

World Maritime University

# The Maritime Commons: Digital Repository of the World Maritime University

---

World Maritime University Dissertations

Dissertations

---

11-5-2017

## Exposure and vulnerability of Senegal to the introduction of harmful aquatic organisms and pathogens by ballast water

Awa Camara

Follow this and additional works at: [https://commons.wmu.se/all\\_dissertations](https://commons.wmu.se/all_dissertations)



Part of the [Environmental Policy Commons](#)

---

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact [library@wmu.se](mailto:library@wmu.se).

**WORLD MARITIME UNIVERSITY**

Malmö, Sweden

**EXPOSURE AND VULNARABILITY OF SENEGAL  
TO THE INTRODUCTION OF HARMFUL  
AQUATIC ORGANISMS AND PATHOGENS BY  
BALLAST WATER.**

By

**AWA CAMARA**

**Senegal**

A dissertation submitted to the World Maritime University in partial Fulfilment of the  
requirements for the award of the degree of

**MASTER OF SCIENCE**

**In**

**MARITIME AFFAIRS**

**(OCEAN SUSTAINABILITY GOVERNANCE AND MANAGEMENT )**

2017

Copyright Awa Camara, 2017

## **DISSERTATION DECLARATION FORM**

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature):



.....

(Date):

18/09/2017

---

**Supervised by: Raphael Baumler, PhD**  
**Associate Professor**

**World Maritime University**

## **Acknowledgement**

First of all, I am very grateful to the International Maritime Organization (IMO) for giving me this opportunity to participate in the MSc program of World Maritime University (WMU) in Sweden.

My greatest appreciation to M. Yerim Thioube, General Director of National Agency of Maritime Affairs, for his indispensable advice and efforts for my participation in this Master program.

I would like to thank the supervisor of this study, Mr. Raphael Baumler, for overseeing all of this work. He has contributed greatly, through his comments, to clarifying certain passages and thus making this document more complete and clearer.

I would like to thank all the WMU Professors, the administrative staff, and the WMU library for all their support and cordiality. Special thanks to Professors of ESSP Program, Professor Larry Hildebrand, and Professor Manuel, for their important advice and support.

I thank all those without whom this paper would not be what it is: as much by the discussions that I had the chance to have with them, their suggestions, contributions and the information provided.

My gratitude to all my colleagues at the National Maritime Agency of Maritime Affairs, too numerous to mention, who took the time to provide information. Each of these exchanges helped me to advance my work.

I would particularly like to thank M. Lamine Bousso for his support and for the comments made during the development of this study.

Since my early days at this University, I have received a lot of help, advice and encouragement from my friends, especially the class of s16 and s17. All this allowed me to mature every day. I thank them and I can never forget the joyous and sad memories I spent with them.

Special thanks to Mamadou Bousso, Mon Cheri, for his unlimited love, which has been there every moment, despite the distance, to support me, to advise me and to give me confidence. Thank you for this unconditional support.

Finally, thank you to my Parents, Brothers, Sister and other members of my family for their support during these 17 months and without which I would not be here today.

## **Abstract**

### **Title of Dissertation:**

Exposure and vulnerability of Senegal to the introduction of Harmful Aquatic Organism and Pathogen by Ballast Water.

Degree: MSc

The introduction of harmful aquatic organisms and pathogens (HAOP) via ballast water presents considerable threats to human health, the marine environment and economic concerns for coastal States. Thus, this global threat has seen a global response through the development of international initiatives and programs by various institutions, and organizations.

Among these, the International Maritime Organization adopted the International Convention for the Control and Management of ship's Ballast Water and Sediments, for prevention, control and eradication of HAOP. The convention entered into force in September 2017.

This study aims to carry out an assessment of the risks associated with Ballast Water discharge in Senegal's marine environment. This can be a major problem for a country like Senegal, which depends heavily on its marine resources.

In this regard, the study examines the level of exposure of Senegal to shipping activities. The risk assessment also analyzes the vulnerability of the marine ecosystem and evaluates the resulting consequences.

After the risk assessment of Senegal, the capacities of Senegal to comply with its responsibilities as port State, flag State and coastal State are reviewed. This supports a SWOT analysis in implementing these obligations.

To address the issue of Ballast Water discharge, the development of a National Ballast Water Management Strategy (NBWMS) is proposed as the best method to manage the risk of the introduction of HAOP.

**KEYWORDS:** Ballast water, Harmful Aquatic Organism and Pathogen, Invasive species, risk assessment, Hazard, Exposure, Vulnerability, Shipping, Biodiversity, sustainability.

## Table of contents

<b>Chapter 1 Introduction.....</b>	<b>1</b>
1.1 Background .....	1
1.2 Objective of the study .....	2
1.3 Methodological approach.....	2
1.4 Scope.....	3
1.5 Structure of the dissertation.....	3
1.6 Limitations of the study.....	4
<b>Chapter 2 - Biological risks associated with ballast water .....</b>	<b>5</b>
2.1 Shipping and introduction of Harmful Aquatic Organisms and Pathogens (HAOP) .....	5
2.1.1 Consequences of introduction of non-native species .....	6
2.1.2 Transformation of Non-native species into Invasive Alien Species (IAS) .....	7
2.1.3 Impacts of transfer of Harmful Aquatic Organism Pathogens (HAOP) VIA Ballast water .....	8
2.2 International Framework to address introduction of HAOP by Ballast Water Discharge. <b>10</b>	
2.2.2 Main International Instruments and Principles .....	11
2.2.3 The International Maritime Organization (IMO) and its response to Ballast Water threat.....	13
2.2.4 The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) .....	14
<b>Chapter 3 Risk for Senegal .....</b>	<b>17</b>
3.1 Risk principle and approach.....	17
3.1.1 Hazard and Risk Relationship .....	17
3.1. 2 Definition of the system to be protected from the Hazard (BW) .....	18
3.1.3 Focus on BW Hazard.....	18
3.2 Analyses of Senegal's exposure to Ballast Water discharge .....	19
3.2.1 Exposure to seaborne trade .....	19
3.2.2 Main Senegalese Ports .....	19
3.2.3 Conclusion on exposure.....	24
3.3 Vulnerability of marine environment in Senegal.....	25
3.3.1 Marine and coastal systems in Senegal .....	25
3.3.2 Potential vulnerable invasion .....	29
3. 3.3 Other trends affecting overall resilience of ecosystem in Senegal.....	30
3.4 Consequences related to the introduction of HAOP in Senegal .....	<b>32</b>
3.4.1 Consequences to food security .....	32
3.4.2 Consequences related to Poverty Growth .....	32

3.4.3 Economic consequences.....	32
3. 4.5 Conclusion – Risk assessment for Senegal .....	33
<b>Chapter 4: Capacity of the State Senegalese to implement the Convention on the Management of Ballast Water .....</b>	<b>35</b>
<b>4.1 Maritime Administration .....</b>	<b>35</b>
4.1.1 Status of ratification of IMO conventions in Senegal .....	35
4.1.2 Maritime Administration entities .....	36
4.1.3 Senegalese capacities in terms of fleet, seafarers, State-operated ships and research abilities .....	41
4.1.4 National regulatory framework in Senegal related to environment protection .....	43
<b>4.2 State obligations in BWM Convention .....</b>	<b>45</b>
4.2.1 Signification of flag State, port State and coastal State responsibilities under international regulations .....	45
4.2.2 Requirements regarding Ballast Water Management Convention .....	46
<b>4.3 Capacity of Senegal to implement BWM Convention .....</b>	<b>47</b>
4.3.1 Level of Readiness as Flag State .....	47
4.3.2 Level of Readiness as Port State .....	48
4.3.3 Level of Readiness as Coastal State .....	49
4.4 Challenges for ratification and implementation of BWMC in Senegal .....	50
<b>4.5 The development of National Strategy .....</b>	<b>51</b>
4.5.1 The procedures of establishment of NBWMS. ....	51
4.5.1.1 Legislation and regulation .....	51
4.5.1.2 Formulation of national Strategy .....	51
<b>5. Recommendations and conclusion .....</b>	<b>53</b>
5.1 SWOT analysis related to implementation by Senegalese Administration of BWM Convention .....	53
5.2 Conclusion.....	54
5.3 Recommendations .....	55
<b>6. References .....</b>	<b>57</b>

## LIST OF FIGURES

Figure 1: Identification of the cause responsible for damage to the marine environment and related natural and human systems .....	6
Figure 2 : Invasion process of species .....	7
Figure 3 : Transfer of HAOP in new environment .....	8
Figure 4: Ballast water exchange process .....	15
Figure 5: From hazard to risk.....	17
Figure 6: Elements to consider in risk evaluation water.....	18
Figure 7: Port of Dakar .....	20
Figure 8: Port of Ziguinchor/ Senegal .....	22
Figure 9: Port of Kaolack.....	23
Figure 10: Saint Louis.....	23
Figure 11: Saloum Delta National Park in Senegal .....	26
Figure 12: Mangrove Sine Saloum .....	27
Figure 13: Djoudj National Bird Park.....	28
Figure 14: Typha invasions in Senegalese river .....	29
Figure 15: Diagram of Ministry of Fisheries and Maritime Economy in Senegal and its directorates and agencies .....	36
Figure 16: Diagram of National Agency of Maritime Affairs .....	38
Figure 17: SRA elements.....	42
Figure 18: Development of policies Strategies and actions plan .....	51



## LIST OF TABLES

Table 1:: Evolution of Traffic (tons) in the port of Dakar 2014-2016.....	20
Table 2: Statistics of vessels in Ziguinchor maritime station in 2015 .....	21
Table 3 : Summary of the exposure of Senegalese Ports (High -Low exposure).....	24
Table 4: Ecosystems dynamic in Senegal .....	29
Table 5: Dependence on marine environment, classification of the most important sector ....	33
Table 6: IMO Convention/instrument ratify by Senegal .....	35
Table 7: Main departments of the MPEM .....	37
Table 8: Main Directorates and Departments of ANAM.....	38
Table 9: Responsibilities of other Institutions in the marine space .....	40
Table 10: The number of vessels registered in the national register, by type.....	41
Table 11: Equipment of the Senegalese navy .....	43
Table 12: Main National Instruments regulating Marine environment .....	43
Table 13: Summary of the State requirements.....	46
Table 14: Review the level of readiness in Flag State .....	47
Table 15: Review the level of readiness in Port State .....	48
Table 16: Review the level of readiness in Coastal State .....	49
Table 17: Steps of the NBWMS .....	52
Table 18: Swot analysis .....	53

## **Boxes**

1. Example of invasive species .....	18
2. Effect of Algae wakame.....	19
3. Effect of <i>Mnemiopsis leidyi</i> in North America.....	21
4. Effect of Zebra Mussel in Canada.....	21

## **LIST OF ABBREVIATIONS**

<b>ANAM</b>	National Agency of Maritime Affairs
<b>ANSD</b>	National Agency for Statistics and Demography
<b>BW</b>	Ballast Water
<b>BWMC</b>	Ballast Water Management (Convention)
<b>BWE</b>	Ballast Water Exchange
<b>CBD</b>	Convention on Biodiversity
<b>COSAMA</b>	Senegalese Consortium for Maritime Activities
<b>CRODT</b>	Research center of Dakar Thiaroye
<b>EEZ</b>	Exclusive Economic Zone
<b>EIA</b>	Environment Impact Assessment
<b>EU</b>	European Union
<b>FAO</b>	Food and Agriculture Organization
<b>ICZM</b>	Integrated Coastal Zone Management
<b>IHR</b>	International Health Regulations
<b>IPHAB</b>	Intergovernmental Panel on Harmful Alga Blooms
<b>IUUF</b>	Illegal Unreported and Unregulated Fishing
<b>GEF</b>	Global Environmental Facility
<b>GISP</b>	Global Invasive Species Program
<b>GDP</b>	Gross Domestic Product
<b>GloBallast</b>	GEF-UNDP-IMO GloBallast Partnership
<b>HAOP</b>	Harmful Aquatic Organisms and Pathogens
<b>HABs</b>	Harmful Alga Blooms
<b>IAS</b>	Invasive Alien Species
<b>ICZM</b>	Integrated Coastal Zone Management

<b>IMO</b>	International Maritime Organization
<b>IRD</b>	Institute of Research for Development
<b>IUCN</b>	International Union for Conservation of Nature
<b>MARPOL</b>	International Convention for the Prevention of Pollution from Ships
<b>MEPC</b>	Marine Environment Protection Committee
<b>MPEM</b>	Ministry of Fisheries and Maritime Economy
<b>NBWMS</b>	National Ballast Water Management Strategy
<b>NGOs</b>	Non-governmental Organization
<b>OMVS</b>	Senegal River Basin Development Organization
<b>PRCM</b>	Regional Partnership for Coastal and Marine Conservation in West Africa
<b>PSC</b>	Port State Control
<b>SBSTTA</b>	Subsidiary Body on Scientific, Technical and Technological Advice
<b>SOLAS</b>	Safety of Life at Sea
<b>RA</b>	Risk Assessment
<b>RAMSAR</b>	Convention on Wetlands
<b>SRA</b>	Same risk area
<b>SSCs</b>	Ship Sanitation Certificate
<b>USAID</b>	United States Agency for International Development
<b>UNCED</b>	United Nations Conference on Environment and Development
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>UNCLOS</b>	United Nations Convention on the Law of the Sea
<b>UNCTAD</b>	United Nations Conference on Trade & Development

## Chapter 1 Introduction

### 1.1 Background

Preservation and conservation of biodiversity and marine resources is essential for humans. They are a source of food, jobs, livelihoods, and many other ecological services. In addition, Oceans regulate the Earth's climate balance by storing the carbon dioxide (UICN, 2017). However, it is increasingly under pressure, due to various threats such as pollution, overfishing and destructive fishing techniques, invasive species and climate change (UNEP, 2016).

In connection to this, since the first United Nations Conference on the Human Environment (UNCHE) (1972), it was recognized and declared by the international community that the improvement of the long-term living conditions of all depended on the preservation of the natural foundations of life. (Fordham International law, 2005).

Pursuant, in June 1992, at the United Nations Conference on Environment and Development (UNCED), Agenda 21 was approved with a series of Principles on the Environment and development. Chapter 17 of the Agenda concern the protection of marine space, including the rational utilization and development of marine resources. In this chapter, the conference recognized that shipping and other marine activities are the causes of marine pollution, thus a preventative and forward-looking approach is better to preventing degradation of the marine environment (UNEP, 2012).

At the same time, the Convention on Biological Diversity (CBD) was adopted during this conference. Under Article 1 of CBD, the purpose is “*the conservation of biological diversity, sustainable use of its components and equitable sharing of benefits arising from the use of genetic resources*”.

In the meanwhile, IMO discussed the impact of Invasive Species introduced by ballast discharges (IMO, 2017b).

Under article 8(h) of the CBD and some supporting documents such as fifteen “guiding principles”, developed by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), highlight the importance of fighting invasive species (CBD, 2014).

In fact, ballast water is a vector for the introduction of Harmful Aquatic Organism and Pathogens (HAOP) into the marine environment. This introduction is recognized as an issue for the marine environment because it impacts human health and socioeconomic human wellbeing (Christopher F. Deacutis, 2002).

Through its potential for massive freight transport, maritime transport has facilitated the growth of trade in the world as 90% of goods traffic is by sea (UN-Business, 2017). *“In 2015, world Gross Domestic Product (GDP) expanded by 2 per cent. In addition, the estimated world seaborne trade volumes surpassed 10 billion tons”*(UNCTAD, 2016). These figures reflect the growing importance of the sea in global economic and strategic issues.

Aware of this, there is a necessity for more operational control of ballast water.

To this worrying question, Senegal’s seas, rivers, lakes and estuaries are not exempted from this risk. As with other West African countries, no real answer exists in Senegal.

## **1.2 Objective of the study**

The objective of this study is to analyse the exposure and vulnerability of Senegal’s marine environment facing the risk of introduction of harmful aquatic organisms and pathogens in the marine environment.

### **Specific objectives**

- Analyze the exposure of Senegal to HAOP introduction
- Assess the vulnerability of Senegal’s marine ecosystem
- Expose the consequences of HAOP introduction
- Determine the requirements of the Ballast Water convention to protect the marine environment
- Analyze the level of preparedness of Senegal.

## **1.3 Methodological approach**

The methodology must be able to answer the problems:

- Evaluation of the risks for Senegal. Method: risk analysis employing both quantitative and qualitative data.

