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ΘΕΜΑ:

ENVIRONMENTAL IMPLICATIONS OF MARITIME TRANSPORT OPERATIONS

ΕΠΙΒΛΕΠΟΥΣΑ ΚΑΘΗΓΗΤΡΙΑ: ΠΑΝΑΓΟΠΟΥΛΟΥ ΜΑΡΙΑ

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ABSTRACT

The aim of this project is to offer the reader an approach to the issue of marine pollution, in relation to maritime activity.

At the beginning the complications that destroy the earth's atmosphere and the harmful gases that burden it, are mentioned. It is also pointed out that shipping contributes to climate change and how it affects the atmosphere, the sea and the land.

Afterwards, extensive research and analysis is carried out on the marine pollution brought by the shipping activity at sea. All categories of infections are reported as well as the problems and complications. Dangerous cargoes transported on ships and contributing to environmental pollution are analyzed and reported too. Some very dramatic and significant accidents are reported and the complications caused to the environment are investigated.

Finally, reference is made to the effects of environmental disasters on the human factor and the conclusions of the project are recorded.

CHAPTER 1 | CLIMATE CHANGE

Humanity is experiencing and trying to deal with the impact of climate change on the planet and society. It is scientifically proven that most of the climate change is now due to human activities as confirmed by the 5th IPCC report. One of these activities is maritime transport. Ships continue to be the most energy efficient means of transportation.

Climate change is constantly affecting maritime transport through the natural phenomenon caused by it, such as the melting of ice and the change of ship routes through the Arctic. The effects of climate change on humanity are constantly increasing, putting pressure on governments to act more as a deterrent to air pollution.

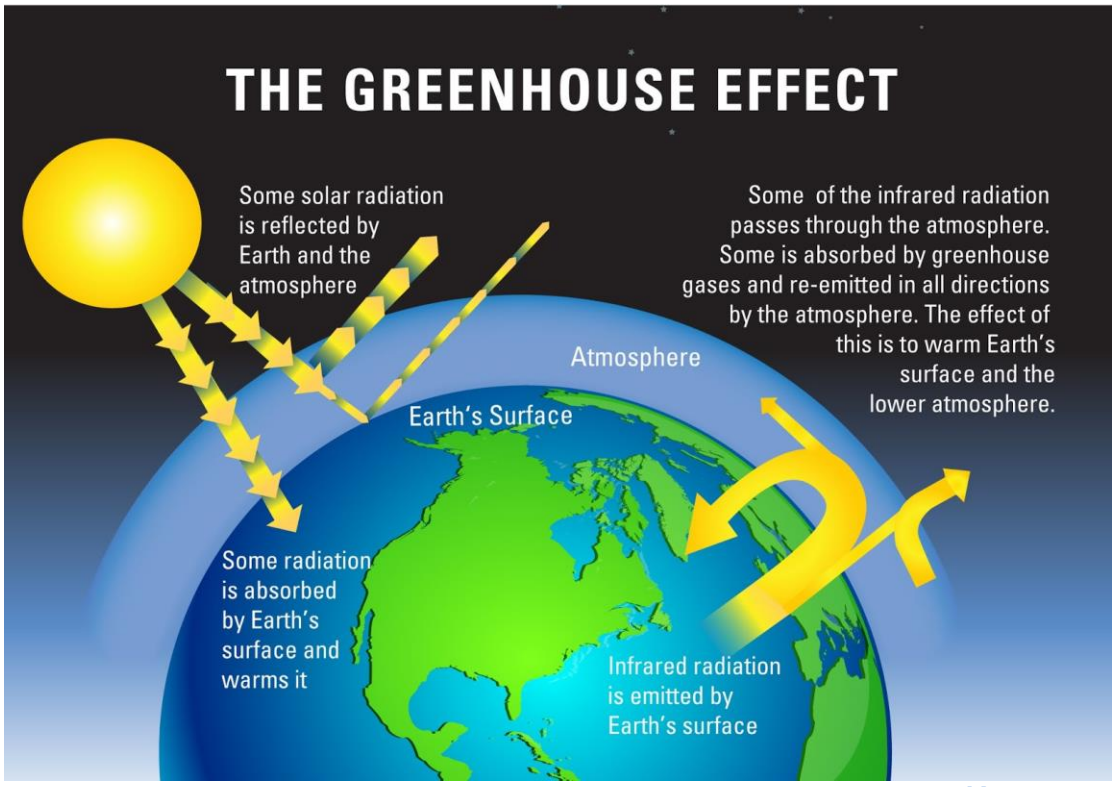
Therefore, through the consequences, it influences the enactment of increasingly strict environmental legislation and rules governing the emission of pollutants that contribute to the greenhouse effect from maritime transport. The object of the study is the evaluation of the actions that are done and implemented at the global level and in shipping regarding the reduction of the emissions of pollutants that participate in the phenomenon of climate change. Climate change, in the most specific sense of the word, is what we are interested in during the period we are going through, with the changes that are observed in the climate, globally, during the last decades. The most obvious and easily observable indicator is the increase in the average temperature of the planet. According to temperature measurements made by scientists at NASA's Goddard Institute for Space Studies (GISS), the Earth's average global temperature has risen by 0.85 ° C since 1880. Two-thirds of this increase has occurred since in 1975 onwards, at a rate of about 0.15-0.20 ° C per decade.

Maritime activity is having a major impact on climate change as well as global phenomena worldwide.

