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Summer school

SUSTAINABLE DEVELOPMENT OF YACHTING AND CRUISE INDUSTRY

Pollution from Maritime Transport

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Basic terms

- **Emission** is the release of substances in a liquid, gaseous or solid state or the release of energy (noise, vibrations, heat radiation) from a certain source into the environment.

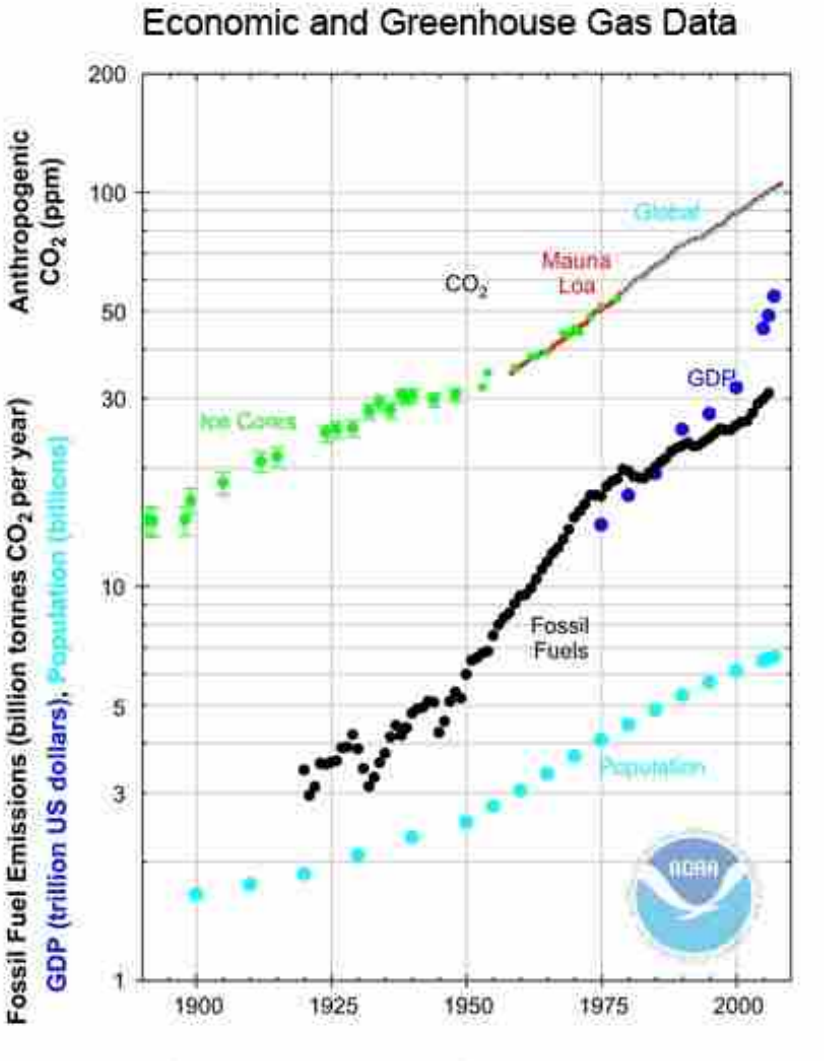
- **Imission** is the concentration of substances in a certain place and at a certain time in the environment.

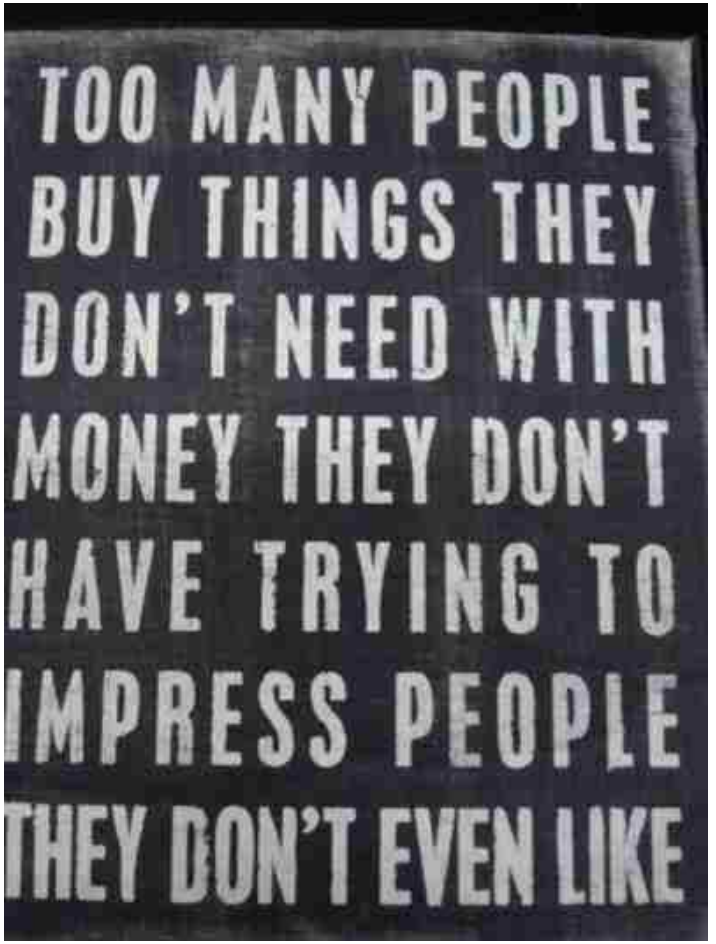
- **Contamination** is a change in the quality of the environment caused by the introduction, release or disposal substances, the influence of energy or other factors, in the amount that changes the beneficial properties of water, soil, air.

- **Pollution** is contamination of a higher intensity that is caused by the introduction, release or disposal of dangerous substances, energy in quantities or concentrations above the permitted limit values, thereby endangering the life and health of people and the state of the environment.

Reasons for Environmental Disturbance

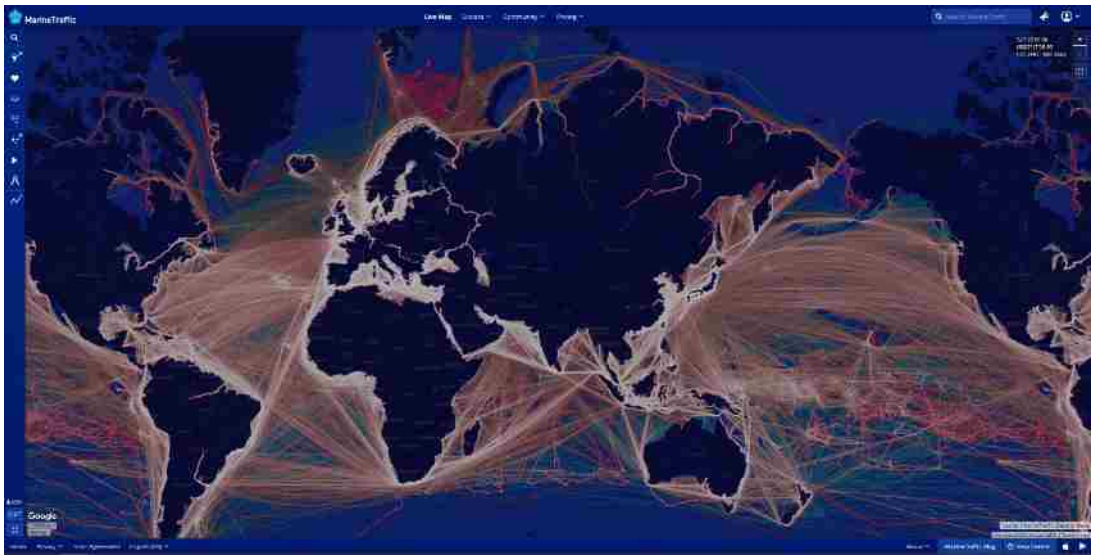
- In 2012, the United Nations Environment Program (UNEP) Global Environmental Outlook 5 report found that "**growing populations and growing economies are pushing ecosystems to destabilizing limits**.„
- The two mentioned processes cause an increase in pressure mostly on the following areas (UNEP, GEO 6):
  1. **Air**
  2. **Biodiversity**
  3. **Oceans and coasts**
  4. **Land and soil**
  5. **Freshwater**


Economic and Greenhouse Gas Data
Anthropogenic CO_2 (ppm)
Fossil Fuel Emissions (billion tonnes CO_2 per year)
GDP (trillion US dollars), Population (billions)
200
100
50
30
10
5
3
1
1900
1925
1950
1975
2000
Global
Mauna Loa
CO_2
Ice Cores
GDP
Fossil Fuels
Population
NOAA


TOO MANY PEOPLE
BUY THINGS THEY
DON'T NEED WITH
MONEY THEY DON'T
HAVE TRYING TO
IMPRESS PEOPLE
THEY DON'T EVEN LIKE

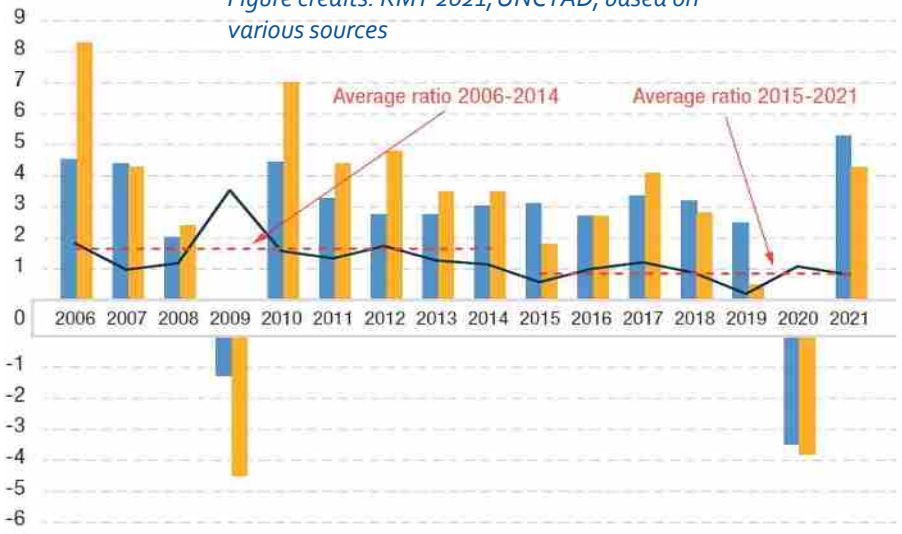
INTRODUCTION TO SHIPPING AND MARINE ENVIRONMENT

'Shipping is essential for the world's economy'



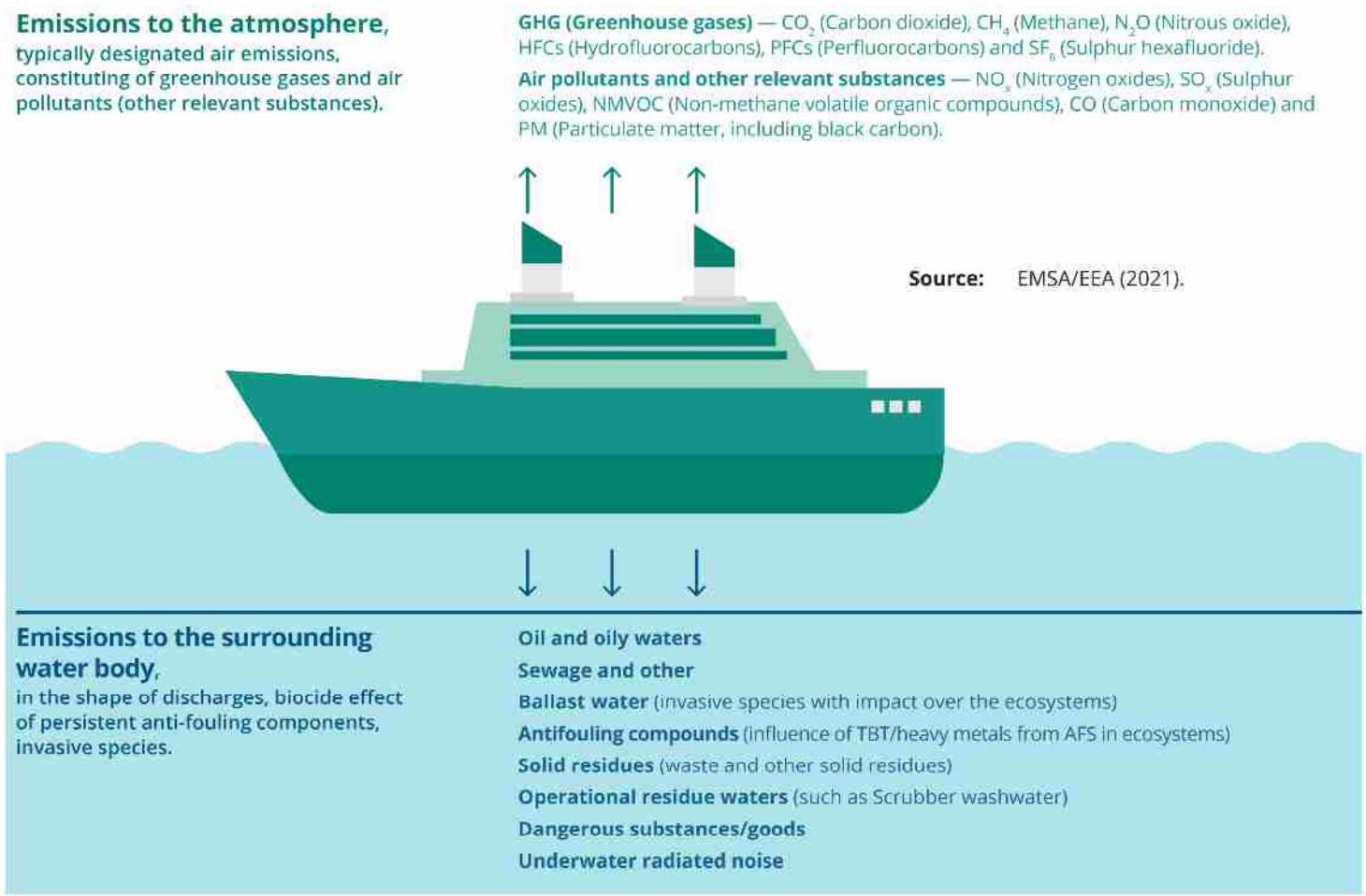
Maritime Traffic Density

UNCTAD (United Nations Conference on Trade and Development) calculations. International maritime trade and world gross domestic product (GDP) and maritime trade-to-GDP ratio, 2006 to 2021.
Figure credits: RMT 2021, UNCTAD, based on various sources



Development of International Maritime Trade

Pollution from Maritime Transport



International legislation on pollution from maritime transport

Two general methods are used to tuckle pollution:

- Corrective measures - expensive and time-consuming
- Preventive measures - requires changes in attitude

MARPOL 73/78 Convention

- Annex I – oil
- Annex II – (other) noxious liquid substances
- Annex III – harmful substances in packaged form
- Annex IV – sewage
- Annex V – garbage
- Annex VI – air

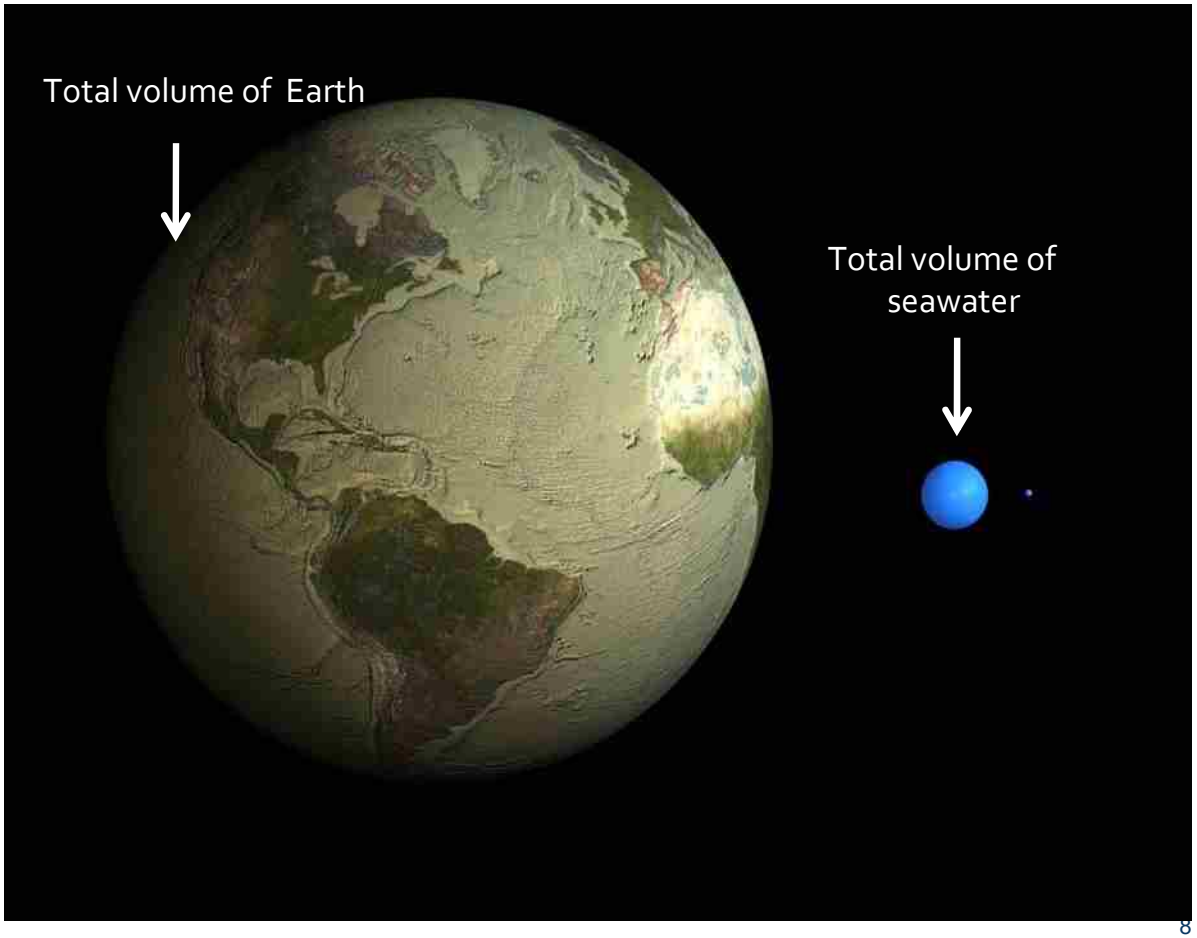
AFS Convention – anti fouling systems

BWM Convention – ballast water management

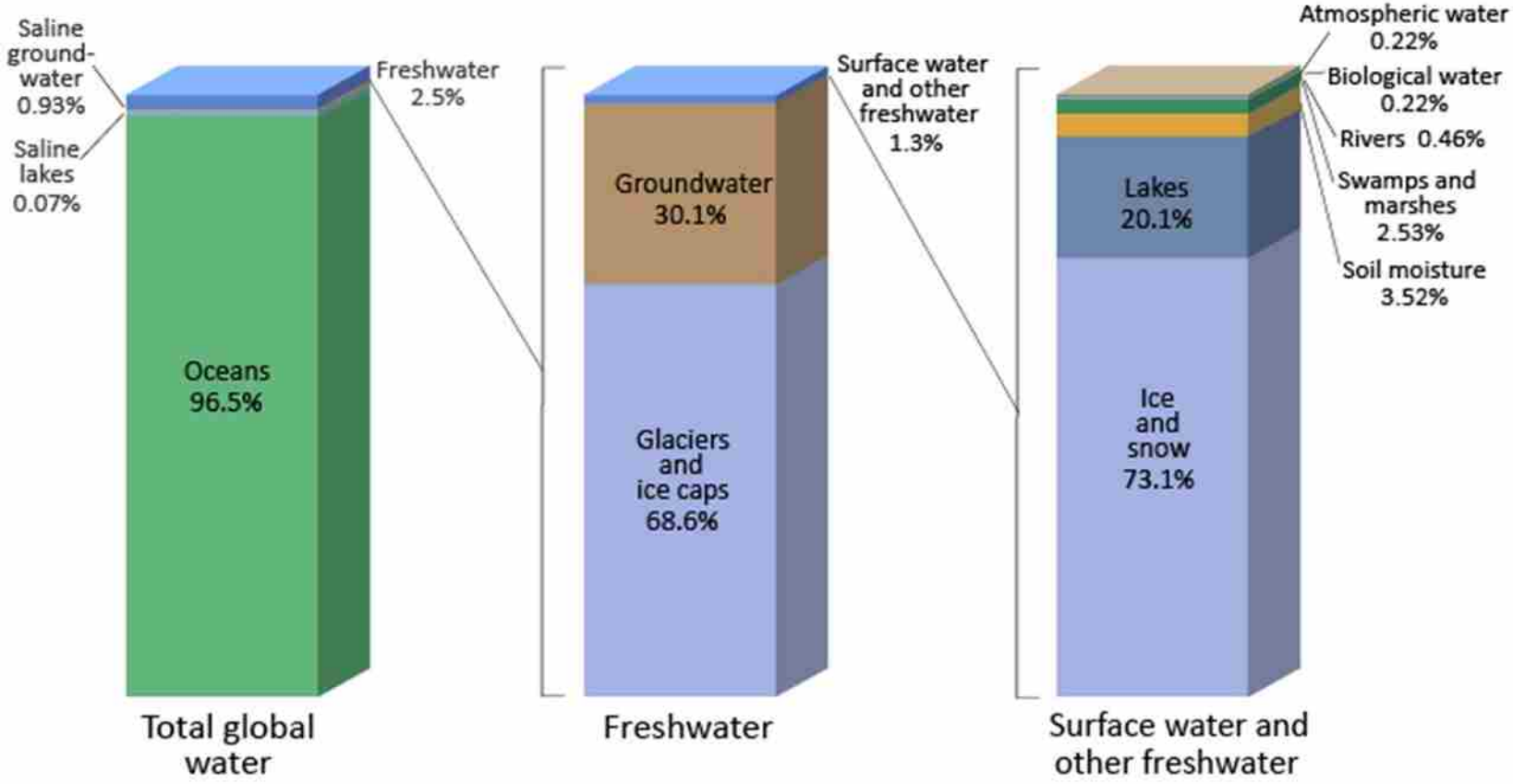
Convention for the Safe and Environmentally Sound Recycling of Ship

Marine environment - Importance of the oceans

Over 70% of our Earth is Water (which seems a lot!)