- Capacity of Senegal to implement adequate measures to control the introduction of HAOP and to analyze the management policies implemented. This point will be developed by document review and interviews with relevant stakeholders in charge of environmental management in Senegal, namely, governmental departments, research institutions, consulting firms, and actors in charge of public or private issues, for instance the Autonomous Port of Dakar.

#### **1.4 Scope**

Located in the extreme west of the African continent, between 12° 20' and 16° 40' North Latitude and 11° 20' and 17° 30' West Longitude, Senegal is positioned at the crossroads of the maritime routes which are the most popular and the most profitable in the context of exchanges with Europe, America and Asia. The port of Dakar has an area of 325 ha, a total water area of 177 hectares and water depth of 12m. The access channel is 195m, and is dredged to 11m deep. On the West Coast of Africa, Senegal has 718 km of coastline with a maritime space of 198 000 km<sup>2</sup> and a wide continental shelf of 196 000 km<sup>2</sup>. Its Exclusive Economic Zone (EEZ) extends 200 nautical miles from the baseline. The coastal and marine environment supports economic growth and provides foreign exchange through coastal tourism, which is 30% of export revenues and creates 600 000 direct jobs. (Republic of Senegal, 2010; UNDP, 2009; UNEP, 2014).

On the basis of the momentum created by the UNCED conference in 1992, Senegal has adopted a consistent approach inspired by a vision within the perspective of sustainable development, in order to react to environmental problems. Consequently, several international conventions have been ratified. Despite these ratifications, **failures are noted on certain aspects, such as ballast water management.**

Given the scale of the problem of invasive species in international decision-making, the study will be based on the documentation of the International Maritime Organization (IMO) and the reports on Senegal. Reference will also be made to any authentic and reliable data sources, such as scientific studies, and relevant government reports.

#### **1.5 Structure of the dissertation**

In connection with the above, chapter (2) sets out the impact related to the transfer of HAOP and the international response to this problem.

Then, chapter three (3) analyze the exposure of Senegal due to the shipping activities, for this purpose, the risk evaluation of Senegalese Ports will be conducted. This assessment will allow to expose the vulnerability of marine ecosystem and which consequence can resulted.

Chapter four (4), will determine the requirement of the International Convention for the Control and Management of Ships 'Ballast Water and Sediments (BWMC) and examine the level of preparedness of Senegal to implement the convention. In addition, a strengths, weaknesses opportunities threats analysis will be conducted in order to present the strengths and weakness. Finally, formulation of general conclusion and recommendations will follow.

### **1.6 Limitations of the study**

The search for information encountered certain difficulties related, on the one hand, to the distance and, on the other hand, the search for the reference persons in this field of study in Senegal.

Some requests were not answered, despite being repeated several times. Occasionally references was not involved or willing to discuss the subject.

After an initial exchange by e-mail or telephone, the actors contacted provided a series of study reports. There are studies available to the public on request and online.

Interviews were conducted by telephone and by e-mail exchange following two methods: a formal first stage, where the person answered as a leader, and a second, more informal stage in the form of a discussion, where the actor interviewed gave more personal impressions, expressed doubts or provided more informal information. Moreover, in some cases, the interviewed actors sent reports of meetings in which they had taken part. These documents enabled the researcher to complete the interviews. The limit of the research is the difficulty of confirming the information provided, as it usually comes from a single source. The information is limited to what the actors want to share.

Elsewhere, reports on invasive species have been found at universities in Senegal, mainly Cheikh Anta Diop University. However, these reports are more relevant to aquatic invasive species.



## **Chapter 2 - Biological risks associated with ballast water**

### **2.1 Shipping and introduction of Harmful Aquatic Organisms and Pathogens (HAOP)**

Since the appearance of steel hulls and machinery such as pumps on ships, seawater has been used as ballast in order to distribute weight on board. Ballast Water (BW) is essential to the safety of ships in operation (e.g. stability, heel and trim adjustment, strengths and stresses, and propeller immersion) to compensate for the effects of cargo weight and location onboard (The National Academies of Sciences, 1996).

Under Article 1.2, the Convention defines BW as: *“Ballast Water means water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship”*. However, BW contains not only seawater, but also organic and inorganic matter present in the area of loading.

Therefore, due to the nature of seaborne trade, large volumes of seawater and organisms are carried by sea in BW tanks from one continent to another. It has been estimated that *“about 3,000 to 7,000 different species are transported every day around the world”* by ships (Bertrand, 2016; Globallast, 2009; Ranasinghe, 2016).

As shown in the annual report of UNCTAD in 2016, for the first time, maritime trade exceeded 10 billion tons in volume, up by 2.1% from 2014 (UNCTAD, 2016). Consequently, this resulted in an increase in the number of HAOP introduced in new environments. Numerous introductions of non-native species can result in disastrous consequences in marine ecosystems (EEA, 2012; GloBallast, 2017; IMO, 2017b).

Introduced by the Convention on Ballast Water Management, the expression Harmful Aquatic Organisms and Pathogens under article 1.8 *“means aquatic organisms or pathogens which, if introduced into the sea including estuaries, or into fresh water courses, may create hazards to the environment, human health, property or resources, impair biological diversity or interfere with other legitimate uses of such areas”*.

Nevertheless, Ballast Water is not the only vector or pathway of HAOP, additional serious ones under consideration by the IMO are biofouling and human sewage as shown in Figure 1.



Figure 1: Identification of the cause responsible for damage to the marine environment and related natural and human systems

Source : (GloBallast, 2013)

Considering biofouling, the risk comes from hull and niche areas which can accumulate large quantities of organisms and relocate them to other locations if the ship's hull and niche areas are not regularly cleaned. In this regard, IMO has developed guidelines and initiated, in 2017, the GloFouling partnership (IMO, 2017e).

### 2.1.1 Consequences of introduction of non-native species

The introduction of non-native species may have detrimental consequences on local ecosystems; some reduce populations by predation and competition, while others cause extinction of native species.

Invasive Alien species (IAS) are causing the destruction of marine biodiversity around the world. It is in this context that the 1992 Convention on Biological Diversity (CBD) considers the necessity to control and eradicate IAS (CBD, 2011; EU, 2004). The CBD, defines “*Alien species*” as “*a species, sub-species or lower taxon, introduced outside its natural past or present distribution; including any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce*”(ISSG, 2005). Additional expressions are also used: “*non-native species or non-indigenous species are more precise and should be used in preference to terms as introduced, exotic, feral, foreign, ornamental or weedy species*”(ISSG, 2005). One example of this is presented in the box 1.

### Box 1: example of invasive species

*Ctenophore Mnemiopsis leidyi*, which is highly preadapted to rapid colonization of new areas. It is a simultaneous hermaphrodite, is able to self-fertilize, and has a high reproductive rate. It is also a generalist carnivorous feeder and can live without food for a long time by simply shrinking during unfavorable conditions.

Source: (Shiganova, 2010)

## 2.1.2 Transformation of Non-native species into Invasive Alien Species (IAS)

All species are not invasive. The invasion process tends to develop over a period of time and, as such, species can remain for a long time in the natural environment without becoming invasive. However, a change in environmental conditions can lead to an increasingly rapid expansion of the species which becomes an IAS and could pose a menace to the new space (GloBallast, 2010).

### The Invasion Process

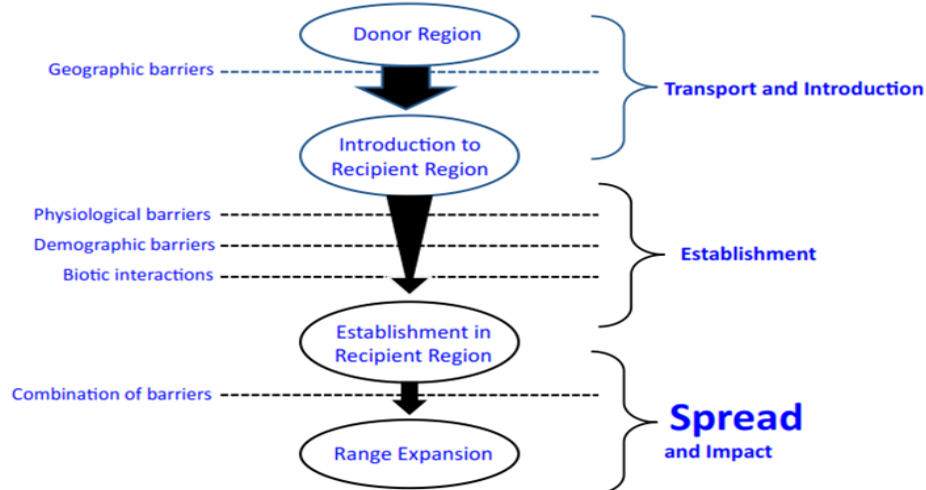


Figure 2 : Invasion process of species

Source: (AQUATICFIELDCOURSE2013, 2013)

### 2.1.3 Impacts of transfer of Harmful Aquatic Organism Pathogens (HAOP) VIA Ballast water

As showed by figure 3, there are diverse effects of the invasion of new species on the marine environment, such as changes to the ecosystem functions, human health and well-being, and economic impacts.

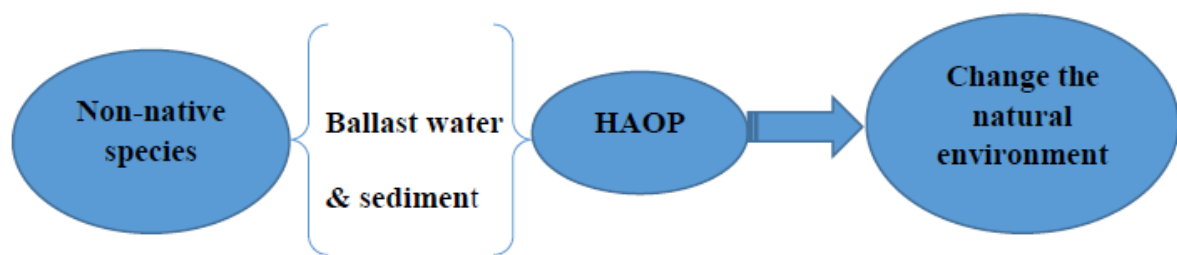


Figure 3 : Transfer of HAOP in new environment

Source: Author

#### Impact on Biodiversity

Under the CBD, “*Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*”(United-Nations, 1992).

Marine biodiversity is essential for provision of ecosystem services (provisioning and regulation, amongst others) (UICN, 2007).

However, IAS is currently the cause of species extinctions and danger to species endangered. To illustrate this, the box 2 present the effect of algae wakame.

#### Box 2: Effect of Algae wakame

To illustrate this, Wakame, originally from Asia, is a popular edible seaweed in Japanese cuisine and Korean cuisine. Algae has been introduced in different regions, including New Zealand, the United States and Europe, where it is currently considered “*one of the most harmful invasive species*”. The phenomena of proliferation and competition with the local species, leading to the disruption of the latter, are listed as consequences

## **Impact on Ecosystem Services**

Coral reefs, mangroves and estuaries ecosystems provide many services to coastal communities.

*“Ecosystem services are the goods and services that biodiversity provides. They include soil formation, the provision of food and fiber, air quality and climate regulation, the regulation of water supply and quality and the cultural and aesthetic value of certain plants and species”* (UNEP FI, 2008).

The report of the Millennium Ecosystem Assessment (2005) defines ecosystem services as *“the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth”*.

Hence, AIS can affect the above-mentioned services and this may have an impact on human well-being, the effect of which is already visible in certain regions of the world, such as Canada with introduction of zebra mussels in the marine environment (Sarah Nienhuis, 2014).

## **Impacts on Human Health**

IAS can be vectors of specific diseases. The negative impact on ecosystems tends to indirectly affect human health. For instance, the *Vibrio cholera*, a seaweed originating in Asia, caused, in 1991, a great epidemic of cholera in Peru (Gil et al., 2004).

In addition, harmful aquatic blooms in marine areas produce dangerous toxins that affect human health and species. Facing this, the UNESCO's Intergovernmental Oceanographic Commission (IOC-UNESCO) put in place an Intergovernmental Panel on Harmful Algal Blooms (IPHAB). The committee's recent report shows that “Toxins produced by HABs are associated with several syndromes, including Paralytic (PSP), Diarrheic (DSP), and Amnesic (ASP)”. Thus, all coastal states, and those who have freshwater reservoirs “can harbor HABs” (UNESCO and GEOHAB, 2015).

## **Impacts on Economic Activities**

Many cases have been identified in different regions of the world, which have resulted in the reduction of fishery products, habitat changes or competition due to the new species alteration. To demonstrate this, the box 3 present the effect of *Mnemiopsis leidyi* in North America.

**Box 3: Effect of *Mnemiopsis leidyi* in North America**

the *Mnemiopsis leidyi*, a carnivorous ctenophore from North America accidentally introduced into the Black Sea by ballast water, was responsible for the collapse of the commercial anchovy fishery, with losses estimated at more than one billion dollars

*Source: (Costello, Bayha, Mianzan, Shiganova, & Purcell, 2012).*

In addition, the box 4, present the effect of Zebra Mussel.

**Box 4: Effect of Zebra Mussel in Canada**

The Zebra Mussel has an industrial impact on certain nuclear power plants in Canada, affecting public water supply plants, which has consequences in water treatment facilities. Although there is management of invasive species, they affect the economic systems in these countries.

*Source: (Benson, 2014)*

Additionally, tourism and recreational activity are affected by HAOP. For instance in Canada, algal blooms pose the problem of degradation of water quality such as eutrophication (Priskin, 2008).

Central North Carolina beaches have suffered an estimated “\$82 million a year in lost income”, for the monitoring and treatment of sickness caused by HABs (Dan Kamykowski, JoAnn Burkholder, 2013).

## **2.2 International Framework to address introduction of HAOP by Ballast Water Discharge**

This section outlines the international response to HAOP and describes the constituents of the current international regulatory framework

### **2.2.1 A global issue needs global action**

Introduction of HAOP is a major economic and social concern because once introduced, they are nearly impossible to remove and as such the environmental consequences are considerable.

As a result, at the international level, the work done shows a growing awareness of the problem. Accordingly, Several Conventions provide States with important guidelines for avoiding the introduction and managing the issue.

### **2.2.2 Main International Instruments and Principles**

This section considers two frameworks: introduction of non-native species and marine environmental protection.

#### **Convention on Biological Diversity (CBD)**

As explained above, CBD provides guiding principles on invasive alien species.

As stated in the 2011-2020 CBD Strategic Plan for Biodiversity, state parties of the Convention are committed to achieving Aichi Biodiversity Targets. Target 9 of the Convention addresses invasive species: *“By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated and measures are in place to manage pathways to prevent their introduction and establishment”*(CBD, 2011, 2013).

#### **The Global Invasive Species Program (GISP) – non-UN Framework but internationally recognized**

*The GISP is “coordinated by the Scientific Committee on Problems of the Environment (SCOPE), in collaboration with the World Conservation Union (IUCN), and CAB International (CABI). This program contributes to knowledge and awareness of invasive species. To this end, it proposes a guide on knowledge of species (UICN, CAB International, 2001).*

#### **The Convention on Wetlands (Ramsar Convention)**

This Convention, drafted at Ramsar (Iran) on 2 February 1971, aims at *“the conservation of wetlands and their resources”* (Ramsar Convention, 2011). Resolution VIII 18 deals with invasive species. The convention provides guideline that states should follow to manage the problem. As a result, the Global Invasive Species Programme (GISP) International Union for Conservation of Nature (UICN) and Ramsar Convention work in one program in Africa. The aim is to offer a framework for the preservation of wetlands and raise awareness of local populations about invasive species (UICN, 2003).

## **The United Nations Convention on the Law of the Sea (UNCLOS)**

The Convention was adopted in 1982 and entered into force in 1994; a number of provisions intend to protect and preserve the marine environment against pollution and harmful organisms. The protection and preservation of the marine environment is addressed in Part XII, Articles 192 to 237 (United Nations, 1983).

Art. 192 places a clear obligation on States: *“States have the obligation to protect and preserve the marine environment”*.

Article 194 recalls that *“States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention”* (United Nations, 1983).

Article 196 states that States:

*“State shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto”* (United Nations, 1983).

In addition, article 94 is particularly important because it recalls the responsibilities of the Flag State (FS) to effectively implement regulations on its fleet. Article 211, 217, 218, 220, 226, emphasizes the compliance and enforcement powers of the States.

