OIL SPILLS AND MARINE ECOLOGY: A GEOPOLITICAL ANALYSIS OF LIABILITY FIXATION

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DECLARATION

I declare that the dissertation entitled **"OIL SPILLS AND MARINE ECOLOGY: A GEOPOLITICAL ANALYSIS OF LIABILITY FIXATION"**, submitted by me in partial fulfilment of the requirements for the award of the degree of **MASTER OF PHILOSPOHY** of Jawaharlal Nehru University, is my own work. The dissertation has not been submitted for any other degree of this university or any other university.

Atul Kumar

CERTIFICATE

We recommend that this dissertation be placed before the examiners for evaluation.

Prof. Swaran Singh 21.7.11

Chairperson

Dr. S. S. Deora 21.7.2011

Supervisor

Dedicated to my

Avani Chacha,

whose guidance benefitted me

throughout my life.

CONTENTS

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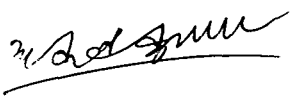

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ABBREVIATIONS:

(1)	P & I Club	:	Protection and Indemnity Association (Club).
(2)	ITOPF	:	International Tanker Owners Pollution Federation.
(3)	TOVALOP	:	Tanker Owners Voluntary Agreement concerning Liability for Oil Pollution.
(4)	CRISTAL	:	Contract Regarding an Interim Supplement to Tanker Liability for oil pollution.
(5)	MARPOL	:	International Convention for the prevention of pollution from ships.
(6)	NPFC	:	National Pollution Funds Centre.
(7)	EPA	:	Environmental Protection Agency.
(8)	OPA 90	:	Oil Pollution Act 1990.
(9)	STOPIA 2006	:	Small Tanker Oil Pollution Indemnification Agreement 2006.
(10)	TOPIA 2006	:	Tanker Oil Pollution Indemnification Agreement 2006.
(11)	HNS Convention:		Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and noxious substances by sea, 1996.
(12)	UNCLOS	:	United Nations Convention on the law of the Sea.
(13)	LOT	:	Load on Top.
(14)	OILPOL	:	Prevention of Pollution of the seas by oil 1954.
(15)	SOLAS	:	International Convention for the Safety of life at sea.

(16)	CLC, 1969	:	Civil Liability Convention, 1971.
(17)	FC 1971	:	IOPC Fund Convention, 1971.
(18)	IOPC	:	International Oil Pollution Compensation Fund.
(19)	COPE	:	Compensation for Oil Pollution in Europe.
(20)	LLMC	:	Convention on Limitation of Liability for Maritime Claims, 1976.
(21)	PSSA	:	Particularly Sensitive Sea Areas.

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Chapter 1: INTRODUCTION

Background and Rationale of the Topic:

Since the late 1800s oil has been one of the world's most commonly used substances, it has been used to heat homes, to lubricate machinery, to make products ranging from asphalt to toys to CD players and computers; to make food, medicine, ink, fertiliser, cosmetics, pesticides and paint; and to generate electricity. The industrial revolution, mechanization, international division of labour and economic competitiveness in the world economy gave an impetus to the hydrocarbons demand.

Rise of the mobility, increasing connectivity, rise of information technology and globalization also not added less in increasing the demand of energy. Dependency on non conventional energy sources and limited enhancement and development of conventional energy sources further creating pressure on the traditional energy sources as fossil fuels and natural gas. Thus, it will not be an exaggeration to say that the oil has become the most important resource for the world economy.

Following characteristics of oil as a resource make it distinct from other resources.

(1) Oil as a resource is finite and a non renewable resource. The petroleum (oil and natural gas) are the product of organic bio-chemical processes for millions of years.

(2) Its distribution is highly concentrated in the pockets of territory of a few countries.

(3) Demand of oil is universal and in inelastic. All the countries in the world, for their economies to develop, require oil, that too in quantities not compromisable. The demand of oil is not elastic in the sense that people require oil in certain quantities irrespective of the rise in oil prices.

(4) Oil has to be refined before the industrial use. Crude oil has many impurities and is unfit for industrial use due to these impurities. Since refineries cannot be located anywhere and everywhere due to economic considerations, the crude oil has to be transported up to the refineries.

