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Ten years of Brazilian ballast water management

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ABSTRACT

In 2005, Brazil addressed the environmental challenges posed by ballast water through a unilateral regulation, called the Maritime Standard N° 20 (NORMAM-20), applied to all shipping in her waters. This world-leading decision was the culmination of a process that started during the 1990′s. Here, we summarize how these ballast water regulations were brought in and adopted and present the findings of 10 years of enforcement (2005–2015) in 39 ports along the Brazilian coast. We show that compliance with the Brazilian standard has increased significantly since the regulations were implemented ($p < 0.001$). After five years of implementation, non-compliance decreased probably reflecting an increase in awareness of the Brazilian Standard and a shift in the shipping industry commitment to minimize and control the spread of invasive species through ballast water. The Brazilian experience shows that very high levels (97%) of compliance with ballast water management regulations can be made to work in a region of global importance to the maritime industry. In the last decade, the rules governing ballast water in Brazil have evolved to address the demands from the maritime community and to provide updates such as imminent requirements for the use of ballast water management systems on board ships. These regulations are rarely cited when ballast water regulations are discussed internationally, yet there is much to learn from the proactive approach taken by Brazil such as what is feasible and enforceable.

1. Introduction

Today, about 80% by volume of international trade is carried by sea along shipping routes that connect coastal regions worldwide (UNCTAD, 2014). The shipping industry has played a very important role in the development of economies around the world; increasing industrialization and changes in the world economies have fuelled the trade and set a growing demand for consumer products and advances in shipping technology mean that has become an increasingly efficient and a swift method of transport (MKC/IMO, 2012). However, shipping activities need environmental controls to help avoid accidents, to curb pollution and inhibit the transfer of organisms across biogeographic boundaries (Leal Neto, 2007).

Ballast water is taken on board ships to improve manoeuvrability, stability and safety and is of major environmental importance since when it is discharged it can spread pathogens that cause disease and can have major ecological and economic impacts if invasive and harmful species are introduced. Descriptions of alien species associated with shipping date back to the 16th Century with a scientific focus on the problem building up through the 1970s leading to Canada and Australia raising the risks posed at meetings of the International Maritime Organization (Galil et al., 2009).

Shipping is the main source of unintentional transfer of organisms, including pathogens, via ballast water discharges and biofouling (Ruiz et al., 2000; Bax et al., 2003; Coutts and Taylor, 2004; Drake and Lodge, 2007; Takahashi et al., 2008). International initiatives have been taken to avoid the transference of non-native species through ballast water, initially with the adoption of voluntary guidelines which recommended the ballast water exchange in mid-ocean as a management option (International Maritime Organization (IMO) Marine Environment Protection Committee Resolution MEPC.50(31), IMO Assembly Resolution A.774(18), IMO Assembly Resolution 686(20)). In 2004, the International Convention for the Control and Management of Ships Ballast Water and Sediments (BWM Convention) (IMO, 2004) was adopted by consensus. After >12 years, in September 2016 the IMO BWM Convention finally reached the 35% of world merchant shipping tonnage as provided in Article 18 and will enter into force on 8th September 2016. Apart from this international regulation and its guidelines, many management practices have been developed to deal with the problem; ballast water exchange in mid-ocean (already mentioned), risk assessment and modelling, technologies to treat the ballast water on board, shipping routes optimization and new ship designs are among them. Management practices ashore like reception and storage

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facilities, as well as mobile solutions in a form of dedicated ships or container size units are also possibilities that enable in-port ballast water treatment (Gregg et al., 2009; Jing et al., 2012; Balaji et al., 2014). Moreover, since Australia has been a pioneer on the matter, it seems appropriate to mention that recently this Country has changed their regulation initially adopted in 2001. In terms of management practices the Biosecurity Act 2015, adopted on 16/06/2016, included as exceptions (and then subject to discharge): ballast water managed with IMO Type Approved Ballast Water Management System listed in the regulation; discharges from ballast water exchanged in defined areas as well as derived from freshwater ballast.

From a national perspective, there have been many major environmental and economic problems associated with the introduction and spread of the golden mussel (*Limnoperna fortunei*) during the 1990′s (i.e. agglomeration and clogging inside cooling systems and discharge pipes, deterioration and obstruction of filters at Itaipu binacional hydroelectric power plant) (Mansur et al., 1999; Danrigran and Drago, 2000). This led Brazil to unilaterally adopt her own ballast water management regulations to minimize the threat posed by invasive species.

1.1. Brazilian maritime administration and ballast water management

The Brazilian Maritime Authority enforces, under naval command, national and international regulations in waters under national jurisdiction and carries out inspections for the protection of human life, the safety of navigation and the prevention of environmental pollution. The Maritime Authority has a main Directorate of Ports and Coasts that oversees the implementation and enforcement of maritime regulations carried out by Port State Control Officers (PSCO).

