



ENVIRONMENTAL POLLUTION IN BANGLADESH BY INLAND PASSENGER VESSEL OPERATION

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ABSTRACT

Bangladesh is well known for its riverine network where the Inland Water Transportation is still considered as the major transportation sector. Around 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 one quarter of all passenger traffic per year. Since long, traditionally river network has been regarded as safe and cost-effective route especially in the southern part of the country. Every year over 95 million passengers are carried through this route. Notwithstanding, a recent study by Asian Development Bank makes an indicative estimate of 332 million passengers in 2020-21. However, the fleet consists of 1061 Passenger vessels of different size and draft. This huge no of passenger vessels plying in inland routes made us vulnerable to significant marine pollution. The inland water ways are getting polluted by direct throwing of bilges, solid waste and oily water. Air pollution due to burning of engine oil-lub oil for running engines/ machineries is also contributing to marine pollution. In this paper, estimation of pollutants such as bilges, oily water and solid waste by inland passenger vessel operation has been made approximately. Amount of fuel burnt by inland passenger vessel operation has also been assessed. 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 on environment by inland passenger vessel operation and the major consequences such as climate change, destruction of fishing zone, respiratory problems of human being and rise of sea level. Few preventive measures have been suggested in this thesis work in the light of design modification, regulatory enforcement to reduce the marine pollutions.

Keywords: Marine Pollution, Passenger Vessel, Bilge, Bilge Water, Solid Waste.

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

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of 10 km from navigable waterway. Due to cheapest, safest and reachable means, the Inland Water Transportation (IWT) sector has become the one of 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 no of vessels plying in inland routes 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 changes 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 passenger 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 passenger 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 passenger 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, journal, research publication, 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:

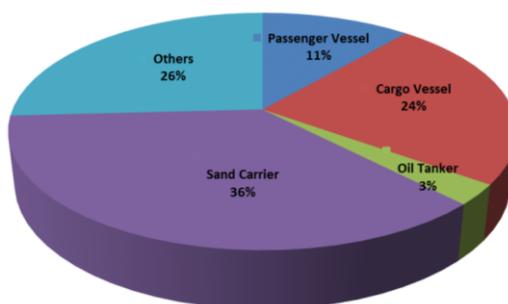


Figure 1: Percentage of Different Types of Inland Vessels

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.

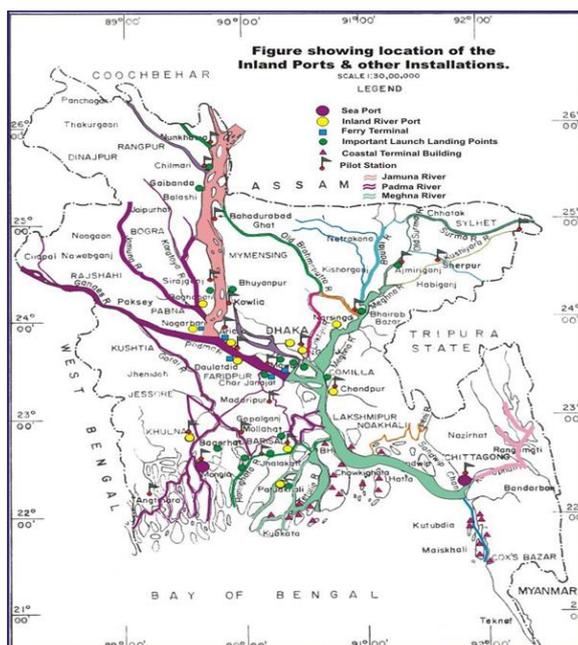


Figure 2: Location of the Inland Ports and Other Installations

Although passenger vessels constitutes around 11% of the total fleet size of inland shipping, but its economic impact is very important and significant. Every year over 95 million passengers are carried through this route [1]. The majority of the passenger services are operated privately. Instead of conspicuous cargo compartments, passenger launches contain smaller private cabins to provide some luxury and privacy to the wealthy passengers. Nevertheless, in most of the passenger launches there remain large open spaces on the decks where the economy class passengers reside disorganized during a journey.