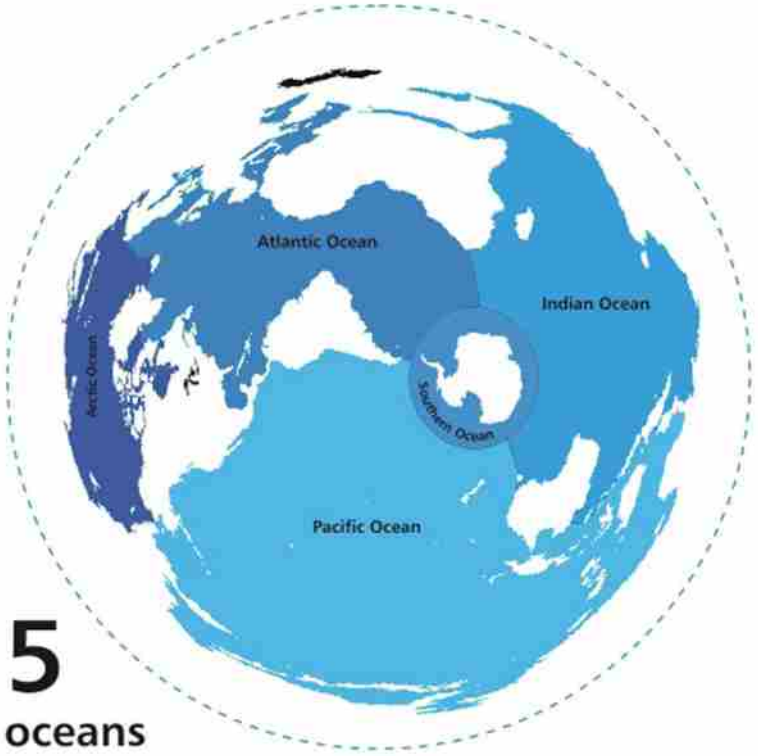
Distribution of Earth's Water



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

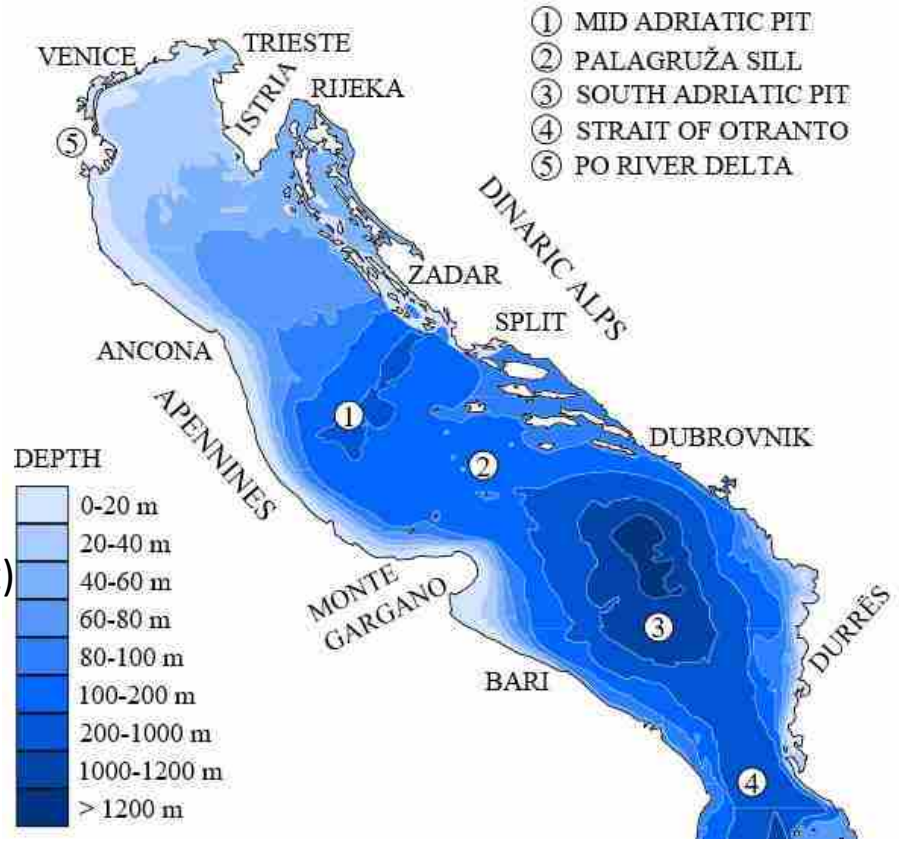
World Oceans

#	Ocean	Area (km^2) (%)	Volume (km^3) (%)	Avg. depth (m)	Coastline (km)
1	Pacific Ocean	168,723,000 46.6	669,880,000 50.1	3,970	135,663
2	Atlantic Ocean	85,133,000 23.5	310,410,900 23.3	3,646	111,866
3	Indian Ocean	70,560,000 19.5	264,000,000 19.8	3,741	66,526
4	Southern Ocean	21,960,000 6.1	71,800,000 5.4	3,270	17,968
5	Arctic Ocean	15,558,000 4.3	18,750,000 1.4	1,205	45,389
Total		361,900,000 100	1.335×10^9 100	3,688	377,412



Adriatic Sea

Max. length	800 km
Max. width	200 km
Surface area	138,600 km2
Average depth	252.5 m
Max. depth	1,233 m
Water volume	35,000 km3
Residence time	3.4±0.4 years
Salinity	38–39 PSU (Practical Salinity Unit)
Shore length	3,739.1 km
Max. temperature	28 °C
Min. temperature	9 °C



The oceans regulate the climate ('conveyor belt')

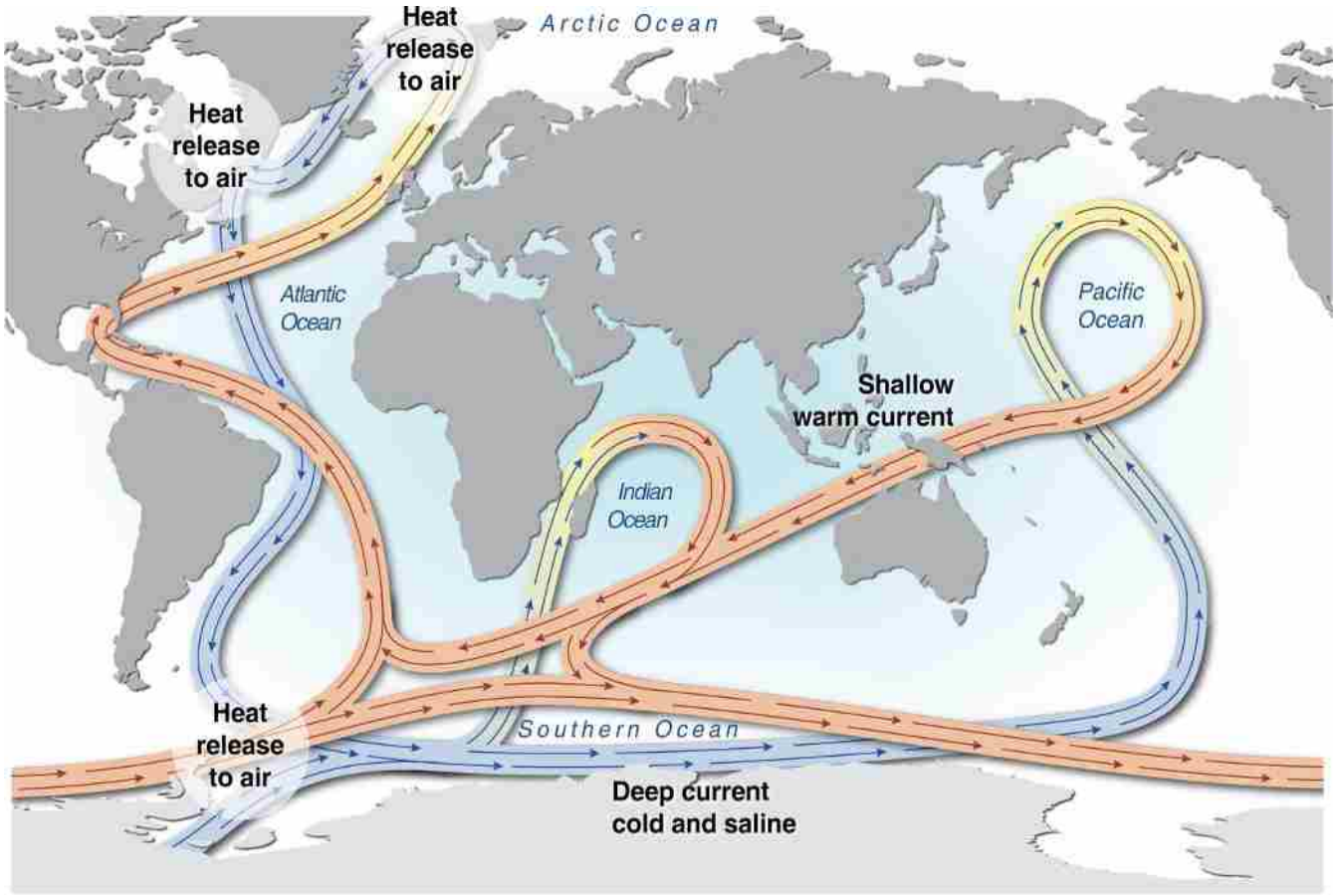


Photo credits: IPCC

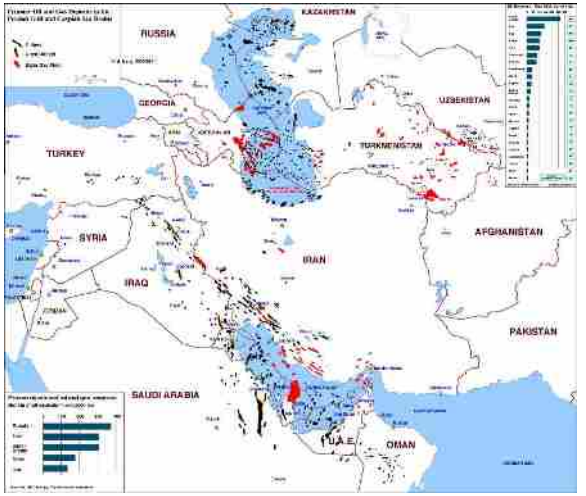
Oceans are an important food source

- 60% of the world population lives near the sea
- Oceans serve as the world's largest source of protein
- Fish is the most important source of protein for over 3 billion people
- >200 million people worldwide work in the fishing industry

Oceans provide energy

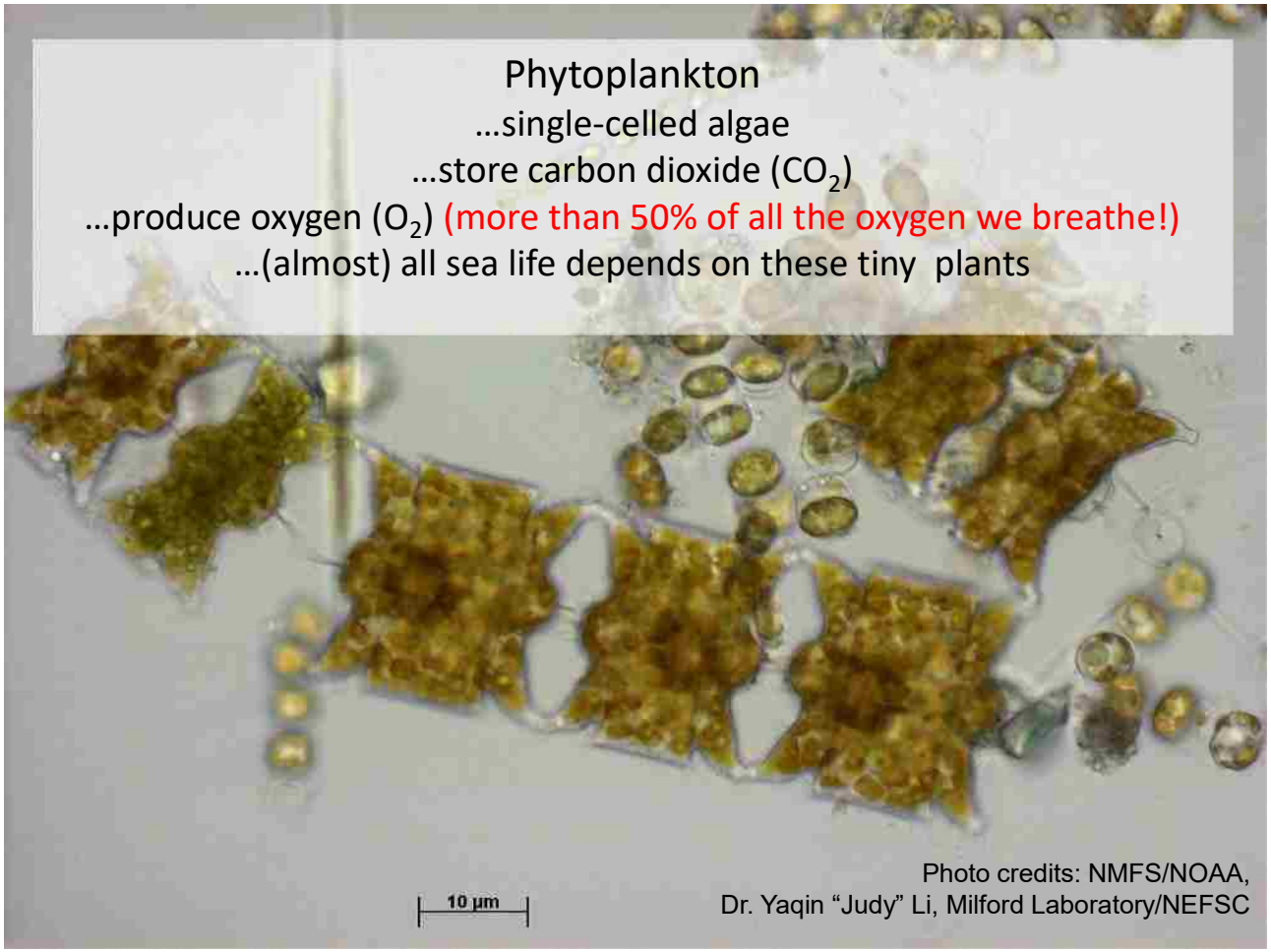
- Fossil fuels:
  - 30% of all crude oil that we use
  - 50% of all natural gas that we use
- Deep sea mineral resources (nodules)
  - Manganese
  - Iron
  - Copper
  - Nickel
  - Cobalt
  - Titanium
  - Other rare-earth elements
- Renewable energy:
  - Offshore wind
  - Tidal
  - Wave
  - Ocean Thermal
  - Salinity Gradient

