EVALUATION OF ENVIRONMENTAL POLLUTION IN BANGLADESH BY INLAND CARGO SHIP OPERATION

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ABSTRACT

Inland Water Transportation is still considered as the major transportation sector in Bangladesh. Over ten thousand of different types of registered vessels and thousands of unregistered vessels are plying in inland routes. This sector carries over 50% of cargo, 80% of fuel-oil and more than one quarter of all passenger traffic per year. River network has been regarded as safe and cost-effective route of the country, especially in the southern part. The fleet of cargo vessels has the static capacity of about 1,000,000 tons. The cargo fleet consists of 2,213 registered ships (2,043 cargo vessels and 170 bay crossing coasters) and make an average 3/4 trips per ship per month. This huge no of operations in inland route has made us vulnerable to significant marine pollution due to direct discharge of bilges, oily water mixture, solid waste and also the air pollution due to age old running engines/ machineries. In this paper, an approximate estimation of pollutants such as bilges, oily water and solid waste has been made followed by the air pollution. An environmental modelling has been done followed by the impacts of pollutants with the help of Eco Indicator 99 (I) of SimaPro. It has been revealed that there are considerable impacts of marine pollution for prolonged inland cargo vessel operation. The major consequences includes the climate change, destruction of fishing zone, respiratory problems of human being and the rise of sea level. At the end, few preventive measures have been suggested in light of design modification, regulatory enforcement to reduce the marine pollutions.

Key Words: Marine Pollution, Cargo Vessel, Bilge, Bilge Water, Solid Waste. Sewage etc

1.0 INTRODUCTION

Bangladesh is a riverine country with a network of huge no of rivers, canals, creeks and water bodies, which are occupying about 11 per cent of the total area of the country. Since long, the river network has been regarded as safe and cost-effective route in Bangladesh. The inland waterways comprise a total length of nearly 6000 km of navigable waterways. More than half of the country's total land area is within a distance of 10 km from navigable waterway. Due to cheapest, safest and reachable means, the Inland Water Transportation (IWT) sector has become one of the major means of transport of the country. For that a huge number of different types of vessels are plying in inland routes. The IWT sector carries over 50% of all arterial freight traffic and one quarter of all passenger traffic each year which clearly defines the dependency on this sector [1] & [2].

The dependency on IWT sector paves the way to increase the number of vessels each year. It is anticipated that this trend is likely to continue in the coming years too largely due to poor condition and huge traffic on road, the increase demand for freight transport and the expected increase in personal mobility. This significant number of vessels plying in inland routes has made us vulnerable to significant marine pollution. The inland water ways are getting polluted by discharging of bilges, solid waste, oily water, and ballast water into the water and also making air pollution through burning of fuel while running of engines or machineries [5].

On the other hand, nowadays climate change issues have become major concern throughout the world and Bangladesh is one of the most vulnerable countries which may experience worst impact of climate change. One of the major causes of climate change could be marine pollution and it can contribute global warming, acid rain, eutrophication, destruction of fishing zone and even degradation the quality of local air. Also, the possible source of environmental

impact is very important to understand the level of mitigation. But unfortunately no such level of study or data has been done so far for accounting the inland vessel source pollution, its impact and possible remedial measures etc.

This paper aims at estimating pollutants such as discharge of bilges, and solid waste as well as fuel consumption by inland cargo vessels operation. Then quantifications of these pollutants have been used for environmental modelling with the help of Eco Indicator 99 (I) of Sima Pro Software. Sima Pro is the most widely used Life Cycle Analysis software which offers standardization as well as the ultimate flexibility and it has also unique features such as parameterized modelling and interactive results analysis. The impacts of such pollutants from inland cargo vessel operation have been found by damage oriented method of Sima Pro through Exposure and effect analysis followed by Fate analysis [6 & 7]. The finding of study can be used to access the scenarios of pollution by inland cargo vessels and may be useful while making some policy to combat pollution.

2.0 RESEARCH METHODOLOGY

The present research is primarily based on collecting quantitative and qualitative primary data and information to address the pollution for different types of inland vessels of Bangladesh. This data has been collected and recorded systematically through field study, open ended questionnaires and interviews with technical personnel. The major information collected are as follows:

- Physical dimensions of different types of inland vessels have been collected from DOS, BIWTA, regional concerned offices and also from on ground survey. These vessels are then categorized for the convenience of estimating different types of pollutants like bilges, solid waste etc.
- Engine power for different types of vessels has been ascertained from approved drawings, interviews with ship designers and builders as well as field data.
- Capacity plan along with line plan have been used to verify quantity of bilges. Moreover the field study was carried out to find out the tank capacity of various vessels.
- Fuel tank has been calibrated to find out hourly consumption of fuel. Moreover the field study, interviews with engine drivers of different types of vessels and ship builders were consulted to find out hourly fuel consumption.

Secondary data source and information have been explored from related private & government organizations, books, journals, research publications, official record etc. that have been kept in the published or unpublished form. Environmental modelling has been done from calculated pollutants to quantify the emission of compounds which causes damage to human health and ecosystem quality.

