

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ



ΤΜΗΜΑ ΝΑΥΤΙΛΙΑΚΩΝ ΣΠΟΥΔΩΝ

ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ

Στην

ΝΑΥΤΙΛΙΑΚΗ

ΔΙΟΙΚΗΤΙΚΗ

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Διπλωματική Εργασία

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του Πανεπιστημίου Πειραιώς ως μέρος των

απαιτήσεων για την απόκτηση του Μεταπτυχιακού

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Διοικητική

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Αυτή η Διπλωματική έχει σκοπό να περιγράψει , να φωτίσει και να παρουσιάσει την προσφορά της Ναυτιλίας σε μία χώρα που αποτελεί συγχρόνως και τη βάση της βαριάς βιομηχανίας της. Η προσφορά της είναι ανεκτίμητη και η λειτουργία της καταλαμβάνει ένα τεράστιο πεδίο δραστηριοτήτων παγκοσμίως καλύπτοντας χιλιάδες θέσεις εργασίας.

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ABSTRACT

Στην παρούσα διπλωματική εργασία θα γίνει λόγος για το πως η παγκόσμια εμπορική ναυτιλία επηρεάζει τη μόλυνση του θαλάσσιου περιβάλλοντος . Αναμφισβήτητα , μία τέτοια "βιομηχανία" δεν είναι δυνατόν να μην μεταφέρει επικίνδυνα φορτία ικανά να μολύνουν το θαλάσσιο κόσμο. Αυτό το θέμα τείνει να υποβαθμίζεται παγκόσμια , όμως θα έπρεπε να δοθεί η δέουσα σημασία αφού επηρεάζει την ίδια τη ναυτιλία ηθικά και οικονομικά και τους θεσμούς που τη διέπουν. Επίσης την Ελλάδα την αφορά άμεσα αυτό το θέμα . αφού έχει τεράστια συμφέροντα στο θαλάσσιο χώρο (όπως αλιεία , τουρισμός , θαλάσσιες μεταφορές) που θα μπορούσαν να τη βγάλουν από τη οικονομική κρίση. Τα κράτη που χειρίζονται αποτελεσματικά τη ναυτιλία τους έχουν και ταχύτερη ανάπτυξη. Τα μέτρα αντιμετώπισης του προβλήματος απευθύνονται τόσο στα φυσικά τόσο και σε νομικά πρόσωπα που εμπλέκονται με την προστασία της θάλασσας. Θα δοθεί επίσης έμφαση στο πότε η ρύπανση γίνεται τυχαία και πότε όχι . Στόχος της διπλωματικής εργασίας είναι να προσφέρει στον αναγνώστη μια προσέγγιση του ζητήματος της μόλυνσης του περιβάλλοντος σε συνάρτηση με τη θαλάσσια δραστηριότητα , να αναφερθούν τρόποι που συμβάλλουν στην ευκολότερη αντιμετώπιση του προβλήματος αυτού αλλά και την επιρροή μιας τέτοιας δραστηριότητας , στον άνθρωπο.

Λέξεις κλειδιά: ναυτιλία , θαλάσσια ρύπανση, πρόληψη θαλάσσιας ρύπανσης, πετρελαιοκηλίδα , θαλάσσιες μεταφορές.

In this dissertation we will discuss about how global merchant shipping affects the pollution of the marine environment. Undoubtedly, such a heavy "industry" couldn't carry dangerous cargo capable of contaminating the marine world. But we ought to give it high importance as it affects shipping itself morally and financially and the institutions that govern it. Greece is also directly concerned with this issue. Since it has huge interests in the maritime area (such as fishing, tourism, maritime transportation) that could get it out of the economic crisis. Countries that handle shipping effectively are also growing faster. The measures to confront the problem are addressed both to individuals and legal sectors who are involved in the protection of the sea. Emphasis will also be placed on when the pollution is accidental and when it is not. The aim of the dissertation is to offer the reader an approach to the issue of environmental pollution in relation to marine activity, to mention ways that contribute to the easier treatment of this problem and the impact of such an activity on humans. **Key words:** marine, marine pollution, marine pollution prevention, oil spill, maritime transport.

Shipping in general

By "shipping industry" or "shipping" in general, we mean all activities that are related to maritime transport of people and goods. It is an integral part of humanity's international trade. Ships of various types, carry people, dry and liquid cargo packed or in bulk, as well as vehicles, animals, etc. across the latitude and longitude of the earth. All merchant ships are included above the flag of a State constitute the Merchant Marine of that State. We also use the term "shipping" when referring to the very operation of the ship, which is the science and art of steering (bridge) and propulsion (engine) but also its loading, so that it sails safely from one point to another. The word "shipping" also refers to the shipping industry of a country which is the set of activities around maritime transport. We call "global shipping" all the national industries that operate and are controlled through maritime legislation enacted by the International Maritime Organization (IMO). The Organization is a technical "part" of the United Nations, based in London and it has member states that vote on International Conventions, Codes and Regulations in three main areas: (a) Training and Certification of seafarers, (b) Safety of life and property at sea (passengers- cargo ship) and (c) Protection of the Marine Environment from the pollution of merchant ships. Warships are not subject to shipping law.

Shipping and Global Economy

Maritime transport is an integral part of international trade, which is the source of life of the world, as stated in the Founding Declaration of Voluntary Commitment of HELMEPA signed by Greek sailors and ship owners in 1982 in Piraeus. The more than 60,000 merchant ships of the world shipping carry 99.6% of the goods safely to their destination at a lower cost. The merchant ship is the most efficient, economical and environmentally friendly means of transport that humanity still has. In the past, all ships looked like each other and were built to carry people and goods. With the development of technology and the increase of needs, today ships are built and equipped with systems and mechanisms depending on the type of cargo they are going to carry. International law requires that every ship be safe for passengers (crew and passengers) and operate in an environmentally friendly manner. In addition to ship safety, special importance is given to environmental protection. An example is the oil (lubricants) - water separators. They are special mechanisms that remove oil and grease from the water that collects at the bottom of the engine rooms. Then they throw back

into the sea the water they cleaned and are controlled by shipping authorities in the ports they visit. Shipping plays an essential role in the economic development of the European Union. Seventy five (75%) of the Union's imports and exports and 37% of the Union's internal trade are operated by vessels which also connect regional and island regions with mainland Europe. The safe navigation and efficient management of merchant ships depends on many factors, which must function as a whole. This can only be achieved if we ensure that ships are properly designed and constructed and they operate properly, recognizing at all stages the value of the human factor. The element of the human factor is applied throughout the chain of activities undertaken by the crew on board, the employees in the offices of a shipping company, the shipyard where the ship is built, the legislators and others. All of the above must work together harmoniously, so that there is the best result. A look at the most well-known shipping incidents and accidents clearly shows that some of them were caused by damage to equipment and components caused by a human error. In other cases, a simple incident can turn into a serious accident due to the human factor. Therefore, there is a strong financial incentive to assess the risks posed by human error and to take measures to reduce the risks. Human error in the operation of ships is traditionally treated as an individual responsibility of the crew. However, there is a tendency to inform the naval family that this mentality is very simple and that the human factor must be taken into account in the design of the ship's systems, equipment and procedures if we want the sailor to operate the ship safely and effectively. To reduce the number of incidents and accidents it is necessary to improve our understanding for the causes of human error. In addition, we need to better understand the factors that affect human performance in relation to the technical systems they operate as well as the work environment. The international shipping community turned its attention to the human factor in the early 1990s, following the Exxon Valdez accident, and was consolidated with the ISM Code and its incorporation into the SOLAS International Convention in 1994. In 2006, the International Labor Organization (ILO) adopted a global treaty on the rights of seafarers with the aim of improving their living and working conditions on board. It is estimated that this global agreement affects more than 1.2 million seafarers worldwide.

Safety on board

The history of the shipping industry from the era of steamships until today is full of ingenuity, professionalism, vision, success but also serious maritime accidents that marked

its course. Maritime safety since the beginning of the last century was considered as an extremely important parameter of international shipping, which in addition to its obvious purpose, e.g. the protection of human life at sea, has a special influence on the design and economic operation of ships. The first attempt at international regulation of maritime safety took place in 1914 with the adoption of the International Convention for the Safety of Human Life at Sea (SOLAS) with the aim of improving the safety of ships. The reasons for the above were the sinking of the Titanic which resulted in the loss of more than 1,500 people.

Since then we have had the experience of a series of international efforts aimed at taking initiatives and promoting actions aimed at the systematic examination of maritime safety issues and the adoption of appropriate solutions as well as their effective implementation. Prominent among them was the establishment in 1948 of the International Maritime Organization (IMO) with the main mission of improving the safety of international shipping through the adoption of International Conventions and other technical regulations. Since then IMO has developed and adopted more than 40 International Conventions and protocols as well as more than 1,000 codes and recommendations not only on safety issues, but also on environmental protection issues as well as compensation issues. It is generally accepted that the IMO's efforts have made a significant contribution to raising the safety standards of international shipping and have prevented the loss of a significant number of human lives. Technological developments in the field of communications also contributed significantly to this purpose as it overturned the previous situation where the ship was virtually cut off from the rest of the world. The communications decisively helped the search and rescue work in case of a maritime accident and in addition they had a social contribution facilitating the contact of the sailors with their loved ones. Ship stability regulations after a breakdown, especially in the event of a collision, as well as provisions for navigation aids and life-saving equipment have also made a significant contribution to improving maritime safety. International Convention SOLAS 74 covers many aspects of a ship's safety including its equipment, fire safety measures, cargo handling and navigation safety. On the other hand, the International Collision Regulations aim to avoid collisions between ships at sea but also to eliminate the possibility of a collision. According to this Convention, risks are divided into two categories:

a) Navigation hazards as they are depicted, listed and described in nautical charts and shipping versions, and b) Dangers that may be caused during encounters with other ships moving in the same area.

Indicative points that must be taken into account for a safe navigation are the constant vigilance in the observance of the bridge deck and engine room, the smart use of all bridge and engine room electronics, the continuous use of Radars, the valid and efficient handling of the ship, the design travel and full monitoring of passage planning and navigation systems that provide monitoring of the deviation from our course when we are close to the mainland and the mandatory observance of all Rules and Regulations. Following the dramatic events of 9/11 in the United States and other terrorist attacks on ships, a new chapter has been added to the SOLAS International Convention which, together with the ISPS Security Code, sets out requirements and measures to protect ships and ports from terrorist attacks and other illegal actions. The contribution of the human factor to maritime safety was recognized as crucial, especially due to the widespread use of high-tech products on ships, which limited the scope of action of seafarers, especially in control stations and computer monitors. The old perception of human error, which was related to the simple human impact on the various parts of the ship, became particularly complicated due to this lack of immediacy.

The adoption of the ISM Code and the SCTW Convention was the IMO's first response in this particularly difficult area. The adoption of the ISM Code also recognized the possible liability of the managers of the shipping companies in accidents that occur on their ships, in the sense that these may not be due to mistakes of seafarers but to erroneous decisions made on land. Contrary to popular belief, shipping is now a meticulously regulated area of commercial activity in which a complex web of international, regional and national regulations applies. Most of the regulations applicable to shipping have been established and are in force internationally, which is essentially due to the nature of shipping which has a genuine international character. The ship owner and operator of a ship that crosses the maritime zones of different countries whose laws it is obliged to obey are usually of different nationalities, while most of the activity of the ship is far from the state of which it flies the flag. For this reason, it is an indisputable need to regulate the basic issues of shipping through international regulations with a uniform application worldwide. Indeed, today shipping is regulated to a large extent by international regulations which are constantly updated and modified to meet the new technologies and the needs of shipping.

The International Maritime Organization (IMO), established in 1948 as a specialized United Nations agency for maritime affairs, best confirmation the above purpose of regulating international shipping. Since then, the London-based IMO has evolved into a stable organization with 168 Member States and three collaborating members. Also in the IMO participate in an advisory role non-governmental international organizations that support the work of the Organization. The three main pillars of IMO's activity are the areas of maritime safety, protection of the marine environment from pollution caused by ships and the human factor in shipping. In the 60 years of operation of the Organization, about 50 international treaties and agreements have been established, while countless protocols and amendments have been adopted. The most important conditions in the three main pillars of the IMO are a) the International Convention for the Safety of Human Life at Sea, 1974, (SOLAS 74) b) the International Convention for the Prevention of Marine Pollution from 1973, as amended from the Protocol of 1978, (MARPOL 73/78) and c) the International Convention on the Standards of Training, Certification and Enforcement of Seafarers of 1978, as revised in 1995(STCW95). SOLAS 74 is considered to be the most important and widely used international convention in the field of maritime safety. The main purpose of the Convention is to set the minimum standards for the construction, equipment and operation of ships in order to ensure their safety, adapting these standards to the respective technical knowledge and technological developments. The Convention sets out the specifications of the various types of ships, as well as the issuance of certificates which certify that a ship meets the required specifications. As important as SOLAS 74, but in the field of protection of the marine environment from pollution caused by ships, is MARPOL 73/78. The Convention, as extended and amended by the 1978 Protocol and its six Annexes, covers pollution caused by both the day-to-day operation of a ship and accidents by setting, inter alia, rules on the discharge of oil and other harmful substances, the technical characteristics that the different types of ships must have in order to ensure the protection of the marine environment, the way the ships are cleaned and the emission limit values. In particular, the Annexes to MARPOL 73/78 contain regulations on:

1. Avoiding oil pollution,
2. Control of pollution by harmful chemicals in bulk,
3. The prevention of pollution by harmful substances carried by sea by ships in packaged form,
4. The prevention of marine pollution from ship effluents, The avoidance of pollution by ship - generated waste and
5. The prevention of air pollution from ships.

In addition to MARPOL, the IMO's work is complemented by other important international conventions of the same Organization such as the International Convention for the Preparation, Cooperation and Response to Marine Pollution (OPRC) and its Protocol adopted in 2000 to extend the scope of the Convention to incidents of pollution by dangerous and harmful substances (OPRC-HNS) but has not yet entered into force. In the same field, the IMO's legislative work has been particularly intensive during the 2000s. As early as the beginning of the new century, the Agency adopted in 2001 the International Convention on the Control of Harmful Shipwreck Systems (Anti-fouling Systems), the purpose of which is to prohibit the use on ships of paints containing substances that are hazardous to the environment. The legislative work of the IMO continued in 2004 with the International Convention on the Control and Management of Ship Ballast and Sediment 2004 (Ballast) which aims to address a particularly important problem, namely the introduction, through the waters of the ballast reservoirs of ships, alien or alien species in marine ecosystems. However, the above convention has not yet gathered the necessary number of Member States to enter into force. The 2007 International Convention on Shipwreck Removal (Wreck Removal) as well as the very recent International Convention on Safe and Environmentally Safe Ship Recycling (Ship Recycling), which was adopted only in May 2009, remain in force. However, as important as the establishment of technical characteristics and rules of operation of ships is, the driving force of shipping is its human resources. It is essential to ensure that every seafarer is adequately trained to perform his duties, and that the working and living conditions on board are appropriate. Ensuring the above is the goal of STCW 95, whose importance is better understood if one considers that the vast majority of maritime accidents are due to human error. Ensuring that the crew of each ship is properly trained and certified, that it has the necessary rest hours and that it lives in appropriate conditions, the Convention seeks to reduce, as far as possible, the margins for human error. However, in addition to the above international treaties, in recent years there have been intensified efforts to regulate shipping issues at regional level, with the European Union, for example, which has been active in regulating various shipping issues. In addition, action has been taken to protect the marine environment from pollution caused by ships by various regional organizations, which have been set up either through the United Nations Environment Program (UNEP, www.unep.org) or independently with a view to developing coordinated action by coastal states to protect the environment of their common seas.

