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HARMFUL INTRODUCTIONS AND BALLAST WATER MANAGEMENT – AN EMERGING PROBLEM IN THE NORTHERN ADRIATIC

ABSTRACT

The article calls our attention to the existing dangers of potentially harmful organisms being introduced in our sea with ships ballast water and to the need of having this matter under control. To this end the article presents the importance of ballast water for a ship, organisms in ballast water, some cases of harmful introductions and the case of Slovenia. Furthermore, legal aspects, ballast water management methods/techniques and monitoring aspects are presented. Finally, the article deals with perspectives for the regulation of the ballast water issue.

KEY WORDS

ballast water, potentially harmful organisms, management, Northern Adriatic

1. INTRODUCTION

An unloaded or partially loaded ship during sail at sea uses additional loads for its seaworthiness. For this purpose water, the so-called "ballast water", is loaded into tanks, the so-called "ballast water tanks". Ballast water may contain all kinds of organisms, which are small enough to pass through inlets and ballast water pumps during operations. Researches have proved that some organisms may survive in ballast water even after voyages of several months. Hence, ballast water loaded on the ship in one part of the world, and then discharged in another may contain viable non-indigenous (alien) and/or harmful marine organisms, pests, pathogens, etc. Marine organisms are also transported as fouling communities on ship hulls. According to some estimations about 10 billion tons of ballast water are transported yearly throughout the world [1], and about 3000 [2] to 4000 [3] different non-indigenous species are introduced daily. Impacts are shown as threatened public health with some fatal cases, collapsed natural equilibrium of marine habitats and economic losses, with the latter estimated at US$123 billion per year [4].

2. THE BALLAST PROBLEM

2.1. Ballast water

Mostly, when the ship sails unloaded or partially loaded, it needs ballast to ensure: adequate draught because of efficient rudder and propeller operation, adequate trim, necessary transversal and longitudinal stability, stress loads within acceptable limits and therewith seaworthiness. Once, sand, stone, bricks or other compact material for ballasting was used, and with the introduction of steel-hulled ships (around 1880) seawater started to be used.

Nowadays, ships, e.g. container, general-cargo, RO-RO (roll-on – roll-off), passenger, fishing and military ships, require small quantities, whereas bulk carriers, tankers, oil–bulk–ore (OBO) and liquefied––petroleum–gas (LPG) carriers require large quantities of ballast water (mainly 10,000 tons and more, to over 100,000 tons per ship).

In the mid-phases of ballasting or deballasting changes occur, which have many different negative impacts. There are known free surface effects, inauspicious changes within shearing forces and bending moments as well as others. According to the International Safety Management Code (ISM Code) ballasting or deballasting procedures must be accomplished according to previously prepared Safety Management Manual. One copy of the Manual should be kept on board. Companies are required to prepare plans for ballasting and deballasting, carry out periodic checks and verify whether the ballast system is functioning properly.

2.2. Nuisance species

Spreading of marine organisms via ships ballast water or the ship hulls has been a known phenomenon for almost a century, but only in the last decade has it gained considerable interest worldwide. This in-

creased interest is the result of negative consequences caused by harmful species in a new environment.

The definition provided by the Aquatic Nuisance Species Task Force (ANS Task Force), a special intergovernmental organisation of the United States of America (USA) which was constituted for preventing and controlling aquatic non-indigenous species, says: "**Non-indigenous species (NIS)** are any species or other viable biological material that enters an ecosystem beyond its historic range, including any such organism transferred from one country into another." The International Maritime Organisation (IMO) definition says: "**Harmful Aquatic Organisms or Pathogens** means aquatic organisms or pathogens which, if introduced into the sea including estuaries, or into fresh water courses, may create hazards to human health, harm to living resources and aquatic life, damage to amenities, impairment of biological diversity or interfere with other legitimate uses of such areas." [5]

Introductions of non-indigenous species are known after nuisance and harmful impacts on the environment. Therefore, they may also be addressed as "nuisance species". Furthermore, impacts of the introduction of non-indigenous species are unpredictable, hence it follows that all non-indigenous species are potentially harmful.

2.3. Some documented cases of harmful introductions of non-indigenous species

The most "prominent" cases in the world are: introduction of the European zebra mussel *Dreissena polymorpha* into the Great Lakes (USA); introduction of the East-American comb jelly *Mnemiopsis leidyi* into the Black and Azov seas; introduction of the cholera bacterium *Vibrio coleare* into coastal waters of the USA; and introduction of toxic dinoflagellates into the Australian waters. [6] Consequences of the above-mentioned and many other documented cases are shown as harmful impacts on human health (cholera, paralytic shellfish poisoning (PSP) – human fatalities...), harmful impacts on marine environment (impoverishment of biodiversity and decrease of the abundance of autochthonous marine species...) and economy losses counted in billions of dollars (shellfish industry, fishery...).

