[1528H] PREVENTION OF POLLUTION FROM SEWAGE ON PASSENGER SHIPS: A COMPARISON BETWEEN INTERNATIONAL AND TURKISH REGULATIONS. HOW CAN ARTIFICIAL INTELLIGENCE (AI) HELP TO IMPROVE THE MOST COMMON ISSUES WITH SEWAGE SYSTEMS?

(YOLCU GEMİLERINDEN KAYNAKLANAN ATIK SU KİRLİLİĞİNİN ÖNLENMESİ METHODLARI: ULUSLARARASI VE TÜRK DÜZENLEMELERI ARASİNDAKİ KARŞILAŞTIRMALAR. YAPAY ZEKA (YZ) GEMİLERDEN KAYNAKLI ATIK SU KIRLILIĞI KONUSUNDA KARŞILAŞILAN EN YAYGIN SORUNLARA ÇÖZÜM OLABİLİR Mİ?)

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ABSTRACT

Passenger ships are a growing economic industry worldwide that has faced criticism due to their environmental impact, as they are major wastewater producers in the seas. Especially, ships with larger capacities have a huge impact on the marine environment. With thousands of passengers and crew on board, passenger ships produce significant amounts of waste that must be properly handled to protect the marine environment and comply with regulations. Current international regulations prohibit sewage into the sea within a specified distance from the nearest land. This regulation only applies to vessels of 400GT and above engaged in international voyages and carrying a minimum of 15 persons on board. It does not address ships carrying fewer persons onboard. However, there are smaller vessels around discharging wastewaters that are not subject to these legal regulations. When pollution reaches the ocean, it adversely impacts marine ecosystems. Therefore, current regulations and authorities such as flag states, port states and classification societies fail to adequately protect the marine environment in the high seas. This article addresses the impact

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Esere Atıf Şekli: Ayça Uçar, "*Prevention of Pollution From Sewage on Passenger Ships: A Comparison Between International Regulation and Turkish Regulations. How Can Artificial Intelligence (AI) Help to Improve the Most Common Issues with Sewage Systems?"*, YÜHFD, C.XXII, 2025/2, s.957-992.

of releasing untreated sewage into the sea and the current regulations that control pollution of the sea by sewage.

Meanwhile, in recent years, Artificial Intelligence (AI) has brought a revolutionary wave of transformation to the shipping industry, such as smart communication systems and efficient waste management. This article will introduce current prevention methods that address the pollution from sewage problem, it aims to identify and tackle the question of whether current regulations are sufficient to protect the marine environment especially concerning ship waste. Lastly, the study will examine how AI enhances the efficiency, reliability and sustainability of sewage systems on passenger ships.

Keywords: *Passenger ships, Artificial Intelligence (AI), Sewage System, Marine Environment, MARPOL, Wastewater.*

ÖZ

Yolcu gemilerinin, dünya genelinde büyüyen bir ekonomik sektör olması nedeni ile bu gemilerden denize dökülen atık su miktarının da fazla olmasına yol açmıştır. Özellikle, daha büyük kapasiteli yolcu gemilerinin, kanalizasyon atıklarını denize boşaltması nedeniyle deniz kirliliği üzerinde büyük bir etkiye sahipler. Binlerce yolcu ve mürettebat ile birlikte, yolcu gemileri deniz çevresini korumak ve hukuki düzenlemelere uymak için uygun şekilde yönetilmesi gereken önemli miktarda atık üretmektedir. Mevcut uluslararası düzenlemeler, en yakın kara parçasından belirli bir mesafe içinde atık suyun denize deşarjını yasaklamaktadır. Bu düzenleme, yalnızca uluslararası sefer yapan ve içinde minimum 15 kişinin bulunduğu 400GT ve üzeri gemilere uygulanmaktadır. Daha az yolcu taşıyan gemiler Uluslararası düzenlemenin dışında kalmaktadır. Ancak, bu yasal düzenlemelere tabi olmayan atık su deşarj eden daha küçük gemiler bulunmaktadır. Kirlilik okyanusa ulaştığında, deniz ekosistemleri üzerinde olumsuz etki yaratmaktadır. Bu nedenle, mevcut düzenlemeler ve bayrak devletleri, liman devletleri ve klas Kuruluşları gibi yetkililer, açık denizlerde deniz ortamını yeterince koruyamamaktadır. Bu makale, atıksu deşarjının deniz üzerindeki etkisini ve gemilerde üretilen atık suların denizi kirletmesini engelleyen mevcut uluslararası ve ulusal düzenlemeleri analiz edecektir.

Son yıllarda Yapay Zeka (YZ), akıllı iletişim sistemleri ve verimli atık yönetimi teknolojisi ile taşıma endüstrisinde devrim yaratmıştır. Bu makalede, gemilerden boşaltılan atık sudan kaynaklanan kirliliği önleyici mevcut yöntemler incelenecek, mevcut düzenlemelerin deniz çevresini

korumak için yeterli olup olmadığınıa ilişkin analiz yapılacak ve çözüm yöntemleri sunulacaktır. Son olarak, çalışma, Yapay Zekanın yolcu gemilerindeki atık su sistemlerinin verimliliğini, güvenilirliğini ve sürdürülebilirliğini nasıl artırdığını inceleyecektir.

Anahtar Kelimeler: *Yolcu gemileri, Yapay Zeka (AI), Kanalizasyon Sistemi, Deniz Çevresi, MARPOL, Atıksu.*

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1. Introduction

The rapid development of maritime transportation in recent years has raised potential environmental challenges. Passenger ships, particularly large cruise ships, have been significant contributors to marine pollution. With thousands of passengers and crew on board, cruise ships produce considerable amounts of waste that must be properly handled to protect the marine environment and comply with regulations.[1531]

Cruise ships generate a variety of waste, including sewage, garbage, oily bilge water, and hazardous waste.[1532] Among this typical waste, sewage waste has received considerable attention in marine pollution prevention. The problem arises due to the discharge of raw sewage into the sea can create health problems, and when pollution reaches the ocean, it harmfully impacts marine ecosystems. There are global regulations prohibiting illegal dumping and runoff from cruise ships to protect the environment. Many organisations fail to comply and release toxins into the water illegally.[1533]

The International Convention for the Prevention of Pollution from Ships (MARPOL), national and regional legislations around the world have been developed to control sewage discharge. However, due to shortages in techniques, facilities, management and a lack of legislation, environmental pollution caused by sewage from ships still poses a risk.

[1531] *Managing waste, including wastewater and food disposal, is a critical aspect of operating cruise ships sustainably and responsibly,*https://www.cruisingjournal.com/en/cruise-guide/cruise-lines-guide/waste-management-on-cruise-ships#google_vignette .,(Access Date: 15.01.2025).

[1532] Qing Chen, Wanqing Wu, Yafei Guo, Jingtai Li, Fang Wei, *Environmental impact, treatment technology and monitoring system of ship domestic sewage: A review, Science of The Total Environment*, Volume 811, 2022 https://www.sciencedirect.com/science/article/pii/S0048969721064883.,(access Date: 01.02. 2025).

[1533] Marsh, Jane, *the Effects of Cruise Ship Waste*, https://environment.co/the-effects-of-cruise-ship-waste/ (Access Date 06.02.2025).

Therefore, new prevention techniques and cost-effective measures must be found to reduce pollution from passenger ships. Artificial Intelligence (AI) has significant potential to enhance sewage management on these vessels and further decrease pollution efficiently. Cruise ships produce considerable amounts of waste. AI-powered waste management is crucial to reducing environmental impact. AI-powered waste management systems classify and sort waste more effectively, separating recyclables from non-recyclables. These systems analyse waste data to identify common waste patterns, helping operators develop better recycling policies and minimise production. AI also supports the treatment of grey water and organic waste to meet environmental regulations.[1534] Therefore, the study examines several ways AI may address common problems with ship sewage systems. Before examining the impact of AI technology on passenger ship sewage management systems, it is worth looking at the definition of sewage waste and tackling the question of how to prevent pollution from sewage at sea. Likewise, assessing current regulations that prohibit untreated ship sewage from being released into the sea will be fundamental.

2. Defining Sewage Waste

Passenger ships, especially cruise ships, are getting bigger, with modern cruise ships having a passenger capacity of almost 10000 passengers.[1535] As a result of growth in the sector, the environmental impact has increased over the years.[1536] Large cruise ships often travel to highly protected areas such as Alaska, the Northern Sea and the Mediterranean Sea, where the discharge of wastewater is highly restricted.[1537] MARPOL annex IV addresses the prevention of pollution by sewage from ships, requiring ships to have appropriate sewage treatment and disinfection systems or a sewage storage

[1534] *10 ways AI is being used in Cruises [2025]*, https://digitaldefynd.com/IQ/ai-in-cruises/#:~:text=9.,by%20ensuring%20proper%20recycling%20practices (Access Date. 01.02. 2025).