## **Food and Agriculture Organization (FAO)**

The FAO Code of Conduct for Responsible Fisheries (1995) also considers invasive species. It calls for the conservation of marine resources (FAO, 2005, 2006b). In connection with this, an ecosystem approach to biodiversity and climate change was also implemented by FAO. The governing bodies of FAO have adopted the Biosecurity Framework to foster a strategic and integrated approach (FAO, 2006a).

## **IHR 2005 and Ballast water (World Health Organization -WHO)**

The 2005 International Health Regulations (IHR) is an international legal instrument that is binding on all WHO member states. It aims, through appropriate action, to help the



international community avoid acute public health risks that can spread across borders and threaten the world. In the framework of the 2005 International Health Regulations (IHR), each State must establish monitoring and vector control programs, within the meaning of Article 1 of the IHR(WHO, 2005).

Since 1951, the IHR has required a Deratting Certificate/Deratting Exemption Certificate “*for the international public health control of ships visiting international ports*”. Every six months this certificate is renewable for ships on international voyage. It is also required that all parts of vessel be inspected. The 2005 IHR replaced this certificate with “*ship sanitation certificates (SSCs)*”.

This certificate allows the control of public health risks on ships. It provides records concerning the sanitary conditions of the vessel. In its guide to inspectors, the WHO highlights the importance of verifying the ballast water system (WHO, 2005).

### **2.2.3 The International Maritime Organization (IMO) and its response to Ballast Water threat**

Since 1988, Canada has raised the issue of ballast water at the IMO. In relation to this, 1997 marked the adoption of Resolution A.868 (20) 55, which revised the “*guidelines for the control and management to minimize the transfer of harmful aquatic organisms and pathogens*”(Scriven, 2014).

However, aware of the limitations of these guidelines, IMO member states worked to develop an essential international framework to control the use of BW.

#### **GloBallast program (2000-2017)**

IMO developed the GloBallast program, a technical cooperation project sponsored by the Global Environment Facility (GEF) to assess and mitigate the impacts of BW discharges (GloBallast, 2010; IMO, 2017a, 2017d).

This project consists of removing the obstacles associated to the implementation of the Convention in developing countries. Divided into phases, the first phase of GloBallast delivered technical assistance. It began in March 2000 and was completed in December 2004 after the adoption of the Convention. The second phase of GloBallast (2007-2017) focused “*on national policy, legal and institutional reforms in targeted developing countries with an emphasis on integrated management* (Globallast, 2009; GloBallast, 2004).

#### **2.2.4 The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention)**

The convention was adopted by IMO in 2004. As soon as the Convention was adopted and, with a view to encouraging its establishment, 14 technical guidelines were developed. In respect to this, all vessels must hold an International Ballast Water Management certificate, demonstrating compliance with the convention requirements (IMO, 2017b).

##### **Entry into force**

The Convention entered into force, on 8 September 2017. The Convention concerns all vessels carrying ballast and traveling internationally under Article 3; however, some ships may be excluded (IMO, 2017c).

The Convention requires the ships to manage Ballast Water according to the standards provided in the annex of the convention. The management of Ballast Water aims to eradicate, inactivate or destroy HAOP. The convention put in place two types of ballast water performance standards.

##### **The D-1 and D-2 Standards**

The BWMC requirements have established two different standards: *“the first is a standard for ballast water exchange, and the second is based on the quality of the ballast water”* (IMO, 2017c).

##### **Regulation D-1 – Ballast water exchange standard – D-1 (BWE)**

D-1 standard prescribes that ships performing ballast water exchange have the obligation to perform it with a performance *of at least 95% volumetric exchange ballast water*. To this end, Regulation B-4 of the Convention supports that (IMO, 2017c):

*“All ships using ballast water exchange should:*

- “Whenever possible, conduct ballast water exchange at least 200 nautical miles from the nearest land and in water at least 200 metres in depth, taking into account Guidelines developed by IMO”;*
- “In cases where the ship is unable to conduct ballast water exchange as above, this should be as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres in depth”.*

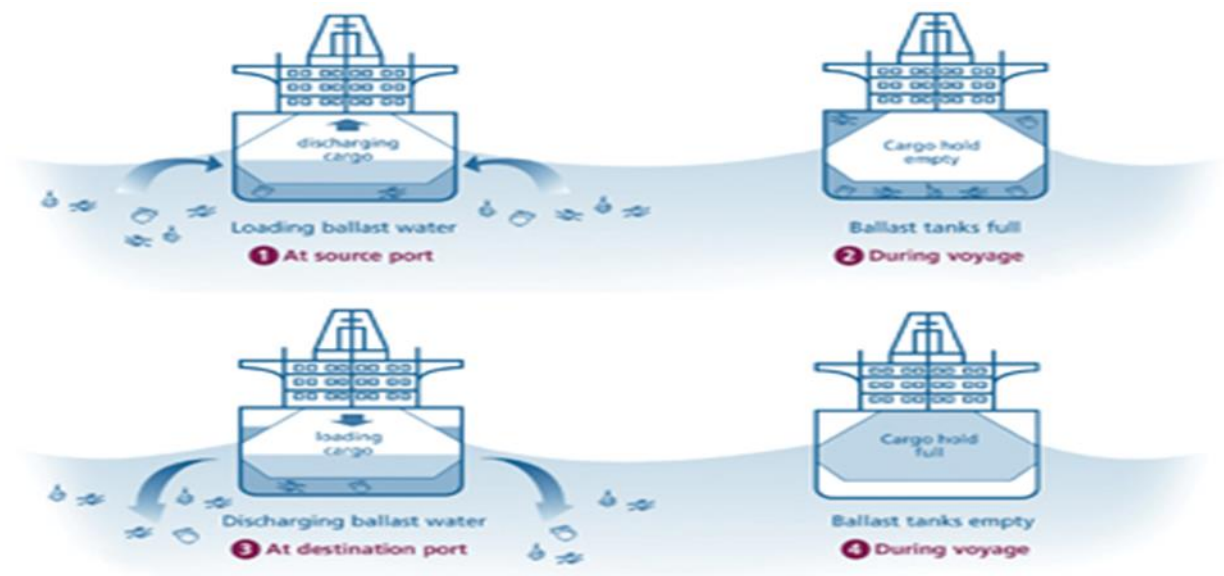


Figure 4: Ballast water exchange process

Source: GloBallast 2016.

The figure 4 show the BW exchange process. The G6 Guidelines for Ballast Water Exchange also provide information on safety and operational aspects (IMO, 2017c).

### **Regulation D-2 -Ballast Water Performance Standards – D-2**

The purpose of D-2 is to make sure that the quality of the water discharged by the ship will meet thresholds considered to be harmless. It is a goal-based standard, offering the possibility to the shipowners to choose the appropriate technique to comply with D-2 (IMO, 2017c).

### **Ballast Water Management Plan**

The mandatory ballast water management plan (reg. B-1) and Ballast Water Record Book must be available on board to demonstrate that ships are complying with requirements. “*Regulation B-1 states that ships are required to have on board and implement a Ballast Water Management Plan approved by the Administration. The Ballast Water Management Plan is specific to each ship and includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices*”(IMO, 2017c).

## **Guidelines of the BWMC**

In the vision of a global interpretation, guidelines are established by IMO for an effective implementation of the Convention. It is within this framework that 14 guidelines have already been adopted (annex1) (Lloyd's Register, 2016).

## **Conclusion**

Increased trade between different parts of the world has favored the transfer of HAOP to marine environments. As such, many initiatives have been launched such as Imo convention, resulting in many actions like GloBallast program and publications. On the same front, IMO initiated the BWMC to reduce the risk of introduction of these species. However, besides these answers, there are always concerns. Once these species are introduced, eradication is complicated, even impossible.

In view of that, the next chapter will analyze the risk related to exposure to Ballast Water discharge of Senegal.

## Chapter 3 Risk for Senegal

This chapter sets out the risk associated with HAOP by using the analysis of GloBallast training on risk assessment 2016. In this context, it is a question of determining the system to be protected against the hazard, then assessing the exposure of the system. This exposure result to examining the vulnerability of the system and the consequences.

### 3.1 Risk principle and approach

By evaluating the exposure, vulnerability and consequences of the introduction of HAOP, the following analysis intends to present the potential risks for Senegal imposed by uncontrolled BW discharges.

#### 3.1.1 Hazard and Risk Relationship

The risk is a probabilistic evaluation of the hazard. The hazard must be identified and the risk quantified or evaluated qualitatively. According to the GloBallast (2016), “*if hazard is the potential for a substance or a condition to cause harm, the likelihood for that hazard to cause harm constitutes risk*”. The figure 5 show the link from hazard to risk.



Figure 5: From hazard to risk

Figure 5: From hazard to risk. *Source: (Globallast, 2016)*

In this study, the hazard/ threat to consider is the discharge of BW, containing potential HAOP, to the marine environment. As the marine ecosystems cannot be “repaired/restored” after the introduction of HAOP, the action/measures to control BW risks must focus on preventing

HAOP discharge. To this end, the analysis will follow the process described in Figure 6, which will serve as a guide for identifying the risks associated with the introduction of HAOP by ballast

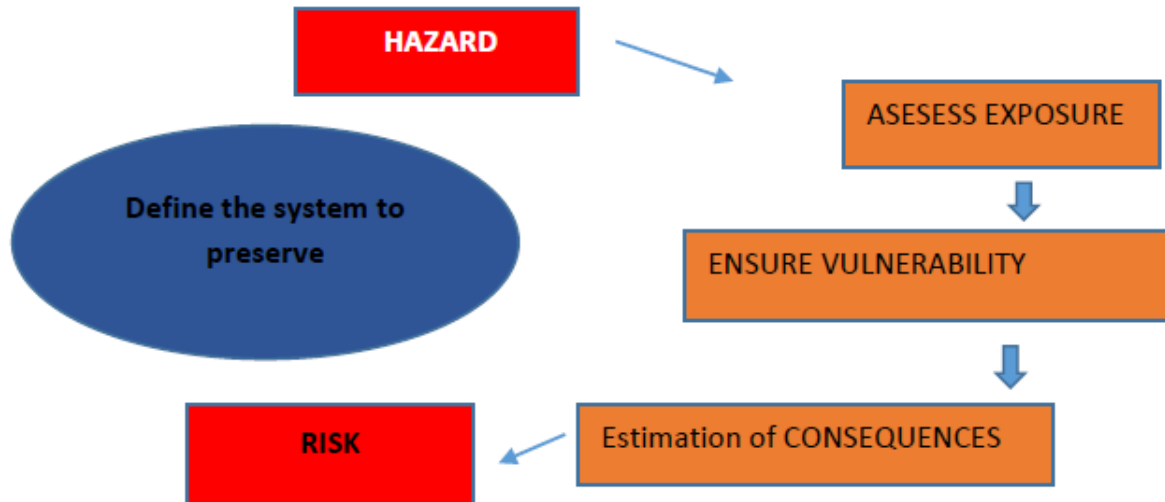


Figure 6: Elements to consider in risk evaluation water

Source: GloBallast 2016

### 3.1. 2 Definition of the system to be protected from the Hazard (BW)

Maritime waters under Senegalese jurisdiction consist of the territorial sea, the contingent zone, the exclusive economic zone, the inland marine waters and rivers. The exclusive economic zone extends over a width of 200 nautical miles (IRD, 2016).

In West Africa, the UNEP Regional Seas Convention named the Abidjan Convention addresses the rapid degradation of marine areas through sustainable management. It determines the framework for any cooperative national or regional action for the protection of the marine environment. As ecosystems are connected, a regional approach is always preferable; however, this analysis is limited to the case of Senegal.

### 3.1.3 Focus on BW Hazard

The hazard to consider is the introduction of HAOP by BW in Senegal. Considering that biological invasions are a global issue, they will certainly not be avoided by a country like Senegal, which increasingly participates in international trade.

### 3.14. Exposure in the context of Senegal

The growth of port activities is very important in Senegal, given its contribution to the country's economy. Its main port, which is the port of Dakar, recorded freight traffic of 10 million to 15 million tons between 2012 and 2015, an increase of 13% (Diallo, 2016). This development of port activities poses the problem of exposure of Senegal.

### **3.2 Analyses of Senegal's exposure to Ballast Water discharge**

#### **3.2.1 Exposure to seaborne trade**

The importance of the maritime sector in Senegal cannot be underestimated as nearly 90 per cent of the country's traded goods are transported by sea (APS SENEGAL, 2013). Senegal is one of the major shipping destinations in West Africa. Trade ranges from small vessels to giant container ships belonging to major shipping companies. Although there are economic benefits of Seaborne trade, it also presents an enormous challenge for Senegal in terms of BW discharge from ships calling the ports of Senegal.

The major ports in Senegal can be ranked in order of importance based on the level of traffic. To this end, the autonomous port of Dakar represents the only port that can accommodate large vessels and container ships. It also represents the port of transit of goods destined for Mali (USAID, 2010). The other ports are ports of Kaolack and Ziguinchor, which are river ports that receive medium-sized ships. The last is the port of Saint Louis which does not have many activities like the other ports, but nevertheless constitutes an important fishing port (ANAM Senegal, 2015b).

#### **3.2.2 Main Senegalese Ports**

##### **Port of Dakar**

The Port Authority of Dakar (PAD) is the public entity that has authority over infrastructure and manages port activities in the main port of the country. The Port is under the purview of the Ministry of Fisheries and Maritime Economy (MPEM).

The port of Dakar has long been considered the backbone of Senegal's economy, generating 85% of customs revenues, and fueling 40% of the State's budget. The volume of freight increased from 11.4 million tons in 2011 to 15.2 million tons in 2015 (Autonomous Port of Dakar, 2016a, 2016b; SSATP, 2002).

In 2016, according to data from the Senegalese port authority, ship traffic totaled 2,749 calls at the port of Dakar. It increased by 4% and 2% respectively compared to 2014 with 2,643 calls

and 2015 with 2,705 port of call (Autonomous Port of Dakar, 2016b). The figure 7 show the presentation of port of Dakar.



Figure 7: Port of Dakar

Source: Google image

Within the port of Dakar is DAKARNAVE, which is a naval repair shipyard. DAKARNAVE is affiliated with LISNAVE INTERNATIONAL, SA. Between 2014 and 2015, various ships frequented this shipyard for metalworking, sheet metal work and piping, electrical repairs and surface treatment (DAKARNAVE, 2011). This may have involved work inside BW tanks and the removal of sediments.

Table 1:: Evolution of Traffic (tons) in the port of Dakar 2014-2016

Type	Traffic	Years		
		2014	2015	2016
<b>Solid bulk</b>	Unloading	2 161 974	2 678 814	3 487 761
	Loading	1 178 588	1 581 089	1 244 379
<b>Liquid bulk</b>	unloading	3 166 200	3 145 290	3 370 928
	Loading	456 070	567 634	813 637
<b>Containers</b>	unloading	2 798 044	3 047 209	3 573 113
	Loading	1 064 212	1 233 035	1 318 494
<b>Divers</b>		2 180 487	2 501 571	2 103 661
<b>Total</b>		13 005 575	14 754 642	15 911 973

Source: report of PAD 2016



Table 1 presents the evolution of traffic in the port of Dakar. Oil tankers and bulk carriers are the most frequent in the port of Dakar and represent the greatest ballast water volumes.

In fact, the majority of cargoes handled at the Port of Dakar between 2014 and 2016 are solid bulk and liquid bulk cargoes as shown in Table 1. Despite the lack of available data on BW discharges, considering the type/number of ships operating in Dakar, there must be large volumes of unmanaged BW discharged in the port.

Under Article 5 of the Ballast Water Convention, which concerns sediment receiving facilities, “each Party undertakes to ensure the provision of adequate reception facilities”. However, the information received from Dakar Port indicates that there is no ballast water management facility at the port of Dakar.

### **Port of Ziguinchor**

As a river port, the Harbour of Ziguinchor allows vessels up to 5,000 DWT (standard size of short sea vessels) to pass there.

The Senegalese Consortium for Maritime Activities (COSAMA) was set up on 13 December 2007 and is responsible for the operation of the Dakar-Ziguinchor shipping line, with the main activity of transporting passengers and goods (COSAMA, 2016). In terms of traffic volume, shuttling between Dakar-Ziguinchor is conducted by three Senegalese vessels. The three ships have the same dimensions but do not work at the same rate (ANAM Senegal, 2015). The number of ports of call for the period 2013-2015 increased from 133 to 329. The total numbers of passengers and freight in 2015 are shown in Table 2.

