Assessment Of The Environmental Risks Associated With The Non-Implementation Of The Convention Of Ballast Water Management And Sediments (BWMS) In The Douala Port Authority

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Abstract
Many researchers today are concerned about the spread or proliferation of invasive non-native species in waters and estuaries around the world. Ballast water and hull fouling (crushing) associated with maritime activities are responsible for the vast majority of accidental marine transfers of non-indigenous species worldwide (Carlton & al., 1995).the objective of this study is to assess the environmental risks associated with the intentional or unintentional discharge of ballast water as part of the activities of ships in the Autonomous Port of Douala with a view to good environmental management in accordance with the "Ballast Water Management and Sediment" convention adopted in London in 2004. The environmental risk assessment was based on the laws and regulations of the Government of the Republic of Cameroon, on international laws and on the international conventions of MARPOL and BWMS of the IMO, as well as on the sample of ships operating in Cameroonian waters. The data used for the analysis was based on visits to ships operating in the operating territory of the Autonomous Port of Douala compared with data from the Indonesian port of Inaport I. The analysis was based on the number of ships discharging ballast water in the port and IMO regulation MEPC 56/23 ANNEX 2. The quantity of ballast water discharged was measured using a statistical method to determine the probability of occurrence of the risk. Using a risk matrix, the environmental risks associated with implementing ballast water management would be ranked. The results obtained indicated that ships without cargo on an international voyage, and therefore in ballast, can carry between 25% and 35% of their deadweight in the form of ballast water to ensure trim and stability. In 2016, the number of ships using the international route in Indonesia was 30,843, while international maritime traffic at the de Douala Port Authority was estimated at 1137 in 2016, and it was assumed that deballasting by ships accounted for 60% of the number of ships, discharging around 25 tons of ballast water each time, so that the total amount of water discharged in the Indonesian port was 450,000 tons. In another approach based on ship tonnage to assess the quantities of ballast water discharged in the port of Douala, empirically we note that Douala in 2016 had landed 11042894 tons for an estimated quantity of ballast water of 2,760,723 tons.

Keywords: ships, ballast water, environmental risk, non-indigenous species, de Douala Port Authority.

INTRODUCTION

Worldwide, 2/3 of trade and economic activities are carried by sea. This indicates that maritime transport plays an essential role. According to Basuki et al (2014), while the pulse of world trade is still beating, the sea will live on to transport goods and services between islands, countries and even continents. Maritime industries have played a key role in the transportation of goods, the global economy and the industrialization of the world (Basuki, Manfaat, Nugroho, & Dinariyana, 2014). However, transport is one of the causes of environmental problems. One example is the transfer of non-native species from one place to another (Simon & al., 2008).

When a ship travels from one area to another, its cargo must be full. As a result, the shipowner benefits and the vessel must be maintained at optimum performance. Optimum performance is achieved when the ship is sailing with maximum cargo, so that the propeller can work optimally to produce thrust. Vessels must be ballasted with a water counterweight when the cargo is not fully loaded. The ship's voyage to the port of destination must be maintained in safe operational conditions, but this can only be done with the ballast water technology system, which is seawater (instead of fresh water). The ballast water pumped into the ship's hull is seawater. The activities of loading and unloading seawater into and out of a ship seem to be activities that cause no problems and do no harm.