University of Exeter

1.1 | GREENHOUSE EFFECT

The greenhouse effect is called the natural process through which the preservation of the temperature conditions prevailing in surface of the Earth. This phenomenon was named after showing its similarity heating process with that of the classic plant greenhouse. It provides an average temperature for the Earth of about 15 °C (if it were not for this atmosphere, its average temperature would be around -23 °C). The Atmospheric greenhouse effect essentially describes a virtual device in which the planet's atmosphere acts as a heat pump driven by an environment that does not interact with radiation but that shows a balance of radiation in the atmospheric system.



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Greenhouse gas is enhanced by human activity, which helps to increase the concentration of greenhouse gases as well as the release of other trace elements, such as chlorofluorocarbons (CFC's). In recent years, there has been an increase in the concentration of several greenhouse gases (Carbon Dioxide, Methane, Nitrogen Oxide, which trap solar radiation in the atmosphere), especially in the case of carbon dioxide (CO_2).

Total Receives solar radiation, corresponding to a flow of approximately 1966 W / m2 (watt / square meter) at the atmospheric limit. Part of it is absorbed by the Earth-atmosphere system, while the rest escapes into space. About 30% of the incoming solar radiation is reflected, at a rate of 6% from the atmosphere, 3% from the clouds and 4% from the Earth's surface. 70% of solar radiation is absorbed, 32% by the atmosphere (including the stratospheric ozone layer), 3% by clouds and the largest percentage (51%) by the surface and oceans.

Due to its temperature, the Earth also emits thermal radiation (in a manner analogous to the Sun), which corresponds to long wavelengths, in contrast to the corresponding solar radiation, which is short-wavelength. The Earth's atmosphere is highly opaque to long-wavelength earth radiation, meaning it has the ability to absorb most of it, about 71%. The atmosphere itself emits long-wave heat radiation, part of which is absorbed by the Earth's surface, which heats up even more. The Earth's atmosphere thus behaves as a second - together with the Sun - source of heat.

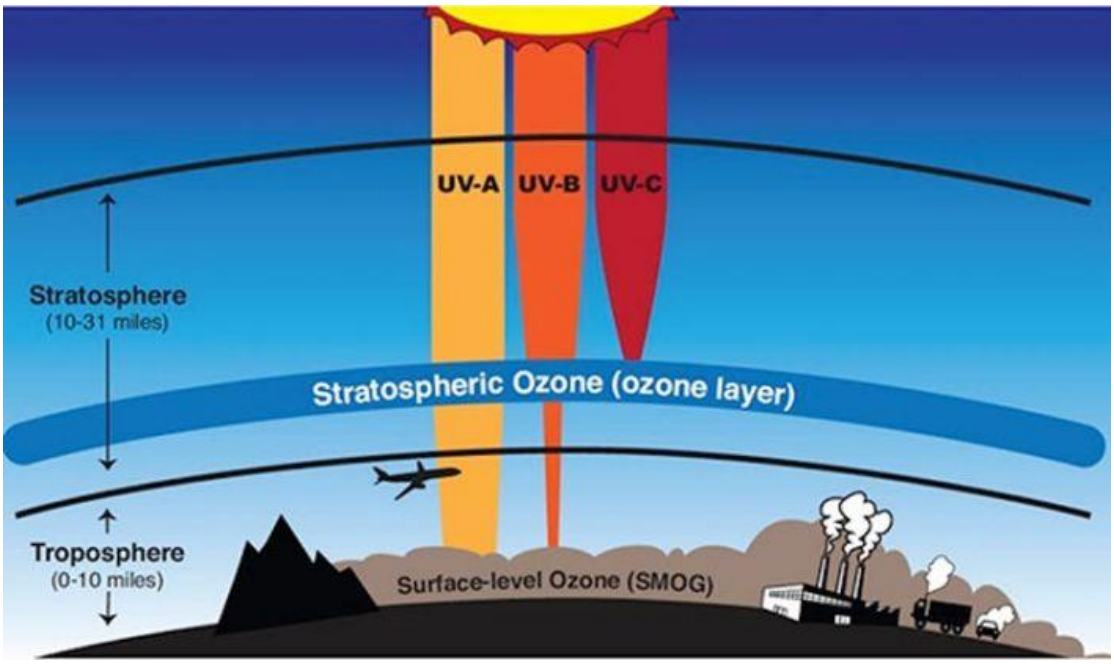
The effects of changing greenhouse gases are relatively difficult to calculate, but of course many of the effects of the phenomenon are obvious, such as:

- The average temperature of the earth will rise. However, some areas may benefit from the average rise in temperature and others may not.
- Warmer conditions are likely to lead to the evaporation of larger volumes of water and consequently more rainfall, but the effects will vary from region to region, as other areas will have a humid climate and others will be affected by drought.
- The greenhouse effect can cause the temperature to rise to a point where the temperature of the oceans rises sharply and causes icebergs and other ice to melt slightly, which will help raise sea levels.
- Some of the planet's animal and plant species may benefit from the increase in the carbon dioxide content of the atmosphere, which will lead to a rapid increase in their population and consequently to the utilization of water. At the same time, however, high temperatures and climate change will lead to climate change in the areas and native species of animals and plants that were favored in the past for their growth may now not be favored and thus there will be a change in the biodiversity of these areas.

In conclusion, gas emissions from maritime operations impacts, globally, the atmospheric air concentrations, increasing the greenhouse gases and as a result it helps the global warming and driving the earth to a new era of really high and dangerous temperatures which are going to inflict every species of the planet.

