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AN ASSESSMENT OF ANNUAL CARBON EMISSION OF MECHANISED TRAWL FISHERY IN KERALA

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Abstract: Globally food production contributes one by fourth of the greenhouse gas emissions by anthropogenic activities. Dominance of fuel use in making hazards to the environment in the form of carbon emission is a proven fact in food producing sectors including fisheries. An assessment of carbon emission by mechanised trawl fishery in Kerala is carried out. According to the study, mechanized trawlers in the state released 0.45 million tonnes of carbon in a year exclusively through fuel use at the rate of 2.24 kg CO_2 per kg of fish landed during the period of study. Total carbon emission from a mechanised trawler in a year is estimated as 206 tonnes. Comparing different length class of trawlers, it is understood that rate of carbon emission is least in very large trawlers (1.87 kg per kg of fish) followed by medium trawlers (1.98 kg per kg of fish), large trawlers (2.6 kg per kg of fish), small trawlers (single-day) (2.73 kg per kg of fish) and small trawlers (multi-day) (4.03 kg per kg of fish). Comparing single-day and multi-day trawlers of similar size, latter found to be emitting 48% more carbon per kg of fish landed.

***Index Terms* – Mechanised trawler, Kerala, Fuel, carbon emission per trawler, carbon emission per kilogram of fish.**

I. INTRODUCTION

Most of the environmental concerns mankind faces can be connected to energy use especially fossil fuels in one way or other. Fossil fuel release carbon dioxide and other greenhouse gases to the atmosphere which leads to the phenomenon, 'greenhouse gas effect' and its concomitant impacts cause changes in climate, sea level rise and global warming. Fossil fuels are also responsible for production of pollutants such as suspended particulate matter, photochemical smog particulates, ozone-depleting substances like CFCs and gaseous emissions such as sulphur dioxide (SO_2), carbon monoxide (CO) and oxides of nitrogen, which are injurious to the environment and human health (TERI, 1999; Pelletier *et al.*, 2007; Avadi & Freon, 2013 and Parker & Tyedmers, 2015). Because of all the specified concerns fuel use can be the key to determine the environmental sustainability of a fishery activity.

Carbon emission from fisheries is based on two aspects primarily as a waste of fossil fuel combustion and secondarily as provision of craft, gear, engine, fuel, ice and other necessities (Ziegler *et al.*, 2003; Hospido & Tyedmers, 2005 and Thrane, 2006).

Purse seining and trawling are the most common fishing methods (Sainsbury, 1971) among which trawling found to be 15 times more energy intensive than purse seining. Not only in comparison with purse seining, trawling found to be more energy intensive when compared to any other fishing methods whether it is active or passive (Wiviott & Mathews, 1975; Leach, 1976; Edwardson, 1976; Lorentzen, 1978; Rawitscher, 1978; Nomura, 1980; Hopper, 1982; Watanabe & Okubo, 1989 and Tyedmers, 2001).

Life cycle assessment (LCA) studies conducted in trawlers shows the dominance of fuel used in trawling operation in carbon emission compared to the emission from the vessel and gear (Ziegler *et al.*, 2003; Hospido & Tyedmers, 2005; Ziegler & Valentisson, 2008; Vázquez-Rowe *et al.*, 2010; Ravi, 2015; Vázquez-Rowe *et al.*, 2012, Vivekanandan *et al.*, 2013; Ghosh *et al.*, 2014; Edwin & Hridayanathan, 1997; Boopendranath, 2000, 2008, 2012; Ziegler *et al.*, 2003; Thrane, 2004a,b; Hospido & Tyedmers, 2005; Ziegler *et al.*, 2009, Fet *et al.* (2010), Cheilari *et al.* (2013) and Vázquez-Rowe *et al.*, 2014).

As the demand for less carbon footprint product is increasing, authorities and stakeholders overlook fuel use profiles and its resultant environmental burdens in fisheries. All these factors necessitate studies on energy input, its intensity and dimensions of burdens caused. On this background an assessment of carbon emission of mechanised trawl fishery of Kerala is depicted.

