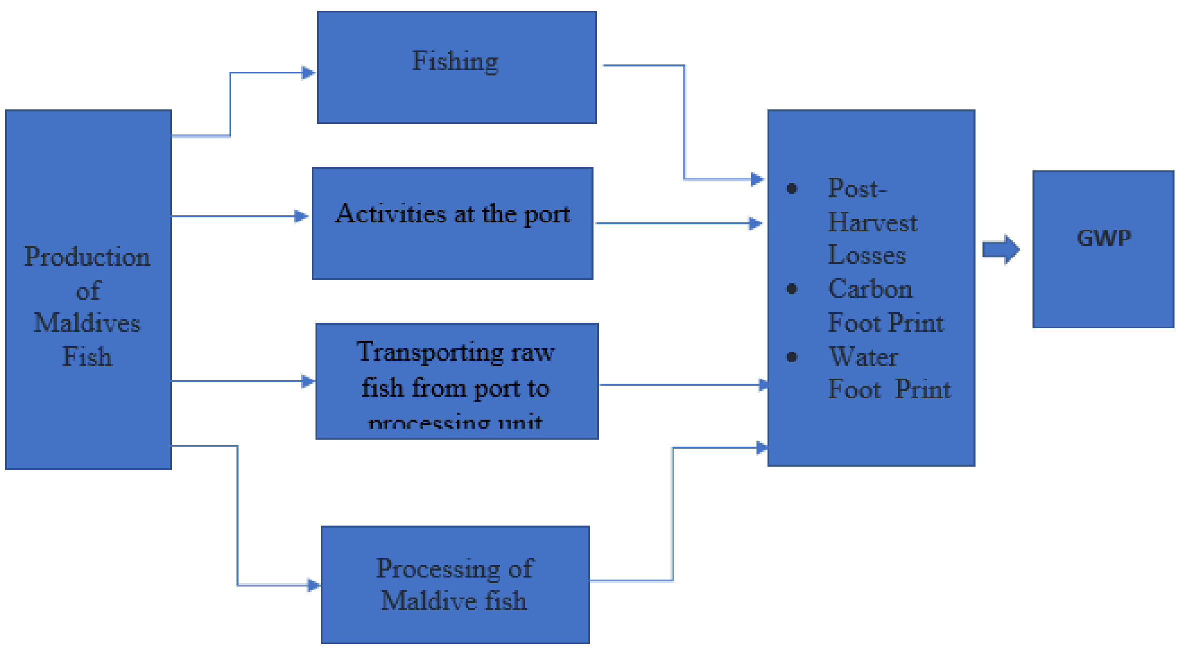


*Figure 2: Conceptual framework*

## Research Method

The sample composed of 30 Maldive fish processors of Kudawella fishing community of the southern coast of Sri Lanka and 10 fishermen at the Kudawella fishing community. The research area is shown in Figure 2. This study applied a participatory and qualitative case study approach along with a structured interviews. Rapid market chain analysis employed to collect the data. The estimation methods were based on the guidelines published by the Intergovernmental Panel on Climate Change for the preparation of Greenhouse gas inventory (IPCC, 2018).

The carbon footprint represents the amount of greenhouse gas (GHG) emissions released during its production, transport and consumption and is calculated as carbon dioxide equivalent ($CO_2e$) (Madin & Macreadie, 2015).The Carbon Emission was calculated using the following equation;

**$\text{Emission}=\Sigma_a [\text{Fuel}_a . EF_a]$** where $\text{Fuel}_{a=}$Fuel sold in Tetra Joules and $EF_a$=Emission Factor which is equivalent 74,100kg/TJ.