3.0 BRIEF DESCRIPTION OF INLAND VESSELS OF BANGLADESH.

Different types of vessels like passenger vessels, cargo vessels, ferry, oil tankers, dumb barges, speed boats, sand carriers and dredgers are plying in the rivers of Bangladesh. Figure 1 shows the percentage of different type vessels in inland routes of Bangladesh:

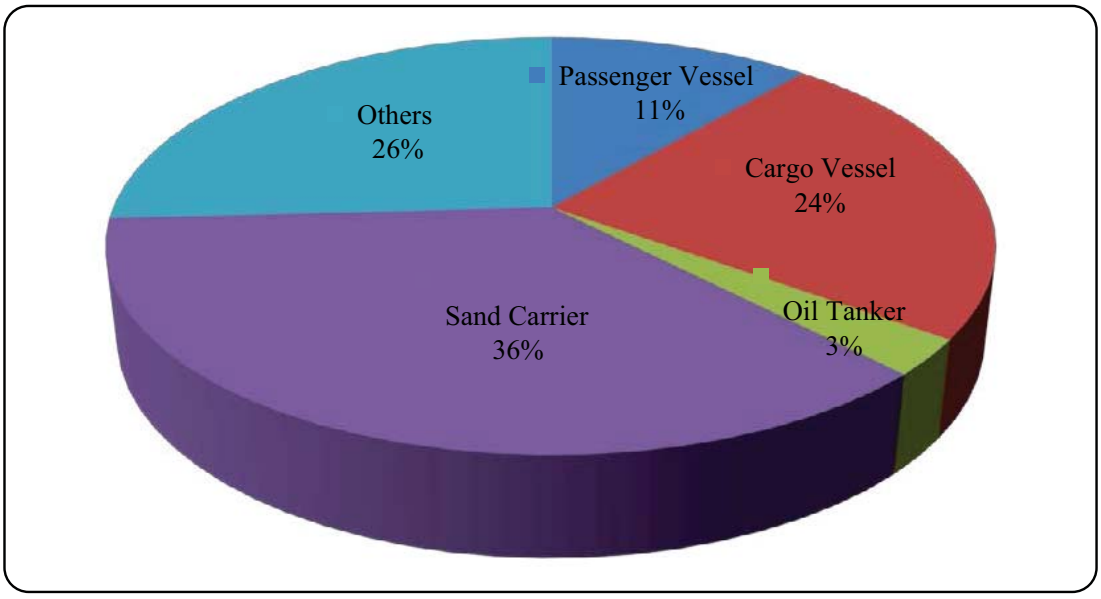

Fig 1: Percentage of Different Types of Inland Vessels

Inland ports and other facilities of Bangladesh include 11 major inland ports, 23 coastal island ports, 133 launch stations and more than 1,000 minor landing points located in rural areas. BIWTA and BIWTC regulate the movement of over 1000 passenger vessels and maintain 22 inland ports along with about 800 terminals. Location of inland ports and other installations are shown in Figure 2.