1.2 | OZONE HOLE

Ozone is a gas found in the Earth's atmosphere and in higher concentrations is found in the stratosphere. Stratospheric ozone is essential because it protects life on Earth by absorbing dangerous ultraviolet (UV-B) radiation. Since 1980s, there has been a significant depletion of stratospheric ozone, mainly over Antarctica. This phenomenon is called the "ozone hole". The result of the phenomenon is the increase of ultraviolet radiation that reaches the earth with negative effects on all ecosystems. The effects of ultraviolet radiation on humans are mainly related to skin and eye diseases.



Dorrian, G. 2019

In addition, the negative effects of ultraviolet radiation on terrestrial ecosystems affect plants more strongly by reducing both their growth and reproduction but mainly by reducing photosynthesis. But also in marine ecosystems, plants and algae are mainly affected, reducing photosynthesis. The result is not only a reduction in global oxygen production but also an impact on food webs as the primary producers of all ecosystems are reduced.

Other organisms that are strongly affected by ultraviolet radiation are amphibians, by reducing the success of hatching or survival of their larvae and insects. Finally, the biogeochemical cycles are affected and especially the carbon cycle, as it is affected by the production and capture of carbon dioxide.

The chemist Paul Crutzen was the first to point out the negative effect of nitrogen oxides on the ozone layer since 1970. But the problem, which was first identified in the 1980s, is the significant reduction in stratospheric ozone levels over Antarctica, especially in the spring, which has been called the ozone hole.

To understand the magnitude of the problem, the concentration of ozone in Antarctica is measured at about 100 DU while in other areas where there is no ozone depletion its concentration is around 300DU. In fact, no hole is created, it changes the thickness of the ozone layer below normal. Under normal conditions, the ozone layer at the poles is thicker than Ecuador and in spring it is thicker than in autumn. Therefore, there is a direct correlation between the thickness of the ozone layer with both the area and the time of year.

In the Arctic it is more difficult to occur due to the winds and due to the fact that the stratosphere in this area is quite hot resulting in the formation of clouds and bleach molecules. What has been observed is that in case of severe cold there is a significant loss of ozone layer of the order of 120-140DU and something like this happened in the years 1994-1995, unlike hot seasons there is even zero loss. However, the greatest ozone depletion in the Arctic was observed relatively recently, in the cold winter of 2010/11, in which case almost 75% of the ozone layer was lost.

In the middle latitudes and specifically in the northern hemisphere measurements showed that the decrease of ozone during the spring period reaches 6% while in the southern hemisphere the percentage ranges from 4-5% during the year, while in the tropics no significant reductions of its concentration were observed.

It is worth mentioning that ozone depletion by 1% corresponds to a 2% increase in UV-B reaching the Earth's surface.

The spring of 2000 has been confirmed as the year with the largest ozone depletion recorded in the Antarctic region, measuring 93.4 DU at a maximum area of 29.8 million km2. By comparison, 2008 was the fifth highest year of ozone depletion in the Antarctic, measuring 99.9 DU over 27.1 million km2.

Grinter M. 12/2020

1.3 | CARBON DIOXIDE CONCENTRATION

Carbon dioxide (CO2) is a colorless, odorless and non-flammable gas, a product of cellular respiration and fossil fuel combustion, with a molecular weight of 44.01g / mol6. Although typically present as a gas, carbon dioxide can be found in solid dry ice as well as liquid, depending on the temperature and pressure it undergoes. This gas is widely used in many types of production processes such as brewing, metallurgy, carbonated beverages, pharmaceuticals, disinfectants and ceramics. It is also the main product produced during volcanic eruptions.

At present data, carbon dioxide levels are at 404.7 ppm, according to updated measurements of the Global Greenhouse Gas Reference Network conducted on 06/03/2017. At the beginning of the 19th century it was at the level of 280 ppm, while during the 1st century was about 260 ppm. These data are made known by parts of "ancient air" trapped in bubbles of known age in the Antarctic ice sheet.

There is an increase of 90 ppm within the 19th and 20th century, that is 0.45 ppm per year, while after the beginning of the 21st century there is a linear increase which exceeds 3 ppm per year, the equation for calculating the concentration of carbon dioxide in the atmosphere.

For the year 2012, total maritime emissions amounted to approximately 938 million tonnes of carbon dioxide and 961 million tonnes of carbon dioxide equivalent, while international shipping is estimated to have contributed 796 million and 816 million tonnes respectively. As a percentage, global shipping activity accounts for 2.2% and 2.1% of global carbon dioxide and greenhouse gas emissions, of which CO2 is the most important, respectively.

For the period 2007-2012, on average, maritime operations, in total (international & domestic) produced, approximately, 3.1% of the annual global carbon dioxide emissions and, approximately, 2.8% of the annual greenhouse gases. Future forecasts suggest that these emissions will increase from 50% to 250% by 2050, depending on upcoming economic and energy developments.

1.4 | CLIMATE CHANGE IMPLICATIONS

International maritime transport, like other economic sectors, faces a twofold challenge in terms of climate change:

1) The need to reduce carbon emissions and, at the same time,
2) Adapt to the potentially far-reaching effects of climate change.

Given the vital importance of international maritime transport for world trade, tackling the challenge of climate change is imperative. With 80% of the volume of world trade by sea, international shipping and ports provide critical links to global supply chains and are essential to the ability of all countries, including isolated ones, to access global markets.