A manganese metal nodules — image credit to wikipedia

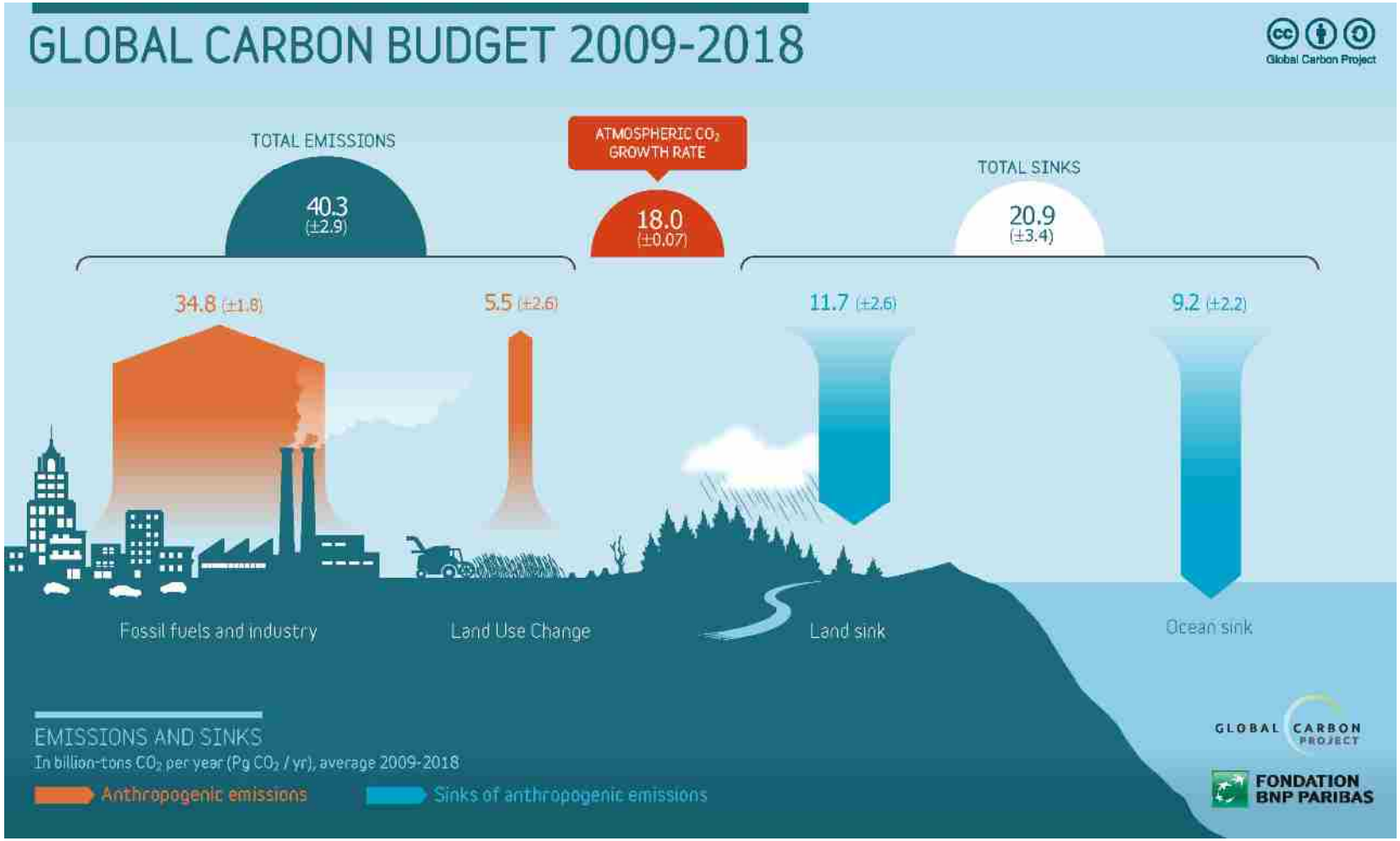


OpenHydro tidal turbine, Bay of Fundy, Orkney Islands

Oceans provide atmospheric oxygen



Oceans provide CO2 absorbtion



Posidonia oceanica

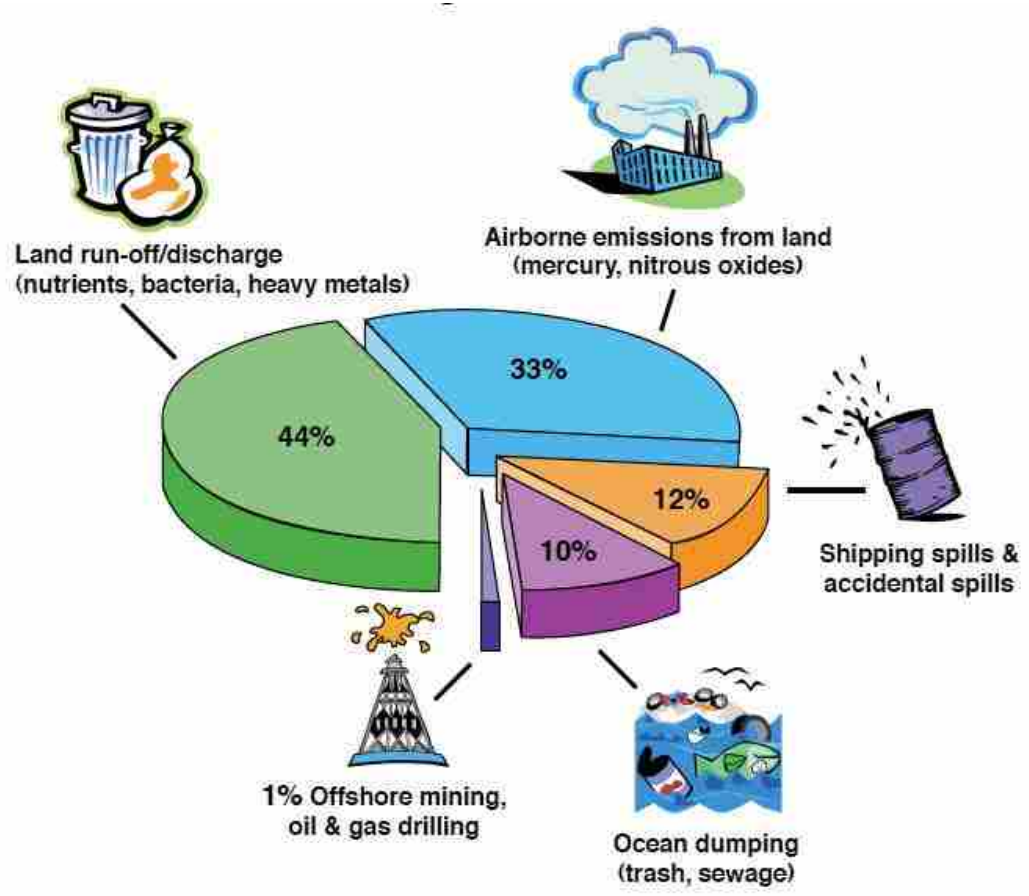
Wikipedia:

- Posidonia oceanica is a seagrass species that is endemic to the Mediterranean Sea.
- It forms large underwater meadows that are an important part of the ecosystem. The fruit is free floating and known in Italy as "the olive of the sea„.
- **The Posidonia has a very high carbon absorption capacity, being able to soak up 15 times more carbon dioxide every year than a similar sized piece of the Amazon rainforest.**

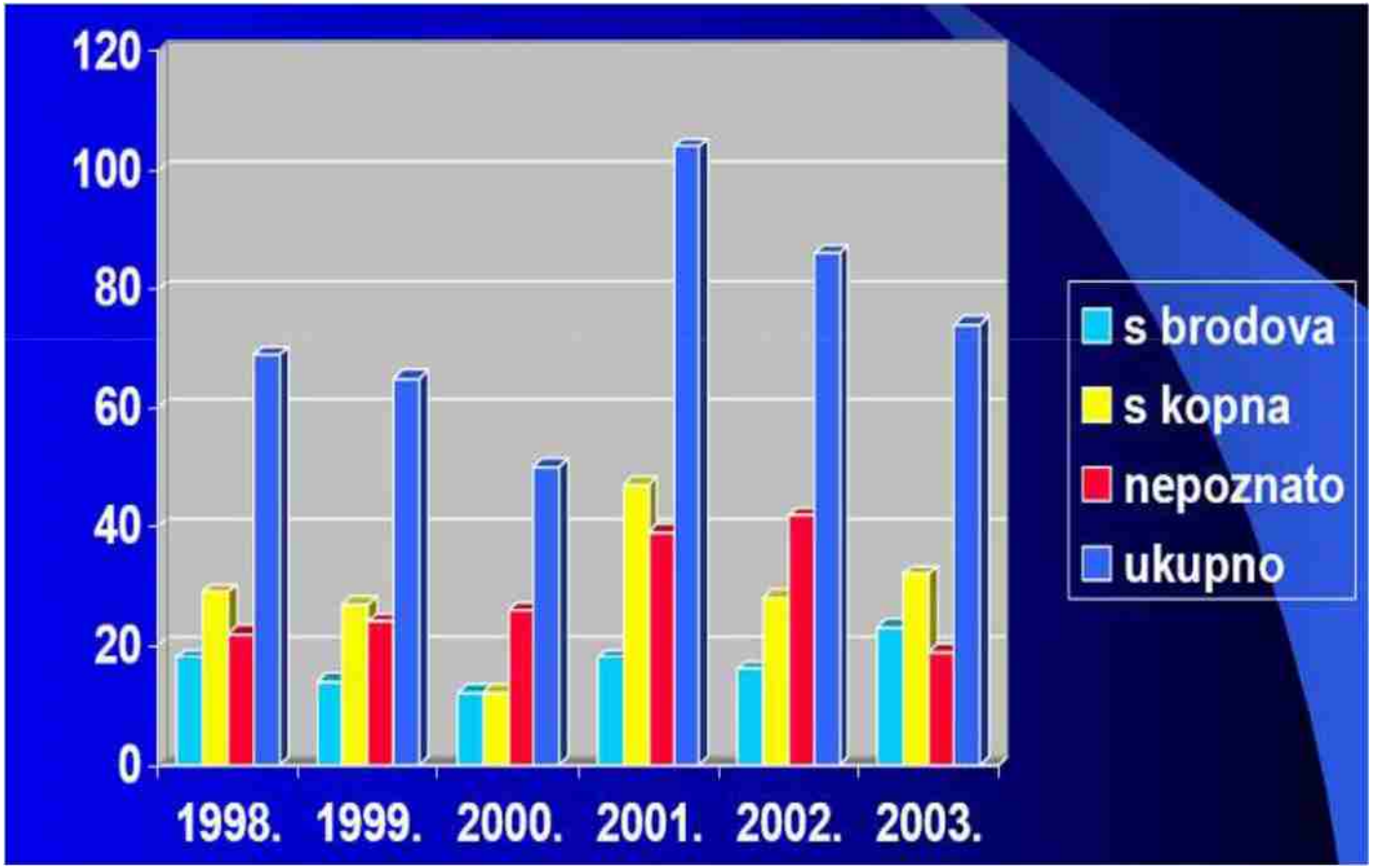
Posidonia oceanica, Wikipedia

Posidonia oceanica range map, Wikipedia

Human activities degrading marine environment



Global marine pollution from different sources



Pollution of the Adriatic Sea according to sources

SHIP SEAWATER POLLUTION

MARPOL Annex	Waste Categories
Annex I	Oily Bilge Water, Oily Residue (Sludge)
Annex IV	Black Water (Sewage) (and Grey Water)[a]
Annex V	[b]A: Plastic, B: Food Waste, C: Domestic Waste, D: Cooking Oil, E: Incinerator Ashes, F: Operational Waste, I: e-Waste

[a] Grey water is not regulated by MARPOL Annex IV.
[b] According to the garbage categories of the Garbage Record Book (Part I) of MARPOL Annex V.

https://livingwithharmony.org/resources/how-cruises-affect-the-environment/

Discharges to the sea - OIL

- Crude oil:
  - 85% C; 12% H
  - Nitrogen (N), sulphur (S), oxygen (O)
  - Various heavy metals (like Fe, Zn)
- Especially the 'aromatic hydrocarbons' are toxic
- Chemical composition varies

- Oil in the sea is seen as a major environmental problem.
- Oil may enter the environment during production, transport and use.

Photo credits: ITOPF/North Sea Foundation

Weathering

- There are eight main processes of oil spill degradation:
  1. Spreading (širenje)
  2. Evaporation (evaporacija)
  3. Dispersion (raspršivanje)
  4. Emulsification (stvaranje emulzije sa morskom vodom)
  5. Dissolution (rastvaranje)
  6. Oxidation (oksidacija)
  7. Sedimentation and sinking (sedimentacija i potonuće)
  8. Biodegradation (biodegradacija)

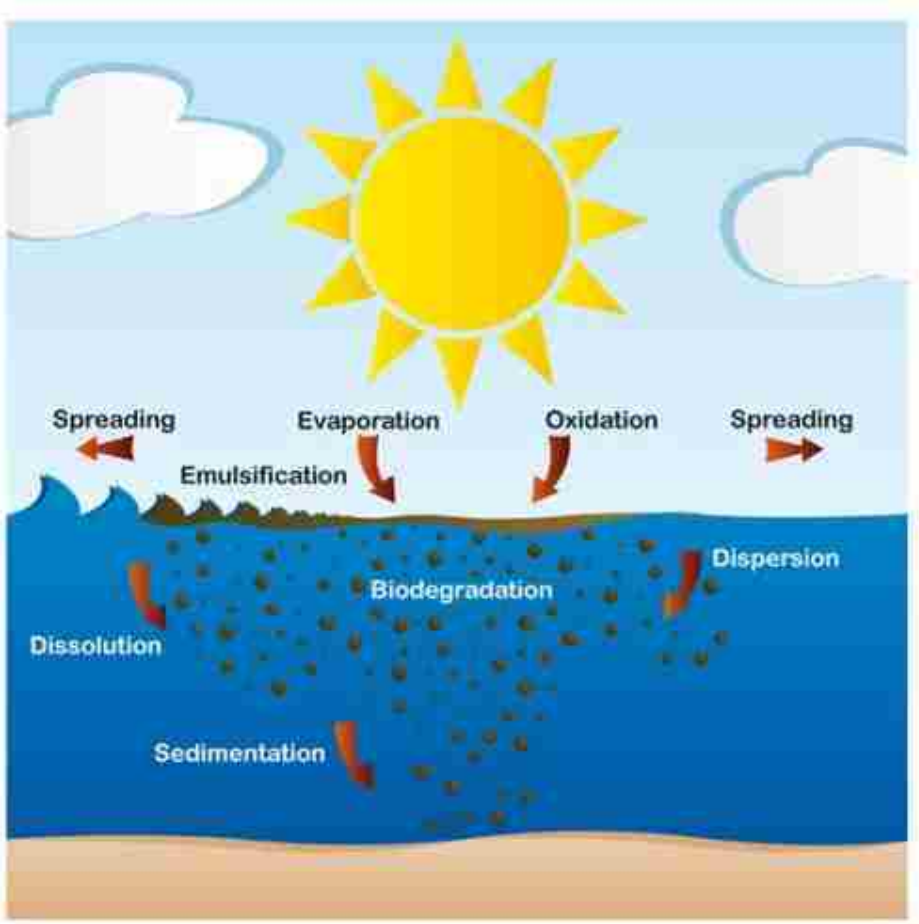


Photo and illustration credits: ITOPF

Main impacts - ecological

Impact depends on:

- Type and amount of oil
- Weather conditions
- Season
- Site of the spill

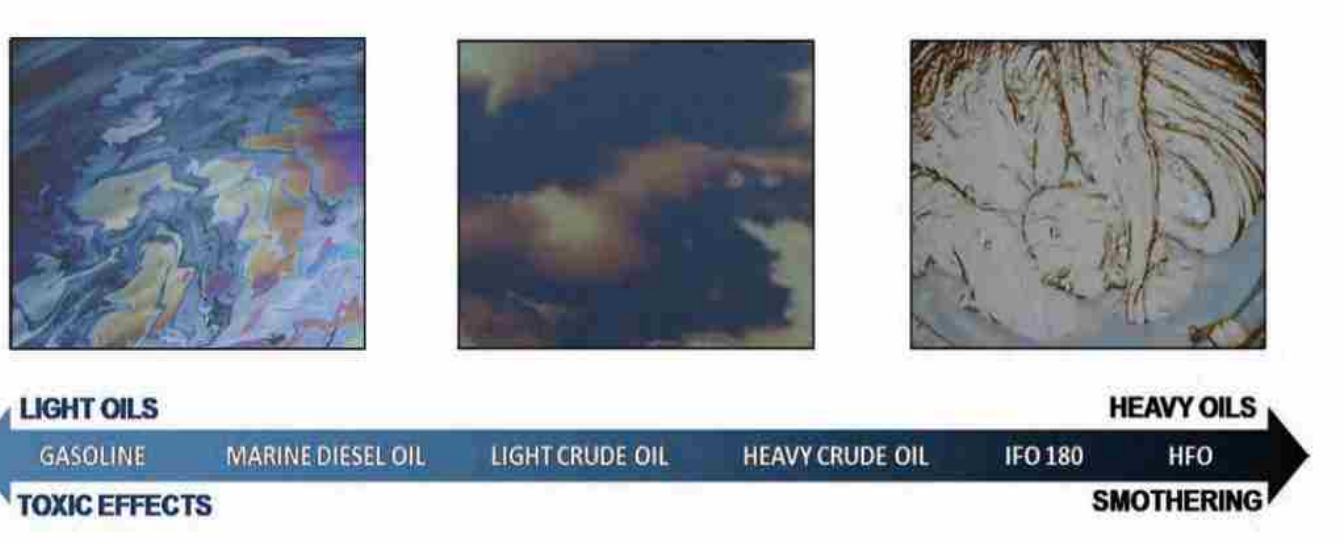


Photo credits: ITOPF

Adverse effects of oil discharges at sea depend more on the site of discharge than on the size of the discharge.

Main impacts - economic

Photo credits: ITOPF/NOAA/Ecomare

The contribution of shipping

Where does oil in the sea come from? (1990-1999)

Total	1,3 million tons oil (1973 – 6,1 million)
Natural seeps	600.000 (47%)
Extraction	38.000 (3%)
Transportation	150.000 (12%)
- tank vessel spills (100.000)	
- operational discharges (36.000)	
Consumption	480.000 (38%)
- land-based (140.000)	
- operational discharges (270.000)	shipping: (33%)
- spills (7.000)	

'Oil in the Sea III: Inputs, Fates and Effect', National Research Council. National Academy of Sciences, Washington, DC, U.S., 2002.

- Only a small fraction of oil in the marine environment comes from accidents (8%)
- Routine shipping operations contribute **three times as much (24 %)**

Photo credits: ITOPF/ProSea

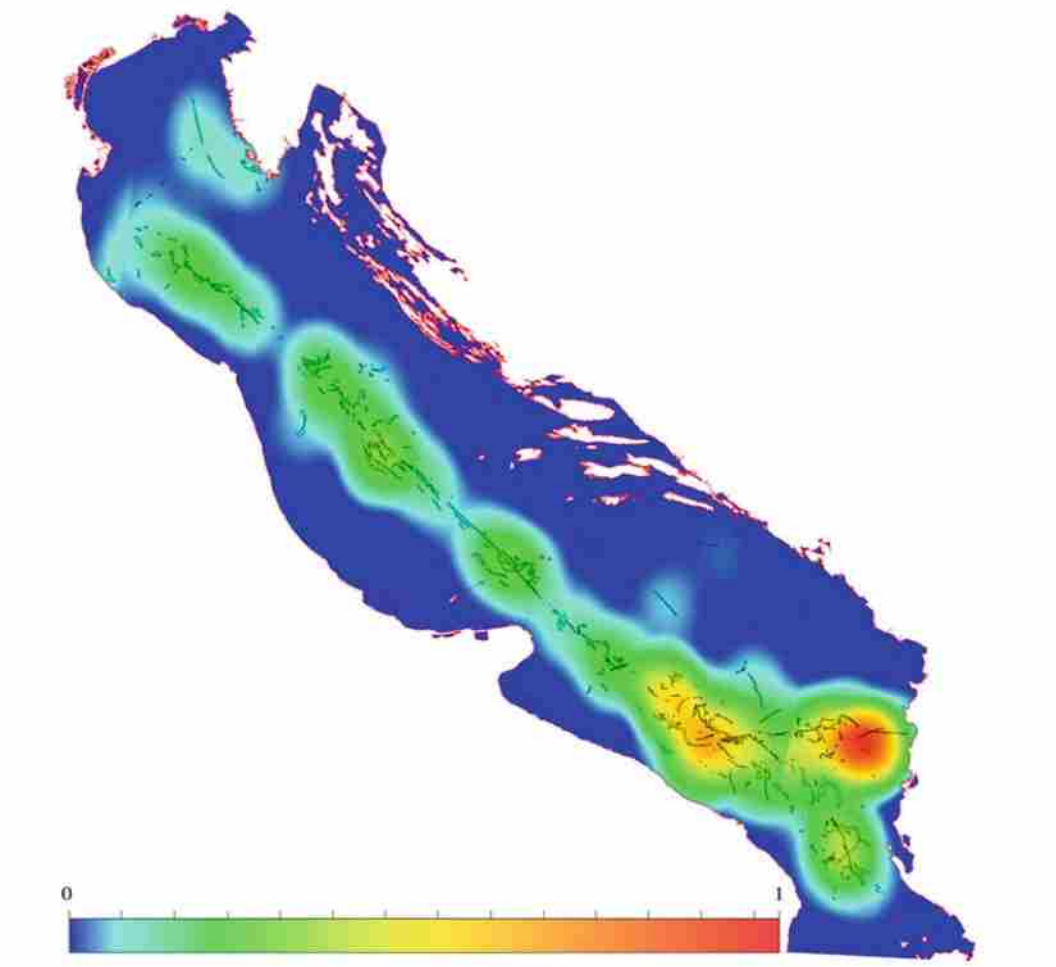


Fig. 13 Probable spills and normalised pollution density in the Adriatic Sea. *Source*: Authors adopted from [25]

Marko Perkovic, Rick Harsch, and Guido Ferraro, Springer 2016

Solutions - MARPOL Annex I (oil and oil products)

- **Discharge permitted, under certain circumstances (15 ppm, *en route*)**
- **Special areas**
- **Double hull**
- **Oil Record book**
- **Port reception fascilities**

Annex I - Definitions

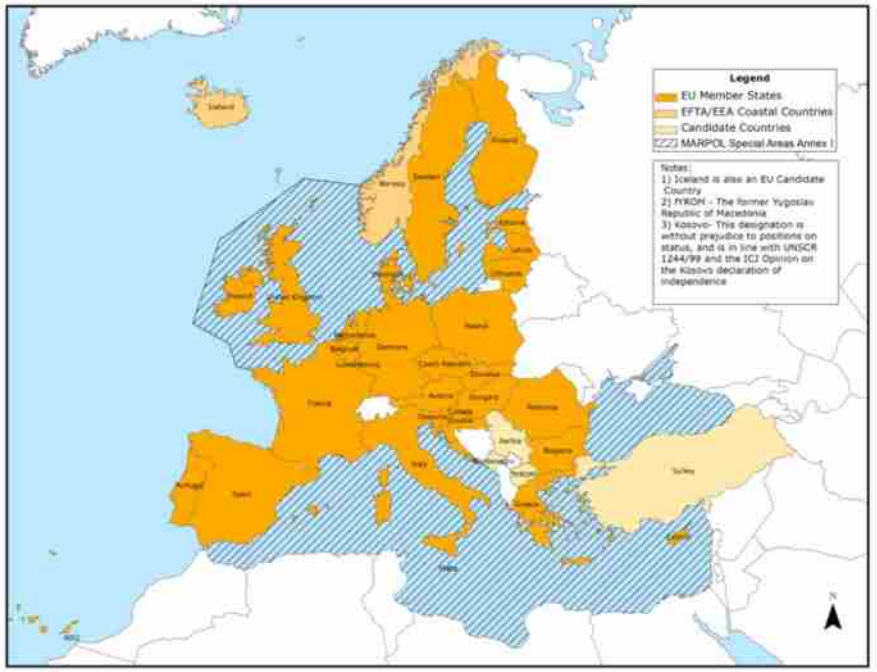
Chapter 1, Regulation 1:

- **Oil**: means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other than those petrochemicals which are subject to the provisions of Annex II) and, without limiting the generality of the foregoing, includes the substances listed in appendix I to this Annex.
- **Oily mixture**: means a mixture with any oil content
- **Oily Bilge Water**: means water which may be contaminated by oil resulting from things such as leakage or maintenance work in machinery spaces. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered oily bilge water.