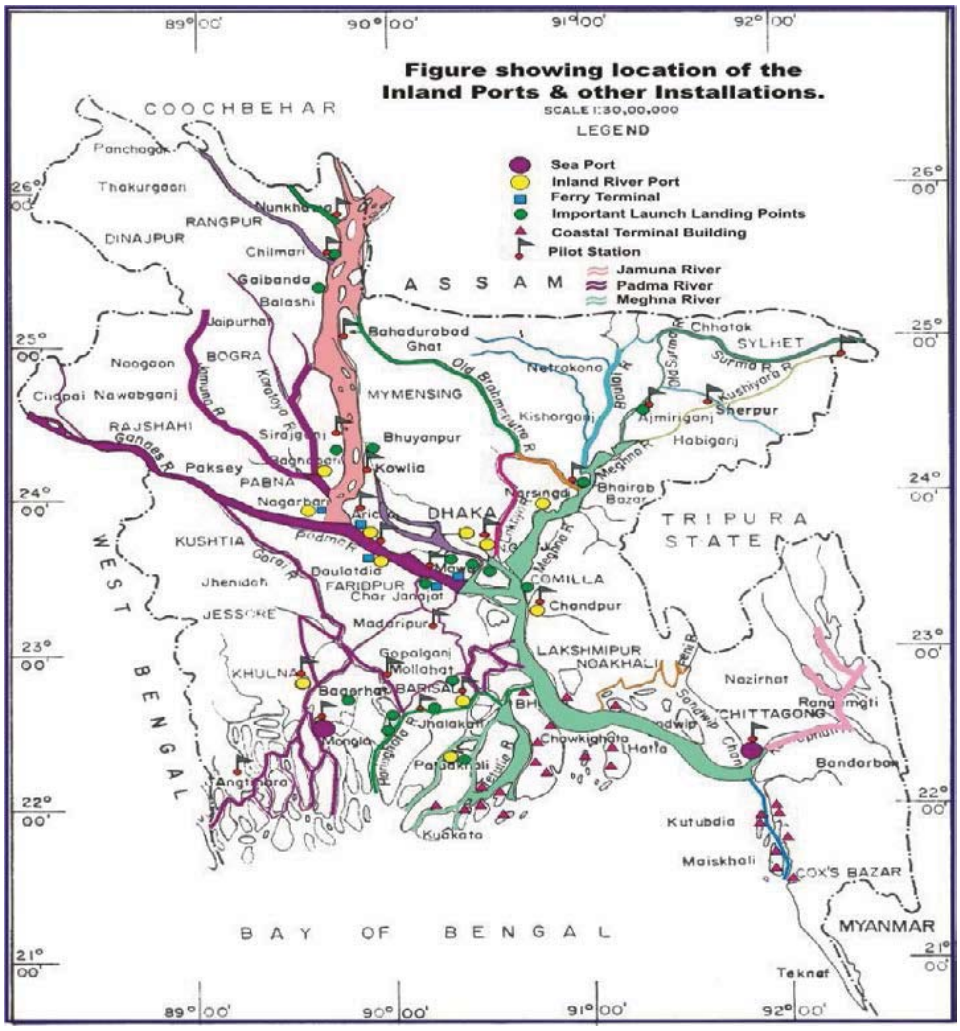

Fig 2: Location of the Inland Ports and Other Installations

Although cargo vessels constitutes around 24% of the total fleet size of inland shipping, but its economic impact is very important and significant. The majority of the cargo services are operated privately. Cargo ships are basically larger vehicles which are made of steel hull and often designed with sub-divisional bulkheads to provide water tightness to the cargo holds. In addition, cargo ships contain cargo hatch openings on the upper deck through which the commodities are being loaded and unloaded. Also some cargo ships contain self-sufficient pumping facilities to load or unload liquid cargoes on or off the cargo holds. Cargo Service Unit is mainly responsible for carrying of various kinds of commodities like food, food grains, Jute & jute goods, cement and clinker from Chittagong and Mongla Port to different inland river ports of the country. In addition, cargo vessels also send to Kolkata (India) port under the Inter country transit and trade protocol agreement between the two countries. The total capacity offered by the cargo fleet is estimated 35.2 million tons [5]

The fleet of cargo vessels has significantly changed since 1998-99. Dumb barges of 300 tons on average have been replaced by self-propelled vessels of higher capacity of 500 to 700 tons. The total static capacity has increased by about one third from about 750,000 tons to about 1,000,000 tons. The fleet consists of 2,200 units (2,030 cargo vessels and 170 bay crossing coasters).Cargo vessels make an average 3/4 trips per month. The breakdown of total cargo vessels is shown below in Table 1.

Table 1: Cargo Vessels of Bangladesh

Catagory	Type	Length Range	Total No
Cat - 1	Small	Upto 30 m	348
Cat - 2	Medium	30 to 50 m	1554
Cat - 3	Large	Above 60 m	311
Total			2213

4.0 ESTIMATION OF POLLUTANT

The cargo ships of inland routes are polluting the marine environment by discharging bilges, solid waste and emission of exhaust gases and pollutants by burning fuel. As the quantification of bilge, solid waste & fuel consumption is necessary to assess the impact of these pollutants, accurate approximation is very crucial. First hand data collected by the researchers had to be verified using various scientific means. For example, quantity of bilge collected from field data is further verified considering running hour of bilge pump from the operators of the ships. Using capacity plan drawing along with sectional shape of the aft portion of ship, quantity of bilge is further verified through measurement of height of bilge water for round trip operation by the ship. Fuel consumption of engine is verified by taking average running hour of the engine as well as log book of the engine where available. First hand data of fuel consumption is also verified using the fuel consumption of engine from manufacturer catalogue. The detail particulars of inland cargo vessels for the calculation are shown below in Table 2:

Table 2: Details of Inland Cargo Vessels of Bangladesh

Cat (Length)	Total No	Engine Power (HP)	No of Engine	Fuel Cons (Ltr/hr)	Avg Running hr/month	Bilge/month/Ship (Ltr)
Cat – 1 (Up to 30m)	348	300-350	01	60	150	375
Cat – 2 (30-50m)	1554	300-350	02	60	120	600
Cat – 3 (Above 50m)	311	450-720	02	75	120	675

In Table 3 the summary of calculation of running hour, fuel consumption and distance covered by cargo vessels Per Year is shown. Similarly, Figures 3 to 6 shows the approximate running hour, distance covered, fuel consumption and quantity of bilges thrown by cargo vessels of Bangladesh. While quantification of pollutants, it has been assumed that the cargo vessels are operating yearly eleven month and remain one month non-operational for maintenance.

Table 3: Summary of Running Hour, Fuel Consumption and Distance Covered by Cargo Vessels per Year

Type	Total No	Total Running Hour (Hr)	Total Fuel Consumption (Ton)	Total Distance Covered (Km)
Category -1 (Up to 30m)	348	574200	34452	6287490
Category – 2 (30m to 50m)	1554	2051280	246153.6	29948688
Category – 3 (Above 50 m)	311	410520	61578	7491990
Total	2213	3036000	342183.6	43728168