After 1960s, there has been a massive shift in the factors which determine the location of oil-refining industry units. Earlier, refineries used to be located near the oil wells, but now, oil refineries are being increasingly located near the port towns, or where the market demand is substantially high. This is due to the fact that more and more fractions of crude oil are now usable in the industries like plastic etc. In terms of the terminology of Alfred Weber, the oil refinery industry has become *"weight gaining"* from a *"weight losing"* industry.[1]

The implication of this fact is that the crude oil is increasingly transported worldwide rather than refined oil.

(5) Major part of the crude oil transportation is done by oil tankers on the sea, rather than the oil pipelines. Sea transport of the crude oil in bulk is far more convenient and economical than carrying it through pipelines.

(6) Since oil is essential for the transport and thus a number of goods and services are dependent upon it, the rise in oil prices can lead to the increase of prices of almost all the commodities of the economy. The oil crisis of the early 1970s had demonstrated that the shortage or price rise of oil can cause a virtual crisis in the world economy. Thus, the oil transport is strategically important for the world economy and domestic economy of a country.

Thus, in the light of above mentioned characteristics of oil and its transport, it can be inferred that the carriage of the oil on the sea is geopolitically and environmentally sensitive issue.

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[1] Lloyd, P.E., and P. Dicken (1977), *A Theoretical Approach to Economic Geography*, New York: Harper and Row.

So, oil transport is strategically important and is potentially hazardous for marine environment. Since oil is used so frequently and for so many different purposes, it needs to be stored, refined and transported by pipelines, ships and trucks. Occasionally, these transport mechanisms, or the people who operate them, fail and become the cause of oil spills.

Although some quantities of oil are already present in trace amounts in marine environment, its introduction into marine environment can have far-reaching impact on the habitats and communities living there.

Since oil in liquid form and some of its components are readily soluble in sea water, it can have various lethal and sub-lethal effects upon the life forms of marine environment. Most of the components of crude oil are lighter than water and therefore they float upon the water, forming a thin film, thereby interfering the interactions between ocean system and atmospheric system.

If occurred in the coastal areas, spill of oil can have harmful impact upon not only organisms living there, but also upon human economic services dependent upon the seas. Impact upon fisheries and tourism can be cited as suitable examples.

There are many sources and causes of oil spills, such as ship/ tanker accident or wreckage, marine blowout (oil spills from offshore drilling establishments like oil rigs) like that of *Deepwater Horizon*, Gulf of Mexico (April 2010), rupture of oil pipelines, or intentional oil spill (what happened in Gulf war, 1991 when Iraqis spilled millions of tons of crude oil into the sea).

However, in dealing with the international regimes concerning the compensation of damage caused by oil spill, the scope in this study has been deliberately narrowed down to the oil spills caused by oil transport at the sea. The main reason for this selection is quite clear. The international regimes for oil pollution damage compensation mainly deal with the spills caused by the oil transportation, and not the other causes of oil spills. In fact, as of now, there is no satisfactory and effective international compensation regime concerning the *point sources* of oil spills (like blowouts from oil rigs).

Another reason for such selection is that the transportation of oil has been the greatest contributor for oil spill damage in marine environment, as compared to the damage caused by oil production and other causes. Since oil production and its transportation has become a global business, an international legal framework is indispensable for the protection of marine environment –which is our common heritage. In the cases of oil spills resulting from the global transport of oil, there are many parties involved. The state whose territory is affected adversely by the incident of oil spills; the oil companies, whose cargo is being carried; the shipping companies whose tankers carry the oil; and other parties, like insurance companies covering the ships, authorities related to navigational assistance etc.

In absence of an international legal framework regarding the oil spill damage, the determination of the nature, and degree of the accountability of such involved parties was very difficult. The problem becomes more complicated when various parties belong to different nationalities. Thus, litigation in domestic courts was almost impossible in certain cases.

Liability (being accountable and paying compensation for damage) related to the oil spills have been one of the most contested issues of the international maritime law. Since the transportation of oil is an essential business for the world economy, a balance has to be maintained between the interests of the private stakeholders (oil companies, shipping companies and insurance companies etc.) and those of the public which is affected by the oil spills. At the same time, the interests of the developing countries also have to be taken into account that do not have wherewithal to arrange for additional safety measures for oil transport and simultaneously, cannot sustain their economies without the import of oil.