2.4. The case of Slovenia

In the Slovenian sea no such case has been recorded to date. However, this statement could result from the lack of researches of this kind conducted in Slovenia. Thus, it is known that every year since 1989 (with the exemption of 1991 and 1992) the sale of molluscs from Slovenian maricultures has been banned as a result of blooms of toxic dinoflagellates [7], whose presence in ballast water has been proved in different parts of the world. Furthermore, there are very interesting results of researches, which have shown possible relation between blooms of toxic dinoflagellates and etiologically unidentified gastrointestinal disorders, evidenced among the hospitalised littoral population of Slovenia in the period of 1983-1992 [8]. Also interesting is the case of the registration of Asian mollusc bivalve *Musculista senhousia* (non-indigenous) in the North-Adriatic [9], which in Australia has been put on the list of unwanted or nuisance species – Marine Target Species List [10] (which are also present in ship ballast water).

3. LEGAL ASPECTS

The United Nations Convention on the Law of the Sea (UNCLOS) and International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) regulate the pollution of the sea from ships. At the 1973 IMO conference the ballast problem was raised for the first time. The Resolution, saying that "ballast water taken in water which may contain bacteria of epidemic diseases, may, when discharged, cause a danger of spreading of the epidemic diseases to other countries", was adopted. The Resolution requested IMO and the World Health Organisation (WHO) to "initiate studies on that problem on the basis of any evidence and proposals which may be submitted by governments". [2]

The result of many years of dedicated work of scientists and experts of IMO and many other organisations were adoptions of *Guidelines for Preventing the Introduction of Unwanted Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges* in 1991 (*Resolution MEPC 50(31)*) and 1993 (*IMO Assembly Resolution A.747(18)*). These resolutions were updated by the *Guidelines for the Control and Management of Ships' Ballast Water to Minimise the Transfer of Harmful Aquatic Organisms and Pathogens*, which was adopted by the 20th Assembly of IMO in November 1997 (*IMO Assembly Resolution A.868(20)*). It must be emphasised that, unfortunately, these guidelines remain recommendatory and are not legally binding. The Guidelines include implementation of preventive measures on ships and in ports (Ballast Water Management, reception facilities, etc.), monitoring of ballast water on ships, monitoring of water in ports, additional education and training of seafarers. [11]

The legal basis for the implementation of protective measures on the national level is: in the USA – *National Invasive Species Act* (NISA 1996); in Australia – *Australian Ballast Water Management Guidelines* (ABWMG) (1990,1998); in Canada – *Canadian guidelines for controlling ballast water discharge into the Great Lakes* (1989) and the local program of Vancou-

ver Port Corporation (VPC) *Ballast Water Exchange Program* (1997); in China – *Regulations Governing the Prevention of Pollution from Ships* and Frontier Health and Quarantine Law of the Peoples of China; in New Zealand – their own Guidelines which were prepared on the basis of Australian Guidelines [6]. Despite the adoption of the new Slovenian Maritime Code (Pomorski zakonik Republike Slovenije) in 2001, the Slovenian legislation does not foresee any preventive or other measures dealing with the ballast problem [12, 13].

4. BALLAST WATER MANAGEMENT (BWM)

The main objective of BWM is the prevention of the introduction of non-indigenous and harmful species and pathogens with ship ballast water. The IMO definition says: "**Ballast Water Management** means mechanical, physical, chemical, biological or other processes to kill, remove, render infertile, or avoid the uptake or discharge of harmful aquatic organisms and pathogens within ballast water and sediments". [5]

4.1. BWM methods and techniques

Any method used is expected to be safe, effective, environmentally acceptable, widely applicable and economical. In the first place, safety of the ship and human life is what we have to keep in mind when designing or implementing BWM. Any method or procedure which may endanger human lives is unacceptable.