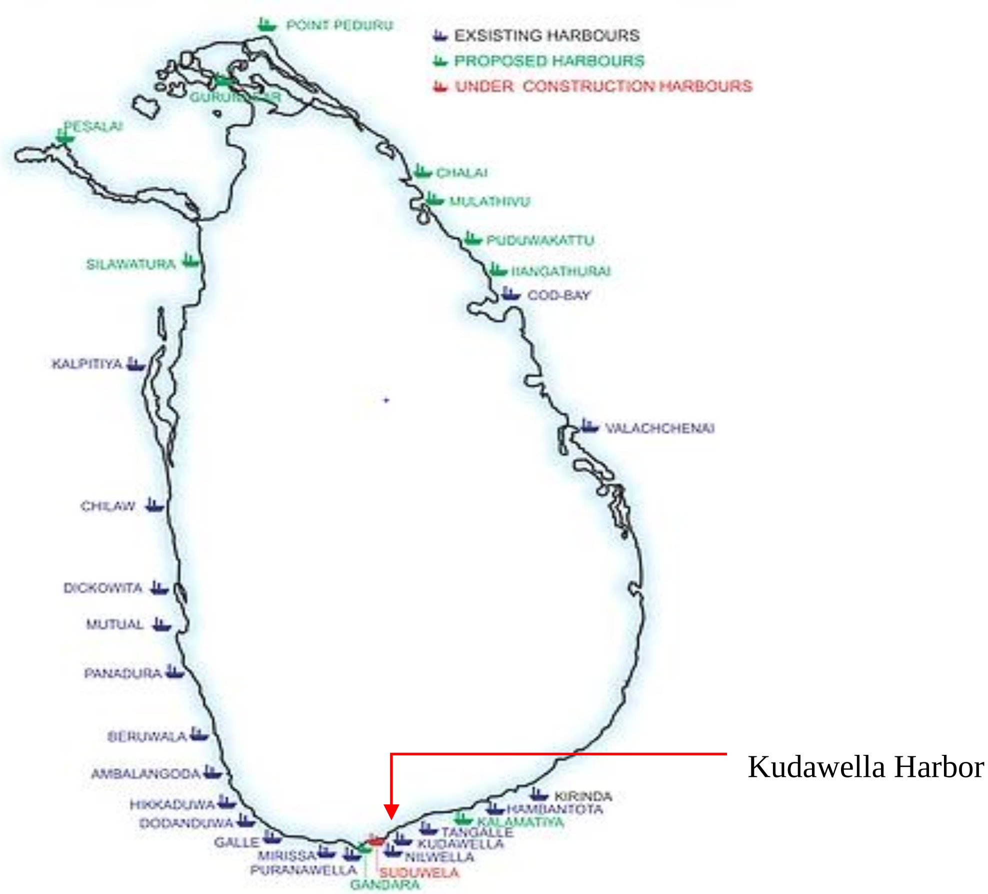


*Figure 3: Research area*

Source: Ceylon Fisheries Harbor Corporation, 2016

## Results and Discussions

### *The fishing journey*

The main livelihood of the community of Kudawella is something or other related to fishing. Most of the females are engaged in Maldive fish processing while the men go away for fishing. Therefore the community under the research study is entangled with the fishery sector. The researcher classified the boats anchored within the *Kudawella* harbor were according to the horse power of the engine and also according to the length of the boat. Wallam boats (20hp), Multi-days boats, Fisher-glass boats (25hp) were the main three types of boat according to the horsepower of the engine. According to the length, the boats ranged from 40 feet boats, 45 feet boats, 30 feet boats, 38 feet boats, 28 feet boats. The fishing operations within the sea last for averagely 20 days ranging from minimally for 1 week and for maximum for 2 months. The average crew size for one trip is around 7 person. The focus group discussions revealed the average amount of tuna fish traded from one trip. The materials taken for one trip includes ice, diesel, kerosene, food stuff, water, alcohol, cigarettes. Usually crushed or the flaked ice is used to prevent the spoilage of the capture fish. It is revealed through studies that crushed ice are better than large block ice. Since block ice will make the fish cool slowly and will have contact with one side of the fish resulting the other side to spoil quickly (Kumolu-Johnson & Ndimele, 2011). It was recorded that around 7500kg was transported from a small boat, while 13,000kg from a medium sized boat (38 feet boat) and around 25,000kg from a large boat(De Silva et al.,2014).

The captured tuna fish is unloaded that the harbor. It was recorded that 1000kg of raw Tuna fish leads for 300kg of post-harvest loss of fish. Existing literature revealed that skipjack tuna and yellow fin tuna could be stored for a maximum of 15 and 21 days respectively at zero degree Celsius (Ganegama Arachchi, et al., 2000).The study revealed that higher post-harvest loss was due to the inadequate amount of ice. All fishermen participated to the study revealed that the damaged raw fish is directly disposed back to the sea.

### *Transportation from Kudawella Harbor to Processing Units*

The average distance from the Kudawella port to the village where processing of Maldive fish take place is 10.2 km. The focus group discussions revealed that the 6.5 liters of diesel is consumed for to transport 1000kg of raw fish (1 trip) to the processing unit. For a month there are 4 trips from port to the processing unit. Thus the Carbon emission is around 0.0705MT $CO_2$ e/Month.