Table 2: Statistics of vessels in Ziguinchor maritime station in 2015

<b>Vessels</b>	<b>Passengers</b>	<b>Frets</b>
<b>Aline Siteo DIATTA</b>	87947	12996
<b>Aguène</b>	14972	4815
<b>Diambogne</b>	15584	4416

*Source: Statistic report of National agency for maritime affairs in Senegal.*

In addition, figure 8 presents the port of Ziguinchor.



Figure 8: Port of Ziguinchor/ Senegal

*Source: Google image*

### **Port of Kaolack**

Import traffic is non-existent in this port. Traffic deals with cereals and building materials. The export trade includes basalt, iodine salt, crude groundnut oil, and peanut lettuce (TAD). The port registered a total number of 39 ship calls in 2015. In 2015, the tonnage shares were 72 700t, 60 750t, and 10 994t for basalt, iodized salt and crude groundnut oil, respectively (ANAM Senegal, 2015b; ANSD Senegal, 2016).

The iodized salt is exclusively exported to the port of Abidjan. Peanut oil and cakes are always directed to Europe where they are usually processed into enriched cake and used as a livestock feed. The basalt is transported to Ziguinchor, the Gambia or Guinea Bissau (ANAM Senegal, 2015b).

Ships in the port of Kaolack have an average length of 82 meters, ranging from 54.3m to 100 meters. Their average width is 12.6 meters and they range between 10 and 15 meters. (ANAM Senegal, 2015b). The figure 9, presents the port of Kaolack.



Figure 9: Port of Kaolack

*Source: Google image*

The ports of Ziguinchor and Kaolack present a medium risk of exposure to ballast water discharge because the great majority of the maritime traffic transits through the port of Dakar. However, even if this exposure is not important, the environmental component of these spaces should not be overlooked because the most important marine areas in Senegal are located there, with marine protected areas, marine parks and wetlands, which are a World Heritage.

### **Port of Saint Louis**

As for the port of Saint Louis, it has virtually ceased all truly significant operations. A study for its reconstruction is underway (ANAM Senegal, 2015b). However, the figure 10 presents an overview of the city of Saint Louis.



Figure 10: Saint Louis

*Source: Google image*

## New development bulk port in Bargny Senegal

The Bulk port of Bargny (in close proximity to Dakar) is a project initiated by Senegal to take charge of the important traffic of existing mining and petroleum products, (APIX SENEGAL, 2017). The project, which targets to contribute to the reduction of traffic to the port of Dakar and, consequently, the decongestion of the capital, will also reduce the turnaround time of loading and unloading of cargoes. Not yet operative, this port does not expose Senegal.

### 3.2.3 Conclusion on exposure

Following this analysis, it is appropriate to consider the high and low risk zones for Senegal in order to take a strategic approach to reducing this threat.

Table 3 : Summary of the exposure of Senegalese Ports (High -Low exposure)

Ports	Indicators	Remarks	Levels of Exposure
<b>Dakar</b>	Level of traffic- high	Frequented by vessel using high volume of BW. The traffic is constant.	High
<b>Ziguinchor</b>	Level of traffic - medium	Visited by small size of ship with stable passenger traffic	Medium
<b>Kaolack</b>	Level of traffic - medium	visited by small size of ship, with frequent traffic	Medium
<b>Saint Louis</b>	Level of Traffic- low	Not frequent traffic	Low

*Source: Author (Awa Camara)*

The data collected on the ports, particularly Dakar Port, indicate high risk in terms of exposure to ballast water discharges. However, there is inadequate data to precisely quantify ballast water exchanges in Senegalese waters and to know the provenance of such BW.

Thus, this becomes a concern and calls for the implementation of national rules and regulations for ports.

This short exposure assessment shows that Senegal is affected by BW discharge and its potential consequences. The next section will examine the vulnerability of the marine environment and the consequences of the vulnerability.

In addition to ballast water, the Port of Dakar is exposed to numerous other stressors such as urban and industrial effluents and residues which penetrate the marine ecosystem. Urban effluent treatment services are deficient in Senegal; these waters are diverted directly to maritime space. (The World Bank, 2004).

The phenomena highlighted in respect of environmental pollution and ecosystem destruction presents conditions for the prevalence of species such as toxic algae. Moreover, the impact of disturbances that are natural and anthropogenic in nature are also create vulnerability to invasion.

### **3.3 Vulnerability of marine environment in Senegal**

Vulnerability is central in risk analysis. Among the plurality of definitions and approaches, the following seems the most appropriate related to BWM: according to GloBallast Partnership Programme Training (2016) “*Vulnerability means the susceptibility of a system to the impact of hazards*”. In this context, the level of exposure determines the risk of vulnerability. To this end, the objective of this section is to present the marine biodiversity in Senegal, assess the vulnerability to biological invasions and determine the socio-economic and environmental consequences.

#### **3.3.1 Marine and coastal systems in Senegal**

The continental shelf extends over 31,000 km<sup>2</sup>. The diversity of the shelf and continental shelf biotopes, as well as the richness of marine waters in phytoplankton, favor a wide diversity of fish stocks. Fish products play an important part in the diet of the Senegalese population. The fisheries sub-sector contributed 7.5% to the GDP of the primary sector and 2.2% to the total GDP in 2012. The estimates of the scientific campaigns carried out by the Oceanographic Research Center of Dakar Thiaroye (CRODT) in 2015, show an increase in pelagic biomass. The exploitation of fishery resources in Senegalese waters is the result of artisanal fisheries, semi-industrial and industrial sectors. Senegal has entered into a Fisheries Agreement with the European Union since 1979 and this agreement has since been renewed. In 2014, Senegal signed a Fisheries Partnership Agreement with the European Union (EU) on tuna for a period of five years. Senegalese aquaculture is mainly focused on fish farming, shrimp farming and oyster farming (EU, 2014; GREENPEACE, 2016; Sub-Regional Fisheries Commission, 2016).



**Casamance River:** The Casamance River, which is more than 250 km long, is the source of life in the Casamance region of Senegal, which bears its name. The area is invaded by backwaters and streams and these hydrographic networks contribute to the agricultural wealth of the Casamance region (FAO, 2009).

**Gambia River:** The Gambia River is 1,130 km long, 500 km of which can be navigated, and originates in the Fouta-Djalón highlands in Guinea and then flows through Senegal, and the Gambia before emptying into the Atlantic Ocean. In Senegal, the river crosses the Niokolo-Koba National Park.

**Saloum River:** The 250 km long Saloum River flows into Senegal in the Sine-Saloum region. In the Saloum Delta, the river arms meet the sea by cutting off the mangrove forest, which allows many species of fish to breed there. Due to the richness of its fauna and flora, the Saloum Delta is a biosphere reserve of United Nations Educational, Scientific and Cultural Organization (UNESCO) (UNESCO, 2017).

**The Senegal River** is the second largest river in West Africa, with a watershed area that spans 343,000 km<sup>2</sup>. The Senegal River Delta is a region of international importance because of the Palearctic migratory birds. The numerous wetlands that it contains, make Senegal one of the main zones of reception of water birds in West Africa. Senegal has five (5) sites of international importance for water birds (Ramsar site) (Ramsar, 2011). The figure 11 shows the Saloum Delta National Park in Senegal.



Figure 11: Saloum Delta National Park in Senegal

*Source: Google image*

## **The mangrove**

The mangrove ecosystem covers an area of about 300 000 hectares in Senegal. More than 115 different species of fish come to breed and grow in the mangrove of the Saloum Delta. As showed in figure 12 The Saloum Delta is one of the largest mangrove reservoirs in Africa (Adg, 2012; Republic of Senegal, 2014).

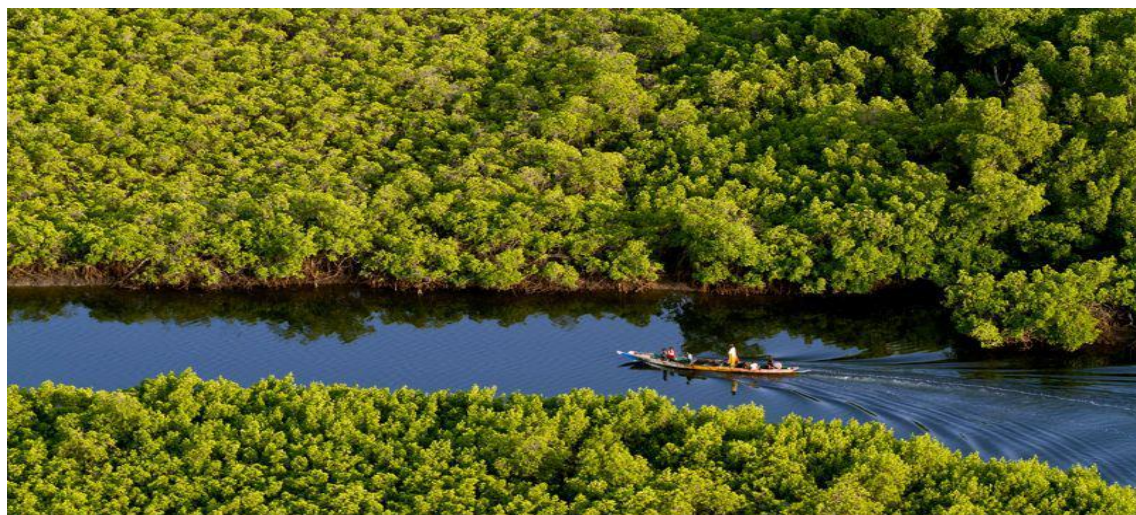


Figure 12: Mangrove Sine Saloum

*Source: Dakar-Echo-.com*

## **The niayes**

Niayes “is the Wolof term used to refer to the long coastal zone”. The Niayes run along the north coast of Senegal (from Dakar to Saint-Louis) for 135 km. They occupy a narrow area (35 km maximum) of about 2 000 km<sup>2</sup>. The Niayes harbors about 419 species, representing nearly 20% of the Senegalese flora (Republic of Senegal, 2014; UNEP, 2015). It serves as a vegetable market for a large number of farmers. At the bottom of the dunes, the fresh water is indeed abundant and shallow. A large number of farms, therefore, profit from this peculiarity of the Niayes. Many farmers live on the spot, in straw huts. Most of the vegetables are sold on the Dakar markets and 80% of the country's ornamental flowers and plants are produced in the Niayes.

## **Djoudj Depression**

Djoudj Depression is a wetland area of about 16,000 ha including a large lake. Created in 1971, the Djoudj National Bird Park has been classified since 1981 as a World Heritage Site by UNESCO. As showed in figure 13, it hosts thousands of migratory birds spread among 300

species. Also, semiaquatic animal species are represented as well as terrestrial mammals (Republic of Senegal, 2014; UNEP, 2015).



Figure 13: Djoudj National Bird Park

*Source: Google image*

These wetlands may be destabilized by the introduction of HAOP. These areas are rich in biodiversity and play an essential ecological role for the country, but are declining sharply. Already vulnerable to the impact of anthropogenic factors, such as pollution and climate change, measures for the protection of these environments are considered insufficient in Senegal.

Most of the studies conducted in Senegal concern the control of invasive plants which negatively impact significant proportions of Senegal Rivers. Species such as *Typha domingensis*, *Salvinia molesta*, *Mimosa pigra* and *Mitragyna inermis* have invaded the aquatic environments of Senegalese Rivers (Diop, 2009).





Figure 14: Typha invasions in Senegalese river

Source: (Association TypHAS, 2014)

Typha, a harmful aquatic plant showed in figure 14, is present in Senegal, in the Senegal River valley and its proliferation has become worrisome. Indeed, the damage caused by this plant to the overall socio-economic life of the riparian populations is a source of concern. Its negative impacts on agriculture, fisheries, livestock, population health and biodiversity are detrimental.

These plants invade water bodies, thus compromising their accessibility for navigation and fishing. These species also cause eutrophication of the water and compete with other local species (Barron, Fox, & Koudeoukpo, 2007; OMVS, 2006).

### 3.3.2 Potential vulnerable invasion

Table 4: Ecosystems dynamic in Senegal

Ecosystems	Non-natives species identified in Senegal	Potential vulnerable invasion	Overall vulnerability in Senegal High/medium/low
<b>Mangroves</b>	Lack of data	lack of data	<p><b>Medium :</b> Strong dependence on natural resources of the local population</p> <p><b>Resilience:</b> Limited because mangrove is used by some invasive species like lionfish Pterois volitans in others</p>

			countries such as Bahamas and San Salvador.
<b>River Senegal</b>	- affected by Typha	- Modification of the hydraulic regime of the river - Development of irrigated crops and nutrient discharges into river waters	<b>High:</b> Invaded by tropical species such as Typha which grows in dense formations on moist soils <b>Resilience:</b> Limited by the effect of climate change.
<b>River Saloum</b>	Lack of data	lack of data	<b>Medium:</b> Strong dependence on natural resources of the local population. <b>Resilience:</b> Limited by human pressure on resources.
<b>Niayes</b>	affected by Typha	highly affected by tropical aquatic plants	<b>High:</b> Strong dependence on primary natural resources and market gardening revenues. <b>Resilience:</b> Limited by the increasing demographic pressure on natural resources.
<b>Le Djoudj</b>	affected by Typha	Vulnerable due to hydro-agricultural developments	<b>High:</b> Decrease of annual flooding resulting in loss of areas. <b>Resilience:</b> Weak enforcement of policies and legislation to protect species and ecosystems that are rich in biological diversity.

Source: Author using various work : (Caro, Frutos, Kitwana, & Shen, 2011; OMVS, 2016)

### 3. 3.3 Other trends affecting overall resilience of ecosystem in Senegal

Senegal's population was estimated at 15.3 million in 2016. (The World Bank, 2016, 2017).

The growth of the human population is a major factor that affects the environment. Overcrowding means that there are more demands for goods, services and resources to meet the needs of the population. Almost all the environmental problems Senegal faces today can be attributed to the increase in the population.

Referring to a report on Senegal's biodiversity in 2015, the current state of knowledge, it is relatively difficult to make an objective assessment of the conservation trend of ecosystems and species because the status of biodiversity has not been updated at a national level.

Nevertheless, based on limited studies, it is known that most ecosystems are characterized by a relatively high degree of degradation, but vary according to the type of ecosystem.

The problems of biodiversity are attributed to various pressures such as habitat destruction and fragmentation, overexploitation of resources, climate change and invasive species.

In addition, the tourist activities, with the extension of buildings for tourist use or habitation, are an aggravating factor in coastal degradation.

Illegal, Unreported and Unregulated Fishing (IUUF) currently constitutes a scourge that destroys coastal and offshore fish stocks. In referring to the Red List of the IUCN, which presents information relating to the status of conservation of plant and animal species, a strong presence of different large sharks is listed in Senegal. Due to the high value of their fins, a threat is constituted against this species in Senegal. The sharks are often a target of illegal and unregulated fishing (Beveridge et al., 2013; FAO, 2011; GREENPEACE, 2015).

Another effect is climate change, which affects the Senegalese coast. This effect include serious landslides due to extreme rainfall and erosion, a generalized decrease in total annual rainfall, and a disturbance to the conduct of the rainy seasons, marked by late starts, with a narrowing of the small rainy season. In addition, increasing salinity and salt water intrusion into freshwaters affects mangrove forests, resulting in their gradual deterioration and causing the destruction of a refuge for aquatic fauna. The abovementioned effects increase the vulnerability of marine ecosystems and reduce their resilience. The threats have negative socio-economic impacts. Senegal suffers from a disturbing sea level rise, which claims between 1 to 1.3m of the coasts annually. (AMCC+, 2015; rfi AFRIQUE, 2015).

### **3.4 Consequences related to the introduction of HAOP in Senegal**

After analyzing the vulnerability of the marine environment in Senegal, the possible consequences can be appreciated under the different segments discussed below

#### **3.4.1 Consequences to food security**

The Fishing sector plays a significant part in the socioeconomic context of the country, as it provides an important source of revenue for local populations. The processing of fish products is a lucrative business for coastal communities. Shellfish harvesting in the Saloum delta provides significant income to the population. Between 9,000 and 10,000 people are active in this sector, including 7,000 to 7,500 fishers (CSE Senegal, 2015; IMARES, 2014; USAID, 2015).