In the Mediterranean region, the Regional Marine Pollution Emergency Center for the Mediterranean Sea¹ in Malta operates within the framework of the UNEP Mediterranean Action Plan. At the national level, each state implements its own laws which usually transpose international regulations into national law, while adapting them to the data and specific needs of that state. However, some countries, such as the United States, often follow a national approach to shipping issues and often abstain from adopting international conventions and rules. Greece, as a shipping power with a direct interest in the existence of a single international legislation on shipping, has signed all the basic conditions of the IMO and seeks in all international and regional for a the uniform regulation of shipping-related issues through the IMO. As a consequence, Greek shipping legislation is usually a transfer of international treaties and regulations to the national system. Responsible for the elaboration and supervision of the implementation of the national legislation is the Ministry of Shipping & Aegean supported by the Coast Guard.

EMSA

Maritime accident investigation will help to narrow down on the actual cause of the accident which will help the injury claimants to claim their rightful due with absolute clarity. EMSA is responsible for providing technical assistance for the implementation of Directive 2009/18/EC establishing the fundamental principles governing the investigation of accidents in the maritime transport sector. It provides the Secretariat for the Permanent Cooperation Framework (PCF) of Accident Investigation Bodies. It is also responsible for the maintenance and enhancement of EMCIP, the European Marine Casualty Information Platform, a tool to store and analyze casualty data and investigation reports provided by the Member States. Activities are aimed at further developing the accident investigation capabilities of the Member States and the ability to collect and analyze casualty data at EU level.

¹ REMPEC, www.rempec.org
University of Piraeus 2019-2020

What sea offers

- **Fisheries - Aquaculture**

Fisheries and aquaculture provide 16% of the animal protein consumed by mankind in a year, while fish is the main source of protein for the 2 billion people in developing countries. Globally, the fishing industry employs 36 million people, 80% of whom live in Asia, while another 80 million people are indirectly employed in fisheries-related services such as processing, transport and trade in fish. This demonstrates the great importance of fishing in social, economic, political and cultural terms. From 1950 to 1990, fishery production increased fivefold. This huge increase is mainly due to the continuous development of industrial fishing through the application of new technologies in the detection of fish stocks and the construction of more efficient fishing equipment and vessels. In Greece, the fishing fleet is characterized by the large number of small vessels. In particular, our country has about 20% of the fishing vessels of the European Union (EU), but only 4.7% of the capacity of the total EU fishing fleet. Thus, according to 2005 data, out of the approximately 18,000 fishing vessels boats, almost 17,000 are under 12 meters long with an average boat age of 26 years. In the same year, the fishery sector in Greece employed about 31,000 people, while the total fishery production exceeded 118,000 thousand tons. Coastline, as well as some Mediterranean reserves. Coastal fishing is mainly in the form of traditional family activity combined with other activities, while it is practiced mainly by elderly and untrained professional fishermen. The ever-increasing demand for high-nutrition foods that are rich in protein, such as fish, has inevitably led to the development of aquaculture. Globally, these crops are the only visible hope for the increase of fishery production, since their volume is constantly increasing, having now exceeded 20% of the total production. Greece has a significant natural advantage in this matter as it has suitable sea areas and protected inland waters. This advantage has been utilized in the best way and especially in the last 15 years the intensive fish farming of seafood has become one of the most developing sectors of the national economy. Today our country is first in the Mediterranean, as well as in the whole European Union, in the cultivation of intensively farmed seafood, such as sea bream and sea bass, while seafood from fish farming ranks 2nd in the export trade in the category "food". The total catches from aquaculture constitute more than 1/3 of the total fishery production of Greece.

- **Shipping**

Thanks to navigation, man discovered the globe and achieved wider communication and transportation of people and goods. Maritime transport is the most economical and basic route for transporting huge quantities of goods over long distances, which is required now by globalization. 90% of world trade is transported daily by oceans by 60,000 ships, while 99.6% of cargo is delivered safely to their destination. In addition, the ship is often the only means of transporting people and goods to islands that do not have airports, like many of the Greek islands on the so-called "barren" lines. For Europe, shipping has been a catalyst for its economic growth and prosperity. Maritime transport favors trade and contacts in all European countries. Shipping ensures adequate energy and food, offers jobs to millions of people and is the main medium for European imports and exports of raw materials, goods and products. Greece maintains the largest merchant fleet of the European Union and one of the largest in the world. According to data from the Hellenic Naval Chamber (NEE), at the beginning of 2009 the Greek-owned fleet numbered more than 4,000 seagoing ships over 1,000 gross tonnage (GRT) with a total displacement of 263 million tons of dead weight, representing 15% of the world.

- **Mining**

Significant amounts of oil and gas are extracted from the marine subsoil, representing more than 25% of world production. Also, precious minerals are mined from the ocean floor, such as Manganese (Mg), Nickel (Ni) and Phosphorus (P), whose marine harvest in many cases exceeds that of land. In general, the marine mineral resources are much more than we are exploiting so far. Extraction of minerals and other materials from the marine environment is done by hydraulic and mechanical means. The mechanical systems operate at very great depths, while the hydraulic systems are limited to a depth of 60 meters. It is noted that these systems have great stress and intense corrosion. In general, bottom mining creates sediment suspension and affects pelagic and benthic organisms. Particularly vulnerable are corals, shells, crabs, lobsters, etc. The main advantages of mining from the marine environment are that deposits can be richer than those on land, the sea offers relatively cheap transport, loading and transport facilities already exist, and there are fewer environmental restrictions on zoning. of them. Disadvantages include the high cost of installation and operation of the equipment, possible political and economic problems that may arise in conjunction with

international arbitration, but also unbalanced environmental problems that must be taken into account.

- **Tourism**

The development of tourism is one of the greatest economic and social phenomena of the twentieth century. During the last decades, tourism has increased significantly, contributing significantly to the increase of the standard of living of the tourist developed areas and to the well-being of the citizens. From 1952 to 2005 the number of international tourist arrivals increased at a rate of 6.5% per year resulting in the total number of travelers jumping from 25 to 806 million. Coastal areas are popular tourist destinations internationally. Coastal tourism is based on a unique combination of resources located on the edge of terrestrial and marine environment: sun, beaches, stunning landscapes, rich biodiversity, seafood and good transport infrastructure. Based on these resources, a variety of profitable services have been developed in many coastal destinations such as hotels and rooms to let, restaurants and other shops, beaches, diving, yacht rental, etc. The Mediterranean is the first preferred tourist destination in the world, attracting 30% of the total tourist traffic. Tourism in the Mediterranean is mainly coastal and is characterized by intense seasonality. Anthropogenic pressures in the coastal zone as a result of tourism development are expected to increase significantly in the near future. According to data from the UN Environment Program / Mediterranean Action Plan (www.unepmap.org), tourist arrivals in the Mediterranean countries are projected to increase from 218 million who visited the region in 2000 to 396 million by 2025. In Greece, the importance of tourism for the economy and society is particularly great. The contribution of the tourism economy in recent years to the Gross National Product (GDP) of the country reaches 18%, while the total employment in the tourism economy corresponds to 20% of employees. In addition, tourism in our country has functioned as a lever for the development of the region, strengthening the local economy and favoring the stay of young people in their areas. However, there are several examples of areas in our country and beyond in the Mediterranean, where the rapid and uncontrolled tourism development has led to environmental degradation and social problems. For example, when there is a large influx of tourists in certain places during the summer months without taking into account the "carrying capacity" based on the infrastructure of the area, environmental problems can arise related to waste management, disposal and use of water, traffic congestion, etc. Our country has an extensive coastline with beautiful beaches,

numerous islands and a relatively healthy marine environment, many areas of special natural beauty, national parks and aesthetic forests, rare biodiversity, excellent climatic conditions and an inexhaustible archaeological and cultural heritage. It is the duty of all stakeholders in the tourism industry of our country, government agencies and the private sector, to cooperate in order to protect and promote our tourism "product" in accordance with the principles of sustainable development.

- **Renewable energy sources**

The term "renewable energy sources" (RES) refers to mild forms of energy utilization that comes from natural processes, such as solar radiation, wind, geothermal, water circulation, etc. Unlike traditional energy sources such as oil and coal, the exploitation of which requires active intervention (mining, pumping and incineration), pollutes the environment and releases large amounts of carbon dioxide into the atmosphere, RES are environmentally friendly as exploiting the already existing flow of energy in nature. They are used either directly (mainly for heating) or through their conversion to other forms of energy (mainly electricity or mechanical energy). The most common forms of RES are solar, wind, geothermal, waterfall (hydroelectric installations) and biomass. Those that apply to the marine and coastal environment are the following:

A) Solar energy: It is widely used for thermal applications on land, for example solar water heaters, especially in countries such as Greece with a lot of sunshine most of the time of the year. The use of solar energy for the production of electricity has recently begun to gain ground in our country with the policy of promoting Renewable Energy Sources by the Greek State and the European Union. At sea, its use has the potential to provide power to small floating units, e.g. desalination or as an additional source of energy in other marine activities, e.g. oil rigs, ship operations, etc. In terms of shipping, a pilot installation of photovoltaic arcs has already begun in available deck and superstructure areas of ships.

B) Wind energy: Used since ancient times for pumping water from wells as well as for mechanical applications e.g. milling in windmills. In recent years it has started to be used more and more for electricity generation with the installation of wind "parks", while its use at sea is promoted since in relation to the land. There are fewer environmental constraints because there is a lot of open space and noise constraints are smaller. The available wind

energy at sea is of better quality and increases up to 20%. The wind is more stable as there are not so strong fluctuations with the consequence that the produced energy increases by a significant percentage. In Greece, especially after the liberalization of the energy market, there was a significant increase in the creation of wind farms. However, in some cases the installation of wind farms in our country has caused the reaction of local communities for reasons of aesthetics, the effects on biodiversity and the noise that accompanies their operation.

C) Energy from tides: It is based on the gravity of the Sun and the Moon, which causes the water level to rise. As the tide "rises", the water is stored, while to "go down" it is forced to pass through a turbine, thus producing electricity. It is applied in countries with high tidal range (difference between flood and low tide), such as England and France.

D) Wave energy: Exploitation of the kinetic energy of sea waves. Other forms of renewable energy sources that apply to the marine environment but are still in the early stages are the production of biofuels from algae and energy from the oceans, based on the temperature difference between the ocean layers through the use of thermal cycles.

International Safety

International law for the protection of the marine environment is a relatively new field of international law, as its development began only in the last century. Until then, mankind believed that the natural wealth of the sea is inexhaustible and did not realize the need to take measures to control human activities that affect the quality of the marine environment. A first realization came at the beginning of the 20th century when the first results of uncontrolled fishing activity began to appear which led to the adoption of the first multilateral conditions for the protection of seals and whales as well as for the regulation of fisheries. Especially on the very important issue of overfishing, the United Nations Convention on Fisheries and Conservation of Offshore Stocks was adopted in 1958. An important step which, without affecting the marine environment in general, affected the protection of the environment in general, was the adoption in 1971 of the Ramsar Convention for the Protection of Wetlands (www.ramsar.org), which implemented for the first time the system of protected areas. One year later, the UNESCO Organization for the Protection of the World Cultural and Natural Heritage (<http://whc.unesco.org>) made it possible to protect marine and terrestrial areas of global importance. In the same year, the United Nations World Conference on the Human Environment declared through the so-

called "Stockholm Declaration" that the protection of the environment is a fundamental duty of the international community, and specifically for the marine environment called on the States to take all appropriate measures to protect it. At the same time, the Conference adopted an Action Plan which, urged states to take further national and international measures to protect the marine environment from all forms of pollution. In this general climate of development of an early ecological consciousness, the very important International Treaty for the Prevention of Pollution from the Disposal of Residues and Other Materials was adopted in December 1972. The Treaty of London, as it is well known, tackles the great problem of dumping offshore waste at sea by completely prohibiting the dumping of some of it and setting strict conditions for the dumping of others. A milestone in international law for the protection of the marine environment was the acceptance in 1982 of the United Nations Conference on the Law of the Sea², which devotes a whole part of it to the protection of the marine environment, while relevant provisions are scattered in other parts of the Convention. The most important element of the Convention is the enforcement to the States of the duty to protect the marine environment in all maritime zones, inside and outside state jurisdiction, and from any form of pollution. In addition to regulating the issue of fisheries and the protection of marine stocks contained in the 1982 Convention, a supplementary Agreement on migratory fish species was adopted in 1995. In the late 1980s, the international community decided that action was needed to address the problem of smuggling hazardous waste from industrialized to developing countries in order to make it easier and less expensive to dispose of. To reduce this phenomenon, the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Treatment³ was adopted in 1989. In 1992, twenty years after the Stockholm Conference, the United Nations hosted the first United Nations Conference on Environment and Development (UNCED) in Rio, Brazil. The result of the Conference was the development and acceptance of important documents such as:

a) The Rio Declaration on Environment and Development, which contained important environmental principles such as the precautionary principle and called on States to cooperate and develop environmental legislation.

² (UNCLOS, www.un.org/Depts/los/)

³ (www.unep.org/regionalseas/)

b) Agenda 21 which promoted the development of new approaches to the management of marine and coastal areas, and c) the International Convention on Biological Diversity for the protection of biodiversity and its use in accordance with ecological criteria (www.cbd.int). Following these initiatives, but specifically for the marine environment, was adopted in 1995 by 108 governments and the European Union the "Washington Declaration on the Protection of the Marine Environment from Land Activities" and the accompanying Global Action Plan, known as the Global Program of Action, the implementation of which was assigned to UNEP (www.gpa.unep.org). The ten-year anniversary of the Rio Conference was celebrated by the UN with the organization of the Johannesburg World Conference on Sustainable Development. Like the 1992 Congress, the Johannesburg Congress adopted the Declaration of the same name and an action plan.

Regional Level

The implementation of the international conventions, declarations and action plans for the protection of the marine environment at regional level is significantly assisted by the Regional Seas Program of UNEP. This program started in 1974 and now includes 13 regional programs with the total participation of 140 states for the protection of the environment of the following sea areas: Caribbean⁴ East Asia⁵ East Africa⁶ Mediterranean⁷ northwest Pacific⁸ , West Africa⁹, Black Sea¹⁰, Northeast Pacific, Red Sea and Gulf of Aden¹¹ Persian Gulf¹² South Asia¹³ Southeast Pacific¹⁴, and South Pacific¹⁵.

