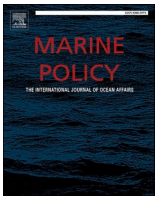
Marine Policy 137 (2022) 104971

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol



Assessing the need for the designation of the Yellow Sea Particularly Sensitive Sea Area (PSSA)

Junghwan Choi

Law School, Dalian Maritime University, No.1 Liaoning Road, Dalian, Liaoning 116026, China

ARTICLE INFO

Keywords:
Particularly Sensitive Sea Area
Yellow Sea
Associated protective measures
International maritime organisation
Vessel-source pollution

ABSTRACT

With each passing decade, industrial and economic activities have increased the severe contamination of the Yellow Sea and marine pollution, caused by various pollutants, has reached an alarming level. One of the main sources of contamination are pollutants from the international shipping industry. Due to an increase in maritime trade volume, driven by the rapid economic growth of China and South Korea, the danger of polluting incidents caused by shipping activities such as accidental and operational discharges from ships continues to rise. The semi-enclosed Yellow Sea poses geographical disadvantages. The depth of the Yellow Sea is relatively shallow. The width of the Yellow Sea does not exceed over 400 nm. China, South Korea, and North Korea have a common interest in the Yellow Sea. Pollution incidents involving oil, hazardous and noxious substances (HNS), or other pollutants from ships which occur in the territorial sea of one of the Yellow Sea states may have serious impacts on the maritime zone of another. Due to narrow sea areas of the Yellow Sea, there is ongoing dispute over maritime boundary delimitation of the Exclusive Economic Zone (EEZ) in the Yellow Sea. Concurrent Chinese and South Korean jurisdictions exist. These disputes are the primary factor hampering regional cooperation when dealing with regulatory instruments in an overlapping EEZ area. This article serves as a starting point for discussion, to make the case for the necessity of a practical regulatory instrument and regional cooperation to prevent vessel-source pollution in the Yellow Sea. In order to overcome the jurisdictional issue in an overlapping EEZ area and effectively address it, this article argues that the designation of a Yellow Sea Particularly Sensitive Sea Area (PSSA) is required. This study is not only assessing need for PSSA designation, but it is reviewing the geographical and environmental significance of the Yellow Sea.

1. Introduction

With the rapid economic growth and increasing interdependence between China and South Korea, the issues relevant to marine pollution in the Yellow Sea have been in the global spotlight. Industrialisation, the high population density of the coastal areas bordering the Yellow Sea, and the exploitation of oil and natural resources for economic development were indicated as primary causes behind the deterioration of all sources of marine pollution. Furthermore, the Yellow Sea has physical features that make it more vulnerable to marine pollution than other sea areas, as a semi-enclosed sea [1]. Vukas states 'every sea connected to another sea or the ocean by a narrow outlet, even when of considerable size, is due to its poor connection to such other sea or ocean particularly vulnerable and deserves special protection' [2]. Narrow outlets result in the slow exchange of waters. Geographical features of semi-enclosed sea make the Yellow Sea difficult to recover the marine environment if its sea area becomes contaminated. The damage to the marine ecosystem and the pollution from South Korea adjacent to the Yellow Sea inevitably have effects on neighbouring states that have a common interest in the Yellow Sea. For instance, the Hebei Spirit spilt approximately 12,500 tonnes of crude oil due to a collision with the barge boat in Taean on the Yellow Sea in 2007. Over 300 km of the coastline of South Korea and EEZ of the Yellow Sea was contaminated [3]. The oil spill greatly influenced fishing activities, agriculture, and marine living resources of the Yellow Sea [3].

Vessel-source pollution, which is classified operational and accidental discharges, is recognised as one of contributor to the worsening of the marine environment in the Yellow Sea. South Korea has the highest degree of dependence on sea trade with foreign countries, accounting for 99.7% of all trade freight [4]. 90% of the total volume of international trade is conducted by shipping in China [5]. China exerts a strong influence on the shipping industry as the largest importer and exporter in the world [6]. The North Korean foreign trade policy is highly reliant on China (approximately 91% of total foreign trade) [7]. According to the

E-mail address: roman2321@naver.com.

https://doi.org/10.1016/j.marpol.2022.104971
Received 5 May 2021; Received in revised form 6 January 2022; Accepted 20 January 2022

2020 edition of *Lloyd's List One Hundred Ports*, six of the world's 10 container ports are in China [8]. Of these, two ports (Qingdao and Tianjin) are situated at the coastal waters of the Yellow Sea. Similarly, the significant ports or offshore terminals of South Korea and North Korea are densely located in the Yellow Sea. The Yellow Sea has the busiest shipping routes, and it is potentially exposed to the risks of vessel-source pollution. In relation to this, oil pollution incidents that have happened in the coastal waters of the Yellow Sea (e.g., the Sea Prince, the Honam Sapphire, and the Heibei Spirit) devastated the marine environment and human life[1] [3,9,10], Enormous recovery costs and compensation against the claims for civil liability were incurred. Due to their nature, ships also generate operational discharges (e.g., bilge waters, ballast waters, grey waters, and garbage, etc.) Such operational discharges from ships have negative consequences for the marine environment to some extent in cases where there are no proper discharge restriction measures of a coastal state. The Yellow Sea has long been exposed to such pollutants from ships. Recently, the air quality of the Yellow Sea states has worsened because of ships' emissions.

The Yellow Sea has a strong possibility of becoming contaminated by various types of vessel-source pollutants unless the Yellow Sea states continue to make regulatory efforts to combat vessel-source pollution. Since China, South Korea, and North Korea have a common interest in the Yellow Sea, marine pollution incidents that occur in maritime zone of one state may inevitably affect another state. As vessel-source pollution results in transboundary pollution, and accidental discharges from ships can occur anywhere and anytime, regional cooperation between the states bordering semi-enclosed seas is needed to prevent vessel-source pollution beforehand or to minimise pollution incidents. However, the dispute of maritime boundary delimitation of the EEZ in the Yellow Sea is becoming major obstacles to regional cooperation. For this reason, there is no useful, effective regulatory instrument to deal with the prevention of vessel-source pollution in the Yellow Sea so far. As a practical and feasible approach, the IMO introduced PSSA concept at the global level to protect a certain sea area where is vulnerable to the risks of international shipping activities. The IMO allows a coastal state to adopt various associated protective measures (APMs) under PSSA resolution.

Against these backgrounds, this study suggests the need for the designation of a PSSA in the Yellow Sea. To achieve the goal of this study, the followings are discussed. The first section conducts essentially a review of the geographical and environmental significance of the Yellow Sea, the complexities in management of pollution and maritime activities. In next sections, this paper introduces PSSA review with case studies, discuss palpability to the Yellow Sea, and present recommendations with discussion of methods that may work or steps to achieving the Yellow Sea PSSA.

2. Characteristics of the Yellow Sea

2.1. Geographical features

Semi-enclosed or enclosed seas have long been recognised as vulnerable to marine pollution because of their geographical disadvantages. As a semi-enclosed sea, the Yellow Sea has had a great deal of exposure to various marine pollutants for a long time. The Yellow Sea is a marginal sea of the Western Pacific Ocean. It is surrounded by the Chinese mainland to the west, the Korean Peninsula to the east, and a line running from just north of the Changjiang River mouth to Jeju Island [11–13]. The innermost of the northern gulf of the Yellow Sea is named Bohai Bay, which entirely consists of Chinese internal waters and territorial waters [14]. The Yellow Sea is unable to properly exert assimilative capacity because there is little water exchange with open seas [15]. As a result, the Yellow Sea is considerably vulnerable to various marine pollutants.

The total area of the Yellow Sea is about 400,000 km^2, and its average depth is 44 m with a maximum depth of 100 m [11,15]. Bohai Bay ranges from an average depth of 21 m to the maximum depth of 72 m [15]. The Han River, Datung River, Yalu River, Guanhe River, and Sheyang River flow into the Yellow Sea. Approximately 1.6 billion tonnes of sediment arising from China's Huanghai River and Changjiang River are deposited in the Yellow Sea annually, eventually making large deltas in the centre of the Yellow Sea [1]. The fresh waters of the Yellow River and Yangtze River flow across the continental shelf, and large volumes of sediments are discharged to the Okinawa Trough [1]. The volume of fresh water discharged from the Yellow River and the Yangtze River to the Yellow Sea peaks in the summer, which has a considerable impact on the salt concentration of the Yellow Sea. Besides, the Yellow Sea is prominently influenced by the monsoon season, which results in changes of biomass in the Yellow Sea [1]. The drift of tidal currents in the Yellow Sea is stronger than in other sea areas, which may lead to pollutant dispersion. Tidal currents reach 4–8 m in the port of Incheon, South Korea [12]. The average tidal current in Bohai Bay is 5 m in the spring season [16]. Strong tidal currents make it difficult to promptly conduct clean-up and preventive operations in the event of oil pollution incidents [17]. (Fig. 1).

