JOURNAL OF MARITIME RESEARCH

Vol XIV. No. I (2020) pp 101–111

ISSN: 1697-4040, www.jmr.unican.es

Maritime Oil Transport and Tanker Accidents - 1950-2015 Review

A.U. Gómez-Correa[1,2], J.A. González-Almeida[1,3], F. Padrón[1,4]

ARTICLE INFO

Article history:
Received 30 March 2020;
in revised form 10 April 2020;
accepted 13 April 2020.

Keywords:
Petroleum transport, oil tanker, oil spill, maritime accidents.

ABSTRACT

The evolution of the maritime transport of oil and hydrocarbons in general is closely linked to the oil industry and therefore moves within an economic framework and interests at international level.
Maritime accidents involving oil tankers are a serious problem due to the spills of polluting substances into the sea that they cause, and although it is an international problem that reached its peak with the accidents and spills of the 1970s, awareness of it has not been raised until a few years ago.
The prevention of maritime accidents, the development of appropriate regulations to minimise risks and the quantification of the effects on the environment, as well as the economic and social impact of these spills, requires an in-depth analysis of the causes and effects that have led to accidents involving these ships over the past decades, and at this precise moment, an assessment of how the sector has evolved and where we stand with respect to past times and how to face the future that lies ahead.

1. Introduction.

Although maritime traffic is not the largest source of hydrocarbons at sea, it is no less important because a spill of this kind can have a major impact on the environment in which it occurs. An oil spill not only causes biological and environmental damage, but also brings with it great economic losses if the place affected is of great tourist interest, or if its economy depends on some activity related to the marine environment.

The basis of our work is based on the study of accidents involving ships that have caused oil spills in the second half of the 20th century and the beginning of the 21st century; for this purpose, we have carried out an extensive study, compiling 175 cases and carrying out a statistical analysis in order to find out the reasons why these oil spills have occurred and whether they could have been avoided.

In this research work, the most relevant maritime casualties that have had an environmental impact are presented, analysed and developed. A limited period of study will be established, starting after the Second World War and ending in the near future, from 1950 to 2015. In order to develop this work with the maximum rigour, a compilation of the most relevant spills has been elaborated in this doctoral thesis, compiling a great variety of items, with the idea of being able to better appreciate both the framework and the evolution produced in each area up to the present day.

2. Literature Review.

2.1. Oil Production Worldwide.

It is unquestionable that, for more than a century now (Yergin, 1992), oil as a source not only of energy but also as a raw material for the production of a multitude of products has been a driving force in world society; and it seems that it will continue to do so for at least a few decades, despite its ”bad press”, mainly due to its power as an environmental pollutant (Baines & Appleton, 2009), either directly or through the products that can be derived from it (fuels, asphalts, chemical products, plastics, gases, etc...).). Along with oil, although perhaps a little

[1]Universidad de La Laguna. C/ Padre Herrera s/n. - 38200 - Apartado Postal 456 - San Cristóbal de La Laguna - Spain - (+34) 922 31 90 00. Grupo I+D CONSEMAR (Contaminación y Seguridad Marítima)

[2]Profesor del Área de Ciencias y Técnicas de la Navegación. Departamento de Ingeniería Agraria, Náutica, Civil y Marítima. E-mail Address: agomezco@ull.edu.es.

[3]Profesor del Área de Construcciones Navales. Departamento de Ingeniería Agraria, Náutica, Civil y Marítima. E-mail Address: jagonal@ull.edu.es.

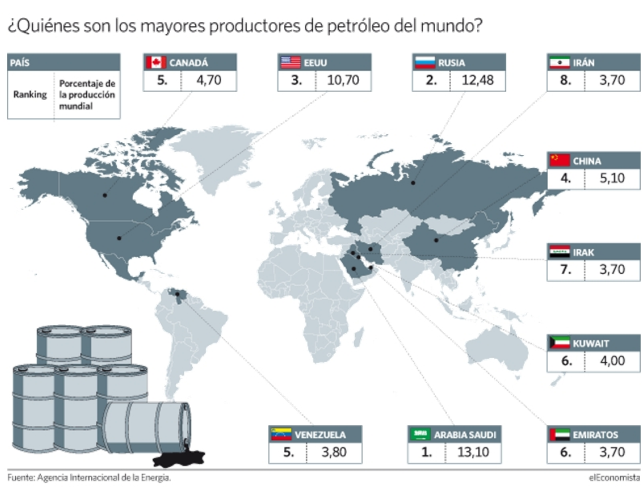
[4]Profesor del Área de Ingeniería de los Procesos de Fabricación. Departamento de Ingeniería Agraria, Náutica, Civil y Marítima. E-mail: fpadron@ull.edu.es

later, there has also been a significant increase in the consumption of other fuels, such as gases, mainly natural gas or methane.

The industrial revolutions that have taken place throughout history have been made possible not only by changes in society and its structures, but also by changes in technology (steam engines, combustion engines, etc.), which undoubtedly led to a change in the main sources of energy (first coal and later oil (Pasdermadjian, 1960). These historic industrial revolutions were the beginning of a race of advances that would give rise to today's modern society and which is still continuing.

It is true that not all countries develop equally, with highly industrialised countries and others that still live with an economy more typical of the Middle Ages, although their development is often closely linked to consumption rather than to the production of this raw material (Alvarez Pelegry, 2015). The list of major oil-producing countries is not very long, and is headed by Saudi Arabia, Russia and the United States, followed by other more modest producers, mostly located in the Middle East (Figure 1).

Figure 1: Countries with the highest oil production.



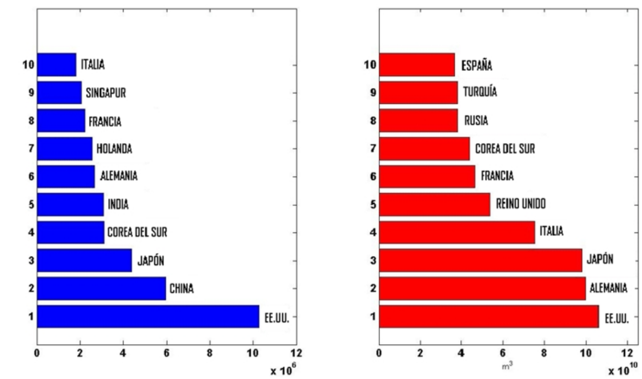
Source: elEconomista.es.

However, the list of oil and gas producers (Figure 2) does not coincide with the list of those that import the most oil and gas (Marzo Carpio, 2009).

Therefore, we must bear in mind that it is necessary to transport these products from the place of production to the area where they will be consumed, and this requires the use of high-capacity means of transport. Although the construction of gas and oil pipelines has intensified (Iglesias, 2003) and the volume transported is still significant, a large part of the transport of these materials must be carried out by ships, as this is the only means of transport with sufficient capacity to move such quantities and, more importantly, with sufficiently competitive associated costs.