Ballasting ships is essential for safe and efficient operation. Many people are unaware that ballasting can lead to changes in the marine ecosystem, raise economic issues and have serious health implications for marine and human life. This is due to the arrival of abundant predatory marine species brought in by ballast water. One of the most important of ballast water management is the risk assessment process, which is conducted to which is conducted to identify and determine the level of risk (David & Gollasch, 2018). Basuki et al. (2016) explained that an environmental risk assessment related to ship repair ship repair used a risk matrix to determine the risk rating.
As a country in the Gulf of Guinea country with several navigable ports in the SOUTH, Littoral and SOUTH WEST of Cameroon and those of surrounding countries, the Atlantic Ocean is subject to a translocation of non-indigenous species that threaten marine environment. One of these threats is the ballasting of ships, in particular the discharge of ballast water in the port of destination. The operational activities of ships with ballast water, intentionally or unintentionally, transfer harmful aquatic organisms and pathogens through ballast water and associated sediments. The ballasting process brings with it predatory species that invade the local environment, leading to the degradation and extinction of local of local species and a deterioration in public health in the localities (Achsah, Mona, Dayne, & Dale, 2014).
Ballasting activities are regulated by an international convention of the IMO (International Maritime Organization), based on the London Protocol and the London Convention. The regulations on the prevention of marine pollution from the disposal of waste and other materials have been in force since 1975. The aim of the London Convention was to introduce effective pollution control orders, covering all types of sources of marine pollution, and to take practical measures to prevent marine pollution from the disposal of wastes and other materials. After five years, the rate of implementation of regulations by the existing shipping industry has reached 5% in Cameroon (Anonymous, 2023). Ballast water is highly detrimental to marine ecosystems at port destinations. It is therefore necessary to produce in order to meet ratified international standards. Ballast water hazards, particularly invasive micro-organisms, are highly detrimental to creatures/micro-organisms. Zaman et al (2019) had to calculate the amount of ballast water discharged by ships and invasive species from the country of origin in the port of Tanjung Perak, Surabaya (Zaman, Pitana, Fadlilah, & Semin, 2019).
IMO ballast water regulations need to be implemented to control the spread of harmful invasive species (Fileman & al., 2016). External ballast water treatment must be carried out to increase the number of ships visiting the Autonomous Port of Douala. The risk assessment for invasive species due to water exchange was interpreted based on two probabilities. Firstly, it is based on the probability of the species being able to enter the port of departure. Secondly, it is based on the probability that the species will be able to survive when placed in the port of destination (new environment) and depends on the similarity of the new environment (Bouda, Bachari, E.I., Bahmed, L., & Boubena, 2016).
Our study was based on an assessment of the environmental risks associated with the intentional or unintentional discharge of ballast water as part of the activities of ships in the Autonomous Port of Douala with a view to sound environmental management in accordance with the Ballast Water Management and Sediment (BWMS) convention adopted in London in 2004.

MATERIALS AND METHODS

The port is located on an estuary in the heart of the Gulf of Guinea at latitude 04°03'5°N and longitude 09°41'8°E. Douala is located on the south-east bank 24km upstream of the Wouri river estuary on the Atlantic coast, around 210 km west of Yaoundé. The Wouri Bridge, 1800m long, links Douala to the banana port of Bonaberie and carries road and rail traffic to western Cameroon. The efficiency of port management in Cameroon is based on several management zones depending on the nature and type of ship docking in the port area. This study was carried out in relation to 16 types of ship that docked in the Douala port management area. The average length of stay of ships in the port of Douala is 4 days. This period is an important and determining factor for the collection of ballast water samples to determine their compliance with the NIS according to the BWM Convention.

Study design

This was a quantitative study using primary and secondary data. The analysis data consisted of data relating to ship visits and the tonnages of ships that had docked in the Cameroonian coast, mainly in the port of Douala.
To complete the analysis, data relating to local and international laws and regulations were also used.

Data analysis

Both primary and secondary data on ship visits to the various terminals were collected. Vessel visit data included the total number of vessels visiting the port and gross tonnage (GT). Data on ship visits and gross tonnage included data on ships sailing on international and domestic routes. These data were collected between 2015 and 2021. The ship visit data was compared with primary data on the potential amount of ballast water discharged by ships. The data on the quantity of ballast water discharged was used as the basis for calculating the environmental risk assessment.

RESULTS AND DISCUSSION

The number of visits and tonnage of ships was used as the basis for calculating the management of ballast water from ships. Data on ship visits were based on data obtained from the Douala Port Authority over a seven-year period (Table 1).

Table 1: Trends in vessel traffic and tonnage at the Douala Port Authority.