[1535] Vilotijević, Alex, Matulja, Tin, Hadjina, Marko, Bolf, Davor. (2020). *Modern Equipment for Waste Management on Cruise Ships, Journal of Maritime & Transportation Science* (accessed 11 February 2025).

[1536] Schumüller, K., Weichgrebe, D. Köster, S. Biogas *potential of organic waste onboard cruise ships — a yet untapped energy source*. Biomass Conv. Bioref. 12, 5647–5662 (2022). https://doi.org/10.1007/s13399-020-01249-0(Acces Date: 12.01.2025).

[1537] Daniels, Simon, Shipboard Management 1st ed., London, Routledge,2024, p 64.

tank on board.[1538] The shipping industry and manufacturers of ship equipment are developing systems to ensure adequate treatment of waste to comply with MARPOL.[1539]

Waste produced on ships can be divided into black water and grey water. Black water includes waste from toilets and urinals, while grey water is wastewater from sinks, laundry and restaurants.[1540] Untreated sewage contains high concentrations of nitrates, phosphates, and organic matter. This can contaminate water bodies such as lakes, rivers, and the sea, as the bacteria in untreated sewage are strong and can consume oxygen from the surroundings at a very high rate, making it difficult for the natural fauna of the aquatic environment to survive.[1541]

3. Hazards of Discharging Untreated Sewage in the Sea and Its Impact on the Marine Environment, as well as the Responsibilities of Organisations

Discharging untreated or substandard ship sewage causes damage to the water environment, marine organisms and even human health. It is of great environmental and social significance to develop more efficient disposal technologies and devices and to strengthen the supervision of sewage discharging from ships.[1542] The sewage generated on ships cannot be stored for a long time, therefore, it must be discharged into the sea.[1543] However, raw sewage released into the sea contains bacteria and viruses. Some cruise ships discharge untreated or inadequately treated sewage into the ocean,

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[1538] *Prevention of Pollution by Sewage from Ships*, https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx (Access Date: 11.02. 2025).

[1539] Daniels, p.64.

[1540] Şahin, V.; Vardar, N. Determination of Wastewater Behavior of Large Passenger Ships Based on Their Main Parameters in the Pre-Design Stage. J. Mar. Sci. Eng. 2020, 8, 546. https://doi.org/10.3390/jmse8080546(accessed 11 February 2025).

[1541] Raunek Kantharia, MARPOL ANNEX 4 *Explained – How to Prevent Pollution from Sewage at Sea at* https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Acces Date 11.02.2025).

[1542] Qing Chen, Wanqing Wu, Yafei Guo, Jingtai Li, Fang Wei, *Environmental impact, treatment technology and monitoring system of ship domestic sewage: A review, Science of The Total Environment*, Volume 811, 2022, p.10, https://www.sciencedirect.com/science/article/pii/S0048969721064883(Access Date: 01.02. 2025).

[1543] Raunek Kantharia, *Sewage Treatment Plant on Ships Explained at https://www.marineinsight.com/tech/sewage-treatment-plant/*(Access Date:11.02. 2025).

especially in areas outside regulated waters, leading to water pollution.[1544] Unfortunately, current international regulations authorise the discharge of untreated sewage up to 12 nautical miles away from the nearest land.[1545] This means that the current regulations do not provide enough protection for the oceans. A vast amount of untreated sewage is dumped into the ocean due to a lack of regulation in the high seas. This sewage is not only full of human waste, but also chemicals, pharmaceuticals, bacteria, viruses, heavy metals, and hazardous waste. Many cruise ships lack sewage treatment facilities to adequately filter out toxins, leading to suffocating marine life such as coral reefs, shellfish and fish.[1546]

Annex IV of MARPOL states that every ship, including passenger ships that are 400 gross tonnage and above or certified to carry more than 15 passengers, must be equipped with either an approved sewage treatment plant or an approved sewage comminating and disinfecting system or a sewage holding tank.[1547] However, not every passenger ship has adequate treatment facilities, and their treatment plant are not fully capable of handling the large volume of waste produced by passengers and crew. As a

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[1544] Akshat, Arora, MARPOL *Annex IV – Regulations for the Prevention of Pollution by Sewage from Ships* https://www.standard-club.com/fileadmin/uploads/standardclub/Documents/Import/news/2019-news/2935886-standard-club-marpol-annex-iv-article.pdf(Access Date: 10.02. 2025).

[1545] Holger Steinbock, Jörg Heuckeroth, *Ship's sewage and garbage (MARPOL Annex IV-V)* https://www.deutsche-flagge.de/en/environmental-protection/sewage/sewage#:~:text=inadequate%20reception%20facilities-,No%20discharge%20of%20untreated%20ship's,the%20sea%20(MARPOL%20Annex%20IV)&text=if%20it%20is%20discharged%20from,miles%20from%20the%20nearest%20land. (Access Date: 02. 02. 2025).

[1546] Where Do Cruise Ships Dump Their Waste? https://foe.org/blog/where-do-cruise-ships-dump-their-waste/

[1547] Prevention of Pollution by Sewage from Ships athttps://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx(Access Date: 15.02.2025); a sewage treatment plant on ships is a "wastewater treatment plant" which refers to the system on board that process and clean sewage (both grey and black water) before it is discharged into the ocean. MARPOL Annex IV requires that ships must have a proper waste management system which comply with international environmental standards. MARPOL ANNEX 4 Explained – How to Prevent Pollution from Sewage at Sea at https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/.,(Access Date: 03.01. 2025); In all seagoing vessels, special arrangements are installed to hold or treat the sewage (before discharging it), especially in special areas or when the ship nears the coastal areas. Following are the treatments methods; Holding tank which determines the capacity of sewage, communicating and disinfecting equipment which comprises filter that breaks the sewage into smaller particles.

result, sewage may be released without sufficient treatment and posing risks to even regulated waters. Generally, sewage treatment systems installed on board must be certified by classification societies. They verify that the system meets the necessary technical specifications and performance standards. These societies conduct periodic inspections of sewage treatment plants on ships to ensure they are functioning properly and complying with regulations. Classification societies have a role to play in upholding the standards set by the International Maritime Organisation (IMO) regarding sewage discharge from ships. [1548]They should perform their duties to comply with the regulation for sufficient sewage treatment plants, failing which would cause pollution to the marine environment.

Likewise, Other authorities such as shipowners, flag states and port authorities also play key roles in inspecting ships for discharging untreated sewage in ports. Any equipment failure or non-compliance with approved drawings may result in an invalid International Sewage Pollution Certificate and a violation of MARPOL Annex IV. Therefore, shipowners and crews must be aware of the MARPOL Annex IV requirements and familiar with the appropriate operation of shipboard sewage treatment systems.[1549] Regulations also required that regular inspections be conducted following approval from the classification society on behalf of the administration (the ship's flag state). Failure to comply with MARPOL and domestic regulations may result in fines and ship detentions.

4. Regulation For Sewage Waste- MARPOL ANNEX IV

A. The Story of MARPOL

The International Convention for the Prevention of Pollution from Ships (MARPOL) was adopted after the Torrey Canyon accident, which was the largest oil tanker spill recorded at the time. This incident led to the creation of a subcommittee on pollution from ships at the IMO.[1550] The Torrey

[1548] Rishab Joshi, The Importance of Classification Societies in the Maritime Industry https://www.marineinsight.com/maritime-law/the-importance-of-classification-societies-in-the-maritime-industry/(Access Date:11.02. 2025).

[1549] Arora, Akshat, MARPOL Annex IV – Regulations for the Prevention of Pollution by Sewage from Ships at https://www.standard-club.com/fileadmin/uploads/standardclub/Documents/Import/news/2019-news/2935886-standard-club-marpol-annex-iv-article.pdf(Access Date: 11.02. 2025).

[1550] Torrey Canyon: The world's first major oil tanker disaster at https://safety4sea.com/cm-torrey-canyon-the-worlds-first-major-oil-tanker-disaster/(accessed 11 February 2025); International Convention for the Prevention of Pollution from Ships (MARPOL) at

Canyon was an oil tanker with a deadweight capacity of 120,000 tons of crude oil. It was built in the United States in 1959.[1551] The oil tanker ship hit rocks off the coast of Cornwall, spilling more than 100,000 tonnes of crude oil into the English Channel[1552]. On March 25, oil began to arrive on Cornish beaches, affecting 100 miles of coastline.[1553] This was the first major oil spill in British and European waters, causing significant damage to marine life[1554]. It remains the UK's worst environmental pollution event and set in motion a chain of events that led to a new international treaty that remains in force today.[1555]

MARPOL is the main international convention covering the prevention of pollution of the marine environment by ships from operational and accidental causes. The MARPOL Convention was adopted on 2 November 1973 at the IMO.[1556] MARPOL received three ratifications from Jordan, Kenya, and Tunisia by 1976. [1557] Following a series of tanker accidents led to a new IMO Conference, and the changes were incorporated into both the Protocol of 1978 relating to the 1974 Convention on the Safety of Life at Sea (1978 SOLAS Protocol).[1558] After the Torry Canyon oil spill incident, the series of disasters continued to occur despite of MARPOL 1973. Likewise, *the Amoco Cadiz* accident[1559], which happened in 1978, triggered MARPOL 1978 amendments.[1560] The largest global oil spill occurred just

https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx/(Access Date: 11.12. 2024).