2.2. Marine environmental characteristics

2.2.1. Marine ecosystem

A total of 64 large marine ecosystems exist in the world, and the Global Environment Facility (GEF) has designated the Yellow Sea as containing a large marine ecosystem.[2] The marine ecosystems in the Yellow Sea have long been threatened by pollution from land-based sources and vessel-source pollution. To restore and conserve the marine ecosystems in the Yellow Sea, in 2000, China and South Korea launched the Yellow Sea Large Marine Ecosystem (YSLME) Project under the financial auspices of United Nations Development Programme and GEF [18]. According to the YSLME Project, there are total 17 species of whales and dolphins, as well as four species of seals and sea lions in the Yellow Sea. The Yellow Sea provides a comfortable habitat for the Eurasian otter *(Lutra lutra*) and the finless porpoise *(Neophocaena phocaenoides)*. Largha seals *(Phoca largha)* migrate to the northern Yellow Sea each winter to breed [19]. According to the YSLME, eight species of marine mammal in this region are endangered. To conserve these species, three sea areas have been designated as Mammal Ecologically Important Areas (MEIA) within the Yellow Sea [19].

The Yellow Sea also offers an essential habitat for algae. Algae generates more than 50% of the world's oxygen through photosynthesis [20]. As the bottom of the food chain, these plants provide the fundamental sources of food and energy to other organisms and top predators. There are 42 species of red algae, 22 species of brown algae, and 11 species of green algae in the northern Yellow Sea; 15 species of green algae, 15 species of brown algae, and 28 species of red algae are observed in the southern Yellow Sea. About 43 species of blue-green algae, 45 species of green algae, 90 species of brown algae, and 217 species of red algae species live exclusively in South Korea [19].

In recent years, various marine pollutants have come to threaten the marine ecosystem of the Yellow Sea. For example, oil pollution and HNS

[1] Over the past few decades, there have been tragic oil pollution incidents, such as The Sea Prince incident (1995), the Honam Sapphire(1995) and the Heibei Spirit(2007) in the coastal waters of the Yellow Sea.

[2] The Global Environment Facility (GEF) was established on the eve of the 1992 Rio Earth Summit to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided over $17 billion in grants and mobilized an additional $88 billion in financing for more than 4000 projects in 170 countries. Today, the GEF is an international partnership of 183 countries, international institutions, civil society organizations and the private sector that addresses global environmental issues.

Fig. 1. An Image of the Yellow Sea.

pollution incidents have caused reproductive issues and the failure of the immune systems of marine mammals, marine life habitat destruction, the toxic contamination of molluscs, and productivity of algae [19].

2.2.2. Wetlands

Wetlands are water areas that provide habitats for the plant and animal life. These areas help to conserve the marine ecosystem and protect the marine environment by maintaining wet conditions, either permanently or temporarily [21]. Due to the interaction of the physical, biological, and chemical characteristics of wetlands, we can protect areas from storms, mitigate floods, stabilise shorelines, and control erosion. Wetlands have a high economic value in terms of the water supply, agricultural timber and other building materials, energy resources, and wildlife resources for tourism and leisure activities [21]. Wetlands also provide a billion people with livelihoods worldwide in modern society.

However, over 50% of wetlands around the world have been destroyed in the past [22]. Of these, more than 60% of Asian wetlands have been lost [23]. Wetlands in the Yellow Sea have been rapidly destroyed as well. Over the past five decades, about 65% of intertidal wetlands have been lost—more than 28% of them between the 1980 s and the 2000 s [24]. Conservationists have estimated that, every year, wetlands will continue to disappear at a rate of 1.5% on average, mainly due to reclamation [25]. Another cause involves habitat modifications, which have led to changes in wetlands' ecological function. Approximately 60% of the coastal wetlands in China have been altered for use for other purposes or reclamation [26]. Jiangsu Province's wetlands disappeared due to their conversion into salt ponds, and others were modified for use in agriculture and aquaculture [26].

A wide array of wetlands that need the protection and conservation are distributed all over the Yellow Sea. There are four designated Ramsar sites in the Chinese coastal regions, including the Dalian National Spotted Seal Nature Reserve, the Shandong Yellow River Delta Wetland, the Dafeng (*Elaphurus davidianus*) National Nature Reserve, and the Shuangtai Estuary [27]. In South Korea, there are 17 Ramsar sites in total throughout the Yellow Sea. This figure accounts for about two- thirds of total Ramsar sites.[3]

2.2.3. Fisheries

The Yellow Sea provides an abundant fishing ground for the Yellow Sea states. Fish represent an essential food source, and fisheries contribute to economic growth. According to the Korea Ocean Research and Development Institute and the Korea Environment Institute, 276 different species of fish live in the Yellow Sea. Of these, only 100 species of fish are used commercially [19]. Over the past few years, overfishing has become recognised as a serious problem in the Yellow Sea, and the exhaustion of the fish stock has emerged as an issue. Overfishing led to the reduction of the populations of red sea bream (*Pagrosomus major*), jewfish (*Otolithoides mijuy*), yellow croaker (*Nibea albiflora*), and white croaker (*Argyrosomus argenteus*) [19]. The trend of commercially catchable fish species has shifted from commercially valuable and large fish to the small-sized, unmarketable fish [28]. Experts have identified marine pollution and reclamation as another cause behind the decrease in fishery biomass and changes in the trends of catch pattern [29].

2.3. The Importance of Maritime Transport

The Yellow Sea significantly contributes to economic growth by

[3] Ganghwa Maehwamareum Habitat, Du-ung Wetland Ramsar Site, Jangdo Wetland, 1100 Altitude Wetland, Han River-Bamseom Islets, Mulyeongari-oreum Ramsar Site, Dongbaekdongsan, Muljangori-oreum wetland, Sumeunmulbaengdui Ramsar Site, Ungok Wetland, Dongcheon Estuary, Songdo Tidal Flat, Seocheon Tidal Flat Jeungdo Tidal Flat, Suncheon Bay, Muan Tidal Flat, Gochang and Buan Tidal Flats

providing various fishing grounds and natural resources to the Yellow Sea states. Along with these roles, the Yellow Sea serves as major international shipping route [30]. The Yellow Sea states have a high degree of dependence on seaborne trade compared to other countries, and the shipping industry is irreplaceable in terms of expanding their economic production [31]. Since the significant ports are situated at the Yellow Sea, many vessels pass through the Yellow Sea daily.

With the growth of seaborne trade over the world, the number of vessels navigating the Yellow Sea will continue to increase. The shipping industry plays a core role in boosting Chinese economic growth. For example, about 36% of the oil products imported from western Asia are consumed in the Asia-Pacific region, including China and South Korea [6]. In relation to this fact, UNCTAD stated that the countries with the most crude oil imports are China and India [6]. In dry cargoes, China is the largest steel producer (53% of the world total) and steel user (51% of the world total) in the world. China is also the largest importer of a variety of products, ranging from iron ore (72% of the world total) and coal (19% of the world total) to grain (46% of world total) [6].

Moreover, approximately 33% of the world container volume is handled in South Korea and China [6]. The world-leading container ports are densely distributed over the Chinese coastal regions on the Yellow Sea, such as Qingdao, Tianjin, Dalian, Yingkou, and Lianyungang. According to *Lloyd's List One Hundred Ports*, the container throughput of these ports stood at 21 million twenty-foot equivalent units (TEUs) (Port of Qingdao), 17.2 million TEUs (Port of Tianjin), 8.7 million TEUs (Port of Dalian), 5.4 million TEUs (Port of Yingkou), and 4.7 million TEUs (Port of Lianyungang) in 2019 [8]. The Chinese container throughput located in the coastal regions of the Yellow Sea amounts to approximately 8% of the world total[4][32]. Remarkably, six of the top 10 container ports are concentrated in China. Amongst them, the ports of Qingdao and Tianjin are situated on the Yellow Sea [8]. It is widely presumed that North Korea relies on foreign trade through shipping [33]. Officially, North Korea has a total of eight port terminals, including Chongjin, Haeju, Dancheon, Nampo, Hyungnam, Songnim, Sonbong, and Wonsan. Amongst them, Nampo, Haeju, and Songim are situated on the Yellow Sea [34]. Nampo is the biggest port of North Korea with a total port cargo handling capability of 1.3 million tonnes. Nampo deals mainly with cement, coal, and general cargoes [35]. The proportion of foreign trade handled through the port of Nampo is estimated at about 29% [35]. Such cargoes largely depend on trade with Shanghai and Dalian (China), Southeast Asia, the Middle East, and Africa. Cargo throughput in Haeju and Songnim account for 9.8% and 2.9% of trade in the country, respectively [35]. These ports play a significant role as export ports to China [36]. The volume of seaborne trade in North Korea is relatively lower than that in China and South Korea. North Korea has shown a high level of dependence on trade with China via ships. (Fig. 2).