YEARS	2015		2016		2017		2018		2019		2020		2021	
TYPES OF VESSELS	Nb	Tonnage	Nb	Tonnage	Nb	Tonnage	Nb	Tonnage	Nb	Tonnage	Nb	Tonnage	Nb	Tonnage
General Cargo	410	5019648	350	4744648	412	5818528	414	5839974	418	6333804	419	5891800	162	2281209
Container carrier	281	3397251	294	3198011	329	3319424	305	3331659	268	3613385	274	3600593	252	3851624
Oil tanker	133	1328598	129	1263037	153	1431425	160	1436701	200	1558189	178	1713143	179	1590109
Banana carrier	85	398796	86	333788							3	17966		
RO/RO	89	508280	82	445021	84	667732	61	672025	76	716543	48	411547	73	539461
Ore miner	7	141913	31	710210										
Butane carrier	39	107267	24	47856	19	27585	18	25855	24	40350				380718
Reefer ship	84	253467	96	190505	121	303612	131	304731	83	330499	86	364741	78	
War ship	6	0	11		12		11		5			218065	4	0
Chemical tanker	10	32909	9	30723	2	183261		183936		199490	26		7	23016
Wine tanker	2	6625	4	38069									1	3008
Asphat tanker	3	7270	6	7628							1	1550		
Gaz tanker	6	10383	13	33398	2	5127	2	5146	2	5581	13	45713	7	36729
Log ship													7	122397
Dry bulk carrier	0	0											208	3838756
Barge/search/passager	1	0	2		1		1							
Overall	1156	11212407	1137	11042894	1135	11756694	1103	11800027	1076	12797841	1048	12265118	978	12667027

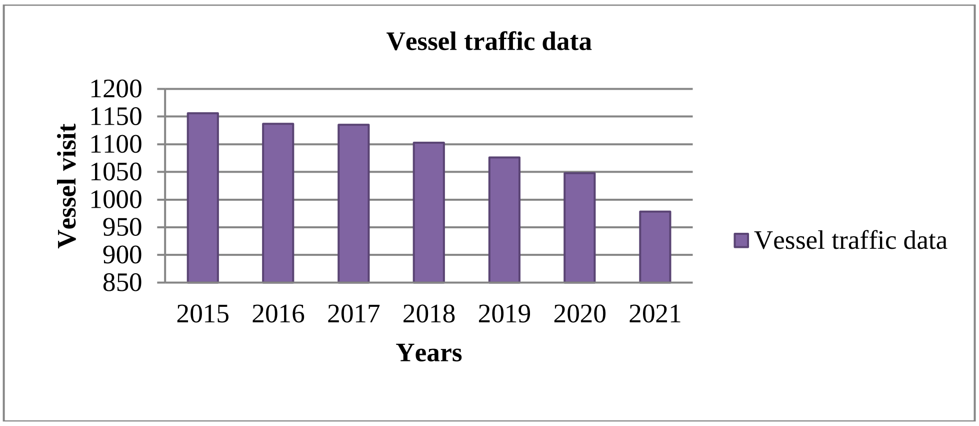

Figure 1: Ship traffic from 2015 to 2021 at the Douala Port Authority (PAD).

We can see from the graph that there is a consecutive drop in vessel traffic in the Douala Port Authority between 2015 and 2021, which may be due either to port infrastructure or to the country's economic levels.

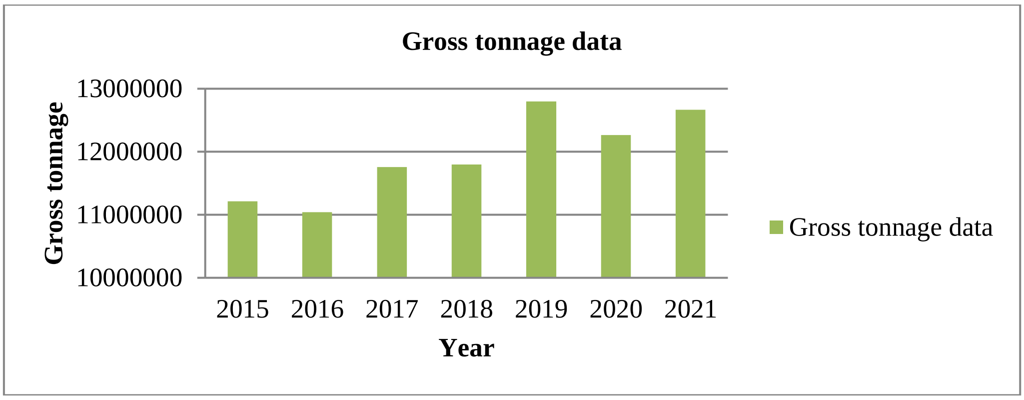

Figure 2: Gross tonnage at the Douala Port Authority.