Keeping all these various multidirectional interests into consideration, the International Maritime Organization came up with an international regime for the compensation of the oil pollution damage caused by oil tankers. This was called the Civil Liability Convention, 1969. Subsequently, it established a Fund in 1971 as a second tier of compensation for oil pollution damage. This was called the International Oil Pollution Compensation Fund, 1971, while the source of finance for the Civil Liability Convention,

1969 (CNC 1969) was insurance for oil tankers; The IOPC Fund, 1971 (Fund, 1971) was financed by the oil industry in the oil receiving member states.

Various protocols to these conventions have been adopted in the view of the changing needs of the time and various principles related to liability have been evolved. Various oil spill incidents from tankers themselves caused many revisions to liability limits in the regimes.

The international compensation regime for damage caused by spills of persistent oil from laden tankers was based initially on two IMO conventions - the 1969 International Convention on Civil Liability for Oil Pollution Damage (1969 CLC) and the 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (1971 Fund Convention). This 'old' regime was amended in 1992 by two protocols, which increased the compensation limits and broadened the scope of the original conventions. In October 2000 agreement was reached on increasing the limits of the 1992 CLC and Fund Convention by a little over 50% with effect from 1st November 2003. In May 2003 a Supplementary ('third tier') Fund was established at the IMO through a new protocol that increases the amount of compensation in States that ratify it to about US$1.2 billion (including the amounts paid under the 1992 CLC and Fund Convention).

The 1969 CLC entered into force in 1975 and lays down the principle of strict liability (i.e. liability even in the absence of fault) for tanker owners and creates a system of compulsory liability insurance. Claims for compensation for oil pollution damage (including clean-up costs) may be brought against the owner of the tanker which caused the damage or directly against the owner's P&I insurer. The tanker owner is normally entitled to limit his liability to an amount which is linked to the tonnage of the tanker causing the pollution.

The 1971 Fund Convention provided for the payment of supplementary compensation to those who could not obtain full compensation for oil pollution damage under the 1969 CLC. The International Oil Pollution Compensation Fund (1971 IOPC Fund) was set up for the purpose of administering the regime of compensation created by

the Fund Convention when it entered into force in 1978. By becoming party to the 1971 Fund Convention, a country became a member of the 1971 IOPC Fund. Payments of compensation and the administrative expenses of the 1971 IOPC Fund were financed by contributions levied on companies in Fund Convention countries that received crude oil and heavy fuel oil after sea transport.

In 1992, a Diplomatic Conference adopted two protocols amending the 1969 CLC and 1971 Fund Convention, which became the 1992 CLC and 1992 Fund Convention. These 1992 Conventions, which provide higher limits of compensation and a wider scope of application than the original conventions, entered into force on 30th May 1996. As in the case of the original conventions, the tanker owner and P&I insurer are liable for the payment of compensation under the 1992 CLC, and oil receivers in countries that are party to the 1992 Fund Convention are liable for the payment of supplementary compensation through the 1992 IOPC Fund. As more States ratified or acceded to the 1992 Conventions, the original conventions rapidly lost significance and the 1971 Fund Convention was terminated altogether on 24th May 2002.

The Supplementary Fund Protocol entered into force on 3 March 2005 and will be financed by contributions payable by oil receivers in the States which opt to ratify it. However, for the purpose of contributions it will be considered that there is a minimum aggregate quantity of 1 million tons of contributing oil received in each Member State.

Scope of Geopolitics in the Issues Related to the Liability for Damage Caused by Oil Spills:

The territory has been a crucial issue in the history of maritime law. The applicability of any domestic or international legal framework depends upon whether the incident is within or beyond the territorial jurisdiction of the concerned court of law. This is one of the reasons why various conventions (like UNCLOS) have been adopted to determine the territorial aspects of political issues.

The CLC 1969 also lays significant emphasis on the aspect of territory. This liability regime is based upon the place of incident (whether the place of oil pollution damage lies in the territory of its member states). The nationality of the shipowner and the oil cargo company is irrelevant here. Also, the loss of the citizens of member states abroad is not relevant. They are eligible for compensation only if the damage has occurred in the territory of a member state. The loss caused by oil spill is *not* compensable if the citizens of a member states are affected by the oil pollution in the territory of a state which is not a member of the convention. Thus, the key to the criteria for compensation is *territory*.

Realizing the importance of the territorial scope of the compensation regime, the CLC 1969 adopted the modifications to the territorial applicability of the regime. By the subsequent protocols to the convention, the territorial scope of the convention was extended from territorial waters to the Exclusive Economic Zone of a member state.