3. The benefits of a PSSA in preventing vessel-source pollution

3.1. The concept of a PSSA

The PSSA concept arises from the IMO Resolution A.982(24). A PSSA is defined as "an area that needs special protection through action by IMO because of its significance for recognised ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities"[37]. The PSSA concept was first introduced by the Swedish delegation at the International Conference on Tanker Safety and Pollution Prevention (TSPP conference) in 1978 [38]. Sweden called for special protection for areas of particular value to prevent oil discharges in these places because of their renewable natural resources or their scientific importance [39]. The Swedish proposal was adopted as Resolution 9 at the TSPP conference.[5] While NGOs (e.g. the Friends of the Earth International and the International Union for Conservation of Nature) had urged the IMO to take proper action for the development of PSSAs based on the Swedish proposal adopted in the TSPP conference, there was not any progress until the mid-1980 s[30, 40] At the 22nd meeting of the Marine Environment Protection Committee (MEPC) in 1986, the IMO began discussing the concept of PSSAs through MEPC/Circ.171 in earnest [41]. After extended discussions, the IMO eventually decided to develop the criteria for the designation of PSSAs and separate guidelines for the member states that wish to have areas in their territories designated as PSSAs [42]. In 1990, Australia submitted to the MEPC the proposal for the identification of the Great Barrier Reef as a PSSA for the first time [43]. In response to the Australian proposal, the MEPC adopted two resolutions (i.e., the identification of Great Barrier Reef as a PSSA and compliance with Australia's pilotage requirements for foreign vessels operating in the Inner Route of the Great Barrier Reef) [44]. At the 17th IMO Assembly in November 1991, the IMO adopted Resolution A.720 (17), *Guidelines for the Designation of Special Areas and the Identification of Particularly Sensitive Sea Areas* (the 1991 guidelines). In December 2005, as the latest version, the IMO adopted Resolution A.982 (24), *Revised Guidelines for the Identification and Designation of PSSA* (PSSA Resolutions or Resolution A.982 [24]) to clarify the procedural requirements for the designation of PSSAs and the criteria for the adoption of Associated Protective Measures(APMs) by isolating the guidelines for the designation of special areas under MARPOL 73/78 [37]. As an independent resolution dealing solely with PSSAs, the IMO aims to encourage member states to develop and promote the designation of PSSAs through Resolution A.982(24) [37].

For a territory to be designated as a PSSA, a state must meet at least one of the criteria referred to in paragraph 4 of Resolution A.982(24). Such criteria are divided into three categories: ecological, socio-economic, and scientific and educational criteria. a sea area that a state wants to have designated as a PSSA must be exposed to the risks of international shipping activities [37]. The meaning of 'the risks of international shipping activities' must contain two factors: vessel traffic characteristics and natural elements. The element concerning the threats of international shipping activities is not an essential criterion for submitting a proposal for the designation of a PSSA [39]. If a sea area already meets at least one of the criteria to be designated as a PSSA under paragraph 4 of Resolution A.982(24), the obligation to prove the vulnerability of its sea area from the threats of international shipping activities would not be imposed [45]. Even so, in practice, the proof of the vulnerability of a sea area may be a significant element because such elements may have a significant effect on the IMO's decision in assessing the need for the designation of a PSSA [46].

3.2. Associated protective measures as an effective mechanism

Resolution A.982 (24) allows a state to establish APMs in order to prevent various pollutants from ships effectively within sea areas to be designated as PSSAs. In the literature, APMs are defined as 'specific regulatory methods' that enable states to protect their sea areas against

[4] According to UNCTAD STAT, World total container port throughput recorded at 811 million TEUs in 2019. About 270 million TEUs of container port throughput handled by China and South Korea.

[5] IMCO TSPP Resolution 9, 'Protection of Particularly Sensitive Sea Areas '(1978) "1) making an inventory of sea areas around the world which are in special need of protection against marine pollution from ships and dumping, on account of the area's particular sensitivity in respect of their renewable resources or in respect of their importance for scientific purposes; 2) assessing as far as possible, the extent of the need for protection, as well as the measures which might to be considered appropriate, in order to achieve a reasonable degree of protection, taking into account also other legitimate uses of the seas; and 3) on the basis of this work, action should be taken with a view to incorporate any necessary revisions within the framework of relevant conventions".

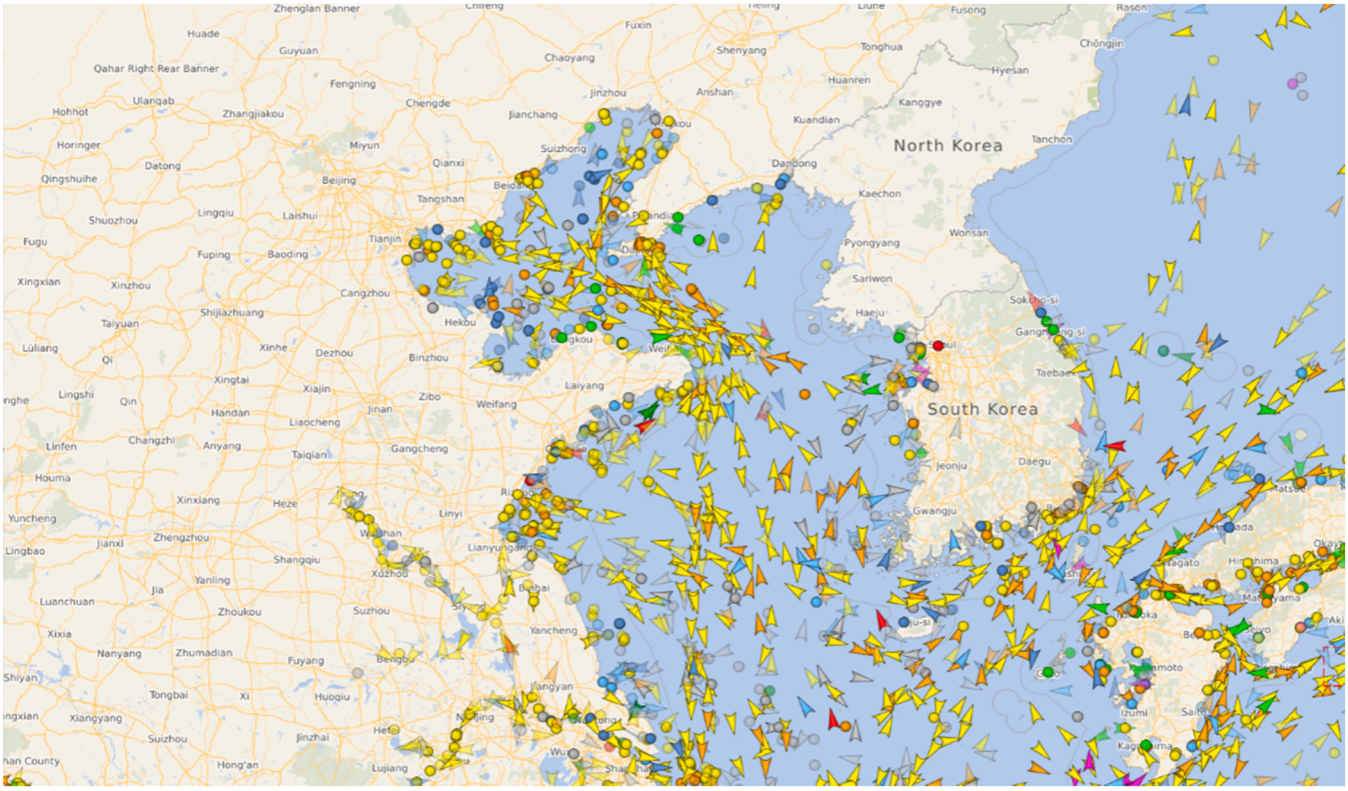


Fig. 2. Ship Tracking in the Yellow Sea on 20th August 2021,.

the risks or the threats posed by international shipping activities [46]. Resolution A.982 (24) requires a state to adopt APMs under existing IMO instruments or general accepted international rules and standards for the prevention of vessel-source pollution or Article 211(6) of UNCLOS. The term 'existing IMO instruments' encompasses IMO conventions, codes, guidelines, and resolutions [47]. Whether existing IMO instruments have a legally binding effect over foreign vessels must be prudently decided by a state when formulating a proposal for the adoption of APMs in a proposed special sea area [39]. Moreover, APMs play a crucial role in the PSSA concept to combat pollution arising from shipping activities. However, PSSAs without APMs are unable to exert their effect properly. Unlike existing IMO instruments, the IMO has been encouraging the prevention of vessel-source pollution in designated PSSAs by allowing states to adopt various APMs.