Gross tonnages increase from 2015 to 2021, with a slight decrease in 2020. Tonnages in the peak years, i.e. 2016 and 2021, show significant growth, with consecutive volumes of 12797841 tones and 12667027 tons in the Douala Port Authority.

Table 2: Vessel and volume of water discharged.

	2015		2016		2017		2018		2019		2020		2021	
TYPES OF VESSELS	Tonnage	H_2O	Tonnage	H_2O	Tonnage	H_2O	Tonnage	H_2O	Tonnage	H_2O	Tonnage	H_2O	Tonnage	H_2O
General Cargo	5019648	1505894,4	4744648	1423394,4	5818528	1745558	5839974	1751992	6333804	1900141	5891800	1767540	2281209	684362,7
Container carrier	3397251	1019175,3	3198011	959403,3	3319424	995827,2	3331659	999497,7	3613385	1084016	3600593	1080178	3851624	1155487
Oil tanker	1328598	398579,4	1263037	378911,1	1431425	429427,5	1436701	431010,3	1558189	467456,7	1713143	513942,9	1590109	477032,7
Banana carrier	398796	119638,8	333788	100136,4		0		0		0	17966	5389,8		0
RO/RO	508280	152484	445021	133506,3	667732	200319,6	672025	201607,5	716543	214962,9	411547	123464,1	539461	161838,3
Ore miner	141913	42573,9	710210	213063		0		0		0		0		0
Butane carrier	107267	32180,1	47856	14356,8	27585	8275,5	25855	7756,5	40350	12105		0	380718	114215,4
Reefer ship	253467	76040,1	190505	57151,5	303612	91083,6	304731	91419,3	330499	99149,7	364741	109422,3		0
War ship	0	0		0		0		0		0	218065	65419,5	0	0

Chemical tanker	32909	9872,7	30723	9216,9	183261	54978,3	183936	55180,8	199490	59847		0	23016	6904,8
Wine tanker	6625	1987,5	38069	11420,7		0		0		0		0	3008	902,4
Asphat tanker	7270	2181	7628	2288,4		0		0		0	1550	465		0
Gaz tanker	10383	3114,9	33398	10019,4	5127	1538,1	5146	1543,8	5581	1674,3	45713	13713,9	36729	11018,7
Log ship													122397	36719,1
Dry bulk carrier	0												3838756	1151627
Barge/search/passager	0													
Overall	11212407	3363722,1	11042894	3312868,2	11756694	3527008	11800027	3540008	12797841	3839352	12265118	3679535	12667027	3800108