Climate change is expected to have various environmental, social and economic impacts, the severity of which varies depending on the geographical location, the country and the region. Rising average sea levels, increased frequency and intensity of extreme storms and waves, droughts and / or river floods and rising average temperatures as well as extreme temperature fluctuations are some of the climate changes that pose a serious threat to coastal (e.g. x. ports) transport. Immediate threats include accelerating coastal erosion, flooding / sinking of ports and coastal roads, water supply problems, restrictions on access to docks and marinas, deteriorating conditions and structural integrity problems of roads, bridges and railways. In addition, transport may be severely affected (e.g. shipping volumes and costs, loading / cargo capacity, and / or onshore storage schedules) may also be severely affected.

The special case of ports is worth noting. With more than 80% of international trade in goods by sea, seaports are critical links in international supply chains, providing vital access to global markets for all countries, including the Mediterranean. Seaports as well as inland connections are vulnerable to various climatic phenomena. Especially in ports located in low island environments, estuaries and their deltas in developing areas, which are characterized by high exposure probability and low adaptability

More specifically, port cities need special attention as they are of great importance for international maritime trade. The Organization for Economic Co-operation and Development (OECD) has predicted that famous and large port cities are vulnerable to climate change and especially to rising sea levels, which will be analyzed below. Typical are Miami, New York, New Orleans, Osaka-Kobe, Tokyo, Amsterdam and Rotterdam (which includes Europe's largest port), which seem to be developed and, in fact, rich countries: the USA, Japan and the Netherlands.

THE IMPLICATIONS

Optionally some of the consequences of the Earth's rising temperature are:

1) High temperatures

2) Melting ice

3) Frequent cold spells and freezing cycles.

These in turn cause or may cause various complications such as:

1) Longer shipping period on the North Sea route, new sea routes on the Northwest Passage (NWP) which in turn leads to

2) Shorter distance for Asia-Europe trade and therefore less fuel consumption.

3) Additional support and navigation services, such as icebreakers and search and rescue operations

4) Competition, lower tolls and reduced transport costs

5) New trade, diversion of existing trade, structure and direction of trade (indirectly through the impact on agriculture, fisheries and energy)

6) Damage to infrastructure, equipment and cargo

7) Increased costs of construction and maintenance of ships, new ship design and reinforced hulls, environmental, social, ecosystem and political considerations

8) Higher energy consumption in ports

9) Fluctuation in demand and supply of shipping and port services

10) Reduction of reliability of services

The rising sea levels

Typically mentioned:

1) Floods and consequently

2) Erosion of coastal areas.

Complications caused by these in maritime transport are:

1) Damage to infrastructure, equipment and cargo (coastal infrastructure, port structures and inland connections)

2) Increased construction and maintenance costs, soil erosion and subsidence

3) Relocation and migration of people and businesses, labor shortages and closure of shipyards

4) Fluctuation in demand and supply of shipping and port services (e.g. relocation) and relocation of vessels

5) The structure and direction of trade (indirectly through the impact on agriculture, fisheries, energy)

6) There will be challenges for the reliability of the services and the reduction of dredging, reduced safety and conditions for sailing.

Extreme weather events

Extreme weather events following climate change are:

1) Tornadoes

2) Thunderstorms

3) Floods

4) Increased rainfall

5) Winds

Complications that could potentially cause problems in shipping activities directly and indirectly related to it are:

1) Damage to infrastructure, equipment and cargo (coastal infrastructure, port structures and inland connections)

2) Erosion and landslides

3) Relocation and migration of people and businesses, labor shortages and closure of shipyards

4) Relocation of means of transport, change in demand and supply of shipping and port services

5) Reduced safety and sailing conditions, a challenge for the reliability of services.

It is observed here that many of these complications are common to the various elements that contribute to climate change. This is because they are complementary and consequential and not mutually exclusive phenomena.

NASA, Global Climate change

CHAPTER 2 | SEA POLLUTION

M. Bin Aqeel 09/2020

Marine pollution is a form of pollution characterized by the presence of pathogenic microorganisms in the environment or markers, which indicate the possibility of the presence of such microorganisms. In general, marine pollution is caused by marine activities, while pollution of the marine environment can also come from land sources.

But the purpose of international law is not to provide for all substances discharged into the sea, but only those that are considered harmful. Pollution can be caused by various factors such as merchant ships during loading and unloading, tank cleaning, ballasting-deballasting, maintenance, repairs and maintenance, sewage and waste discharges but also by accidents of all kinds (e.g. explosions, collisions), from dumping of radioactive waste, but also from the extraction and exploitation of the seabed.

Factors that have contributed to the rapid spread of the problem are both the use of oil as a major source of energy and the large increase in maritime transport of oil and other chemical elements.

2.1 | OIL SPILLS

Oil is a mixture of organic compounds, with harmful effects on the environment due to their toxicity. The oil spill is the result of oil spilling into the sea, creating a stain in the sea waters, and its transport due to inertia, winds and currents.

Oil burdens the environment with toxic substances and affects the ecosystem. Oil spill pollution is the leading source of marine pollution worldwide. Basic oil pollution is expressed by the word "oil spill" or "oil pollution". This is the pollution of the environment by the outflow of oil from ships, which outflow can be due to various situations. Initially, the first type of oil pollution, which comes from shipping, is "operational pollution", pollution that comes from shipping, the operation of the ship, from the beginning, the ways of building a ship, up to the operation (maintenance, maintenance and finally dismantling).

Crude oil is a mixture of hydrocarbons, containing organic compounds of sulfur nitrogen and oxygen. Petroleum process species are directly related to the nature of the hydrocarbons that make up oil. Oil is divided into three main categories:

1. Paraffin oils consisting of solid paraffin, the process of which results in saturated aliphatic hydrocarbons, such as methane, ethane, propane and butane.