Also, under the auspices of the UNEP Regional Maritime Program, five collaborating programs have been established for the following regions: Arctic (www.pame.is), Antarctic (www.ccamlr.org), Baltic (www.helcom.fi), Caspian (www.caspianenvironment.org) and Northeast Atlantic (www.ospar.org). The goal of all these Programs is to achieve more

⁴ (www.cep.unep.org)

⁵ (www.cobsea.org)

⁶ (www.unep.org/nairobiconvention)

⁷ (www.unepmap.org)

⁸ (www.nowpap.org)

⁹ (www.unep.org/abidjanconvention)

¹⁰ (www.blacksea-commission.org)

¹¹ (www.persga.org)

¹² (www.ropme.com)

¹³ (www.sacep.org)

¹⁴ (www.cpps-int.org)

¹⁵ (www.sprep.org)

comprehensive protection and more conscious use of the marine environment through the cooperation of neighboring countries in collective and specialized actions. To this end, these regional programs adopt regulations on discharges from ships, cooperation in the event of severe marine pollution from an emergency, land pollution, waste transport, while one of the common features of the Regional Maritime Programs is the establishment of marine protected areas in which harmful activities are prohibited or subject to restrictions.

The relevant action of the European Union, which has been increasingly active in the field of the protection of the marine environment for the last two decades, should also be mentioned at this point. The Union, which has been pursuing its own "Common Fisheries Policy" since the 1970s, has set up an extensive network of protected areas called NATURA 2000 for the protection of biodiversity, which now focuses on the development of a network of marine protected areas. In the field of pollution prevention, especially after the ERIKA tanker accident in 1999, the European Commission has promoted the adoption of a set of European legislation on ship pollution. In addition, with the drafting of the Maritime Strategy Directive 2008/56 / EC, the Union has laid an even powerful foundation for the development and coordination of action plans, collaborations, assessment and planning of human activities based on environmental criteria by the Member States of the Union. The Union is also, as a European Community, a party to the 1997 Kyoto Protocol on Climate Change, in which the integration of shipping is a very topical and controversial issue.

National Level

In addition to partnering and participating in international and regional legislative initiatives, a state's willingness and effectiveness in protecting its marine environment is expressed primarily through national law. The need for effective national legislation is even better understood if one considers that about 80% of marine pollution is due to land-based sources. There are indeed countries that are particularly passionate about the protection of the marine environment, such as Australia and Canada, and in our country in recent years the effort to prevent environmental pollution is intensifying. In Greece, the protection of the environment is guaranteed by the Constitution itself. According to Article 24 of the Constitution, "the protection of the natural and cultural environment is an obligation of the state and a right of everyone", while for its protection the state is obliged to take special preventive or repressive measures within the framework of the principle of sustainability. The basic

legislation for the protection of the marine environment is the P.D. 55/98 "Protection of the Marine Environment" which codified the older Law 743/78. The P.D. 55/98, which applies to the ports, coasts and territorial waters of Greece as well as, without prejudice to international Conventions, on the high seas, defines the obligations of ships, oil refineries, shipyards, hotels, industries and any kind of business which has an adverse effect on the marine environment. In case of pollution the P.D. sets out the responsibilities of those responsible as well as any administrative and criminal sanctions. In addition to the above specialized legislation, the protection of the marine environment is also subject to the provisions of Law 1650/86 which is the fundamental national law for the protection of the environment in general. For this purpose, Law 1650/86 contains regulations for the protection of soil, water and air from most sources of pollution, while it also contains the provisions applicable to the establishment and operation of protected areas. According to these provisions, the two National Marine Parks that exist today in our country were established, the one in the Northern Sporades ([/www.alonissos-park.gr/](http://www.alonissos-park.gr/)) and in Zakynthos¹⁶. With regard to the institutions, the responsibilities for the protection of marine environmental are shared between the Directorate for the Protection of the Marine Environment (formerly the Ministry of Merchant Shipping, now under the Ministry of Environment, the Ministry of Civil Protection) and the Ministry of the Environment and Climate Change.

Ecosystems

Marine ecosystems are the largest of Earth's aquatic ecosystems and are distinguished by waters that have a high salt content. These systems contrast with freshwater ecosystems, which have a lower salt content. Marine waters cover more than 70% of the surface of the Earth and account for more than 97% of Earth's water supply and 90% of habitable space on Earth. Marine ecosystems include near shore systems, such as the salt marshes, mudflats, sea grass meadows, mangroves, rocky intertidal systems and coral reefs. They also extend outwards from the coast to include offshore systems, such as the surface ocean, pelagic ocean waters, the deep sea, oceanic hydrothermal vents, and the sea floor. Marine ecosystems are characterized by the biological community of organisms that they are associated with and their physical environment.

¹⁶ (www.nmp-zak.org/site)

1. Salt marsh

Salt marshes are a transition from the ocean to the land, where fresh and saltwater mix. The soil in these marshes is often made up of mud and a layer of organic material called peat. Peat is characterized as waterlogged and root-filled decomposing plant matter that often causes low oxygen levels (hypoxia¹⁷). These hypoxic conditions causes growth of the bacteria that also gives salt marshes the sulfurous smell they are often known for. Salt marshes exist around the world and are needed for healthy ecosystems and a healthy economy. They are extremely productive ecosystems and they provide essential services for more than 75 percent of fishery species and protect shorelines from erosion and flooding. Salt marshes can be generally divided into the high marsh, low marsh, and the upland border. The low marsh is closer to the ocean, with it being flooded at nearly every tide except low tide. The high marsh is located between the low marsh and the upland border and it usually only flooded when higher than usual tides are present. The upland border is the freshwater edge of the marsh and is usually located at elevations slightly higher than the high marsh. This region is usually only flooded under extreme weather conditions and experiences much less waterlogged conditions and salt stress than other areas of the marsh.

2. Mangroves

Mangroves are trees or shrubs that grow in low-oxygen soil near coastlines in tropical or subtropical latitudes. They are an extremely productive and complex ecosystem that connects the land and sea. Mangroves consist of species that are not necessarily related to each other and are often grouped for the characteristics they share rather than genetic similarity. Because of their proximity to the coast, they have all developed adaptations such as salt excretion and root aeration to live in salty, oxygen-depleted water. Mangroves can often be recognized by their dense tangle of roots that act to protect the coast by reducing erosion

¹⁷ **Hypoxia** is a condition in which the body or a region of the body is deprived of adequate oxygen supply at the tissue level. Hypoxia may be classified as either generalized, affecting the whole body, or local, affecting a region of the body.^[2] Although hypoxia is often a pathological condition, variations in arterial oxygen concentrations can be part of the normal physiology, for example, during hypoventilation training or strenuous physical exercise.

Hypoxia differs from hypoxemia and anoxemia in that hypoxia refers to a state in which oxygen supply is insufficient, whereas hypoxemia and anoxemia refer specifically to states that have low or zero arterial oxygen supply.^[3] Hypoxia in which there is complete deprivation of oxygen supply is referred to as **anoxia**.

from storm surges, currents, wave, and tides. The mangrove ecosystem is also an important source of food for many species as well as excellent at sequestering carbon dioxide from the atmosphere with global mangrove carbon storage is estimated at 34 million metric tons per year.

3. Intertidal zones

Intertidal zones are the areas that are visible and exposed to air during low tide and covered up by saltwater during high tide. There are four physical divisions of the intertidal zone with each one having its distinct characteristics and wildlife. These divisions are the Spray zone, High intertidal zone, Middle Intertidal zone, and Low intertidal zone. The Spray zone is a damp area that is usually only reached by the ocean and submerged only under high tides or storms. The high intertidal zone is submerged at high tide but remains dry for long periods between high tides. Due to the large variance of conditions possible in this region, it is inhabited by resilient wildlife that can withstand these changes such as barnacles, marine snails, mussels and hermit crabs. Tides flow over the middle intertidal zone two times a day and this zone has a larger variety of wildlife. The low intertidal zone is submerged nearly all the time except during the lowest tides and life is more abundant here due to the protection that the water gives.

4. Estuaries

Estuaries occur where there is a noticeable change in salinity between saltwater and freshwater sources. This is typically found where rivers meet the ocean or sea. The wildlife found within estuaries is unique as the water in these areas is brackish - a mix of freshwater flowing to the ocean and salty seawater. Other types of estuaries also exist and have similar characteristics as traditional brackish estuaries. The Great Lakes are a prime example. There, river water mixes with lake water and creates freshwater estuaries. Estuaries are extremely productive ecosystems that many humans and animal species rely on for various activities. This can be seen as, of the 32 largest cities in the world, 22 are located on estuaries as they provide many environmental and economic benefits such as crucial habitat for many species, and being economic hubs for many coastal communities. Estuaries also provide essential ecosystem services such as water filtration, habitat protection, erosion control, gas

regulation nutrient cycling, and it even gives education, recreation and tourism opportunities to people.

5. Lagoons

Lagoons are areas that are separated from larger water by natural barriers such as coral reefs or sandbars. There are two types of lagoons, coastal and oceanic/atoll lagoons. A coastal lagoon is, as the definition above, simply a body of water that is separated from the ocean by a barrier. An atoll lagoon is a circular coral reef or several coral islands that surround a lagoon. Atoll lagoons are often much deeper than coastal lagoons. Most lagoons are very shallow meaning that they are greatly affected by changes in precipitation, evaporation and wind. This means that salinity and temperature are widely varied in lagoons and that they can have water that ranges from fresh to hypersaline. Lagoons can be found in on coasts all over the world, on every continent except Antarctica and is an extremely diverse habitat being home to a wide array of species including birds, fish, crabs, plankton and more. Lagoons are also important to the economy as they provide a wide array of ecosystem services in addition to being the home of so many different species. Some of these services include fisheries, nutrient cycling, flood protection, water filtration, and even human tradition.

6. Coral reefs

Coral reefs are one of the most well-known marine ecosystems in the world, with the largest being the Great Barrier Reef. These reefs are composed of large coral colonies of a variety of species living together. The corals form multiple symbiotic relationships with the organisms around them.

Bottom of the Sea

The deep sea contains up to 95% of the space occupied by living organisms. Combined with the sea floor (or benthic zone), these two areas have yet to be fully explored and have their organisms documented. In addition to providing many benefits to the natural world, marine ecosystems also provide social, economic, and biological ecosystem services to humans. Pelagic marine systems regulate the global climate, contribute to the water cycle, maintain biodiversity, provide food and energy resources, and create opportunities for recreation and

tourism. Economically, marine systems support billions of dollars worth of capture fisheries, aquaculture, offshore oil and gas, and trade and shipping. Ecosystem services fall into multiple categories, including supporting services, provisioning services, regulating services, and cultural services.

Threats

- Drivers of change in marine ecosystems

Although marine ecosystems provide essential ecosystem services, these systems face various threats.

- Human exploitation and development

Coastal marine ecosystems experience growing population pressures with nearly 40% of people in the world living within 100 km of the coast. Humans often aggregate near coastal habitats to take advantage of ecosystem services. For example, coastal capture fisheries from mangroves and coral reef habitats are estimated to be worth a minimum of \$34 billion per year. Yet, many of these habitats are either marginally protected or not protected. Mangrove area has declined worldwide by more than one-third since 1950, and 60% of the world's coral reefs are now immediately or directly threatened. Human development, aquaculture, and industrialization often lead to the destruction, replacement, or degradation of coastal habitats. Moving offshore, pelagic marine systems are directly threatened by overfishing. Global fisheries landings peaked in the late 1980s, but are now declining, despite increasing fishing effort. Fish biomass and average trophic level of fisheries landing are decreasing, leading to declines in marine biodiversity. In particular, local extinctions have led to declines in large, long-lived, slow-growing species, and those that have narrow geographic ranges. Biodiversity declines can lead to associated declines in ecosystem services. A long-term study reports the decline of 74–92% of catch per unit effort of sharks in Australian coastline from the 1960s to 2010s.

Marine Pollution

The world has witness dramatic consequences of oil pollution to marine environment in the past century. At present, oil pollution liability and compensation is among important technical and legal areas of discussion by scholars. The Civil Liability Conventions (CLC) regime is the established regime into force that regulates issues of liability and compensation for oil pollution damage. The question is whether this regime contributes to the protection of marine environment. On the one hand, the importance of oil to development cannot be overemphasized. On the other hand, the danger and effect of oil pollution to marine environment cannot be ignored. In this paper, the legal regime for oil pollution damage liability and compensation is examined, together with a legal reflection of application of CLC regime in the Erika oil pollution incident. Thereafter, there are discussions on the protection of marine environment through highlights on the role of the conventions, challenges arising from provisions of the convention and convention application. Lastly, the paper gives suggestions on the measures to be taken by all stakeholders of maritime transport to achieve cleaner oceans through protection of marine environment.

Marine pollution occurs when harmful effects result from the entry into the ocean of chemicals, particles, industrial, agricultural and residential waste, noise, or the spread of invasive organisms. Eighty percent of marine pollution comes from land. Air pollution is also a contributing factor by carrying off iron, carbonic acid, nitrogen, silicon, sulfur, pesticides or dust particles into the ocean. Land and air pollution have proven to be harmful to marine life and its habitats.

The pollution often comes from nonpoint sources such as agricultural runoff, wind-blown debris, and dust. Pollution in large bodies of water can be aggravated by physical phenomena like the biological effects of Langmuir circulation. Nutrient pollution, a form of water pollution, refers to contamination by excessive inputs of nutrients. It is a primary cause of eutrophication of surface waters, in which excess nutrients, usually nitrates or phosphates, stimulate algae growth. Many potentially toxic chemicals adhere to tiny particles which are then taken up by plankton and benthic animals, most of which are either deposit feeders or filter feeders. In this way, the toxins are concentrated upward within ocean food chains. Many particles combine chemically in a manner highly depletive of oxygen, causing estuaries to become anoxic.

When pesticides are incorporated into the marine ecosystem, they quickly become absorbed into marine food webs. Once in the food webs, these pesticides can cause mutations, as well as diseases, which can be harmful to humans as well as the entire food web. Toxic metals can also be introduced into marine food webs. These can cause a change to tissue matter, biochemistry, behavior, reproduction, and suppress growth in marine life. Also, many animal feeds have a high fish meal or fish hydrolysate content. In this way, marine toxins can be transferred to land animals, and appear later in meat and dairy products.

In order to protect the ocean from marine pollution, policies have been developed internationally. There are different ways for the ocean to get polluted, therefore there have been multiple laws, policies, and treaties put into place throughout history.

There are many ways to categorize and examine the inputs of pollution into marine ecosystems. Patin (n.d.) notes that generally there are three main types of inputs of pollution into the ocean: direct discharge of waste into the oceans, runoff into the waters due to rain, and pollutants released from the atmosphere.