At the end of the First World War, the rise of internal combustion engines became evident, to the detriment of steam engines, thus bringing about this important change at the end of the war. In addition, petroleum came onto the scene as a fuel, to the detriment of other oils for burning in diesel, which had been used until then, and displacing the coal used in steam engines.

Figure 2: Top 10 oil (left) and gas (right) consuming countries.

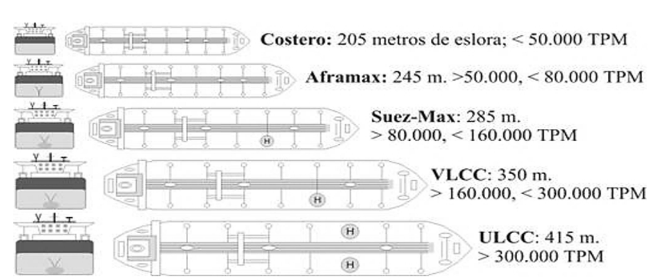


Source: G Leone, Francesco & Pelino, Vinicio, 2013.

2.2. *Transport of Petroleum by Sea.*

From the above, we can understand that most of the production centres are located far from the consumption centres, giving rise to an international oil transport network that covers the entire globe, with well-defined routes (Illustration 4) along which tankers transit (Lun & Hilmola, 2013). Together with oil tankers, we can take into consideration other tankers such as gas tankers (LNG or LPG) and the different types of chemical tankers, and in addition to their intrinsic characteristics, depending on the type of cargo they carry, the most determining factor that we can find in them is their dimensions (Figure 3). The dimensions of tankers have varied throughout history, reaching vessels such as the ULCC (Ultra Large Crude Carrier), with a length of 400 metres and a capacity of more than 300,000 deadweight tonnes. Although these "mastodons" marked an era, they soon fell out of fashion and were replaced by smaller but faster vessels, capable of transporting large quantities in a shorter space of time.

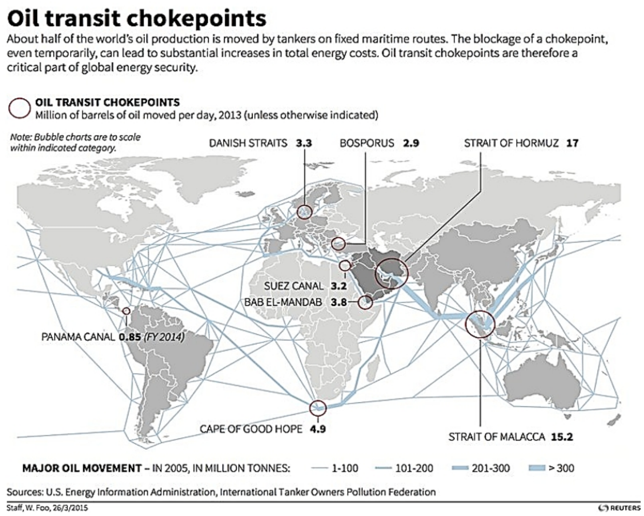
Figure 3: Basic types of tankers, according to their dimensions and capacities.



Source: marenostrum.org.

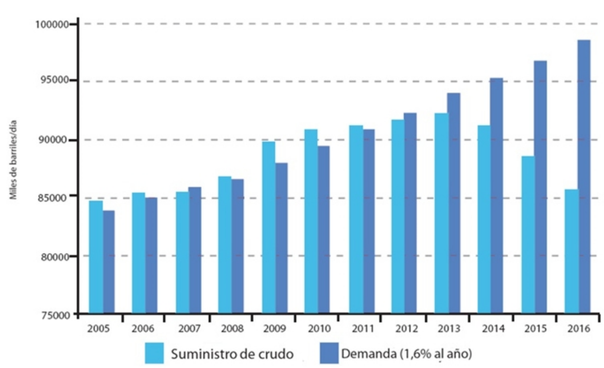
The demand for oil has been growing steadily over the last decades and producing countries or organisations have taken it upon themselves to regulate the market as they wish (Navarro, 1974). The maritime transport of crude oil began at the end of the nineteenth century. Since then, the volume of crude oil transported by sea has increased steadily. The only significant

Figure 4: Map showing the main oil transit points of the world and the main oil movement routes.



Source: RNGS Reuters.

Figure 5: World oil supply vs. projected demand.



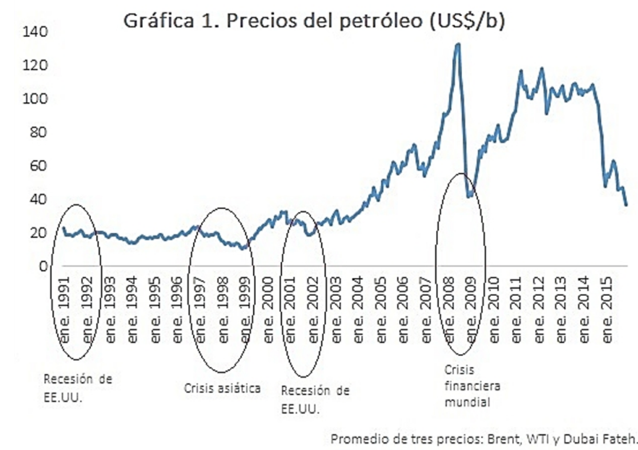
Source: BP Statistical Review, 2008.

exceptions are the so-called oil crises in 1973 and 1979 with a subsequent decline in oil consumption and production. Today, tankers transport about 2 billion tonnes of crude oil by sea each year (Jean-Paul Rodrigue, 2009).

Until 2011, oil demand and production went in parallel and producers met market requirements, but from that year onwards the trend was reversed, so that while demand continued to grow, production began to fall significantly (Illustration 5), also as a result of the 2008 crisis, when that year and the following one saw a significant drop in the price of a barrel of crude oil (Figure 6).

The transport of crude oil will depend mainly on the requirements imposed by the refinery industries. Refineries use crude oil for the production of petroleum products. What type and how much of a petroleum product can be produced depends on the capacity of the refinery and the types of crude oil, called grades, available. Refinery operations generally require different grades of crude oil to produce their desired product range. Today's dynamic global market for crude oil and re-

Figure 6: Evolution of oil prices over the last decades.



Source: World Bank, 2015.

fined products demands versatile refining operations. Refineries must adapt to changing crude grade availabilities and varying demand for refined products. This changing environment also affects transportation. If refinery requirements or supply options change, transportation must adapt, with new routes, or by modifying vessel characteristics.