2. Asphalt oils are those that produce petroleum products such as fuel oil and mineral oils. Products of the process´ of these oils are saturated cyclic polymethylene hydrocarbons

3. Asphalt paraffin oils are a mixture of the above two types of oil. Products in this category are gases such as nitrogen (N2), carbon dioxide (CO2), hydrogen sulfide (H2S), and helium (He).

Oil spills are a serious pollutant as well cause immediate problems in the marine environment. They continuously affect the flora and living life that you come in contact with oil. In this category belong to fish, marine mammals and then people through the food chain, as well as land creatures like birds belong to this category. Through food chain there is a risk of extinction of species or living generation of life.

The severity of the problem is emphasized as recovery from oil spill pollution is needed 10-20 years for the marine environment, while a lot more for coastal areas and beaches. In addition, the technical treatment of oil spills is difficult to achieve, as with contact with the environment, the oil is subject to physicochemical changes.

Such physicochemical changes are the following:

1. The spread of oil over the extent of marine waters due to its natural forces gravity and surface stresses. In addition the crude oil spilled into the sea can spread for over 12 hours by creating thick layers thickness from 0.5 to 0.3 mm. Moreover, with his "help" air, oil slicks travel along the seawater.

2. The oil being liquid, evaporates (for accurately evaporate volatile fractions into the atmosphere, thus contributing to air pollution.

3. Dissolution of oil is a physicochemical change with minimal products and therefore practical dissolution oil is not made specifically in seawater. The reason is the salt content of seawater and the inability to dissolve hydrocarbons in it.

4. Another physicochemical change is biodegradation. This process depends on its temperature environment, the presence of oxygen and of course the species of the oil.

5. Oil slicks tend to thin films and the hydrocarbons of this surface react chemically with atmospheric oxygen. This process is called photo-oxidation. The oil spilled into the sea outside oil spills on their surface seawater, can also sink to its bottom of the sea. This results from the adhesion of sediments and sand near beaches, resulting in pollution of the bottom in shallow water.

The effects of this pollution are many, so natural as well as environmental. Initially, the membranes of the oil slicks act as natural barrier between the exchange of air and substances by atmosphere at sea, affecting marine life. The effects are related to the lack of oxygen, the chlorophyll composition and increase in its temperature marine environment. This also contributes to the impact of biologically harmful effects as well as in such areas microorganisms are created in its water marine, marine flora and living life are affected. The effects of the above on humans, have mainly related to health. The volatile fractions of oil spills cause poisoning by inhalation and through the food chain (fish feed and of shellfish from infected areas).

Oil pollution due to shipping can result from either maritime accidents or operational shipping processes.

MARITIME ACCIDENTS

Maritime accidents initially involve the sinking of a ship in seawater, resulting in a spill. The sinking is usually either due to technical malfunctions, damage, or occurs as an accident due to difficult weather conditions that the ship cannot cope. Another type of accident is accidents caused by fires or explosions due to malfunction of machinery or dangerous cargo carried by merchant ships.

Landing or shipwrecks are also a type of maritime accident that usually occurs in ports. Finally, collisions between ships or with artificial obstacles such as piers and platforms are also considered a type of accident. Operating processes also cause pollution by spilling oil into the environment, but also by more general pollution due to materials and harmful substances. Examples are the shipbuilding, with the elimination of pollutants in the form of heavy metals from paints, greases and residues of sandblasting and water cannons, rust or even useless residues from maintenance of ships such as sheets or cables.

In addition to the maintenance and construction of ships, pollutants are also created by shipbuilding. The main reason is that ships are usually dismantled near seawater, and despite the small amount of pollutants released during the dismantling of a ship, the overall pollution is significant for the sea.

The process of loading, unloading also belongs to the operating procedures. It is the process that ships follow when disposing of the water they use by filling their tanks to make their voyage when not loaded with their commercial cargo. This process also removes some oil residues into the sea, which usually cause oil spills. The problem is due both to the process itself and to the large number of ships carrying oil.

2.2 | ACCIDENTAL POLLUTION

In this chapter, we will look at the pollution that is "accidentally" caused by some accidents that occur during maritime transport, we will see and analyze the main categories of accidents, the causes that are caused as well as their consequences.

Specifically, the main categories of accidents are the following:

- The death or injury of a person, caused by ship operations
- The loss or abandonment of the ship
- The material damage to the ship
- The grounding or collision of the ship
- Material damage resulting from ship operations
- Damage to the environment caused by damage to the ship

The landing of ships takes place mainly in coastal areas due to mechanical damage, bad weather or incorrect navigation and is observed mainly in large tankers. The term "ship collision" refers not only to contact with other ships but also to contact with a permanent establishment (e.g. port piers, oil rigs, etc.). According to statistical studies, 80% of collision cases are the result of human error. The material damage to the ship (may be a fire or an explosion due to the transport of oil or fuel), shows high percentages in human losses, since the ship does not have immediate help from the shore if e.g. the ship is in the middle of the ocean, and the conditions become even simpler forms difficult with the changes of the weather. We have a ship loss when there is war (piracy), when fuel is transported during wartime situations.

Finally, damage to the structure of the ship occurs when the outer hull or its walls have been damaged due to some displacement of cargo, poor maintenance or some mechanical damage. However, apart from accidents, there is the case of mixed accidents, such as: Fire and sinking, collision and sinking, grounding and fire, collision and explosion, etc.