One common path of entry by contaminants to the sea are rivers. The evaporation of water from oceans exceeds precipitation. The balance is restored by rain over the continents entering rivers and then being returned to the sea. The Hudson in New York State and the Raritan in New Jersey, which empty at the northern and southern ends of Staten Island, are a source of mercury contamination of zooplankton (copepods) in the open ocean. The highest concentration in the filter-feeding copepods is not at the mouths of these rivers but 70 miles (110 km) south, nearer Atlantic City, because water flows close to the coast. It takes a few days before toxins are taken up by the plankton.

Pollution is often classed as point source or nonpoint source pollution. Point source pollution occurs when there is a single, identifiable, localized source of the pollution. An example is directly discharging sewage and industrial waste into the ocean. Pollution such as this occurs particularly in developing nations. Nonpoint source pollution occurs when the pollution comes from ill-defined and diffuse sources. These can be difficult to regulate. Agricultural runoff and wind-blown debris are prime examples.

Pollutants enter rivers and the sea directly from urban sewerage and industrial waste discharges, sometimes in the form of hazardous and toxic wastes, or in the form of plastics.

In a study published by *Science*, Jambeck *et al.* (2015) estimated that the 10 largest emitters of oceanic plastic pollution worldwide are, from the most to the least, China, Indonesia, Philippines, Vietnam, Sri Lanka, Thailand, Egypt, Malaysia, Nigeria, and Bangladesh.

Inland mining for copper, gold, etc., is another source of marine pollution. Most of the pollution is simply soil, which ends up in rivers flowing to the sea. However, some minerals discharged in the course of the mining can cause problems, such as copper, a common industrial pollutant, which can interfere with the life history and development of coral polyps. Mining has a poor environmental track record. For example, according to the United States Environmental Protection Agency, mining has contaminated portions of the headwaters of over 40% of watersheds in the western continental US.^[8] Much of this pollution finishes up in the sea.

Analysis of Main Causes of Marine Pollution

Seawater turbidity caused by marine pollution will seriously affect the photosynthesis of marine plants (phytoplankton and algae), thus affecting the productivity of the sea, the fish are also harmful. Heavy metals and toxic organic compounds and other toxic substances accumulate in the sea, and through the enrichment of marine life, marine animals and other animals to feed poisoning. Oil goes into the sea, so that a large number of dissolved oxygen is absorbed by oil; the oil film covering the water, made the separation between seawater and air, this can also cause the sea water hypoxia.

Seawater hypoxia can cause marine life death. Oil will make economic fish, shellfish and other seafood produce has oil smell, adult fish and shellfish in the long-term living in the polluted seawater in the accumulation of certain harmful substances, when we eat them, it will harm the human health. Because of organic matter and nitrogen and phosphorus pollution, some algae plankton in sea water can multiply quickly and rapidly. Different algae have different colors, which cause red, pink and green colors, which are called red tide. The red tide caused by sea water hypoxia will make a large number of fish, shellfish and other marine animals due to lack of oxygen and suffocation. Oceans as an important part of human life, its changes will directly or indirectly affect human life. Marine pollution will have a great impact on human life. So what are the causes of marine pollution?

In this chapter I will describe about the main causes of marine pollution.

1. Ship pollution

Ships can pollute waterways and oceans in many ways. Oil spills can have devastating effects. While being toxic to marine life, polycyclic aromatic hydrocarbons (PAHs), found in crude oil, are very difficult to clean up, and last for years in the sediment and marine environment.

Oil spills are probably the most emotive of marine pollution events. However, while a tanker wreck may result in extensive newspaper headlines, much of the oil in the world's seas comes from other smaller sources, such as tankers discharging ballast water from oil tanks used on return ships, leaking pipelines or engine oil disposed of down sewers.

Discharge of cargo residues from bulk carriers can pollute ports, waterways, and oceans. In many instances vessels intentionally discharge illegal wastes despite foreign and domestic regulation prohibiting such actions. An absence of national standards provides an incentive for some cruise liners to dump waste in places where the penalties are inadequate. It has been estimated that container ships lose over 10,000 containers at sea each year (usually during storms).^[16] Ships also create noise pollution that disturbs natural wildlife, and water from ballast tanks can spread harmful algae and other invasive species.

Ballast water taken up at sea and released in port is a major source of unwanted exotic marine life. The invasive freshwater zebra mussels, native to the Black, Caspian, and Azov seas, were probably transported to the Great Lakes via ballast water from a transoceanic vessel. Meinesz believes that one of the worst cases of a single invasive species causing harm to an ecosystem can be attributed to a seemingly harmless jellyfish. *Mnemiopsis leidyi*, a species of comb jellyfish that spread so it now inhabits estuaries in many parts of the world, was first introduced in 1982, and thought to have been transported to the Black Sea in a ship's ballast water. The population of the jellyfish grew exponentially and, by 1988, it was wreaking havoc upon the local fishing industry. "The anchovy catch fell from 204,000 tons in 1984 to 200 tons in 1993: sprat from 24,600 tons in 1984 to 12,000 tons in 1993: horse mackerel from 4,000 tons in 1984 to zero in 1993. Now that the jellyfish have exhausted the zooplankton, including fish larvae, their numbers have fallen dramatically, yet they continue to maintain a stranglehold on the ecosystem.

Invasive species can take over once occupied areas facilitate the spread of new diseases, introduce new genetic material, alter underwater seascapes, and jeopardize the ability

of native species to obtain food. Invasive species are responsible for about \$138 billion annually in lost revenue and management costs in the US alone.

2. Atmospheric pollution

Another pathway of pollution occurs through the atmosphere. Wind-blown dust and debris, including plastic bags, are blown seaward from landfills and other areas. Dust from the Sahara moving around the southern periphery of the subtropical ridge moves into the Caribbean and Florida during the warm season as the ridge builds and moves northward through the subtropical Atlantic. Dust can also be attributed to a global transport from the Gobi and Taklamakan deserts across Korea, Japan, and the Northern Pacific to the Hawaiian Islands.

Since 1970, dust outbreaks have worsened due to periods of drought in Africa. There is a large variability in dust transport to the Caribbean and Florida from year to year; however, the flux is greater during positive phases of the North Atlantic Oscillation. The USGS links dust events to a decline in the health of coral reefs across the Caribbean and Florida, primarily since the 1970s.

Climate change is raising ocean temperatures and raising levels of carbon dioxide in the atmosphere. These rising levels of carbon dioxide are acidifying the oceans. This, in turn, is altering aquatic ecosystems and modifying fish distributions, with impacts on the sustainability of fisheries and the livelihoods of the communities that depend on them. Healthy ocean ecosystems are also important for the mitigation of climate change.

3. Deep sea mining

Deep sea mining is a relatively new mineral retrieval process that takes place on the ocean floor. Ocean mining sites are usually around large areas of polymetallic nodules or active and extinct hydrothermal vents at about 1,400 – 3,700 meters below the ocean's surface. The vents create sulfide deposits, which contain precious metals such as silver, gold, copper, manganese, cobalt, and zinc. The deposits are mined using either hydraulic pumps or bucket systems that take ore to the surface to be processed. As with all mining operations, deep sea mining raises questions about environmental damages to the surrounding areas.

Because deep sea mining is a relatively new field, the complete consequences of full-scale mining operations are unknown. However, experts are certain that removal of parts of the sea floor will result in disturbances to the benthic layer, increased toxicity of the water column, and sediment plumes from tailings. Removing parts of the sea floor disturbs the habitat of benthic organisms, possibly, depending on the type of mining and location, causing permanent disturbances. Aside from direct impact of mining the area, leakage, spills, and corrosion would alter the mining area's chemical makeup.

Among the impacts of deep sea mining, sediment plumes could have the greatest impact. Plumes are caused when the tailings from mining (usually fine particles) are dumped back into the ocean, creating a cloud of particles floating in the water. Two types of plumes occur: near-bottom plumes and surface plumes. Near-bottom plumes occur when the tailings are pumped back down to the mining site. The floating particles increase the turbidity, or cloudiness, of the water, clogging filter-feeding apparatuses used by benthic organisms. Surface plumes cause a more serious problem. Depending on the size of the particles and water currents the plumes could spread over vast areas. The plumes could impact zooplankton and light penetration, in turn affecting the food web of the area.

4. Land runoff

Surface runoff from farming, as well as urban runoff and runoff from the construction of roads, buildings, ports, channels, and harbors, can carry soil and particles laden with carbon, nitrogen, phosphorus, and minerals. This nutrient-rich water can cause fleshy algae and phytoplankton to thrive in coastal areas; known as algal blooms, which have the potential to create hypoxic conditions by using all available oxygen. In the coast of southwest Florida, harmful algal blooms have existed for over 100 years. These algal blooms have been a cause of species of fish, turtles, dolphins, and shrimp to die and cause harmful effects on humans who swim in the water.

Polluted runoff from roads and highways can be a significant source of water pollution in coastal areas. About 75% of the toxic chemicals that flow into Puget Sound are carried by storm water that runs off paved roads and driveways, rooftops, yards and other developed land. In California, there are many rainstorms that runoff into the ocean. These rainstorms occur from October to March, and these runoff waters contain petroleum, heavy metals, pollutants from emissions, etc.

5. Acidification

The oceans are normally a natural carbon sink, absorbing carbon dioxide from the atmosphere. Because the levels of atmospheric carbon dioxide are increasing, the oceans are becoming more acidic. The potential consequences of ocean acidification are not fully understood, but there are concerns that structures made of calcium carbonate may become vulnerable to dissolution, affecting corals and the ability of shellfish to form shells.

Oceans and coastal ecosystems play an important role in the global carbon cycle and have removed about 25% of the carbon dioxide emitted by human activities between 2000 and 2007 and about half the anthropogenic CO₂ released since the start of the industrial revolution. Rising ocean temperatures and ocean acidification means that the capacity of the ocean carbon sink will gradually get weaker, giving rise to global concerns expressed in the Monaco and Manado Declarations.

A report from NOAA scientists published in the journal *Science* in May 2008 found that large amounts of relatively acidified water are upwelling to within four miles of the Pacific continental shelf area of North America. This area is a critical zone where most local marine life lives or is born. While the paper dealt only with areas from Vancouver to northern California, other continental shelf areas may be experiencing similar effects.

A related issue is the methane clathrate reservoirs found under sediments on the ocean floors. These trap large amounts of the greenhouse gas methane, which ocean warming has the potential to release. In 2004 the global inventory of ocean methane clathrates was estimated to occupy between one and five million cubic kilometers. If all these clathrates were to be spread uniformly across the ocean floor, this would translate to a thickness between three and fourteen meters. This estimate corresponds to 500–2500 gigatonnes carbon (Gt C), and can be compared with the 5000 Gt C estimated for all other fossil fuel reserves.

6. Eutrophication

Eutrophication is an increase in chemical nutrients, typically compounds containing nitrogen or phosphorus, in an ecosystem. It can result in an increase in the ecosystem's primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.

The biggest culprit are rivers that empty into the ocean, and with it the many chemicals used as fertilizers in agriculture as well as waste from livestock and humans. An excess of oxygen-depleting chemicals in the water can lead to hypoxia and the creation of a dead zone.

Estuaries tend to be naturally eutrophic because land-derived nutrients are concentrated where runoff enters the marine environment in a confined channel. The World Resources Institute has identified 375 hypoxic coastal zones around the world, concentrated in coastal areas in Western Europe, the Eastern and Southern coasts of the US, and East Asia, particularly in Japan. In the ocean, there are frequent red tide algae blooms that kill fish and marine mammals and cause respiratory problems in humans and some domestic animals when the blooms reach close to shore.

In addition to land runoff, atmospheric anthropogenic fixed nitrogen can enter the open ocean. A study in 2008 found that this could account for around one third of the ocean's external (non-recycled) nitrogen supply and up to three per cent of the annual new marine biological production. It has been suggested that accumulating reactive nitrogen in the environment may have consequences as serious as putting carbon dioxide in the atmosphere.

One proposed solution to eutrophication in estuaries is to restore shellfish populations, such as oysters. Oyster reefs remove nitrogen from the water column and filter out suspended solids, subsequently reducing the likelihood or extent of harmful algal blooms or anoxic conditions. Filter feeding activity is considered beneficial to water quality by controlling phytoplankton density and sequestering nutrients, which can be removed from the system through shellfish harvest, buried in the sediments, or lost through denitrification. Foundational work toward the idea of improving marine water quality through shellfish cultivation to was conducted by Odd Lindahl et al., using mussels in Sweden.

7. Plastic debris

Marine debris is mainly discarded human rubbish which floats on, or is suspended in the ocean. Eighty percent of marine debris is plastic – a component that has been rapidly accumulating since the end of World War II. The mass of plastic in the oceans may be as high as 100,000,000 tones (98,000,000 long tons; 110,000,000 short tons).

Discarded plastic bags, six pack rings, cigarette butts and other forms of plastic waste which finish up in the ocean present dangers to wildlife and fisheries. Aquatic life can be threatened through entanglement, suffocation, and ingestion. Fishing nets, usually made of

plastic, can be left or lost in the ocean by fishermen. Known as ghost nets, these entangle fish, dolphins, sea turtles, sharks, dugongs, crocodiles, seabirds, crabs, and other creatures, restricting movement, causing starvation, laceration, infection, and, in those that need to return to the surface to breathe, suffocation.

Many animals that live on or in the sea consume flotsam by mistake, as it often looks similar to their natural prey. Plastic debris, when bulky or tangled, is difficult to pass, and may become permanently lodged in the digestive tracts of these animals. Especially when evolutionary adaptations make it impossible for the likes of turtles to reject plastic bags, which resemble jellyfish when immersed in water, as they have a system in their throat to stop slippery foods from otherwise escaping. Thereby blocking the passage of food and causing death through starvation or infection.

Plastics accumulate because they don't biodegrade in the way many other substances do. They will photodegrade on exposure to the sun, but they do so properly only under dry conditions, and water inhibits this process. In marine environments, photodegraded plastic disintegrates into ever-smaller pieces while remaining polymers, even down to the molecular level. When floating plastic particles photodegrade down to zooplankton sizes, jellyfish attempt to consume them, and in this way the plastic enters the ocean food chain.

Many of these long-lasting pieces end up in the stomachs of marine birds and animals, including sea turtles, and black-footed albatross. In a 2008 Pacific Gyre voyage, Algalita Marine Research Foundation researchers began finding that fish are ingesting plastic fragments and debris. Of the 672 fish caught during that voyage, 35% had ingested plastic pieces.

Plastic debris tends to accumulate at the center of ocean gyres. The North Pacific Gyre, for example, has collected the so-called "Great Pacific Garbage Patch", which is now estimated to be one to twenty times the size of Texas (approximately from 700,000 to 15,000,000 square kilometers). There could be as much plastic as fish in the sea. It has a very high level of plastic particulate suspended in the upper water column. In samples taken in 1999, the mass of plastic exceeded that of zooplankton (the dominant animal life in the area) by a factor of six.