Territorial issues related to the liability for oil pollution damage are strategically important from another point of view. The business operation of the most oil and shipping companies is on a worldwide basis, so the possible oil spill damage caused by them is likely to occur, to a great extent, in the territory of a country other than their own. So, it became strategically necessary for the countries to evolve an international legal framework for addressing the issue of oil pollution damage caused by foreign oil companies. So, it is undeniable that the politics of liability fixation has a spatial and territorial component inherent in it.

Fixation of the liability has also a power dimension related to the compensation for oil pollution damage. When the multinational oil giants from powerful states (like the United States) operate in less developed countries, they try to minimize their operating costs by avoiding proper safety mechanisms. Oil companies from the United States are found to grossly violate the safety standards in the offshore drilling in the Nigerian coasts, in order to keep the operational costs as low as possible[2]. The lack of

[2] Eweje, Gabriel (2006), "Environmental Costs and Responsibilities Resulting from Oil Exploitation in Developing Countries: The Case of the Niger Delta of Nigeria", *Journal of Business Ethics,* 69:27–56.

strict domestic laws regarding the fixation of liability for the damage caused by oil spills in the less developed countries is the main reason for the negligence on the part of oil and shipping companies.

Issues Related to Liability Fixation: the problem of liability has following components in it:

(a) Who is to be held liable for the oil pollution damage?

(b) In case of joint liability, what should be the method of deciding the relative shares of such parties?

(c) What should be the amount of liability?

(d) What should be an agreeable criterion for admissibility of the claims for liability (whether the claims made for compensation are *bona fide*)?

(e) What are the approaches and methods of determining the costs related to the oil spill damages?

(f) How is the loss of species and their habitats in the marine environment going to be assessed in monetary terms?

(g) What are the criteria for reasonableness of the cost of prevention of the environmental damage caused by the oil spills?

These questions are discussed in detail in the following chapters.

Objectives of the Study: The study has been done while having following objectives into consideration:-

(1) To analyse the various dimension of the impact of oil spill upon the marine environment.

(2) To have a comparative analysis of the international regimes and conventions related to the liability fixation for oil pollution damage.

(3) To analyse the geopolitical dimensions related to the international conventions designed for liability fixation.

(4) To analyse the aspirations of regional powers in relation to the workability of an international regime for oil pollution compensation.

(5) To cover the geopolitical dimensions of the US policy towards the international oil pollution compensation regime.

Statement of the Problem: Oil spills have far-reaching and persistent impact upon the global marine environment. In this context, there is a pressing need for an international compensation regime covering various types of oil spills damage. Without the support of the major stakeholders of oil industry like the US, such a regime is likely to be ineffective in view of providing sufficient and speedy compensation to victims of oil pollution damage.

Hypotheses:

(1) Regional approaches to oil spill liability fixation are not sufficient; an international regime for compensation is a fundamental necessity.

(2) The United States has shown double standards in dealing with the oil pollution liability in its domestic state laws on hand and international laws, on the other hand.

Sources of Information:

A wide variety of sources has been consulted for the study. Most of the sources are of the secondary nature. However, some primary sources like reports and the publications of various organizations like the United Nations, International Maritime organization and various conventions are used as references. So, the sources of the information for the study include books, articles, periodicals, publications of international organizations.

Research Methods:

To a large extent, the study is sought to be qualitative, comprising of the descriptive analysis of the data and the information obtained. The focus of the undertaken research is geographic aspects of the impact of oil spills upon the marine environment. A geopolitical approach is followed while analyzing the various dimensions of liability fixation related to the oil spill damage. So, the main basis of the study of the impact of oil spill upon marine environment and the politics of liability fixation is the study of available literature from a viewpoint of geopolitical paradigm.

Scheme of Chapterisation:

The study is divided into several broad sections for the ease of understanding, each being treated as a separate chapter. Hence, the study is divided into five such chapters.

Chapter 1: This is an introductory part of the whole study. The introduction has tried to cover the fundamentals of the liability fixation, the background and the rationale of the study. Problem statement and hypotheses related to the topic are also dealt with in this chapter. It further introduces various dimensions of the CLC, liability fixation and covers the scope of geopolitics in the topic. Relevant sources for the information for the study and the methodology involved in the study are mentioned.

Chapter 2: Oil Spills: A Brief Survey.