CAUSES OF ACCIDENTAL POLLUTION

Factors that cause accidental pollution are:

- Rules of classical naval discipline
- Incomplete crew training
- Multilingualism on board
- The ages of the ships
- The human factor

It is a fact that when people on bridges do not understand the satellite alarm signals (either because someone "inferior" tells them to do it, or out of ignorance of the use of the systems, or because they do not know the language of the person reporting the problem, the ship is old and there are incorrect indications on the compass, etc.) then the chances of a maritime accident increase. Finally, the human factor can in turn contribute to accidental pollution for various reasons such as due to fatigue, stress and confusion, intoxication, lack of information and instructions for a new means of technology, etc.

As a result, the marine ecosystem is disturbed and species of fauna and flora become extinct. In addition, we have a decline in the value of urban land in coastal areas due to environmental degradation. However, the effects are also seen in the tourism industry, since the tourist flag of the region is degraded and at the same time the income of the country is reduced, as well as the jobs. However, these are not the only consequences, as the fishing industry and human health are also affected, as pathogenic microorganisms and viruses enter the polluted waters through the food chain or by swimming on dirty beaches.

The phenomenon of "eutrophication" is now known, where due to water pollution the various algae grow at a rapid rate, some of them rot and decompose consuming the oxygen of the water. As a result, many fish and other organisms die and unpleasant odors are created. Finally, the country's economy is "falling", as many millions are paid in fines for the pollution caused. A typical event that happened and caused many of the above consequences or perhaps most of them, is the sinking of the oil tanker

Torrey Canyon (1968) where 100,000 tons of crude oil were spilled into the sea. So it would be "valuable" to deal with marine pollution much more seriously all of us, since the consequences affect us directly and individually but also as a state, and especially our country has many economic benefits from the sea (tourism, fishing).

2.3 | FUNCTIONAL POLLUTION

In this chapter we will also look at "operational" pollution, which is defined as any non-accidental form of pollution that causes in the marine environment the usual consequences of a merchant ship, the causes that cause it and the consequences that occur.

Specifically, any shipbuilding process contributes to the operational pollution (e.g. from the construction of the ship itself, residues of paints, greases, oils, rust .. come in direct contact with the sea. Also, from the installation of the ships engine various lubricants, coolants, etc. In the shipbuilding processes are also registered the oxygen welds, steel cutting, lubrications, etc.), unloading processes (the type of pollution depends on the type of cargo, liquid cargo causes greater pollution) where the cargo is discharged into the sea due to a strong wind for example if it is dry, or some damaged piping material /orifices if it is wet.

This category also includes fuel transfers (from land to ship or from ship to ship). Another factor that helps in pollution is the sealing-desalination processes. That is, many oil tankers fill their tanks with sea ballast in order to be able to sail, and then do waxing with which many residues from the tanks are carried to the sea. The processes from the dismantling of the ship are another cause of functional contamination, since in order to produce scrap iron, gaseous, liquid and solid residues are created. Smoke and dust (gases) are created from the cutting of sheet metal at high temperatures, residues (liquids) are created from the tanks that wash the ships before the cutting, and finally we have residues (solid form) from rust, mud, plastics, etc.

Another source of challenge is the deliberate dumping of substances from ships such as sewage caused by filling (sewage, sinks, baths ...) and the "unloading" of the sheet (part of the ship that collects all debris during the travel waste management, repair-maintenance, pollution from reef paints, etc.), and when it fills it empties into the sea). Finally, operational pollution is caused as in accidental pollution, so in

operational pollution, the consequences are the same from port activities (towing, refueling ships) and affect all living organisms on and off the sea.

In summary, it is important to mention that the problem of marine pollution already exists in Greece, mainly in the Saronic Gulf, and according to statistics 85% is due to land sources while 15% to merchant ships. This means that we must all be immediately aware and act accordingly before the problem spreads to other areas.

2.4 | DANGEROUS CARGO

Dangerous goods are those that cause marine pollution, which does not come from land sources and are carried by merchant ships. (Military ships carrying war chemicals, ammunition, etc. are not considered to do so intentionally).

In Greece, these loads are classified according to the requirements of the I.M.O. and the International Maritime Dangerous Goods Code (I.M.D .G.) and are divided into 9 classes:

• Explosives

•Gases

• Flammable liquids

• Flammable solids

• Oxidizing substances

• Poisonous, toxic and infectious substances

• Radioactive substances

• Corrosive

• Various dangerous substances

Explosives are those substances that by themselves or with other compounds cause explosions.

Gases are substances in liquid form at ambient temperature pressure or dissolved under the pressure of a solvent.

Flammable liquids are those that emit flammable vapors when they are at <61 degrees C in closed containers, and <65.5 degrees C when in open containers.

Flammable solids are those that can be ignited with the help of heat.

Oxidants are substances that can easily release oxygen and increase the intensity of a fire.

Poisonous toxic and infectious substances are those that cause death or serious damage to human health or those that contain pathogenic microorganisms.

Radioactive are substances that emit radioactivity.

Corrosives are substances that under normal conditions can cause damage to living organisms.

In the various hazardous substances, we classify all those that are hazardous but cannot fall into any of the above categories.

Hazardous substances include crude oil and all its products (gasoline, kerosene ...), chemical charges (e.g. LPG), bulk dry hazardous charges (e.g. zinc sulfide, coal, tar ..) and packaged cargo (e.g. liquefied petroleum gas / products, oil in containers, straw, cotton, etc.). So when one of the above loads, such as oil is poured into the sea, a stain is created (a thin surface layer "film") which oxidizes quickly with the help of the sun. Tar is created in various sizes, which will either erupt on the shores or sink to the bottom of the sea. Emulsions are also created that increase the volume of pollution. A typical example is the EXXON VALDEZ shipwreck (Alaska, 1989), where emulsion was created immediately after the accident.