Midway Atoll, in common with all the Hawaiian Islands, receives substantial amounts of debris from the garbage patch. Ninety percent plastic, this debris accumulates on the beaches

of Midway where it becomes a hazard to the bird population of the island. Midway Atoll is home to two-thirds (1.5 million) of the global population of Laysan albatross. Nearly all of these albatross have plastic in their digestive system and one-third of their chicks die.

Toxic additives used in the manufacture of plastic materials can leach out into their surroundings when exposed to water. Waterborne hydrophobic pollutants collect and magnify on the surface of plastic debris, thus making plastic far more deadly in the ocean than it would be on land. Hydrophobic contaminants are also known to bio accumulate in fatty tissues, biomagnifying up the food chain and putting pressure on apex predators. Some plastic additives are known to disrupt the endocrine system when consumed, others can suppress the immune system or decrease reproductive rates.

Floating debris can also absorb persistent organic pollutants from seawater, including PCBs, DDT, and PAHs. Aside from toxic effects, when ingested some of these affect animal brain cells similarly to estradiol, causing hormone disruption in the affected wildlife. Saido, a chemist with the College of Pharmacy, conducted a study in Nihon University, Chiba, Japan, that discovered, when plastics eventually decompose, they produce potentially toxic bisphenol A (BPA) and PS oligomer into the water. These toxins are believed to bring harm to the marine life living in the area.

A growing concern regarding plastic pollution in the marine ecosystem is the use of microplastics. Microplastics are little beads of plastic less than 5 millimeters wide, and they are commonly found in hand soaps, face cleansers, and other exfoliators. When these products are used, the microplastics go through the water filtration system and into the ocean, but because of their small size they are likely to escape capture by the preliminary treatment screens on wastewater plants. These beads are harmful to the organisms in the ocean, especially filter feeders, because they can easily ingest the plastic and become sick. The microplastics are such a concern because it is difficult to clean them up due to their size, so humans can try to avoid using these harmful plastics by purchasing products that use environmentally safe exfoliates.

8. Toxins

Apart from plastics, there are particular problems with other toxins that do not disintegrate rapidly in the marine environment. Examples of persistent toxins are PCBs, DDT, TBT, pesticides, furans, dioxins, phenols, and radioactive waste. Heavy metals are metallic chemical elements that have a relatively high density and

are toxic or poisonous at low concentrations. Examples are mercury, lead, nickel, arsenic, and cadmium. Such toxins can accumulate in the tissues of many species of aquatic life in a process called bioaccumulation. They are also known to accumulate in benthic environments, such as estuaries and bay muds: a geological record of human activities of the last century.

9. Underwater noise

Marine life can be susceptible to noise or the sound pollution from sources such as passing ships, oil exploration seismic surveys, and naval low-frequency active sonar. Sound travels more rapidly and over larger distances in the sea than in the atmosphere. Marine animals, such as cetaceans, often have weak eyesight, and live in a world largely defined by acoustic information. This applies also to many deeper sea fish, who live in a world of darkness. Between 1950 and 1975, ambient noise at one location in the Pacific Ocean increased by about ten decibels (that is a tenfold increase in intensity).

Noise also makes species communicate louder, which is called the Lombard vocal response. Whale songs are longer when submarine-detectors are on. If creatures don't "speak" loud enough, their voice can be masked by anthropogenic sounds. These unheard voices might be warnings, finding of prey, or preparations of net-bubbling. When one species begins speaking louder, it will mask other species voices, causing the whole ecosystem to eventually speak louder.

According to the oceanographer Sylvia Earle, "Undersea noise pollution is like the death of a thousand cuts. Each sound in itself may not be a matter of critical concern, but taken all together, the noise from shipping, seismic surveys, and military activity is creating a totally different environment than existed even 50 years ago. That high level of noise is bound to have a hard, sweeping impact on life in the sea."

Noise from ships and human activity can damage Cnidarians and Ctenophora, which are very important organisms in the marine ecosystem. They promote high diversity and they are used as models for ecology and biology because of their simple structures. When there is underwater noise, the vibrations in the water damage the cilia hairs in the Coelenterates. In a study, the organisms were exposed to sound waves for different numbers of times and the results showed that damaged hair cells were extruded or missing or presented bent, flaccid or missed kinocilia and stereocilia.

10. Adaptation and mitigation

Much anthropogenic pollution ends up in the ocean. The 2011 edition of the United Nations Environment Programme Year Book identifies as the main emerging environmental issues the loss to the oceans of massive amounts of phosphorus, "a valuable fertilizer needed to feed a growing global population", and the impact billions of pieces of plastic waste are having globally on the health of marine environments.

Bjorn Jennssen (2003) notes in his article, "Anthropogenic pollution may reduce biodiversity and productivity of marine ecosystems, resulting in reduction and depletion of human marine food resources". There are two ways the overall level of this pollution can be mitigated: either the human population is reduced, or a way is found to reduce the ecological footprint left behind by the average human. If the second way is not adopted, then the first way may be imposed as the world ecosystems falter.

The second way is for humans, individually, to pollute less. That requires social and political will, together with a shift in awareness so more people respect the environment and are less disposed to abuse it. At an operational level, regulations, and international government participation is needed. It is often very difficult to regulate marine pollution because pollution spreads over international barriers, thus making regulations hard to create as well as enforce.

Without appropriate awareness of marine pollution, the necessary global will to effectively address the issues may prove inadequate. Balanced information on the sources and harmful effects of marine pollution need to become part of general public awareness, and ongoing research is required to fully establish, and keep current, the scope of the issues. As expressed in Daoji and Dag's research, one of the reasons why environmental concern is lacking among the Chinese is because the public awareness is low and therefore should be targeted.

The amount of awareness on marine pollution is vital to the support of keeping the prevention of trash from entering waterways and ending up in our oceans. The EPA reports that in 2014 Americans generated about 258 million tons of waste, and only a third was recycled or composted. In 2015, there was over 8 million tons of plastic that made it into the ocean. The Ocean Conservancy reported that China, Indonesia, Philippines, Thailand, and Vietnam dump more plastic in the sea than all other countries combined. Through more sustainable packing this could lead to eliminating toxic constituents, using fewer materials, making more readily available recyclable plastic. However, awareness can only take these

initiatives so far. The most abundant plastic is PET (Polyethylene terephthalate) and is the most resistant to biodegradables. Researchers have been making great strides in combating this problem. In one way has been by adding a special polymer called a tetra block copolymer. The tetra block copolymer acts as a laminate between the PE and iPP which enables for an easier breakdown but still be tough. Through more awareness, individuals will become more cognizant of their carbon footprints. Also, from research and technology, more strides can be made to aid in the plastic pollution problem.

Specific examples

- Chinese and Russian industrial pollution such as phenols and heavy metals in the Amur River have devastated fish stocks and damaged its estuary soil.
- Wabamun Lake in Alberta, Canada, once the best whitefish lake in the area, now has unacceptable levels of heavy metals in its sediment and fish.
- Acute and chronic pollution events have been shown to impact southern California kelp forests, though the intensity of the impact seems to depend on both the nature of the contaminants and duration of exposure. Due to their high position in the food chain and the subsequent accumulation of heavy metals from their diet, mercury levels can be high in larger species such as bluefin and albacore. As a result, in March 2004 the United States FDA issued guidelines recommending that pregnant women, nursing mothers and children limit their intake of tuna and other types of predatory fish.
- Some shellfish and crabs can survive polluted environments, accumulating heavy metals or toxins in their tissues. For example, mitten crabs have a remarkable ability to survive in highly modified aquatic habitats, including polluted waters. The farming and harvesting of such species needs careful management if they are to be used as a food.
- Surface runoff of pesticides can alter the gender of fish species genetically, transforming male into female fish.
- Heavy metals enter the environment through oil spills – such as the Prestige oil spill on the Galician coast and Gulf of Mexico which unleashed an estimated 3.19 million barrels of oil– or from other natural or anthropogenic sources.
- In 2005, the Ndrangheta, an Italian mafia syndicate, was accused of sinking at least 30 ships loaded with toxic waste, much of it radioactive. This has led to widespread investigations into radioactive waste disposal rackets.

- Since the end of World War II, various nations, including the Soviet Union, the United Kingdom, the United States, and Germany, have disposed of chemical weapons in the Baltic Sea, raising concerns of environmental contamination.
- The Fukushima Daiichi nuclear disaster in 2011 caused radioactive toxins from the damaged power plant to leak into the air and ocean. There are still many isotopes in the ocean, which directly affects the benthic food web and also affects the whole food chain. The concentration of ^{137}Cs in the bottom sediment that was contaminated by water with high concentrations in April–May 2011 remains quite high and is showing signs of very slow decrease with time.

Different Kinds of Pollution

A. Marine pollution caused by ships

Because of its low cost and the advantage of large cargo volume, ship transportation has become the most important transportation mode. With the great development of industrial technology and rapid population growth, the volume of sea freight has increased significantly year by year, and the tonnage and size of ships have been increasing. But with the emergence of marine pollution problems are becoming more serious. Ship in the course of the operation, it is inevitable to introduce some pollutants into the ocean, causing marine pollution.

B. Oil pollution caused by ship transport

The oil pollution caused by ship transport mainly includes two categories: the first is the pollution caused by normal navigation, e.g. cabin bilge water, oil tanker ballast water, washing water and so on.

The second category is due to shipping accidents, e.g.: oil spill. Among all types of marine pollution, oil pollution should be said that the most serious. Because oil is difficult to volatile, making the oil on the sea to form a terrible oil film, resulting in a series of serious consequences.

C. Harmful substances caused by Marine pollution

In recent years, with the transport of dangerous chemicals increased ship, harmful substances caused by pollution is also growing. In general, this type of pollution includes: (1) pollution caused by the transport of liquid toxic substances in bulk, including ballast water and tank washing water, cargo pump bilge water, and the other is due to the accident caused by a large number of toxic and hazardous substances spillover and loading and unloading operations in the drop, leakage and so on.

(2) Packaging harmful substances caused by the pollution. In case of transport of hazardous substances in containers on board ships, packaging damage, leakage, spillage and spillage on open decks and bilges will result in maritime contamination when water is removed from the ship's surface to remove these spilled toxicants. In addition to these toxic substances mixed garbage, separators or other materials are also sources of pollution, of course, when the emergency abandonment of the goods will also cause serious marine pollution.

D. Pollution from domestic sewage and garbage

Ship sewage usually is the excreta from daily, such as toilet discharge, medical room discharge, and the activities of the premises of the discharge material. Ship waste is mainly solid waste, such as a variety of daily necessities, food and work supplies. As the sewage water containing bacteria, viruses and various eutrophication substances, resulting in emissions of seawater after the pollution, such as the eutrophication of sea water and lead to depletion of dissolved oxygen, organics corrosive stench, making the seawater serious pollution. Marine waste can also cause environmental pollution due to the presence of substances that are toxic or difficult to degrade, such as plastics.

E. Pollution of air by ships

Ship air pollution caused mainly in the following three aspects: (1) fuel combustion. Exhausted carbon dioxide (CO₂), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x) and other causes of air pollution. (2) The use of refrigerants, fire extinguishing agents, detergents, foaming agents (insulation materials), such as the production of chlorofluorocarbons (CFCs), halocarbons (Halon), the ozone layer of the atmosphere produced serious harm. (3) Liquid hydrocarbons in the hydrocarbon gas or harmful gases, the proliferation of air pollution caused by the atmosphere.

The above four points we can see the ship pollution caused by the following characteristics:

1. Diversity of pollutants in ships. The substances discharged by the ship are oil, toxic and hazardous substances, ship waste, on board living wastewater. One of the main is the oil substances.
2. The pollution of ships is fluid and non - border. The mobility of seawater, the mobility of the ship determines the pollutants from the ship into the ocean cannot be limited to or fixed at a point and stationary. A pollution may spread to many countries, to the pollution caused by a lot of inconvenience.
3. Ship pollution is highly hazardous and has a wide range. The pollution of the marine environment is damaged and the habitat environment of the marine organisms is destroyed, which seriously affects the adjustment function of the ocean itself. It will bring serious harm to the marine ecological environment, marine biological resources and marine fishery production, thus affecting the global ecological balance, a serious threat to human living environment.

F. Marine pollution caused by oil

Oil as the basis of industry, it can't be replaced for industry, the oil bring us a lot of convenience in production and life, but also brought the significant pollution to the environment, especially the marine environment, and now, oil Pollution has become one of the most important causes of marine pollution.

G. Status of Offshore Oil Pollution

Oil pollution is associated with the discovery and use of oil. At present, oil energy accounts for about 33% of the world's total energy. The widespread use of petroleum and its products has had a serious impact on the environment. According to statistics, the total annual amount of oil poured into the ocean is between 200 to 1000 million tons every year. With the development of the petroleum industry, the marine area contaminated by petroleum is expanding and the pollution degree is also increasing. The oil pollution in China is also very serious, every year, there will have about 10 million tons oil discharged into the ocean in China, this caused the fisheries losses about hundred million dollars each year. According to the National Marine Environmental Monitoring Network monitoring, China's offshore oil content of more than one or two types of sea water quality standards of the sea area has reached 56,000 square kilometers. With the rapid development of the oil industry, many environmental problems have been brought, such as oil spills, leakage, settlement and discharge, which are caused by accident, abnormal operation and overhaul in crude oil

extraction, transportation and processing. Oil pollution has become a major pollution of the marine environment, the marine and coastal ecological environment caused serious harm. Marine oil pollution comes mainly from oil spill, offshore oil production, marine transport, atmospheric transport, urban pollution and water discharge. Of which natural sources account for about 92%, and human activities account for about 8% and the most serious environmental impact of human activities caused by sudden oil spills. According to United Nations statistics, the annual oil well blowout accidents and oil tanker accidents caused oil spill as high as 2.2×10^7 t. A large number of oil spill into the marine environment instantly, through the proliferation, drift and other effects on the marine ecological environment and society caused serious damage. Offshore oil pollution by oil input type, can be divided into sudden input and chronic long-term input. Sudden input includes oil tanker accidents and offshore oil spills and blowout accidents, while the chronic long-term input is the port and ship operations oily wastewater discharge, natural seabed leakage, oily sediments erosion after exudation, industrial waste water discharge. The main causes of pollution are as follows: the frequent sea oil shipping increases the probability of oil spill at sea; the port loading and unloading oil operation is frequent, there is a hidden danger of spill oil; large-scale oil tanker has increased the occurrence of major oil spill accidents The possibility of oil spill treatment to improve the difficulty of offshore oil exploration and development of oil spills and wastewater discharge.

Over the years, transportation of petroleum has been taking place through vessels and pipelines. Transportation of oil that has been mostly used as a source of energy as well as fuel throughout the world has been very successful through tankers which are specialized vessels for carrying oil.

Technological development and industrial revolution contributed much to developments in the use of oil as the primary source of energy. Importance of petroleum and its products to the development of the world cannot be overemphasized. Petroleum plays a great role in the production of energy throughout the world as it is the world's primary energy source. Both technological and economic development has been contributed much by petroleum. On the other hand, environmental sustainability and economic sustainability are essential parts of sustainable development.