Initially, at the end of the 19th century, the transport of oil was carried out in a rather rudimentary manner and without taking into consideration the repercussions on the environment. Crude oil was stored in barrels in the holds of traditional cargo ships. The demand for this raw material was almost nonexistent at that time, in contrast to today. The development of internal combustion engines (Daimler's internal combustion engine in 1887 and the diesel compression engine in 1897) gave rise to the second industrial revolution, complemented half a century later with the discovery of the jet engine, making oil practically irreplaceable in the field of transport, both road and air (Fernández, 2014); This, together with the development of the petrochemical industry, would end up sentencing coal as the raw material par excellence and giving this position to oil, in a "reign" that has lasted more than seven decades and still has some time left in this position (Bertonha, 2011).

The socio-economic period that followed the end of the Second World War, known as the "Golden Age of Capitalism" or "Golden Years", which lasted until the first oil crisis in 1973, was marked by an unparalleled mercantile growth in which tankers, specifically oil tankers, were the main protagonists of this period (Barciela-López, 2005). Developed countries based their progress on a total dependence on fuel, which led to an increase in the size of ships for their transport and to an increase in crude oil exports worldwide, due in part to their low cost compared to other raw materials and to the decrease in freight rates (Renouvin, 1969). By this time, tankers of more than 100,000 tons capacity had become widespread, although most of them were structurally limited in their ability to navigate some of the major shipping lanes, such as the Suez and Panama canals (Guernier, 1978).

The nationalisation of the Suez Canal on 26 July 1956 resulted in the Sinai War (Suez Canal Authority, 2018), in which Egypt caused the sinking of forty ships, leading to a total blockade of the canal for a year, until it was reopened. This blockade would be repeated a decade later in 1967, as a consequence of the so-called Six-Day War (Figueras, 1967), where the canal would again be blocked with the sinking of several ships, making navigation impossible until its reopening in June 1975.

2.3. *The Age of Supertankers.*

This succession of conflicts had as a direct consequence the need for corporations to build oil tankers of enormous dimensions, given that the voyages were going to be longer, the need to make the most of the vessels' cargo capacity prevailed; sailing from the Middle East to the West, rounding the Cape of Good Hope, giving way to the era of supertankers (Seoane & Laxe, 2009). The term ”supertankers” refers to vessels capable of carrying more than 250,000 dwt, also known as VLCCs and ULCCs. The increase in the size of these tankers, the speed with which they had to be built and the longer voyages, together with other factors, would result in major environmental disasters, largely due to errors in construction, as a result of poor regulations.

Table 1: Top 20 largest tankers built, by length.

	Name	Length	Gross Tonnage	Operator	Status
1	Seawise Giant	458.46 m /1,504.1 ft	260,851	Orient Overseas Container Line	1979–2009
2	Pierre Guillaumat	414.23 m / 1,359.0 ft	274,837	Cie Nationale de Nav	1977–1983
3	Batillus	414.22 m / 1,359.0 ft	273,550	Société Maritime Shell France	1976–1985
4	Bellamya	414.22 m / 1,359.0 ft	274,267	Société Maritime Shell France	1976–1986
5	Prairial	414.22 m / 1,359.0 ft	274,825	Cie Nationale de Nav	1979–2003
6	Esso Atlantic	406.57 m / 1,333.9 ft	247,161	Esso Tankers Inc. Liberia	1977–2002
7	Esso Pacific	406.57 m / 1,333.9 ft	247,160	Esso Tankers Inc.	1977–2002
8	Nai Superba	381.92 m / 1,253.0 ft	198,783		1978–2001
9	Nai Genova	381.92 m / 1,253.0 ft	188,947		1978–2000
10	Berge Emperor	381.82 m / 1,252.7 ft	203,112	Bergesen d.y. & Co	1975–1986
11	Berge Empress	381.82 m / 1,252.7 ft	211,358	Bergesen d.y. & Co	1976–2004
12	TI class (4 ships)	380 m / 1,247 ft	234,006	Tankers International L.L.C	2002– In Service
13	Andros Petros	378.39 m / 1,241 ft	218,447	Northern Sealanes Corp	Broken up
14	Esso Mediterranean	378.39 m / 1,241 ft	218,447	Esso Tankers Inc	Broken up
15	Coraggio	378.04 m / 1,240 ft	205,960	Pluto S.p.A. Di Navigazio	Broken up
16	Hilda Knudsen	378.01 m / 1,240 ft	203,966	Knut Knutsen O.A.S.	Broken up
17	Esso Deutschland	378.01 m / 1,240 ft	203,869	Esso A.G.	Broken up
18	Jinko Maru	366.0 m / 1,200 ft	209,787	Sanko Line	Broken up
19	Al Rekkah	365.99 m / 1,200 ft	210,068	Kuwait Oil Tanker Co S.A.K.	Broken up
20	Aiko Maru	365.86 m / 1,200 ft	209,788	Sanko Line	Broken up

Source: vesseltracking.net.

The 1970s saw important political, regulatory and social changes that would have a major impact on the transport of crude oil by sea. The first oil price crisis began on 6 October 1973, in the middle of the Cold War and a direct consequence of the Yom Kippur War (Kettell, 2018), which directly pitted Israel against the joint forces of Egypt and Syria, which, with the support of the Soviet Union, demanded the return of the Golan Heights, taken by Israel six years earlier, and which had the support of the US, increasing the scale of the conflict. Although victory in this conflict went to the Israeli side, its Western allies (which included European countries as well as the US) would suffer the consequences later, when the Arab bloc that controlled the Organisation of Petroleum Exporting Countries (OPEC) promoted a boycott of Israel and an embargo on the Western nations that had supported it during the conflict (Maldonado V., 2005). This measure led to an immediate increase in the price of oil, which quadrupled by the end of the same year, forcing the affected nations to take important measures to alleviate the scarcity of resources, significantly affecting their industry and economy; although the Arab exporting countries, which were part of OPEC, saw their wealth increase considerably and developed economically (Ruiz-Caro, 2001). On 17 March 1974, the end of the OPEC embargo against the United States (with the exception of Libya) was announced, setting in motion a period of economic prosperity for the main industrialised oil-consuming countries.

At the end of the 1970s, while the world economy was still in full recovery, the second oil crisis occurred as a result of the Iranian Revolution (Simonoff, 2004) or Revolution of the Ayatollahs (1978) and the Iran-Iraq War (1980) (Jurídica, 1983). The increase in the price of crude oil as a result of these conflicts had serious repercussions on the rest of the countries, which had to impose restrictions on consumption and subsidies on imports.

Towards the end of 1981, there was a gradual fall in crude oil prices, which, together with the surplus generated by the previous crises and the energy saving measures implemented by many countries and the reduction in consumption, caused oil prices to fall even further, which would ultimately benefit the consumer countries and reduce the profits of the major exporters such as the Soviet Union and OPEC (López, 2008).