[1551] Daniels, Simon, Shipboard Management 1st ed., London, Routledge,2024, p. 61.

[1552] Soyer Barış, Tettenborn Andrew, *Pollution at Sea Law and Liability*,1st Edition, Informa Law, London,2012, p.7.

[1553] Berlingieri, Francesco, *International Maritime Conventions* (Volume 3): *Protection of the Marine Environmen*t ,1st ed., Informa Law from Routledge.,2015, p.3

[1554] Torrey Canyon oil spill: The day the sea turned black at https://www.bbc.co.uk/news/uk-england-39223308 (Access Date:13. 02.2025).

[1555] Techera Erika, McCann Joy, *The Unruly Ocean: Law and Justice in the World's Oceans, Seas and Shorelines*, Routledge; 1st edition ,2024, p. 226.

[1556] International Convention for the Prevention of Pollution from Ships (MARPOL) https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx(Access Date:11 December 2024).

[1557] Daniels, p.62.

[1558] Ibid, at p.62.

[1559] Techera Erika, McCann Joy, *The Unruly Ocean: Law and Justice in the World's Oceans, Seas and Shorelines*, Routledge; 1st edition ,2024, p. 226.

[1560] Ibid at p. 26; *The Amoco Cadiz*; ran aground on the coast off France in 1978, rupturing the cargo tank and spilling crude oil into the ocean.

the following year, when the *Atlantic Empress*[1561] spilt 287,000 tonnes of oil into the ocean in 1979. This accident further influenced the law yet, a large spill was to come. In 1989, the Exxon Valdez oil super tanker struck, spilling oil in the Prince William Sound, Alaska. This accident resulted in the tanker, grounding, causing huge oil pollution in US waters and killing thousands of animals. It was followed by the ABT Summer spill in 1991. After a series of oil disasters, amendments were adopted in 1992 to MARPOL, requiring new ships to be fitted with segregated tanks and double hulls to reduce the risk of oil spills, and older vessels were gradually taken out of service[1562]. In 1997, a protocol was adopted to amend the Convention, and a new Annex VI was added, which entered into force on 19 May 2005. MARPOL has been updated and amended throughout the years.[1563]

B. Regulation for Sewage Waste- MARPOL ANNEX IV

The discharge of sewage waste from ships is regulated under MARPOL Annex IV.[1564] MARPOL Annex IV contains a set of regulations regarding the discharge of sewage into the sea, including regulations regarding the ship's equipment and systems for the control of sewage discharge, the provision of port reception facilities for sewage, and requirements for survey and certification.[1565]

Six technical Annexes were established in the MARPOL convention to prevent and control pollution from ships. Crucial declarations are summarised in each Annex to provide the main points of restriction for each type of waste. Among these, Annex IV is the regulation for sewage, which

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[1561] https://shipwrecklog.com/log/history/atlantic-empress/; *The Atlantic Empress* was Greek oil tanker that collided with the Aegean captain in 1979. The spill released and estimated 90 million gallons of oil into the Atlantic Ocean.

[1562]Techera Erika, McCann Joy, *The Unruly Ocean: Law and Justice in the World's Oceans, Seas and Shorelines*, Routledge; 1st edition ,2024, p. 226.

[1563] International Convention for the Prevention of Pollution from Ships (MARPOL) https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx/(Access Date: 10. 11. 2024).

[1564] Raunek Kantharia, MARPOL ANNEX 4 Explained – How to Prevent Pollution from Sewage at Sea at https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date 11. 02. 2025).

[1565] Prevention of Pollution by Sewage from Ships https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx/(Access Date: 11. 02. 2025); Sands Philippe, *Principle of International Environmental Law*, Cambridge Univrsity Press 2nd edition,2003, p.443.

came into force in 2003, 25 years after its inclusion in the convention in 1978.[1566] According to MARPOL Annex IV, the oceans are capable of absorbing and dealing with raw sewage through natural bacterial action. Therefore, the regulations in Annex IV of MARPOL only forbid sewage discharge into the sea within a special distance from the nearest land, unless otherwise provided.[1567] Governments are required to make sure that adequate facilities at ports and terminals for the function of sewage are prepared without causing delays to ships. The Annex came into force on September 27, 2003. A revised version of Annex IV was adopted on 1 April 2004 and entered into force on 1 August 2005.[1568] Annex IV of the MARPOL Convention applies to all ships, including passenger ships on international voyages with a size of 400 gross tonnage and above, or which are certified to carry more than 15 people. The Annex requires ships to be equipped with either an approved sewage treatment plant or an approved comminuted and disinfecting system, or a sewage holding tank.[1569] Untreated Sewage may be discharged at more than 12 nautical miles from the nearest land when the ship is underway, proceeding at not less than 4 knots. The rate of discharge of untreated sewage shall be approved by the Administration.[1570]

[1566] Qing Chen, Wanqing Wu, Yafei Guo, Jingtai Li, Fang Wei, Environmental impact, treatment technology and monitoring system of ship domestic sewage: A review, Science of The Total Environment, Volume 811, 2022 at https://www.sciencedirect.com/science/article/pii/S0048969721064883, p.3 (Access Date: 01. 02.2025).

[1567] Prevention of Pollution by Sewage from Ships https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx/(Access Date: 10. 02. 2025).

[1568] Holger Steinbock, Jörg Heuckeroth, Ship's sewage and garbage (MARPOL Annex IV-V) https://www.deutsche-flagge.de/en/environmental-protection/sewage/sewage#:~:text=inadequate%20reception%20facilities-,No%20discharge%20of%20untreated%20ship's,the%20sea%20(MARPOL%20Annex%20IV)&text=if%20it%20is%20discharged%20from,miles%20from%20the%20nearest%20land. (Access Date: 25. 02.2025).

[1569] Prevention of Pollution by Sewage from Ships https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx/(Access Date: 15. 02. 2025).

[1570] Prevention of Pollution by Sewage from Ships https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx/(Access Date: 21, 02.2025).

C. Special Areas

The most recent amendment to MARPOL Annex IV designated a "Special Area" as well as relevant requirements for the discharge of sewage from passenger ships.[1571] MARPOL identifies special areas of the ocean where specific methods are required to prevent pollution. These are given a higher degree of protection than other parts of the ocean. Likewise, these recent amendments were drafted especially for passenger ships. According to MARPOL Annex IV, rigorous discharge limits are imposed on all passenger ships. The Marine Environment Protection Committee (MEPC) adopted resolution MEPC.200(62) amending MARPOL by entitling the Baltic Sea as a special area. Under Annex IV, passenger ships, which are operating in special areas, are prohibited from releasing sewage unless they have an approved sewage treatment plant[1572]. The Baltic Sea area was adopted as the first special area for sewage discharge regulation. This regulation especially targets passenger ships, which are the major cause of sewage-related pollution in the sea and in coastal water bodies. The regulation prohibits the release of raw sewage into the seas of Baltic region. Untreated sewage produced on the passenger ship can either be treated in a

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[1571] Holger Steinbock, Jörg Heuckeroth, Ship's sewage and garbage (MARPOL Annex IV-V) https://www.deutsche-flagge.de/en/environmental-protection/sewage/sewage#:~:text=inadequate%20reception%20facilities-,No%20discharge%20of%20untreated%20ship's,the%20sea%20(MARPOL%20Annex%20IV)&text=if%20it%20is%20discharged%20from,miles%20from%20the%20nearest%20land(Access Date: 23. 02. 2025).

[1572] MEPC 64/23/Add.1 Annex 22, page 42012 "Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plants "https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Resolution%20MEPC.227(64).pdf (accessed 11 February 2025); These Guidelines amend the Revised guidelines on implementation of effluent standards and performance tests for sewage treatment plants, adopted by resolution MEPC.159(55), by including the standards of section 4.2 that only apply to passenger ships which operate in MARPOL Annex IV special areas and which intend to discharge treated sewage effluent into the sea.; Akshat Arora, MARPOL Annex IV – Regulations for the Prevention of Pollution by Sewage from Ships https://www.standard-club.com/fileadmin/uploads/standardclub/Documents/Import/news/2019-news/2935886-standard-club-marpol-annex-iv-article.pdf; Currently, the Baltic Sea area is the only Special Area under Annex IV. In accordance with resolution MEPC.275(69), the discharge requirements for Special Areas in regulation 11.3 of MARPOL Annex IV for the Baltic Sea Special Area shall take effect: on 1 June 2019, for new passenger ships[1]; on 1 June 2021, for existing passenger ships other than those specified in .3; and on 1 June 2023, for existing passenger ships en route directly to or from a port located outside the special area and to or from a port located east of longitude 28°10' E within the special area that do not make any other port calls within the special area.