By the 1960's oil pollution from ships was becoming more of a threat as amount of oil being transported by sea was increasing as were the number and size of tankers. Oil spills at sea have contributed to the loss of other industries like fisheries and tourism, as also degradation

of marine environment. Beside remarkable contribution of oil to development, catastrophic effect of oil to marine environment is worthy learning.

Effects of Oil Pollution to Marine Environment

Petroleum can contribute to the damage of marine environment and its amenities. Not only does oil pollution inflict damage to the natural environment, but also harm economy. In fact, spills from non vessel sources like pipelines and offshore facilities are more numerous than spills from vessel sources.

Even though oil spills from vessels may not be the most polluting activity in as far as marine pollution is concerned, once a major spill of crude oil occurs at sea it is indeed disastrous. At the same time, the size of tankers has been increasing with increase in technological advances, thus more threat of worse consequences of oil pollution at sea. The world witnessed the first biggest oil spill through the Torrey Canyon in 1967. Furthermore, to name but a few, the Exxon Valdez (that ground in Prince William Sound, Alaska, spilled approximately 40,000 tons of crude oil), the Erika (spilled approximately 30,884 tons of fuel oil and polluted over 400 kilometers French coast), the Prestige (broke in two and sunk west of Vigo –Spain. Approximately 63,000 tons of heavy fuel oil was spilled). On top of that, there is the Deepwater Horizon Oil Spill of 2010 which is so far considered the largest oil spill of all times. In the named oil spill incidents, the adverse effects of hydrocarbons has been demonstrated evidently; the damage to shoreline, marine ecosystem, fisheries and coastal amenities are remarkable.

Such damage corresponds to financial, commercial, and other related losses. Preventive measures, clean-up operations and restoration, property damage have all proved to cost to a great extent both resources and time. Besides, the cost of damage done to the environment can neither be quantified nor fully recovered.

Despite the fact that oil pollution at sea was first recognized as a problem during World War I, the first international convention on prevent oil pollution at sea was adopted after World War II.

Hazards of Offshore Oil Pollution

1. Ecological hazards

(1) The impact of sea air exchange: Oil film covering the sea, blocking O₂, CO₂ and other gas exchange. Caused the destruction of the ocean dissolved gas cycle balance.

(2) The impact of photosynthesis: Oil hinder the sun into the ocean, so that the water temperature drops, undermine the ocean O₂, CO₂ balance, which also destroyed the objective conditions of photosynthesis. At the same time, dispersed and emulsified oil invades marine plants, destroying chlorophyll, blocking normal division of cells, blocking plant respiratory tract, and then destroying the main body of photosynthesis.

(3) The consumption of dissolved oxygen in seawater: a large number of the degradation of oil consumption of oxygen in the water, but the main way the sea water reoxygenation dissolved oxygen film was obstructed, made a direct result of sea water hypoxia.

(4) Poisoning: The polycyclic aromatic hydrocarbons contained in petroleum are highly toxic to organisms, and the toxicity is significantly related to the number of aromatic rings and the degree of alkylation. First of all, the absolute toxicity of macromolecular compounds is very high, and in water, low molecular class due to the strong water-soluble and subsequent great bioavailability, also showed severe toxic effects. Hydrocarbons can be further exacerbated by bioaccumulation and transport of food chains. Evidence suggests that hydrocarbons have mutagenic and carcinogenic effects, while the ecological risk of chronic oil pollution is more difficult to assess.

(5) Destruction of coastal wetlands: Oil development and other human activities led to the loss of serious coastal wetlands in China. According to preliminary estimates, China's total loss of coastal wetland area of about 2.19 million hectares, accounting for 50% of the total coastal wetland area.

2. Social harm

(1) The harm of oil pollution to fisheries: Oil pollution as a result of inhibition of photosynthesis, reduce the dissolved oxygen content, destruction of biological physiological function, marine fisheries resources are gradually declining.

(2) The occurrence of red tide stimulated by oil pollution: The occurrence probability of red tide increased in the oil-polluted sea area. Although the mechanism of red tide is still inconclusive, the role of petroleum hydrocarbon should be considered.

(3) The impact of oil pollution on industrial and agricultural production: Oil in the oceans is easy to attach to fishing nets, increase the difficulty of cleaning, reduce the efficiency of network equipment, increase fishing costs, resulting in huge economic losses. On the beach drying plant, sewage is undoubtedly difficult to use, for desalination plants and other needs to seawater as raw material for the enterprise. Polluted seawater is bound to substantially increase production costs.

(4) The impact of oil pollution on tourism: Offshore oil can be easily attached to the beach and so tarnish attractive beachfront entertainment, the image of the coastal city.

Impact on human health

Marine oil pollution on human health has a direct or indirect impact on the health hazards of anesthesia and suffocation, chemical pneumonia, dermatitis and so on. Such as gasoline for the narcotic poisoning, acute poisoning can cause central nervous system and respiratory system damage; inhaled a large number of diesel oil droplets in the short term can lead to chemical pneumonia. Such as underground oil tank and oil pipeline corrosion leakage of soil and ground water pollution, not only cause soil Stalinization, poisoning, leading to soil destruction and destruction, and its toxic substances through crops, especially groundwater into the food chain system, the ultimate direct harm to human . Especially oil into the ocean, but also through the food chain in the final enrichment in the human body, resulting in serious harm to human health. Gasoline, diesel, kerosene in the toxic and harmful substances on the human nervous system, urinary system, respiratory system, circulatory system, blood system and other hazards. Foreign studies have found that children living near gas stations or auto repair shops have a fourfold higher risk of developing acute leukemia than those who have children who are at risk of developing acute leukemia. These children are at risk of developing acute leukemia. The risk of acute non-lymphocytic leukemia is seven times higher than that of children living in the same area but not near the gas station. This shows that oil on human health will have a great harm.

Effects on aquatic organisms

Oil pollutants into the marine environment will have a huge impact on the growth and reproduction of aquatic organisms and the ecosystem as a whole. Toxic compounds in pollutants can change the cell activity, algae and other plankton acute poisoning death. When the oil concentration in the sea is $10^{-4} \sim 10^{-3} \text{mg / L}$, it can affect the early development of fish eggs and fish. The oil coating will lead to a large number of bird deaths, such as Exxon's Valdez shipwreck accident in four months, causing up to 30,000 birds killed. Heavy components of oil sank to the bottom of the sea and cause damage to benthic organisms. Oil will penetrate into higher plants such as *Spartina anglica* and mangrove plants, alter the physiological functions such as cell permeability, and serious oil pollution may even lead to the death of these tidal zones and salt marsh plants. The chemical toxicity of petroleum to marine organisms depends on the type and composition of the oil. Usually,

the toxicity of refined oil is higher than that of crude oil. The toxicity of low molecular weight hydrocarbon is higher than that of high molecular weight hydrocarbon. In various hydrocarbons, the toxicity is descending in order of aromatics, alkenes, cyclic hydrocarbons and chain hydrocarbons. The damage of petroleum hydrocarbons to marine organisms is mainly to destroy the normal structure and permeability of cell membranes and interfere with the enzyme system of organisms, thus affecting the normal physiological and biochemical processes of organisms. Such as oil pollution can reduce phytoplankton photosynthesis intensity, hinder cell division, reproduction, so that many animals, embryos and larvae developmental abnormalities, growth retardation; oil can also make some animal diseases such as fish gill necrosis, skin erosion, suffering from stomach As well as carcinogenic.

Impact on fisheries

Oil pollution can inhibit photosynthesis, reduce the oxygen content in seawater, destruction of the normal physiological function of organisms, so that the gradual decline of fisheries resources. In the contaminated waters, the poor quality of water to make a large number of objects of death. Survived also because of containing oil pollutants and smell, resulting in inedible. Fish and shellfish in the oil content of 0.01mg / L of living in the sea water for 24h can be with oil, if the concentration increased to 0.1mg / L, 2 ~ 3h can make it with a smell. Oil will be attached to the fish gills, the fish suffocation.

The formation of oil film can hinder the re-oxygenation of water, the impact of marine plankton growth, damage to marine ecological balance.

Impact on the environment

The formation of oil in the sea oil film can hinder the exchange of gas between the atmosphere and sea water, affecting the sea surface of the electromagnetic radiation absorption, transmission and reflection. Long-term oil film covering the polar ice will enhance the endothermic capacity of the ice and accelerate the melting of the ice, potentially affecting global sea-level changes and long-term climate change. The oil in the sea surface and seawater can dissolve the lipophilic components in the pollutants such as halogenated hydrocarbons and reduce the rate of interfacial migration and transformation. Oil pollution will damage the coastal scenic area and beach. Affected by ocean currents and waves, the oil in the oceans easily accumulates on the shore, polluting the beach and destroying the tourism resources. 2002 Panamanian oil tanker "prestige" broken oil spills, making the

original charming scenario of the Galician coast of Spain became a black oil of hell, to the local tourism industry a heavy blow.

Twelve Types of Maritime Accidents

Shipping accidents are unexpected events that result in financial loss and properties, damages and either loss of people. Several reasons as human errors, technical failures, natural conditions, shipping factors, route conditions and cargo related factors play role in these accidents. Unfortunately, shipping accidents are inevitable cases of maritime field, in contravention of creative and innovative technologies in shipping sector and execution of precautionary safety rules and regulations. Main purpose of this paper is to investigate the effects of shipping accidents on marine environment in Turkish Seas. Within this scope firstly, the literature related shipping accidents and marine environment were handled. Then, the statistics of shipping accidents and marine environment in Greek Seas were analyzed. Finally, future projections were provided in the light of presented matters and current developments. When one uses any mode of transport, accidents are bound to happen. Accidents occur because of negligent mistakes but the effects of the same are lasting and lingering. There have emerged and are emerging so many accident cases, that it has become to keep track of them. Road accidents, rail accidents and aircraft crash landings are accidents that everyone today has become accustomed hearing about. In a similar manner, even maritime accidents occur, casualties are caused and damages have to be borne. However, unlike in the former three cases, there are several possible types of maritime accidents. The oceanic area is very vast and therefore the variations in accidents are also numerous. The effects of the occurrences of marine accidents include not just humans but also the marine creatures and the marine environment and ecosystem.

1. Offshore Oil Rig Mishaps: The recently occurred oil spill in the Gulf of Mexico is an offshore oil rig accident. Offshore oil rigs constitute great danger in terms of their heavy machinery and the complexities of the processes involved. Even a minor error by way of negligence of a simple process or overlooking in the working of a machinery part can lead to immense damaging consequences across the world.

2. Cruise Vessel Mishaps: Cruise vessels form a very important part in the vacation itinerary of people. However, a major type of maritime accident occurs in cruise

vessels. Cruise vessels could capsize or face tough weather conditions causing the ship to develop major problems. Another important cause of accidents in cruise ships is because of the negligence on the part of workers. As per statistical data nearly 75% of fires are caused because of a mere mistake by people working on the cruise ship.

3. Commercial Fishing Mishaps: Even fishing for commercial purposes can lead to fatal incidents being caused. Inexperienced fishermen – sometimes even experienced ones – can fall overboard. Harsh weather conditions can also cause severe damages to a commercial fishing expedition.

4. Accidents on Tugboats: Tugboats are those which help move huge ships to enter docks. They are small in nature but are powerful to ensure that the large vessels are handled safely. But sometimes because of the blockage of the visibility of tugboats by the larger vessels, maritime accidents occur. Also human error on the part of the pilot of the tugboat can also lead to unwanted and unexpected tugboat mishaps.

5. Accidents on Crude Oil Tankers and Cargo Ships: The major cause of accidents on cargo tankers is explosions. Since the very nature of the materials these tankers transport is dangerous and highly flammable, even the most minor of explosions can cause enormous losses. According to statistics, one of the main reasons for oil tanker accidents occurring is because of workers' negligence – nearly 84-88%.

6. Grounding of Ships: Ship grounding occurs when the bottom of the ship's hull scrapes through the ocean-bed. This type of maritime accident has a lot of impact on the ship's hull and more on the overall oceanic area where the grounding has started to occur and has finally culminated. The danger to workers aboard the ship is another important consequence because of the mishap.

7. Marine Accident because of Drugs and alcohol: Drug or substance abuse is a major problem across the world. Even in the marine world, substance abuse can cause irreparable damage. If the workers of a particular ship engage in substance abuse or alcohol, the addiction-induced frenzy could cause the worker to behave erratically and thereby lead to an unwanted maritime accident on board ships.

8. Crane Mishaps: Just like crane operations on the land, marine crane operations on ports and on ship are also risky. The risk is further stressed because of the oceanic operations where the cranes are required. Because of faulty wires or winches, crane workers can lose their life or in a worst case scenario, be alive but with irreparable physical handicap. Alternatively, accidents because of crane operations are also caused because of negligence and inexperience on the part of the worker.

9. Accidents in Shipyards: The shipyards the place where the ship is assembled and constructed in its entirety. Fitting and welding accidents are common in the shipyard which could spare the worker his life but hamper the worker's overall working abilities. Similarly constant inhaling of poisonous fumes also becomes another shipyard accident cause.

10. Maritime Accidents on Diving Support Vessels: People who want to explore the mysteries of the deep sea use a diving support craft to take a plunge into the water. However if the diving support craft is unfit and if the crew also happens to be really unfit to oversee and manoeuvre the whole operation effectively, a major accident can be caused.

11. Accidents on Barges: Barge mishaps occur mainly because of the overall build of the barges themselves, which allows them limited movement on the water and because of the problems of the barge-towing equipments. These problems could be caused due to inexperience on the part of the person at the helm of the towing boats or due to usage of faulty towing cables.

12. Cargo Hauling Accidents: Cargo hauling maritime accidents are those accidents caused to workers who work as cargo haulers. However, according to several maritime accident investigations, it has been reported that cargo hauling workers overstate their cargo-hauling injuries. The maritime accident investigation, consequentially reports that because of this, this profession has one of the most severe rate of work-place absenteeism.

It can be seen from the above mentioned types of maritime accidents, that mistakes on the part of the workers and operators play a major role in the accidents being caused. But in order to find out what was the actual cause of the marine accident, a maritime accident investigation is necessary.