Some of the ships carrying dangerous goods are:

- Tankers (crude oil)
- Product carriers
- Chemical carriers
- Bulk carriers
- Container ships
- Pallet ships

The danger of the above ships is due, not only to the cargo they carry but also to the following issues:

- Depending on the tonnage of the ships
- The age of the ships
- The flag of the ships

M. Schuler

This bulk carrier sunk off the coast of Hong Kong at 2013, carrying nickel ore, one of the most dangerous cargos.

SPECIAL SUBSTANCES

There are some rare substances we can find on ships that need special treatment and precautions.

Asbestos

Is material used as insulating material in ship mechanisms such as boilers, tanks and steam pipes with hot water. It is a carcinogenic substance of category A. Based on the classification of the International Research Service of Cancer (IARC). It is material that has been banned for years, but there is no exact record for the quantity contained in the wrecked ships.

Mercury

Is a highly toxic substance. It is usually found accumulated in plankton, the shells and through the process of bioaccumulation in fish. In humans it passes through food and is responsible for poisonings that shake the nervous system. Mercury is found in various ship consumables.

Electrolytes from batteries

Are harmful toxic substances released from solutions sulfuric acid (electrolyte) and other toxic particles lead.

The list of harmful and toxic materials on a ship is large and each ship is required to carry a document with the name green passport, a document that describes exactly the quantities of each material that contains and must be approved by the respective registrar.

2.5 | ACCIDENTS

Summarizing this chapter let us look at some accidents recently, which caused major ecological disasters due to the dangerous cargo they contained.

The sinking of the Russian submarine Kursk

Pentapostagma 02/2020

It happened off the Barents Sea, in August of 2000, during exercise. The sinking, according to official Russian government sources, occurred when an explosion was caused by a leak of hydrogen peroxide fuel from a defective torpedo brought by the submarine. The accident caused major disturbances in the sea area. Radioactivity measurements were performed in both the Barents Sea and the Norwegian Sea.

Isotopic concentrations of I-131, Cs-137, Cs-134 and Co-60 were found in the Barents Sea for the period 16 August 2000 - 22 August 2000 on 21 water samples were less than 0.5 Bq per Kg for each isotope. In the water near the "Kursk" the analysis of the samples did not show increased levels of radioactivity. No increased levels of radioactivity were measured in the water through the "Kursk". No increased levels of

radioactivity were found in the sediments from the seabed around Kursk. However, they point out that some of the samples (21 in number) need further analysis.

The radiation dose was measured on board the Seaway Eagle, near the Kursk and above the reactor compartment before the Norwegian divers entered the Kursk. Maximum levels measured were below 0.1 mSv / h or 100 mSv / h.

Of course these radioisotopes that were mentioned did not have and have no reason to be in the natural environment as they directly affect life at sea.

Sinking of Prestige

Ispania.gr

A typical accident that took place 11 years ago and was considered one of the biggest ecological disasters in Europe, and that the court decided this year (13/11/2013) the 9-month imprisonment of the Greek captain Apostolos Magouras.

In the 1970s in Japan there was a massive construction of tankers that met the safety requirements of that time. These specifications resulted in the production of tankers very quickly at very low prices in order to immediately meet the particularly high ...

demand of that time. Of the 1,800 tankers at sea, it is estimated that about 300 are single-hull, built in Japan before 1980, and are therefore vulnerable to accidents. The Prestige was one of those ships. It was built in 1976 at the Hitachi Zosen shipyards in Japan. It was also reported that the American classification society that was monitoring the ship had identified problems and had given orders to repair them.

The wreck occurred when the oil tanker, which had suffered a mechanical breakdown, could not withstand the waves and bad weather and was cut in two. The ship finally sank on November 19, 2002 off Corbution and the 50,000 tonne cargo of oil contained in the tankers of the single-bottomed tank escaped into the sea causing enormous pollution. The total 200 km of oil slick threatened an area of major ecological importance and a particularly important fishing zone. Strong winds and sea currents swept the oil slick towards the newly formed National Marine Park of the Atlantic Islands of Galicia.

The Deepwater Horizon oil rig

E. Schwartzman

The Gulf of Mexico oil spill incident is the second in the same area after the Gulf of Mexico oil spill (1979). The cause of the incident was the malfunction of the Makondo oil well with the consequence of the explosion of a well that existed on the Deepwater Horizon platform. The drilling took place within the US Exclusive Economic Zone, 66 kilometers off the coast of Louisiana. The shareholders of the project were BP (65%), Anadarko (25%) and MOEX Offshore (10%). The US government said the oil leak was 4.9 million barrels, a disaster much larger than the first time. This is the fourth most devastating water accident in the world.

The platform was built in 2001 by the Korean company Hyundai Heavy Industries, on behalf of the company R&B Falcon, before its merger with Transocean. The podium operated under the flag of the Marshall Islands and from 2008 to September 2013 was chartered by BP. With this platform, the largest oil well had been drilled, at a depth of 10,000 meters.

In April 2010, it exploded, firing a fiery "ball" with an area of 64 kilometers from that point. There were 126 people working on the podium, of which 7 were from BP, 79 from Transocean and the rest were from other companies. 94 people were rescued by outboard, and rescue helicopters, of which 17 were injured. The U.S. Coast Guard searched for 11 people who, three days later, were found dead. The platform sank on April 22, causing an oil spill.