Today, many BWM methods are known (Figure 1), but none of them, unfortunately, fulfils the expectations. Most of them are in the testing phase. The following methods seem to be most promising: Ballast Water Exchange (BWE) (Sequential, Flow-through and Dilution method) and Norway model (two-stage treatment – cyclonic separator and the ultraviolet light treatment). BWE are widely used methods (since 1991). Meanwhile, the Norway model was for the first time installed on the passenger ship Regal Princess. [14]

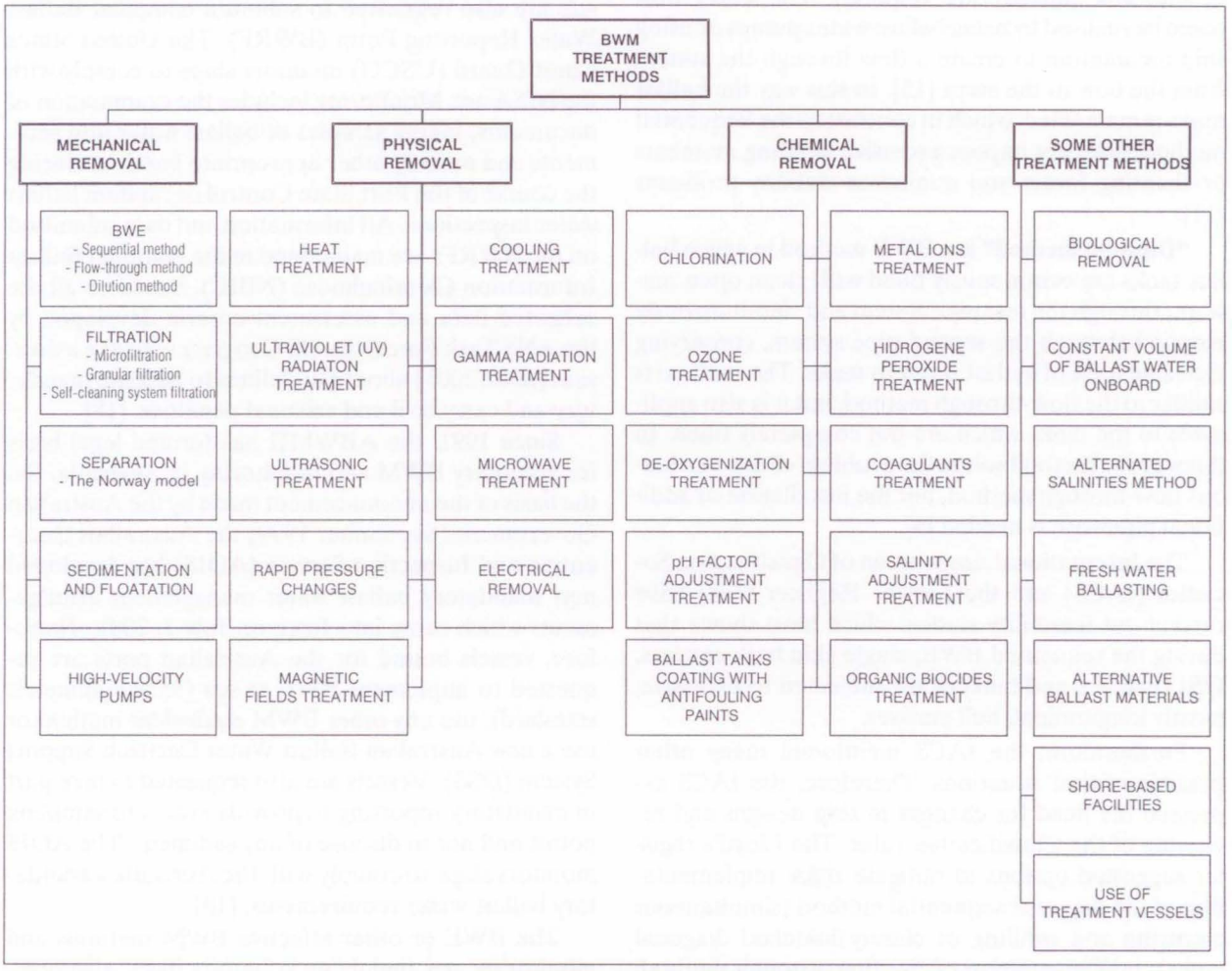

Figure 1 - BWM treatment methods [6].

The BWE methods are requested by IMO (Sequential and Flow-through method in the IMO Assembly Resolution A.868(20)), and the Dilution method, beside those two, is accepted by the Australian legislation. The methods are based on the results of researches which have shown that marine organisms living in near-coastal, port and estuarine water, released in mid-ocean, and vice-versa, oceanic organisms released in coastal water, generally do not survive.

"**Sequential method**" is a BWE method in which ballast tanks are (in sequence one after the other) pumped out and refilled with clean open seawater. This method requests a lot of attention dedicated to the safety of the ship (stability, free-surface effects, shear forces, bending moment, torsion moments, over and under pressurisation of tanks, etc.), and therefore, it should be carried out in favourable sea and swell conditions and be continuously supervised [11].