### *Processing of Maldive fish*

Maldive fish locally known as *umbalakada* is considered as one prominent value addition of Tuna fish. It is used as a major ingredient in many curries and used as condiment. It is a type of tuna that is produced by traditional methods of processing. The processing of Maldive fish includes few steps which had been practicing from generation to generation by these fishing communities in Sri Lanka. The raw Tuna fish brought from the off shores are de-headed and gutted. The remnants are then disposed to the sea. It was revealed that to produce 1kg of Maldive fish, 6 kg of raw Tuna fish is required. Once de-heading and gutting of fish is done, it is required to wash the fish thoroughly. The raw fish is cut horizontally and covered with salt. Salting is done to enhance the quality fish.

and The study revealed that 0.2kg of salt was required to process 1kg of Maldive fish. The salted fish is then dropped into a wire basket and boiled in an aluminium drum. The cooked fish is then smoked to drain the water. Smoking is done in home built kiln mostly using coconut husks as the firewood. Usually 4kg of firewood is consumed in production of 1kg of Maldive fish. The combustion of the firewood also generate a considerable amount of generation of greenhouse gases. Firewood falls under the category of other primary solid biomass which contributes 11TJ/Gg (IPCC, 2018).Thus the carbon foot print calculated for the production of 1kg of Maldive fish is recorded as 4.4MT $CO_{2\ e}$ per MT.Finally the smoked fish is sun dried. Though the government had proposed techniques like drying using electricity, none of the interviewers have adapted the method and also revealed that none of the members in their community practice use of electricity to dry their fish. They believe it to be an expensive method to adapt. Finally the dried Maldive fish is stored in a cool dry place.

Processing of Maldive fish also requires the naturally available resource, water. The study attempted to calculate the amount of water used for processing of Maldive fish. It was recorded that around 2.5 to 3 liters of water was used in processing of 1kg of Maldive fish.The raw materials needed for processing of Maldive fish is summarized below in figure 4.

