Original Research Article

A Recent Overview of CO₂ Footprint by the Mechanised Fishing Trawlers of Kerala, India

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A B S T R A C T

Marine fisheries of India has been witnessed with substantial increase of fishing effort and fishing efficiency during the last five decades which resulted in overexploitation of fish stocks together with the increase of fossil fuel burning and CO₂ emission into the atmosphere. The present study covered three important fishing harbours of Kerala to reveal an estimation of CO₂ footprint (considering the emission of CO₂ only during the fishing operation) by the mechanised fishing trawlers which showed a considerable higher value than the previous studies. There is a huge scope to reduce the level of CO₂ emission by implementing proper scientific policies and also by improving fuel efficiency of marine fishing vessels.

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Marine fisheries of India, Overexploitation, CO₂ emission, Important fishing harbours of Kerala, CO₂ footprint, Fuel efficiency of marine fishing vessels

Introduction

Marine fish production in India has registered a phenomenal growth from 0.5 MMT to 3.63 MMT in 2016.

The rapid upliftment of commercial fisheries sector was characterised by the mechanisation of propulsion, gear and catch handling along with the introduction of synthetic gear materials, development of acoustic fish detection and satellite based remote sensing techniques and advances in electronic navigation and position fixing equipment (Hameed and Boopendranath, 2000). The advent of motorisation and mechanisation enabled the Indian fishing fleet to increase the area and depth of operation, to use new and larger gears (trawls with long head rope) more effectively and to provide sufficient speed for propulsion and gear handling during loading and unloading operations.

One of the important characters of this fisheries sector is its extreme dependence on fossil fuels and the resultant emission of Green House Gases (GHGs). The utilization of fossil fuels has increased the accessibility
of the marine resources to the sector while simultaneously threatened the marine environment and ecosystem by causing climate change and ocean acidification. Violation of scientific policies and effective controls has led to an increase of the size of the fleet in terms of number and size of the crafts as well as the engine power which has ultimately made the situation more critical and the environment-friendliness, economic viability and sustainability of the marine fisheries sector are at stake.

**Materials and Methods**

During the above study conducted in 2017-2018, three major fishing harbours of Kerala were selected namely Kalamukku, Munambam and Beypore.

A number of 30 trawlers were surveyed from these harbours and the data regarding the Length Overall (LOA) of the trawler, hp of engine installed, duration of fishing hrs./day, total fuel consumption per fishing trip and quantity of catch harvested per fishing trip had been collected through structured questionnaire and direct observation.

The emission of CO₂ has been estimated by considering the standard conversion factor that 1 litre of diesel produces 2.64 kg of CO₂ (1 liter of diesel weighs 835 gram. Diesel consists of 86.2% of carbon, or 720 gram of carbon per liter diesel. In order to combust this carbon to CO₂, 1920 gram of oxygen is needed. The sum is then 720 + 1920 = 2640 gram of CO₂/liter diesel) or in other words, 1 ton of diesel combusts to evoke 3.16 ton of CO₂ into the atmosphere.

**Results and Discussion**

The present study showed that the average CO₂ emission intensity (t CO₂/t catch) by all the mechanised fishing trawlers operated in Beypore, Kalamukku and Munambam fishing harbours were respectively 2.64, 1.95 and 2.62 respectively. This study has been conducted on the trawlers having a wide range of LOA of 8-35m operated by marine engines of different hp (68-550hp). Vivekanandan et al., (2013) reported that in 1961, only 5.7% of the boats were of large category (OAL > 40’), whereas in 2010 about 30% of the boats were of large category and at present, this category exceeds up to 70-80%. This unwieldy increase of fishing fleet in terms of number and size of the craft coupled with the indiscriminate installation of high powered diesel engines have contributed to the absolute increase in diesel consumption resulting in excess emission of GHGs into the atmosphere.