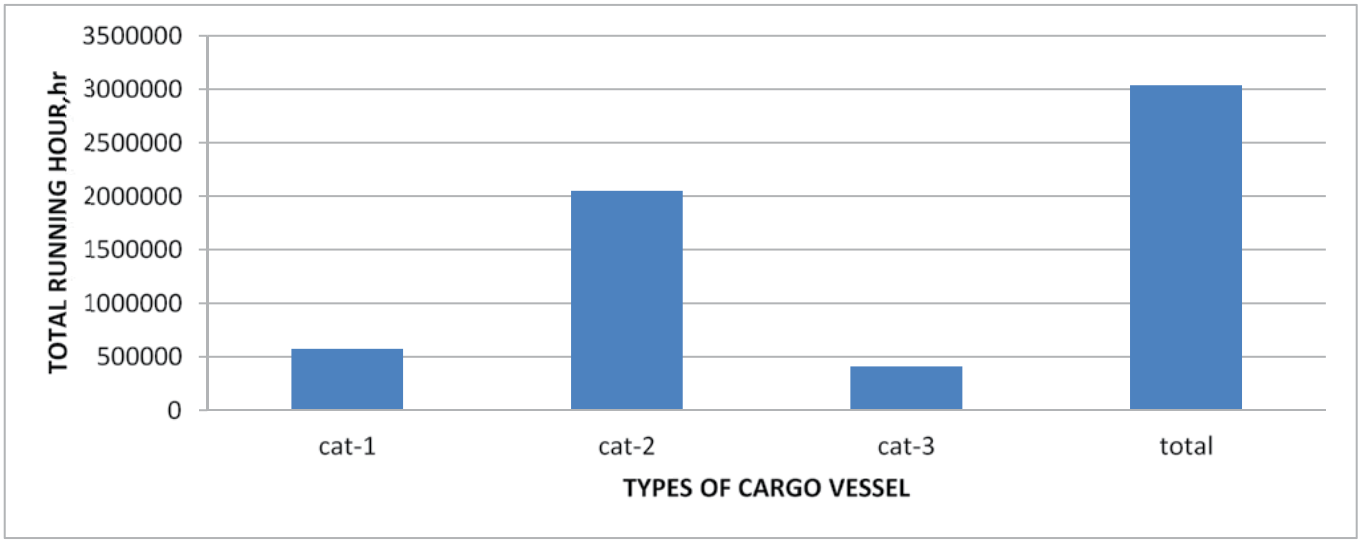

Fig 3: Summary of Calculation of Running Hour (Cargo Vessels)