Maritime Accidents

“The “Prestige” oil tanker sinking incident”

Event Review

November 19, 2002, another oil tanker sank. Behind the sinking of oil tankers is the widespread destruction of marine life such as fish and shrimp shellfish, and hundreds of thousands of wild seabirds are starved to death and freeze to death in a number of survivability. Each year, a variety of harmful substances are infiltrated into the marine food chain. Will thus threaten mankind itself ... "Prestige" is a Greek company's oil tanker with Bahamas' flag, carrying 77,000 tons of fuel oil, The trip was from Latvia to Gibraltar. November 13 evening, the ship sailed to 9km away from the Galicia region of Spain encountered the gale, and suffered a hole in the side. There was a 35 meters' long gap appeared on the hull, a large number of fuel leakage started. The Spanish government immediately dispatched rescue ships and helicopters to rescue 27 crew members on the tanker to safety zone, and sent 4 tugs to towed "prestige" to the international waters. On 19th, the wind was blown to the Portuguese direction, and from the Portuguese waters about 93 km the ship were broken into two parts, sinking into the 3600 meters deep seabed. The accident on the local ecological environment caused great disaster, some tributaries on the coast, swamps and grassland vegetation pollution is serious. Because the fuel is a large, viscous mixture, it is more toxic and harder to clean than crude oil. Due to the strong winds at sea, the coastline that leaks oil stains is about 400 kilometers long, making it one of the most serious ecological disasters in the history of the world. On the coast of 500 km north of Spain, 179 beaches were heavily polluted and more than 10,000 seabirds died. Coastal more than 4,000 fishermen due to pollution of fishing resources can't go fishing, the economic loss of 300 million euros. The Spanish authorities estimate that the entire oil clean-up may would take six months, costing \$ 42.05 million. World Wildlife Fund, the local ecological environment at least 10 years is expected to return to normal. In addition, the livelihood of some 4,000 Spanish fishermen and nearly 30,000 industry practitioners has also been greatly affected. The local government has issued a fishing ban, and prohibit the fishing range with the spread of the fuel and continue to expand. Which for the vast majority of fishermen is undoubtedly a fatal blow. The prestige oil tanker spends about 125 tons of oil per day, and the oil spill may last for 5 to 39 months, the Spanish scientific committee, which said the monitors of the tanker's oil spill, said on Dec. 10. The Spanish Scientific Committee concluded this based on data from submarines being surveyed at the site. In the sea near the

site of the wreck also formed an area of 1,000 square kilometers of fuel pollution zone. To January 4, 2003, "prestige" oil tanker on the leak of fuel has drifted to the French coast, the local ecological environment poses a serious threat. And until January 11, the Spanish government's first deputy prime minister said that the Spanish government will take positive measures to seal the fastest speed is still oil spill "prestige" oil tanker on all the oil spill cracks. According to the report of the International Maritime Organization, "prestige" was the fourth shipwreck (made in Japan) within 10 years. The 20th century 70 years, the docks of Japan built a large number of inferior quality ships. At present, there are more than 1,000 single-hull oil tankers in the world, and more than 300 ships were built with inferior steel at that time in Japan, of which three were in 1992, 1993 and 1999 caused serious oil spills. In view of the single-hull tanker accident rate than the double-hull tanker 5 times higher, the United States has long banned the import of single hull oil tankers, France also began to force the Japanese-made single-hull tanker retired. But the international oil traders to reap huge profits, not only continue to use such vessels to transport oil, but also to prevent countries to force the old ship scrapped. "Prestige" has been 26 years of age, as early as 1999 should be suspended. When it was last inspected, it was also found to have a gap in the hull that required urgent repairs. But in June this year the ship in the Strait of Gibraltar and Greece to stay, local officials were not re-examination would approve the release. Such an old-fashioned dangerous ship, actually swaggering in the sea cruising to the crash so far.

Environmentalists pointed out that around the world sailing nearly 1,000 similar single-hull old tanker, also has become a threat to the global marine ecology of the "mobile time bomb." Despite the urgency of the matter, the parties involved in the oil spill have focused on how to shirk responsibility. First, Spain and Portugal, the two governments in the clean-up of the division of responsibilities on the oil. To protect their tourism and fisheries are not affected, the two governments have denied that the incident belongs to the territorial waters of their own territory, and ordered the rescue team to drag the tanker into their own port, the last "prestige" was dragged from the incident to 240 km away on the high seas. The experts pointed out that if stranded in protected waters, the ship could have been "more easily controlled." Then Spain and the United Kingdom who is responsible for the outbreak of diplomatic disputes. The West government said the tanker has the practice of docking in the British Strait of Gibraltar, but the British side has never carried out the necessary checks. And because the tanker did not meet the EU's safety standards, European countries, the port should not even allow it to stop. The British government immediately denied that the ship

was docked in Gibraltar, the British ambassador to Spain said the accusations are "unfounded."

This incident has also aroused grave concern from the rest of the EU. In this regard, the European Commission Vice-President for Energy and Transport called on member states to take immediate and urgent steps to eliminate single-hull tankers from the EU. The European Commission plans to announce a list of ships with bad shipping conditions from January 2003 onwards, forbidding them from entering EU ports. From 2004 onwards, the use of life beyond the provisions of the dangerous vessels to strengthen the port annual inspection efforts, and plans to completely ban by 2015 all 30,000 deadweight tons single-hulled tankers in the EU waters infested.

Accident processing

After the accident, the International Foundation for the Prevention of Cruelty to Animals quickly set up emergency relief teams, with the local wildlife protection organizations in the shore to establish seabird relief center. A large number of rescue workers and volunteers to those in the sea oil struggling puffins, seagulls and other seabird salvage center sent to the careful care and feeding, and finally put them back to nature. This time, Spain and France, in accordance with the spirit of the United Nations Law of the Sea, decided on 27 November 2002 to restrict strictly any vessel carrying dangerous cargoes liable to cause marine pollution, such as petroleum crude oil, fuel oil, Strictly limiting the age of 15 years of single-hull vessels through the territorial waters of the two countries.

At the end of November 2002, the EU 15 ministers of transport meeting agreed that in 2006 after the ban on Member States transport companies operating with single-hull tankers, and are not allowed to commission single-hull oil tankers; And on board personnel severely punished.

Impacts

The oil spill happened after "prestige" sinking in the Galician coast and further in a more extensive area. This area is rich in a variety of birds and sponges, extremely rich in fishery resources, coral clumps and beautiful scenery is the seabirds and other marine life important place to stay and migrate.

There are numerous tourists every year. The fuel oil is a kind of fuel which used to ship or power plant, it is black, more viscous, pungent smell, it's more difficult to cleaning up, it has long decomposition cycle. Particularly harmful to the ecosystem. By November 25, Spain's

500-kilometer coast was contaminated by black waves, 135 beaches covered with oil. Some of the beach oil more than half a meter, caused amount of sea fish, shellfish died. Seabirds who stick to oil, can't fly, either trapped to death, either because of hunger and death. "A vessel like this is not supposed to be so close to the coast because it's an important habitat for many organisms," said Dr. Simon Cripps of the World Wildlife Fund. "We see that there are 17 or 18 different species of birds thus die."

The spill caused hundreds of miles of Spanish coastline to be contaminated, tens of thousands of seabirds, countless fish deaths, more than 4,000 fishermen in a very long time can't make a living.

Treatment of contaminated beaches costs as much as \$ 42.05 million, and the entire governance process takes at least six months. Moreover, to eliminate the ecological problems caused by oil spills, but also patiently waiting for twenty or thirty years. According to the report of the Economic Committee of Porter Weitra show that if you want to clean up the oil leaked prestige, the EU countries need to invest large sums of money, is expected to total 12 billion US dollars is huge.

The accident also to the local economy, tourism, fisheries and so has a significant impact. The contaminated area includes a large number of fishing areas, the leakage caused by a large number of shellfish, fish and other marine life after the accident, the Spanish government ordered the blockade of 128 kilometers of sea, causing local fishermen can't go fishing, which means Most of the fishermen are fully engaged.

The local because of its beautiful scenario attracts a large number of tourists each year to travel, the pollution of the local tourism industry caused a serious blow, 90 beach pollution, resulting in a decline in the number of tourists, hotel occupancy rate. These have given the local economy a serious impact.

“Gulf of Mexico oil spill”

Event Review

May 5, 2010, the US Gulf of Mexico oil spill caused the international community's attention, many countries to the United States transported equipment and personnel to help the United States as soon as possible to deal with pollution problems. Although Iran and the United States in the nuclear energy project on the existence of serious conflict, but also to provide the United States to play the technology of killing wells. July 15, 2010, BP announced that the new oil control device has been successfully cover the underwater oil spill point, "no further oil into the Gulf of Mexico."

Local time April 20, 2010 about 10 o'clock in the evening, Louisiana, a coastal oil drilling platform exploded, drilling platform sinking in about two days, the oil wells under the sea damaged began to leak. The National Oceanic and Atmospheric Administration estimates that about 5,000 barrels of oil are leaking at the bottom of a sinking offshore drilling platform in the Gulf of Mexico, five times the previous estimate. Oil wells continue to leak the same day, the engineers also found a leak point. In order to avoid floating oil drift to the US coast, the US disaster relief departments to take measures to burn, burn thousands of liters of crude oil. April 28, 2010, British Petroleum engineers found the third oil spill point. According to the chart provided by the Coast Guard and relief departments, the oil slick covers an area of about 160 km and a maximum width of about 72 km. US Gulf of Mexico oil spill accident June 23, 2010 deteriorated again: originally used to control the oil spill point of the underwater device was removed due to failure to repair, billowing crude oil has been suppressed for several weeks after the spewing out, Continue to contaminate the vast waters of the Gulf of Mexico. July 15, 2010, monitoring the Gulf of Mexico oil spill from the bottom of the camera video capture screenshots show that the oil spill into the new oil control device and then no signs of oil leakage. In the Gulf of Mexico oil spill occurred nearly 3 months later, BP announced on the 15th, the new oil control device has successfully covered underwater oil spill point, "no further oil into the Gulf of Mexico."

Cause of the event

A "BUBBLE": Beyer is a member of the US National Academy of Engineering responsible for the safety of oil pipelines, in the 1990s as the British oil company risk assessment consultant. According to these records, Beyer restored the process before and after the explosion. The workers set up and tested a cement seal at the bottom of the well, then lowered the internal pressure of the drill pipe and attempted to set up a cement seal. At this time, set the sealing caused by the chemical reaction to produce heat, resulting in a methane bubble generation, leading to this seal was destroyed.

Methane is normally in a crystalline state on the seafloor. Deep-sea drilling platform operations often encounter methane crystals. The methane bubble rises from the high pressure at the bottom of the drill pipe to the low pressure, breaking several safety barriers. "A small bubble becomes a pretty big bubble," Beyer says. "The expanding bubble is like a cannon, jetting into your face.

"Gas cloud" hood: April 20 incident, the drilling platform workers observed drill pipe suddenly jet. Then the gas and crude oil come up. Gas flocked to a room with flammable

materials, where the first explosion occurred. Followed by a series of explosions, lit up the crude oil. Inquiry records show that when a rise of "gas cloud", covering the "deep horizon." Large-scale engine drilling rig then exploded.

The engine exploded, igniting the drill floor, with fire everywhere. About 36 hours after the explosion, the Deepwater Horizon sank into the Gulf of Mexico.

Valve failure: a "blowout valve" big as a double-decker bus, weighing 290 tons. As the last barrier to prevent oil spill, "anti-spray valve" installed in the wellhead, close the oil pipe in the event of oil spills. But "Deepwater Horizon" and "anti-spray valve" does not normally start. "Deep Horizon" equipped with an automatic backup system. The system should be activated when the worker fails to activate the "blowout preventer", but it did not work at the time. After the incident, BP attempted to use underwater robots to start "anti-spray valve", failed to work.

Impacts

Economy: As of June 1, 2010, the oil spilled into the Gulf of Mexico ranged from 17 million gallons to 27 million gallons of oil that could fill 25 to 40 Olympic-size pools. Even more frightening is that leakage continues, the daily oil spill in 12000 barrels to 19000 barrels, far more than the previous assessment of 5000 barrels. Under the influence of the oil spill, President Obama had to announce a moratorium of six months on 33 deep-water drilling projects, and to suspend oil drilling projects along the coast of Alaska. British oil companies in the public criticism of the first to bear the brunt.

Media reports pointed out that BP since the beginning of hire "Deep Horizon" has been invested in huge funds, start-up costs as high as 100 million US dollars. BP said it had spent \$ 930 million in response to the oil spill, including measures to control oil spills and payouts.

Environment: Louisiana governor said on May 26, 2010, more than 160 kilometers of the coast of the state by the leakage of crude oil pollution, pollution than the Mississippi and Alabama coastline of the total length. The Gulf Coast ecological environment is experiencing "disaster", the relevant experts pointed out that the pollution may cause 1,000 miles of coast along the Gulf of Mexico wetlands and beaches destroyed, fisheries damage, fragile species extinction. "This time is particularly sensitive, because many animals are preparing to lay eggs in the Gulf of Mexico, large blue fin tuna are multiplying, their eggs and young fish floating in the sea. Seabirds are nesting, while the spawning turtle. The beaches are devastated and the effects are deadly. Larry Crod, a marine biologist at Duke

University, says a major oil spill would destroy the entire ecosystem and the economic activity that is built on it. University of South Florida oceanographer Weisiboge is more worried that the oil will be involved in the Gulf of Mexico sets of flow. Because once into the set of flow, oil spread to the Florida Strait just a week or so; another week, Miami Beach will see the oil. Crude oil entering the taint will pollute Turtle National Park, causing local coral reefs to die, followed by dolphins, sharks, waders and crocodiles in the Everglades National Park.

Politics: As the leakage of oil wells have not been blocked, the Obama administration is facing increasing external pressure, its ability to be questioned. Fifty-one percent of Americans are dissatisfied with Obama's approach to dealing with the spill, with 60 percent saying the government is incapable of averting similar incidents in the future, according to the latest data from the CNN poll.

US Coast Guard Commander Admiral Allen said that the United States has not considered an alternative solution to oil spills, BP should continue to work to prevent the leakage of crude oil.

Bush's ruling period in response to Katrina hurricane disaster and criticized, and now the Republican Party to seize Obama's "pigtail", launched its fierce criticism. "In the 35-day period, President Barack Obama has not been able to use the government's resources to deal with the situation," said Rep. Darrel Issa, a Republican from California, after the oil spill in the Gulf of Mexico. "Republicans also sneered through the media," In the course of the disaster, we see the president still have time to play golf, political donations and large state banquet. President Barack Obama responded: "The oil spill in the Gulf of Mexico was anxious." On the day I got the oil blast, I told my team that we had to spare all our resources to deal with it effectively.

Oil spill accident. Obama also said that the government has sent 1,000 federal workers to the disaster relief, the government is taking all means to control the spread of the disaster, but Obama's conduct of the government also conducted a review.

British Petroleum Company announced on the 18th, has been completed from the bottom of the cement plugging the work of the Gulf of Mexico oil spill, cement has been solidified. If further testing shows that no new oil spill points, you can officially declare the leak well is completely blocked.

British Petroleum Company said in a press release the same day, engineering staff from the 17th to the oil spill into the cement, about 18 o'clock that night to complete the perfusion. At present, the cement injected into the well has solidified, and the engineers will carry out the

final "pressure and gravity" test. If the test results show that no new oil spill point appears, the oil spill will be officially declared "dead". BP in early August by injecting cement from the top, blocking the Gulf of Mexico oil spill. After that, the company has been preparing for its "bottom block" project, that is, through a large amount of mud and mud into the accident wells to the bottom of the accident, the implementation of permanent sealing leakage wells.