II. Materials and methods

The data of fuel usage have been collected from 40 selected trawlers operated form Munambam and Cochin harbours of Ernakulam district of Kerala. Fuel consumption and catch of each trip of selected trawlers were collected for continuous two years from June, 2014 to May, 2016. Data was collected using pretested questionnaire, which administered to the engine driver of the trawlers and were collected back after their arrival.

The carbon emission associated with fuel use is calculated based on the data published by Environmental Protection Agency of US in which equivalent carbon emission of one litre of diesel use is defined as 2.7 kg (USEPA, 2014).

III. Results and discussion

Commercial fisheries is exclusively dependent upon fossil fuel for navigation, operation and any other activities which require energy. Fuel use contribute heavily to the emission of greenhouse gases that will make dramatic changes in the atmosphere and climate. Greenhouse gas emission from a fishery is a function of different variables among which fuel is found to be prominent. Here a narrower analysis has been carried out on carbon footprint of mechanised trawlers through fuel use. Heavy dominance of fuel use in environmental burdens caused by a fishing vessel has been reported by Boopendranath (2000, 2008 & 2012), Ziegler & Valentinsson (2008), Ziegler *et al.* (2009), Vaquer-Rowe *et al.* (2010 & 2012), Vivekanandan *et al.* (2013), Ziegler *et al.* (2003), Thrane (2004a,b), Hospido & Tyedmers (2005) and Edwardson (1976).

Carbon footprint is a measure of carbon emission caused by an activity directly or indirectly (Wiedmann & Minx, 2008). Since energy consumption has a direct impact on environment, carbon emission can be used as an indicator of environmental burdens of the system (Dutilh & Kramer, 2000) and it is an indicator of energy efficiency and environmental burden created by a system. Carbon footprint is expressed in terms of carbon emission from a vessel in a year and amount of carbon emission per unit weight of fish landed.

A. Carbon emission per vessel per year

Annual carbon emission from different length class of trawlers has been estimated in kilogram CO_2 equivalent. Average carbon emission per vessel per year is given in fig.1.

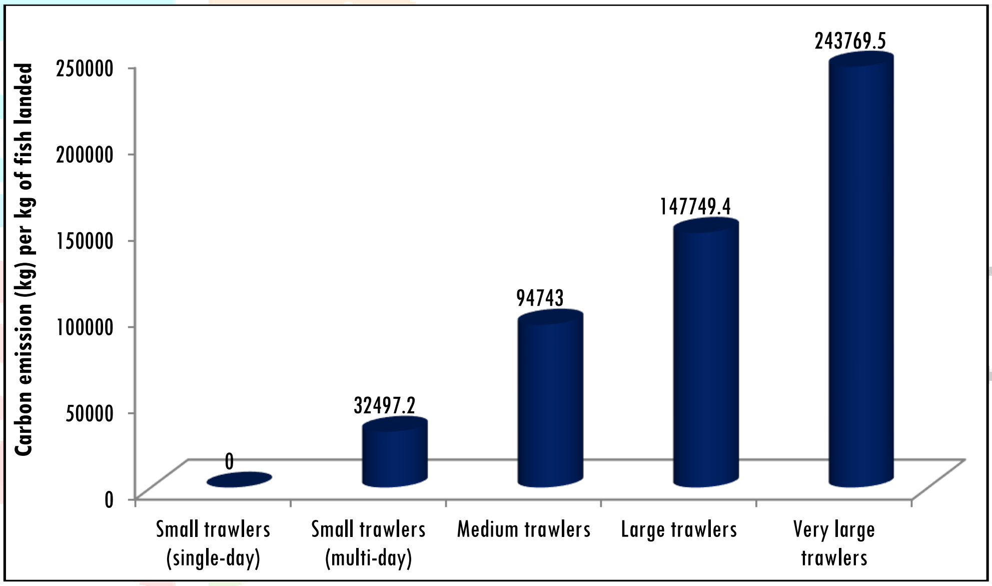

Fig.1. Average annual carbon emission of mechanized trawlers

B. Carbon emission per kilogram of fish landed

Result of the assessment of carbon emission per kilogram of fish landed is given in table 1. Average carbon emission per kilogram of fish landed is higher in small trawlers (multi-day) followed by small trawlers (single-day), large trawlers, medium trawlers and very large trawlers (Fig.2). Among different size class of trawlers, very large trawlers found to be efficient by releasing least carbon per fish landed as a result of higher quantity of catch.