It can be shown from table 1–3 that the vessels installed with engines having horse power of 411-550 are responsible for high (>2) CO₂ emission intensity. During the course of study, it has been shown that these trawlers operated with newly imported high speed diesel engines have already been unscientifically overpowered (according to the standard table recommended by Baiju and Boopendranath, 2014). Increase in fishing efficiency and fishing power have helped the marine fisheries to increase the catch but simultaneously, overexploitation and depletion of few stocks have made the situation more critical. In this communication, the menace of overpowering has ultimately led to tremendous elevation of fishing expenditure by increased fuel cost (Fuel cost accounts for 50–54% of operating cost of mechanized boats) thereby making the operation uneconomical and also increased CO₂ emission.

Hence, there is an urgent need to regulate the number and size of craft operating in marine fisheries sector and to down-size the craft, gear and engine power in various categories of craft to make the sector economically viable and sustainable.
**Table 1** CO₂ footprint by the mechanised trawlers operated in Beyapore Fishing Harbour, Kerala

| L₀A(m) | Hp of engine | CO₂ emission/fishing trip(kg) | Quantity of catch/fishing trip(kg) | Emission intensity (t CO₂/t catch) |
|--------|--------------|------------------------------|-----------------------------------|-----------------------------------|
| 9.3    | 68           | 184.8                        | 100                               | 1.848                             |
| 10.5   | 68           | 184.8                        | 100                               | 1.848                             |
| 10.5   | 68           | 184.8                        | 100                               | 1.848                             |
| 10.97  | 106          | 316.8                        | 150                               | 3.16                              |
| 11.6   | 68           | 792                          | 125                               | 6.3                               |
| 18.9   | 236          | 4752                         | 3500                              | 1.35                              |
| 19.8   | 300          | 5016                         | 4000                              | 1.25                              |
| 19.9   | 427          | 11880                        | 6000                              | 2                                 |
| 19.9   | 427          | 9240                         | 3800                              | 2043                              |
| 21.1   | 411          | 13200                        | 5000                              | 2.64                              |
| 21.1   | 411          | 13200                        | 5000                              | 2.64                              |
| 21.4   | 495          | 9504                         | 5000                              | 2                                 |
| 24.39  | 427          | 10560                        | 4000                              | 2.64                              |
| 24.39  | 427          | 10560                        | 4000                              | 2.64                              |
| 25     | 495          | 13728                        | 3500                              | 3.92                              |
| 25.91  | 427          | 11880                        | 4000                              | 3                                 |
| 25.91  | 427          | 11880                        | 4000                              | 3.23                              |
| 25.91  | 427          | 14520                        | 4500                              | 3.22                              |
| 25.91  | 427          | 10560                        | 4000                              | 2.64                              |
| 27     | 411          | 7392                         | 7000                              | 1.056                             |
| 27     | 495          | 14520                        | 4500                              | 3.22                              |
| 28.96  | 495          | 10560                        | 5000                              | 2.1                               |
| 32.31  | 427          | 13200                        | 4000                              | 3.3                               |
| 32.31  | 495          | 12672                        | 7000                              | 1.81                              |
| 32.31  | 427          | 11880                        | 5500                              | 2.16                              |
| 32.31  | 427          | 11880                        | 5500                              | 2.16                              |
| 33.53  | 495          | 15312                        | 6000                              | 2.55                              |
| 34.14  | 550          | 17952                        | 7000                              | 2.5                               |
**Table 2** CO₂ footprint by the mechanised trawlers operated in Kalamukku Fishing Harbour, Kerala