In addition, the fisheries and aquaculture sub-sector is one of the six high-value-added areas chosen through the Accelerated Growth Strategy (SCA) to effect a structural transformation of the Senegalese economy (PRCM, 2016).

Biological invasion has the potential to harm the ability of Senegal to enhance food security because invasive species affect marine ecosystems and alter some species which have high economic value.

#### **3.4.2 Consequences related to Poverty Growth**

Coastal regions constitute one of Senegal's main potentials, the stakes of which are perceived by the size of the human population. More than 75% of the population lives within 60 km of the shoreline. These populations belong to different communities depending on the activity carried out. The Senegalese coastline has a strong community of fishers (CSE senegal, 2015; The World Bank, 2015). Poverty alleviation is at risk due to biological invasion as shortage of commercial viable fish species and subsequent job losses could have negative impacts on the livelihood of the coastal population.

For the rural population that lives on agriculture and livestock, the excessive development of Typha also raises problems with respect to livestock activities. In fact, typha causes the proliferation of certain parasites, and prevents livestock access to watercourses (PNUD, 2014).

#### **3.4.3 Economic consequences**

Tourism is a key sector for the socio-economic development of Senegal. It is the second source of foreign currency after fishing. Senegal owes the diversity of its offering to the generosity of its coasts, which extend widely over the Atlantic Ocean, but also to its political stability.

Senegal is considered the leading tourist giant in West Africa. Tourism is mainly seaside (PRCM, 2016).

Citing the impact of invasive species on Canada's tourism sector, Senegal's tourism industry could also be impacted negatively due to economic losses emanating from biological invasion and intervention and mitigation measures, requiring huge financial resources.

Table 5: Dependence on marine environment, classification of the most important sector

Sectors	Services	Remarks	Conséquences of Invasion
<b>Fisheries</b>	Food security- high dependence Jobs - high employment	Provides 75% of animal proteins. Creates 600 000 direct and indirect jobs.	High
<b>Shipping</b>	Trade - high volume of trade Income and employment and huge support for government revenue	Port of Dakar received around 2000 vessel/ year.	High
<b>Tourism</b>	Aesthetic Value - high Cultural Heritage -very important Income – high for coastal population	The second source of foreign currency after fishing.	High
<b>Aquaculture</b>	Food security- medium Income and employment - low	Developing sub-sector.	Medium

Source: Author (Awa Camara)

### 3. 4.5 Conclusion – Risk assessment for Senegal

The analysis of the exposure and vulnerability of Senegal to the risks of introduction of HAOP shows that ports are potential hotspots for “importing and exporting” harmful aquatic species.

Data collected shows that Dakar port is the leading port in terms of exposure due to the number and types of vessels that frequent it lacks adequate regulations.

Senegal has a marine diversity that plays an important role in food production, and medicine. However, this marine biodiversity is marked by a regressive dynamic linked to human activities, accentuated by climate change, salinization of land and invasive species. This loss of marine biodiversity affects most development sectors such as livestock, fisheries, and tourism and thus impacts the living conditions of human populations.

Currently, the major challenge that Senegal is facing is how to reconcile the conservation of biodiversity with the needs of a population whose demand for resources is constantly increasing.

From all indications, the risk to Senegal of a possible bio-invasion is not negligible, because the risk is high.

The sustainable use of marine biodiversity will require a vision to manage and control. For this reason, it is imperative that this vision address urgent concerns relating to the implementation and enforcement of the obligations reference in the International Convention on Ballast Water Management.

In addition, the safety of maritime activities will be essentially enhanced through the development of strict sanitary surveillance. This will not only ensure the realization of the economic development of maritime trade, it will also benefit other sectors such as tourism, fisheries, and aquaculture.

The next chapter will analyze Senegal's capacity to implement the Ballast Water Management Convention, including the implementation of a "Ballast Water Management Plan" by Senegalese ports.

## Chapter 4: Capacity of the State Senegalese to implement the Convention on the Management of Ballast Water

The signing and implementation of the BWMC requires States to commit, implement and enforce BW requirements.

The Ballast Water Convention assigned to flag States, port States, and coastal States the responsibility to ensure the protection of the marine environment. In this regard, this chapter examines the provisions set out in the convention, and the current maritime legislation of Senegal. Furthermore, the chapter will assess the mandate of the maritime regulatory bodies in Senegal, in line with the requirements of the convention.

### 4.1 Maritime Administration

#### 4.1.1 Status of ratification of IMO conventions in Senegal

As a member of the IMO, Senegal, after ratifying some international maritime conventions, has to respect its commitment by implementing and enforcing regulations.

Table 6 shows the list of IMO Conventions ratified by Senegal.

Table 6: IMO Convention/instrument ratify by Senegal

IMO Conventions included in III code	Other IMO conventions ratified by Senegal
The International Convention for the Safety of Life at Sea (SOLAS), 1974 and Protocols, 1988	The International Mobile Satellite Organization (IMSO 76)
	Convention on the International Maritime Satellite Organization (INMARSAT 76)
The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978;	Convention on Facilitation of International Maritime Traffic (FAL 65)
The International Convention on Standards of Training, Certification and Watch keeping for Seafarers (or STCW), 1978/ 2010 Manila amendments	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION 1969)

Convention on the International Regulations for Preventing Collisions at Sea (COLREG 1972)	International Convention on Civil Liability for Oil Pollution Damage (CLC 69)  CLC Protocol 92
The International Convention on Load Lines (LL), 1966/88	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND) 76
Convention on of tonnage measurement of ships 1969	Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA 88)
	International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC 90)

*Source: Author extracted from (IMO website – Status of convention, 2017).*

Senegal has introduced the provisions of these Conventions in its domestic law.

The 2002 Merchant Shipping Code constitutes the most important piece of national legislation incorporating IMO conventions. However, some other legislations integrate other IMO requirements.

#### **4.1.2 Maritime Administration entities**

The main institutions involved in maritime affairs and the protection of the marine environment in Senegal are described in this section (status and responsibilities).

#### **Ministry of Fisheries and Maritime Economy in Senegal**

The Ministry of Fisheries and Maritime Economy is responsible for fisheries, aquaculture, management and exploitation of the seabed, merchant marine and international maritime traffic sectors in Senegal.

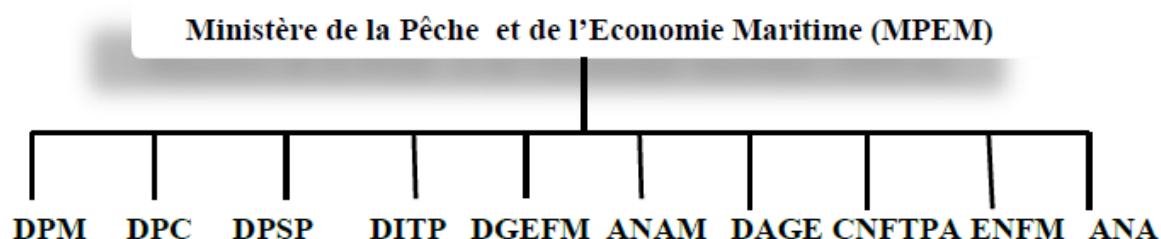


Figure 15: Diagram of Ministry of Fisheries and Maritime Economy in Senegal and its directorates and agencies

*Source Author*



The missions are conducted by the following departments, as shown in figure 15.

Table 7: Main departments of the MPEM

<b>Fisheries and aquaculture management</b>	
Direction des Pêches Maritimes (DPM)	Directorate of Maritime Fisheries
Direction de la Pêche continentale (DPC)	Directorate of Inland Fisheries
Direction de la Protection et de la Surveillance des Pêches (DPSP)-	Directorate of Protection and Surveillance of Fisheries
Direction des Industries de Transformation de la Pêche (DITP)-	Directorate of Industries of Processed Fish
Centre National de Formation des Techniciens des Pêches et de l'Aquaculture (CNFTPA)	National Training Centre for Fisheries and Aquaculture Technicians
Agence National de l'Aquaculture (ANA)	National Aquaculture Agency
<b>Departments related to shipping</b>	
Agence Nationale des Affaires Maritimes (ANAM)	National Agency of Maritime Affairs
Ecole Nationale de Formation Maritime (ENFM)	National School of Maritime Training
<b>Other departments</b>	
Direction de la Gestion et de l'Exploitation des Fonds marins (DGEFM) -	Directorate of the Management and Exploitation of the Seabed
Direction de l'Administration générale et de l'Equipement (DAGE)-	Directorate of General Administration and Equipment

*Source Author*

The roles concerning the maritime (shipping) authority are delegated to the ANAM. In this regard, ANAM has the following responsibilities:

- To contribute to the definition of Policies related to shipping and port activities;
- To define strategies development guidelines for maritime transport, navigation and Ports
- To approve the exercise of maritime activities, both commercial and recreational
- To supervise the international register of ships activities;
- To establish registration for shipping activities;

- To manage and develop seafarers' activities and training;
- Participation in the promotion of bilateral, regional and international cooperation.

(ANAM Senegal, 2015a).

ANAM, designated as the Senegalese maritime authority, carries out most of flag State, port State, and coastal State duties in line with UNCLOS and other relevant conventions.

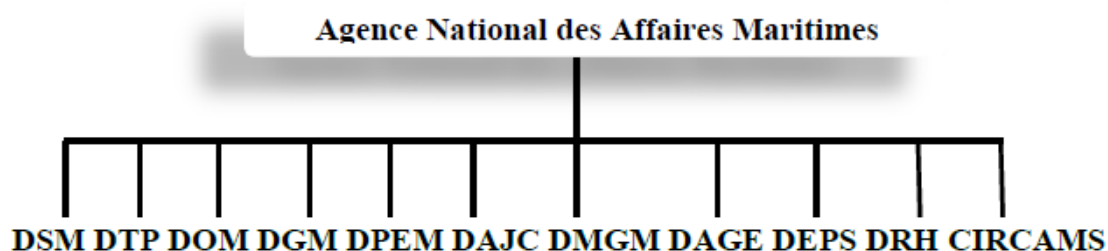


Figure 16: Diagram of National Agency of Maritime Affairs

*Source Author*

Figure 16 and Table 8 present the Directorates and Departments of ANAM.

Table 8: Main Directorates and Departments of ANAM

Directorates	
Direction de la Sécurité Maritime (DSM)	Directorate of Maritime Safety
Direction des Transports Maritime et Fluviaux et des Ports (DTP)	Directorate of Maritime Transport, River and Ports
Direction des Operations maritimes (DOM)	Directorate of Maritimes Operations
Direction des Gens de Mer (DGM)	Directorate of Seafarers
Direction des Projets et Enquêtes Maritimes (DPEM)	Directorate of Maritime Project and Surveys
Departments	
Département des Affaires Juridiques et de la Cooperation (DAJC)	Department of Legal Affairs and Cooperation
Département Médecine des Gens de mer (DMGM)	Department of Seafarers Medicine
Département de l'Administration General (DAGE)	Department of General Administration

Département Etudes Planification et Stratégies (DEPS)	Department of Studies, Planning and Strategies
Département des Ressources Humaines (DRH)	Department of Human Resources
Circonscriptions Maritimes (CIRCAMS)	Maritime Divisions (Regions)

*Source: Author*

The ANAM-Directorate of Maritime Safety is responsible for the administration of ships. For this purpose, periodic inspections are carried out in terms of PSC and flag state duties.

As part of the protection of the marine environment, the ANAM-Directorate of Maritime Operations participates in maritime navigation police. To this end, this service is competent for the surveillance of Senegalese coasts against dumping and discharges. Also, in order to anticipate events that may occur in the marine environment, voluntary investigations are conducted by the ANAM-Directorate of Marine Projects and Surveys on these potential situations (ANAM Senegal, 2016).

After the “*M/V Joola*” disaster in 2002 (Capsize of ferry *Joola* – about 1863 fatalities) (Martime Cyprus, 2016), a reinforcement of the State action at sea was initiated. To support emergency response in marine safety, security and protection of the marine environment, the High Authority for the Operational Coordination of Maritime Safety, Maritime Security and Protection of the Marine Environment (HASSMAR) was created directly under the Presidency office (CSRP, 2016).

The HASSMAR intervention in the marine environment is centered on three (3) plans:

- The National Plan to combat marine pollution (POLMAR),
- The National Plan for maritime security (SURMAR) to establish an effective national system for prevention, and rapid response
- The Search and Rescue Plan (SAR) for maritime search and rescue emergency operations.

Concerning the BWB, the MPEM is involved with the responsibility to establish a ballast water management system in Senegal.

### **Other governmental entities related to the marine environment**

The principal body in charge of development and implementation of policies in relation to environmental protection and monitoring, is the Ministry of the Environment and Sustainable Development (MoE) (DEEC SENEGAL, 2016).

Senegal ratified the 1992 Convention on Biological Diversity in 1994 and the implementation of this Convention is ensured by the MoE.

In connection to this, a national strategy and its action plan on the conservation of biodiversity is implemented by the MoE. This strategy represents the national framework for the protection of biodiversity in Senegal (Republic of Senegal, 2015).

In addition, the MoE has a National Biosafety Committee, which is responsible for identifying the adverse effects on biological diversity, human and animal health, of any genetically modified organisms (Republic of Senegal, 2011). This committee can take part in the implementation of the NBWMS.

To implement policies in the maritime domain, the MoE is supported by MPEM and other entities as described in Table 9.

Table 9: Responsibilities of other Institutions in the marine space

Structures	Functions
<b>Ministry of Water and Sanitation</b>	Implement the State's policy in the field of hydraulics and sanitation, industrial and household waste disposal, storm water purification, water quality, air quality and soil quality. Participate in the restoration and preservation of the marine ecosystem through the Agency of Promotion of the National Hydrographic Network.
<b>Ministry of Energy and Renewable Energy Development</b>	Implement the policy on underground energy resources at sea.
<b>Ministry of Health and Social action</b>	Development and monitoring of the implementation of health policy and programs. As part of the implementation of IHR 2005 (WHO), the Ministry's Strategic Plan 2016-2018 is designed to ensure a permanent monitoring of health risks (Republic of Senegal, 2016).

<b>Ministry of Agriculture</b>	Promoting sustainable agriculture, contributing significantly to accelerated growth for rural poverty reduction. Through the Senegalese institute of Agricultural Research, the ministry participates in the valorization of certain aquatics invasive species in Senegal.(ISRA SENEGAL, 2015)
<b>Ministry of Higher Education, Universities, Regional University Centers and Scientific Research</b>	Develop and implement the policy of higher education and scientific research. Coordinate and monitor international cooperation in higher education and scientific research. Research and monitoring of marine environment and laboratories.
<b>Ministry of the Armed Forces</b>	A section in charge of environmental protection in the Gendarmerie was created by decree. Its role is to fight against all forms of pollution, and aggressions on the marine environment.

*Sources: Author*

#### **4.1.3 Senegalese capacities in terms of fleet, seafarers, State-operated ships and research abilities**

The flag State of Senegal accounts for a small number of ships, as shown in Table 10.

Table 10: The number of vessels registered in the national register, by type

<b>Type of vessels</b>	<b>Numbers</b>
Passenger ships	11
Cargo Ships	04
Fishing vessels	272

*Source: Statistic report of National Agency for Maritime Affairs in Senegal 2015.*

Passenger Ships and small cargo vessels mostly trade in the areas of Ziguinchor, Kaolack and neighboring countries such as The Gambia and Guinea Bissau. These neighboring countries are governed by a regional program for the conservation of the coastal and marine zone of West Africa. All these countries share the same characteristics of their marine environments. This means that they have the same species of fish, marine mammals and migratory species (PRCM, 2011). Therefore, the region can share a “Same Risk Area” (SRA) – however a complete analysis needs to be developed. Indeed, the current discussion at the IMO concerns the

possibility of coastal states to delimit « Same Risk Area ». This delimitation follows a particular process, namely conforming to the G7 guideline « risk assessments of the BWMC» (MEPC 71, 2017).

According to the study of the Maritime Environmental Consultancy LITEHAUZ, the main elements of the SRA are describe in the Figure 17.