Marine Pollution Control

Measures

There is a great need for revision on the meaning of pollution damage under CLC regime as it does not satisfy modern needs for environmental protection. Environmental damage should clearly be defined in the convention as far as compensation is concerned. This should be reflected in the law, policy and administration of CLC regime. There should be no restrictions to compensation for environmental damage so as to allow full restoration of the state of marine environment after the contamination by a respective oil spill. Additionally, the financial limits provided under the regime needs to be lifted. If the existing financial limit cannot be lifted for any particular reason, it could be feasible to pre-allocate a certain percentage of the available fund to be exclusively for environmental damage and the other part for other no environmental damage claims. Dedicating a reasonable part of the funds for environment damage compensation could guarantee environmental protection through restoration of the state of marine environment after an oil spill.

Despite that marine environment is best in self recovery after oil spill, further revision is needed on both mode of assessment and admissibility of claims to allow more claims on environmental damage and preventive measures for cleaner oceans.

Coastal states should involve in marine environment research and studies for a better understanding of the value of marine environment so that to eliminate problems in times of oil spill incidents especially in claiming for compensation for marine environment. There should be pre-determined studies of the state of marine environment before the happening of an oil spill to be able to provide sufficient evidence at the time of destruction of environment due to contamination by oil.

State parties to international conventions should fulfill the role of implementing relevant conventions in their respective states. In the implementation of conventions, measures should be taken to ensure harmonization of the law in the interpretation of provisions of the conventions in national courts.

Incentive brought by CLC regime is among important factors in promoting environmental protection. Proper application of relevant conventions on liability and compensation together with other maritime conventions like.

1. Change the energy structure

From China's existing energy structure inspired, I think the energy structure of the impact on the environment can't be ignored. According to many surveys, in the range of 2000 meters from the surface below the surface of the crust, the forecast of the total coal resources of 5,059.2 billion tons. In terms of reserves, by the end of 2013, China's proved reserves of coal were 114.5 billion tons (62.2 billion tons for anthracite and bituminous coal, 52.3 billion tons for sub-bituminous coal and lignite), accounting for 12.8% of the world's proved reserves of coal.

China has now become the world's largest coal-producing countries, the world's coal bear nearly half of the output. Coal as China's most important energy resources, reserves, wide distribution, coal quality is better and more complete varieties. In China, coal plays a dominant role in energy supply, with a share of 67.5%. China's coal output in 2013 was 3.68 billion tons (1.84 billion tons of oil equivalent), an increase of 1.2%, accounting for 47.4% of world coal production.

2. Measures for the Control of Marine Pollution by Ships

1. To strengthen China's legislation on ship pollution prevention and control, establish and improve the marine environmental law system in China, adhere to the legislation of ship pollution prevention and control and the uniformity of the environmental legal system, especially marine environmental legal system, and correctly handle ship pollution prevention and control Legislation and related marine environmental law and the relationship between the characteristics and adhere to the comprehensive and systematic review of existing ship pollution control legislation on the basis of the necessary amendments and additions, the key legislation and general legislation combined to improve the marine pollution prevention legislation at the same time Formulate national laws and regulations on prevention and control of pollution from inland waters. While strengthening the domestic legislation on ship pollution prevention, we should study and learn from the advanced experience and effective management methods of foreign ship pollution prevention legislation, adopt the system and measures of pollution prevention and protection of marine environment prevailing in various countries, and make the best according to actual

needs. Possible participation in the relevant conventions, should make every effort with international standards, the international conventions of the specific, domestic. International treaties are an important manifestation of modern international law. In international relations, the state has an international obligation under international treaties. It has the duty to make its domestic law consistent with its international obligations. Therefore, the marine environmental protection law is made according to the relevant international conventions. Amendments are absolutely necessary. The 21st century is the era of great development of marine industry, which requires us to be from a strategic perspective, attention to the ocean, treat the sea. The implementation of the revised law not only improves China's legislation on marine environmental protection, but also plays an important role in strengthening marine environmental management, further protecting and improving the marine environment, protecting ecological balance and promoting sustainable economic and social development of our country. On the world level, on the basis of the above, countries should develop a complete system of marine environmental law, for those of the marine environment pollution caused by the ship should be punished.

2. To further improve the marine environmental protection awareness, to minimize or avoid human factors caused by pollution. For the operational pollution of ships, strengthen the publicity and education, so that the majority of the crew fully aware of the dangers of pollution in the waters, to help them understand the prevention of pollution, the protection of the marine environment of great significance and enhance anti-pollution awareness. Increase penalties, illegal operations or bring the pollution of the re-incorruptible vessels, punish them to take measures to strengthen the supervision and inspection of water pollution, efforts to minimize sea pollution. Strictly abide by the laws and regulations on the prevention of pollution from ships, and improve management standards, improve the allocation of anti-fouling equipment for ships, so that ships have a strong ability to deal with waste in accordance with the requirements of the relevant international conventions. All types of ships should be equipped with oil and water separation equipment, port construction of oil containing sewage treatment facilities and emergency equipment. At the same time, it is necessary to increase public awareness and public awareness of environmental protection and stimulate public participation in marine environmental protection. Is the most effective prerequisite for the complete eradication of marine pollution?

3. Oil pollution control measures

As a kind of environmental pollution, offshore oil pollution has aroused close attention all over the world, and prevention and control of offshore oil pollution is urgent. Governance of marine oil pollution should start from the humanities, to find solutions.

1. Raise environmental awareness and protect the ocean. Ocean gave birth to the rich life of the earth, for the development of life on Earth to provide a vast space. But with the development of society, people actually the ocean as a natural dumping sites, resulting in a large number of waste water, waste gas, waste discharge into the sea. Ocean self-purification capacity is limited, if the human pollution of the ocean exceeds the threshold of self-purification capacity of the sea, marine pollution will certainly have a devastating impact on the entire planet. China has about 320,000 kilometers of coastline, 388,000 square kilometers of territorial waters and nearly 3 million square kilometers of jurisdiction of the sea, which is an important resource for sustainable development in China. However, according to a comprehensive survey of coastal and tidal resources in China: the total amount of pollutants entering China's coastal waters is 6.5 million tons / year, of which oil is 180,000 tons / year, China's oil pollution shows an increasingly serious trend. Therefore, it is necessary to improve people's environmental quality and change people's traditional idea of using the ocean as a natural garbage dump driven by oil interests. It is fully aware that damage to the marine environment is not only endangering a sea area, but also affecting the whole world's behavior.

2. To strengthen legislative oversight, increase law enforcement efforts. In accordance with the UN Convention on the Law of the Sea and other international laws and regulations, all countries should accelerate the formulation and implementation of special laws on offshore oil pollution in accordance with their national conditions, ratify the International Convention on Oil Pollution Preparedness, Response and Cooperation as soon as possible, Pollution control, strengthen the management of oil tankers and crew training; the international community to cause sea and high seas oil pollution units, organizations, countries should be dealt with severely, at the same time, should strengthen international cooperation and common governance of offshore oil pollution .

3. To prevent and control pollution of coastal waters of industrial pollutants in the environment. First, by adjusting the industrial structure and product mix, change the mode of economic growth, the development of circular economy. The second is to strengthen the management of key industrial pollution sources, the implementation of the whole process of cleaner production. Third, in accordance with the "who is polluted, who bear the" principle,

professional treatment and in situ treatment, prohibit industrial pollution sources of toxic and hazardous substances emissions. Fourth, the implementation of environmental impact assessment and the "three simultaneous" system. Fifth, the implementation of total pollutant discharge control and sewage permit system.

4. To prevent, mitigate and control pollution of coastal cities along the coastal waters of the environment. Including the adjustment of irrational town planning, strengthening urban greening and coastal forest construction, protection of coastal wetlands, speed up the coastal urban sewage collection pipe network and the construction of sewage treatment facilities, increase urban sewage collection and treatment capacity, improve urban sewage treatment facilities denitrification and dephosphorization.

5. To prevent, mitigate and control the pollution of marine pollutants in the marine environment. Start the ship oil pollutant "zero emissions" plan, the implementation of the ship sewage system seal system. The establishment of large-scale port wastewater, waste oil, waste recycling and treatment systems, transportation and fishing vessels to achieve the discharge of pollutants focused on recycling, shore treatment, discharge standards.

6. To prevent and reduce the occurrence of sudden pollution accidents. The development of marine oil spills and toxic chemicals spill contingency plans, the development of port environmental pollution accident contingency plans and the establishment of emergency response system.

7. Prevention and control of offshore oil platform oil pollution generated by oil and garbage on the marine environment pollution. So that the environmental quality of oil and gas fields and the surrounding areas meet the environmental quality control requirements of such functional areas, not adverse effects on other marine functional areas adjacent to the development process, no major oil spill occurred. The oil spill response plan should be formulated for the offshore oil exploration and development.

4. Heavy metal pollution control measures

First of all, heavy metal pollution is difficult to control, which is inseparable from its characteristics, but also it is more and more attention of the reasons, so in the control and control of heavy metal pollution must be fully taken into account its characteristics. As the heavy metal pollutants are persistent pollutants, can't be completely removed from the environment, can only change the location or the existence of the form, so the heavy metal pollution in the "anti" and to control as an adjunctive measure.

1. Source Governance

Around the heavy metal pollution enterprises, especially the backward technology, serious environmental pollution enterprises serious environmental safety problems investigation and found a solution to a warning one, and resolutely eliminate the hidden dangers of pollution in the bud. Scientifically adjust the environmental safety protection distance of heavy metal enterprises and prohibit the construction of new related projects in areas with important ecological functions and areas where environmental quality can't be stabilized due to heavy metal pollution. Organize the development of heavy metal industry in key areas, environmental impact assessment of key industries, improve the system of laws and regulations as the prerequisite for the acceptance of the environmental impact assessment documents of the relevant construction projects in the heavy metal industry. In the future, those who did not complete the elimination of backward production capacity in areas where significant pollution caused by mass incidents in the region, suspended its new focus on the prevention and control of pollutant discharge construction project approval.

Environmental protection departments at all levels should effectively strengthen the heavy metal pollution incident information submitted in the event of a problem, it is necessary to report and properly handle and assist the local government to do a good job of information disclosure, mass appease and publicity and education, and earnestly safeguard the environmental rights and interests of the masses, Maintain social harmony and stability.

Environmental protection departments should be on a regular basis these enterprises around the soil water and other sample testing to ensure that the surrounding heavy metal emissions standards, do not pollute the environment. Strengthen the treatment mechanism of enterprise waste, so that recycling, to prevent environmental pollution, while improving the health conditions of labor to ensure the health of workers.

2. Cleaner production

The new and expanded large-scale smelting projects should strictly control the total amount of heavy metal emissions. The transformation of industrial water circulation system, improve the industrial water cycle rate. Reasonable deployment of enterprise production water, to promote the cascade use of water technology. Improve the level of industrial wastewater treatment technology, the wastewater back to the production system for processing. Strengthen the research on key technologies related to clean production and popularize and apply the existing advanced technologies, accelerate the technological

progress of the industry and improve the quality and efficiency of the development of the industry.

Optimize the layout of enterprises, located in large and medium cities, towns and other densely populated areas on the wind direction and from the nearest sensitive point distance of less than 1km of heavy non-ferrous metal smelting enterprises should be through the relocation, stop production, etc. exit. At the same time to strengthen the green plant around to ensure that the vegetation coverage, in order to reduce pollution particles. Such as oleander, acacia, camphor, tree, crape myrtle and other plants, can effectively absorb HF, Cl₂, SO₂ and other harmful gases, and reduce dust concentration around the plant.

3. Improved technology

Improve industry technology, technology and equipment, automation and mechanization, reduce the amount of heavy metal pollutants. Strengthen the industry heavy metal pollution control core technology research, increase business "three wastes" treatment. Strengthen the comprehensive utilization of resources, and promote industrial upgrading.

Heavy metal pyrometallurgy should pay attention to the flue gas purification treatment, hydrometallurgy should pay attention to wastewater discharge standards, such as the use of microbial wet copper smelting, the premise is to do well seepage leakage well to ensure that the leaching solution is not leaking. Raw materials through the car for transport, transport vehicles must be closed vehicles or top cover, to prevent dust or spilled. After being transported to the raw material area, it is directly discharged into the raw material workshop. The raw material workshop should be closed structure. In order to prevent the secondary dust generation, the raw material workshop should be regularly sprinkled and humidified. For factory vehicles must be thoroughly cleaned before leaving the factory to avoid the pollution caused by vehicles carrying the surrounding environment, rinse wastewater should be collected to the sewage treatment plant to the rear of the plant.

Adjust the industrial structure, accelerate the elimination of backward production equipment rely on scientific and technological progress, and actively promote energy-saving emission reduction technology development. Improve the degree of enterprise intensive, the use of advanced technology and large-scale equipment, improve energy efficiency. Vigorously research and development of cleaner production technologies and equipment, focusing on technology integration and innovation, strengthen the study of circular economy technology. Frequent outbreaks of heavy metal pollution incident to bring us bursts of pain at the same time as we wake up wake up the alarm of environmental protection, the incentive behind the

more worthy of our exploration and reflection. Environment is the necessary condition for our survival, if we do not treat the environment, then the environment will be different ways to retaliate against mankind, we only take the economic and environmental harmonious development path, can truly benefit the people.

Laws and policies

- In 1948, Harry Truman signed a law formerly known as the Federal Water Pollution Control Act that allowed the federal government to control marine pollution in United States of America.
- In 1972, the Marine Protection, Research, and Sanctuaries Act of 1972 was passed by the Council on Environmental Quality which controls ocean dumping.
- In 1973 and 1978, MARPOL 73/78 was a treaty written to control vessel pollution, especially regarding oil. In 1983, the International Convention for the Prevention of Pollution from Ships enforced the MARPOL 73/78 treaty internationally.^[119]
- The 1982 United Nations Convention on the Law of the Sea (UNCLOS) was established to protect the marine environment by governing states to control their pollution to the ocean. It put restrictions on the amount of toxins and pollutants that come from all ships internationally.
- In 2017, the United Nations adopted a resolution establishing Sustainable Development Goals, including reduced marine pollution as a measured goal under Goal 14.

Conclusion: Suggestion and Prospect

The marine environment has a huge impact on human life. The global warming caused by marine pollution and rising sea level also pose a great threat to mankind. Marine oil pollution caused by the destruction of the biological chain, environmental degradation and other issues are also very serious.

Heavy metal pollution to the sea is a direct result of human life, heavy metals through the natural cycle into the ocean in the biological chain, and ultimately into the human body, the human health caused a huge impact.

Protection of the marine environment is the responsibility and obligation of each of us, and the marine environment is now faced with a huge test, not optimistic. However, in recent years, with the enhancement of people's environmental awareness, the marine environmental protection has been more and more attention. More and more new environmentally friendly energy be used, environmental monitoring efforts to enhance the discharge of industrial wastewater discharge standards, we can see the hopeful of marine environmental protection. With the progress of mankind, I believe that marine environmental problems will eventually be resolved.

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