A recent study by Asian Development Bank makes an indicative estimate of 332 million passengers in 2020-21. However, the present fleet consists of 1061 Passenger vessels of different size and draft. As per survey analysis, the larger and medium passenger vessels accomplish one one-way trip per day whereas the smaller category vessels conduct two trips of shorter duration (3-4 hrs/trip). The breakdown of total inland passenger vessels is shown below in Table 1:

Table 1: Passenger Vessels of Bangladesh

Catagory	Type	Length Range	Average Passenger capacity	Total No
Cat - 1	Small	Up to 30 m	146	779
Cat - 2	Medium	30 to 50 m	475	220
Cat - 3	Large	Above 50 m	821	62
Total				1061

4.0 ESTIMATION OF POLLUTANT

The passenger 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. In order to solid waste calculation, it is assumed that 40% passenger uses the toilet during travelling. The assumption was made on field survey and with the interview of vessel's master. 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 passenger vessels for the calculation are shown below in Table 2:

Table 2: Details of Inland Passenger Vessels of Bangladesh

Cat (Length)	Total No	Engine Power (HP)	No of Engine	Fuel Cons (Ltr/hr)	Avg Running hr/month	Passenger Capacity	Bilge/month /ship (Ltr)
Cat – 1 (Up to 30m)	779	125-200	01	25	240	145	450
Cat – 2 (30-50m)	220	450-720	02	70	300	475	750
Cat – 3 (Above50m)	62	1200-1500	02	120	300	821	950

In Table 3 the summary of calculation of running hour, fuel consumption and distance covered by passenger vessels Per Year is shown. Similarly, Figures 3 to 5 shows the approximate fuel consumption, quantity of bilge and solid waste thrown by passenger vessels of Bangladesh. While quantification of pollutants, it has been assumed that the passenger 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 Passenger Vessels per Year

Type	Total No	Total Running Hour (Hr)	Total Fuel Consumption (Ton)	Total Distance Covered (Km)
Category -1 (Up to 30m)	779	2056560	51414 Ton	22519332
Category – 2 (30m to 50m)	220	726000	101640	10599600
Category – 3 (Above 50 m)	62	204600	49104	3733950
Total	1061	2987160	202158	36852882