APMs are divided two categories such as measures for the safety of navigation and special discharge restriction measures. Firstly, there are current adopted APMs related to the safety of navigation, such as the vessel traffic service (VTS) and pilotage regimes [39]. The IMO first adopted Resolution A.572 (14) *General Provisions on Ships' Routeing* in 1985 to provide procedures and guidelines for the criteria of the adoption of ships' routeing measures [48]. Resolution A.572 (14) aims at preventing and reducing the risk of pollution or other damage to the marine environment caused by ships colliding or grounding in or near environmentally sensitive areas.[6] The legal basis for ships' routeing measures is underpinned by Regulation 10, Chapter V of the International Convention for the Safety of Life at Sea (SOLAS) and Rule 1(d) and Rule 10 of Convention on the International Regulations for Preventing Collisions at Sea(COLREG). Ship's routeing measures are concretely comprised of Traffic Separation Scheme(TSS), two-way routes, recommended tracks, areas to be avoided, inshore traffic zones, precautionary areas, and deep-water routes [49]. Amongst ships' routeing measures, TSS is the most notable APM; its legal source arises from Rule 10 of COLREG and is based on various IMO resolutions—such as A.572 (14), MSC.71 (69), and MSC.165 (78).

Concerning the second category of APMs, paragraph 6.1.1 of Resolution A.982 (24) allows a state to cite the concept of 'special areas' and 'emission control areas' under the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978(MARPOL 73/78) in order to protect the marine environment of PSSAs from vessel-source pollution.[7] In that case, a state may apply stringent discharge standards to foreign vessels navigating in designated PSSAs. To do so, a sea area where a state wishes to propose the designation of a PSSA should be preferentially designated as a special area or emission control area by the IMO. The procedures and criteria for the designation of 'special areas' and 'emission control areas' are stipulated in Resolution A. 927(22) and Appendix 3 to Annex VI of MAPROL 73/78 [42]. Besides the citation for special areas or emission control areas, a state can prevent foreign vessels from discharging ballast waters within proposed PSSAs based on the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM).

3.3. Current status of PSSAs

As seen in Table 1, a total of 17 PSSAs have been designated so far since the Great Barrier Reef was first declared a PSSA in 1990. These designated PSSAs are adopted and implemented by each MEPC resolution. Of these, six PSSAs are in European waters, and five PSSAs are situated in Central America, South America, and the US [50]. The EU and the US are actively and practically striving to protect of their coastal waters from the threats of various pollutants from ships through existing IMO instruments based on regional cooperation. Unfortunately, there are no designated PSSAs in East Asian seas to date despite the need for

[6] IMO Resolution A.572(14) Annexe 1.1.

[7] IMO Resolution A.982(24) para6.1.1.

Table 1
Current Status of Designated PSSAs and APMs by the IMO.

Designated PSSAs	Years	Adopted APMs
Great Barrier Reef (Australia)	1990	Compulsory pilotage (inner), Recommended pilotage, Mandatory ship reporting system
Sabana-Camagüey Archipelago in Cuba	1997	MARPOL 73/78 Annex V special area, Area to be avoided, Traffic-separation schemes (TSSs)
Malpelo Island (Colombia)	2002	An area to be avoided
Florida Keys (United States)	2002	Four areas to be avoided,Three mandatory no-anchoring areas
Wadden Sea (Denmark, Germany, and Netherlands)	2002	MARPOL Annex I and V special area, Recommended TSSs, Mandatory deep-water route, Mandatory ship reporting system
Paracas National Reserve (Peru)	2003	Four recommended TSSs, Area to be avoided
Western European Waters (Portugal, Spain, France, Belgium, UK, and Ireland)	2004	Recommended TSSs, Mandatory ship reporting system, Area to be avoided, Recommended deep-water route
Torres Strait (Australia and Papua New Guinea)	2005	Recommended pilotage, Recommended two-way route, Mandatory ship reporting system
Canary Islands (Spain)	2005	Five areas to be avoided, Three recommended TSSs, Mandatory ship reporting system
Galapagos Archipelago (Ecuador)	2005	Mandatory ship reporting system, Mandatory TSSs, Area to be avoided
Baltic Sea area (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden)	2005	MARPOL 73/78, Annex I, II, V, and VI(Sox) special area, Mandatory ship reporting system, Localized compulsory pilotage, Recommended TSSs, Deep-water route between TSSs, Two areas to be avoided
Papahānaumokuākea Marine National Monument (United States)	2007	Mandatory ship reporting system, Area to be avoided
Strait of Bonifacio (France and Italy)	2011	Mandatory ship reporting system, Recommended pilotage, Recommended two-way route
Saba Bank (Netherlands)	2012	Mandatory no-anchoring areas, Area to be avoided
Coral Sea extension	2015	Ships' routing systems (in SOLAS V), Recommended two-way route
Jomard Entrance (Papua New Guinea)	2016	Recommended two-way route
Tubbataha Reefs Natural Park (Philippines)	2017	Recommended pilotage, Area to be avoided

Source: IMO website

special measures to combat vessel-source pollution because of its significance to the marine environmental, marine traffic, economic and historical characterises, and natural resources.

3.4. Implications

The PSSA concept has played a notable role in preventing vessel-source pollution compared to other existing IMO instruments since the concept of PSSA was introduced in 1992. A PSSA is a very useful method to prevent marine pollution from ships in a particular sea area where is vulnerable to marine pollution in its functional aspects [39]. A PSSA has a unique advantage that a coastal state can apply discharge regulations for particular pollution substances through complementary regulatory relation with MAPROL 73/78 as well as various protective measures [46]. A PSSA is called 'a comprehensive regulatory mechanism' protecting the marine environment from the threats of international shipping activities [51–53]. A coastal state vulnerable to vessel-source pollution is able to protect its sea areas from various vessel-source pollutants by adopting effective and practical APMs. Unlike other regulatory instruments over vessel-source pollution, the IMO allows a coastal state to adopt various APMs, including (but not limited to) measures for the safety of navigation and measures for discharge restrictions under existing IMO instruments, such as conventions, codes, and resolutions [51]. As a core role in the PSSA concept, the application of APMs over foreign vessels makes it possible for a coastal state to prevent operational or accidental discharges from ships in a particular sea area that requires special attention. The most important benefit of the establishment of a PSSA is to grant discretionary authority for the adoption of wider protective measures based on existing IMO instruments or UNCLOS to a coastal state [54]. For instance, protective measures for the safety of navigation such as TSS, VTS, ship reporting system and pilotage system are helpful to combat accidental discharges from ships by enhancing safe and efficient navigation within a PSSA [46]. The APMs regarding special discharge restrictions strictly prohibit the ship from discharging any pollutants. Such measures are directly and greatly contributing to protect a particular sea area where needs a special attention for the protection the marine environment from vessel-source pollution.

Another advantage is that a PSSA promotes global awareness of the need for the protection of the marine environment from various vessel-source pollutants within designated PSSAs due to its significance in the ecological, socio-economic, and marine environmental aspects [39]. In particular, officials in a PSSA can alert foreign vessels to the dangers of the violations of discharge standards while travelling in the PSSA. The promulgation of the designation of PSSAs can help coastal states to protect sea areas by raising public awareness of the need for special attention to the protection of the marine environment [55]. The master or the shipowner must pay more attention in order ensure that the vessel does not violate the adopted APMs in a designated PSSA than in other sea areas [54]. Besides, the simple and concise PSSA designation procedures may facilitate the submission of the application to the IMO and the final designation of a PSSA than 'special areas' under MARPOL 73/78. In this light, the expansion of a PSSA may be conducive to the acceleration of the achievement of common or global pursuits to prevent and reduce vessel-source pollution.

4. The Yellow Sea PSSA

4.1. Case studies for the way forward on the Yellow Sea PSSA: The need for governing body

To attain the designation of the proposed Yellow Sea PSSA, the Yellow Sea states need to set up a phased, strategic approach. The analysis of the environmental, geographical, and maritime traffic characteristics and the study of the impact of vessel-source pollution on the marine environment and potential risks of shipping activities in the Yellow Sea should take precedence in order to highlight the need for a comprehensive regulatory instrument at the regional level [56]. Such scientific certainty would help the Yellow Sea states to determine the geographical scope and APMs. After the PSSA is established, the matter how the Yellow Sea states can faithfully and practically implement the adopted APMs becomes important. Thus, the Yellow Sea states need to consider establishing an administrative governing body (e.g., a commission) responsible for cooperation and coordination in regional activities with respect to the prevention of vessel-source pollution in the Yellow Sea to push ahead with a proposal and deal with overall matters related to the Yellow Sea PSSA. The commission can play various roles in formulating the proposal [56]. Firstly, the commission can play a role as a policymaker in establishing the institutional strategy at the regional level and implementing the IMO instruments. As there is no regional convention on the prevention of marine pollution from ships in the Yellow Sea, the Yellow Sea states should make an effort to create a regional convention or agreement through the commission. Secondly, the commission should be able to act as a coordinator in negotiating the decisions regarding APMs, the geographical scope, and procedural

matters.