The consequences were financial for the major shareholder as well as environmental. The oil spill prevailed in the area for 87 days. Its quantity was estimated from the beginning by the British oil supplier to be between 1,000 and 5,000 barrels per day. However, the Technical Flow Control Team stated that it was equivalent to 62,000 barrels, proving that it was in a rapid phase and managed to collect only 10%.

According to satellite images, the size of the oil spill reached 180 kilometers, which is the size of the state of Oklahoma. In early June, the oil spill covered the coasts of Louisiana, Florida, Mississippi (state), and Alabama, over an area of 201 kilometers. Another 26 kilometers off the coast of Louisiana, covered in September of the same year while in October it covered the coast of Texas.

The oil spill has caused massive water pollution and the death of several species of birds and mammals, many of which are endangered species.

CHAPTER 3 | CONCEQUENCES & CONCLUSION

Taking into account what has been analyzed above we conclude that the consequences of the sinking of ships are catastrophic for the environment, sea or land and for humans.

Reduction of tourism

In a country like Greece, tourism plays an important role in the overall picture of our economy as it is one of our main income, and as it is known to all of us we take advantage of the beautiful parts of our country (especially during the summer months) and our beautiful beaches in order to get profits and be able to afford to pay the installments we have for the loans we have taken as a country.

So if a sea is polluted, the nearest shores at the scene of the accident are automatically polluted. This in turn leads to the temporary or permanent cessation of large tourism businesses (hotels, shops and various other tourism businesses) as tourists will no longer consider this place as a place of attraction, because the water will be green and not blue, will cause bad breath, marine organisms will be dead and the phenomenon of eutrophication will multiply day by day.

Reduction or cessation of fishing

Water pollution contributes to the death of marine organisms or to their contamination by heavy metals that if consumed by humans will have serious health problems. So the pollution of an area whose main income is fishing, as for example in many of our islands, will lead to the cessation of fishing and the "poverty" of this place due to ecological problems it will face.

Pause of house reconstruction

Naturally, houses near a contaminated area will no longer be rebuilt as people will be afraid of being infected by various viruses as well as will not be able to withstand the stench of water.

Psychological consequences

The activities that the inhabitants of the area used to do and which are not covered by compensations. Such activities are the cessation of fishing on the shores affected by oil spills, the cessation of swimming in the sea, the bliss that caused a walk in the area, the reduction of the local economy from revenues affected by the proximity of the sea (such as beach parties, concerts, water sports, etc.).

Cleaning costs

It is not calculated on the basis of the amount of oil spilled (because in no case are the oil slicks always the same), but on the basis of the type of pollutant. In fact, it is better to let the natural environment recover on its own, but the pressure of the world and the aesthetics to provide immediate solutions, overcome the long-term solutions. Heavy equipment and sufficient staff are therefore used to remove or reduce oil or other pollutants from the sea and the coast.

According to the analysis of the total cost of accidents (where 96% of the 358 accidents that have occurred in the last 10 years) it seems that the costs were shared equally between ship-owners and oil producers. The most expensive oil slicks were caused by small tankers e.g. the NAKHODKA and ERICA accidents.

The three biggest oil spills are:

- ATLANTIC EMPRESS, 1979 (287.000 t)
- ABT SUMMER, 1991 (260.000 t)
- CASTILLO DE BELLVER, 1983 (252.000 t)

The cost-effectiveness of a sea clean-up depends on a number of factors, including the training of staff, the equipment and materials required, the number of boats available, and how well and efficiently such a clean-up operation has been conducted. Coastal cleaning, however, costs less than sea cleaning, because it is based on manual methods, while coastal cleaning requires expensive equipment, boats, aircraft, and trained pilots.

Of course, the cost does not depend only on whether the cleaning is done offshore or on the coast but also on how extensive the cleaning will be, so that the contaminated area returns to its normal levels.

Cleaning costs are affected by various factors, such as:

- The type of product spilled
- The location and time period of the oil spill's effect on sensitive areas
- The limits of responsibility in the specific place
- Local and national laws
- The cleaning techniques that have been undertaken
- Weather conditions during cleaning operations
- The human factor

Heavy fuels that leave oil slicks that are difficult to decompose immediately and that have the ability to travel long distances, combined with weather conditions can help or vice versa cleaning companies and this will determine their final cost.

CONCLUSION

According to all the information mentioned in the above work, it appears that the consequences of marine pollution directly affect all of us (whether we are individuals or legal entities). In fact, our country, which is surrounded by the sea, should pay special attention to this problem, since its economic benefits are also affected.

Only quality water can ensure plant, vital and human life, which is why society as well as each individual has an equal obligation to protect water from pollution. The consequences are many but just as important, that is, man himself is infected through the food chain and the marine ecosystem, at the same time the phenomenon of eutrophication increases.

The time of self-purification is very long since it takes many years for nature to return to its original physical state, which means that our planet would lose this wealth it has.

But beyond that, there is something important that many may not be aware of. Research has shown that contamination of water with metals e.g. Mercury can cause the person to tremble, fatigue or destroy brain cells. Similarly, contaminating water with lead can cause bone fractures or possibly impotence / infertility. These investigations were carried out after the incident in Japan in 1953-1966 where people died or became incapacitated because they ate fish from the mercury-contaminated bay. Thus, it has been shown that aquatic organisms can convert inorganic compounds of mercury into organics that are highly toxic.

Therefore, now that we see the importance of marine pollution and its consequences, we should take environmental destruction seriously and start looking for original solutions to reduce accidents at sea.

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