This chapter deals with the basic concepts related to oil spills. It deals with the definition, types and causes of oil spills, various incidents of oil spills and numerous other aspects of the oil spills.

Further, this chapter intends to cover the details and the liability issues related to the recent *Deepwater Horizon* oil spill in the Gulf of Mexico.

Chapter 3: Impact of oil spill upon marine ecology.

This chapter seeks to describe the various dimensions of the impact of oil spills upon marine biological processes, population and communities, trophic structure, and biochemical cycles etc.

It also deals with the factors that determine the nature and extent of the harmful effects of oil spills upon marine ecology. A separate section is devoted to the damage caused to the mangrove ecosystems and recovery aspects of environmental damage.

The next section of the chapter intends to cover the effectiveness, mechanism and detrimental effects of oil spill removers which are commonly used.

Finally, the inadequacies and problems related to the research regarding the oil spill impact on marine ecosystems are highlighted.

Chapter 4: International regimes addressing the problem of oil spill damage liability and compensation.

This chapter deals with the detailed provisions of the international regimes for the liability and compensation issues related to the damage caused by oil spills.
It covers the need and historical evolution of international regimes for environmental compensation and international legal framework before and after the Civil Liability Convention of 1969. It also deals with various terminologies and concepts related to international law in this context. Further, it covers various provisions and amendments of the Civil Liability Convention, its membership and its funding. The chapter further covers the various aspects of the costs related to the oil pollution compensation. Methods of cost assessment regarding the oil pollution damage are also included. Some voluntary agreements regarding the oil spill damage liability are also mentioned in the chapter. The chapter concludes with the inclination and geopolitics of the US and European Union towards the Civil Liability Convention of 1969 and other related regimes.

Chapter 5: This is the concluding part of the study. Besides giving a performance appraisal of the international regimes, the conclusion makes some remarks about the hypotheses proposed in the beginning. This chapter also deals with the evolution of concept of territory as incorporated in various regimes. Besides, the chapter further

examines how the consideration of environmental protection has been taken into account in various international regimes related to liability fixation.

Finally, the chapter concludes with the challenges and future prospects regarding the liability fixation regimes.

Chapter 2: Introduction to Oil Spills

An oil spill is the accidental petroleum release into the environment, that release or spill over of a liquid petroleum hydrocarbon such as crude oils, into the environment that on land and sea due to human activity, and is a form of pollution. The term often refers to marine oil spills, where oil is released into the ocean or coastal waters. Oil spills include releases of crude oil from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products (such as gasoline, diesel) and their by products, and heavier fuels used by large ships such as bunker fuel, or the spill of any oily refuse or waste oil. At other times, natural disasters, or malicious acts by countries at war, terrorists, vandals or illegal dumpers result in oil spills.

Thus, oil spill is the presence of significantly large amount or layers of crude or refined oil on soil or sea water, whereas oil slick is the layer of oil floating on the surface of water. Oil slicks float on oceans and seas, covering them in a thick film of crude or refined petroleum oil. When freight ships carrying tens of thousands of tons of fuel crash, malfunction, or encounter harsh weather, they spill enormous amounts of oil into the water. Since oil and water don't mix, the oil spreads out into a layer that hovers, as one mass, on top of the ocean.

Thousands of oil slicks result from massive oil spills every year. Oil slicks are difficult to control or contain and even more challenging to clean up. Once formed, an oil slick becomes an unpredictable problem. It might end up spreading, migrating, thinning or thickening, moving towards land or further out to sea. An international community of activists, organizers, and technical developers has formed to identify, manage, and eliminate the devastating oil slicks.

Oil spills can happen in a number of ways, including the mishandling of oil pipes and tankers. The fate of an oil slick is determined by many factors, including local and regional weather, ocean currents, and tides when near a land mass, the relationship between air and water temperature, the chemical composition of the crude or refined oil, wind direction, and the presence of icebergs. These factors are discussed in the next chapter. Humans must intervene with tracking devices, booms, absorbent materials, and chemical treatments.

In addition to prominently profiled sources of oil spills and oil slicks, a lot of oil enters the marine environment through day to day human activity. *Storm drains*, for

example, collect a great deal of oil waste from the streets and pass it on to the world's oceans. The most dangerous type of oil spill is one which dumps a large amount of oil all at once, overloading the ability of the ocean to process it. These large oil spills affect marine life very negatively.