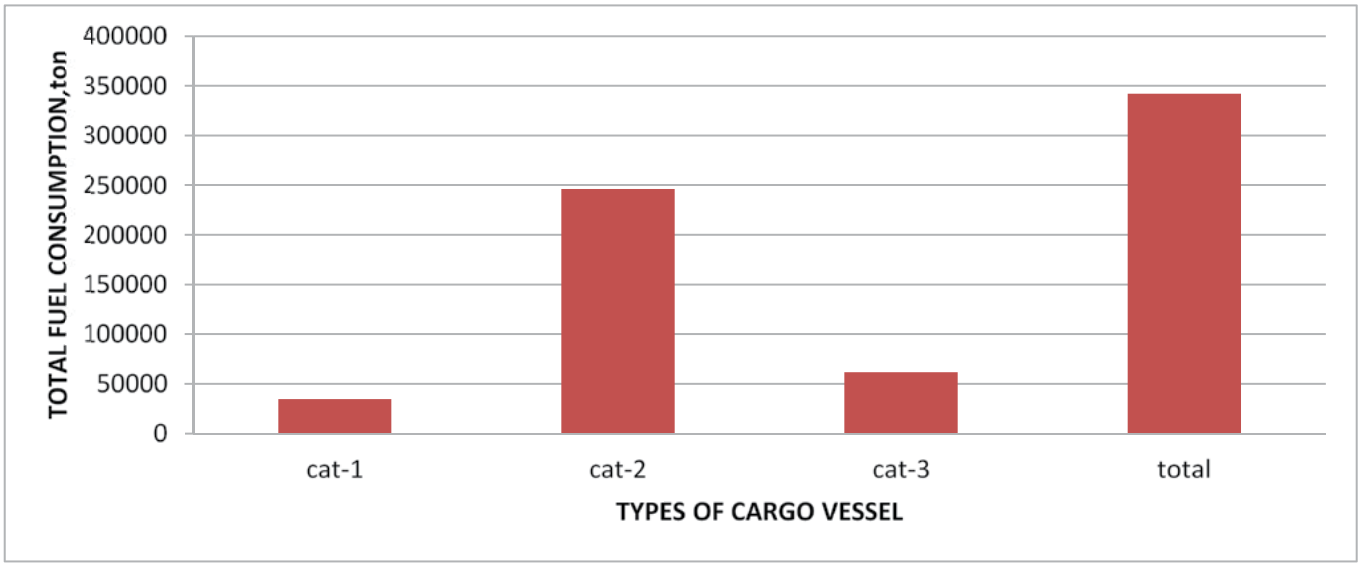

Fig 4: Summary of Total Fuel Consumption by Inland Cargo Vessels of Bangladesh

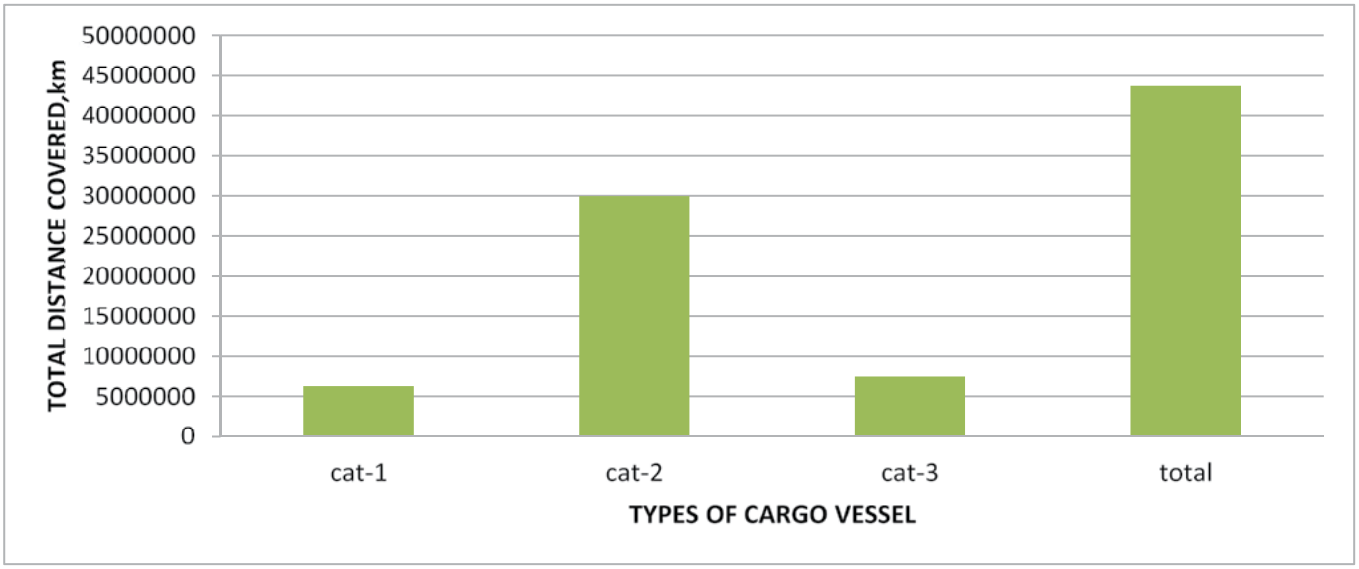

Fig 5: Summary of Calculation of Distance Covered (Cargo Vessels)

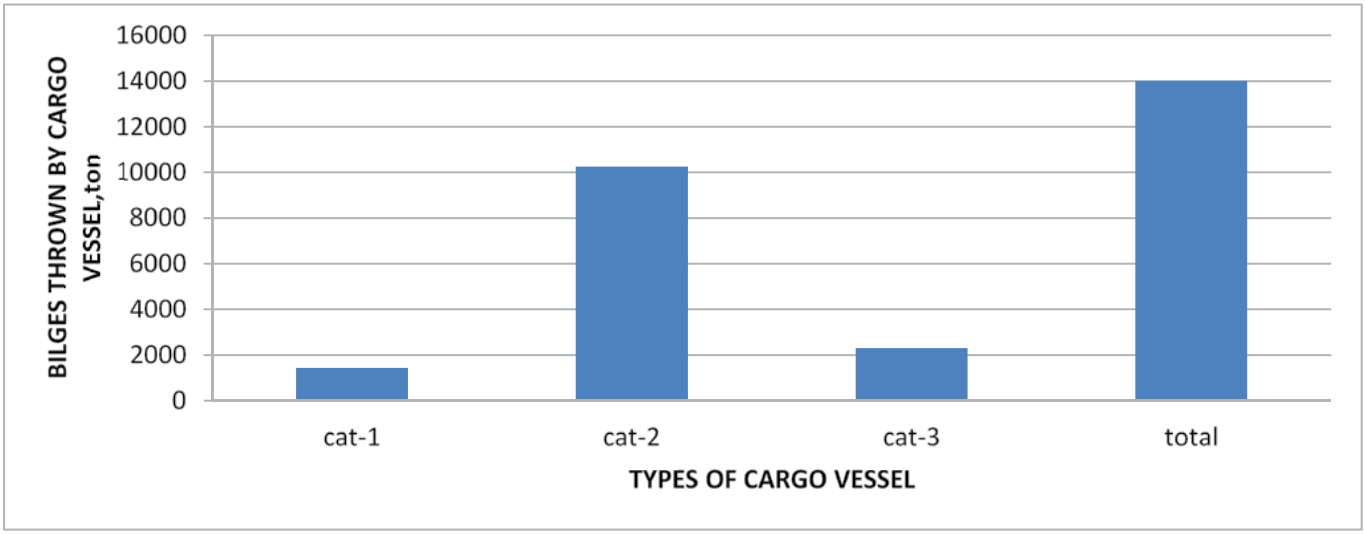

Fig 6: Summary of Total Bilges Thrown by Inland Cargo Vessels of Bangladesh

5.0 IMPACT ANALYSIS OF POLLUTANT

The estimated quantity of pollutants has been used as input to find out the impact on environment using Sima pro software, Eco indicator 99 (I) v2.04. Sima Pro is the most widely used Life Cycle Analysis software which offers standardization as well as the ultimate flexibility and it has also unique features such as parameterized modelling and interactive results analysis. Eco-indicator 99 uses the damage-oriented approach. The development of the Eco-indicator 99 methodology started with the design of the weighting procedure. However, the impacts of such pollutants from inland cargo vessels operation have been found by damage oriented method of Sima Pro through Exposure and effect analysis followed by Fate analysis [6 & 7].The environmental impact model of cargo vessel is shown Figure 7. The impacts of pollutants for different sizes of cargo vessels through characterization, weighting and single score were found using the above mentioned software and shown in Figures 8 to 11