Annex I - Special areas

- Regulation 1 - “A Special Area is a sea area where for recognized technical reasons in relation to oceanographic and ecological condition and to the particular character of its traffic…special mandatory methods for the prevention of sea pollution by [oil] is required.”

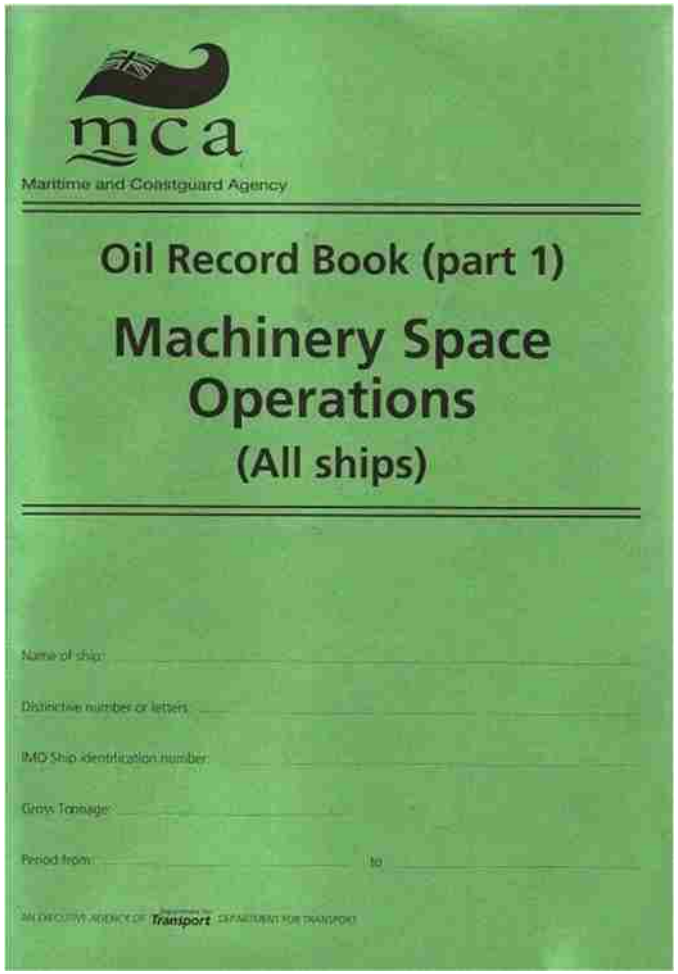
Special Areas	Adopted	Date of Entry into Force	In Effect From
Mediterranean Sea	2 Nov 1973	2 Oct 1983	2 Oct 1983
Baltic Sea	2 Nov 1973	2 Oct 1983	2 Oct 1983
Black Sea	2 Nov 1973	2 Oct 1983	2 Oct 1983
Red Sea	2 Nov 1973	2 Oct 1983	-
"Gulfs" area	2 Nov 1973	2 Oct 1983	1 Aug 2008
Gulf of Aden	1 Dec 1987	1 Apr 1989	-
Antarctic area	16 Nov 1990	17 Mar 1992	17 Mar 1992
North West European Waters	25 Sept 1997	1 Feb 1999	1 Aug 1999
Oman area of the Arabian Sea	15 Oct 2004	1 Jan 2007	-
Southern South African waters	13 Oct 2006	1 Mar 2008	1 Aug 2008



MARPOL annex I: Special Areas in Europe

Sea Area	Ship type and size	Discharge criteria
Anywhere outside a special area	All ships of 400 gross tonnage (GT) and above	**No discharge except when**: - **The ship is en route**; - **The oily mixture is processed through an oil filtering equipment** as required in the applicable parts of regulation 14 of Annex I (for ships between 400 GT and 10 000 GT regulation 14.6; for ships > 10 000 GT regulation 14.7) - **The oil content of the effluent without dilution does not exceed 15 ppm**; - On oil tankers, the oil mixture does not originate from cargo pump-room bilges and is not mixes with oil cargo residues.
Anywhere within a special area	All ships of 400 GT and above	**Same as outside a special area, however, the oil filtering equipment should be provided with alarm arrangements and arrangements that the discharge is automatically stopped when the content of the effluent exceeds 15 ppm**.
All areas except the Antarctic Area	Ships of less than 400 GT	No discharge except when: - **The ship is en route**; - Equipment approved by the Administration to ensure that the **oil content of the effluent without dilution does not exceed 15 ppm shall be in operation**; - On oil tankers, the oil mixture does not originate from cargo pump-room bilges and is not mixes with oil cargo residues.
Antarctic area	All ships irrespective of their size	No discharge.

Annex I - Oil Record Book (ORB)



Oil Record Book Part 1: According to the Convention, every tanker larger than 150 GRT and every ship larger than 400 GRT, every ship in international navigation, and all larger ships, regardless of tonnage, must have an oil record book if they use oil/petroleum as fuel.

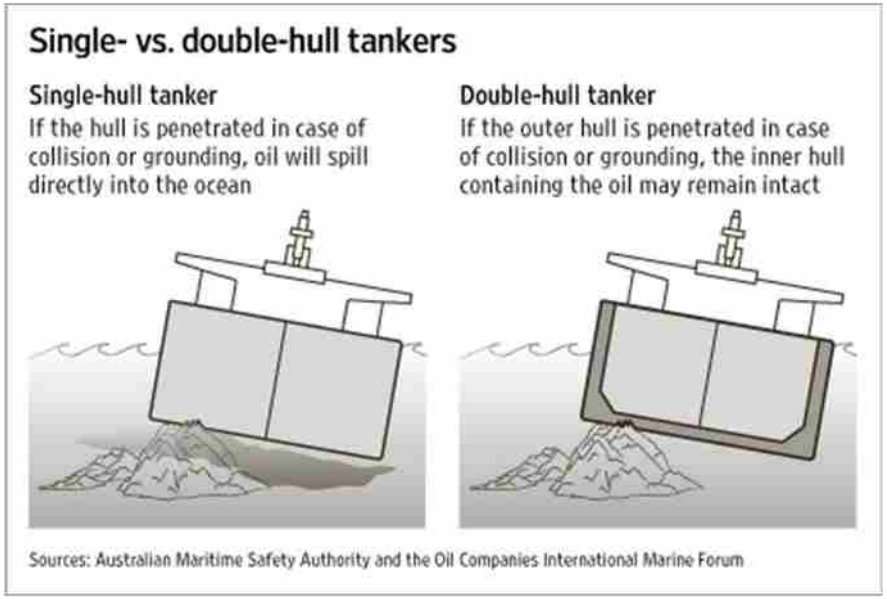
Oil Record Book (Part I) Entries:

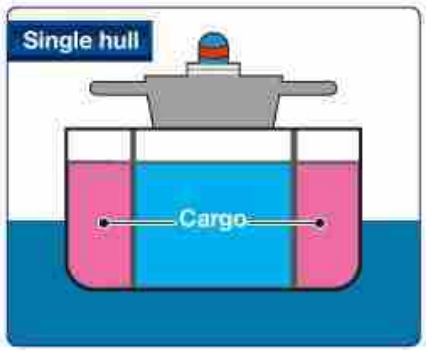
› The Oil Record Book Part I shall be completed on each occasion, on a tank-to-tank basis if appropriate, whenever any of the following machinery space operations take place in the ship:

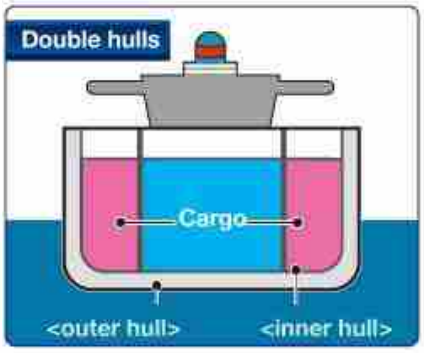
- › Ballasting or Cleaning of oil fuel tanks.
- › Discharge of dirty ballast or cleaning water from oil fuel tanks.
- › Collection and disposal of oil residues (sludge).
- › Discharge overboard or disposal otherwise of bilge water which has accumulated in machinery spaces.
- › Bunkering of Fuel or Bulk lubricating oil.

Annex I - Double hull

- Chapter 4, Part A, Regulation 19, 20, 21
- Regulation 19 - Double hull and double bottom requirements for oil tankers delivered on or after 6 July 1996
- **Double Bottom or Double Hull Design: Under Marpol annex 1 all oil tankers delivered on or after 6 July 1996; must be equipped with double hull structure. It is a hull design where there is two watertight surfaces between the main cargo tank and outside water. The regulation 21 of annex 1 clearly bans any single hull ship from carrying heavy oil.**
- 2015 za sve ostale brodove







Annex I - Port receptions

- Chapter 5, Regulation 37
- The MARPOL 73/78 Convention states that facilities must be provided in ports for the reception of all operational waste, at a reasonable cost, in order to deter ships from discharging waste at sea.
- Therefore, each port must establish and implement a plan for the reception and treatment of operational waste for ships entering a given port.

Port reception facilities

Discharges to the sea - SEWAGE

Sewage means drainage from:

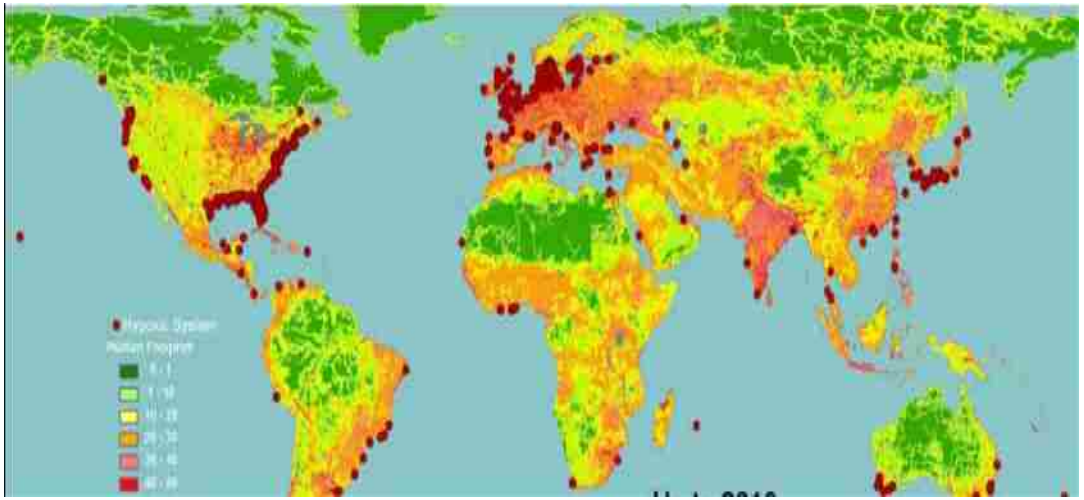
- Toilets
- Medical units
- Live animal spaces
- Mixed waste waters (if involving the above)

- Large quantities of waste water from cruise and passenger vessels
- Waste from the livestock cargo, in most cases cows, sheep or goats

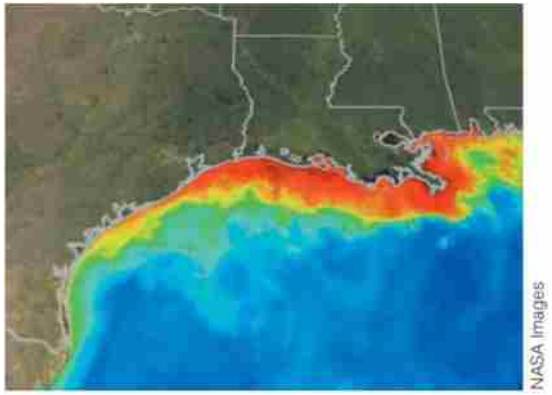
Sewage = extra nutrients → may lead to eutropication

Consequences of eutrophication

- Increased algae growth
- Less penetration of light into deeper areas
- Reduction of photosynthesis
- Less oxygen production
- Increased consumption of oxygen for the decomposition of dead algae
- Hypoxia – decrease in the amount of oxygen
- Anoxia – complete lack of oxygen
- Possible occurrence of H_2S and methane CH_4



Hipoksična obalna područja

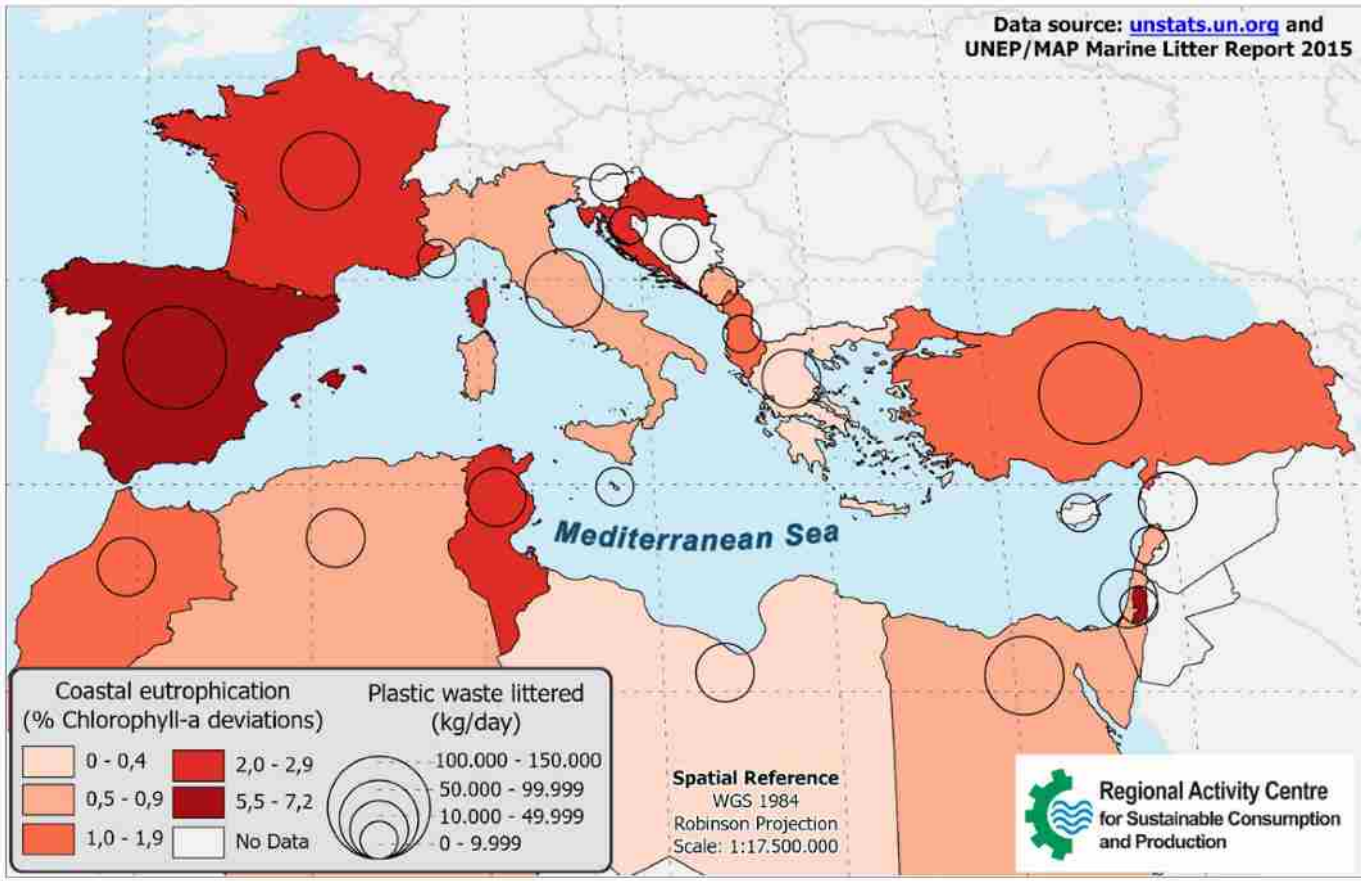


Enhanced NASA satellite image illustrates summer phytoplankton (algae) activity along the Gulf of Mexico coastline. Reds and oranges indicate high concentrations of phytoplankton and river sediments, and corresponding low-oxygen levels.