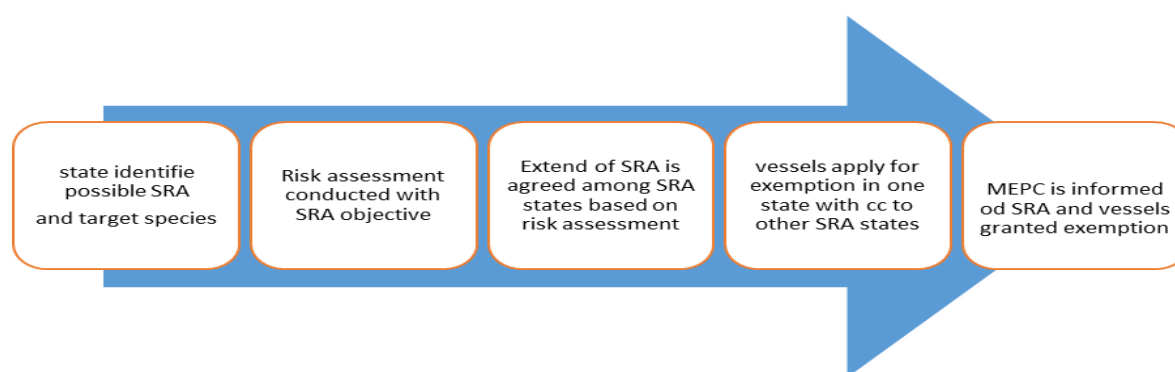


Figure 17: SRA elements

*Source: authors, inspired to (LITEHAUZ, 2016)*

### **Administration of Seafarers**

The missions related to the Seafarers' Administration have been assigned to the ANAM, these include the organization of professional activity, the management of seafarers' records, the social protection system, the maritime labor inspection and regulation (ANAM Senegal, 2016). In 2016, there were 2813 certificates of competence delivered by ANAM.

The fulfillment of these responsibilities by ANAM complies with the regulatory obligations prescribed by the STCW Convention for training, certification and watchkeeping. Training the seafarers is important for maintaining the safe conditions at sea. It also strengthens operational capacities for the protection of the marine environment. Therefore, seafarers have a significant role in the efficiency of maritime trade.

### **Equipment of the Senegalese navy**

Although the maritime fleet is not large enough as described in Table 9, in a context marked by the rise of illegal acts (70 piracy attacks in 2016 in the African zone (DGRIS, 2017) and IUU Fishing), the State of Senegal intends to acquire naval capacities able to intervene at sea and to ensure the protection of its coastline.

The main tasks carried out at sea are fisheries inspections to combat IUU fishing and the response against illegal acts at sea such as drug trafficking, arms and human trafficking (Global Security, 2017).

Table 11: Equipment of the Senegalese navy

<b>Ships</b>	<b>types</b>
<b>Fouladou</b>	Patrol ( <u>Fast Attack Ship</u> )
<b>Kedougou</b>	Patrol ( <u>Fast Attack Ship</u> )
<b>Ferlo</b>	Patrol( <u>Fast Attack Ship</u> )
<b>Conejera</b>	Patrol ( <u>Fast Attack Ship</u> )
<b>Fouta</b>	Patrol ( <u>Fast Attack Ship</u> )
<b>Njambuur</b>	Patrol ( <u>Fast Attack Ship</u> )
<b>Popenguine</b>	Coastal Monitoring Building
<b>Podor</b>	Coastal Monitoring Building
<b>Saint louis</b>	Coastal Monitoring Building
<b>Gorée</b>	Transport Building Chalands
<b>Carabane</b>	Transport Building Chalands
<b>CTM 2</b>	Transport Building Chalands
<b>Samba Laobe Fall</b>	Buoy
<b>Itaf Deme</b>	Fisheries Research
<b>2X stars</b>	Coast Guard Rapid Inspection
<b>1x Featured</b>	Coast Guard Rapid Inspection
<b>4x Featured</b>	Coast Guard Rapid Inspection
<b>2x classifieds</b>	Coast Guard Rapid Inspection

Source : Author

#### 4.1.4 National regulatory framework in Senegal related to environment protection

The establishment of coordinated political and legal frameworks constitutes an imperative for effective environmental management. These frameworks support the institutional and administrative responsibilities at the national level. Table 12 presents the various national instruments that regulate the marine environment in Senegal.

Table 12: Main National Instruments regulating Marine environment

<b>Instruments</b>	<b>Role</b>
<b>The Environmental Code 2001</b>	Sets out the guiding principles for good environmental management.
<b>The 2002 Merchant Shipping Code</b>	It represents the basic text specifically regulating pollution in the marine and coastal environment in Senegal.

<b>Law No. 2015-18 of 13 July 2015 establishing the Code of Maritime Fishing</b>	Regulate Fishing activities.
<b>Code of State Domain 1976</b>	Organizes the domain of the State. Article 5 (a) of the Code of State Domain, which deals with the natural public domain,
<b>Law No. 2010-09 of 23 April 2010 on the police of seaports</b>	Under the provision of article 2, which is protecting the waters of ports and harbors "No one shall be detrimental to the good condition of ports and harbors in their depth and cleanliness and in their facilities". In this article, the ballasting or deballasting operations may only be carried out in places and receptacles other than those provided for this purpose.

*Source: Author*

### **Conclusion:**

The structures engaged in the management of the marine environment are multiple and each has its own scope and responsibilities. However, the implementation of the Ballast Water Convention in Senegal implies concomitant action by state institutions. The introduction of HAOP presents often uncontrollable situations with multidimensional difficulties. This requires the joint global response of expertise and plural approaches from these different institutions.

Therefore, the following developments will focus on the requirements and the level of preparedness of the country.



## **4.2 State obligations in BWM Convention**

UNCLOS emphasizes the importance for States to fulfill their obligations in the field of environment (Tanaka, 2012). Moreover, contracting States to the BWM Convention have to comply with its specific requirements. These specific requirements can be distributed as flag State, port State and coastal State obligations.

### **4.2.1 Signification of flag State, port State and coastal State responsibilities under international regulations**

In order to ensure that States conform to their IMO instrument obligations, the "III Code" has been developed. It sets out a number of principles that member states should observe and divides State responsibilities into flag/port/coastal State obligations.

#### **Flag State responsibilities**

Under UNCLOS Article 94, the flag State has a duty to ensure that vessels flying its flag conform with the obligations of international maritime safety and safety rules for navigation and the protection of the marine environment (Tanaka, 2015).

In addition, under IMO regulations, flag States are required to carry out regular inspections in order to verify the compliance of the vessels and issue certificates. Flag States have the right to enforce laws and regulations on ships and take appropriate measures against ships in violation of the international and domestic regulations.

#### **Port State responsibilities**

The port States have power to inspect foreign ships in ports to verify that ships comply with IMO regulations (GloBallast, 2002).

#### **Coastal State responsibilities**

The responsibility of coastal states is to protect their national water. Under UNCLOS, the coastal State exercises its sovereignty in inland waters, territorial sea, contiguous zone and exclusive economic zones (EEZ). The continental shelf includes the seabed and subsoil of the submarine areas that extend beyond the territorial seas of the coastal states (United Nations, 1983).

However, this power “*shall not prejudice the innocent passage rights of vessels which comply with international regulations on shipping activity*” (United Nations, 1983).

#### 4.2.2 Requirements regarding Ballast Water Management Convention

With reference to Article 2 of the Convention, “*the Parties undertake to give full effect to the provisions of this Convention and it’s Annex in order to prevent, minimize and, as a last resort, eliminate the transfer of Harmful aquatic organisms and pathogens through the control and management of ballast water and sediment from ships*”(IMO, 2017c).

Considering this, Table 13 delineates a summary of the requirements of the BWMC using a Flag/Port/Coastal state approach. This was inspired by the dissertation “*the Review of the Capacity of the Implementation of Ballast Water Management Convention in Sri Lanka as flag State, Port State, Coastal State*” authored by Ms THALATHA SREENI RANASINGHE.

Table 13: Summary of the State requirements

Requierments	Flag State	Port State	Coastal State
1	Protection and guidance for the national fleet	Protecting port areas and socio-economic activities	Environmental monitoring and scientific research
2	Establishing National legislations, Survey and Certification	Compliance monitoring and enforcement	Contingency Plans, Preparedness, Awareness and additional measures
3	Approval for BWM Systems	Training of Port State Control Officers (PSCO)	Risk assessment, Exemptions and determination of designation areas / warnings
4	Training of crew members	Regional and International Cooperation	Detection and investigation of violations and notification
5	Violations detection and sanction / accident investigation	Sediments Reception Facilities	Regional and international cooperation

Source: Author inspired by (RANASINGHE 2016), from Professor Baumler.

### 4.3 Capacity of Senegal to implement BWM Convention

#### 4.3.1 Level of Readiness as Flag State

The flag State has different types of responsibilities that are related to the administration.

The table 14 presents the convention requirement and observation based on current situation of Senegal.

Table 14: Review the level of readiness in Flag State

<b>Preparedness level as flag State</b>	
<b>Requierments</b>	<b>Remarks</b>
<b>Protection and guidance for the national fleet</b>	The management of the fleet is carried out by the Maritime Safety Directorate of ANAM. A fleet tracking register is updated regularly
<b>Establishing National legislations, Survey and Certification</b>	The revised regulatory texts are implemented by ANAM
<b>Approval for BWM Systems</b>	Not yet engaged in Senegal
<b>Training of crew members</b>	The training is held by the competent institutes under the supervision of the ANAM
<b>Violations detection and sanction</b>	One service of ANAM makes a regular investigation. The Merchant code provides the sanction if there is detection of violation

*Source: The Author*

#### 4.3.2 Level of Readiness as Port State

In this regard, Table 15 contains an analysis of the level of conformity to the requirement.

Table 15: Review the level of readiness in Port State

Preparedness level as port State	
Requierments	Remarks
<b>Protecting port areas and socio-economic activities</b>	The 2010 decree relating to the police of the ports regulates the zones of access to the port of Dakar.
<b>Compliance monitoring and enforcement</b>	The Procedures for verifying the implementation of port state responsibilities are established by ANAM.
<b>Training of Port State Control Officers (PSCO)</b>	ANAM regulates the formation of PSCOs. In 2016, accredited inspectors were recruited to strengthen the number of inspectors present
<b>Regional and International Cooperation</b>	Abidjan Convention is a space for cooperation between the countries of western Africa on the control of the marine space. And the subject of ballast water was addressed by the Convention for the first time in 2015.
<b>Sediments Reception Facilities</b>	There are no reception facilities yet in the port but a process to eliminate polluting water from ships exists with private companies. In this process, all vessels must declare their cargo before arriving at the port of Dakar. In order to verify the destination of the products received by the private companies, the port requests a certificate from the private companies.

Source: The Author

### 4.3.3 Level of Readiness as Coastal State

Table 16 shows an analysis of the level of preparedness.

Table 16: Review the level of readiness in Coastal State

Preparedness level as coastal State	
Requierments	Remarks
<b>Environmental monitoring and scientific research</b>	as refers to the State of marine environment report in 2015, there is a lack of environmental monitoring and scientific research in Senegal
<b>Contingency Plans, Preparedness, Awareness and additional measures</b>	Awareness campaigns exist on sites affected by invasive plants in Senegal.
<b>Assessment, Exemptions and determination of designation areas</b>	Senegal is non-compliant in this regard
<b>Detection and investigation of violations and notification</b>	ANAM, through its Investigations Department, carries out this task, investigations are executed regularly after accidents and violation of rules.
<b>Regional and international cooperation</b>	Many international organizations and NGOs are present in Senegal as part of the fight against invasive plants. In addition, there are regional programs for the conservation of coastal marine areas in west Africa

Source: The Author

### Conclusion of the evaluation of Senegalese capacities to implement BWMC

When evaluating the capacity of Senegal to implement the BWMC, not all prerequisites are yet implemented such as the ratification of the convention. However, Senegal has just initiated the accessing process to the Convention (Republic of Senegal, 2017) and will enhance its capacity in the near future with the expected support of the IMO Technical Cooperation.

#### **4.4 Challenges for ratification and implementation of BWMC in Senegal**

Implementation and enforcement of the BWMC requirements can face some challenges.

##### **Governance issue**

There are inadequate integration and harmonization of the various sectorial policies and administrative responsibilities as it relates to sustainable development. In addition, the competition for resources also hampers the coordination, implementation, monitoring and evaluation of the strategies deployed (Republic of Senegal, 2012, 2015).

However, Senegal is supported by several international organizations and non-governmental organizations such as UNEP, FAO, and IUCN. They technically and financially support public policies and local initiatives.

##### **Financial issue**

The lack of financial resources of developing countries like Senegal, is hindering the implementation of certain programs, particularly those related to environmental protection.

##### **Social issues**

An increasing population will exacerbate food security, health and education issues, as the Senegalese population is, on average, very young (The World Bank, 2016). These various factors affect decision-making and prioritization of activities.

In addition, there is a deficit of public awareness of maritime concerns and HAOP (Republic of Senegal, 2015).

The harmonization of policy is often challenged by inconsistencies in priorities when changing management levels, which hampers implementation and decision-making (Republic of Senegal, 2015).

##### **Lack of scientific research related to marine environment and HAOP**

According to the State of marine environment report 2015 in Senegal, there are deficiencies in national institutions in conducting marine scientific research. Thus, it increases dependence and over reliance on elite western institutions or agencies for scientific research.

## 4.5 The development of National Strategy

The implementation of the convention in Senegal would benefit from following the process proposed by GloBallast monograph n°18 “*Guidelines for Development of a National Ballast Water Management Strategy*”, 2010.

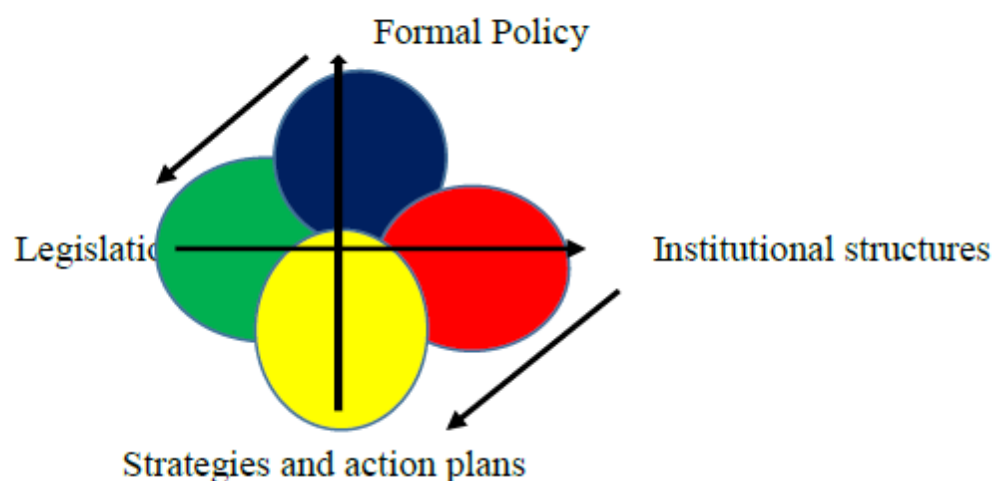


Figure 18: Development of policies Strategies and actions plan

Source: Authors inspired from (GloBallast Monograph Series n 18)

### 4.5.1 The procedures of establishment of NBWMS.

#### 4.5.1.1 Legislation and regulation

To regulate ballast water discharge in Senegal, it is necessary to adopt and promulgate a law.

#### 4.5.1.2 Formulation of national Strategy

The strategy will serve as a framework for integrating and re-orienting environmental protection policies. It must detail the roles and responsibilities of the entities engaged in its implementation. As such, Table 17 presents a summary of the action to be conducted and the stakeholders involved.