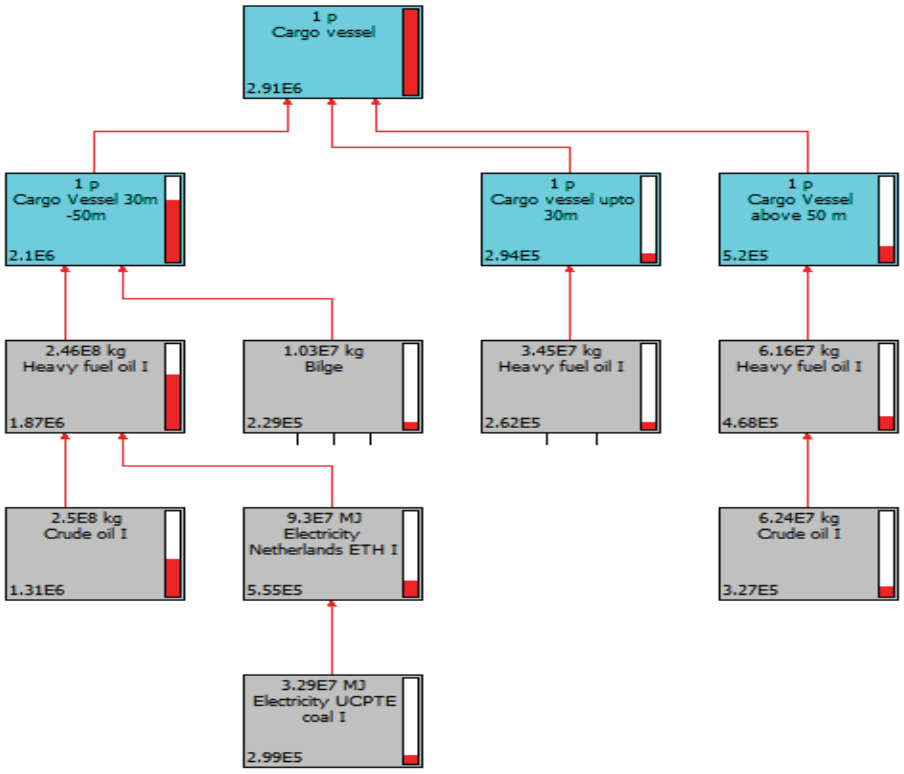

Figure 7: Impact Model of Inland Cargo Vessels

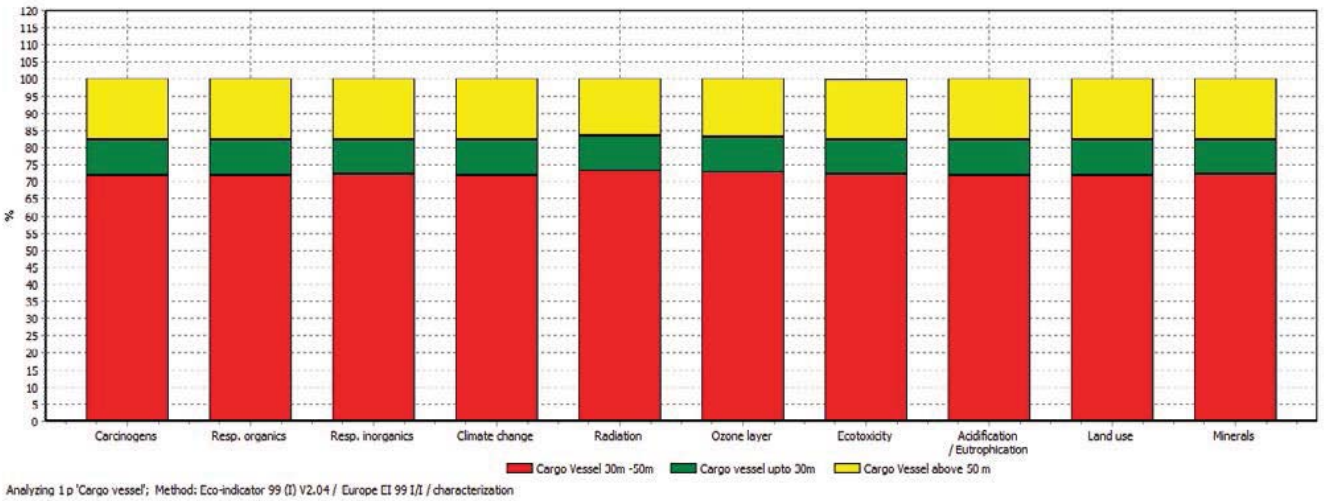

Fig 8: Impacts of Pollutants Discharged by Cargo Vessels/Yr 'Eco-Indicator 99 (I) (Characterization)