It should be noted that human activity is not solely responsible for oil pollution in the oceans. Oil spills can also occur due to natural seepage from oil bearing areas. Though a vast amount of oil enters the ocean from this little-understood phenomenon, it does not appear harmful; however, it does change the surrounding environment. Yet, over time, organisms living in these areas adapt and create ecosystems in which they can survive, and even thrive. Scientists continue to study this phenomenon to better understand how oil changes the way the organisms live.

Natural disasters such as hurricanes or floods can also cause oil spills. For example, Hurricane *Katrina* was responsible for the release of more than 7 million gallons[3] of oil into the ecosystem, originating from oil storage facilities, processing plants, and pipelines.

Oil wastes that enter the ocean come from many sources, some being accidental spills or leaks, and some being the results of chronic and careless habits in the use of oil and oil products. Most waste oil in the ocean consists of oily stormwater drainage from cities and farms, untreated waste disposal from factories and industrial facilities, and unregulated recreational boating.

It is estimated that approximately 706 million gallons of waste oil enter the ocean every year, with over half coming from land drainage and waste disposal; for example, from the improper disposal of used motor oil. Offshore drilling and production operations and spills or leaks from ships or tankers typically contribute less than 8 percent of the total. The remainder comes from routine maintenance of ships (nearly 20 percent), hydrocarbon particles from onshore air pollution (about 13 percent), and natural seepage from the seafloor (over 8 percent).

Offshore oil spills or leaks may occur during various stages of well drilling and repair operations. These stages can occur while oil is being produced from offshore wells, handled, and temporarily stored; or when oil is being transported offshore, either by flowline, underwater pipeline, or tanker. Of the approximately 706 million gallons of waste oil in the ocean each year, offshore drilling operations contribute about 2.1 percent, and transportation accidents

[3] 1 gallon is equal to approximately 3.785 litre.

(both ships and tankers) account for another 5.2 percent. The amount of oil spilled or leaked during offshore production operations is relatively insignificant.

Oil waste from offshore drilling operations may come from disposal of oil-based drilling fluid wastes, deck runoff water, flowline and pipeline leaks, or well failures or blowouts. Disposal of offshore production waste can also pollute the ocean, as can deck runoff water, leaking storage tanks, flowline and pipeline leaks, and the wells themselves. Oil spilled from ships and tankers includes the transportation fuel used by the vessels themselves (bunker oil) or their cargos, such as crude oil, fuel oil, or heating oil.

Thus, the causes of oil spills can be divided into two groups: accidents and operations.

Accidents:

There is often a large oil loss in accidents; up to 1/5 have an oil loss of over 700 tonnes.

- *Collisions*: a common accident with 475 occurring between 1974 and 1999.
- *Hull failures*: these accidents occurred the most between 1974 and 1999, with 671 hull failures between these two years.
- *Fires and explosions*: this is the most uncommon type of accident, only occuring 154 times between 1974 and 1999.
- *Groundings*: a common accident with 518 occurring between 1974 and 1999, and the greatest number of oil losses over 700 tonnes.

Operations:

Most oil losses occur when ships are carrying out routine operations at ports or oil terminals, but the majority of such spills are small, with 93% of them producing a spillage of less than 7 tonnes.

- *loading/discharging*: commonest cause of oil spillages (either during routine operations or resulting from accidents), with 3070 occurring between 1974 and 1999.
- *bunkering*: the least common operational oil loss with only 566 occurring between 1974 and 1999.

Oil Spill Behaviour:

When oil is spilled in the ocean, it initially spreads in the water (primarily on the surface), depending on its relative density and composition. The oil slick formed may remain cohesive, or may break up in the case of rough seas. Waves, water currents, and wind force the oil slick to drift over large areas, impacting the open ocean, coastal areas, and marine and terrestrial habitats in the path of the drift.

Oil that contains volatile organic compounds partially evaporates, losing between 20 and 40 percent of its mass and becoming denser and more viscous (i.e., more resistant to flow). A small percentage of oil may dissolve in the water. The oil residue also can disperse almost invisibly in the water or form a thick mousse with the water. Part of the oil waste may sink with suspended particulate matter, and the remainder eventually congeals into sticky tar balls. Over time, oil waste weathers (deteriorates) and disintegrates by means of *photolysis* (decomposition by sunlight) and *biodegradation* (decomposition due to microorganisms). The rate of biodegradation depends on the availability of nutrients, oxygen, and microorganisms, as well as temperature.