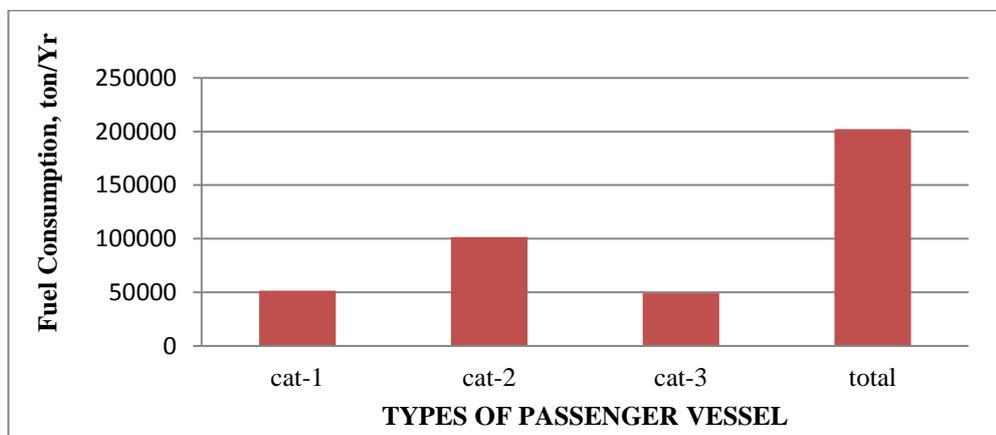


Figure 3: Summary of Total Fuel Consumption by Inland Passenger Vessels of

Bangladesh

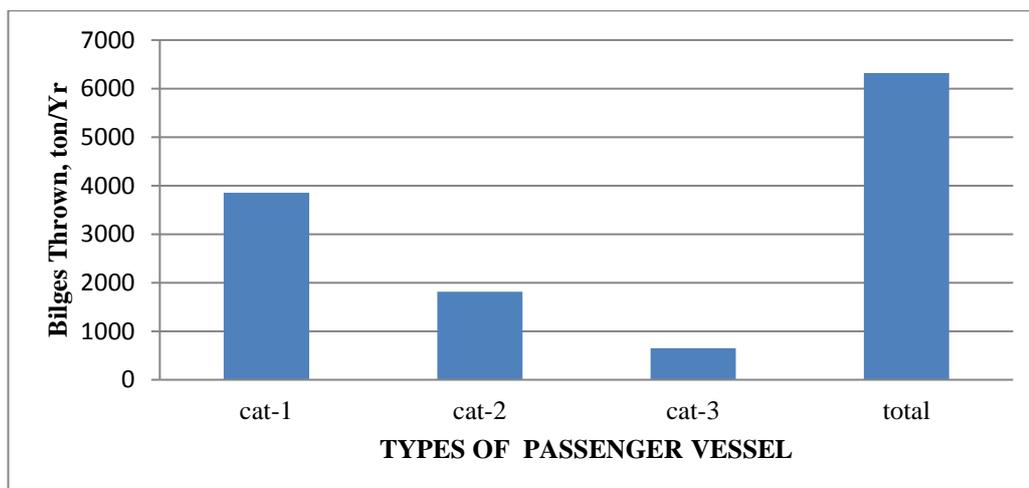


Figure 4: Summary of Total Bilges Thrown by Inland Passenger Vessels of Bangladesh

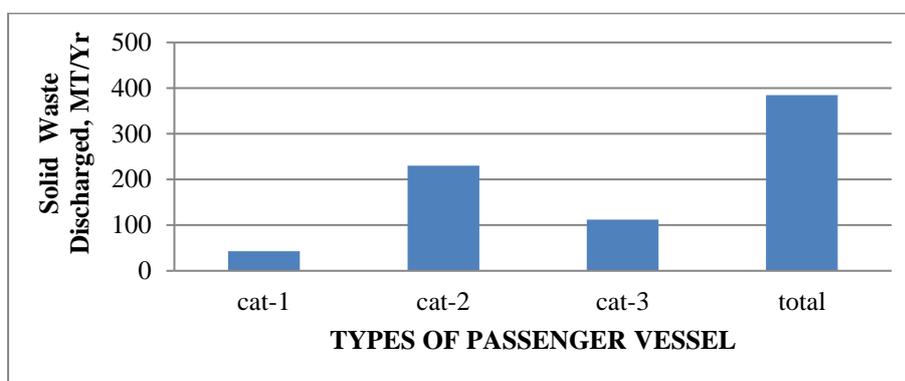


Figure 5: Summary of Solid Waste Discharged by Inland Passenger Vessels of Bangladesh

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 passenger vessel 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 passenger vessel is shown Figure 6. The impacts of pollutants for different sizes of passenger vessels through characterization, weighting and single score were found using the above mentioned software and shown in Figures 7 to 9.