As we can see so far, oil transport is big business, highly influenced by the geopolitical movements that have taken place throughout recent history, although it is a sector with significant associated risks, not only from an economic point of view, but also from the point of view of the ship itself. The number of tanker accidents and the consequences for the environment have been innumerable and very difficult to quantify, as their effects last over time.

2.4. *Oil Tanker Accidents.*

Accidents and incidents involving tankers can be very diverse, with the greatest impact on public opinion being caused by those that result in major oil spills into the sea, generating the well-known ”oil slicks”. The effect of polluting, if we take into consideration the vast regulations that deal with it, is an aggression to the environment, leading to the deterioration of the natural environment through the use of different forms of energy or the introduction or application of harmful substances. This results in an alteration of the ecological balance, with significant disturbances to the physical environment that may or may not be reversible, which includes by extension both living organisms (flora and fauna) and human health (Masvidal, 2008).

A definition of marine pollution would be, ”Marine pollution is considered to be the intentional or unintentional spillage, through the activities of ships and offshore platforms, of materials classified as noxious or polluting, including the sinking of ships, aircraft, platforms and other constructions at sea” (Zambonino, 2001).

The 1982 United Nations Convention on the Law of the Sea (UNCLOS), in Part 1, Article 1, 4, defines pollution of the marine environment as: ”The introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries), which results or is likely to result in such harmful effects as damage to living resources and marine life, hazards to human health, impairment of maritime activities including fishing and other legitimate uses of the sea, impairment of the quality of sea water for use and impairment of places of recreation” (UN, 1982).

As well as being a risk to the environment, sailing on this type of vessel poses a significant risk to their crews. Although safety measures have increased over time, largely as a result of the accidents that have occurred, there are numerous cases in which crew members have been affected. To cite some examples, we find the relatively recent cases of the María Alejandra (1977), the Prestige (2002) or the Sanchi (2018); where the crews of oil tankers neglect their duties with the tragic consequences that we are all familiar with. Although these are not isolated cases, safety on board is vital on any ship, but especially on oil tankers. But the cases mentioned, in the first one, only two crew members were saved (due to negligence where the tanks were ordered to be cleaned with hot water at 80 degrees Celsius, without having previously inertised them due to a breakdown in the generation plant) (Lorenzo, 2018); in the second case, an unfortunate management by the shipping company and then by the administration resulted in a major spill with devastating consequences affecting the Galician, Portuguese and French coasts (Terrés, 2018), and in the third case, 32 crew members disappeared (Madrigal, 2018).

It is a fact that spills of crude oil and its derivatives into the sea from maritime traffic throughout history have been reduced to a large extent through the application of international conventions, increased ship safety, innovative techniques for combating pollution and improved training of crews in this area. A significant part of the incidents that cause these spills are due to human error; it is therefore essential to know and manage pollution prevention and response techniques in order to minimise the effects of spills that will continue to occur as long as there are ships and oil transport by sea (Waldichuk, 1978).

Although maritime transport is not the largest source of marine pollution, its importance should not be overlooked, since a major spill can lead to a significant deterioration of the environment in which it occurs. It should be borne in mind that an oil spill not only causes damage to the natural environment, but also to all levels of society.

In the event of an oil spill at sea, the planning that has been carried out in advance to be prepared for such a situation is decisive; it is vital to carry out a rapid and effective assessment of the situation, and the speed with which the response is carried out is also of great importance, all of which are key elements for effective action. Although it may seem a simple task, it is not, given that a multitude of factors must be taken into consideration (Rivera, 2015). For this reason, it is essential to draw up a contingency plan, a tool that will be of great help when dealing with an oil spill situation (Ministerio de Fomento, 2004). Its preparation requires a prior and exhaustive study of the different situations that may occur, as well as a precise description of the environment and the area where the spill will occur, environmental, oceanographic and meteorological conditions, and the economic structure of the area and its surroundings must also be considered in order to determine the possible economic and social consequences (Ministry of the Presidency. Government of Spain, 2013).

Table 2: Ranking of the 25 largest oil spills in the last 30 years.

	Barco / Plataforma	Año	Localización	Crudo perdido (toneladas)
1	Deepwater Horizon	2010	Luisiana, EEUU	779.000
2	Atlantic Empress	1979	Tobago	280.000
3	ABT Summer	1991	700 millas de Angola	260.000
4	Castillo de Bellver	1983	Saldanha Bay, Sudáfrica	257.000
5	Amoco Cádiz	1978	Costas francesas de Bretaña	227.000
6	Haven	1991	Génova, Italia	140.000
7	Odyseey	1988	700 millas de Nueva Escocia	132.000
8	Torrey Canyon	1967	Islas Scilly	119.000
9	Urquiola	1976	A Coruña, España	108.000
10	Irenes Serenade	1980	Navarín, Grecia	100.000
11	Hawaiian Patriot	1977	300 millas de Honolulu	99.000
12	Independenta	1979	Bosphorus, Turquía	93.000
13	Jakob Maersk	1975	Oporto, Portugal	88.000
14	Braer	1993	Islas Shetland	85.000
15	Khark 5	1989	120 millas - Costa Marruecos	80.000
1	Sea Empress	1996	Milford, Reino Unido	76.000
17	Katina P	1992	Maputo, Mozambique	72.000
18	Nova	1985	20 millas de Irán	70.000
19	Aegean Sea	1992	A Coruña, España	67.000
20	Prestige	2002	A Coruña, España	64.000
21	Assimi	1983	55 millas de Muscat, Omán	53.000
22	Metula	1974	Estrecho de Magallanes, Chile	53.000
23	World Glory	1968	Sudáfrica	52.900
24	Exxon Valdez	1989	Prince William Sound, Alaska	37.000
25	Wafra	1971	Cape Agulhas, Sudáfrica	30.000

Source: International Tanker Owners Pollution Federation. ITOPF.

Around 90% of the world's trade volume is carried by sea transport. Among them, more than half of the cargoes can be considered hazardous or dangerous from a safety and environmental point of view. Similarly, many materials used in the operation of ships have the potential to harm the environment. Ships, in their regular work, generate a series of different types of waste, the disposal of which into the sea can give rise to pollution events in the marine ecosystem (International Maritime Organisation, 2018).

International rules concerning the construction and operation of ships are contained in the conventions established by the IMO. The main rules concerning the construction of ships can be found in the Safety of Life at Sea Convention (SOLAS), although this convention is more concerned with the safeguarding of human life.