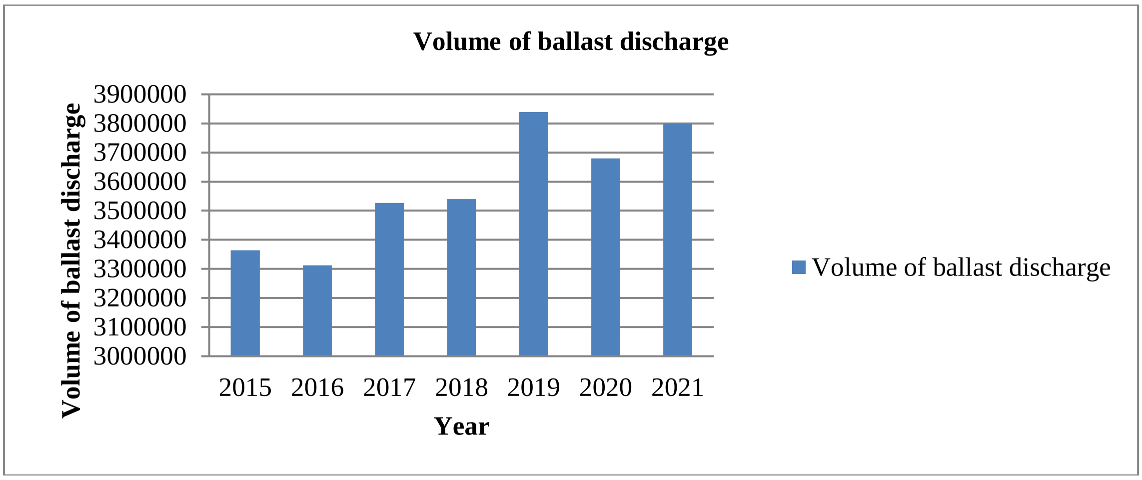

Figure 3: Volume of ballast water discharged.

Potentially estimated discharges had two peaks in 2019 and 2021 with large quantities of discharge water of a consecutive volume of 3839352 tons and 3800108 tons. We observe an upward trend in the quantity of ballast water discharged into the Wouri river.

According to MEPC 56/23 ANNEX 2, the overall probability of a successful invasion also depends in part on the number of organisms and the frequency with which they were introduced throughout the duration of the derogation. It was therefore recommended that a risk assessment should take into account at least the following four factors: (i) the total volume of water released, (ii) the volume of water released during an event (trip), (iii) the total number of release events, and (iv) the temporal distribution of release events. Researchers used ship visit data and MEPC 56/23 ANNEX 2 to calculate the amount of ballast water discharged by ships.

The deterioration of seawater is due to the discharge of waste from ships, oil splashes from ship operations and the disposal of waste by ships, whether intentional or accidental. The most recent problem concerns ballast water management. This has contributed to damage to seawater and marine ecology. This damage is due to the presence of invasive species in ballast water (Table 3).

Table 3: Risk analysis.

Frequent E(5)	<60% of vessels do not comply with legislation on the protection of bathing water	**Intermediaite**	**High**	**High**	**Extreme**	**Extreme**
Very likely D(4)	25%<X<60% of vessels do not comply with " Ballast water management standards"	**Low**	**Intermediaite**	**High**	**High**	**Extreme**
Can occur C(3)	5%< X<25% of vessels do not comply with " Ballast water management standards"	**Low**	**Low**	**Intermediaite**	**High**	**High**
Less likely B(2)	1%<X<5% of vessels do not comply with " Ballast water management standards"	**Very low**	**Low**	**Low**	**Intermediaite**	**High**
Rarely A(1)	1% of vessels do not comply with legislation on the protection of bathing water	**Very low**	**Very low**	**Low**	**Low**	**Intermediaite**
		I Not heavy	**II Heavy**	**III Quite heavy**	**IV Very heavy**	**V Disaster**

Effect/Consequence

Factors influencing the environment	Each vessels discharges up to 5 tones of ballast water	Each vessels discharges between 5 and 10 tones of ballast water	Each vessels discharges between 10 and 20 tones of ballast water	Each vessels discharges between 20 and 30 tones of ballast water	Per vessels discharging ballast water>30 tones

Since the Ballast Water Management Convention was ratified in 2017, no mechanism has been put in place to implement the various ballast water discharge procedures. According to the risk analysis, Cameroon is in the extreme risk range.

CONCLUSION

The quantity of ballast water discharged is influenced by: (i) the total volume of ballast water discharges, (ii) the volume of water discharged during an event (voyage), (iii) the total number of discharge events, and (iv) the temporal distribution of discharge events. The quantity of ballast water could be used to determine the environmental risk analysis. Assuming that each ship docking at the Port of Douala would potentially discharge between 25 and 35% of ballast water corresponding to its tonnage is estimated to be around 2,760,723 tons of ballast water is an extreme risk to the environment and could contaminate the Port of Douala.

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Conflicts of interest: The authors declare that they have no conflicts of interest.

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