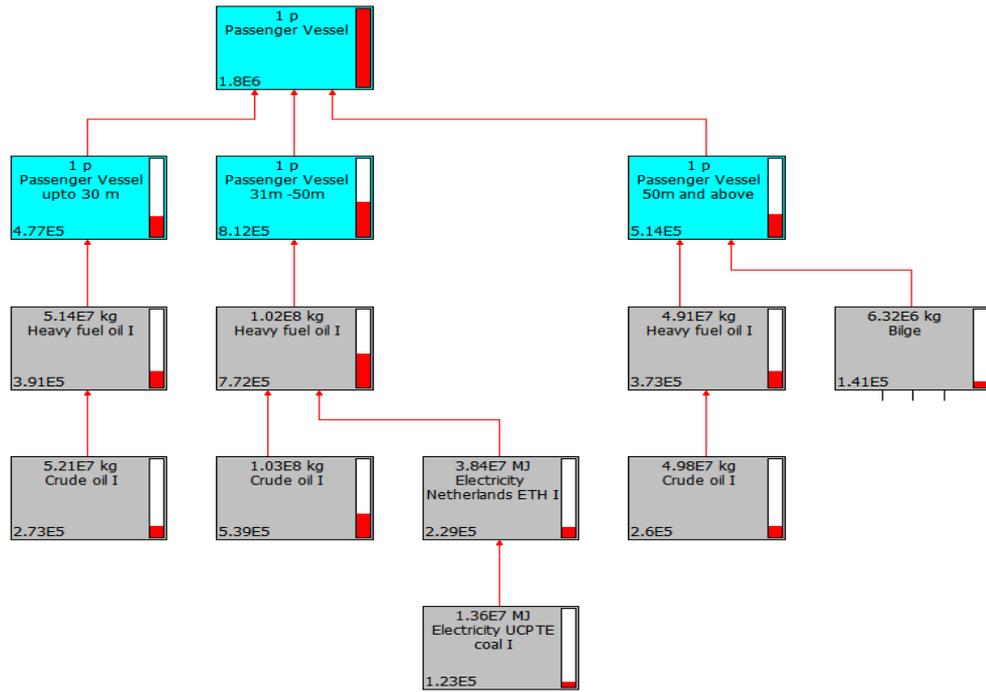


Figure 6: Impact Model of Inland Passenger Vessels

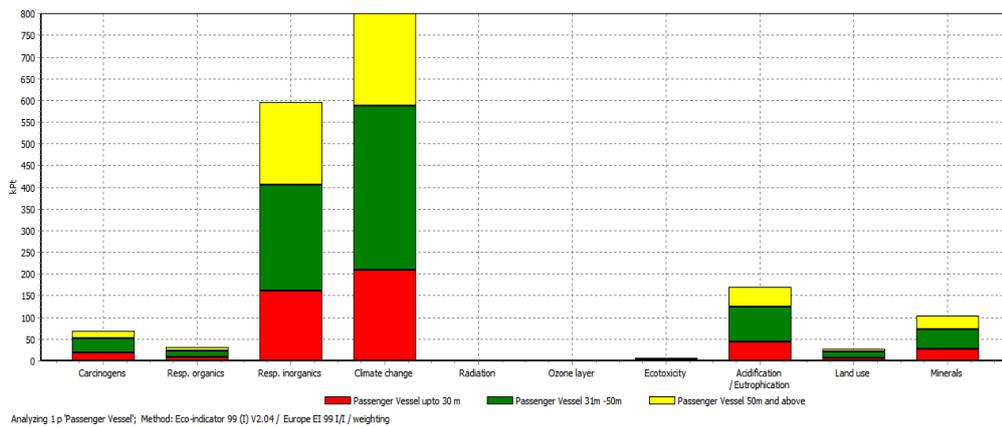
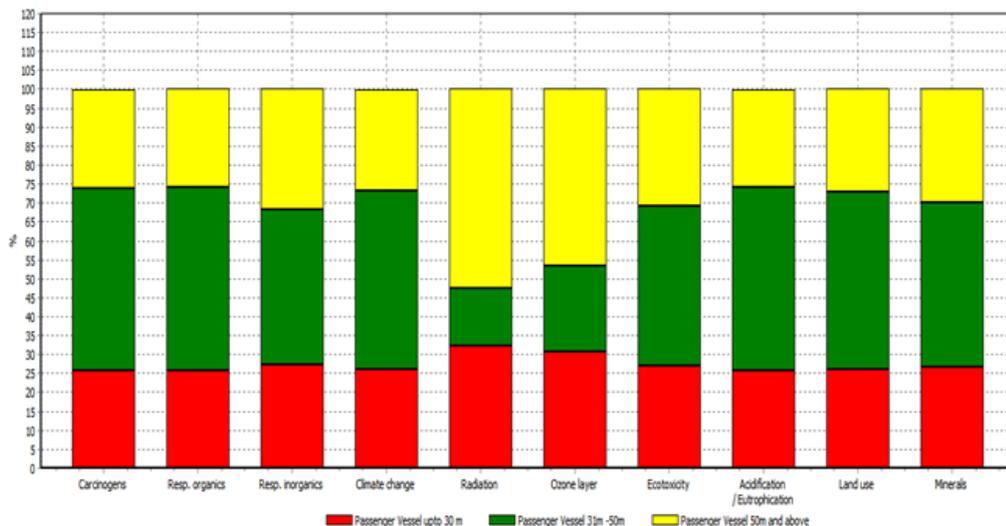
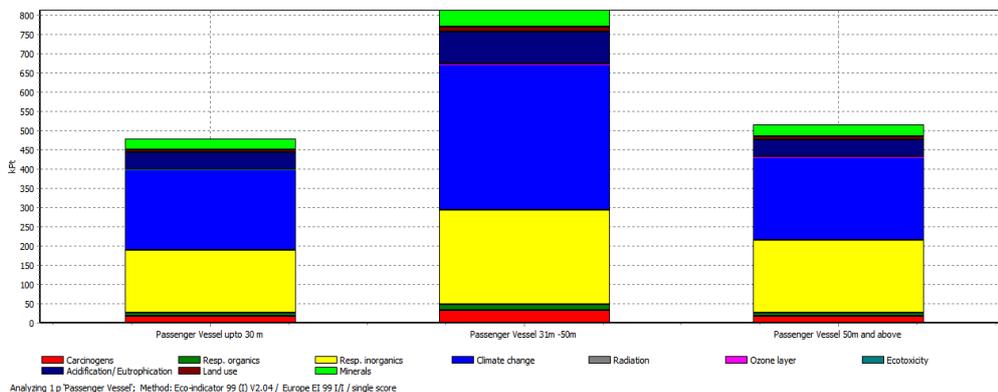