Biggest problem areas

- Discharge in sea areas with:
  - High water temperatures
  - Low oxygen
  - Little currents

- Discharge in enclosed seas
  - Meditteranean
  - Baltic Sea
  - …



Solutions - MARPOL Annex IV

- **Discharge permitted, under certain circumstances**
- **Special areas**
- **Port reception fascilities**

Annex IV - Definitions

Black water consists of the following wastes produced on ship:

- Waste generated from drainage and in any other form from toilets and urinals
- Waste generated from the drainage of a medical dispensary, sickbay, etc. via washbasins, washtubs and scuppers located in such premises
- Drainage from the cargo hold of living animals; or other wastewaters when mixed with the drainages of such spaces

Gray water produced on ship consists of:

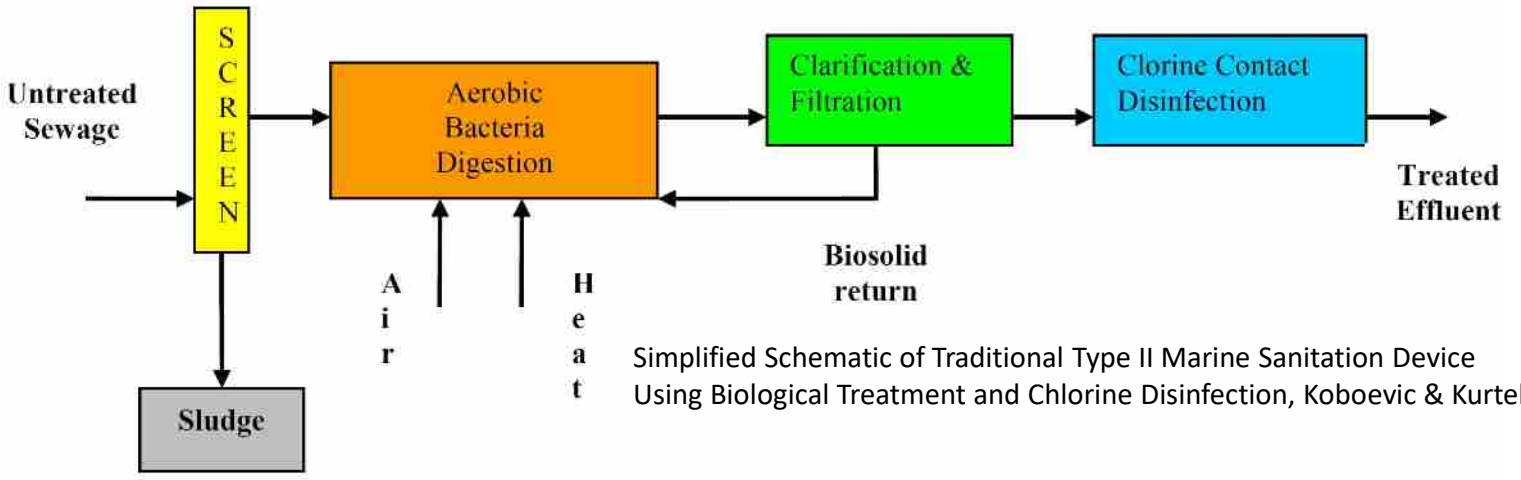
- Waste generated from the drainage of dishwasher and washbasin in the galley
- Waste generated from the drainage of cabin showers, bath and washbasin drains
- Waste generated from the drainage of laundry
- Wastewater from interior deck drains
- Condensate from refrigerators and air conditioners.

Together they are called wastewater

- Every ship of 400 GT and above engaged in international voyages and carrying at least 15 persons must be equipped with either a sewage tank of adequate capacity or an approved Sewage Treatment Plant (STP) or both,
- Discharge of sewage from a ship is permitted if it has an approved sewage treatment plant that can treat raw sewage and discharge shredded and disinfected sewage. With this arrangement, discharge is permitted at a distance of more than 3 nautical miles from the nearest land when the ship is moving at a speed of 4 knots and above.
- Ships may be allowed (depending on the area they sail) to discharge untreated sewage only at a distance of more than 12 nautical miles from the nearest land if the ship is moving at a speed of 4 knots and above.
- The ship must maintain the rate of discharge of waste water from the ship as recommended by the Administration.

Sewage holding tank

Sewage treatment plant



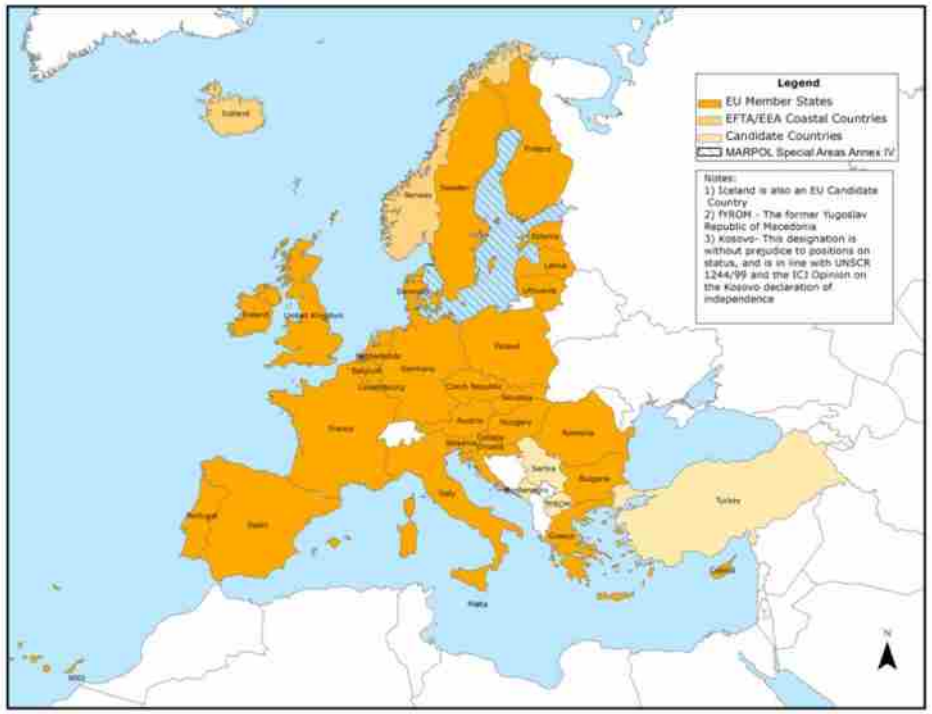
Simplified Schematic of Traditional Type II Marine Sanitation Device Using Biological Treatment and Chlorine Disinfection, Koboevic & Kurtela

Special areas - Baltic Sea

- The Baltic sea area has been adopted as the first special area for sewage discharge regulation. **This regulation targets passenger ships,** which are the major cause of sewage-related pollution at sea and in coastal water bodies.

- This regulation bans the discharge of untreated sewage out at sea in the Baltic area region. The untreated "raw" sewage produced on the ship can either be treated in an STP before discharge or the collected sewage can be transferred to the shore facility.

- The sewage treatment plant installed on a passenger ship, intending to discharge sewage effluent in Special Areas, should additionally meet the nitrogen and phosphorus removal standards when tested for its Certificate of Type Approval by the Administration.

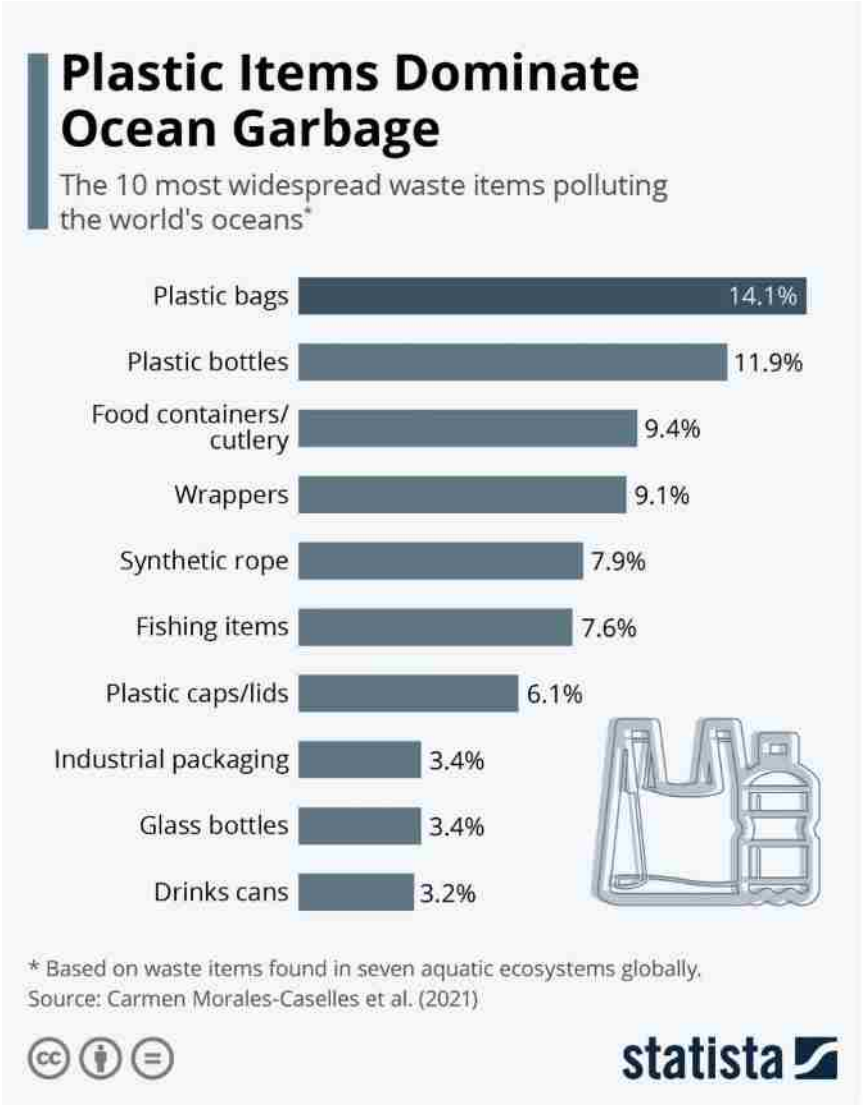


MARPOL annex IV: Special Areas in Europe

Illustration credits: Norman Einstein

Discharges to the sea – SOLID WASTE

- Marine litter: Solid material discarded, disposed of or abandoned in the marine and coastal environment (UNEP)
- In many regions, plastics constitute between 60 and 80% of all marine litter
- The Mediterranean seabed, plastics accounted for 77% of all debris, of which 93% plastic bags
- The ocean surface of the North Pacific, plastics accounted for 89% of all floating litter



Fate of marine litter entering the ocean

Of all litter that enters the sea

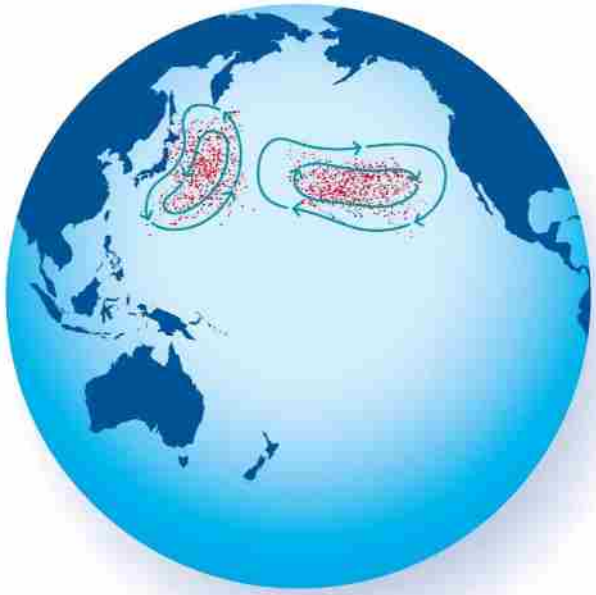
- 15% keeps floating on the surface
- 15% washes ashore (beaches, other coastal areas)
- 70% ends up on the seabed

(Estimates of 'Save the North Sea project')

Photo credits: Jacki Clark ,Lindsey Hoshaw, Algalita Marine Research Foundation, NOAA

Waste on the ocean surface: pools of garbage

- Continent-sized areas of floating plastic on the ocean surface
- Winds and sea currents drive marine litter together

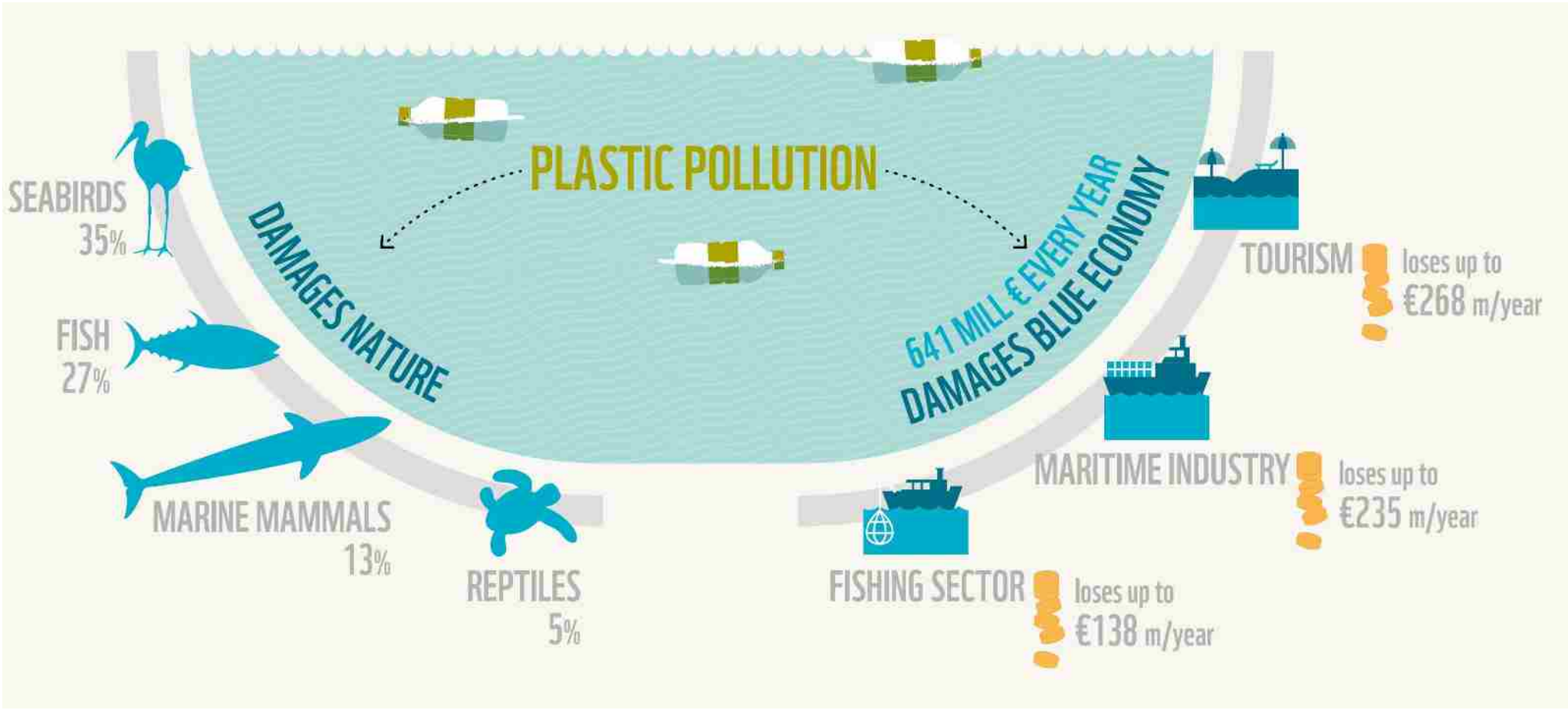


•FILM CLIP

- Ocean surface worldwide: 13,000 plastic pieces per square kilometer
- North Pacific Gyre – 334.000 plastic pieces per square kilometer

Photo credits: Lindsey Hoshaw, Algalita Marine Research Foundation / ProSea

Issues with marine litter



Ingestion

Litter sometimes resembles food

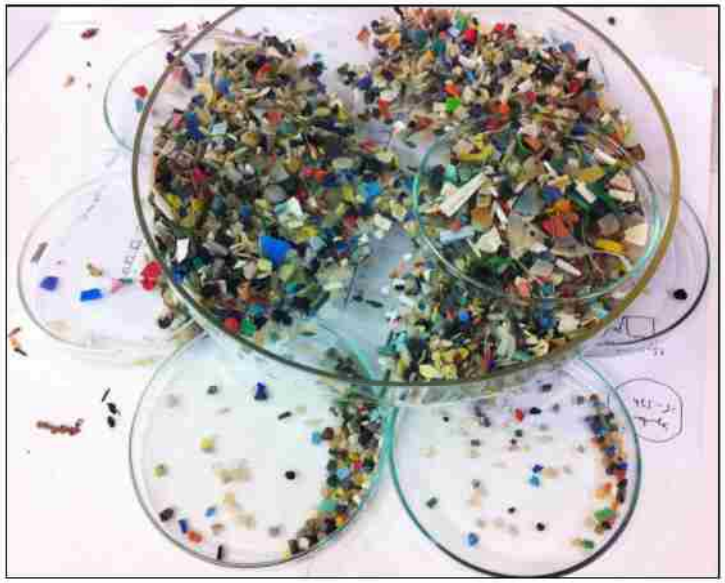
Photo credits: ProSea / Rebecca Hosking, BBC

Plastic removed from gut of dead leatherback turtle

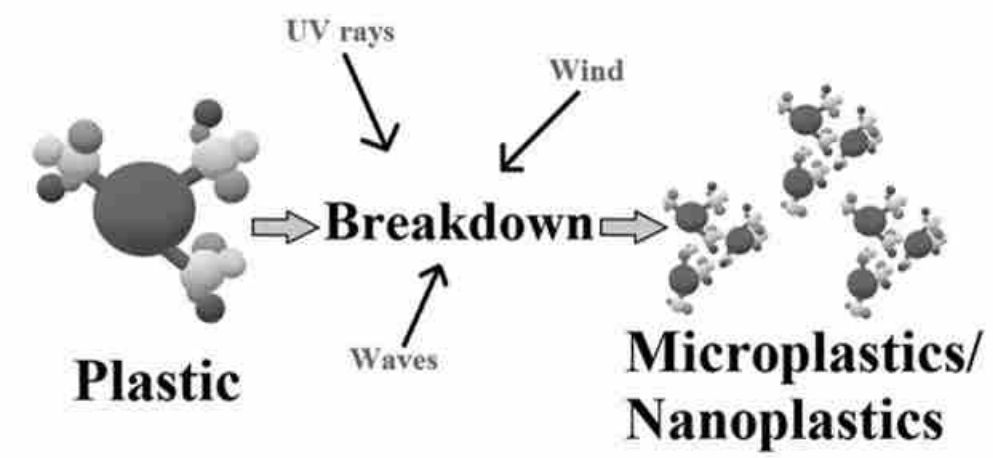
Photo credit: P. Richardson

Growing problem of microplastics

- Microplastics: smaller than 5 mm Ø
- Nanoplastics: smaller than 100 nm Ø
- Sources:
  - large pieces of plastic litter break down
  - scrub soaps / cosmetics

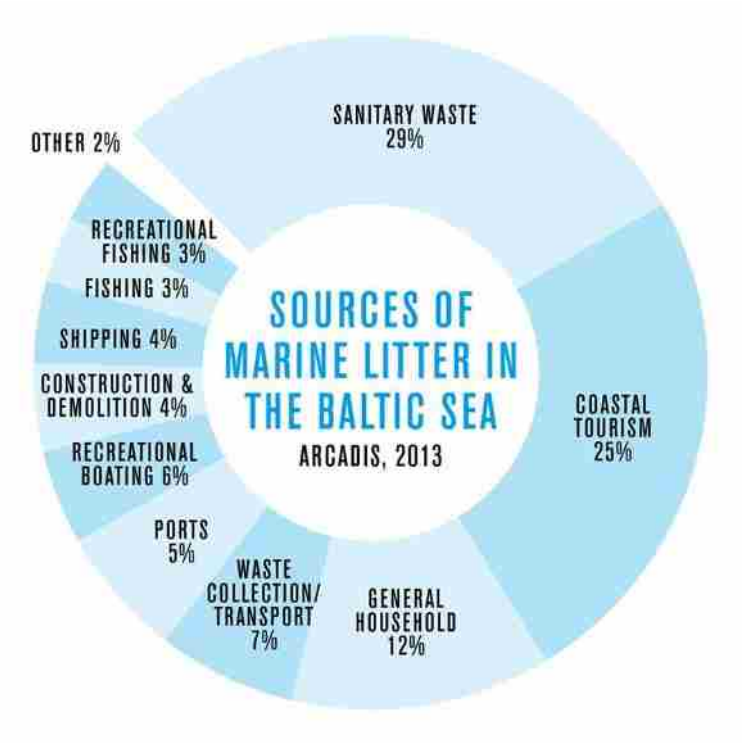


Marine plastic fragments sorted by size in the lab (photo: Paula Sobral)



Contribution of shipping to the marine litter problem

- Worldwide: shipping discharges 5 million litter items into the oceans every year (UNEP) or 6.5 million tons (Derraik 2002).