Such is the extent to which oil tanker accidents involving oil spills are so widespread in public opinion that, as a general rule, the ordinary citizen considers that the main cause of marine oil pollution is due to tanker operations and the waste they generate; However, a 1990 study by the International Organisation INTERTANKO, which includes more than 300 shipowners in the industry as members and covers 80% of the world fleet, concluded that pollution caused by the discharge of industrial wastes from land into the sea accounted for more than 60% of the total, while pollution caused by tanker operations (whether loading, unloading, tank washing or bilge pumping) accounted for 20%, while discharges due to accidents accounted for only 5% (INTERTANKO, 2010).

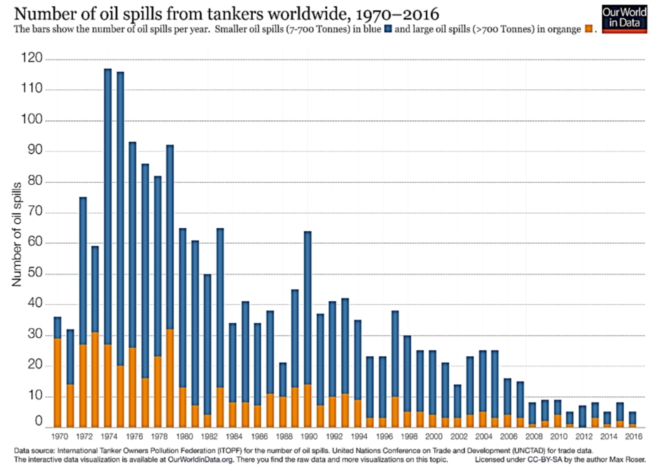
The standard par excellence for minimising and eliminating such pollution from ships is the International Convention for the Prevention of Pollution from Ships, 1973, as amended by the Protocol of 1978 (MARPOL 73/78). The adoption of the MARPOL Convention in November 1973, covering pollution by oil, chemicals, harmful substances carried in packaged form, sewage and rubbish, had a significant impact on reducing the environmental impact of pollution from ships. Its effectiveness was evidenced by a study conducted by the International Tankers Owners Pollution Federation (ITOPF) in 1997, which claimed that in the decade from 1986 to 1996 accidental oil pollution had been reduced by almost 50% compared to the values recorded in the previous decade (Figure 9) (Roser, 2017).

It should not be forgotten that the media has also played a very important role in the fight against marine pollution, as the impact of public opinion on oil slicks or tar agglomerates on beaches has led the main crude oil transporters to invest in safety and pollution prevention measures, as the impact of accidents often entails significant economic losses due to negative publicity (Terán, 2014).

International concern about the successive disasters caused by shipping and maritime commerce has been taken up by legal and technical initiatives aimed at increasing safety in the activity and with the objective of protecting human life at sea and the marine environment. The development by the IMO in 1993 of the International Management Code for the Safe Operation of Ships and the Prevention of Pollution (ISM/IGS Code) is a reflection of this concern on the part of governments and a consequence of various studies carried out which showed that 80% of maritime accidents were caused by human error and were associated with problems in the management of shipping companies, which also led to the revision of the International Convention on Standards of Certification and Watchkeeping for Seafarers (STCW), updated in 2010 with the Manila amendments (Rojas, 2000).

The accident and subsequent spill of the 120,000 ton Torrey Canyon supertanker, which occurred on 18 March 1967 in the Seven Stones reefs (England), caused a huge oil slick that reached the northern coast of France; However, it will also be remembered for being one of the first spills and for the multitude of errors and improvisations that were made to combat the spill, which made the situation even worse, due above all to the lack of experience in intervening in this type of incident, with consequences that can be considered even worse than those that were intended to be avoided. In just five years, from 1969 to 1973, there were more than 80 accidents with more than 3 million tons of crude oil spilled into the sea; by the end of 1974, there were nearly half a thousand accidents resulting in oil spills into the sea (United States Department of Commerce. Boreau of the Census, 1980).

Figure 7: Evolution of spills between 1970 and 2006.



Source: ourworldindata.org.

Subsequently, the 1978 and 1989 accidents of the Amoco Cadiz and the Exxon Valdez, off the coasts of France and Alaska respectively, were, due to their magnitude and the effects caused, two cases that would have decisive consequences in the modification of tanker safety regulations and in the prevention and fight against pollution caused by spills from ships.

A major milestone in the modification of tanker construction regulations came with the accident on 12 December 1999 of the Maltese-flagged tanker Erika, which was loaded with 30,000 tonnes of heavy fuel oil No. 2, sinking off the coast of Brittany (France) and spilling a third of its cargo, causing a major ecological disaster. It sank off the coast of Brittany (France), spilling a third of its cargo, which caused an ecological disaster of the first magnitude, giving rise to the subsequent approval of the so-called Erika I and II packages, which dealt with safety procedures, inspection, classification, etc... and accelerated the process of construction of tankers. ... as well as speeding up the entry into force of double hulls for tankers and the control of maritime traffic; in addition to the establishment of a new compensation fund for oil pollution damage at sea and the creation of the European Maritime Safety Agency (EMSA), as technical support for the European Commission and the Member States in the application of safety and assessment standards.

Three years after the sinking of the Erika, on 19 November 2002, the oil tanker Prestige sank 130 miles from Cape Finisterre, when it was loaded with more than 77,000 tonnes of crude oil and spilling a tenth of its load of heavy fuel oil, following a leak in the hull, followed by a series of decisions that would cause one of the ecological disasters of the Spanish coasts, highlighting the lack of preparation of the administrations to deal with situations of these characteristics.

The direct consequence was the approval of the Erika III package of measures in 2004, with a series of legislative proposals based on improved control of international regulations for ships registered under European flags, a revision of the regulations on port control by state administrations to improve the effectiveness of inspections, a strengthening of the measures for the reception of ships in difficulty and support for the development of the SafeSeaNet network, It also includes improvements in the rules relating to Classification Societies, as well as the development of a single European framework for the investigation of accidents, in addition to guaranteeing compensation for those potentially affected, for which a Directive is established to deal with the civil liability of shipowners, through the contracting of compulsory insurance (Alvarado, 2009).