Figure 7: Impacts of Pollutants Discharged by Passenger Vessels/Yr 'Eco-Indicator 99 (I) (Characterization)



Analyzing 1 p Passenger Vessel; Method: Eco-indicator 99 (I) V2.04 / Europe EI 99 (I) / characterization

Figure 8: Impacts of Pollutants Discharged by Passenger Vessels/Yr ‘Eco-Indicator 99 (I) (Weighting)



Analyzing 1 p Passenger Vessel; Method: Eco-indicator 99 (I) V2.04 / Europe EI 99 (I) / single score

Figure 9: Impacts of Pollutants Discharged by Passenger Vessel ‘Eco-Indicator 99 (I) (Single Score)

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 water transportation, stationary waste reception facilities will be the best probable solution. 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	Port Arrangement
Passenger Vessel	Cat – 1 (Up to 30m)	a. Bilge	a. Storage Tank	a. Storage Tank
	Cat– 2 (30m to 50m)	b. Solid waste	b. Pump	b. Pump

	Cat – 3 (Above 50m)		a. Sewage Tank b. Bilge Tank c. Pump	
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b. Legal Frame works

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. Government monitoring mechanism should ensure proper utilization of rules and regulations in case of ship building, operation and during survey.

7.0 CONCLUSIONS

Bangladesh is a country with huge number of rivers and it depends heavily on inland water transportation for transportation of goods, cargos, fuel-oil and passengers. There are around ten thousand various types of vessels plying in inland routes, among which the passenger ship, cargo ship, oil tanker and sand carrier are the major contributor of marine pollution. One quarter of all passenger traffic (over 95 million passengers) per year is carried by passenger vessels (1061 Passenger vessels at present). A recent study by Asian Development Bank makes an indicative estimate of 332 million passengers in 2020-21. This huge no of passenger vessels made us vulnerable to significant marine pollution due to direct throwing of bilges, solid waste and oily water. Air pollution due to burning of engine oil - lub oil for running engines/ machineries is also contributing to marine pollution.

The quantity of various pollutants like bilges, solid waste and harmful gases were calculated for one year considering the vessels operational time as eleven month. Basing on the quantity of pollutants, the environmental impact models of passenger vessels were made and the impacts of pollutants through Sima Pro (characterization, weighting and single score) were found. . SIn case of discharging the bilges & running hour of machineries the small vessels (Cat 1) and in solid waste discharging the medium vessels (Cat 2) are contributing the maximum.

The results of impacts of pollutants by passenger vessels, cargo vessels, oil tankers and sand carriers were compared and found that the impact of pollutants discharged by oil tanker is much higher than the other vessels, followed by sand carriers, cargo vessels and at last the passenger vessels. Preventive measures in this regard includes Technical Frame works, Legal Frame works, General Awareness and Coordination & Monitoring, which can reduce the marine pollution by inland passenger vessels of Bangladesh significantly.

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