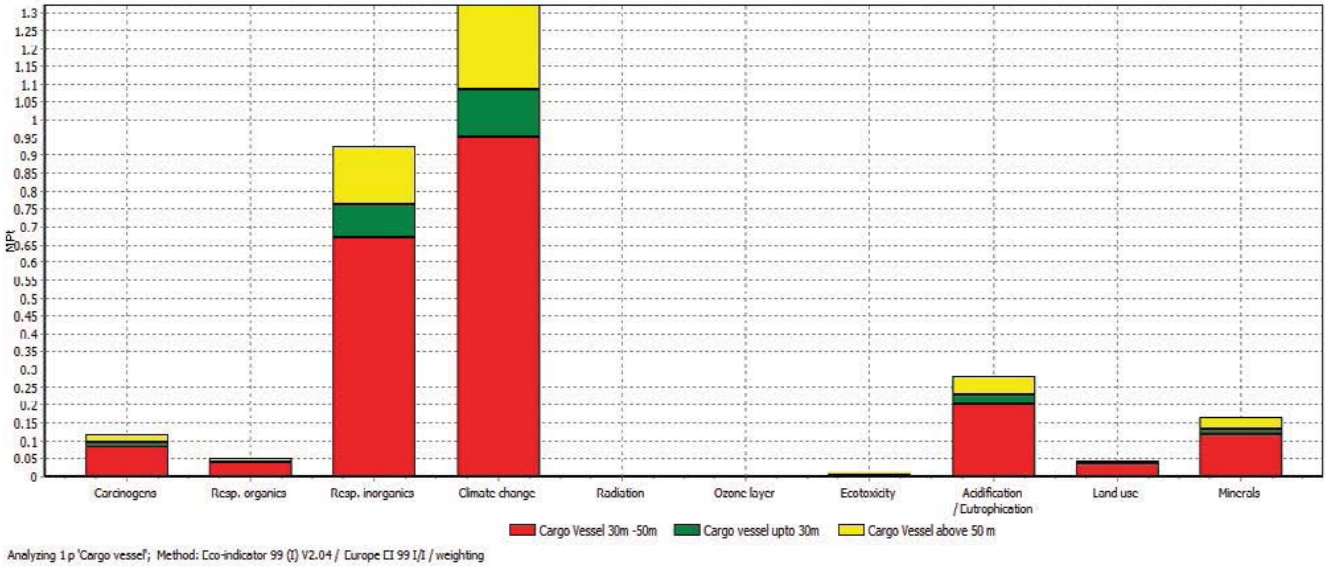

Fig 9: Impacts of Pollutants Discharged by Cargo Vessels/Yr 'Eco- Indicator 99 (I) (Weighting)

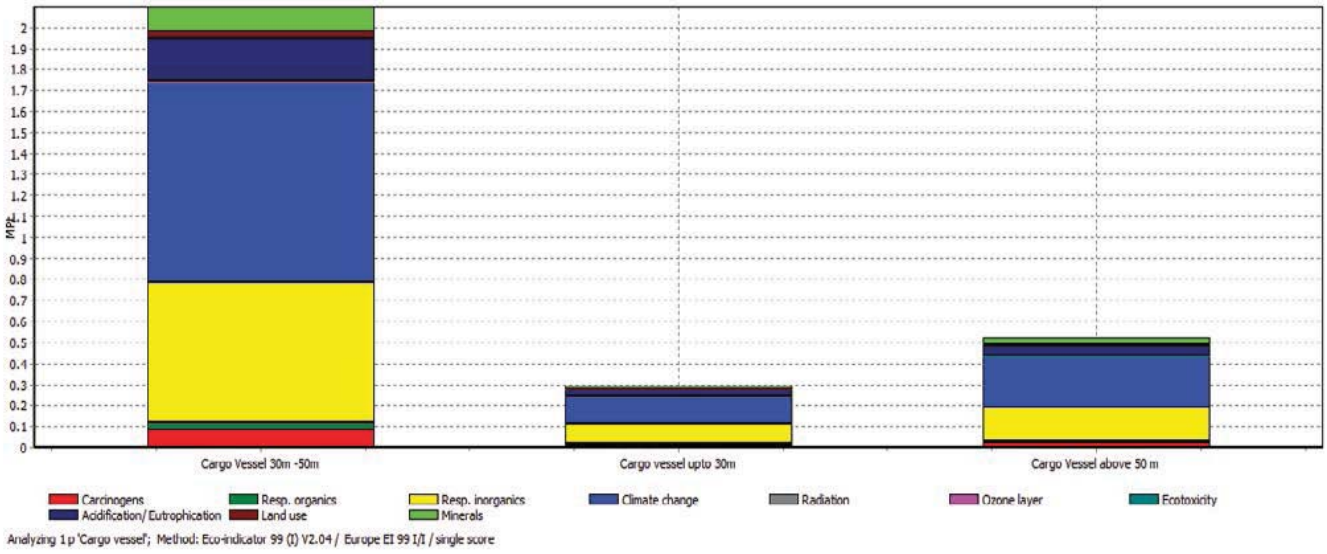

Fig 10: Impacts of Pollutants Discharged by Cargo Vessel 'Eco-Indicator 99 (I) (Single Score)