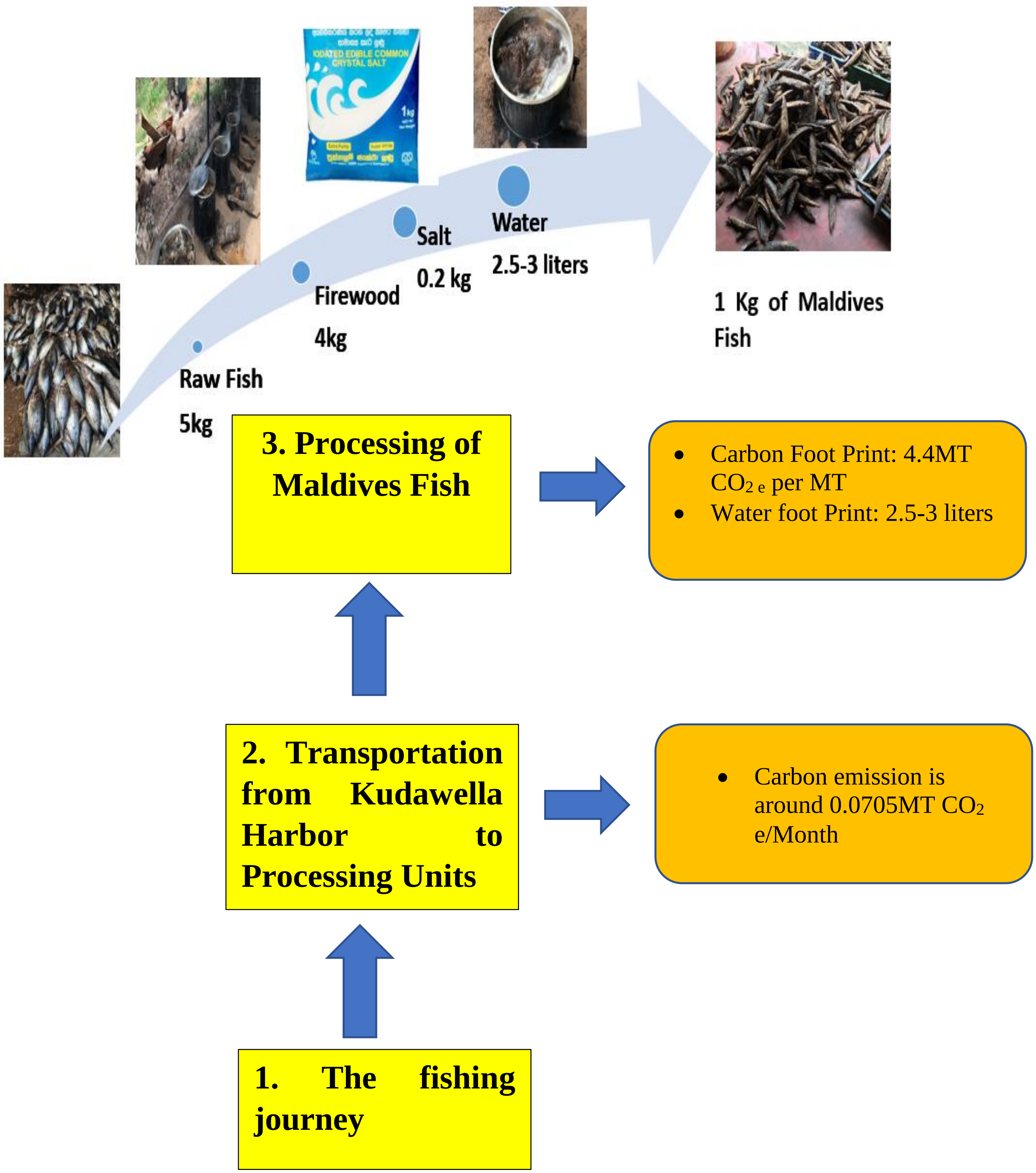


*Figure 4: Raw materials for processed food*

## Conclusion

The study revealed that 5 kg of raw fish were required to produce 1 kg of Maldives Fish out of which 3 kg is dumped as waste. The waste produced were dumped into the sea. Energy source used for processing of Maldive fish was combustion of coconut husks and the requirement per one kg of Maldives fish was 4kg of coconut husks thus 4.4MT $CO_{2\ e}$ per MT of Maldive Fish. The fishing operation at the sea estimated 6000 liters of diesel which thereby contributed for a value of 16.08MT $CO_2$ e/trip. The transportation of raw fish from offshores to the point of processing estimated a value of 0.0705MT $CO_2$ e/Month .The estimated water requirement of processing Maldive fish ranges from 2.5-3 litres/kg of Maldive fish. The study revealed that Diesel was one of the major contributor of Carbon-dioxide in the Maldive fish value chain. Proper Post Harvest Management practices will thereby help to mitigate the GWP.

## Recommendation

It is important to teach all actors in the fish value addition chain, the best practices on post-harvest management. Thereby they will take actions to minimize the post-harvest losses .An area based market is another sustainable option to minimize the transportation distance used to transport the processed Maldive fish rather than selling the Maldive fish to number of intermediaries. Use of fish waste in the production of animal feed and compost will be a good investment for the local community and thereby will reduce the dumping of waste into the sea. Therefore the knowledge and technical knowhow on production of animal feed should be disseminated to these fishing communities. Introduce environmental friendly efficient processing and drying methods such as capitalizing the solar energy would be a lucrative solution to reduce the greenhouse emission created by the combustion of firewood at the Maldive production.

# References

Ahmed, A. (2008). Post-harvest losses of Fish in developing countries. *Nutrition and Health, 19*, 273-287

Akande, G., & Diei-Ouadi, Y. (2010). *Post-harvest losses in small-scale fisheries:Case studies in five sub-Saharan African countrIes.* Rome: Food and Agriculture Organization of the United Nations.

De Silva, D., Torbjorn, T., Jayasooriya, M., & Lalith, A. (2014). Ecological foot print of the postharvest losses in Tuna industry: A case of Sri Lanka. International Institute of Fisheries Economies of Trade.

Ganegama Arachchi, G., Jayasinghe, J., Wijeratne, M., Perera, W., Jayasooriya, S., & Hettiarachchi, k. (2000). Handling practices and post-harvest losses of tuna catches from multi-day boats operating from fish landing site Negombo,; Sri Lanka. *Sri Lanka Journal of Aquaculture, 5*, 87-95.

IPCC. (2018). *IPCC,2018,Task force on National Greenhouse Gas Inventories :2006 IPCC Guidelines for National Greenhouse Gas Inventories,.* Intergovernmental Panel on Climate Change.

Kroodsma, D. A., Mayorga, J., Hochberg, T., Miller, N. ,., Boerder, K., Ferretti, F., . . . Boris, W. (2018). Tracking the global footprint of fisheries. *Science, 359*, 904–908 .

Kumolu-Johnson, C. A., & Ndimele, P. (2011). A Review on Post-Harvest Losses in Artisanal Fisheries of Some African Countries. *Journal of Fisheries and, 6*(4), 365-378.

Leo, F. d., Miglietta, P. P., & Slađana, P. (2014). Marine Ecological Footprint of Italian Mediterranean Fisheries. *Sustainability, 6*, 7482-7495.

Madin, E., & Macreadie, P. (2015). Incorporating carbon footprints into seafood sustainability certification and eco-labels. *Marine Policy, 57*, 178-181.

Park, J., Gardner, C., Chang, M., Kim, D., & Jang, Y. (2015). Fuel Use and Greenhouse Gas Emissions from Offshore Fisheries of the Republic of Korea. *PLOS ONE, 10*(8).

Swartz, W., Sala, E., Tracey, S., Watson, R., & Pauly, D. (2010). The Spatial Expansion and Ecological Footprint of Fisheries (1950 to Present). *PLoS ONE, 5*(12). doi:10.1371/journal.pone.0015143

Tan, R. R., & Culaba, A. B. (2009). *Estimating the Carbon Footprint of Tuna Fisheries.* WWWF Binary Item.