| L<sub>OA</sub>(m) | Hp of engine | CO₂ emission/fishing trip (kg) | Quantity of catch/fishing trip (kg) | Emission intensity (t CO₂/t catch) |
|------------------|--------------|-------------------------------|-------------------------------------|-----------------------------------|
| 9.3              | 68           | 185                           | 100                                 | 1.85                              |
| 10.75            | 68           | 185                           | 100                                 | 1.85                              |
| 15.86            | 110          | 1584                          | 2000                                | 0.8                               |
| 17.37            | 220          | 2640                          | 1000                                | 2.64                              |
| 17.37            | 220          | 2640                          | 1000                                | 2.64                              |
| 17.7             | 140          | 2244                          | 1500                                | 1.5                               |
| 17.37            | 192          | 2376                          | 1500                                | 1.6                               |
| 19.5             | 280          | 5148                          | 2000                                | 2.6                               |
| 19.7             | 280          | 5280                          | 3000                                | 1.76                              |
| 19.9             | 140          | 1980                          | 1500                                | 1.32                              |
| 19.9             | 236          | 4488                          | 2000                                | 2.24                              |
| 19.9             | 236          | 4488                          | 2000                                | 2.24                              |
| 19.9             | 280          | 5280                          | 3000                                | 1.76                              |
| 21.1             | 280          | 5544                          | 3500                                | 1.58                              |
| 21.1             | 280          | 6864                          | 3500                                | 1.96                              |
| 21.1             | 280          | 5544                          | 3000                                | 1.84                              |
| 21.1             | 411          | 13200                         | 5000                                | 2.64                              |
| 21.1             | 411          | 13200                         | 5000                                | 2.64                              |
| 21.4             | 427          | 8844                          | 5000                                | 1.76                              |
| 21.4             | 495          | 9240                          | 5000                                | 1.84                              |
| 21.4             | 495          | 9240                          | 5000                                | 1.84                              |
| 21.4             | 495          | 9240                          | 5000                                | 1.84                              |
| 25               | 495          | 9768                          | 4000                                | 2.44                              |
| 25               | 495          | 7524                          | 5000                                | 1.5                               |
| 25.91            | 411          | 7656                          | 5000                                | 1.53                              |
| 25.91            | 427          | 7656                          | 5000                                | 1.53                              |
| 25.91            | 495          | 8976                          | 3500                                | 2.56                              |
| 25.91            | 495          | 8976                          | 4000                                | 2.24                              |
Table 3 CO₂ footprint by the mechanised trawlers operated in Munambam Fishing Harbour, Kerala

| LOA (m) | Hp of engine | CO₂ emission/fishing trip (kg) | Quantity of catch/fishing trip (kg) | Emission intensity (t CO₂/t catch) |
|---------|--------------|-------------------------------|-----------------------------------|----------------------------------|
| 8.994   | 68           | 185                           | 100                               | 1.85                             |
| 9.3     | 68           | 198                           | 100                               | 1.98                             |
| 10.15   | 68           | 211.2                         | 100                               | 2.11                             |
| 17.55   | 120          | 2640                          | 2500                              | 1.05                             |
| 17.7    | 140          | 2376                          | 1500                              | 1.6                              |
| 17.7    | 192          | 2376                          | 2500                              | 0.95                             |
| 19.5    | 280          | 7392                          | 3000                              | 2.46                             |
| 19.5    | 280          | 7392                          | 3000                              | 2.46                             |
| 19.5    | 411          | 10560                         | 4000                              | 2.64                             |
| 19.7    | 280          | 6600                          | 3500                              | 1.88                             |
| 19.7    | 280          | 6600                          | 3500                              | 1.88                             |
| 19.7    | 280          | 6600                          | 3500                              | 1.88                             |
| 21.1    | 411          | 14520                         | 5000                              | 3                                |
| 21.4    | 495          | 10032                         | 3500                              | 2.86                             |
| 24.39   | 411          | 8712                          | 3000                              | 2.9                              |
| 24.39   | 411          | 10560                         | 4000                              | 2.64                             |
| 24.39   | 495          | 13200                         | 3500                              | 3.77                             |
| 25      | 411          | 10560                         | 3500                              | 3.01                             |
| 25      | 411          | 10560                         | 3500                              | 3.01                             |
| 25      | 495          | 10560                         | 3500                              | 3.01                             |
| 25      | 427          | 11880                         | 5000                              | 2.38                             |
| 27      | 495          | 15312                         | 4500                              | 3.4                              |
| 27      | 495          | 15312                         | 4500                              | 3.4                              |
| 27      | 495          | 15840                         | 4000                              | 4                                |
| 27      | 495          | 13728                         | 3500                              | 3.92                             |
| 27      | 550          | 17424                         | 5000                              | 3.49                             |
| 27      | 550          | 17160                         | 5000                              | 3.43                             |

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