In addition, the commission can play a significant role in coordinating and carrying out the designation of a special area under MARPOL 73/78. While the NOWPAP and the CORSEA administered by UNEP play a role as the governing bodies of each action plan under regional sea programmes covering the Yellow Sea, these do not concentrate on the prevention of marine pollution from ships [57]. Since the geographical scope of the proposed PSSA is too vague, the NOWPAP and the CORSEA may have difficulty establishing a regional legal framework for the prevention of marine pollution from ships in the Yellow Sea [58]. Despite North Korea's observer status, the country was not involved in the NOWPAP or the CORSEA [59]. For these reasons, the establishment of an administrative governing body to deal with the prevention of vessel-source pollution in the Yellow Sea is needed to forge an agreement for the designation of the proposed Yellow Sea PSSA amongst the Yellow Sea states. The following case studies can guide the discussion of which aspects would be applicable to the Yellow Sea, then the Yellow Sea recommendations. Case studies insight the significance of the role of a governing body when formulating a proposal for the designation of a PSSA.

4.1.1. The Baltic Sea PSSA case

The first case involves the Baltic Sea PSSA, which was first proposed by the Baltic Marine Environment Protection Commission (HELCOM), which is the governing body of the Helsinki convention, in 2001 and 2003 [60]. This organisation plays various roles: It is a marine environmental policymaker; an environmental focal point providing information about the state of and trends in the marine environment, as well as the efficiency of measures to protect it; a supervisory body that dedicated to ensuring that all parties fully implement HELCOM environmental standards throughout the Baltic Sea; and a coordinating body [60]. The Baltic Sea was designated as a PSSA in 2005 through the efforts of HELCOM. The organisation still provides an important platform for dealing with matters related to the Baltic Sea PSSA and the coordination of regional activities.

4.1.2. The Wadden Sea PSSA case

In a second example, Denmark, Germany, and the Netherlands agreed to submit a proposal for the designation of the Wadden Sea PSSA to the IMO at the Ministerial Declaration of the 9th Trilateral Governmental Conference in 2001 [61]. The trilateral application for the designation of the Wadden Sea PSSA was mainly coordinated through the Common Wadden Sea Secretariat [61]. This organisation was established in 1987 according to an administrative agreement concluded between the Danish Ministry of the Environment, the German Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, and the Dutch Ministry of Economic Affairs [61]. The Secretariat coordinates the activities of the cooperation and reviews evaluation reports. The members have also attempted to raise awareness of relevant issues, held discussions on risk management as a central aspect of navigational safety, and promoted the implementation of the adopted APMs ever since the Wadden Sea was designated as a PSSA in 2002 [61].

4.1.3. The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC)

The third example is the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC). This organisation's members have consistently suggested the need for designation of a Mediterranean Sea PSSA due to its geographical disadvantages and the environmental, socio-economic, and cultural significance, as well as the intense maritime traffic congestion[8][62]. Eventually, REMPEC decided to develop an implementation strategy for the designation of a Mediterranean Sea PSSA at the 14th Ordinary Meeting of the Contracting Parties to the Barcelona Convention in 2005 [63]. Although the parties involved have not yet submitted the final application for the designation of the Mediterranean Sea PSSA to the IMO, they agreed to continue to initiate the process of identification of those areas which, after examination according to the REMPEC focal points, could be proposed for designation as a PSSA based on the publication *Regional Strategy for Prevention of and Response to Marine Pollution from Ships (2016–2021)* [64]. Recently, REMPEC released a statement indicating that an assessment of the benefits, costs, and feasibility of implementing an ECA to limit SOx from ships in the Mediterranean Sea has begun [65]. Moreover, REMPEC is dedicated to coordinating and cooperating on regional activities in an attempt to identify a sea area in which two or more states have common interests as a PSSA or an ECA.

4.1.4. Recommendations for the Yellow Sea management

Likewise, the Yellow Sea states need to consider establishing a governing body with administrative responsibility to deal actively and directly with regional cooperation and coordination on the designation of the proposed Yellow Sea PSSA. The governing body can continue to play the central role in devising a strategic approach for the prevention of marine pollution from ships in the Yellow Sea even after as the designation of the PSSA. To do so, the conclusion of an administrative agreement on the establishment of the governing body is needed. It is also worth discussing this agenda in more in depth at South Korea's annual maritime safety policy meeting. After determining a strategic direction to establish an administrative governing body for promoting the designation of the proposed Yellow Sea PSSA, South Korea and China should ask North Korea to participate in an administrative agreement.

4.2. Review of the need for designation of the Yellow Sea PSSA

As regards to why the Yellow Sea needs to be designated as a PSSA, first, the Yellow Sea has been recognised as one of polluted sea areas in the world since the report entitled *Dying Sea* was released by the Worldwatch Institute in 1992 [66]. As one of the semi-enclosed seas in the world, the Yellow Sea features some geographical disadvantages that result in the worsening of the marine environment and the marine ecosystems [67]. For example, the Yellow Sea is shallow, and the movement of the ocean current is more prominent than in other sea areas [16]. Such geographical disadvantages make it more difficult for the Yellow Sea to circulate compared with open seas [11]. Sediments from major rivers in South Korea and China pour into the Yellow Sea. In addition, industrial and domestic wastewaters from the coastal regions of the Yellow Sea result in severe pollution in the Yellow Sea.

Although industrialisation and urbanisation in the coastal waters of the Yellow Sea constitute the primary cause exacerbating the situation in the marine environment, policymakers should not overlook the fact that vessel-source pollution has also accelerated the deterioration of the marine environment of the Yellow Sea. The Yellow Sea has long played a

[8] The REMPEC, which is administered by the IMO and UNEP, is the governing body of the Protocol concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea to the Barcelona Convention ("the 2002 Prevention and Emergency Protocol"). The primary objective of REMPC encourages the Contracting Parties to the Barcelona Convention to ratify, implement and enforce the IMO instruments so as to prevent vessel-source pollution in the Mediterranean Sea.

vital role as an international shipping route. In particular, the major ports are densely situated at the coastal regions of the Yellow Sea. Since the Yellow Sea states depend highly on seaborne trade with foreign countries, the Yellow Sea is still exposed to the risks of operational or accidental discharges from ships. Besides, as significant fishing grounds between the Yellow Sea states, the Yellow Sea provides abundant food and contributes to the economic growth of the Yellow Sea states [15]. Due to severe marine pollution, some fish stocks are threatened with exhaustion [15]. The Yellow Sea is a sea area that needs particular protective measures and intensive regional cooperation to protect and preserve the coastal sea area and the resources from vessel-source pollution because of its environmental, socio-economic, and scientific significance.

The second factor concerns the necessity of a comprehensive legal instrument to deal specifically with the matters for the prevention of vessel-source pollution. The IMO has long acted as a global rulemaking organisation to protect and preserve the marine environment from the threats of international shipping activities. The IMO provides a wide range of global regulatory instruments, ranging from the prevention of accidental and operational discharges from ships, the control of ballast waters, and the establishment of an international cooperation framework for pollution incidents to international civil liability regimes for pollution damage. The fundamental limitation in applying the IMO instruments is that the implementation wholly relies on member states. The status of ratification by the Yellow Sea states is closely associated with the profit of their marine industries and economic levels. The Yellow Sea states have somewhat different attitudes towards the implementation of the IMO conventions at the domestic level [68]. Moreover, there are still ongoing disputes regarding the maritime boundary delimitation between China and South Korea and the status of Northern Limit Line (NLL) on the Korean peninsula [69]. Due to these issues, fundamental limitations exist, along with a legal vacuum in exercising enforcement jurisdiction over the IMO instruments. While the Yellow Sea is contained in the Coordinating Body on the Seas of East Asia (CORSEA) and in the Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP), which are administered by United Nations Environment Programme(UNEP), these sea programmes do not provide an effective regional instrument for the prevention of vessel-source pollution [70,71] The absence of the participation of North Korea in regional sea programmes is one factor weakening the effectiveness of regional regimes in dealing with the protection of the marine environment in the Yellow Sea [72]. Given that North Korea does not often cooperate with the international community in the marine environment field, except for the IMO diplomatic conference, the designation of a PSSA may become a significant motivation to improve regional cooperation by encouraging North Korea without any administrative burden.