Table 17: Steps of the NBWMS

<b>Actions</b>	<b>Responsibilities</b>	<b>In Senegal</b>
<b>Assessment of marine environment</b>	Before putting in place NBWMS, it's important for Senegal to make rapid assessment on marine environment, based on the example of GloBallast n18, 2010 and the principles established in monograph 22 on PBBS	The existing data on marine environment can be used as a reference in Senegal.
<b>Identify the lead agency</b>	Senegal must designate a lead agency responsible for coordinating and developing the implementation of the strategy.	The MPEM or the MoE can be the focal point.
<b>Establishment of National task Force</b>	Then, has to set up a Task Force, which should play an advisory role and support the process of developing the strategy. To this end, this task force must be constituted by all the relevant actors involved in this sector such as ministry of environment, Ministry of Fisheries, Ministry of Agriculture, Port, university, shipyard, ship owner, coast guard etc.	<p>The following stakeholders may participate in the implementation of the strategy:</p> <ul style="list-style-type: none"> <li>National Biosecurity Authority</li> <li>Port Autonome de Dakar</li> <li>Fisheries Administration</li> <li>Ministry of Health and Social Action</li> <li>others Ministries</li> <li>Dakarnave shipyard</li> <li>Fishing and aquaculture industries</li> <li>Mining and oil industry</li> <li>Universities and research institutes</li> <li>NGO and general public</li> <li>Seafarers representatives</li> <li>Shipowners representatives</li> </ul>

Source: Author inspired from Monograph 18



## 5. Recommendations and conclusion

### 5.1 SWOT analysis related to implementation by Senegalese Administration of BWM Convention

Table 18: Swot analysis

Strengths	Weaknesses
Existence of institutional framework for the protection of marine environment.	Weakness of the existing instrument Fragmentary approaches as a constraint Lack of enforcement capacity Lack of scientific research in HAOP
Opportunities	Threats
Existence of Program for conservation of marine and coastal area in regional level Existence of partners of development	Absence of National Strategy and action plan for ballast water management. Overlapping of the entities' roles in marine area

*Source: Author*

## **5.2 Conclusion**

The discharge of unmanaged ballast water presents major risks to the environment and human health. Its impacts have triggered international responses. Among these international responses, the Ballast Water Management Convention was adopted to control the risk of the introduction of HAOP into the marine environment.

Ballast water management is an issue in Senegal because of the country's exposure to shipping traffic. The ports are the main areas of transferring HAOPs, so after considering the high and low risk zones in Senegal in order to take a strategic approach, the main Port of Dakar was found to present a higher risk and requires more focus.

This situation increases the vulnerability of marine ecosystems. The overall vulnerability of marine areas, particularly wetlands, is higher, because of the presence of aquatic invasive species. Hence, the place and role of fisheries, tourism and aquaculture sectors in the country's economy and the welfare of the population are affected. These consequences threaten food security and encourage poverty growth.

The policy framework in place for ballast water management is inadequate and needs to be addressed. Senegal as flag State, port State and coastal State is required to control the introduction of HAOP by BW discharge.

As flag State, the Convention requires the establishment of national legislation, survey and certification, management of the fleet, ballast water approval system, crew training and violation detection. The level of readiness is medium.

As port State, the responsibility of Senegal is to protect ports, to set up reception facilities and facilitate training for inspectors of the PSC. It was demonstrated that Senegal does not have reception facilities for ships frequenting these port areas. The level of readiness is medium.

As coastal State, scientific research and environmental monitoring, preparedness and public awareness, risk assessments and exemptions, detection of violations and regional and international cooperation are the main responsibilities. Not all requirements recommended by the Convention are implemented. The level of readiness is medium.

As shown, there is a need to implement and enforce the Ballast Water Convention.

However, implementing this convention will not be achieved without challenges. These challenges are largely related to governance issues and socio-economic concerns.

For that reason, an effective approach: the development of a National Ballast Water Management Strategy (NBWMS), will enable Senegal to have a tool for the implementation of the Convention.

Of course, it is not enough to merely propose approaches to follow. This should be done within a comprehensive integrated management framework in the maritime area, in order to avoid isolated responses.

Supported in its development by a National Task force, the NBWMS would be a new instrument for Senegal. External support would be appreciated in the implementation and development of the convention, particularly in areas such as scientific research and risk assessment.

Therefore, this study will provide recommendations for the implementation of the BWM Convention in Senegal.

### **5.3 Recommendations**

The following points should be considered when implementing the BWM Convention in Senegal:

- ❖ Establishment of legal and institutional frameworks that will permit the conduct of various practices encompassing different categories of actors (National Task Force) in the strengthening national environmental policy and programs (National Ballast Water Management Strategy);
- ❖ To strengthen maritime governance in order to avoid institutional barriers and overlapping functions.
- ❖ Emphasis the ecosystem based management approach which empowers all stakeholders. To this effect, special attention must be paid to capacity building;
- ❖ Consider appropriate resources for the implementation of the strategy. Cooperation with international institutions to support development and international funds can be taken into account.  
Ensure continuous commitment to protect certain fragile ecosystems. It will be a question of revising the regulation on the environment to articulate it around the requirements of the Convention.
- ❖ Develop appropriate inspections, monitoring and risk assessment regime.
- ❖ Promote environmental education and awareness.

- ❖ As a final point, in reference to “*the Guidelines for risk assessment under Regulation A-4 of BWM convention (G7)*”, the concept of “*Same Risk area*” (SRA) may be developed in regional cooperation.

## 6. References

- Adg. (2012). *Mangrove, an ecosystem to be protected ... Practical guide for the use of the Rural Communities*. Retrieved from [http://ong-adg.be/bibliadg/bibliotheque/opac\\_css/doc\\_num/divers/manuel\\_adg\\_capitalisation\\_mangrove\\_version\\_finale.pdf](http://ong-adg.be/bibliadg/bibliotheque/opac_css/doc_num/divers/manuel_adg_capitalisation_mangrove_version_finale.pdf)
- AMCC+. (2015). Integrated coastal zone management in Senegal. Retrieved from <http://www.gcca.eu/fr/programmes-nationaux/afrique/amcc-senegal>
- ANAM Senegal. (2015a). *annual report*. dakar.
- ANAM Senegal. (2015b). *Annual report 2015*. Dakar. <https://doi.org/10.1017/CBO9781107415324.004>
- ANAM Senegal. (2016). *annual report*. Dakar.
- ANSD Senegal. (2016). *Economic and social situation in senegal*. Retrieved from <http://www.ansd.sn/ressources/publications/13-transport-SESN2013.pdf>
- APIX SENEGAL. (2017). PORT MINERALIER DE BARGNY. Dakar. Retrieved from <http://investinsenegal.com/PORT-MINERALIER-DE-BARGNY.html>
- APS SENEGAL. (2013). 90% des échanges commerciaux effectués par voie maritime. *SENEWEB-NEWS*. Retrieved from [http://www.seneweb.com/news/Commerce/90-des-echanges-commerciaux-effectues-par-voie-maritime-selon-pape-diouf\\_n\\_94828.html](http://www.seneweb.com/news/Commerce/90-des-echanges-commerciaux-effectues-par-voie-maritime-selon-pape-diouf_n_94828.html)
- AQUATICFIELDCOURSE2013. (2013). INVASIVE SPECIES. Retrieved from <https://aquaticfieldcourse2013.wordpress.com/environmental-change-and-lake-ecosystems/invasive-species/>
- Association TypHAS. (2014). TypHAS - Une école de chaumiers au Sénégal. *Ulule*. Retrieved from <https://fr.ulule.com/ecole-chaumiers-senegal/>
- Autonomous Port of Dakar. (2016a). port of Dakar. Retrieved from <http://www.portdakar.sn/fr/content/position-geographique>
- Autonomous Port of Dakar. (2016b). *Trajectory 2012 2023 of Port of Dakar*.
- Barron, J., Fox, P., & Koudeoukpo, J. B. (2007). WATER AND POVERTY LINKAGES IN AFRICA: SENEGAL CASE STUDY. Retrieved from <https://www.sei-international.org/mediamanager/documents/Publications/Water-sanitation/AfDB-Water-and-Poverty-Senegal-FINAL.pdf>
- Benson, A. (2014). Nonindigenous Aquatic Species. *Science for a Changing World*. Retrieved from <https://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=5>
- Bertrand, P. (2016). Ballast water treatment. France. Retrieved from <http://www.cite-sciences.fr/fr/ressources/science-actualites/detail/news/traitement-des-eaux-de-ballast-la-convention-internationale-enfin->

- ratifiee/?tx\_news\_pi1%5Bcontroller%5D=News&tx\_news\_pi1%5Baction%5D=detail&cHash=003711fbf4d26993aa2b25b6ea111678
- Beveridge, M., Charles, A., Dieckmann, U., Fock, H. O., Froese, R., Keller, M., ... Zimmermann, C. (2013). *The Future of the Fishes*. *World Ocean Review* (Vol. 2). Retrieved from [http://worldoceanreview.com/wp-content/downloads/wor2/WOR2\\_english.pdf](http://worldoceanreview.com/wp-content/downloads/wor2/WOR2_english.pdf)
- Bloch, L. Y. (2014). Invasive Species of the Pacific Northwest : Wakame. Retrieved from [http://depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2015/09/Unidaria\\_pinnatifida\\_Bloch\\_2014.pdf](http://depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2015/09/Unidaria_pinnatifida_Bloch_2014.pdf)
- Caro, R., Frutos, H. De, Kitwana, A. N., & Shen, A. (2011). *Typha Charcoal in Senegal : Changing a National Threat into Durable Wealth*. MASSACHUSETTS. Retrieved from <http://mitsloan.mit.edu/actionlearning/media/documents/s-lab-projects/SupDeCo-report.pdf>
- CBD. (2011). *Living in harmony with nature*. Retrieved from <https://www.cbd.int/undb/media/factsheets/undb-factsheets-en-web.pdf>
- CBD. (2013). guides to the Aichi Biodiversity Targets, (February), 42. Retrieved from <http://www.cbd.int/nbsap/training/quick-guides/>
- CBD. (2014). PATHWAYS OF INTRODUCTION OF INVASIVE SPECIES, THEIR PRIORITIZATION AND MANAGEMENT, 18. Retrieved from <https://www.cbd.int/doc/meetings/sbstta/sbstta-18/official/sbstta-18-09-add1-en.pdf>
- Christopher F. Deacutis, P. D. and R. C. R. (2002). *BALLAST WATER AND INTRODUCED SPECIES*. Retrieved from <http://www.nbep.org/publications/other/ballast/BallWaterIntroSpeciesRpt.pdf>
- COSAMA. (2016). A PROPOS DE NOUS. Dakar: COSAMA. SA. Retrieved from <http://cosama.sn/a-propos-de-nous/>
- Costello, J. H., Bayha, K. M., Mianzan, H. W., Shiganova, T. A., & Purcell, J. E. (2012). Transitions of *Mnemiopsis leidyi* (Ctenophora: Lobata) from a native to an exotic species: A review. *Hydrobiologia*, 690(1), 21–46. <https://doi.org/10.1007/s10750-012-1037-9>
- CSE senegal. (2015). RAPPORT SUR L' ETAT DE L' ENVIRONNEMENT AU SENEGAL. Retrieved from <http://www.cse.sn/index.php/fr/publications/suivi-de-l-etat-sur-l-environnement/rapports-sur-l-etat-de-l-environnement/category/27-rapports-sur-l-etat-de-l-environnement>
- CSRP. (2016). *Institutional Framework*. Dakar. Retrieved from <http://www.spcsrp.org/en/senegal>
- DAKARNAVE. (2011). DAKARNAVE shipyard. Retrieved from <http://www.dakarnave.com/Services+-+Mechanical+work>
- Dan Kamykowski, JoAnn Burkholder, R. H. (2013). Algal Studies Aimed at Avoiding Harmful Blooms. North carolina. Retrieved from <https://projects.ncsu.edu/research/results/about.html>
- DEEC SENEGAL. (2016). environmental ministry of senegal. Dakar. Retrieved from <http://www.denv.gouv.sn/#>

- DGRIS. (2017). La sécurité des espaces maritimes d'Afrique de l'Ouest et d'Afrique centrale. France: Ministère des Armées. Retrieved from <http://www.defense.gouv.fr/dgris/enjeux-transverses/la-securite-des-espaces-maritimes-d-afrique-de-l-ouest-et-d-afrique-centrale/la-securite-des-espaces-maritimes-d-afrique-de-l-ouest-et-d-afrique-centrale>
- Diallo, A. O. (2016). Port de Dakar : chiffre d'affaires en hausse et aide japonaise. *Jeune Afrique*. Retrieved from <http://www.jeuneafrique.com/358994/economie/senegal-port-de-dakar-affiche-chiffre-daffaires-de-40-milliards-de-francs-cfa-2015/>
- Diop, N. (2009). *Aquatic plants of western Africa*. Dakar. Retrieved from [http://www.sud-expert-plantes.ird.fr/writable/versions/sep/projets/dossier\\_308-upload-308\\_ChapOuvr\\_biodiversity\\_in\\_western\\_africa.pdf?1385983882](http://www.sud-expert-plantes.ird.fr/writable/versions/sep/projets/dossier_308-upload-308_ChapOuvr_biodiversity_in_western_africa.pdf?1385983882)
- EEA. (2012). *The impacts of invasive alien species in Europe*. Retrieved from <http://www.botanicgardens.eu/downloads/EEAimpactsIAS2012.pdf>
- EU. (2014). Fisheries Partnership Agreement. Retrieved from [https://ec.europa.eu/fisheries/cfp/international/agreements/senegal\\_en](https://ec.europa.eu/fisheries/cfp/international/agreements/senegal_en)
- FAO. (2005). *Ethical issues in fisheries*. Retrieved from <http://www.fao.org/3/a-y6634e.pdf>
- FAO. (2006a). *Part 1 Biosecurity principles and components*. Retrieved from <ftp://ftp.fao.org/docrep/fao/010/a1140e/a1140e01.pdf>
- FAO. (2006b). *Report and Documentation of the Expert Workshop on Marine Protected Areas and Fisheries Management. FAO Fisheries Report (Vol. 825)*. Retrieved from <ftp://ftp.fao.org/docrep/fao/010/a1061e/a1061e.pdf>
- FAO. (2009). *LIFE CYCLE ASSESSMENT OF SOUTHERN PINK SHRIMP PRODUCTS FROM SENEGAL*. Rome. Retrieved from <ftp://ftp.fao.org/docrep/fao/011/i0910e/i0910e00.pdf>
- FAO. (2011). Les pêches et l'aquaculture face au changement climatique. Retrieved from [ftp://ftp.fao.org/FI/brochure/climate\\_change/policy\\_brief\\_fr.pdf](ftp://ftp.fao.org/FI/brochure/climate_change/policy_brief_fr.pdf)
- Fordham International law. (2005). *From Stockholm to New York, via Rio and Johannesburg: has the environment lost its way on the global agenda? Fordham International Law Journal (Vol. 29)*. Retrieved from <https://pdfs.semanticscholar.org/8b31/243469bfc12b7cc826b801ab949d04d095b4.pdf>
- Gil, A. L., Louis, V. R., Rivera, I. N. G., Lipp, E., Huq, A., Lanata, C. F., ... Colwell, R. R. (2004). Occurrence and distribution of *Vibrio cholerae* in the coastal environment of Peru. *Env Micro*, 67(7), 699–706. <https://doi.org/10.1111/j.1462-2920.2004.00601.x>
- Global Security. (2017). Senegal Navy. GlobalSecurity.org. Retrieved from <https://www.globalsecurity.org/military/world/africa/sn-navy.htm>
- Globallast. (2009). *Guidelines for National Ballast Water Status Assessment*. United Kingdom. Retrieved from <file:///C:/Users/HP/Downloads/globallast-monograph-series-no17-guidelines-for-national-ballast-water-status-assessment.pdf>
- Globallast. (2016). *GEF-UNDP-IMO GloBallast Partnerships Programme training on PORT BIOLOGICAL BASELINE SURVEYS (PBBS)*. United Kingdom. Retrieved from [file:///C:/Users/HP/Desktop/GloBallast\\_Risque Assessment.pdf](file:///C:/Users/HP/Desktop/GloBallast_Risque Assessment.pdf)
- GloBallast. (2002). *Legislative Review*. London.