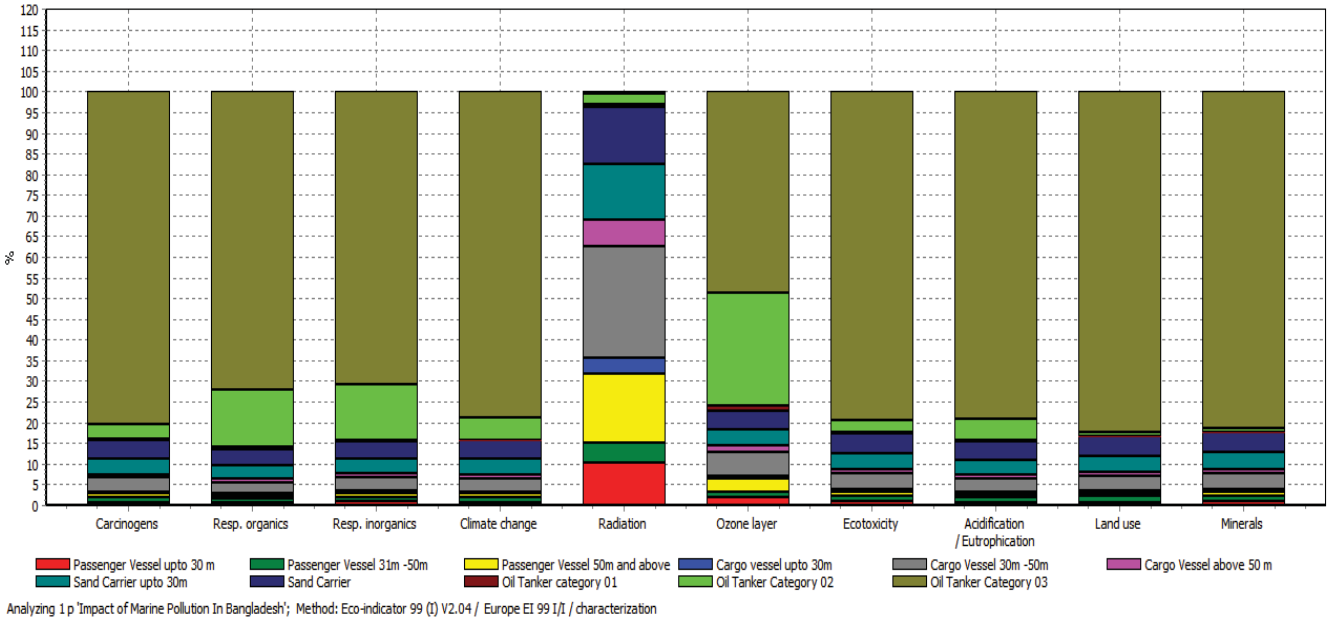

Fig 11: Overall Impacts of Pollutants 'Eco-Indicator 99 (I) (Characterization)

6.0 PREVENTIVE MEASURES

There are various methods of pollution prevention but relatively the best technique includes:

a. Technical Framework. The technical framework recommends the combination of two technical solutions for ship waste treatment; stationary waste reception facilities (such as green terminals in ports) and self-propelled waste collection vessels. As our concern is only the inland cargo vessel operation, the ships must have Sewage Treatment Plant and Bilge Water Separator on board to prevent the environmental pollution. Though the inclusion of these system may additional expenditure but will provide environmental friendly ships with negligible marine pollution. In this respect, the frameworks for our passenger vessel should be provided with following structures as shown in Table 4:

Table 4: Proposed Technical Framework for Pollution Prevention

Type	Category	Pollutants	Measures
Cargo Vessel	All categories E-mail address: kaosar518@ gmail.com	a. Bilge b. Solid waste	a. Storage Tank b. Bilge –Water separator and c. STP on board
		a. Air Pollution	a. New ropulsion Engine and machinery instead of age old machinery

b. Legal Framework. Environmental laws can make it tougher for people to pollute the marine environment. In accordance with 1976 ordinance, the discharge of bilges, oily mixture and sewage into inland water is prohibited. The owners and the Ship builders should be respectful about the rules and provide the necessary facilities on board ship to prevent the marine pollution.

c. General Awareness, Coordination & Monitoring. Greater public awareness can make a positive impact to reduce the ship borne marine pollution. The coordination among the ship designer, builder, owner and the related government bodies can reduce the marine pollutions significantly. Government monitoring mechanism should ensure proper utilization of rules and regulations in case of ship building, survey and operation.

7.0 CONCLUSIONS

7.1 Bangladesh depends heavily on inland water transportation for transportation of goods, cargos, fuel-oil and passengers. Over ten thousands various types of vessels (like passenger ship, cargo ship, oil tanker and sand carrier) are plying in inland routes with a significant increasing rate in every year. However, the quantity of various pollutants like bilges, solid waste, sewage and harmful gases discharged by the inland cargo fleet (consists of 2213 registered ships of various sizes) were calculated for one year considering the vessels operational time as eleven month in this research work. The quantity

of pollutants discharged by Cargo vessels were also compared with other vessels (Sand carriers, Passenger vessels and Oil tankers) and found much higher followed by Sand carriers, Passenger vessels and Oil tankers. The accumulated quantities of pollutant by the inland vessels are shown below in Table 5.

Table 5: Discharged Quantity of pollutants/Year

Type	Cat	Bilges Discharged (Ton)	Sewage Discharged (MT)	Oily water (Ton)	Ballast water (Ton)	Fuel Burnt (Ton)
Cargo Vessel	Cat -1	1435.50	-	-	-	34452
	Cat -2	10256.40	-	-	-	246453.6
	Cat -3	2309.175	-	-	-	61578
	Total	**14001.075**	**-**	**-**	**-**	**3424836**
Passenger Vessel	Cat -1	3856.050	42.845	-	-	51414
	Cat -2	1815.00	229.9	-	-	101640
	Cat -3	647.90	111.98	-	-	49104
	Total	**6318.95**	**384.73**	**-**	**-**	**202158**
Oil Tanker	Cat -1	212.85	-	39150	-	5108.40
	Cat -2	935	-	1054680	-	25357.20
	Cat -3	255.75	-	-	306900	6138
	Total	**1403.60**	**-**	**1093830**	**306900**	**36603.60**
Sand Carrier	Cat -1	5179.02	-	-	-	286209
	Cat -2	5182.10	-	-	-	158794.35
	Total	**10361.12**	**-**	**-**	**-**	**632669**

Considering the calculated quantity of pollutants, the environmental impact models of cargo vessels have been made and the impacts of pollutants through characterization, weighting and single score were determined. It has been revealed that there are considerable impacts of marine pollution for prolonged inland cargo vessel operation. The major consequences includes the climate change, destruction of fishing zone, respiratory problems of human being and the rise of sea level.

7.2 Few Preventive measures to reduce the environmental pollution from the practical point of view are also suggested here which includes the technical frame works, legal frame works, general awareness, coordination & monitoring. Though it is quite difficult to nullify the marine pollution in our country but our efforts will obviously reduce the significant marine pollution in near future.

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