3. Methodology.

In order to complete this work, almost 180 ship accidents resulting in oil spills were analysed, extracting the information from various databases and repositories, using "files" which contain detailed information on each incident. The following list of main resources has been used for this purpose:

- GISIS *(Global Integrated Shipping Information System)*

  https://gisis.imo.org/

- CTX *(Center For Tankship Excellence Database)*

  http://www.c4tx.org/

- EMCIP *(European Marine Casualty Information Platform)*

  https://portal.emsa.europa.eu/emcip-public/

- EQUASIS *(Electronic Quality Shipping Information System)*

  https://www.equasis.org/

- *wrecksite.eu* Database

  http://www.wrecksite.eu

- *Marinetraffic.com* Database

  http://www.marinetraffic.com

- CEDRE *(Centre of Documentation,Research and Experimentation on Accidental Water Pollution) Database*

  http://wwz.cedre.fr

- *Shipspotting* Database

  http://www.shipspotting.com

- *FleetMon* Database

  https://www.fleetmon.com

- *VesselFinder* Database

  https://www.vesselfinder.com

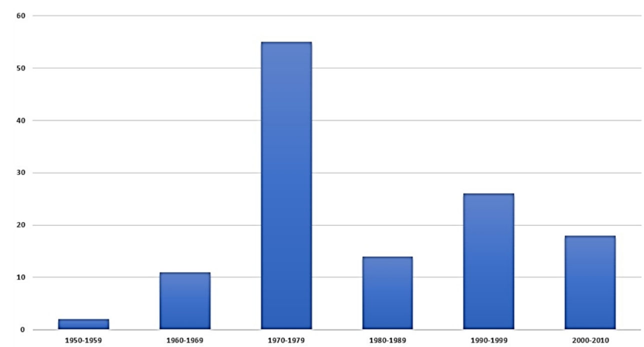
- *Auke Visser* Database

  http://aukevisser.nl

To obtain the data, we have used a case study or analysis as the main tool (Becker, 1974), in the period between 1950 and 2015, for tanker accidents.

4. Results and Discussion.

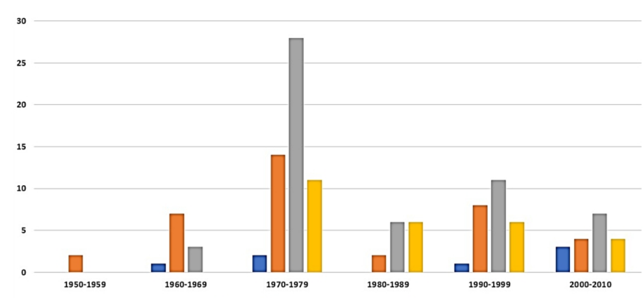
Figure 8: Evolution of B/T accidents per decade resulting in oil spills.



Source: Authors.

Here we can see that by far the seventies were the years in which most tanker accidents occurred, the increase in capacity, longer voyages and safety-related factors such as tank washing and lack of inerting caused many of them. In addition, there are a number of other factors that are mainly due to the "human factor" such as collisions or even groundings. Concern about these and the enactment of new regulations and measures seem to have had an effect in view of the way accidents have evolved.

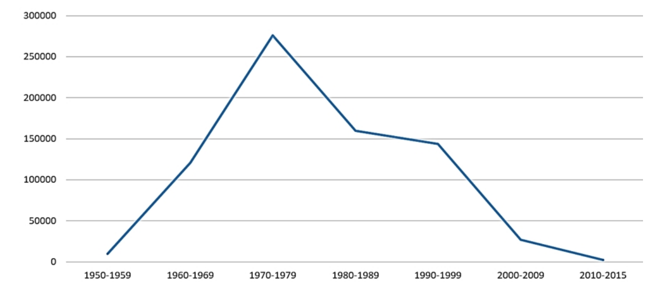
Figure 9: Tankers involved in accidents by decade according their length.



Source: Authors.

In general, vessels of 200-300 m in length are the ones with the most accidents, basically because they are the ones that are built the most and form the bulk of the fleet. In view of the Figure, we can see that over time, the number of accidents resulting in spills has generally decreased, regardless of the size of the vessels. However, as we have already mentioned, the increase in size means that problems that were previously unnoticed are becoming apparent, and significantly a larger ship has a higher risk of causing a spill.

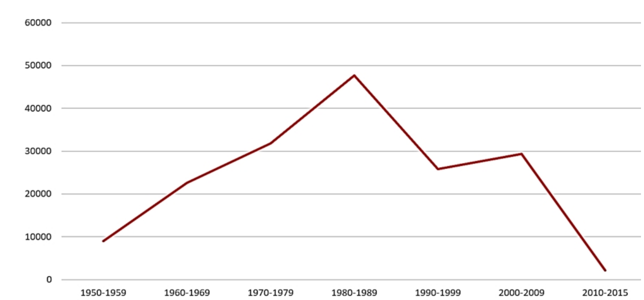
Figure 10: Evolution of maximum size of oil spills (Tn).



Source: Authors.

In Figure 10 we can see the evolution of the maximum size of the spills. Of course, this is a function of the maximum size of the ships, so in the 1950s, they are not very large, but as the size of the ships grows, we can see how the average amount of oil spilled grows, with a maximum peak in the 1970s. The application of regulations and measures to prevent accidents on oil tankers and avoid oil spills at sea has had the desired effect and the average size of spills has decreased considerably. Measures such as mandatory inerting and double hulls, with stricter inspection measures by port states under the Paris MoU, have brought about this change.

Figure 11: Evolution of average size of oil spills (Tn).



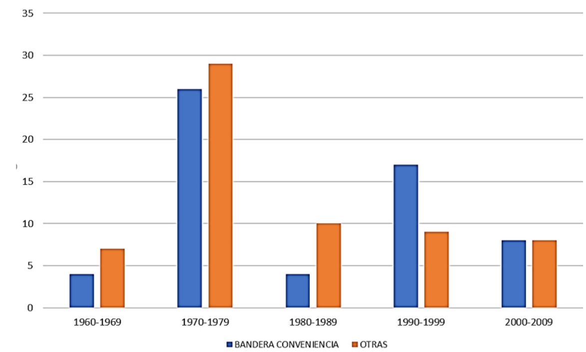
Source: Authors.

Similar to the previous figure, the average size of spills has reduced over time, despite the fact that the size of ships has increased from T2 to the current VLCC and ULCC. At the moment we are facing another problem and that is the ”small quantity” spills, but not from tankers, but from bulkcarriers, container ships, Ro-Ro, etc....

We were also interested to know what the flag distribution of ships causing spills is like, and in this case the distribution is perfectly even. The split is perfectly even: 50% for ships under flags of convenience and 50% for classic flags of convenience. A large part of the tanker fleet is registered under flags of convenience, which from the point of view of the application of safety and pollution rules may result in a higher risk, due to a more lax application of the rules.

In Figure 12, as we can see, over time there is a predilection for shipping companies to register under flags of convenience and the 1990s, where the majority of accidents occur on flag of convenience ships, is very enlightening. This is in accordance with the hypothesis put forward by many experts, including the

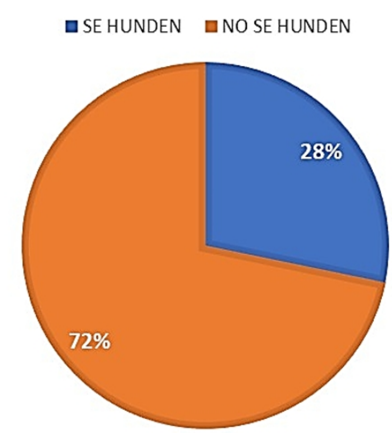
Figure 12: Flag of B/T casualties by decade.