- GloBallast. (2004). The GEF-UNDP-IMO GloBallast Programme : Addressing marine biosafety through global partnerships. Retrieved from [http://archive.iwlearn.net/globalballast.imo.org/globalballast.imo.org/wp-content/uploads/2015/01/GloBallast\\_Leaflet\\_Rio.pdf](http://archive.iwlearn.net/globalballast.imo.org/globalballast.imo.org/wp-content/uploads/2015/01/GloBallast_Leaflet_Rio.pdf)
- GloBallast. (2010). *Guidelines for Development of a National Ballast Water Management Strategy*. London.
- GloBallast. (2013). *Identifying and Managing Risks from Organisms Carried in ships 'Ballast Water*. London.
- GloBallast. (2017). Ballast water as a vector. Retrieved from <http://globalballast.imo.org/ballast-water-as-a-vector/>
- GREENPEACE. (2015). AFRICAN FISHERIES, A LOST PARADISE? Retrieved from <http://www.greenpeace.org/africa/fr/notre-action/Defendons-nos-oceans/Peche-frauduleuse-1/>
- GREENPEACE. (2016). Senegal, Artisanal fisheries. Retrieved from <http://www.greenpeace.org/africa/fr/Actualities/Blogs-de-Greenpeace-Afrique/senegal-pcheurs-artisans-prennent-parole/blog/56630/>
- IMO. (2017a). Aquatic Invasive Species (AIS). Retrieved from [http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/AquaticInvasiveSpecies\(AIS\).aspx](http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/AquaticInvasiveSpecies(AIS).aspx)
- IMO. (2017b). Ballast Water Management. Retrieved from <http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/Default.aspx>
- IMO. (2017c). International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM). Retrieved from [http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-\(BWM\).aspx](http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx)
- IMO. (2017d). Marine Environment. Retrieved from <http://www.imo.org/en/OurWork/Environment/Pages/Default.aspx>
- IMO. (2017e). New global project to address bioinvasions via ships' hulls. London: International Maritime Administration. Retrieved from <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/20-biofouling.aspx>
- IRD. (2016). *Les frontières de l'environnement marin sénégalais*. Dakar. Retrieved from [http://horizon.documentation.ird.fr/exl-doc/pleins\\_textes/divers17-02/010069147.pdf](http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers17-02/010069147.pdf)
- ISRA SENEGAL. (2015). *Changement climatique et espèces invasives en Afrique de l'Ouest*. Dakar. Retrieved from [https://www.ciheam.org/publications/178/019\\_bis\\_-\\_Diop.pdf](https://www.ciheam.org/publications/178/019_bis_-_Diop.pdf)
- ISSG. (2005). *Introduction to Invasive Alien Species*. Retrieved from [http://www.issg.org/pdf/publications/GISP/GISP\\_TrainingCourseMaterials/Management/ManaginginvasivesModule1.pdf](http://www.issg.org/pdf/publications/GISP/GISP_TrainingCourseMaterials/Management/ManaginginvasivesModule1.pdf)
- Lloyd's Register. (2016). *Understanding ballast water management Guidance for shipowners and operators*. Retrieved from [http://www.lr.org/en/\\_images/229-77062\\_Understanding\\_Ballast\\_Water\\_Management\\_0314\\_tcm155-248816.0\\_August](http://www.lr.org/en/_images/229-77062_Understanding_Ballast_Water_Management_0314_tcm155-248816.0_August)



2016.pdf

- Maritime Cyprus. (2016). Le Joola, Senegalese ferry capsized off the coast of Gambia with death toll of nearly 2000, 26 Sept. 2002. *International Maritime News*. Retrieved from <https://maritimecyprus.com/2016/09/25/flashback-in-history-le-joola-senegalese-ferry-capsized-off-the-coast-of-gambia-with-death-toll-of-nearly-2000-26-sept-2002/>
- MEPC 71. (2017). *Ballast Water Management*. London. Retrieved from [https://ww2.eagle.org/content/dam/eagle/regulatory-news/2017/MEPC 71 Brief.pdf](https://ww2.eagle.org/content/dam/eagle/regulatory-news/2017/MEPC%2071%20Brief.pdf)
- Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-Being: Biodiversity Synthesis. *Ecosystems*, 285. <https://doi.org/10.1057/9780230625600>
- OMVS. (2006). *Role and stakes of the Diama dam*. Retrieved from [http://www.portail-omvs.org/sites/default/files/fichierspdf/c2-barrage\\_diama\\_-\\_role\\_et\\_enjeux\\_-juin\\_2006\\_-\\_vf\\_1.pdf](http://www.portail-omvs.org/sites/default/files/fichierspdf/c2-barrage_diama_-_role_et_enjeux_-juin_2006_-_vf_1.pdf)
- OMVS. (2016). Le Barrage de Diama. Dakar. Retrieved from <http://www.portail-omvs.org/infrastructure-regionale/barrages/barrage-diama>
- PNUD. (2014). Situation de reference de la biodiversite dans les zones de peuplement en typha, 47. Retrieved from file:///C:/Users/HP/Desktop/plante invasive au senegal.pdf
- PRCM. (2011). *A la decouverte de l'environnement côtier et marin en Afrique de l'Ouest*. Guinee-Bissau. Retrieved from A la decouverte de l'environnement côtier et marin%0A en Afrique de l'Ouest
- PRCM. (2016). *Marine and coastal environmental law in Senegal*. Retrieved from [http://www.prcmarine.org/sites/prcmarine.org/files/droit\\_de\\_l'environnement\\_au\\_senegal\\_0\\_1.pdf](http://www.prcmarine.org/sites/prcmarine.org/files/droit_de_l'environnement_au_senegal_0_1.pdf)
- Priskin, J. (2008). *Implications of Eutrophication for Lake Tourism in Québec*. Quebec. Retrieved from <https://teoros.revues.org/139>
- Ramsar. (2011). The Annotated Ramsar List of Wetlands of International Importance. The Ramsar Convention on Wetlands. Retrieved from [http://archive.ramsar.org/cda/en/ramsar-documents-list-anno-senegal/main/ramsar/1-31-218%5E16208\\_4000\\_0\\_\\_](http://archive.ramsar.org/cda/en/ramsar-documents-list-anno-senegal/main/ramsar/1-31-218%5E16208_4000_0__)
- Ramsar Convention. (2011). Ramsar's liquid Assets Wetlands, Ramsar 1971-2011: 40 Years of the Convention on. *Sementara*, 36. Retrieved from [www.ramsar.org](http://www.ramsar.org)
- Ranasinghe, T. S. (2016). *Review of the capacity of the implementation of Ballast Water Management Convention in Sri Lanka as flag state , port state and coastal state*. Malmo. Retrieved from file:///C:/Users/HP/Desktop/Review of the capacity of the implementation of Ballast Water Man 1.pdf
- Republic of Senegal. (2010). *FOURTH NATIONAL REPORT ON IMPLEMENTATION OF THE CONVENTION ON BIOLOGICAL DIVERSITY*. Retrieved from <https://www.cbd.int/doc/world/sn/sn-nr-04-fr.pdf>
- Republic of Senegal. (2011). MINISTERE DE L'ENVIRONNEMENT ET DE LA PROTECTION DE LA NATURE. Dakar: Secetaire General du gouvernement. Retrieved from <http://www.jo.gouv.sn/spip.php?article9134>
- Republic of Senegal. (2012). *RAPPORT NATIONAL DU SENEGAL*. Dakar. Retrieved from

## COMMISSION NATIONALE DU DEVELOPPEMENT DURABLE

- Republic of Senegal. (2014). IMPLEMENTATION OF THE INTERNATIONAL CONVENTION ON DIVERSITY BIOLOGICAL. Retrieved from <https://www.cbd.int/doc/world/sn/sn-nr-05-fr.pdf>
- Republic of Senegal. (2015). State of marine environment, (38). Retrieved from <http://www.cse.sn/index.php/en/publications/suivi-de-l-etat-sur-l-environnement/rapports-sur-l-etat-de-l-environnement>
- Republic of Senegal. (2016). *Plan strategic, 2016-2018*. Dakar. Retrieved from <http://www.sante.gouv.sn/UserFiles/File/plcous.pdf>
- Republic of Senegal. (2017). *Conseil des Ministres du 15 février 2017*. Dakar. Retrieved from [file:///C:/Users/HP/Desktop/conseil des ministres du 15 fevrier 2017.pdf](file:///C:/Users/HP/Desktop/conseil%20des%20ministres%20du%2015%20fevrier%202017.pdf)
- rfi AFRIQUE. (2015). The adverse consequences of climate change. *Rfi AFRIQUE*. Retrieved from <http://www.rfi.fr/afrique/20151201-cop21-climat-senegal-bargny-cote-atlantique-ronge-ocean-erosion>
- Sarah Nienhuis, T. J. H. and T. C. D. (2014). *An empirical analysis of the consequences of zebra mussel invasions on fisheries in inland , freshwater lakes in Southern Ontario* (Vol. 5). CANADA. Retrieved from [http://www.reabic.net/journals/mbi/2014/3/MBI\\_2014\\_Nienhuis\\_et al.pdf](http://www.reabic.net/journals/mbi/2014/3/MBI_2014_Nienhuis_et al.pdf)
- Scriven, D. R. (2014). *The Development of Ballast Water Management in Canada: A Critical Analysis of the Journey*. CANADA. Retrieved from [http://www.cmla.org/papers/Ballast\\_Water\\_Management\\_Paper\\_Tetley\\_Award\\_2015.pdf](http://www.cmla.org/papers/Ballast_Water_Management_Paper_Tetley_Award_2015.pdf)
- Shiganova, T. (2010). Biotic Homogenization of Inland Seas of the. <https://doi.org/10.1146/annurev.ecolsys.110308.120148>
- SSATP. (2002). Ports and maritime transport in West and Central Africa. Retrieved from <http://www.i-conferences.org/wp-content/uploads/2016/09/2007-Rapport-SSATP-sur-les-ports-en-Afrique.pdf>
- Sub-Regional Fisheries Commission. (2016). Senegal fisheries context. Retrieved from <http://www.spcsrp.org/en/senegal>
- Tanaka, Y. (2012). *The International law of the sea* (First edit). Cambridge: Cambridge University Press.
- Tanaka, Y. (2015). *The International Law of the Sea* (Second Edi). United Kingdom: Cambridge University Press.
- The National Academies of Sciences. (1996). Controlling Introductions of Nonindigenous Species by Ships' Ballast Water. In The National Academies Press (Ed.), *Controlling Introductions of Nonindigenous Species by Ships' Ballast Water* (p. 141). Washington: 2017- National Academy of Sciences. Retrieved from <https://www.nap.edu/read/5294/chapter/4#31>
- The World Bank. (2004). *ENVIRONMENTAL ASSESSMENT OF THE GIRMaC PROGRAM*. Retrieved from <http://documents.worldbank.org/curated/en/183991468759908322/pdf/E8830VOL10101PAPER.pdf>

- The World Bank. (2015). Coastal erosion and the future of Senegal. Retrieved from <http://blogs.worldbank.org/nasikiliza/where-will-the-footprints-be-when-there-is-no-more-sand-coastal-erosion-and-the-future-of-senegal>
- The World Bank. (2016). Senegal Presentation. Retrieved from <http://www.banquemondiale.org/fr/country/senegal/overview>
- The World Bank. (2017). Country Overview. Retrieved from <http://www.worldbank.org/en/country/senegal/overview>
- UICN. (2003). *ALIEN INVASIVE SPECIES IN AFRICA* <sup>â€™</sup> *S WETLANDS*. Nairobi. Retrieved from <https://portals.iucn.org/library/sites/library/files/documents/2003-003.pdf>
- UICN. (2007). *Marine biodiversity*. Retrieved from [https://www.iucn.org/sites/dev/files/import/downloads/iucn\\_no13\\_francais\\_screen.pdf](https://www.iucn.org/sites/dev/files/import/downloads/iucn_no13_francais_screen.pdf)
- UICN. (2017). Marine. International Union for Conservation of Nature. Retrieved from <https://www.iucn.org/theme/species/our-work/marine>
- UICN, CAB International, S. (2001). *Global Strategy on Invasive Alien Species* (Dome Print). IUCN, Gland, Switzerland and Cambridge, UK in collaboration with the Global Invasive Species Programme. Retrieved from <http://www.issg.org/pdf/publications/GISP/Resources/McNeeley-et-al-EN.pdf>
- UN-Business. (2017). International Maritime Organization. Retrieved from <https://business.un.org/en/entities/13>
- UNCTAD. (2016). *Review of Maritime Transport 2016. Review of Maritime Transport - Annual Report*. <https://doi.org/10.1017/CBO9781107415324.004>
- UNDP. (2009). National Report on Human Development in Senegal, 102. Retrieved from [http://www.sn.undp.org/content/dam/senegal/docs/OMD/undp-sn-Rapport National Developpement Humain Senegal 2009.pdf](http://www.sn.undp.org/content/dam/senegal/docs/OMD/undp-sn-Rapport%20National%20Developpement%20Humain%20Senegal%202009.pdf)
- UNEP. (2012). *Measuring Progress: Environmental Goals and Gap*. <https://doi.org/10.1016/j.envdev.2013.01.002>
- UNEP. (2014). *Regional Oceans Governance Making Regional Seas Programmes, Regional Fishery Bodies and Large Marine Ecosystem Mechanisms Work Better Together. UNEP Regional Seas Report and Studies*. Retrieved from <https://www.cbd.int/doc/meetings/mar/soiom-2016-01/other/soiom-2016-01-unesp-06-en.pdf>
- UNEP. (2015). GREEN economy scoping study in senegal, 45. Retrieved from [http://web.unep.org/greeneconomy/sites/unep.org.greeneconomy/files/publications/senegal\\_scoping\\_study\\_interieur\\_web.pdf](http://web.unep.org/greeneconomy/sites/unep.org.greeneconomy/files/publications/senegal_scoping_study_interieur_web.pdf)
- UNEP. (2016). Time to embed biodiversity into the 2030 Agenda. Nairobi: UN Environment. Retrieved from <http://www.unep.org/stories/story/time-embed-biodiversity-2030-agenda>
- UNEP FI. (2008). *Biodiversity and Ecosystem Services*. Retrieved from [http://www.unepfi.org/fileadmin/documents/bloom\\_or\\_bust\\_report.pdf](http://www.unepfi.org/fileadmin/documents/bloom_or_bust_report.pdf)
- UNESCO. (2017). Wetlands. United Nations Educational, Scientific and Cultural Organization. Retrieved from <http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/specific-ecosystems/wetlands/>

- UNESCO and GEOHAB. (2015). *Harmful Algal Blooms*. Copenhagen. Retrieved from <http://unesdoc.unesco.org/images/0023/002334/233419e.pdf>
- United-Nations. (1992). Convention on Biological Diversity, 30p. Retrieved from <https://www.cbd.int/doc/legal/cbd-fr.pdf>
- United Nations. (1983). *The Law of the Sea: with index and final act of the third UNCLOS* (First edit). New york: St Martin's Press INC.
- USAID. (2010). *Dakar-Bamako Corridor Cost of Transport Analysis*. Dakar. Retrieved from [http://www.borderlesswa.com/sites/default/files/resources/jan13/USAID\\_PCE\\_Dakar\\_Bamako\\_Corridor\\_Cost\\_of\\_Transport\\_Analysis.pdf](http://www.borderlesswa.com/sites/default/files/resources/jan13/USAID_PCE_Dakar_Bamako_Corridor_Cost_of_Transport_Analysis.pdf)
- WHO. (2005). Handbook for Inspection of Ships and Issuance of Ship Sanitation Certificates, 150. Retrieved from file:///C:/Users/HP/Downloads/WHO\_2011\_-\_Handbook\_for\_inspection\_of\_ships\_and\_issuance\_of\_ship\_sanitation\_certificates.pdf

## **Annexs**

### **Annex i**

#### **Guidelines of the BWMC**

<b>G1</b>	Guidelines for Sediment Reception Facilities
<b>G2</b>	Guidelines for Ballast Water Sampling
<b>G3</b>	Guidelines for Ballast Water Management Equivalent Compliance
<b>G4</b>	Guidelines for Ballast Water Management and Development of Ballast Water Management Plans
<b>G5</b>	Guidelines for Ballast Water Reception Facilities
<b>G6</b>	Guidelines for Ballast Water Exchange
<b>G7</b>	Guidelines for Risk Assessment under Regulation A-4 of the BWM Convention
<b>G8</b>	Guidelines for Approval of Ballast Water Management Systems
<b>G9</b>	Procedure for Approval of Ballast Water Management Systems that Make Use of Active Substances
<b>G10</b>	Guidelines for Approval and Oversight of Prototype Ballast Water Treatment Technology Programmes
<b>G11</b>	Guidelines for Ballast Water Exchange Design and Construction Standards
<b>G12</b>	Guidelines on Design and Construction to Facilitate Sediment Control on Ships
<b>G13</b>	Guidelines for Additional Measures Regarding Ballast Water Management Including Emergency Situations
<b>G14</b>	Guidelines on Designation of Areas for Ballast Water Exchange

## **Annex ii**

### **Key principles in addressing marine IAS through National Strategy**

<b>The Precautionary Principle</b>
<b>The Ecosystem approach</b>
<b>The Polluter pays principle</b>
<b>Cross-sectoral integration:</b>
<b>Regional and international Co-operation</b>