Generation of waste on board a cruise ship

- Butt (2007) reported that cruise ships represented less than 1 % of the world's merchant fleet; however, he estimated that they would account for 25 % of all waste generated by these ships.
- It is calculated that a **cruise ship** with a capacity of some 2,000-3,000 passengers can generate some 1,000 tonnes of **waste per day** which can be broken down as follows (Oceana 2004):
  - ✓ 550,000-800,000 litres of greywater
  - ✓ 100,000-115,000 litres of blackwater
  - ✓ 13,500-26,000 litres of oily bilge water
  - ✓ 7,000-10,500 kilos of garbage and solid waste
  - ✓ 60-130 kilos of toxic waste
- This means that the generation of **waste per passenger per day** comes to at least
  - ✓ 300 litres of greywater,
  - ✓ 40 of blackwater,
  - ✓ 10 of bilge water,
  - ✓ 3.5 kilos of garbage and
  - ✓ 30 grams of toxic waste.

Solutions - MARPOL Annex IV

- **Discharge permitted, under certain circumstances**
- **Special areas**
- **Integrated Garbage Management System (Garbage Management Plan – GMP, Garbage placarding, Garbage record book)**
- **Port reception fascilities**

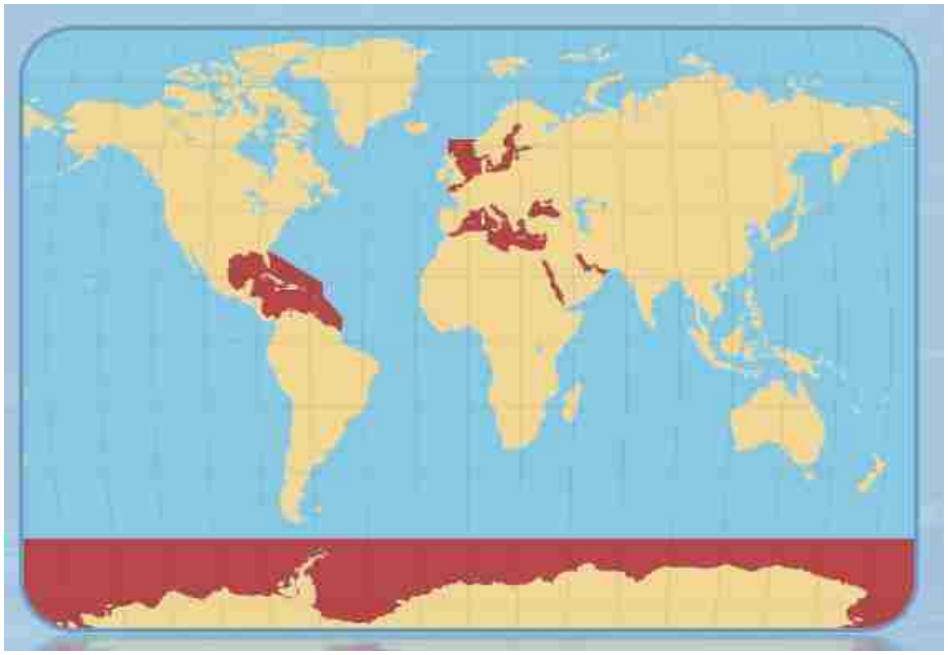
Annex V - Definitions

Garbage means all kinds of food wastes, domestic wastes and operational wastes, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention. Garbage does not include fresh fish and parts thereof generated as a result of fishing activities undertaken during the voyage, or as a result of aquaculture activities which involve the transport of fish including shellfish for placement in the aquaculture facility and the transport of harvested fish including shellfish from such facilities to shore for processing.

Zero discharge policy (except food waste, certain cargo residues, …).

Garbage Type [1]	All ships except platforms [4]		Offshore platforms located more than 12 nm from nearest land and ships when alongside or within 500 metres of such platforms[4] Regulation 5
	Outside special areas and Arctic waters Regulation 4 (Distances are from the nearest land)	Within special areas and Arctic waters Regulation 6 (Distances are from nearest land, ice-shelf or nearest fast ice)	
Food waste comminuted or ground[2]	Discharge permitted ≥3 nm, en route and as far as practicable	≥12 nm, en route and as far as practicable[3]	Discharge permitted
Food waste not comminuted or ground	Discharge permitted ≥12 nm, en route and as far as practicable	Discharge prohibited	Discharge prohibited
Cargo residues[5,6] not contained in washwater	Discharge permitted ≥12 nm, en route and as far as practicable	Discharge prohibited	Discharge prohibited
Cargo residues[5,6] contained in washwater		≥12 nm, en route and as far as practicable (subject to conditions in regulation 6.1.2 and paragraph 5.2.1.5 of part II-A of the Polar Code)	
Cleaning agents and additives[6] contained in cargo hold washwater	Discharge permitted	≥12 nm, en route and as far as practicable (subject to conditions in regulation 6.1.2 and paragraph 5.2.1.5 of part II-A of the Polar Code)	Discharge prohibited
Cleaning agents and additives[6] in deck and external surfaces washwater		Discharge permitted	Discharge prohibited
Animal carcasses (should be split or otherwise treated to ensure the carcasses will sink immediately)	Must be en route and as far from the nearest land as possible. Should be >100 nm and maximum water depth	Discharge prohibited	Discharge prohibited
All other garbage including plastics, synthetic ropes, fishing gear, plastic garbage bags, incinerator ashes, clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery and similar refuse	Discharge prohibited	Discharge prohibited	Discharge prohibited

Annex V Special areas



Special Areas	Adopted #	Date of Entry into Force	In Effect From
Mediterranean Sea	2 Nov 1973	31 Dec 1988	1 May 2009
Baltic Sea	2 Nov 1973	31 Dec 1988	1 Oct 1989
Black Sea	2 Nov 1973	31 Dec 1988	-
Red Sea	2 Nov 1973	31 Dec 1988	-
"Gulfs" area	2 Nov 1973	31 Dec 1988	1 Aug 2008
North Sea	17 Oct 1989	18 Feb 1991	18 Feb 1991
Antarctic area (south of latitude 60 degrees south)	16 Nov 1990	17 Mar 1992	17 Mar 1992
Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea	4 Jul 1991	4 Apr 1993	1 May 2011

Garbage Management Plan – GMP is required on the following vessels:

- ships of 100 GT and more.
- ships with a certificate for the transport of 15 or more persons.
- fixed or floating platforms.

Garbage record books are required on the following ships:

- Any vessel of 400 GT and above
- Any ship certified to carry 15 or more persons engaged on voyages to ports or shore terminals under the jurisdiction of other Parties to MARPOL,
- Any fixed or floating platform

Part I		
A Plastics	B Food wastes	C Domestic wastes
D Cooking oil	E Incinerator ashes	F Operational wastes
G Animal carcasses	H Fishing gear	I E-waste

Categories of waste classification on ship

Non-recyclable plastics and plastics mixed with non-plastic garbage	"Non-recyclable plastics" (Red)
Incinerator ashes	"Incinerator ashes" (Black)
Food wastes	"Food Waste" (Green)
Rags	Labelled only
Recyclable garbage	
○ Glass	"Glass" (Blue)
○ Cooking oil	Labelled only
○ Aluminum cans	"Aluminum Cans" (Grey)
○ Paper, cardboard, corrugated board	Labelled only
○ Wood	"Wood" (Brown)
○ Metal	"Metal" (Grey)
○ Plastics (including Styrofoam or similar plastic material)	"Plastics" (Yellow)
Hazardous wastes	"Hazardous Waste" (Red)
E-waste	"E-waste" (Red)
Cargo residues (non-HME)	"Cargo residues (non-HME)" (Brown/White Stripes)
Cargo residues (HME)	"Cargo residues (HME)" (Red)

Port reception fascilities

www.porteconomics.eu

1. RECEPTION FACILITY AND PORT PARTICULARS

1.1 Location/Terminal name:	
1.2 Reception facility provider(s)	
1.3 Treatment facility provider(s) – if different from above:	
1.4 Waste Discharge Date and Time from:	to

2. SHIP PARTICULARS

2.1 Name of ship:	2.5 Owner or operator:
2.2 IMO number:	2.6 Distinctive number or letters:
2.3 Gross tonnage:	2.7 Flag State:
2.4 Type of ship: ☐ Oil tanker ☐ Chemical tanker ☐ Bulk carrier ☐ Container ☐ Other cargo ship ☐ Passenger ship ☐ Ro-ro ☐ Other (specify)	

3. TYPE AND AMOUNT OF WASTE RECEIVED

MARPOL Annex I – Oil	Quantity (m^3)
Oily bilge water	
Oily residues (sludge)	
Oily tank washings	
Dirty ballast water	
Scale and sludge from tank cleaning	
Other (please specify)	
MARPOL Annex II – NLS	**Quantity (m^3)/Name[5]**
Category X substance	
Category Y substance	
Category Z substance	
OS – other substance	
MARPOL Annex IV – Sewage	**Quantity (m^3)**

MARPOL Annex V – Garbage	Quantity (m^3)
A. Plastics	
B. Food wastes	
C. Domestic wastes (e.g. paper products, rags, glass, metal, bottles, crockery, etc.)	
D. Cooking oil	
E. Incinerator ashes	
F. Operational wastes	
G. Cargo residues[6]	
H. Animal carcass(es)	
I. Fishing gear	
MARPOL Annex VI – related	**Quantity (m^3)**
Ozone-depleting substances and equipment containing such substances	
Exhaust gas-cleaning residues	

On behalf of the port facility I confirm that the above wastes were delivered.

Signature: ..... Full Name and Company Stamp: .....

5 Indicate the proper shipping name of the NLS involved.
6 Indicate the proper shipping name of the dry cargo.

Potvrda o predaji otpada ovlaštenom operateru otpadom

Directive (EU) 2019/883 on port reception facilities for the delivery of waste from ships

- The new Directive (EU) 2019/883 on port reception facilities for the delivery of waste from ships (PRF Directive) replaces the previous Directive 2000/59/EC as from 28 June 2021.

- The Directive applies to all seagoing ships, irrespective of their flag, calling at, or operating within, a port of a Member State of the European Union.

- **The Directive applies to all waste from ships including cargo residues, which are covered by Annexes I, II, IV, V and VI to the MARPOL Convention, and has to be implemented as from 28 June 2021.**

- The port states must ensure the availability of adequate port reception facilities and make the relevant information publicly available and easily accessible to the ship operators.

SHIP AIR POLLUTION

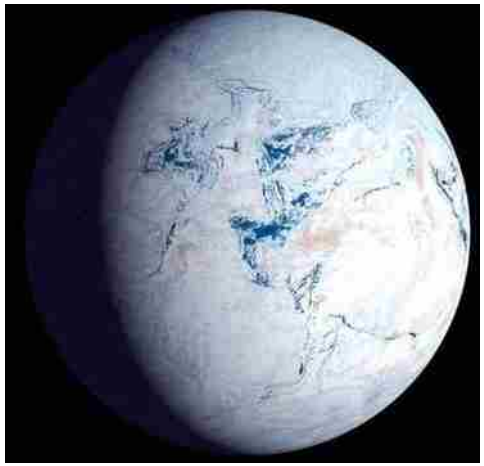
MARPOL Annex	Pollutant Categories
Annex VI	NOx, SO2, PM, CO2 ...

"Any change in global temperatures and precipitation over time due to natural variability or to human activity"

IPCC (Intergovernmental Panel on Climate Change)

GHG

The Earth without the greenhouse effect



Average temperature -18 °C

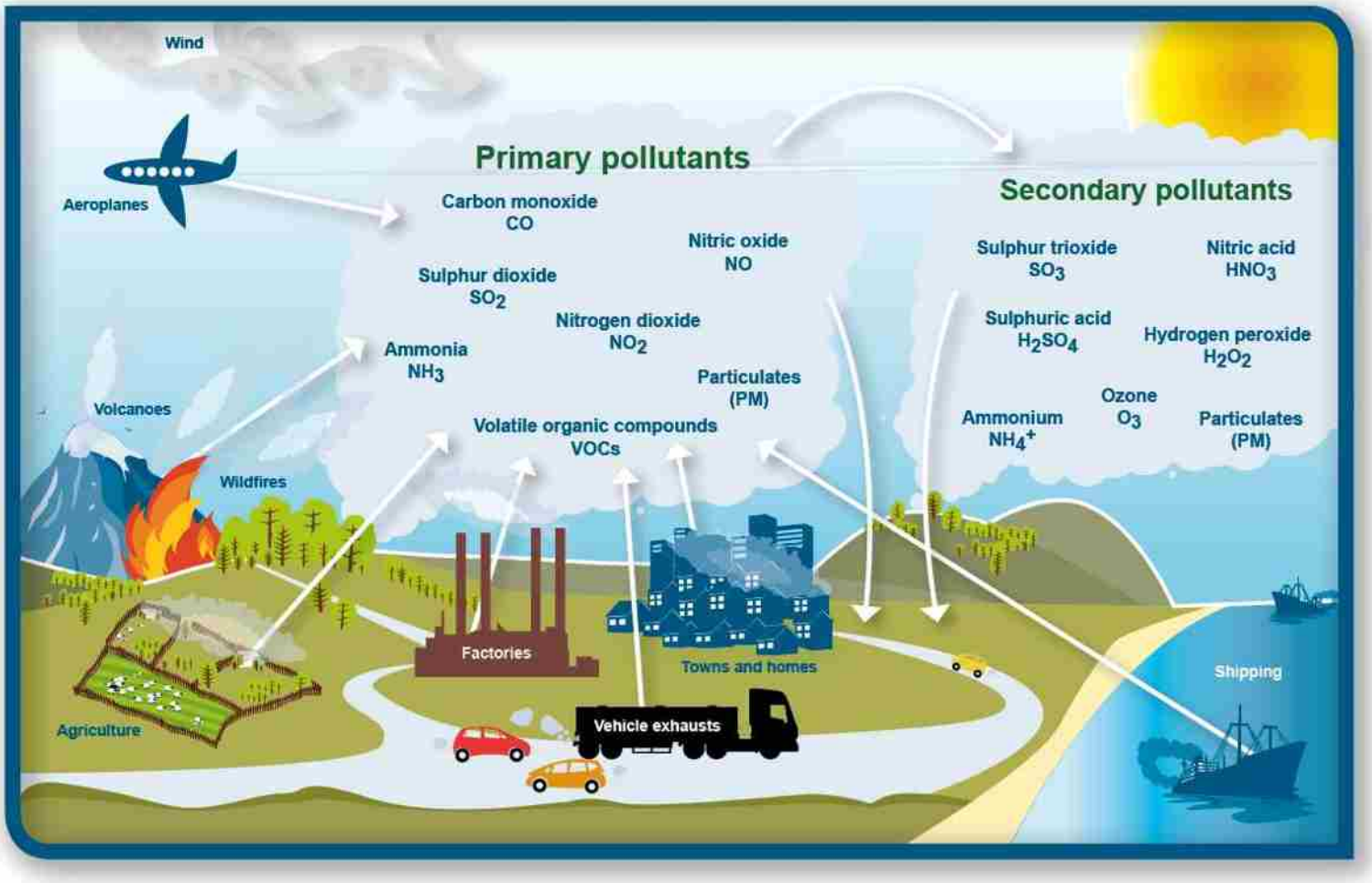
The Earth thanks to the greenhouse effect

Average temperature 14 °C

The Earth with enhanced greenhouse effect

Average temperature >14.5 °C
(so far…)

Air pollution



Emission from Maritime Transport

CO_2 – carbon dioxide (**engine**)

SOx – sulphur oxides (**engine**)

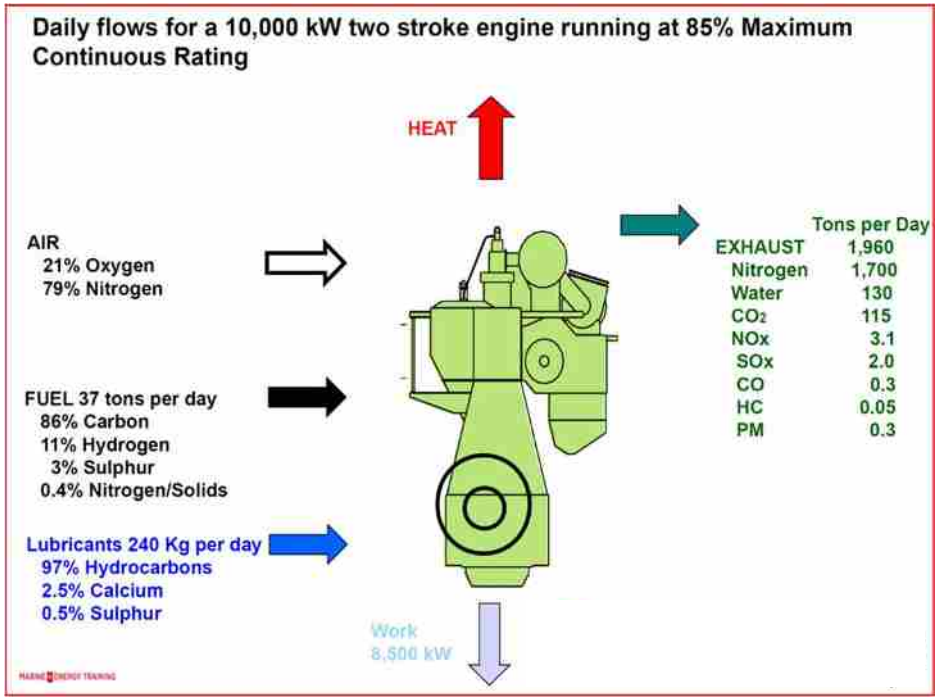
- examples: SO_2, SO_3 ...
- Sulphur (S) in fuel reacts with oxygen (O_2) in air

NOx – nitrogen oxides (**engine**)

- examples: NO, NO_2, N_2O_2 ...
- Nitrogen (N_2) in air reacts with oxygen (O_2) in air

PM – Particulate Matter (**engine**)

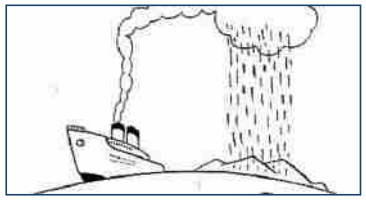
- small particles, such as ash, burned lubricant oil

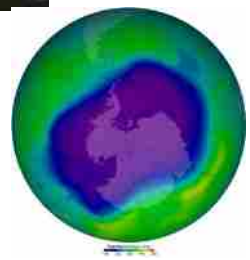


Halons and CFCs (**cooling systems**)

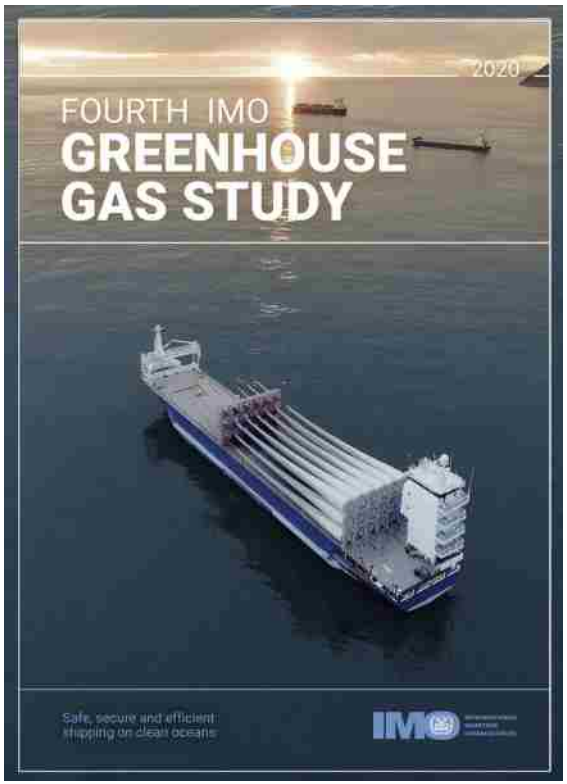
VOCs – Volatile Organic Compounds (**cargo-related**)

Substance	
CO_2	Climate Change
SOx	Air quality (smog - health problems) Acidification Climate change
NOx	Air quality (smog - health problems) Acidification Climate change
PM	Air quality (health problems)
Halons and (H)CFC's	Depletion of ozone layer
VOC's	Air quality (potentially carcinogenic)

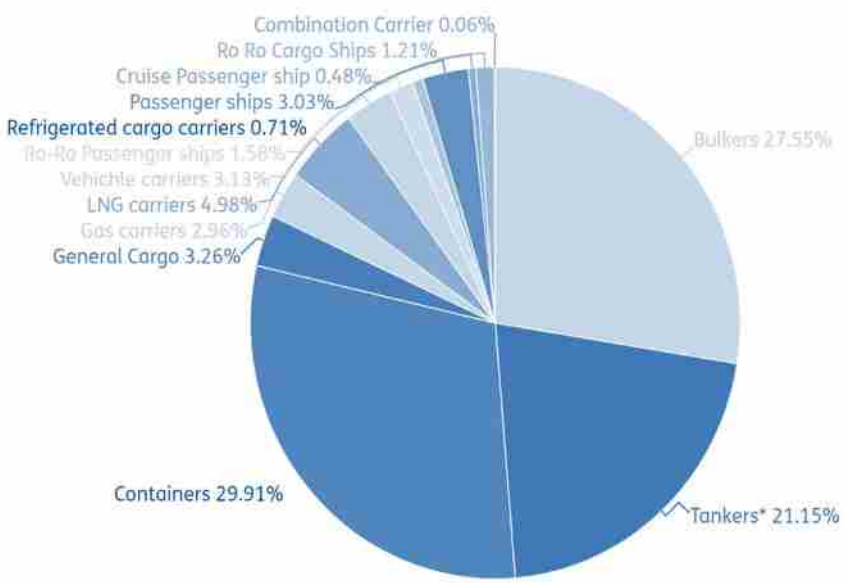




Global CO_2 Emission from Maritime Transport



- ✓ Total amount of GHG emissions from shipping have increased from 977 million tonnes in 2012 to 1,076 million tonnes in 2018 (9.6% increase).
- ✓ The share of shipping emissions has increased from 2.76% in 2012 to 2.89% in 2018.