Oil Spill Interaction with Shoreline:

If oil waste reaches the shoreline or coast, it interacts with sediments such as beach sand and gravel, rocks and boulders, vegetation, and terrestrial habitats of both wildlife and humans, causing erosion as well as contamination. Waves, water currents, and wind move the oil onto shore with the surf and tide. Beach sand and gravel saturated with oil may be unable to protect and nurture normal vegetation and populations of the substrate biomass. Rocks and boulders coated with sticky residue interfere with recreational uses of the shoreline and can be toxic to coastal wildlife. The details of the oil spill impact on coastal communities are dealt with in the next chapter.

Examples of Large Spills:

The largest accidental oil spill on record (Persian Gulf, 1991) put 240 million gallons of oil into the ocean near Kuwait and Saudi Arabia when several tankers, port facilities, and storage tanks were destroyed during war operations. The blowout of the *Ixtoc I* exploratory well offshore Mexico in 1979, the second largest accidental oil spill, gushed 140 million gallons of oil into the Gulf of Mexico. By comparison, the wreck of the *Exxon Valdez* tanker in 1989

spilled 11 million gallons of oil into Prince William Sound offshore Alaska, and ranks fifty-third on the list of oil spills involving more than 10 million gallons. The number of large spills (over 206,500 gallons) averaged 24.1 per year from 1970 to 1979, but decreased to 6.9 per year from 1990 through 2000.

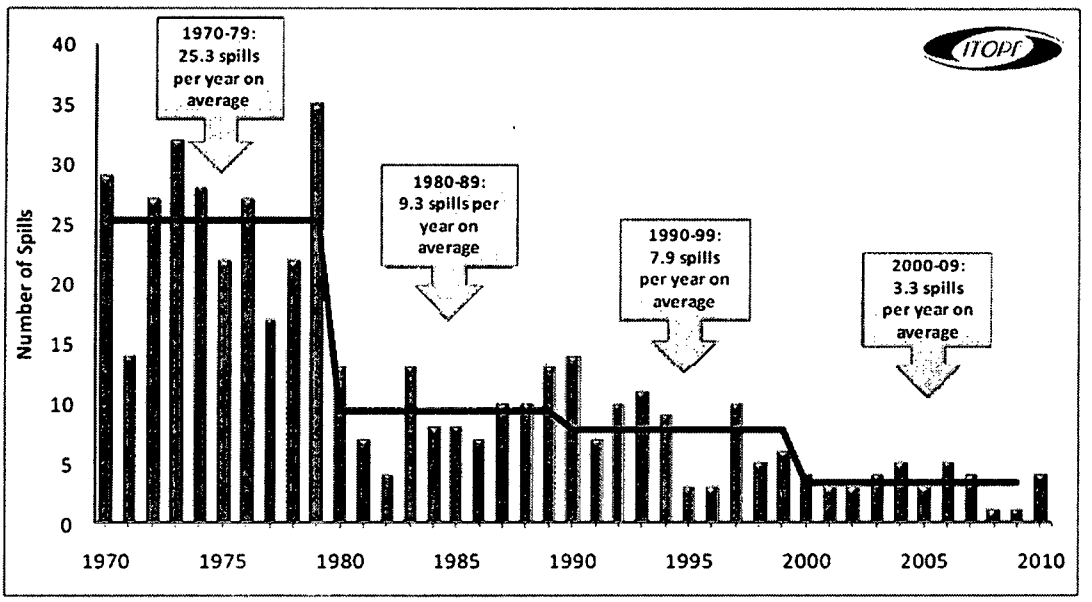

Figure 2.1: Number of large spills (over 700 tonnes) from 1970 to 2010.

Source: Oil Spill Statistics, 2010, ITOPF

Damage to Fisheries, Wildlife, and Recreation:

Oil spills can be very harmful to the environment. Marine birds and mammals, fish and shellfish are all affected, as are plants and the wildlife that feeds on plants. Oil destroys the insulating ability of fur bearing mammals, such as sea otters, and the water-repelling abilities of a bird's feathers, thus exposing these creatures to harsh weather. Birds and animals also swallow oil when they try to clean themselves, which can poison them. If an oil spill occurs on land, the local and even the regional aquifers and watersheds can become polluted.