Source: Authors.

European Union, who are wary of the strict application of the rules by flags of convenience.

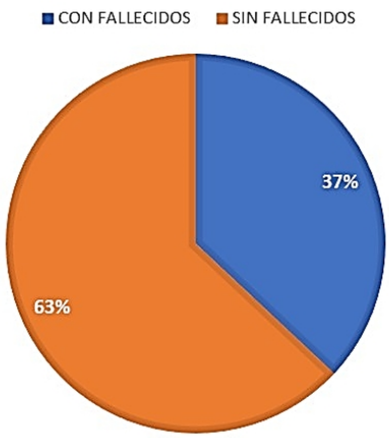
Figure 13: Percentage of B/T sinking during the accident..



Source: Authors.

In Figure 13 is very significant and corroborates one of the maxims of shipbuilding, which is precisely the great stability of tankers. If we study their stability conditions, accidents due to collisions, hull breakage or even explosions affecting one or a few tanks do not put the vessel at risk of sinking (72%). As we can see, B/Ts have an enviable stability and it is very difficult for them to sink after an accident. In this sense, B/Ts are safer than other types of vessels in the event of a leak and consequent heeling. The lower sinking rate may also be related to better safety measures on board and stricter regulations.

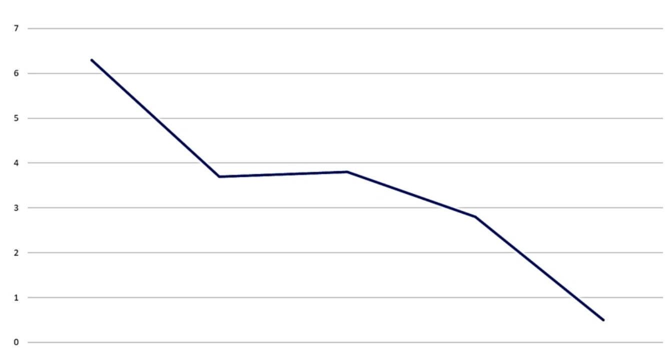
Figure 14: Percentage of B/T sinking during the accident.



Source: Authors.

From a human point of view, it is of no interest to analyse the characteristics of tanker accidents and in view of the following figure we can infer that fortunately the majority of accidents involving oil spills do not involve fatalities, although as we can see, the fact that in almost 40% of accidents there is one gives us a clue as to the extent to which the risk of death is greater for the crews sailing on these vessels. For decades, most shipping companies have not put all the technical means at their service to improve the safety of their crews on board. Apart from that, we know of very different situations, several studies show the enormous problems that the consumption of alcohol or drugs posed for the crews and how this could be an added risk when it came to making important decisions regarding the tasks carried out on board. In this sense, there has been a concern on the part of society to improve working and living conditions on board, as well as to minimise risks. We will see that over the years, a policy of crew reduction has been pursued, parallel to greater automation of ships, but we must consider that an accident on these ships can cause a large number of casualties.

Figure 15: Evolution of the average number of deaths in tanker accidents..



Source: Authors.

Figure 15 shows that the average number of fatalities in tanker accidents is decreasing. On the one hand, tankers are quite safe and fatalities occur in less than 40% of accidents. On the other hand, the number of crews has been decreasing, along with the number of accidents (especially those related to fires and explosions), so that all this, together with the improvement of living conditions on board and the regulations governing the health of the crew, means that the risk of dying in an accident on a tanker or oil tanker is significantly reduced.

Conclusion.

Today, there is no alternative to the mass transport of hydrocarbons at reasonable costs, excluding the construction of pipelines, but these do not allow them to reach all end customers as ships do.

It is well known that since its discovery and the beginning of its exploitation, oil has been a big business that has propitiated the growth of large corporations and fortunes, but there is no doubt that it has also been, with its pros and cons, the real engine that has driven modern society. Its role as a source of energy and raw material is indisputable, and although in recent decades society has become more environmentally aware, it is undeniable that today it is very difficult to do without it, let alone transporting it by sea.

The exploitation of oil and its transport would not have been possible without the participation of a large number of ”actors” who, either through innovation and technology, financing or even speculation and taking significant risks, have driven this great industry at different times in history.

Maritime transport is a high-risk job in a hostile environment. Transporting a substance with such a high polluting power by sea is a risk that our society has decided to take in order to move forward.

From the accidents studied, we can firstly deduce the great power that the oil corporations and the large shipping companies that transport crude oil have had and continue to have, but a market with multiple branches is also generated, in which the producing countries and the end clients are included, all of them immersed in a tug-of-war in search of the greatest possible profit.

The IMO plays a very important role, legislating and regulating precisely the safety of people at sea and the prevention of pollution as basic pillars. Today the IMO is a vital organisation and has been so since its constitution shortly after the Second World War; it was necessary to bring some order to a sector that was growing by leaps and bounds, driven by the eagerness of many investors and developers, but also of many unscrupulous speculators who only thought of business and profits. The more independence the IMO is able to acquire and authority over states, the safer shipping will be.

In view of the results obtained, we believe that more still needs to be done to reduce accidents in the transport of oil by sea, especially accidents caused by collisions and groundings, which depend heavily on the training, preparation and experience of the crews. Once the vessel leaves port, it depends expressly on the ”seamanship” of its crew members, so it is essential to work in this direction.

References.

Alvarado, M. O. (1 de diciembre de 2009). Erika: una condena que hizo historia. (E. e. Acción, Editor) Obtenido de https://www.ecologistaenaccion.org.

Alvarez Pelegry, E. (2015). El precio del petróleo: relación con otros mercados e implicaciones para la competitividad industrial. Información Comercial Española, ICE: Revista de economía, 59-70.

Baines, E. N., & Appleton, P. G. (2009). Industrial Pollution : Oil Spills, Toxicity and Risk Assessment. Nueva York: Nova Science Publishers, Incorporated.

Barciela-López, C. (2005). La Edad de Oro del capitalismo (1945-1973). En F. M. Comín, Historia económica mundial, siglos X-XX (págs. 339-388). Barcelona: Crítica.

Becker, H. (1974). Observación y estudios de casos sociales. David Sills Enciclopedia internacional de las Ciencias Sociales, T.3, Mauhnundrid, Aguilar,, 384-389.