"Flow-through method" is a BWE method in which ballast tanks are continuously filled with clean open seawater, producing an overflow through air pipes. For the complete exchange three full exchanges of the tank capacity are required. The water flow could be realised by using ballast water pumps or using ship momentum to create a flow through the system from the bow to the stern [15]. In this way the ballast tanks remain filled, which in contrast to the Sequential method, does not impose excessive bending moments or shearing forces and minimises stability problems [11].

"Dilution method" is a BWE method in which ballast tanks are continuously filled with clean open seawater through the one pipe system and simultaneously emptied through the second pipe system, conserving the same level of ballast water in tanks. The method is similar to the flow-through method, but it is also applicable to the tanks which are not completely filled. In this way the method solves the problem of the continuous flow-through method, but the installation of additional pipework is needed [6].

The International Association of Classification Societies (IACS) and the Lloyd's Register (LR) have carried out feasibility studies which have shown that during the sequential BWE, single skin bulk-carriers, OBO carriers and tankers are subjected to excessive, mostly longitudinal, hull stresses.

Furthermore, the IACS mentioned many other possible critical situations. Therefore, the IACS expressed the need for changes in ship designs and reviewing of the Classification rules. The Lloyd's register suggested options to mitigate risks: implementation of the diagonal sequential method (simultaneous emptying and refilling of closely matched diagonal tanks); implementation of the flow-through method; development of the ship's specific operational envelope; modifications of the ship's structure and/or engine systems; isolation (non release of ballast water); or use of any acceptable treatment method. [16,17]

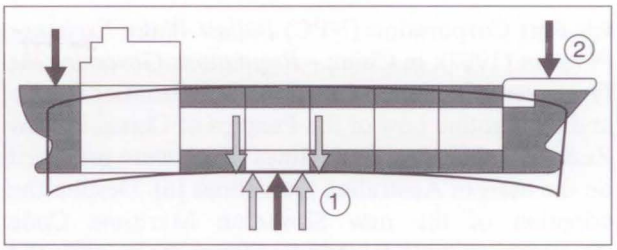

Figure 2 - Shearing force(1) and bending moment(2) effect during the sequential BWE.

4.2. BWM and monitoring of US ports

The NISA forms the legal basis for BWM and monitoring in the **USA**. Therefore, ships bound for the ports of USA (from the outside of the Exclusive Economic Zone (EEZ)) are requested (on voluntary bases except for vessels bound for the Great Lakes or the Hudson River) to implement BWE or any other BWM method confirmed by the US authorities. Vessels are also requested to submit a compiled Ballast Water Reporting Form (BWRF). The United States Coast Guard (USCG) monitors ships to comply with the NISA act. Monitoring includes the examination of documents, taking samples of ballast water and sediments and making other appropriate inquiries during the course of the Port State Control or random ballast water inspections. All information and data submitted on the BWRFs are maintained in the National Ballast Information Clearinghouse (NBIC). Based on all the collected data and assessment criteria developed by the ANS Task Force, the US Congress will take a decision (2002/2003) about Guidelines to become mandatory and carry civil and criminal penalties. [18]

Since 1991, the ABWMG has formed legal basis for voluntary BWM and monitoring in **Australia**. On the basis of the announcement made by the Australian Government (September 1999) the Australian Quarantine and Inspection Service (AQIS) has developed new mandatory ballast water management arrangements which came into force on July 1, 2001. Therefore, vessels bound for the Australian ports are requested to implement BWE at sea (95% volumetric standard), use any other BWM equivalent method or use a new Australian Ballast Water Decision Support System (DSS). Vessels are also requested to take part in mandatory reporting to provide access to sampling points and not to dispose of any sediment. The AQIS monitors ships to comply with the Australia's mandatory ballast water requirements. [19]

The BWE or other effective BWM methods and monitoring are, mainly on voluntary basis, also practised in some other countries such as: New Zealand,

Canada, China, Israel, Chile and Argentina, and discharge of any kind is prohibited in the Panama Canal [2]. Slovenia has no provisions for BWM and does not monitor discharges of ballast water in the Slovenian sea.

5. PROSPECTS FOR THE REGULATION OF THE BALLAST PROBLEM

The ballast problem is present worldwide with different levels of intensity. Globally, there is a need for harmonised legislation, standardisation of procedures and implementation of strict monitoring in the field of harmful introductions.

