

# Green versus sustainable: The case of shipping

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## Abstract.

The environmental effects of shipping have historically been addressed at the IMO level by focusing on specific pollutants and developing policy instruments which led to greener technologies and operations. An emblematic example is the diminishing of oil pollution by ships due to the Annex I of MARPOL 73/78 with innovations such as double hulls and crude oil tank washing. Current environmental issues include energy efficiency, atmospheric pollution, and the introduction of alien species by ships in the marine environment. However, there are concerns according to which regulations aimed at solving of some problem can exacerbate another. For example, the introduction of low sulfur fuel oil to combat SO<sub>2</sub> pollution would result in increased CO<sub>2</sub> emissions and a modal shift to land transport (trucks). Ideally the effort to achieve green shipping must consider the economic and social consequences of each measure. Recently, an initiative for sustainable shipping has emerged, a comprehensive approach aiming at maintaining the economic growth of shipping while ensuring social welfare and environmental protection. In this context, the aim of this paper is to explore the classic term of sustainability in the context of shipping. The synergies and antagonisms between different environmental policies and social and economic issues in shipping are discussed.

**Keywords:** IMO, energy efficiency, atmospheric pollution, social welfare, economic growth

## 1. Introduction

Maritime transport is the most efficient and cost-effective method of international movement of goods from one location to another (IMO, 2013). As all modes of transport, it is cross cutting and permeates many economic sectors: It facilitates international trade, supports food security, delivers energy and enables industrial development (IMO, 2013). Shipping generates employment and helps create prosperity, thereby fulfilling critical economic as well as social functions. In 2015, world seaborne trade volumes are estimated to have accounted for over 80 per cent of total world merchandise trade (UNCTAD, 2016). Due to its global nature, a diverse range of interrelating actors are involved in the shipping industry. These include contributors engaged in the design and construction, the ownership, operation, management and crewing of ocean-

going merchant vessels, in seafarer training, as well as in the classification, finance, and liability and insurance aspects of shipping. Other stakeholders are the cargo owners, as well as the ultimate end-users (i.e. customers of transport services), and ancillary services such as pilotage, vessel traffic services, towage and salvage (IMO, 2013). International shipping can only operate smoothly and efficiently if regulations and standards that ensure “level playing fields” across the world are agreed, adopted and implemented (Tan, 2006). In cases that a country takes unilaterally more strict measures, the competition is distorted. In addition, unilateralism (with obvious actors the EU and the USA) usually means the exportation of safety and pollution risks to less developed regions of the world (Tan, 2006). Therefore, very early, the regulatory framework for shipping was developed at the International Maritime Organization (IMO) level (Tan, 2006). IMO, a specialized UN agency established in 1948, is the global standard-setting and coordinating authority for the safety, security and environmental performance of international shipping. IMO regulations cover the design, construction, operation, manning and recycling of ships, the education of seafarers, as well as liability and compensation following accidents and incidents (IMO, 2013). The safety of shipping is always being the overriding priority (IMO, 2013). The principal legal instrument developed by IMO regarding environmental protection was MARPOL 73/78, a convention that currently has six technical annexes (pollution by oil, noxious liquid substances, harmful substances in packaged form, sewage, garbage and air pollution from ships) and came into force in 1983. The aim of this study is to review two environmental regulatory processes at the IMO level: The emblematic and successful regulations on oil pollution and the more recent regulations on the reduction of SO<sub>2</sub> emissions by ships. The discussion of the strengths and the shortcomings of the two procedures concludes with the need of a more holistic way of action, and the introduction of the concept of sustainability in shipping.

## 2. Oil pollution by ships

Oil is one of the most important commodities carried by ships. Each year, around 2.900 million tons of crude oil and oil products are transported by tankers (IMO, 2017). Annex I of MARPOL 73/78 set oil discharge criteria from oil tankers, through the oil discharge and monitoring