National regulations on ballast water began in 2000 with the adoption of the Brazilian Maritime Authority's Standard n° 08 (NORMAM 08), superseded by reviews in 2013 and 2015 (Portaria N° 49/DPC, 2015). This required that each vessel in Brazilian territorial waters to send a completed Ballast Water Form to the local Port Captaincy and that a copy was shown during Port State Control inspections. In 2001, the Brazilian National Health Surveillance Authority imposed a similar requirement (Resolution RDC n° 217) (Resolução RDC n° 217, 2001) to limit public health problems associated with ballast water with epidemiological surveillance and vector control at Sanitary Control Ports. This followed the occurrence of a small cholera outbreak in Paranaguá Bay, southern Brazil, in 1999, where the disease had never previously been reported (Rivera et al., 2013). Already at that time, regulations for health surveillance made the Ballast Water Form mandatory for granting entry to ships into Brazilian ports. The resolution raises the possibility of sampling of ballast water tanks for identifying the presence of pests and pathogens and to verify physical and chemical parameters, at the Sanitary Authority's discretion (article 28). In December 2009, this sanitary rule was updated by Resolution RDC n° 72 (Resolução RDC N° 72, 2009).

In 2005, after a period of discussions with the Brazilian maritime community, the Director of Ports and Coasts adopted the Brazilian Maritime Standard for ballast water management (NORMAM-20) which stipulates obligations to ships and/or their agents including filling out and sending the Ballast Water Form and providing information about the ballast water handled by the ship and its management, mainly through the mid-ocean exchange (Castro et al., 2010). In 2014 the rule was revised and providing information about ballast water management systems has become compulsory (Portaria N° 26/DPC, 2014).

Taking into account the additional task on ballast water and considering the nature of the inspection (not merely documental), during the period between the adoption of the Brazilian Standard (June 2005) and its entry into force (October 2005), PSCO located along the coast were trained by specialists on ballast water, senior inspectors and ship's masters. Moreover, informative material and presentations on the new requirements were also delivered to ship owners and maritime agents, with a view to discuss and clarify any aspects associated with the adoption of the new ballast water requirements.

Inspection of ballast water is generally conducted during ordinary inspections by Port State Control officers and is based on documents required by the Brazilian ballast water regulations, like the Ballast Water Management Plan and the Ballast Water Reporting Form (see Appendix). The exchange of ballast water in the mid-ocean is also required by Brazilian regulation. Ballast Water Management Plan minimum requirements are identical to those provided in the BWM Convention whereas the Ballast Water Reporting Form is a variation of the IMO Resolution A.686(20), from 1997. The ballast water history of each ship is usually checked as the form is sent prior to arrival and this is checked again during the inspection on board. This is to verify whether the ship exchanged water in the mid-ocean and where it was conducted. Further analysis is conducted in the Brazilian Navy's Research Institute (IEAPM) located in Arraial do Cabo, Rio de Janeiro, where an ongoing project has taken place since the regulation was adopted. Finally, at PSCO's discretion or when national campaigns are applied, ballast water samples are taken and a refractometer is used to verify the salinity of the water. At this stage, a further indication of the mid-ocean exchange is desirable. In 2014, a new field was added to the Form regarding the existence of a certified ballast water management system already installed. Therefore, data verified and collected by Port State Control officers are mainly related to the ballast water management practices adopted by the ship. Additional provisions are also requested when ships are navigating between national ports/terminals located in different hydrographic basins. In this case, ships must exchange their ballast water to avoid the spread of invasive species as they are operating within similar water bodies. Rules on ballast water exchange in Brazil apply to domestic shipping when rivers from different hydrographic basins are crossed. Exemptions from ballast water management practices are provided in the regulation and are similar to those provided in the BWM Convention; however, in some cases, a valid Exemption Certificate issued by the Directorate of Ports and Coasts is required.

In case of non-compliance the local Maritime Authority can apply fines or warn, detain or prohibit the vessel"s entry and/or discharge its ballast water, request the vessel to leave the port or terminal in order to discharge or exchange its ballast water prior to operations in the port/terminal. Sanctions are applied depending on the seriousness of the violation and its potential threat to the aquatic environment, varying from educative measures to fines in most cases.

This is an exploratory descriptive study to evaluate the status of adherence to the Brazilian regulation on ballast water in a 10 years period; here we consider the Brazilian experience of ballast water management over the past decade, based on inspections' reports. During the period, Brazilian port State control officers verified vessel compliance to the national standard and reported back the results to the Brazilian Maritime Authority. Additional important initiatives taken concerning ballast water issues within the country are also reported.

2. Methodology

2.1. Design and area of study

We considered 11,183 vessels in 39 ports/terminals (ANTAQ, 2016) aboard which naval inspections were carried out by the Brazilian Port State Control Officers during the period between 2005 and 2015. These ports/terminals are distributed along seven (of nine) Naval Districts according to the criteria adopted by the Brazilian Navy. Areas 1 to 7 cover the following ports and/or terminals:

Area 1: Ports/terminals of Rio de Janeiro, Angra dos Reis/Itacuruçá, Itaguaí/Sepetiba, Vitória, Praia Mole/Tubarão, Ponta de Ubu, Barra do Riacho/Portocel;

Area 2: Ports/terminals of Aracaju, Salvador;

Area 3: Ports/terminals of Fortaleza, Recife, Natal/Termisa, Suape, Pecém, Paracuru, Mucuripe, Maceió, Cabedelo, Areia Branca;

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