Sewage Treatment Plant (STP) before discharge, or the collected sewage can be transferred to a shore facility. The sewage treatment plant installed on passenger ships, intending to discharge sewage waste in Special Areas, should additionally meet the nitrogen and phosphorus removal standards when tested for its Certificate of type Approval by the Administration.[1573]

Therefore, passenger ships entering special areas must comply with the regulations. The Baltic Sea is recognised as a special area by MARPOL Annex IV, and relevant organisations such as classification societies make sure that passenger ships have a proper sewage treatment plant (STP) and STP meets the required specifications and standards. Besides, shipowners, flag states and port authorities also play an important role in vigorous periodic inspection to meet the regulations by MARPOL Annex IV. In addition to the International Maritime Organisation, the European Union (EU) requires that ship and port operators duly dispose of garbage onshore. The directive (EU) 2019/883 of the European Parliament and of the Council on port reception facilities for the delivery of waste from ships, amending Directive 2010/65 /EU and repealing Directive 2000/59/EC, contains detailed requirements for EU ports, such as port reception facilities for ship waste. According to the directive, EU port states must provide adequate port reception facilities and inform ship operators about them.[1574] Since Türkiye is not part of the EU, it is worth examining how sewage waste from passenger ships is managed in Turkish ports.

D. Regulations for Sewage in Türkiye

The prevention of sewage pollution from passenger ships in Turkish waters, like in other countries, is an environmental issue. Türkiye, with its

[1573] Raunek Kantharia, MARPOL ANNEX 4 Explained – How to Prevent Pollution from Sewage at Sea at https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date: 11. 02. 2025).

[1574] Holger Steinbock, Jörg Heuckeroth, Ship's sewage and garbage (MARPOL Annex IV-V) https://www.deutsche-flagge.de/en/environmental-protection/sewage/sewage#:~:text=inadequate%20reception%20facilities-,No%20discharge%20of%20untreated%20ship's,the%20sea%20(MARPOL%20Annex%20IV)&text=if%20it%20is%20discharged%20from,miles%20from%20the%20nearest%20land. (Access Date: 25. 11. 2024); Masters of sea-going ships in EU ports are obliged to dispose of all ship waste before leaving the port – unless there is enough storage capacity on board for the waste accrued so far and the waste that is anticipated to be produced on the voyage to the next port. Details on the calculation of storage capacity is given in the Implementing Regulation (EU) 2022/89.

extensive coastline and numerous tourist destinations, faces the challenging problem of managing waste from passenger ships, particularly large cruise ships, which have been a major factor in marine pollution. Significant amounts of waste are produced by these large cruise ships, posing a risk to the marine environment. Therefore, it is important to examine key approaches and regulations related to preventing pollution from sewage in Türkiye.

Türkiye is a member of the International Convention for the Prevention of Pollution (MARPOL) from Ships, particularly Annex IV of the MARPOL Convention states that every ship of 400 gross tonnage and above, which is engaged in international voyages and carrying a minimum of 15 people on board must be equipped with either a sewage holding tank of appropriate capacity or an approved sewage treatment plant (STP). Discharge of sewage is subject to provision 2 of Annex IV, which requires ships to be equipped with either an approved sewage treatment plant or an approved comminuted and disinfecting system, or a sewage holding tank.[1575] Sewage that is not sterilised may be discharged at a distance of more than 12 nautical miles from the nearest land when the ship is on the way and proceeding not less than 4 knots, and the rate of discharge of untreated sewage shall be approved by the Administration.[1576]

Similarly, the Barcelona Convention, which Türkiye adopted in 2002 under Law No.24854, Article 5, specifies the general obligation for contracting parties to take all adequate measures to prevent pollution caused by dumping from ships and aircraft within the Mediterranean Sea.[1577] The primary aim of Article 5 of the Barcelona Convention is to prevent pollution of the Mediterranean Sea by actively taking measures against dumping

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[1575] *Prevention of Pollution by Sewage from Ships* https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx/(Access Date: 15.02. 2025).

[1576] *Turkish Waters Marine Pollution: Strict Regulation and Extraordinary Fines Maritime Mutual Risk Bulletin No. 69* https://maritime-mutual.com/risk-bulletins/turkish-waters-marine-pollution-strict-regulation-and-extraordinary-fines/(Access Date: 13.02. 2025).

[1577] Boratav Ali,*Mavi Kart, DAU ve teknelerin gri-siyah su atıklarının yönetimi ile ilgili yasal çerçeve metinleri - Türkiye, Birleşmiş Milletler, Avrupa Birliğihttps*://www.maviyolculukrehberi.net/post/mavi-kart-dau-ve-teknelerin-gri-siyah-su-at%C4%B1klar%C4%B1n%C4%B1n-y%C3%B6netimi-ile-ilgili-yasal-%C3%A7er%C3%A7eve-metinleri (accessed 15 February 2025); Guidelines of the EC reporting obligations under the Barcelona Convention and its Protocols in force https://www.eea.europa.eu/publications/Technical_report_No_45/file(Access Date: 15. 01. 2025).

waste from ships and aircraft. contracting states are not only required to take necessary steps but are also obliged to mitigate any pollution that does occur.[1578]

As regards pleasure crafts, guidelines concerning pleasure craft activities and protection of the marine environment in the Mediterranean UNEP (DEPI)MED IG. 17/10 Annex IV, *"Pleasure craft" means all kinds of craft, including yachts, used for the purpose of leisure, sport or recreational activities, be they privately owned or chartered, and using any type of propulsion system.* [1579]According to Annex IV REMPEC/WG.27/6, article 28, pleasure crafts should comply with the regulation of MARPOL Annex IV. Article 29 of the Guidelines of Prevention of pollution from pleasure craft established that pleasure crafts of less than 400 gross tonnage which are certified to carry less than 15 persons should make sure, irrespective of whether the craft is engaged on international voyage, that the craft has a sewage retention system that can be emptied in port reception facilities.[1580]

In accordance with international regulations, Turkish Environmental Law No. 2872 of 1983 (as amended in 2023) was established.[1581] Article 20 of the Turkish Environmental Code states that "vessels causing pollution in Turkish waters, for example through the discharge of petroleum products, dirty ballast water, garbage and sewage into the sea, are subject to fines imposed by local authorities.[1582]

[1578] *Turkish Waters Marine Pollution: Strict Regulation and Extraordinary Fines Maritime Mutual Risk* Bulletin No. 69https://maritime-mutual.com/risk-bulletins/turkish-waters-marine-pollution-strict-regulation-and-extraordinary-fines/(access Date: 10. 01.2025).

[1579] Decision IG 17/9: Guidelines concerning pleasure craft activities and the protection of the marine environment in the Mediterranean UNEP(DEPI)/MED IG.17/10 Annex V https://www.rempec.org/en/knowledge-centre/online-catalogue-items/activity-reports/pleasure-craft (accessed 27.02. 2025).

[1580]https://www.rempec.org/en/knowledge-centre/online-catalogue-items/activity-reports/pleasure-craft(access Date:30.02.2025).

[1581] Environment Law No. 2872. https://faolex.fao.org/docs/pdf/tur7700.pdf(Access Date:11.02. 2025).

[1582] Hamzeh Yassmin, *Marine pollution fines in Turkiye as of 1 January 2023* https://www.standard-club.com/knowledge-news/marine-pollution-fines-in-turkiye-as-of-1-january-2023-4820/#:~:text=The%20Turkish%20Environmental%20Code%201983%20(law%20no.,imposed%20by%20the%20local%20authorities. (Access Date:13.01. 2025); garbage and sewage discharged to sea by vessels up to 25,419.48 TRY,18 to 50 GT 50,843.27 TRY,50 to 100 GT 101,686.55 TRY,100 to 150 GT 152,531.26 TRY,150 to 1,000 GT 1,146.10 TRY/GT,1,001 to 5,000 GT An additional 229.21 TRY/GT. more than 5,000 GT An additional 26.44 TRY/GT.

Turkish Environmental Law No. 2872 Article 5 states that it is unlawful to dump ballast and bilge water or wastes and effluent of any kind either directly or indirectly into the seas, inland seas, straits, gulf, harbours, natural or manmade lakes, rivers or canals, or shores within Turkish territorial waters or Türkiye's free and restricted economic zones.[1583]

Similarly, the Regulation on Waste Receiving from Ships and Waste Control numbered 25682 and dated 26/12/2004 in the official gazette, based on MARPOL 73/78, EC 2000/59 obliges that ports must set up waste reception facilities with sufficient capacity and technical equipment to properly receive ship-generated waste, ensuring that ships can dispose of their waste without delay upon request. This obligation primarily falls on the port manager, who must obtain a license to operate these facilities and dispose of collected waste.[1584] In Regulation on Waste Receiving From ships and Waste Control numbered 25682, a ship is defined any boat, regardless of the purpose of use, boats of all structures and types, such as all sea vessels, air cushion boats, hydrofoil boats, platforms and submarines, that can set off at sea and in inland waters with a device other than paddles.[1585]

Regulations regarding the discharge of sewage are gradually increasing for tourism and recreational vessels such as yachts and small boats. However, there is currently no international convention that requires private pleasure craft to have a holding tank in compliance with MARPOL Annex IV. This regulation only applies to vessels that exceed 400GT or carry more than 15 passengers.[1586] MARPOL Annex IV does not address those vessels carrying fewer persons, which can be ships and ferries sailing in inland waters.