Thirdly, designating the Yellow Sea as a PSSA is imperative because the Yellow Sea has not been granted a special status at the IMO level so far. The Yellow Sea PSSA can raise public awareness about the significance of protection of the marine environment of the Yellow Sea and can contribute to combating vessel-source pollution effectively by imposing strict discharge standards and the navigational safety measures on foreign vessels. The Yellow Sea has been exposed to the threats of various marine pollutants from ships for a long time. Given the environmental and geographical significance of the Yellow Sea and its maritime traffic characteristics, the Yellow Sea should be given a special status under the IMO regulatory framework to actively and effectively prevent operational and accidental discharges from ships.

In the future, the proposed Yellow Sea PSSA may play a crucial role as a comprehensive management tool in preventing vessel-source pollution by providing effective and useful APMs against foreign vessels. The Yellow Sea states can also overcome current legal issues concerning the exercise of the enforcement jurisdiction over foreign vessels in an overlapping area of the EEZ through the proposed Yellow Sea PSSA by offering a unified and harmonised enforcement procedure for APMs. A Yellow Sea PSSA would strengthen regional cooperation for dealing with the prevention of vessel-source pollution, and it could serve as a valid legal instrument by encouraging the participation of North Korea.

4.3. Adoption of effective APMs in the Yellow Sea PSSA

4.3.1. Measures for the safety of navigation

The most serious oil pollution incidents are related to accidental discharges from ships (e.g., collisions, groundings, bad weather, etc.). The international community has been striving to eliminate maritime accidents by providing practical navigational safety measures at the global level [73]. Based on the IMO instruments, a coastal state can apply more strict navigational safety measures than global standards considering their marine traffic characteristics and marine environmental characteristics. The IMO allows a coastal state to take various navigational safety measures within a PSSA under existing IMO instruments, including (but not limited to) SOLAS, COLREG, and non-binding documents (e.g., Resolutions, Codes, and Guidelines) [46]. A coastal state can enjoy regulatory shopping to improve the safety of navigation in PSSAs if approved by the IMO. Currently, all PSSAs have established navigational safety measures as APMs (i.e., TSSs, areas to be avoided, pilotage schemes, and ship-reporting systems) [46].

To determine which navigational safety measures are effective as APMs in the Yellow Sea, an analysis for maritime traffic characteristics and risk assessment of the Yellow Sea should take precedence. In addition to such an analysis, this paper strongly recommends the necessity of introducing the transnational Vessel Traffic Management and Information System (VTMIS) in the Yellow Sea. The transnational VTMIS can considerably contribute to decreasing numbers of maritime accidents that may happen beyond territorial seas or in overlapping EEZ areas. The transnational VTMIS is a practical application of the coastal states' precautionary jurisdiction [74]. For instance, the British and French maritime authorities jointly operate the transnational VTMIS and the Dover Strait Channel Navigation Information Service to improve maritime safety and the efficiency of navigation [75]. Another reason for the necessity of the introduction of the transnational VTMIS as an APM in the Yellow Sea PSSA is that China and South Korea may be unable to properly exercise enforcement jurisdiction over vessel-source pollution due to the overlapping area of the EEZs in the Yellow Sea. Taking prior measures is of paramount significant to prevent marine pollution from ships beforehand in disputed areas. The introduction of the transnational VTMIS may help to prevent accidental discharges beforehand by enhancing navigational safety and monitoring illegal discharges that have happened beyond the territorial sea. The Chinese and South Korea maritime authorities can also provide a comprehensive and systematic maritime traffic service with vessels passing through the Yellow Sea in consideration of its marine traffic congestion. The transnational VTMIS may play a crucial role as clear grounds that foreign vessels have violated discharge standards in the Yellow Sea. Based on such evidence, the Yellow Sea states may conduct a physical inspection or institute legal proceedings if foreign vessels' activities have resulted in marine pollution in the EEZs.

4.3.2. Special discharge restrictions

To invoke the strict discharge standards of MARPOL 73/78 as APMs, the Yellow Sea must be preferentially designated as a special area. Despite the need, the Yellow Sea has not yet been designated as a special area. Considering the geographical vulnerability, marine environmental and socio-economic significance, and maritime traffic characteristics, the Yellow Sea needs to be designated as a special area under Annex I (oil), Annex V (garbage), and Annex VI (ECA) of MARPOL 73/78 [76]. In that case, the Yellow Sea states may apply strict discharge standards against foreign vessels navigating the Yellow Sea PSSA by citing special area regimes of MARPOL 73/78. The Yellow Sea can be also granted a dual special status as both a special area and a PSSA by the IMO.

Moreover, since 1 January 2016, China has implemented a Domestic Emission Control Areas (DECA) to reduce SOx emission from ships within the Pearl River Delta, the Yangtze River Delta, and the Bohai Sea [77]. Given that air pollution is becoming a critical issue all over the world, the Chinese efforts to reduce sulphur at the domestic level may become a significant motivation to extend the ECA to the Yellow Sea through designation of an ECA under Annex VI of MARPOL 73/78. The more stringent SOx emission limit (compared to the global level) can be applied to the Yellow Sea PSSA.

In addition, the Yellow Sea states need to establish prohibition measures for the discharge of ballast waters as APMs in the Yellow Sea PSSA. Article 2(3) of the BWM stipulates that a state may take more stringent measures individually or jointly with other parties with respect to the prevention, reduction, or elimination of the transfer of harmful aquatic organisms consistent with international law. Based on this provision, the Yellow Sea states would be able to take joint special discharge measures with respect to the control of ballast waters as APMs in the Yellow Sea as necessary.

4.3.3. *Surveillance system*

As another appropriate measure, the Yellow Sea states need to introduce a comprehensive surveillance system to monitor oil spills and illegal discharges within the Yellow Sea PSSA. For example, the EU provides a wide range of surveillance mechanisms using military surveillance, the *Sistema Integrado de Vigilancia Exterior*, and the coastal VTS [78]. To monitor any kinds of vessel-source pollution in European waters, the EMSA established a satellite-based surveillance system for illegal oil discharges (i.e. 'CleanSeaNet') [79]. The EMSA provides member states with radar satellite images obtained from a commercial satellite provider. Such surveillance systems not only play a crucial role as *ex post facto* evidence concerning the violation of discharge standards, but they can also result in a precautionary effect by alerting vessels of oil spills or illegal discharges when they pass through particular sea areas [79]. The establishment of a comprehensive surveillance system can considerably help the Yellow Sea states to control and monitor illegal discharges and oil pollution that may occur beyond the coastal state's jurisdiction.

5. Conclusion

While the total volume and the frequency of contamination by pollutants from vessels is comparatively low compared to land-based sources, the negative influence of various pollutants from ships on the marine environment and the marine ecosystem should not be overlooked. Oil and HNS spill incidents have more a fatal effect on the marine environment than those from land-based sources [80]. Vessel-source pollution may occur anywhere and anytime. Namely, the geographical range of marine pollution from ships is very extensive and not limited to a particular sea area. The Yellow Sea has suffered a number of tragic oil and HNS pollution incidents (e.g., the Sea Prince, the Honam Sapphire, and the Heibei Spirit) [81]. Vessels inevitably produce operational discharges because many ships now use the Yellow Sea to enter the coastal ports of South Korea and China. These operational pollutants include harmful substances that threaten marine life and the marine environment in the Yellow Sea. In addition, with increasing numbers of vessels passing through the Yellow Sea, ship emissions are accelerating air pollution along with land-based sources. A high level of regional cooperation is required to exercise unified, harmonised enforcement and legislative jurisdiction over foreign vessels within the Yellow Sea. Considering that maritime boundary disputes are impeding regional cooperation, there is a need to devise a way for regulatory instruments to prevent vessel-source pollution beforehand by overcoming the issues of maritime boundaries. If countries do not cooperate, the Yellow Sea's marine environment may become worse.

The PSSA Resolution stipulates that a state must meet at least one requirement for the designation of a PSSA amongst a total of 17 criteria, which are compartmentalised into ecological, socio-economic, and scientific elements. The IMO provides member states with minimum criteria to use the PSSA concept, compared with the criteria for the designation of special areas under MARPOL 73/78. The Yellow Sea is eligible to become a PSSA in consideration of the significance of its environmental, socio-economic, and marine traffic characteristics. The Yellow Sea PSSA can combat various marine pollutants from ships both effectively and actively. In the PSSA concept, APMs play a core role. The most important factor in establishing a PSSA is to determine APMs. Concerning what APMs will be effective in the Yellow Sea PSSA, this paper proposes not only special discharge restrictions and the introduction of the transnational VTMIS but also the establishment of a comprehensive surveillance system.