Bertonha, J. F. (2011). Notas sobre a geopolítica do petróleo no século XXI. Meridiano 47. Instituto Brasileiro de Relações Internacionais, 9-10.

Fernández, J. L. (2014). LOS HIDROCARBUROS EN ESPAÑA: CINCUENTA AÑOS DE HISTORIA. Economía Industrial, Nº 394, 103-115.

Figueras, J. M. (1967). La Guerra de los Seis Días. Barcelona: Juventud.

Guernier, E. (1978). Suez y Panama. Anuario de Estudios Centroamericanos, 535 -537.Iglesias, E. P. (2003). Petróleo y gas natural. Madrid: Ediciones AKAL.

INTERTANKO. (21 de abril de 2010). 40 Years Leading the way. Obtenido de www.intertanko.com: https://www.intertanko-.com/upload/Publication/Book%20Shop/40th%20Through%20-the%20years.pdf

Jean-Paul Rodrigue, C. C. (2009). The Geography of Transport Systems. New York: Routledge.

Jurídica, I. V.-i.-i. (1983). Análisis de la guerra impuesta del régimen de Irak contra la República Islámica del Irán. La Embajada.

Kettell, S. (11 de mayo de 2018). Oil crisis. Obtenido de Encyclopædia Britannica, Inc.: http://academic.eb.com.accedys-2.bbtk.ull.es/levels/collegiate/article/600990.

López, J. H. (2008). GEOPOLÍTICA DEL PETRÓLEO Y CRISIS MUNDIAL. Dyna. Universidad Nacional de Colombia, Vol.75(156).

Lorenzo, J. C. (10 de mayo de 2018). La tragedia del petrolero "María Alejandra". Obtenido de De la mar y los barcos: http://-www.puentedemando.com/la-tragedia-del-petrolero-maria-alejandra/.

Lun, Y. H., & Hilmola, O.-P. (2013). Oil Transport Management. Londres: Dordrecht Springer London.Madrigal, A. C. (19 de enero de 2018). The World Has Never Seen an Oil Spill Like This. theatlantic.com, págs. https://www.theatlantic.com/-technology/archive/2018/01/the-oil-spill-that-wasnt/550820/.

Maldonado V., F. (2005). La OPEP: Cuarenta y cinco años de historia y dos interpretaciones teóricas. Actualidad Contable FACES Año 8 Nº 11, Julio-Diciembre, 30-44.

Marzo Carpio, M. (2009). La producción de petróleo y gas natural en el horizonte global del 2030. Ekonomiaz: Revista vasca de economía, 40-61.

Masvidal, D. E. (2008). LA FUNCIÓN DE LOS PUERTOS EN LA PREVENCIÓN POR LA CONTAMINACIÓN DE PETRÓLEO EN LOS MARES INTERNACIONALES. Brasil: Universidade do Vale do Itajaí.

Ministerio de Fomento. (14 de febrero de 2004). Real Decreto 253/2004, de 13 de febrero, por el que se establecen medidas de prevención y lucha contra la contaminación en las operaciones de carga, descarga y manipulación de hidrocarburos en el ámbito marítimo y portuario. Obtenido de Boletín Oficial del Estado: https://www.boe.es/buscar/doc.php?id=BOE-A-2004-2753.

Ministerio de la Presidencia. Gobierno de España. (15 de enero de 2013). Real Decreto 1695/2012, de 21 de diciembre, por el que se aprueba el Sistema Nacional de Respuesta ante la contaminación marina. Obtenido de Boletín Oficial del Estado: https://www.boe.es/buscar/doc.php?id=BOE-A-2013-408.

Navarro, R. H. (1974). OPEP: precios del petróleo y crisis energética. Caracas: Universidad Central de Venezuela, Facultad de Ciencias Económicas y Sociales, División de Publicaciones.

ONU, O. d. (1982). Convención de las Naciones Unidas sobre el Derecho del Mar. Nueva York: ONU. Organización de las Naciones Unidas.

Organización Marítima Internacional, IMO. (2018). Convenio internacional para prevenir la contaminación por los buques (MARPOL) 1973/1978. Organización Marítima Internacional (OMI).

Pasdermadjian, H. (1960). La segunda revolución industrial. Madrid: Tecnos .Renouvin, P. (1969). Historia de las relaciones internacionales (Siglos XIX y XX). Madrid: AKAL Textos.

Rivera, A. C. (2015). Iniciación a los derrames de hidrocarburos. Santander - España: Escuela Técnica Superior de Náutica. Universidad de Cantabria.

Rojas, M. B. (2000). ENTRADA EN VIGOR DEL CODIGO INTERNACIONALDE GESTION DE LA SEGURIDAD MARITIMA: (Aspectos a ser considerados por el Estado Rector del Puerto). Revista de Marina. VOLUMEN 117, NÚMERO 854 (ENERO - FEBRERO 2000), [Online].

Roser, M. (2017). Oil Spills. Obtenido de OurWorldInData.org: https://ourworldindata.org/oil-spills.

Ruiz-Caro, A. (2001). El papel de la OPEP en elcomportamiento del mercadopetrolero internacional. Santiago de Chile: Proyecto CEPAL/Comisión Europea "Promocióndel uso eficiente de la energía en América Latina".

Seoane, M. J., & Laxe, F. G. (2009). Tráfico marítimo y economía global. La Coruña - España: Netbiblo.

Simonoff, A. C. (2004). La revolución iraní en perspectiva foucaultiana. Cuestiones de Sociología.

Suez Canal Authority. (5 de julio de 2018). Canal History. Obtenido de https://www.suezcanal.gov.eg/English/About/Suez-Canal/Pages/CanalHistory.aspx.

Terán, N. (29 de septiembre de 2014). Arte y Petróleo: una historia de amor. Obtenido de gk.city: https://gk.city/2014/09/29-/arte-y-petroleo-historia-amor/.

Terrés, J. Z. (10 de mayo de 2018). El proceso del 'Prestige'. Obtenido de Cuaderno Especial. Diciembre de 2013: chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/http:-//www.naucher.com/redaccion/Cuaderno%20Especial%20PRESTIGE_alta%20(2).pdf.

United States Department of Commerce. Boreau of the Census. (1980). Statistical Abstract of the United States (1980). National Data Book and Guide to Sources. Los Angeles (California): Universidad de California.

Waldichuk, M. (1978). La contaminación mundial del mar: Una recapitulación. Vancouver (Canadá): Unesco. Organizaci6n de las Naciones Unidas para la Educación, la Ciencia y la Cultura.

Yergin, D. (1992). La historia del petróleo. Barcelona: Plaza & Janes.Zambonino, P. M. (2001). La Protección Jurídico Administrativa del Medio Marino: Tutela Ambiental y Transporte Marino. Valencia: Tirant lo Blanch.