International Conventions also do not address the issue of pleasure crafts, which are sailing within the territorial waters of another country. Every

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[1583] Environment Law No. 2872. https://faolex.fao.org/docs/pdf/tur7700.pdf(accessed 15 February 2025).

[1584] *Gemilerden Atik Alınması ve Atıkların Kontrolü Yönetmeliği* https://mevzuat.gov.tr/anasayfa/MevzuatFihristDetayIframe?MevzuatTur=7&MevzuatNo=5672&MevzuatTertip=5

[1585] Boratav Ali,Mavi *Kart, DAU ve teknelerin gri-siyah su atıklarının yönetimi ile ilgili yasal çerçeve metinleri - Türkiye, Birleşmiş Milletler, Avrupa Birliği* https://www.maviyolculukrehberi.net/post/mavi-kart-dau-ve-teknelerin-gri-siyah-su-at%C4%B1klar%C4%B1n%C4%B1n-y%C3%B6netimi-ile-ilgili-yasal-%C3%A7er%C3%A7eve-metinleri(Access Date: 11.02 2025).

[1586] *Holding Tanks*, https://www.rya.org.uk/knowledge/abroad/holding-tanks#:~:text=Discharge%20of%20any%20kind%20may,than%20emptied%20into%20the%20sea. (Access Date: 15.02. 2025).

coastal state has its law regarding with discharge of sewage for tourism/recreational vessels such as yachts and small boats, which are carrying fewer than 15 people on board.[1587] Number 31792 Blue Card 2013-12 GATS Implementation Regulation came into force in 2013. According to the Circular on marine waste application, oil tankers over 150GT and ships over 400 GT are subject to GATS (Ship Waste Tracking System). This circular was prepared in accordance with the Environmental Law No. 2872, the Regulation on Waste Collection from Ships, the MARPOL 73/78 convention and the EC 200/59 Directive. This circular requires that ships over 150GT and ships over 400 GT, regardless of their type, must deliver waste with a Blue Card to designated facilities in Türkiye.[1588] Facilities are responsible for establishing a waste collection and electronic tracking system. Ships coming from abroad must obtain a blue card within 48 hours. Diving tourism ships have a limited voyage of 3 hours and must dispose of waste every 7 days. Cabotage line ships and passenger ships operating within the port must report waste every 24 hours. Boats on in-harbour trips are limited to 3 hours and must report waste every 7 days.[1589]

The Blue Card Circular was established to provide further clarification on managing waste from ships in Turkish waters in accordance with Environmental Law No. 2872. It covers the provision of waste reception services to vessels arriving at facilities such as fishing shelters, marinas, and dry docks. The circular also aims to establish the Blue Card System to track this service, and to define the procedures and responsibilities of the relevant institutions and organisations in implementing the system[1590]. In May 2020,

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[1587] *Mavi Kart, DAU ve teknelerin gri-siyah su atıklarının yönetimi ile ilgili yasal çerçeve metinleri - Türkiye, Birleşmiş Milletler, Avrupa Birliği* https://www.maviyolculukrehberi.net/post/mavi-kart-dau-ve-teknelerin-gri-siyah-su-at%C4%B1klar%C4%B1n%C4%B1n-y%C3%B6netimi-ile-ilgili-yasal-%C3%A7er%C3%A7eve-metinleri

[1588] *10 SORUDA denizlerimizin Mavi Kart'la imtihanı https*://www.yachtturkiye.com/yazarlar/ali-boratav/10-soruda-denizlerimizin-mavi-kartla-imtihani.html(Access Date: 11.02 2025).

[1589] https://www.denizlerdeyiz.org/wp-content/uploads/2020/05/k-mavi-kart-GENELGE-2013-12.pdf(Access Date: 11.02 2025).

[1590] Ergenç, Cem Mehmet, "*Mavi Kart Uygulamasının Sürdürülebilir Deniz Turizmine Etkisi*". Dokuz Eylül Üniversitesi Denizcilik Fakültesi Dergisi 13, sy. 2 (Aralık 2021): 247-66. https://doi.org/10.18613/deudfd.540251. p.253. (Access Date: 11.02 2025); Rumana Riffat, Taqsim Husnain, *Fundamentals of Wastewater Treatment and Engineering,* 2nd ed. Informa Law, 2024.

a new system was implemented- the ship Waste Tracking System (GATS), also known as DAU (Denizcilik Atıkları Uygulması), [1591]which applies to petroleum tankers with a gross tonnage (GRT) of 150 or more other ships with a GRT of 400 or more.[1592] The system regulates the collection of waste from specified ships and the tracking management process online. According to the regulation on Waste Collection from Ships and Waste Control, ships must notify designated coastal facilities about their waste and he collection of the waste can be tracked online through the system.

However, the Blue Card System (MKS) is still mandatory for ships not included in the GATS. This means the MKS applies to all ships capable of generating waste but not subject to GATS. Commercial ships, recreational and tourist ships and fishing vessels are required to register their waste in the Blue Card System (MKS) and deliver their waste to an authorised waste reception facility within 48 hours after returning to port, on the day of departure from port.

This requirement also applies to coastal facilities serving the ships, such as fishing shelters, yacht marinas, dry docks, and similar facilities.[1593] Both systems are crucial in ensuring proper management of waste generated by ships to protect the environment. They assist shipowners and coastal facilities in complying with legal responsibilities by providing transparent tracking of waste management processes.[1594] Marine vehicles that do not produce waste are exempt from the circular, preventing small ships from facing fines or other penalties.

E. Benefits of the Ship Waste Tracking System (GATS) and Blue Card System (MKS)

Proper waste management systems on board ships and coastal facilities are technically important obligations for ship operators and coastal states. Preventing sewage pollution from passenger ships in Turkish waters, like in

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[1591]*Türkiye: Update on gray water and black water disposal requirements* https://www.sailworldcruising.com/news/251083/Update-on-gray-and-black-water-disposal-requirements; Circular No. 2020/20 on Maritime Waste Management, issued on July 8, 2020.

[1592] Circular on Marine Waste application article three, https://webdosya.csb.gov.tr/db/cygm/icerikler/genelge-20220910100702.pdf(Access Date: 11.02 2025)

[1593] https://webdosya.csb.gov.tr/db/cygm/icerikler/genelge-20220910100702.pdf(Access Date: 11.02 2025)

[1594] *Türk Limanlarında Mavi Kart Uygulaması* https://atayat.com/turk-limanlarinda-mavi-kart-uygulamasi/

other countries, is an environmental issue. [1595]The waste produced by some types of ships can amount to thousands of tons daily. In recent years, digitalisation, particularly AI, has brought a revolutionary wave of transformation to the shipping industry.[1596] The Ship Waste Tracking System and the Blue Card System have introduced transparent and accurate waste management systems. These systems have helped merge the waste tracking procedure into a single platform, reducing bureaucracy. All processes are now handled online and digitally. This has led to eliminating the need for paper and plastic cards. Besides, local authorities (municipalities) and Coast Guard agencies will monitor waste disposal operations through the same online system, allowing for real-time tracking and inspections. Small vessels, such as yachts and boats that fall outside the scope of the MARPOL Convention, will use the Blue Card System entirely online. Digitalisation strengthens measures for sewage-related marine pollution prevention and ensures stricter control over the management of ship-generated waste through digital systems, thus reducing environmental impact and promoting sustainability.

5. Potential problems in the current regulations, as well as proposed regulations, and efforts to prevent pollution from passenger ships

Although regulations on the discharge of sewage are gradually increasing, MARPOL Annex IV does not address ships carrying fewer persons, such as ships and ferries sailing in domestic waters.[1597] MARPOL Annex IV only applies to ships that exceed 400 GT or carry more than 15 passengers. Tourism and recreational ships, such as yachts and small boats, are also not covered under MARPOL regulations. These ships discharge a considerable amount of sewage into the sea, contributing to a significant percentage of marine pollution.[1598]

[1595] *10 ways AI is being used in Cruises [2025],* https://digitaldefynd.com/IQ/ai-in-cruises/#:~:text=9.,by%20ensuring%20proper%20recycling%20practices. (Access Date: 11.02 2025).

[1596]https://www.cevremuhendisligi.org/index.php/cevre-aktuel/haberler/1321-denizcilik-atiklari-uygulamasi-hakkindaki-genelge

[1597]*MARPOL ANNEX 4 Explained – How to Prevent Pollution from Sewage at Sea* https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date: 15.02 2025).