The PSSA may prove significantly helpful in increasing public awareness about the significance of the protection of the marine environment of the Yellow Sea. Since the Yellow Sea has not yet been conferred a special status at the IMO level, the Yellow Sea PSSA may become the first step towards directly dealing with the prevention of vessel-source pollution based on regional cooperation and coordination. The Yellow Sea states should start to discuss a proposal for the designation of a PSSA as soon as possible. When formulating a proposal, the Yellow Sea states have to make every effort in good faith to attain the final goal: designating a PSSA through the establishment of a commission that plays a role as the coordinator and policymaker in cooperating and coordinating for the project. Without a doubt, it can be said that the proposed Yellow Sea PSSA may pave the way for a cleaner Yellow Sea by preventing vessel-source pollution.

References

[1] S.K. Teng, H. Yu, L. Tong, C.I. Choi, D. Kang, H. Liu, Y. Chun, R.O. Juliano, E. Rautalahti-Miettinen, D. Daler, Yellow Sea, global international waters assessment, GIWA Reg. Assess. 34 2012 2 3.16.

[2] Budislav Vukas, Enclosed or semi-enclosed seas, in: B. Vukas (Ed.), The Law of The Sea: Selected Writings, Martinus Nijhoff Publishers, Leiden, 2004, p. 283.

[3] Cedre, The Heibei Spirit. ⟨https://wwz.cedre.fr/en/Resources/Spills/Spills/Hebei-Spirit⟩, 2007, 2008 (accessed 10 January 2021).

[4] Korea Shipowners' Association, The Importance of Shipping Industry. ⟨http://www.shipowners.or.kr/eng/ks_industry/ks_industry1.php⟩, 2020 (accessed 14 January 2021).

[5] Bao Jiang, Jian Li, Chunxia Gong, Maritime shipping and export trade on "Maritime Silk Road", Asian J. Shipp. Logist. 34.2 (2018) 83–90, 84.

[6] UNCTAD, Review of Maritime Transport. ⟨https://unctad.org/webflyer/review-maritime-transport-2020⟩, 2020 (accessed 4 May 2021), 6, 11.

[7] B.M. Jeong, Cooperation plan for north korea's port logistics system, Rev. Unification Econ. 65 (2009) 14.

[8] Lloyd's List, The 2020 edition of Lloyd's List One Hundred Ports. ⟨https://lloydslist.maritimeintelligence.informa.com/one-hundred-container-ports-2020⟩, 2020 (accessed 1 May 2021).

[9] Cedre, The Sea Prince incident. ⟨https://wwz.cedre.fr/en/Resources/Spills/Spills/Sea-Prince⟩, 2007 (accessed 10 January 2021).

[10] ITOPF, The Honam Sapphire. ⟨https://documentservices.iopcfunds.org/wp-content/uploads/sites/2/2020/01/71FUND_EXC.46_8_en.pdf⟩, 2007 (accessed 10 January 2021).

[11] M.J. Valencia, The Yellow Sea: transnational marine resource management issues, Mar. Policy 12 (1988) 382–395, 385.

[12] C.H. Koh, J.S. Khim, The Korean tidal flat of the Yellow Sea: physical setting, ecosystem and management, Ocean Coast. Manag. 102 (2014) 398–414, 400.

[13] G. Hempel, K. Sherman, Large Marine Ecosystems of the World: Trends in Exploitation, Protection, and Research, Elsevier Science, Amsterdam, 2003, p. 122.

[14] M.R. Auer, Prospects for Environmental Cooperation in the Yellow Sea, Emory Int. Law Rev. 5 (1991) 163–208, 164.

[15] GEF/UNDP, Yellow Sea Large Marine Ecosystem Preliminary Transboundary Diagnostic Analysis. ⟨https://iwlearn.net/resolveuid/d066663c6e3935d55e93d15b1061e7ca⟩, 2010 (accessed 20 March 20 2021).

[16] N.J. Murray, Z. Ma, R.A. Fuller, Tidal flats of the Yellow Sea: a review of ecosystem status and anthropogenic threats, Austral Ecol. 40.4 (2015) 472–481, 477.

[17] YSLME, YSLME PROJECT. ⟨http://www.yslmep.org/?page_id=43⟩ (assessed 28 December 2021).

[18] W.J. Teague, H.T. Perkins, Z.R. Hallock, G.A. Jacobs, Current and tide observations in the southern Yellow Sea, J. Geophys. Res. Oceans 103 (1998) 27783–27793, 27788.

[19] KORDI and WWF, Yellow Sea Ecoregion; A Global Treasure, A Global Responsibility. ⟨https://www.wwf.or.jp/activities/lib/pdf/%5BENG%5DYellowSea_Ecoregion-A_glob al _treasure_a_global_responsibility(Fact%20sheet).pdf⟩, 2006 (accessed 20 March 2021).