Table 1. Carbon emission per kilogram of fish landed from mechanised trawlers (Average is given in parenthesis)

Type of trawler	Carbon emission per fish landed (kg/kg)
Small trawlers (Single-day)	1.5 - 3.6 (2.73)
Small trawlers (multi-day)	2.95 - 5.79 (4.03)
Medium trawlers	0.81 - 6.17 (1.98)
Large trawlers	0.66 - 4.75 (2.6)
Very large trawlers	1.13 - 2.31 (1.87)
Mechanised trawlers (Kerala)	**0.66 - 8.1 (2.24)**

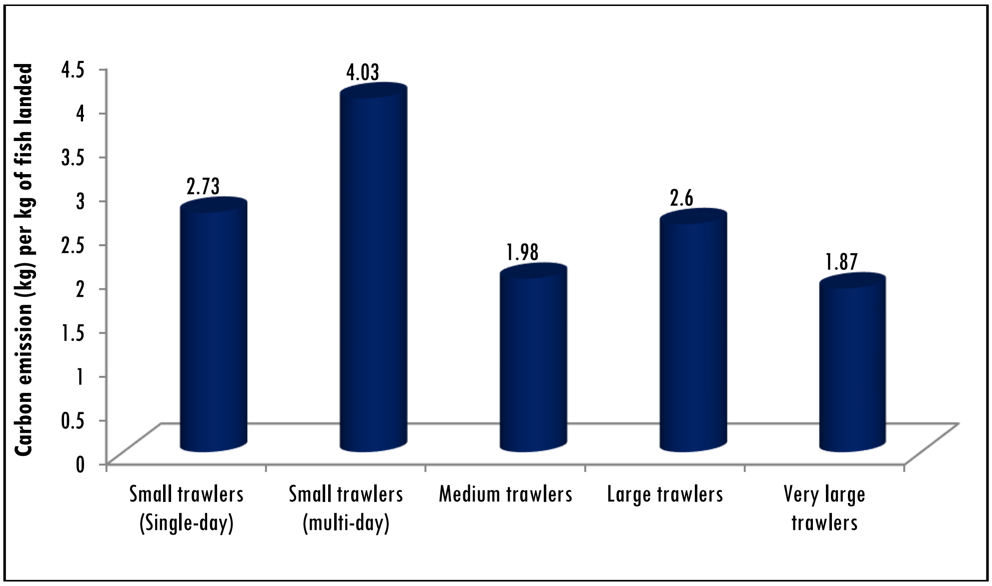

Fig. 2. Average carbon emission per kilogram of fish landed from mechanised trawlers

C. Total carbon emission per year

Considering Kerala trawl fishery, on an average it released 0.45 million tonnes of carbon in a year during the study period (Table 2) at an average rate of 2.24 kg of carbon per kg of fish landed (Table 1). Total carbon emission from a mechanised trawler in a year is estimated as 206 tonnes. The contribution of multi-day trawlers to the emission of carbon to the atmosphere is very high when compared to single-day trawlers; multi-day trawlers emit 48% more carbon per kg of fish landed. Ravi (2015), Boopendranath (2000), Tyedmers *et al.* (2005) and Vivekanandan *et al.* (2013 also reported a similar trend among mechanised tarwlers in the state.

Table 2. Average annual carbon emission from mechanised trawlers

Type of trawler	Average carbon emission (kg)	No. of active trawlers in a year	Total carbon emission in a year
Small trawlers (single-day)	32497.2	108	3522696.48
Small trawlers (multi day)	94743	325	30810423.6
Medium trawlers	147749.4	217	32032071
Large trawlers	243769.5	1452	354089826
very large trawlers	396176.4	65	25767313.11
Total		**2167**	**446222330.2**

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