system, which were stricter in special areas, marine areas with special ecologic or hydrographic characteristics that made them more prone to oil pollution. Also Annex I makes it mandatory for new oil tankers to have segregated ballast tanks dedicated to carry ballast water so as to obviate the need to carry ballast water in cargo tanks. The segregated ballast tanks should be located to protect the oil cargo in incidents of collision. This was superseded by the requirement for oil tankers delivered from 1996 onwards to be fitted with a double hull (IMO, 2017). The crude oil washing (COW) system involves the washing of tanks with oil instead of water. Apart of cargo oil, fuel oils of all ships may also be a considerable source of oil pollution. Annex I set a limit of 15 ppm allowable discharges of bilge water through the oily water separator. Statistics from industry and independent bodies show that Annex I of MARPOL 73/78, along with other safety-related regulations such as the introduction of mandatory traffic separation schemes and international standards for seafarer training, have been instrumental in the continuous decline of accidental oil pollution that has taken place over the last 40 years (IMO, 2017; ITOF, 2017). The policy development at the IMO level is a complex and lengthy procedure that is influenced by a diverse set of actors and stakeholders, representing different and often conflicting types of interests, including coastal, port, shipping, cargo, international business, security, environmental etc (Karim, 2015). However, the catalyst for regulatory action on oil pollution, developed the last 50 years was often public outcry to specific catastrophic oil tanker accidents (e.g. Torrey Canyon, 1967; Argo Merchant, 1976; Amoco Cadiz, 1978; Exxon Valdez, 1989; Erika, 1999; Prestige, 2002) (Tan, 2006). Thus the regulatory response has characteristically been reactive, as opposed to proactive, in nature. This approach emphasizes on equipment and “hardware” standards instead of paying attention to intangible, “software” factors such as the human element and systemic deficiencies in the structure of ship registration, ownership and management, surveys and inspections and the enforcement by flag states (Tan, 2006). More recently, an anticipatory approach to environmental decision making at IMO prevailed with deliberations and new regulatory instruments on antifouling paints, the transport of harmful aquatic organisms by ships, atmospheric pollution, energy efficiency and CO<sub>2</sub> emissions and land interventions such as ship dismantling.

### **3. The regulations for the abatement of the emissions of SO<sub>2</sub> by ships**

The shipping sector uses fuel grades that are no longer accepted in most land-based installations or road vehicles. Approximately 80% of the fuel consumed in international shipping consists of heavy fuel oil (HFO) and most of the remaining 20% of marine distillate oil (MDO) or marine gas oil (MGO) (Axel, 2011). HFO mainly consists of residual streams from the distillation or cracking units in the refineries. The average sulphur content of HFO was 2.6% worldwide in 2009, or 26 000 ppm (Axel, 2011), which may be compared to a maximum of 10 ppm sulphur in diesel fuel allowed in European road vehicles from 2009 (Directive 2003/17/EC). When the fuel is burned in the marine engines, the sulphur is converted to SO<sub>2</sub>. It is estimated that 4–9% of global SO<sub>2</sub> emissions are attributable to ships (Eyring *et al*, 2010). SO<sub>2</sub> contributes