[20] R.L. Chapman, Algae: the world's most important "plants"-an introduction, Mitig. Adapt. Strateg. Glob. Change 18.1 (2013) 5–12, 5.
[21] Ramsar Handbook, An Introduction to the Ramsar Convention on Wetlands, in: Gland, Switzerland: Ramsar Convention Secretariat. ⟨https://www.ramsar.org/sites/default/files/documents/library/handbook1_5ed_introductiontoconvention_e.pdf⟩, 2016 (accessed 2 April 2021), 9.
[22] Ramsar, State of the World's Wetlands and their Services to People: A compilation of recent analyses. ⟨https://www.ramsar.org/sites/default/files/documents/library/strp19_4_bn7_e.pdf⟩, 2015 (accessed 2 April 2021), 4.
[23] N.C. Davidson, How much wetland has the world lost? Long-term and recent trends in global wetland area, Mar. Freshw. Res. 65 (2014) 934–941, 938.
[24] J. MacKinnon, Y.I. Verkuil, N.J. Murray, IUCN situation analysis on East and Southeast Asian intertidal habitats, with particular reference to the Yellow Sea (including the Bohai Sea). ⟨https://www.iucn.org/content/iucn-situation-analysis-east-and-southeast-asian-intertidal-habitats-particular-reference-yellow-sea-including-bohai-sea-0⟩, 2016 (accessed 6 April 62021).
[25] N.J. Murray, R.S. Clemens, S.R. Phinn, H.P. Possingham, R.A. Fuller, Tracking the rapid loss of tidal wetlands in the Yellow Sea, Front. Ecol. Environ. 12 (2014) 267–272, 267.
[26] M. Walton, Biodiversity conservation and the Yellow Sea large marine ecosystem project, J. Korean Soc. Mar. Environ. Energy 13 (2010) 335–340, 336-337.
[27] Ramsar, The Ramsar Sites Information Service in China. ⟨https://www.ramsar.org/wetland/china⟩, 2016 (accessed 10 April 2021).
[28] KORDI and KEI, Fish of the Yellow Sea Ecoregion and their habitats. ⟨https://www.wwf.or.jp/activities/data/200710y-seamap04e.pdf⟩, 2017 (assessed 28 December 2021).
[29] WWF, The Yellow Sea Ecoregion. ⟨https://en.wwfchina.org/en/what_we_do/marine/yellow_sea_ecoregion/threats/⟩, 2017 (assessed 28 December 2021).
[30] S. Zhang, S. Jin, H. Zhang, Wei Fan, F. Tang, S. Yang, Distribution of bottom trawling effort in the yellow sea and east China sea, Plos One 11 (11) (2016), e0166640.5, https://doi.org/10.1371/journal.pone.0166640.
[31] B. Jess, Logistics of container transport in the Yangtze & Yellow Sea regions, J. Int. Logist. Trade 1.1 (2003) 1–27, 12.
[32] UNCTADSTAT, Container Port throughput. ⟨https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=13321⟩, 2019 (accessed 10 April 2021).
[33] S.W. Lee, J.W. Seo, J. Kauppila, L. Martinez, N. Okamoto, 2019-2020 KOTI-ITF-EASTS Special Research Report on Transport Connectivity in East Asia, The Korea Transport Institute, 2020.
[34] T.W. Chung, J.W. Jeon, System dynamics-based prediction of North Korean port volumes, Asian J. Shipp. Logist. 37.4 (2021) 337–344, 340.
[35] B.M. Jeong, Integration Plan of the Shipping and Logistics System between North Korea and South Korea, Korea Maritime Institute, 2008, pp. 11–14.
[36] Ministry of Unification, North Korea's Economic. ⟨http://nkinfo.unikorea.go.kr/nkp/overview/nkOverview.do?sumryMenuId=EC210⟩, 2018 (accessed 10 April 10 2021).
[37] IMO Resolution A.982(24), Revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas, 2006.
[38] United States Senate Committee on Commerce, Science, Transportation, IMCO protocols: hearing before the committee on commerce, science, and transportation, J. Travel Res. 1979 (1978) 159, https://doi.org/10.1177/004728757901800161.
[39] J. Roberts, Marine Environment Protection and Biodiversity Conservation: the Application and Future Development of the Imo's Particularly Sensitive Sea Area Concept, 88, Springer Science & Business Media, Berlin, 2006, 112, 192, 258, 512.
[40] IMO MEPC 23/16/1, Identification of Particularly Sensitive Areas: note by Friends of the Earth International. Submitted by Friends of the Earth International, 1986.
[41] IMO MEPC/Circ.171, MEPC Circular on Particularly Sensitive Sea Areas, 1986.
[42] IMO Resolution A.927(22), Guidelines for the Designation of Special Areas under MARPOL 73/78 and Guidelines for the Identification and Designation of Particularly Sensitive Sea Area, 2002.
[43] IMO MEPC 30/19/4, Identification of particularly sensitive sea areas, including development of guidelines for designating special areas under Annex I, II and V, submitted by Australia, 1990.
[44] IMO Resolution MEPC.44(30), Identification of the Great Barrier Reef region as a particularly sensitive sea area, 1990.
[45] B. Sage, Precautionary coastal states' jurisdiction, Ocean Dev. Int. Law 37.3 (2006) 359–387, 374.
[46] M.J. Kachel, Particularly Sensitive Sea Areas, The IMO's Role in Protecting Vulnerable Marine Areas, Springer Science & Business Media, Berlin, 2008, 166, 190, 222, 252.
[47] E.J. Molenaar. Coastal State Jurisdiction over Vessel-source Pollution, Kluwer Law International BV, Alphen an den Rijn, 1998, p. 438.
[48] IMO Resolution A.572(14), General Provisions on Ships' Routeing, 1985.
[49] J. Roberts, Protecting sensitive marine environments: the role and application of ships' routeing measures, Int. J. Mar. Coast. Law 20.1 (2005) 135–159, 135.
[50] IMO, Particularly Sensitive Sea Areas help protect fragile environments from the risks posed by shipping. ⟨http://pssa.imo.org/#/intro⟩, 2021 (accessed 22 April 22 2021).
[51] R.C. Beckman, PSSAs and transit passage-Australia's pilotage system in the torres strait challenges the IMO and UNCLOS, Ocean Dev. Int. Law 38 (2007) 325–357, 350.
[52] K.M. Gjerde, Cuba's Sabana-Camaguey Archipelago: the second internationally recognised particularly sensitive sea area, Int. J. Mar. Coast. Law 13 (1998) 252.
[53] K.M. Gjerde, Protecting particularly sensitive sea areas from shipping: a review of IMO's new PSSA guidelines, in: H. Thiel, J. Anthony Koslow (Eds.), Managing Risks to Biodiversity and the Environment on the High Sea, Including Tools Such as Marine Protected Areas - Scientific Requirements and Legal Aspects, Bundesamt für Naturschutz, Bonn, 2001, pp. 125–126.
[54] K.M. Gjerde, D. Freestone, Particularly Sensitive Sea Areas-an important environmental concept at a turning-point, Int. J. Mar. Coast. Law 9 (1994) 425–468, 431.
[55] A. Prylipko, Alina, PSSA in the Baltic Sea: Protection on Paper or Potential Progress, World Maritime University, Malmo, 2014, p. 23.
[56] D.O. Cho, H.H. Ju, A consideration on Yellow Sea governance of Korea and China, J. Korean Soc. Mar. Environ. Saf. 19.2 (2013) 186–192, 192.
[57] NOWPAP, Northwest Pacific Action Plan (NOWPAP). ⟨https://www.unep.org/nowpap/?_ga=2.116086470.1339996027.1620096514–1940903930.1620096514⟩, 2020 (accessed 2 May 2 2021).
[58] NOWPAP, State of the Marine Environment in the NOWPAP Region. ⟨https://www.unep.org/nowpap/zh-hans/node/104?%2Fresources%2Freport%2Fstate-marine-environment-nowpap-region-2007=⟩, 2007 (accessed 2 May 2 2021).
[59] M.J. Valencia Involving the DPRK in Northeast Asia: regional economic and environmental cooperation NAPSNet Spec. Rep. 1994 28.⟨https://kida.re.kr/data/kjda/RKJD_A_9464530_O.pdf⟩.
[60] HELCOM, HELCOM, ⟨https://helcom.fi/about-us/⟩, 2021 (accessed 2 May 2021).
[61] Common Wadden Sea Secretariat, Common Wadden Sea Secretariat, ⟨https://www.waddensea-worldheritage.org/common-wadden-sea-secretariat⟩, 2021 (accessed 3 May, 2021).
[62] REMPEC, The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea. ⟨https://www.rempec.org/en⟩, 2021 (accessed 3 May2021).
[63] UNEP(DEPI)/MED IG.16/13, ANNEX III -Recommendation for 2006–2007. ⟨https://wedocs.unep.org/bitstream/handle/20.500.11822/7271/05ig16_13_ann3_recommendations_eng.pdf?sequence=1&isAllowed=y⟩, 2006 (accessed 3 May 2021).
[64] REMPEC/WG.36/6/Corr.1, Regional Strategy for Prevention of and Response to Marine Pollution from Ships 2016–2021.⟨https://www.rempec.org/en/knowledge-centre/online-catalogue/wg-36–6-corr_1.pdf⟩, 2015 (accessed 4 May 2021).
[65] IMO, IMO helps assess further sulphur reductions in the Mediterranean. ⟨https://imo.org/en/MediaCentre/Pages/WhatsNew-1172.aspx⟩, 2018 (accessed 4 May, 2021).
[66] A.E. Platt, Dying seas, Oceanogr. Lit. Rev. 7 (1995) 599.
[67] K.K. Cho, Building an Environmental Regime in the Yellow Sea sphere, Korean J. Int. Stud. 1.1 (2003) 203–226, 205.
[68] J.H. Choi, Domestic Legal, System of the Yellow Sea states for the prevention of vessel-source pollution under the UNCLOS: a comparative legal study, J. East Asia Int. Law 14.2 (2021) 219–244, 225.
[69] J.M.D. Van, M. Jon, M.J. Valencia, M.G. Jenny, The North/South Korea boundary dispute in the Yellow (West) Sea, Mar. Policy 27.2 (2003) 143–158, 149.
[70] NOWPAP, Northwest Pacific Action Plan (NOWPAP). ⟨https://www.unep.org/nowpap/?_ga=2.116086470.1339996027.1620096514–1940903930⟩. 1620096514, 2021 (accessed 2 May 2021).
[71] COBSEA, Coordinating Body on the Seas of East Asia. ⟨https://www.unep.org/cobsea/⟩, 2021 (accessed 2 May 2 2021).
[72] E.A. Olsen, Marine environmental cooperation in northeast asia, Korean J. Def. Anal. 7 (7–28) (2009) 10–11.
[73] E. Anyanova, Oil pollution and international marine environmental law, in: Sime Curkovic (Ed.), Sustainable Development-authoritative and Leading Edge Content for Environmental Management, Intechopen, London, 2012, https://doi.org/10.5772/37399, 201, 34.
[74] Y.C. Lee, An international legislative study on the introduction of transnational VTMIS, Marit. Law Rev. 20 (2008) 30.
[75] D. Anderson, Modern Law of the Sea: Selected Essays, Brill, Leiden, 2007, p. 169.
[76] A.K.J. Tan, Vessel-source Marine Pollution: the Law and Politics of International Regulation, Cambridge University Press, Cambridge, 2005, p. 133.
[77] X.T. Wang, W. Yi, Z.F. Lv, F.Y. Deng, S.X. Zheng, H.L. Xu, J.C. Zhao, H. Liu, K. He, Annual changes of ship emissions around China under gradually promoted control policies from 2016 to 2019, Atmos. Chem. Phys. Discuss. 21 (2021), https://doi.org/10.5194/acp-21-13835-2021.
[78] European Commission, Legal Aspects of Maritime Monitoring & Surveillance Data – Summary Report.⟨https://op.europa.eu/en/publication-detail/-/publication/a6551ad5-ecd1–4b3c-b95f-d3d6a097e54d⟩, 2008 (accessed 2 May 2 2021).
[79] EMSA, Addressing Illegal Discharges in the Marine Environment. ⟨http://www.emsa.europa.eu/csn-menu/items.html?cid=122&id=1879⟩, 2008 (assessed 28 December 2021).
[80] ITOPF, Response to Marine Chemical Incidents, Technical Information Paper No.17. ⟨https://www.itopf.org/fileadmin/uploads/itopf/data/Documents/TIPS_TAPS_new/TIP_17_Response_to_Marine_Chemical_Incidents.pdf⟩, 2014.
[81] D.O. Cho, Limitations of 1992CLC/FC and enactment of the special Law on M/V Hebei spirit incident in Korea, Mar. Policy 34.3 (2010) 447–452, 448.