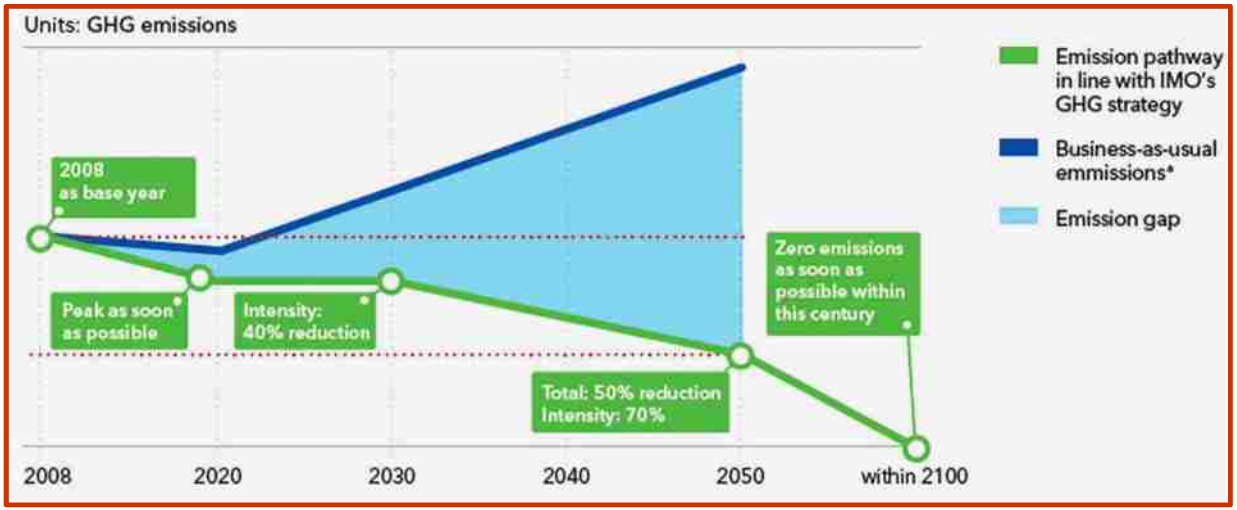


Share of CO2 emission by ship type (2019)

IMO Legislation – MARPOL Annex VI

Chapter 4 - Energy Efficiency Regulations

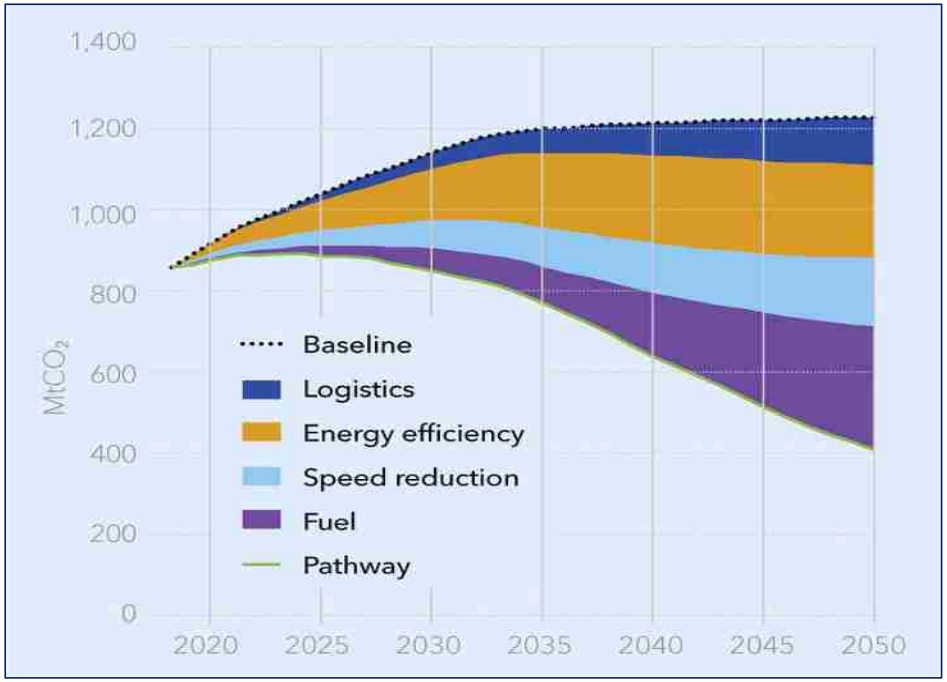
Application	Reg.19
Attained EEDI	Reg.20
Required EEDI	Reg.21
SEEMP	Reg.22
DCS (Data Collection System)	Reg.22A
Technical coop. and techn. Transfer	Reg.23



***Source**: https://doi.org/10.1080/25725084.2019.1707938*

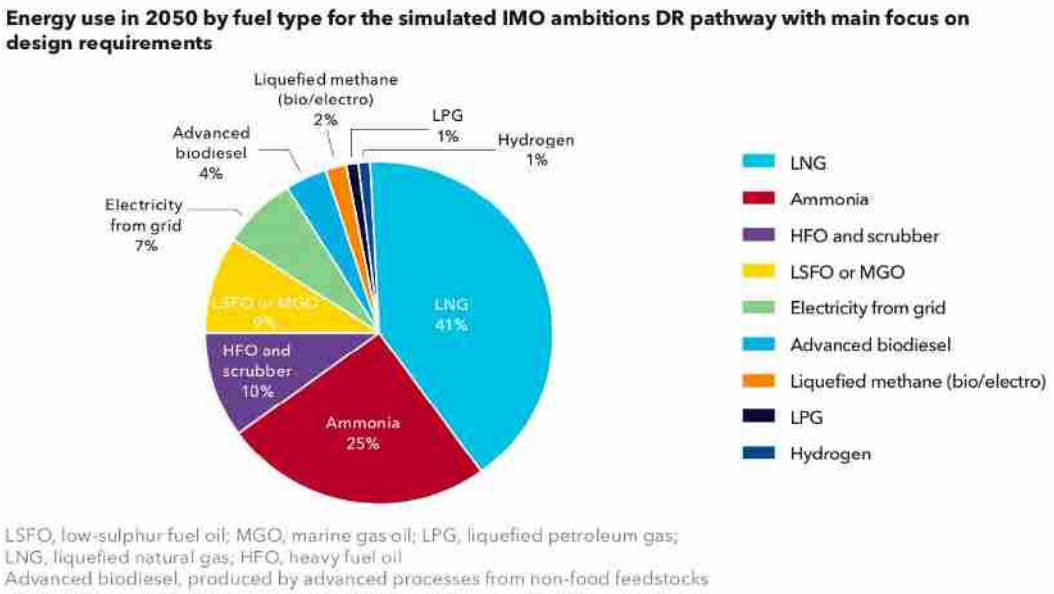
What does future bring

Shipping CO_2 emission reduction by measures (2018-2050)



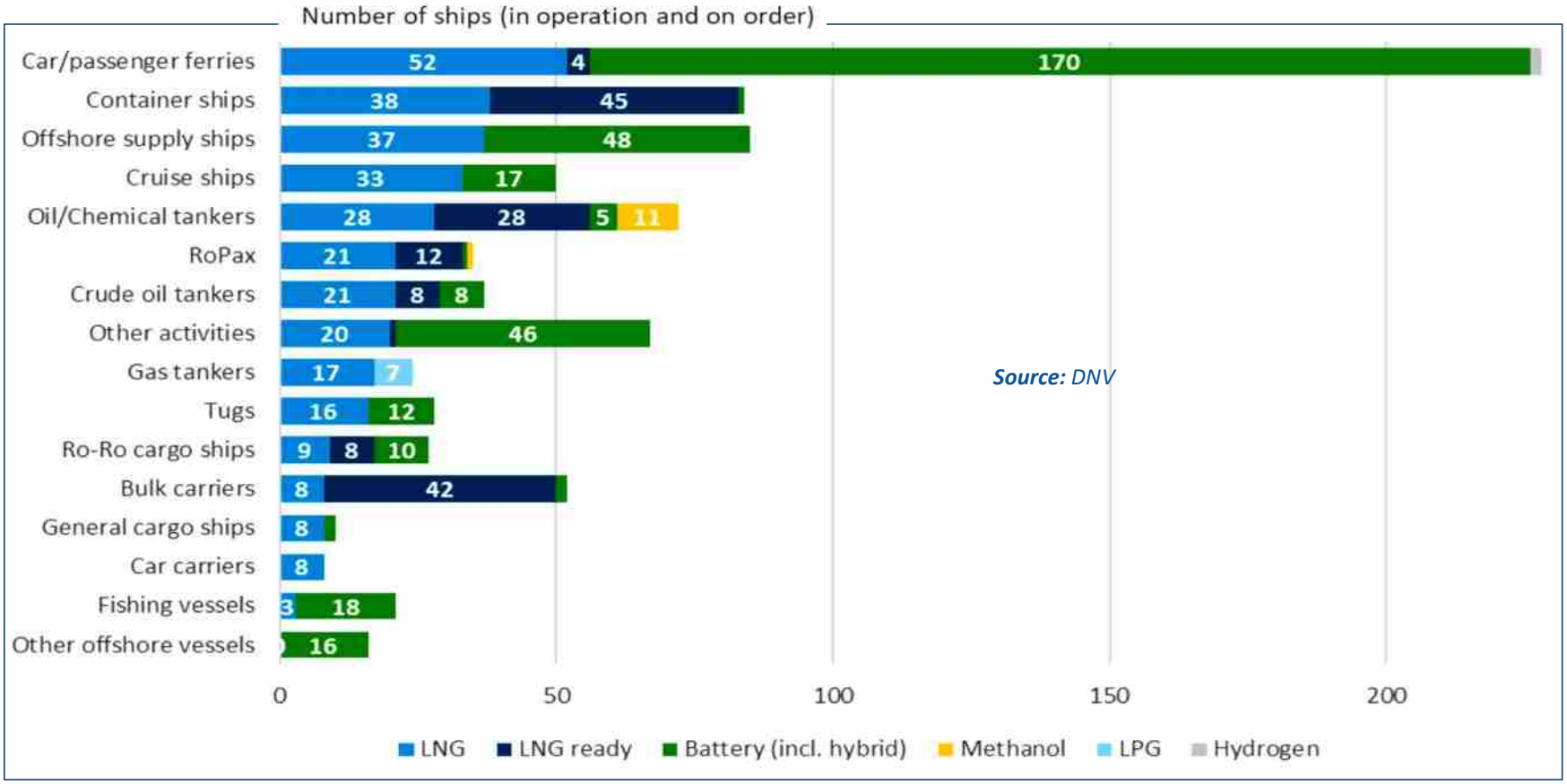
Source: *https://www.dnv.com/expert-story/maritime-impact/the-future-proof-ship.html*

Energy use in shipping towards 2050



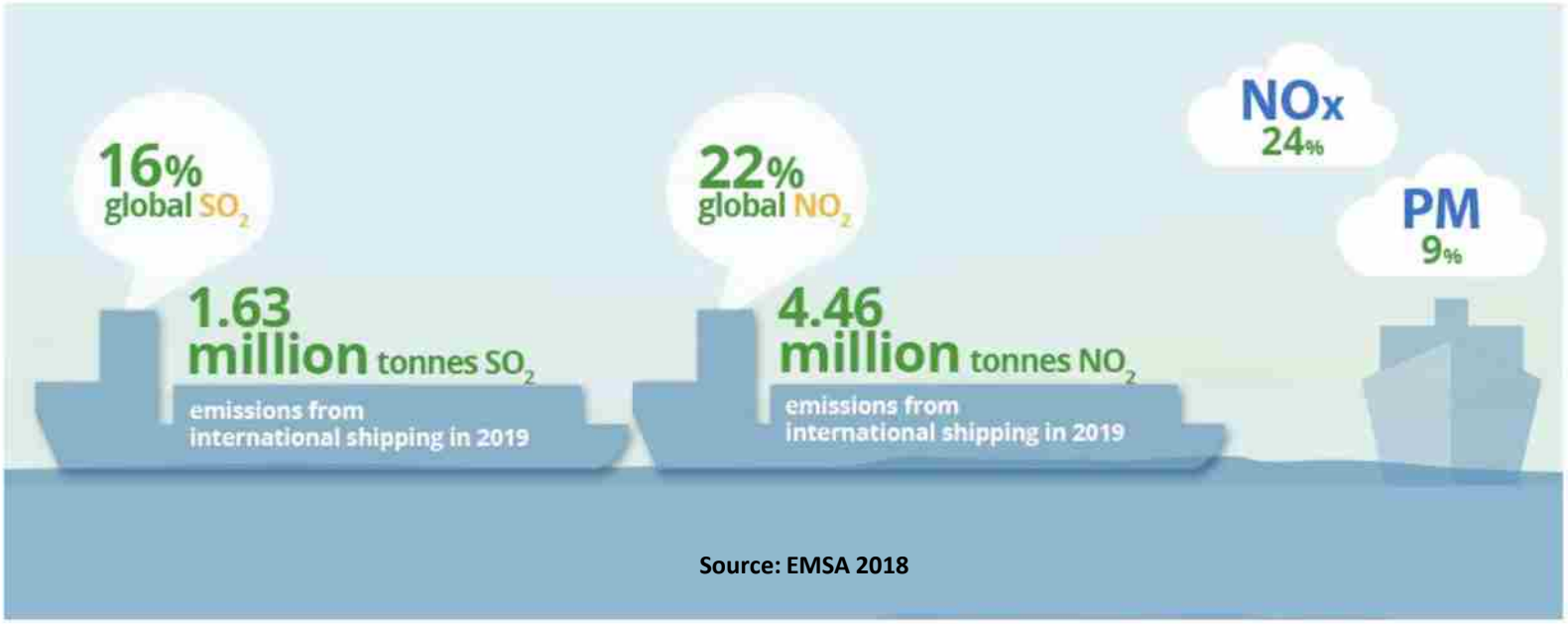
Source: *Maritime Forecast to 2050, DNV GL 2018*

Uptake of Alternative Fuels in the World Fleet (July 2019)



Source: *DNV*

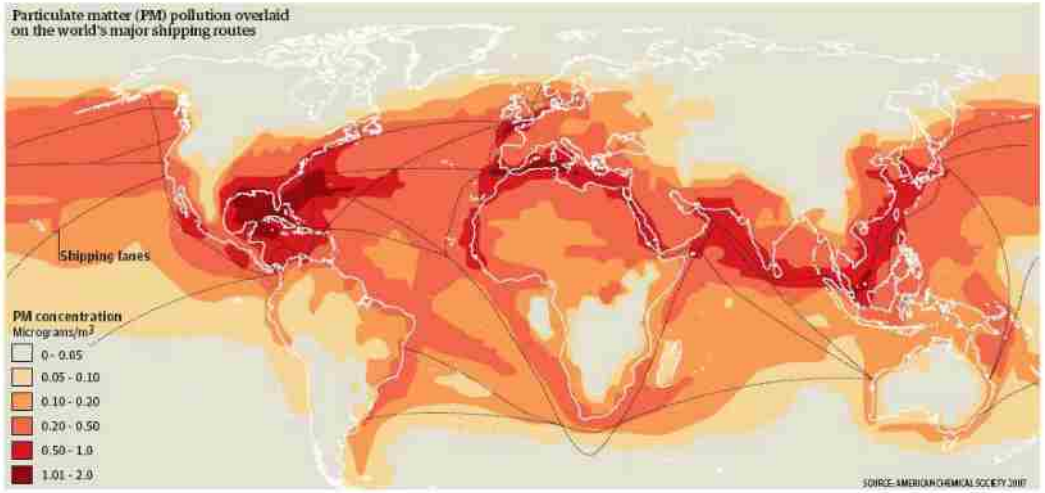
Emission of Pollutants from Maritime Transport