The Ballast Water Working Group (BWWG), the subgroup of the Marine Environment Protection Committee (MEPC (IMO)), consisting of the representatives of the member States and observed by interested organisations is dedicated to the ballast problem. The activities of BWWG group are focused on finalising of the international legal instrument in the form of the International Convention. Its adoption is expected to be realised at the Diplomatic Conference in association with the MEPC 49th session in 2003 [20]. On the way leading to the adoption, the BWWG has identified the current lack of standards and criteria regarding the effectiveness of the BWM methods as the most prominent problem.

In 1997 the IMO initiated the joint Global Environment Facilities (GEF)/IMO/ United Nations Development Programme (UNDP) project entitled *Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries*. Collected information was published in 1998 [21]. In 2000 the IMO initiated a three-year programme entitled *Global Ballast Water Management Programme*, also known as the GloBallast. Funding was provided by the GEF and the UNDP. This programme is aimed at reducing the transfer of harmful marine species in ship ballast water, by assisting developing countries to implement the existing IMO voluntary Guidelines (Assembly Resolution A.868(20)), and to prepare for the introduction of the International Convention which is currently being developed by the IMO (BWWG). [4]

In the light of recognising the permanent threat deriving from the ballast water of ships docking in the Northern Adriatic ports, the Faculty of Maritime Studies and Transportation from Portorož (Slovenia) has already initiated the research project entitled *Harmful Introductions and Ballast Water Management in the Slovenian Sea* (project No. L2-3208). The main aims of the project are: research into the extent of this phenomenon in the Slovenian sea with the emphasis on the Port of Koper; and proposal of guidelines for the prevention of harmful introductions, according to international and Slovenian legislation and organisation of the parties involved in maritime traffic in Slovenia. This very important step for the Republic of Slovenia was enabled by the financial support of the Ministry of Education, Science and Sports of the Republic of Slovenia and Luka Koper d.d. (Port of Koper), being in this case also beneficiaries.

6. CONCLUSIONS

A ship indispensably needs ballast water for its safety operation. Ballast water may contain all kinds of organisms which pose a threat to human health, environment and economy. Today, we have many documented cases of harmful introductions throughout the world. In the Slovenian sea as well as in the Northern Adriatic there have been no such cases recorded to date, which could be due to the lack of researches of this kind carried out by Slovenia, Croatia and Italy.

The ship ballast water has been recognised by the IMO and the WHO as a vector of harmful introductions of nuisance species and pathogens. The results of researches carried out in Europe and other parts of the world have shown regular presence of non-indigenous and harmful species in the ship ballast water.

The Northern Adriatic ports are involved in the international (intercontinental) maritime traffic and they include also the Port of Koper. In this region, the ballast water is released from the ships without any survey. On the basis of researches carried out in the world we propose a **hypothesis**, that non-indigenous and other potentially harmful organisms are also present in the ballast water released from the ships in the Port of Koper as well as in other ports of the Northern Adriatic.

In the last ten years, especially in the last few years, this problem has achieved greater dimensions in the world. That is probably the reason why IMO has focused on adopting the new legally binding Convention. Meanwhile, Australia made a decision to implement her own mandatory rules.

The research project *Harmful Introductions and Ballast Water Management in the Slovenian Sea* of the Faculty of Maritime Studies and Transportation is very important for the future regulation of the ballast problem in Slovenia. Besides, it could also be an excellent starting point for an international research project in collaboration with Croatia and Italy. The research project could lead to promising results, which could be applied in favour of the protection of human health, unique marine environment and national economies in the region of the Northern Adriatic, and in a wider area as well.

POVZETEK

ŠKODLJIVI VNOSI IN UPRAVLJANJE BALASTNIH VOD – NASTAJAJOČI PROBLEM V SEVERNEM JADRANU

Članek želi pritegniti pozornost na obstoječe nevarnosti kot posledico vnosov potencialno škodljivih organizmov z balastnimi vodami ladij in na potrebo po vzpostavitvi nadzora navedene problematike. V ta namen so v članku predstavljeni nekateri osnovni pojmi glede pomena balastne vode za ladjo, organizmov v balastni vodi ter navedeni nekateri primeri vnosov s škodljivimi posledicami v svetu, kot tudi razmere v Sloveniji. V nadaljevanju je opravljen pregled pravnih vidikov in možnih metod oz. tehnik upravljanja balastnih vod s ciljem preprečevanja škodljivih vnosov ter predstavljen vidik monitoringa. Za konec so predstavljene perspektive ureditve te problematike v svetu, kot tudi v Sloveniji.

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