to the formation of particulate matter that epidemiological studies have consistently linked with pulmonary diseases, premature death etc. Corbett *et al* (2007) have estimated that, because the vast majority (70%) of these emissions occur within 400 km of coastal areas, around 60.000 early deaths each year are attributed to shipping emissions, mainly in the seaside areas of East Asia, South Asia and Europe. Uncertainties in the data and methods used to calculate mortalities bound this estimate within the range of 20.000-104.000 (Eyring *et al*, 2010). It is estimated that SO<sub>2</sub> emissions due to ship activity within the passenger port of Piraeus account for 56.9% of the total SO<sub>2</sub> emissions within the greater Athens area (Tzannatos, 2010). The reductions in sulphur oxide emissions are expected to have a significant beneficial impact on the environment and on human health, particularly that of people living in port cities and coastal communities. Regulations for the control of SO<sub>2</sub> emissions are included in Annex VI to MARPOL73/78 Convention. The current global limit of sulphur content in marine fuels is 3.5% m/m and it is going to be significantly reduced to 0.50% m/m in 2020. In addition, IMO established certain SO<sub>2</sub> Emission Control Areas (SECAS) in which the sulphur limit has been 0.10% m/m since 1/1/2015. The SECAs established under MARPOL Annex VI for SO<sub>2</sub> are the Baltic Sea area; the North Sea area; the North American; and the United States Caribbean Sea area. Ships can meet the requirement by using low-sulphur fuel oil (Marine Gas Oil - MGO) which is currently 73% more expensive compared to IFO380 (Heavy Fuel Oil - HFO) (Ship & Bunker, 2017). Bunker prices constantly fluctuate due to market forces and the cost of crude oil (Notteboom and Vernimmen, 2009). Nevertheless there are estimations that shipping bunkers accounted for at 47% of ship's costs (Notteboom and Vernimmen, 2009), therefore the new regulations will impose significant costs for the shipping industry. The cost increase for low sulphur fuel will either be passed on to customers or will force some operators out of the market (Psaraftis and Kontovas, 2009). Ships may also meet the SO<sub>x</sub> emission requirements by using approved equivalent methods, such as exhaust gas cleaning systems (scrubbers) and natural gas as a fuel. Both options result in costs due to installation of new machinery and equipment onboard. The higher fuel prices of the cleaner fuel at SECAs may result in a reverse cargo shift from sea to land (trucks) that has the potential to produce more emissions on land than those saved at sea (Psaraftis and Kontovas, 2009). This modal shift is against the key goals of the European Commission's white paper on transport, which requires “a 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport by 2050” (EC, 2011). A further concern on the use of clean, low sulfur fuel oil is that the process of heavy fuel oil purification will result in excess CO<sub>2</sub> emissions (Gratsos *et al*, 2010). However this is not proved to be true in the study of Bengtsson *et al* (2011) who examined different marine fuels including HFO (1% sulphur) and MGO (0,1% sulphur) and concluded that the global warming potential of the compared fuels are of the same order of magnitude. An interesting side effect of the increased sulphur content of the marine fuels is that it helps cooling the atmosphere. In fact, shipping's high SO<sub>2</sub> emissions lead to a high burden of sulfate aerosols in the atmosphere. These aerosols scatter back light (both direct

and indirect effects via clouds included); this cooling is for a few decades stronger than the warming from the CO<sub>2</sub> emitted (Fuglestedt *et al.*, 2009). However, due to short lifetime of SO<sub>2</sub> molecules, at a time scale of centuries the warming effect of CO<sub>2</sub> emitted by ships will prevail. This means that any potential proposal to maintain SO<sub>2</sub> emissions to lower the rate of temperature change implies that future generations would be committed to continue elevated SO<sub>2</sub> emissions (Fuglestedt *et al.*, 2009). Taking into account the effects of SO<sub>2</sub> on human health and acidification, the restrictions on the sulphur content of the marine fuels are justified. The above discussion eloquently outlines the complexity of the problem. Since maritime transport is a crosscut economic activity, closely related to many aspects of economic and social life, it is expected that any change in technology and operations that are necessary to reduce its environmental footprint would also influence its economic viability and societal contribution. In this framework, IMO and stakeholders have recently pursued a comprehensive approach aiming at maintaining the economic growth of shipping while ensuring social welfare and environmental protection.

#### 4. The concept of sustainability in shipping

According to the classic definition in Brundtland Report (United Nations 1987), “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Emphasis is given to the fact that the present actions determine the future of the planet. The sustainability concept integrates three, equally important dimensions: economic development, environmental protection, and social welfare. Regarding the maritime industry, the term sustainability is often used as a synonym for the environmental aspects of shipping (Cabezas-Basurko *et al.*, 2008). This narrow definition tends to favour the introduction of technological solutions mainly, that may reach one sustainability goal but simultaneously may contradict with another goal (Chatzinikolaou and Ventikos, 2011). Moreover, among all environmental aspects, sustainability often coincides with energy efficiency and CO<sub>2</sub> emissions of ships or the emissions of toxic atmospheric pollutants (Chatzinikolaou and Ventikos, 2011). Atmospheric emissions from all economic sectors and especially the emissions of greenhouse gasses is one of the major current issues on the agenda of academics and decision makers. The social and economic pillars of sustainability in shipping are neglected. The relevant discussions on a more holistic view of the term sustainability, based on the initial principles of sustainable development started at the beginning of the 21st century when IMO, amongst others, established the direction and goals to be achieved for a sustainable future for the maritime industry (IMO, 2013). Large shipping companies and stakeholders have also responded by developing consortia that pursue the goals of sustainability (SSI, 2011). Sustainable shipping (or sustainable waterborne transport) is defined as “a cost-effective commercial activity, in which the environmental load is not bigger than that which the environment can currently and in the future bear, and that the social community (directly and indirectly) in contact with it is not being negatively affected” (Cabezas-Basurko *et al.*, 2008). This

concept is divided into the following areas with specific goals and actions for each area (IMO, 2013):