[1598] Holding Tanks https://www.rya.org.uk/knowledge/abroad/holding-tanks#:~:text=Discharge%20of%20any%20kind%20may,than%20emptied%20into%20the%20sea. (access Date: 11.02 2025).

In addition, MARPOL Annex IV permits ships to discharge treated sewage more than 3 nautical miles from the nearest land when the ship is proceeding at a speed of 4 knots or higher.[1599] Beyond that, there are no restrictions on dumping polluted sewage and greywater into the sea. Likewise, it is legal to dump sewage and food waste into the sea in the United States. U.S. law mandates that cruise ships must treat waste within 3.5 miles of shore. However, beyond that, there are limitations on discharging sewage into the sea.[1600] Pollution from especially passenger ships is totally preventable with effective regulations and existing technology. MARPOL only applies to ships flagged under countries that are signatories to the convention. This means that ships subject to the convention can discharge raw sewage into the high seas.[1601]

However, while MARPOL allows for raw sewage discharge beyond restricted zones, untreated sewage poses a significant threat to marine life and the environment. Although MARPOL provides clear guidelines on sewage discharge to minimise harm to the environment, it still goes against the essence of sustainable maritime practice and environmental protection. Raw sewage may contain harmful bacteria, viruses and parasites, which can negatively impact marine biodiversity. Even if sewage is released in an area beyond the restricted zone, it still carries contaminated substances that are sensitive to coastal ecosystems, and they can affect wildlife, fisheries and coral reefs.[1602]

Many countries, including Türkiye, are members of the MARPOL Convention. However, each country has its own jurisdiction over ships cruising within its territorial waters. Turkish Environmental Law No. 2872, Article 5 prohibits the dumping of ballast and bilge water, as well as any waste or effluent directly or indirectly into Turkish territorial waters,

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[1599]https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date: 15.02 2025).

[1600] Cruise Ship Pollution, https://beachapedia.org/Cruise_Ship_Pollution(Access Date: 04.03 2025).

[1601]*MARPOL ANNEX 4 Explained – How to Prevent Pollution from Sewage at Sea* https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date: 15.02 2025).

[1602] Zahra Ahmed, *6 Causes of Sewage Pollution in The Ocean* https://www.marineinsight.com/environment/causes-of-sewage-pollution-in-the-ocean/(Access Date: 17.02 2025).

including free restricted economic zones, seas, inland, straits, gulfs, harbours, lakes, rivers, canals, or shores. [1603]

In May 2020, the Ship Waste Tracking System (GATS) was implemented for petroleum tankers with a gross tonnage (GRT) of 150 or more other ships with a GRT of 400 or more[1604]. The Blue Card Circular was established to provide further clarification on waste management from ships in Turkish waters in line with Environmental Law No. 2872.[1605] The Blue Card System (MKS) is mandatory for ships that are not included in the GATS, which means MKS applies to all ships capable of generating waste but not subject to GATS.

Therefore, although MARPOL Annex IV does not deal with ships that are not exceeding 400 GT or carrying fewer than 15 people on board, Turkish domestic Law requires that these smaller ships, which are sailing Turkish waters, should have holding tanks to prevent raw sewage from discharging into Turkish waters. Besides, visiting ships are also required to have a suitable holding tank in line with their legislation, however, this requirement is rarely enforced for visiting boats. Consequently, if a visiting ship does not have an adequate holding tank, it must still adhere to the regulations of the coastal state and refrain from releasing untreated sewage directly into the sea.[1606]

While MARPOL Annex IV, to which Türkiye is a party, does not specifically regulate sewage prevention for smaller ships, Turkish domestic law has measures in place to safeguard Turkish waters from sewage pollution. Ships may be equipped with sewage holding tanks, and coastal states are required to provide adequate sewage reception facilities in compliance with Turkish environmental law. All seagoing ships, including

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[1603] Environment Law No. 2872. https://faolex.fao.org/docs/pdf/tur7700.pdf(accessed 15 February 2025).

[1604] *Circular on Marine Waste application article three*, https://webdosya.csb.gov.tr/db/cygm/icerikler/genelge-20220910100702.pdf(Access Date: 27.02 2025).

[1605] Ergenç, Cem Mehmet, "Mavi Kart Uygulamasinin Sürdürülebilir Deniz Turizmine Etkisi". Dokuz Eylül Üniversitesi Denizcilik Fakültesi Dergisi 13, sy. 2 (Aralık 2021): 247-66. https://doi.org/10.18613/deudfd.540251. p.253. (Access Date: 05.03 2025).

[1606]Holding Tanks https://www.rya.org.uk/knowledge/abroad/holding-tanks#:~:text=Discharge%20of%20any%20kind%20may,than%20emptied%20into%20the%20sea.; Türkiye: Update on gray water and black water disposal requirements https://www.sailworldcruising.com/news/251083/Update-on-gray-and-black-water-disposal-requirements(Access Date: 01.03 2025)

passenger ships, must have systems in place to hold or treat sewage before discharging it into the sea, especially when in special areas or near coastal regions. The most common type of system used is a sewage treatment plant (STP) that relies on biological or aerobic digestion processes. One of the main benefits of using an STP is that the treated sewage can be safely discharged into the high seas. According to Turkish regulations, ships must have holding tanks to prevent the discharge of raw sewage into Turkish waters. Additionally, visiting ships are expected to have suitable holding tanks in line with their own legislation, although enforcement for visiting boats is rare. Nonetheless, even if a visiting ship lacks an adequate holding tank, it must comply with coastal state regulations and refrain from releasing untreated sewage directly into the sea.[1607] Having said that, holding tanks may not have enough capacity to store raw sewage and treat it properly. Holding tanks have limited capacity and need to be emptied regularly at ports. Ships may face logistical challenges if they are unable to access a reception facility at ports. However, the Sewage Treatment Plant (STP) complies with strict maritime pollution standards of MARPOL Annex IV. Besides, ships equipped with STP do not rely on port facilities.[1608]

There are other challenges that Turkish authorities should keep in mind. Specifically, the lack of adequate sewage treatment or reception facilities may lead to illegal dumping. Ports in Türkiye are required to provide sewage reception facilities.[1609] Ships are generally required to pay fees for utilising port reception facilities. The Turkish Coast Guard and port authorities actively monitor ships to ensure compliance with sewage control regulations. Inspections by the ports should be carried out regularly to ensure that ships are not illegally discharging sewage into Turkish waters. Furthermore, passenger ships that do not comply with the regulations should face heavy penalties or be denied entry.

Additionally, some older ships may not be equipped with modern treatment systems. Collaboration between international organisations, government authorities, and the maritime industry will be key to addressing

[1607] Ibid.
[1608] Ibid.
[1609] Ülker, Duygu & Goksu, Serap & Yalcin, Ender & Canbulat, Onder. (2023). Ship-Generated Waste Management in Istanbul Ports: An Analytical Methodology to Evaluate Waste Reception Performance (WRP). Journal of ETA Maritime Science. 11. 259-269. 10.4274/jems.2023.53244. p. 264https://jag.journalagent.com/jems/pdfs/JEMS_11_4_259_269.pdf(access Date: 15.02 2025).

this challenge.[1610] Another issue is untrained crew members who do not know how to use holding tanks or STP on the ships. Turkish maritime authorities should provide training programs for crew members on proper sewage management to ensure that ships meet environmental standards. As Türkiye relies on tourism, especially along the Aegean and Mediterranean coasts, public awareness will play a crucial role in preventing sewage-related pollution. Therefore, campaigns and education should be conducted for both the public and the maritime industry on the importance of not discharging sewage into Turkish waters.

6. The Impact of Artificial Intelligence (AI) on Sewage-Related Pollution from Passenger Ships

Artificial Intelligence (AI) has become increasingly popular in various industries, including waste management and sewage systems. AI has a significant impact on improving monitoring, tracking and sewage treatment plants. Ship-generated pollutants constitute a significant portion of marine pollution, prompting the International Maritime Organisation to regulate this issue is of utmost importance.[1611]

Especially cruise ships produce significant amounts of waste, and efficient sewage management is crucial to reduce the environmental impact. AI can be used to monitor sewage systems in real time, gathering data from various sensors embedded in the ship's sewage treatment system. These sensors can track parameters such as water quality, flow rates, temperature variations, and chemical concentrations.[1612] AI-powered waste management systems categorise and sort waste more efficiently. These systems analyse waste data to identify common waste patterns, helping operators develop better recycling policies and minimise waste production. AI also supports the treatment of gray water and organic waste to meet environmental

[1610]https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date: 15.02 2025).

[1611] Ülker, Duygu & Goksu, Serap & Yalcin, Ender & Canbulat, Onder. (2023). Ship-Generated Waste Management in Istanbul Ports: An Analytical Methodology to Evaluate Waste Reception Performance (WRP). Journal of ETA Maritime Science. 11. 259-269. 10.4274/jems.2023.53244. p. 259 https://jag.journalagent.com/jems/pdfs/JEMS_11_4_259_269.pdf(Access Date: 10.02 2025).