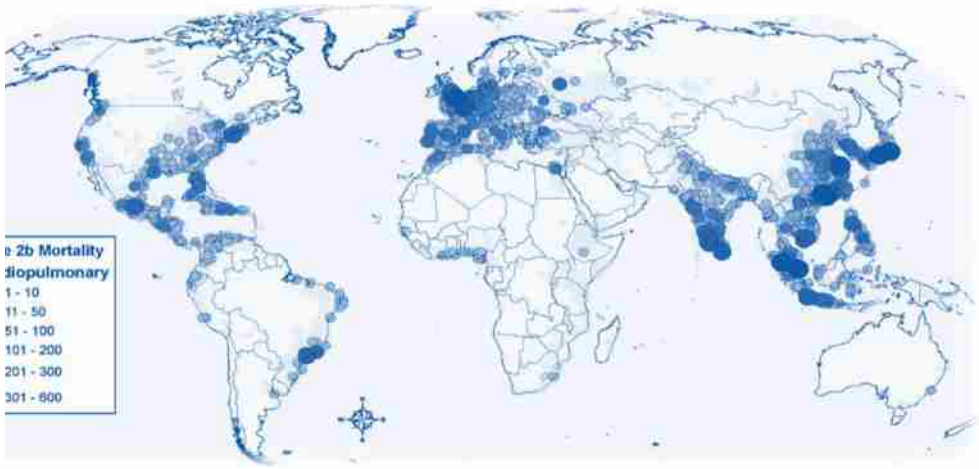
Source: EMSA 2018

Emission of Pollutants from Maritime Transport

Particulate Matter pollution overlaid on the world's major shipping routes



Mortality associated with PM emissions from marine diesel engines



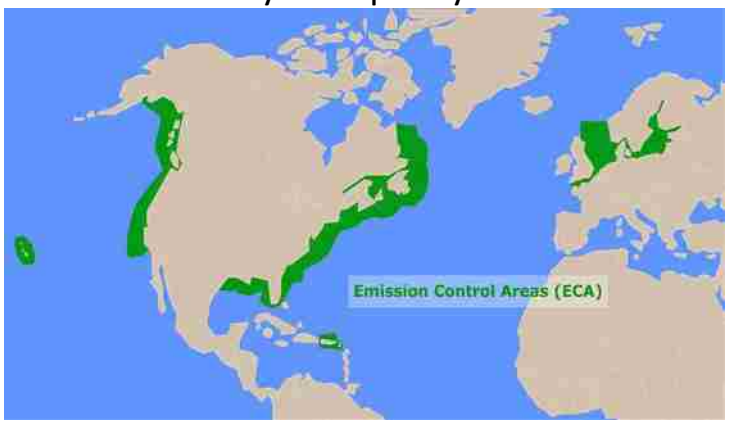
Source: *J.Corbett et all 2007*

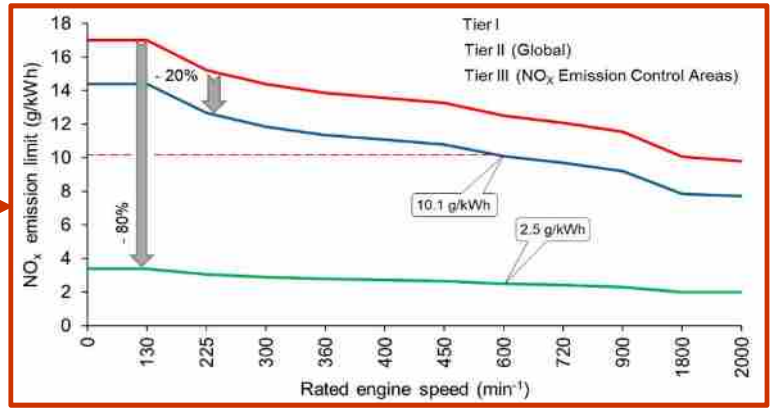
PM 2,5

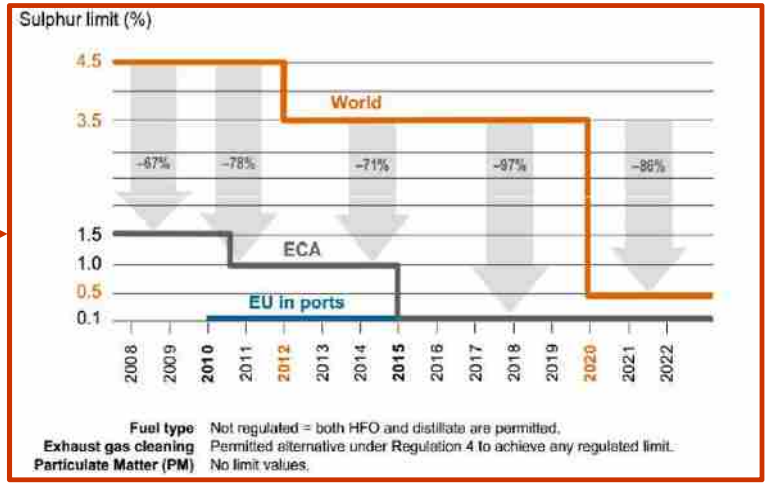
IMO Legislation – MARPOL Annex VI

Chapter 3 - Requirements for Control of Emissions

Ozone depleting substances	Reg.12
Nitrogen oxides (NOx)	**Reg.13**
Sulphur oxides (SOx) and PM	**Reg.14**
Volatile organic compounds (VOC)	Reg.15
Shipboard incineration	Reg.16
Reception facilities	Reg.17
Fuel oil availability and quality	Reg.18



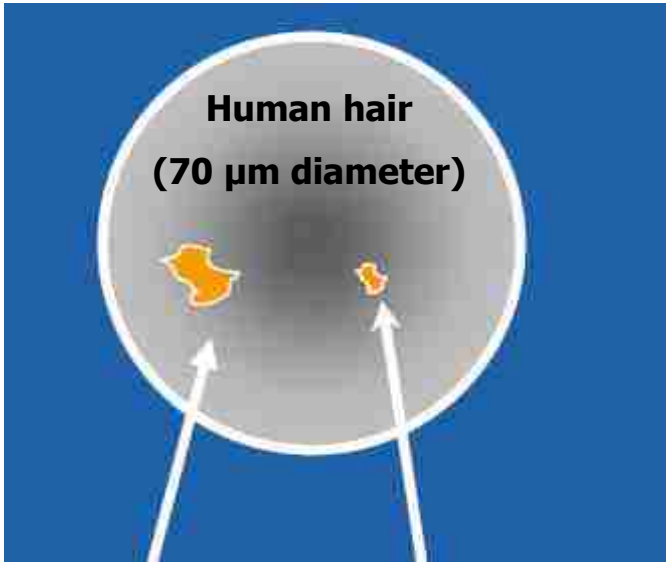




https://doi.org/10.3390/jmse8100820

Unregulated emission of PM

- Particulate matter includes soil particles, soot, lead, asbestos, microorganisms, sea salt, and sulfuric acid droplets.
- Microscopic particles are considered more dangerous than larger particles because they are inhaled more deeply into the lungs.
- Some particulate matter has toxic or carcinogenic effects.
- PM can be divided based on their aerodynamic diameter:
  - ✓ PM10 – particles with an aerodynamic diameter smaller than 10 µm
  - ✓ PM2.5 – smaller than 2.5 µm
  - ✓ Ultrafine particles – up to 0.1 µm or 100 nm
  - ✓ Nano particles – up to 50 nm.



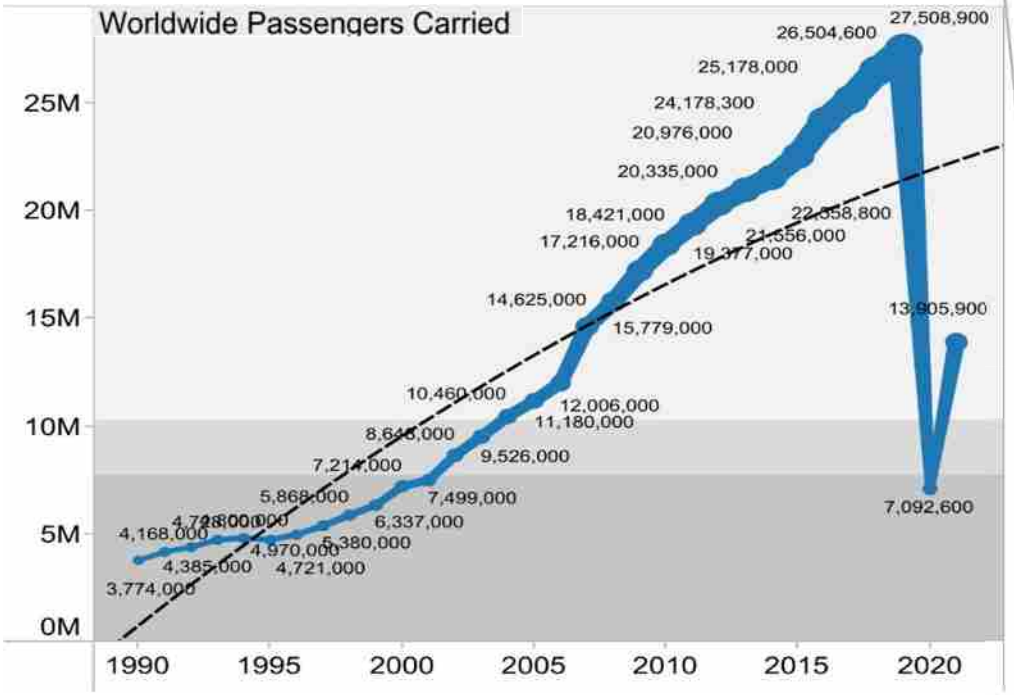
2005 V.S. 2021 WHO **air quality guidelines (AQGs)**

Preventable PM2.5 deaths avoided if new AQGs met globally: ~80% Source: WHO

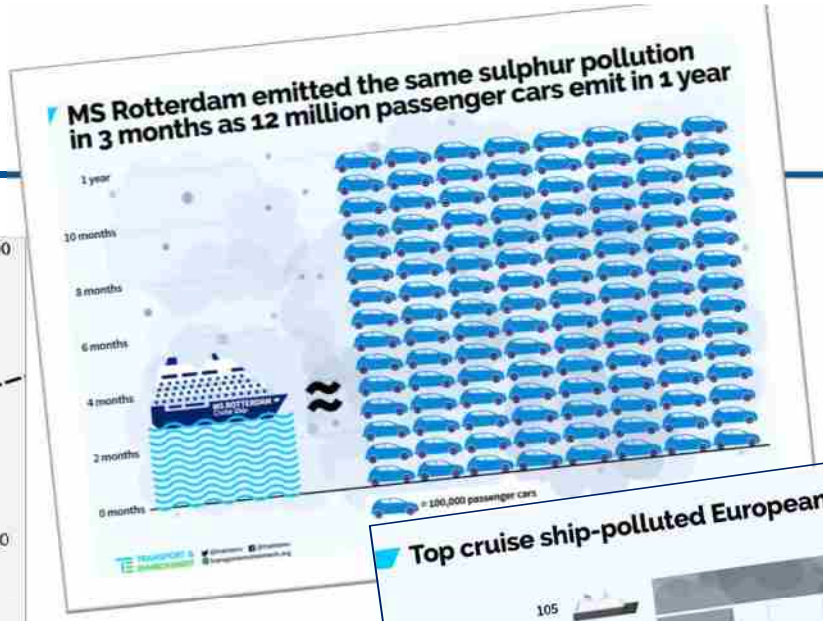
Pollutant	Averaging Time	2005 AQGs	2021 AQGs
PM2.5 µg/m³	Annual	10	5
	24-hour	25	15
PM10 µg/m³	Annual	20	15
	24-hour	50	45
Ozone (O3) µg/m³	Peak Season†	-	60
	8-hour**	100	100
Nitrogen dioxide (NO_2) µg/m³	Annual	40	10
	24-hour*	-	25
Sulfur dioxide (SO_2) µg/m³	24-hour	20	40
Carbon monoxide (CO) mg/m³	24-hour*	-	4

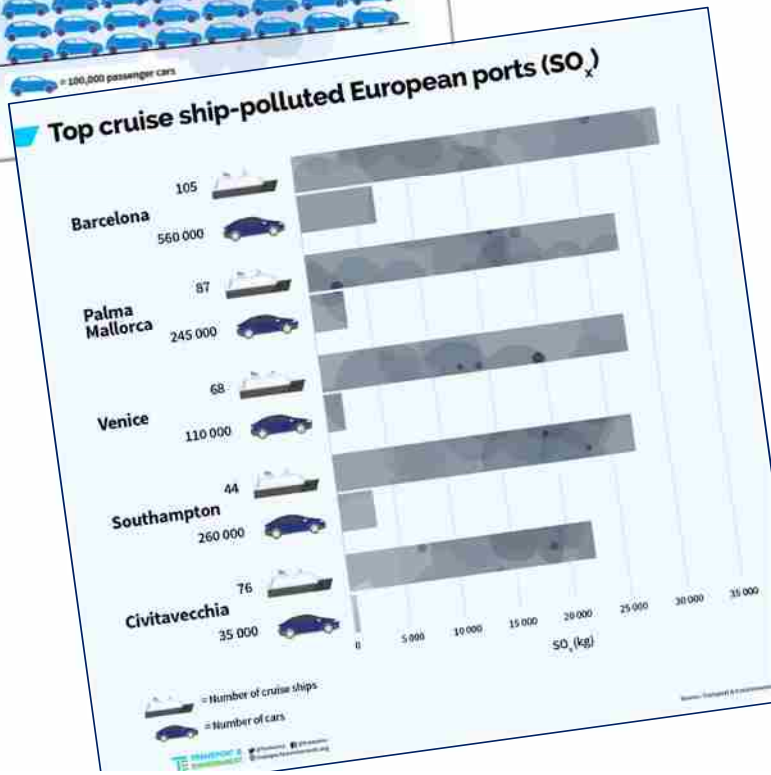
* New averaging time for 2021 | † Peak season – average of daily maximum 8-hour mean ozone concentration during the six consecutive months with the highest six-month running average of ozone concentration | ** 8-hour average. SO, 10-minute average, and CO, 8-hour, 1-hour and 15-minute averages unchanged from previous recommendations. Source: World Health Organization

Focus on Sustainable Cruise Tourism



Source: *Cruise Market Watch*





High pollution level on cruise ships

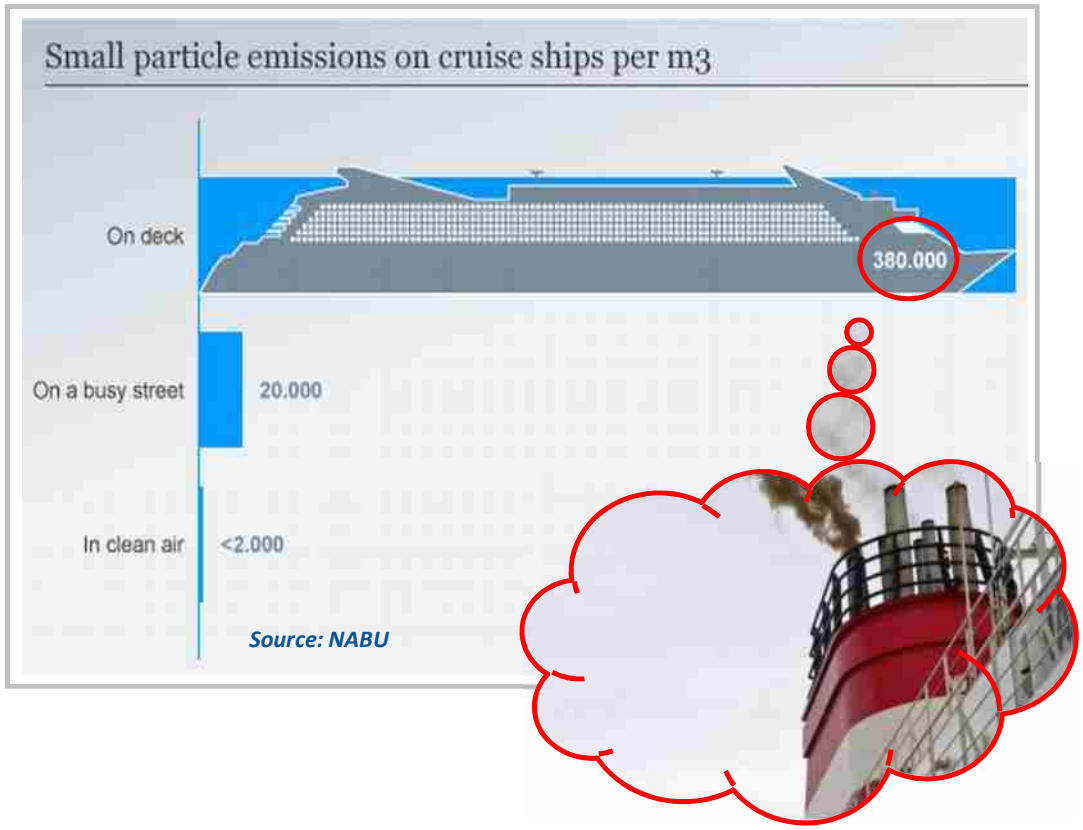
NABU finds high pollution levels on cruise ships deck

by The Editorial Team — January 25, 2017 in Emissions

Undercover air tests on the passenger deck of a European cruise ship have shown 'high levels of health damaging ultra-fine particles' in the ambient air, the German NGO NABU (Nature And Biodiversity Conservation Union) says.

NABU conducted a series of air pollution measurements inhe passenger deck of a European cruise ship now unveiled high loads of health damaging ultra-fine particles in the ambient air. A journalist documented concentrations up to 200 fold above natural background levels.

The measurements were carried out but a French TV team working for the famous TV show "Thalassa" which was broadcasted last Friday, January 20th on France 3. In recent months NABU had already conducted a series of air pollution measurements in several port cities and next to cruise ship terminals in Venice, Hamburg, Marseille and Barcelona.



Environmentally friendly cruise ships

LIQUIFIED NATURAL GAS (LNG)

- 49% of new capacity on order will rely on LNG for primary propulsion

EXHAUST GAS CLEANING SYSTEMS (EGCS)

- More than 69% of global capacity utilizes EGCS and 96% of non-LNG new builds will have EGCS installed

SHORE SIDE ELECTRICITY

- 58% of new capacity is committed to be SSE compatible 32% of global fleet capacity already capable of SSE, and 25% of existing capacity will be retrofitted to use SSE

ADVANCED WATER TREATMENT SYSTEMS

- 99% of new ships on order will have these systems in place, bringing global capacity served by these systems to 78.5%

Norwegian experience

Geiranger Fjord

Norwegian parliament adopts zero-emission regulations in the fjords

3RD MAY 2018 | IN NEWS | BY MARIE LAUNES

The Norwegian Parliament has adopted a resolution to halt emissions from cruise ships and ferries in the Norwegian world heritage fjords as soon as technically possible and no later than 2026. This will make the fjords the world's first zero emission zone at sea. The decision will have a positive impact on the local population, transport and tourism, climate and the environment, and the maritime industry.

In 2026 only ships with zero emissions will be allowed to tour the scenic Geiranger fjord.

"For the first time in the world there is a requirement for emission-free sailing in the fjords and their harbours. Norway has long been a world leader in emission-free ferries based on sound political decisions on zero-emission requirements. Now the country is taking a step further in the maritime green shift, with global repercussions. At the national level, this will mean a welcome development towards emission-free solutions on many tourist ships, a significant decrease in greenhouse gas emissions and a halt to harmful local air pollution," says Marius Holm, head of the environmental foundation ZERO.

https://www.cruiseindustrynews.com/

Norway Extends Zero-Discharge for Heritage Fjords to 2030

May 04, 2020

The Norwegian Maritime Directorate (NMD) has recommended an extension of the zero discharge deadline for the so-called World Heritage Fjords from 2026 to 2030. The recommendation was sent to the Norwegian Ministry of Climate and Environment.

https://maritimecleantech.no

Comparative considerations

Geiranger Fjord

Kotor Bay

***Source**: wallpaperflare.com*

Possibilities for exhaust emission reduction from Cruise Ships in Kotor Bay area

- Monitoring of air quality available
- Monitoring of marine fuel quality (sulfur content) available
- Shore side electricity available
- Shore side or barge based exhaust gas after-treatment technology available
- Optimization of cruise ship stay in the Kotor Bay
- New taxation in accordance of cruise ship's green level
- Anchor position change to outside of Kotor Bay, etc.

Source: Port of Gothenburg

EXCLUSIVE - Dubrovnik Port Authority installs air quality monitoring system

Written by Mark Thomas Jul 24, 2019 Print Email

Published in Dubrovnik

The Dubrovnik Port Authority has taken a huge step in order to monitor the quality of the environment and the air of the busiest cruise ship ports in Croatia.

Given the ever more frequent topics related to environmental protection, air pollution, the sea, the land and their causes, and just who and indeed what is "guilty" an air quality measuring station has been installed at the Port of Dubrovnik.

As part of the Inter-PASS Intermodal Interconnection between ports and airports, a project approved by the INTERREG ADRION program, an ECO measuring station was acquired for the purpose of monitoring air quality, relative humidity, atmospheric air, air temperature, nitrogen oxide and monoxide concentrations, sulphur dioxide, carbon monoxide, UV index with display results on the screen and

SUSTAINABLE DEVELOPMENT

Cruise Industry Environmental Efforts

https://www.youtube.com/watch?v=FhQtGx98GCA&t=83s

https://www.youtube.com/watch?v=YUKk72Y1rvA

https://os.copernicus.org/articles/17/699/2021/

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