1. Safety culture and environmental stewardship: A Sustainable Maritime Transport System (SMTS) must promote a safety culture that would go beyond mere regulatory compliance and deliver added value for the system. It must minimize the environmental impact of shipping and activities of maritime industries.
2. Education and training in maritime professions and support for seafarers: A SMTS requires properly trained and educated seafarers and non sea-going maritime professional. Such training and education should be based on, inter alia, the STCW (Standards of Training, Certification and Watchkeeping for Seafarers) Convention. The quality of life for seafarers at sea is important in order to maintain and develop the maritime transport industry as an attractive career option for talented professionals.
3. Energy efficiency and ship-port interfaces: Shipping is continuously exploring ways to further reduce fuel consumption. As ships do not operate independently from shore-based, efficiency must extend beyond the ships themselves to shore-based entities (ports, which must deliver an efficient service and provide the essential maritime infrastructure, as well as other entities in the logistics chain pertaining to cargo handling, vessel traffic management and routing protocols).
4. Energy supply for ships: For a SMTS, global distribution and availability of marine fuels (both conventional and clean such as LNG and low-sulphur fuel oils) must be ensured.
5. Maritime traffic support and advisory systems: A SMTS requires co-operation and harmonization in the development of optimal systems for navigation, including pilotage and ice breaking services, where necessary, the use of intelligent routing systems and aids for weather routing, including e-navigation.
6. Maritime security: Seafarers, ships and shipping lanes must be protected by the communities that rely on them and benefit from sea trade. Protection measures must respond to the threats posed to sea trade and to the ships and the seafarers in its service.
7. Technical cooperation: New and sustainable funding sources and partnerships for technical co-operation should be developed, both for ship- and shore-based functions in critical areas of activity (such as shipbuilding and repair, port facility development and management, and maritime personnel training).
8. New technology and innovation: New ships will be increasingly sophisticated in all aspects of their design, construction and operation, while existing ships will be expected to meet ever more stringent efficiency as well as environmental demands, which will require them to adapt their operational practices and to comply with new regulatory requirements for retrofitting equipment.
9. Finance, liability and insurance mechanisms: A SMTS should be supported with available, sound financing

for construction of new ships or conversion or modification of existing ships. A SMTS relies on regulations governing liability and compensation in the event of maritime incidents as these provide much needed liability limits and compensation for loss or damage caused to third parties.

10. Ocean governance: Any reallocations of ocean uses must be properly understood and agreed by all concerned, paying attention to relevant harmonized, global standards and ensuring the sustainability of the different uses.

The above 10 areas are balanced and support the simultaneous development of the three pillars of sustainability. The environmental dimension is directly represented by environmental stewardship and energy efficiency and energy supply for ships. The focus on energy is justified due to its connection with greenhouse effect and global warming. Additionally it must be noted that although many different environmental impacts of shipping are addressed reasonably well with single technologies (e.g. scrubbers for SO<sub>2</sub> emissions, selective catalytic reduction for NO<sub>x</sub> emissions, filtration and chlorination or UV light for ballast water treatment etc), the fuel consumption and energy efficiency of the ships is only incrementally improved with the simultaneous use of several operational or technological measures (e.g. weather routing, slow steaming, low carbon fuels, optimization of hull and superstructure etc). Therefore it is critical to focus the efforts on the improvement of this aspect of shipping performance taking into account future plans for decarbonization.

## 5. Conclusions

In the last 50 years, shipping has made a tremendous progress towards a green, energy efficient, safe and secure operation. The legislative process was initially reactive and forced by great marine disasters (e.g. accidental oil pollution). Nonetheless it managed to reduce oil pollution of the oceans. Gradually it became more pro-active, dealing with subjects such as atmospheric pollution, energy efficiency and the introduction of invasive marine species. The challenge in the beginning of the 21st century is to integrate the concepts of environmental protection with the economic development and social welfare, and make the shipping sustainable.

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