[1612]Agarwala, Nitin. (2021). Managing Marine Environmental Pollution using Artificial Intelligence. https://www.researchgate.net/publication/348815686_Managing_Marine_Environmental_Pollution_using_Artificial_Intelligence, p.120, (Access Date: 27.02 2025).

regulations. Likewise, Royal Caribbean Cruise Company has implemented AI-based waste management systems that can recognise and classify waste items into recyclable and non-recyclable categories. This system helps the passenger ships meet rigorous environmental regulations by ensuring adequate recycling practice.[1613]

MARPOL Annex IV requires that ships should have an approved sewage treatment plant or holding tank to treat the raw sewage before they are discharged into the sea. If an AI system is used in ships, AI may identify potential leaks or malfunctions in sewage treatment systems. This will lead to optimising waste management practices and ultimately leading to more effective pollution mitigation strategies. Using advanced sensor technology and machine learning algorithms helps to analyse data from ships sewage systems[1614]. AI systems can also assist ship operators in ensuring compliance with local and international environmental regulations. These systems can generate automated reports based on the ship's sewage treatment processes, ensuring that it meets required standards for discharge. AI can be integrated with virtual assistants to provide real-time guidance to ship crew members. AI can help the crew to overcome troubleshooting issues without needing extensive technical knowledge. AI could also offer training modules to ensure that crew members are well-equipped to handle the most common sewage system issues.[1615]

There is no denying that AI will have a significant impact on reducing sewage-related pollution more effectively. Therefore, International regulations like MARPOL should require that all seagoing ships should integrate AI into their systems. Increased regulation and stricter enforcement of pollution law, such as fines for improper sewage discharge, can push the ships to adopt AI system.

In recent years, Türkiye adopted a Ship Waste Tracking System (GATS) for petroleum tankers with a gross tonnage (GRT) of 150 or more another

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[1613] 10 ways AI is being used in Cruises [2025] https://digitaldefynd.com/IQ/ai-in-cruises/#:~:text=9.,by%20ensuring%20proper%20recycling%20practices. (Access Date: 15.02 2025).

[1614] Durlik, Irmina, Tymoteusz Miller, Ewelina Kostecka, Adrianna Łobodzińska, and Tomasz Kostecki. 2024. "Harnessing AI for Sustainable Shipping and Green Ports: Challenges and Opportunities" *Applied Sciences* 14, no. 14: 5994. https://doi.org/10.3390/app14145994 p.34(Access Date: 27.02 2025).

[1615] Capodaglio, Andrea G., and Arianna Callegari. 2025. *"Use, Potential, Needs, and Limits of AI in Wastewater Treatment Applications" Water* 17, no. 2: 170. https://doi.org/10.3390/w17020170,p.22, (Access Date: 27.02 2025).

ships with a GRT of 400 or more.[1616] The Blue Card System (MKS) is compulsory for ships that are not included in the GATS, which means MKS applies to all ships capable of generating waste but not subject to GATS. The Ship Waste Tracking System and the Blue Card System have brought a transparent and accurate waste management systems. These systems helped to waste tracking procedure merge into a single platform, which reduced bureaucracy. All processes are now handled online and digitally. This has led to Local authorities (municipalities) and Coast Guard agencies monitoring sewage disposal operations through the same online system, allowing for real-time tracking and inspections. Small vessels, such as yachts and boats that fall outside the scope of the MARPOL Convention, will use the Blue Card System entirely online. Digitalisation strengthens measures for sewage-related marine pollution prevention and ensures stricter control over the management of ship-generated waste through digital systems, thus reducing environmental impact and promoting sustainability.

Similarly, AI enhances water quality in coastal waters by providing advanced tools for detecting and analysing contaminants in port waters. An AI system can integrate data from various sensors that measure parameters such as temperature, concentration of harmful substances like heavy metals, oil and chemicals. This early detection enables prompt response efforts, minimising damage and facilitating quicker cleanup operations.[1617]

7. Challenges with AI Systems

AI has a significant impact on improving sewage management on passenger ships and helping to prevent pollution at sea. However, there are obstacles to tackle before fully adopting operated AI systems on ships. Many maritime operations still rely on outdated systems that are incompatible with modern AI technologies. Integrating AI into these systems requires substantial investments, legal and technical renovation. Besides, not only do shipowners need to integrate AI into their system, but also port authorities and sewage reception facilities are compatible with AI

[1616] Circular on Marine Waste application article three, https://webdosya.csb.gov.tr/db/cygm/icerikler/genelge-20220910100702.pdf(Access Date: 23.02 2025).

[1617] Durlik, Irmina, Tymoteusz Miller, Ewelina Kostecka, Adrianna Łobodzińska, and Tomasz Kostecki. 2024. "Harnessing AI for Sustainable Shipping and Green Ports: Challenges and Opportunities" *Applied Sciences* 14, no. 14: 5994. https://doi.org/10.3390/app14145994 p.34(Access Date: 27.02 2025).

technology.[1618] Another issue is to train personnel; the shortage of skilled professionals is a significant barrier. Implementing and maintaining AI systems requires specialised skills in data science, machine learning, and AI engineering. The maritime industry faces a shortage of such skilled professionals.

The lack of regulations for using AI to treat sewage from ships could indeed be a significant obstacle. AI has the potential to optimise the sewage treatment process, improve efficiency and reduce environmental impact. However, without clear guidelines, safety protocols, and regulations, there could be risks related to the reliability, transparency, and potential unintended consequences of AI systems in such a critical application.

Without adequate regulations, it is challenging to ensure that AI systems are safe, reliable and perform as expected in real-world conditions, especially when it comes to environmental protection. If something goes wrong with AI systems while treating sewage, it is unclear who will be responsible for the failure, whether it's developers, the ship operators or the manufacturers of the AI systems. Therefore, clear regulations would help define responsibility. In the maritime industry, the use of different systems onboard ships, coupled with the lack of standardised data and technology protocols, could hinder the implementation of AI-based solutions. Regulations could help to create standards for data exchange and system integration. Likewise, without clear regulations, there could be privacy concerns, especially if sensitive operational data is being transmitted or used for unintended purposes. Addressing these issues will require cooperation between countries, industries and regulatory bodies to create frameworks that ensure AI can be used efficiently and safely in sewage treatment.

8. Conclusion:

The rapid growth of maritime transportation in recent years has introduced significant environmental challenges. Large cruise ships have emerged as major contributors to marine pollution. With thousands of passengers and crew members aboard, these ships generate substantial waste that necessitates proper management to safeguard the marine environment and adhere to regulatory standards.

[1618] Durlik, Irmina, Tymoteusz Miller, Ewelina Kostecka, Adrianna Łobodzińska, and Tomasz Kostecki. 2024. "Harnessing AI for Sustainable Shipping and Green Ports: Challenges and Opportunities" *Applied Sciences* 14, no. 14: 5994. https://doi.org/10.3390/app14145994 p.34(Access Date: 15.02 2025).

To address the issue of sewage discharge, MARPOL, along with various national and regional legislations, has been established. However, due to shortages in technology, facilities, management practice and legislative frameworks, environmental pollution resulting from ship sewage remains a considerable threat.

Annex IV of the MARPOL Convention applies to all ships, including passenger ships on international voyages with a size of 400 gross tonnage and above or which are certified to carry more than 15 people. The Annex requires ships to be equipped with either an approved sewage treatment plant or an approved comminuted and disinfecting system, or a sewage holding tank.[1619] Sewage, which is not sterilised, may be discharged at a distance of more than 12 nautical miles from the nearest land when the ship is on the way and proceeding at not less than 4 knots, and the rate of discharge of untreated sewage shall be approved by the Administration.[1620]

Although regulations on the discharge of sewage are gradually increasing, MARPOL Annex IV does not address ships carrying fewer persons, such as ships and ferries sailing in domestic waters.[1621] Tourism/recreational ships such as yachts and small boats are also not covered under the MARPOL regulation. In fact, such ships discharge a considerable amount of sewage into the sea, contributing to a significant percentage of marine pollution.[1622]

While MARPOL allows for raw sewage discharge beyond restricted zones, untreated sewage, even in unrestricted areas of high seas, still poses a major threat to marine life and the environment. Although MARPOL provides clear guidelines about sewage discharge to minimise harm to the

[1619] Prevention of Pollution by Sewage from Ships https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx(Access Date: 14.02 2025).

[1620] Prevention of Pollution by Sewage from Ships https://www.imo.org/en/OurWork/Environment/Pages/Sewage-Default.aspx/(access Date: 27.02 2025).

[1621] MARPOL ANNEX 4 Explained – How to Prevent Pollution from Sewage at Sea https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/

[1622] Holding Tanks https://www.rya.org.uk/knowledge/abroad/holding-tanks#:~:text=Discharge%20of%20any%20kind%20may,than%20emptied%20into%20the%20sea. (Access Date: 12.02 2025).

environment, it goes against the essence of sustainable maritime practice and environmental protection.[1623]

Numerous nations, including Türkiye, are signatories to the MARPOL Convention; however, each country maintains its own jurisdiction over ships operating within its territorial waters, which falls under the authority of the coastal state. In accordance with Turkish Environmental Law No. 2872, Article 5, it is prohibited to discharge ballast and bilge water, as well as any type of waste or effluent, either directly or indirectly, into the seas, inland seas, straits, gulfs, harbours, natural or artificial lakes, rivers, canals, or shores within Turkish territorial waters or Türkiye's exclusive and restricted economic zones.

In May 2020, the Ship Waste Tracking System (GATS)was implemented for petroleum tankers with a gross tonnage (GRT) of 150 or more, and other ships with a GRT of 400 or more. [1624]The Blue Card Circular was established for further clarification of managing waste from ships in Turkish waters in line with the Environmental Law No. 2872.[1625] The Blue Card System (MKS) is compulsory for the ships that are not included in the GATS, which means MKS applies to all ships capable of generating waste but not subject to GATS.

Consequently, while MARPOL Annex IV does not address vessels under 400 GT or those carrying fewer than 15 individuals on board, Turkish domestic law mandates that these smaller vessels operating in Turkish waters must be equipped with holding tanks to prevent the discharge of untreated sewage. Furthermore, visiting vessels are required to have appropriate holding tanks in accordance with local legislation, although enforcement of this requirement is infrequent. Nonetheless, even if a visiting ship lacks a suitable holding tank, it must adhere to the regulations of the coastal state and refrain from discharging untreated sewage directly into the sea.

[1623] Zahra Ahmed, *6 Causes of Sewage Pollution in The Ocean* https://www.marineinsight.com/environment/causes-of-sewage-pollution-in-the-ocean/(Access Date: 11.02 2025).

[1624] Circular on Marine Waste application article three, https://webdosya.csb.gov.tr/db/cygm/icerikler/genelge-20220910100702.pdf(Access Date: 15.01 2025).

[1625] Ergenç, Cem Mehmet, "Mavi Kart Uygulamasinin Sürdürülebilir Deniz Turizmine Etkisi". Dokuz Eylül Üniversitesi Denizcilik Fakültesi Dergisi 13, sy. 2 (Aralık 2021): 247-66. https://doi.org/10.18613/deudfd.540251. P.253. (Access Date: 11.01 2025).

Although MARPOL Annex IV to which Türkiye is a party, does not have a prevention of sewage-related regulation for smaller ships, Turkish domestic Law has regulations to protect Turkish water from sewage related pollution. The ships may be fitted with a sewage holding tank, and coastal states should have adequate sewage reception facilities in accordance with Turkish Environmental Law. Holding tanks have limited capacity and need to be emptied regularly at ports. Ships may face logistical challenges if they are unable to access a reception facility at ports. However, the Sewage Treatment Plant (STP) complies with strict maritime pollution standards of MARPOL Annex IV. Besides, ships equipped with STP do not have to rely on port facilities.[1626]

There are other challenges that Turkish authorities should bear in mind. Particularly, there is still a lack of adequate sewage treatment or reception facilities that may lead to illegal dumping. Ports in Türkiye are obliged to provide sewage reception facilities.[1627] Ships are generally required to pay fees for utilising port reception facilities. The Turkish Coast Guard and port authorities actively monitor ships to ensure they comply with sewage control regulations. Inspections by the ports should be carried out regularly to ensure that ships are not illegally discharging sewage into Turkish waters. Besides, those passenger ships which do not comply with the regulations should face heavy penalties or be denied entry.

Additionally, some older ships may not be equipped with modern treatment systems. Collaboration between international organisations, government authorities, and the maritime industry will be key to addressing this challenge.[1628] Another issue is an untrained crew who do not know how to use holding tanks or STP on the ships. Turkish maritime authorities should offer training programs for crew members on proper sewage management to ensure that ships meet environmental standards. A Türkiye

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[1626] Holding Tanks, https://www.rya.org.uk/knowledge/abroad/holding-tanks#:~:text=Discharge%20of%20any%20kind%20may,than%20emptied%20into%20the%20sea. (Access Date: 11.02 2025).

[1627] Ülker, Duygu & Goksu, Serap & Yalcin, Ender & Canbulat, Onder. (2023). Ship-Generated Waste Management in Istanbul Ports: An Analytical Methodology to Evaluate Waste Reception Performance (WRP). Journal of ETA Maritime Science. 11. 259-269. 10.4274/jems.2023.53244. (Access Date: 11.02 2025).

p. 264https://jag.journalagent.com/jems/pdfs/JEMS_11_4_259_269.pdf(Access Date: 11.02 2025).

[1628]https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/(Access Date: 15.02 2025).

relies on tourism, especially along the Aegean and Mediterranean coasts, public awareness will play a crucial role in preventing sewage-related pollution. Therefore, campaigns and education should be conducted for both the public and the maritime industry on the importance of discharging sewage into the Turkish waters. AI has become increasingly popular in various industries, including waste management and sewage systems. AI has a significant impact on improving monitoring, tracking and sewage treatment plants. Ship-generated pollutants constitute a significant portion of marine pollution, prompting the International Maritime Organisation to regulate this issue is of utmost importance.[1629] Especially cruise ships produce significant amounts of waste, and efficient sewage management is crucial to reduce the environmental impact. AI can be used to monitor sewage systems in real time, gathering data from various sensors embedded in the ship's sewage treatment system. These sensors can track parameters such as water quality, flow rates, temperature variations and chemical concentrations.

MARPOL Annex IV requires that ships have an approved sewage treatment plant or holding tank to treat the raw sewage before they are discharged into the sea. If AI system is used on ships, AI may identify potential leaks or malfunctions in sewage treatment systems. This will lead to optimising waste management practices and ultimately lead to more effective pollution mitigation strategies.

AI will have a significant impact on reducing sewage-related pollution more effectively. Therefore, International regulations like MARPOL should require that all seagoing ships should integrate AI into their system. Increased regulation and stricter enforcement of pollution law, such as fines for improper sewage discharge, can push the ships to adopt AI systems.

In recent years, Türkiye adopted a Ship Waste Tracking System (GATS) for petroleum tankers with a gross tonnage (GRT) of 150 or more other ships with a GRT of 400 or more.[1630] The Blue Card System (MKS) is compulsory for the ships that are not included in the GATS, which means

[1629] Ülker, Duygu & Goksu, Serap & Yalcin, Ender & Canbulat, Onder. (2023). Ship-Generated Waste Management in Istanbul Ports: An Analytical Methodology to Evaluate Waste Reception Performance (WRP). Journal of ETA Maritime Science. 11. 259-269. 10.4274/jems.2023.53244. p. 259 https://jag.journalagent.com/jems/pdfs/JEMS_11_4_259_269.pdf

[1630] Circular on Marine Waste application article three, https://webdosya.csb.gov.tr/db/cygm/icerikler/genelge-20220910100702.pdf(Access Date: 11.02 2025).

MKS applies to all ships capable of generating waste but not subject to GATS. The Ship Waste Tracking System and the Blue Card System have brought a transparent and accurate waste management system. These systems helped to waste tracking procedure merge into a single platform, which reduced bureaucracy. All processes are now handled online and digitally. This has led to Local authorities (municipalities) and Coast Guard agencies monitoring sewage disposal operations through the same online system, allowing for real-time tracking and inspections.

AI significantly enhances sewage management systems on passenger ships and helps in mitigating marine pollution. Nevertheless, several challenges must be addressed prior to the full implementation of AI systems on ships. Many maritime operations rely on outdated systems that are incompatible with modern AI technologies. Integrating AI into systems requires substantial investments, legal and technical renovations. Besides, not only do shipowners need to integrate AI into their systems, but port authorities' sewage reception facilities also need to be compatible with AI technology.[1631] Another issue is training personnel; the shortage of skilled professionals is another significant barrier. Implementing and maintaining AI systems requires specialised skills in data science, machine learning, and AI engineering. The maritime industry faces a lack of such skilled professionals.

Additionally, the absence of regulations governing the use of AI for sewage treatment on ships poses a significant hurdle. While AI holds the promise of optimising sewage treatment processes, enhancing efficiency, and minimising environmental impact, the lack of clear guidelines, safety protocols, and regulations raises concerns regarding the reliability, transparency, and potential unintended consequences of AI applications in this vital area. Regulation could help to create standards for data exchange and system integration. Addressing these issues will require cooperation between countries, industries and regularity bodies to create frameworks that ensure AI can be used efficiently and safely in sewage treatment.

[1631] Durlik, Irmina, Tymoteusz Miller, Ewelina Kostecka, Adrianna Łobodzińska, and Tomasz Kostecki. 2024. "Harnessing AI for Sustainable Shipping and Green Ports: Challenges and Opportunities" *Applied Sciences* 14, no. 14: 5994. https://doi.org/10.3390/app14145994 p.34
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