Oil spills present the potential for enormous harm to deep ocean and coastal fishing and fisheries. The immediate effects of toxic and smothering oil waste may be mass

mortality and contamination of fish and other food species, but long-term ecological effects may be worse. Oil waste poisons the sensitive marine and coastal organic substrate, interrupting the food chain on which fish and sea creatures depend, and on which their reproductive success is based. Commercial fishing enterprises may also be affected permanently.

Wildlife other than fish and sea creatures, including mammals, reptiles, amphibians, and birds that live in or near the ocean, is also poisoned by oil waste. The hazards for wildlife include toxic effects of exposure or ingestion, injuries such as smothering and deterioration of thermal insulation, and damage to their reproductive systems and behaviour. Long-term ecological effects that contaminate or destroy the marine organic substrate and thereby interrupt the food chain are also harmful to the wildlife, so species populations may change or disappear.

Coastal areas are usually thickly populated and attract many recreational activities and related facilities that have been developed for fishing, boating, and scuba diving, swimming, nature parks and preserves, beaches, and other resident and tourist attractions. Oil waste that invades and pollutes these areas and negatively affects human activities can have devastating and long-term effects on the local economy and society. Property values for housing tend to decrease, regional business activity declines, and future investment in such property is risky.

Long-term Fate of Oil on Shore:

The fate of oil residues on shore depends on the spilled oil's composition and properties, the volume of oil that reaches the shore, the types of beach and coastal sediments and rocks contacted by the oil, the impact of the oil on sensitive habitats and wildlife, weather events, and seasonal and climatic conditions. Some oils evaporate, disperse, emulsify, weather, and decompose more easily than others. The weather and seasonal and climatic conditions may accelerate or delay these processes.

Oil waste that coalesces into a tar-like substance or that saturates sediments above the surf and tide level is especially persistent. Efforts to remove the oil and clean, decontaminate, and remediate an oil-impacted shoreline may make the area more visibly attractive, but may be more harmful than helpful in terms of actual recovery.

Cleanup and Recovery:

When oil spills, it can be cleaned by booms and skimmers (floating barriers), chemical and biological dispersants, burning, washing off with hoses, vacuum trucks, shovels and road equipment. However, none of these methods can truly clean all of the oil, particularly if the spill contaminates a river, lake or part of an ocean.

The techniques used to clean up an oil spill depend on oil characteristics and the type of environment involved; for example, open ocean, coastal, or wetland. Pollution-control measures include containment and removal of the oil (either by skimming, filtering, or *in situ* combustion), dispersing it into smaller droplets to limit immediate wildlife damage, biodegradation (either natural or assisted), and normal weathering processes. Individuals of large-sized wildlife species are sometimes rescued and cleaned, but micro-sized species are usually ignored.

Oil spill countermeasures to clean up and remove the oil are selected and applied on the basis of many interrelated factors, including ecological protection, socioeconomic effects, and health risk. It is important to have contingency plans in place in order to deploy pollution control personnel and equipment efficiently.

Figure 2.2: Workers clean up an oil refinery spill that polluted Anacortes Bay, Washington.

Environmental Recovery Rates:

The rate of recovery of the environment when an oil spill occurs depends on factors such as oil composition and properties and the characteristics of the area impacted, as well as the results of intervention and remediation. Physical removal of oil waste and the cleaning and decontaminating of the area assist large-scale recovery of the environment, but may be harmful to the substrate biomass. Bioremediation efforts—adding microorganisms, nutrients, and oxygen to the environment—can usually boost the rate of biodegradation. Because of the type of oil spilled and the Arctic environment in which it spilled, it is estimated that the residue of the *Exxon Valdez* oil spill will be visible on the Alaskan coast for 30 years.

Costs and Prevention:

The costs of an oil spill are both quantitative and qualitative. Quantitative costs include loss of the oil, repair of physical facilities, payment for cleaning up the spill and remediating the environment, penalties assessed by regulatory agencies, and money paid in insurance and legal claims. Qualitative costs of an oil spill include the loss of pristine habitat and communities, as well as unknown wildlife and human health effects from exposure to water and soil pollution.

Prevention of oil spills has become a major priority; and of equal importance, efforts to contain and remove oil that has spilled are considered to be prevention of secondary spills. The costs associated with oil spills and regulations governing offshore facilities and operations have encouraged the development of improved technology for spill prevention. The Oil Pollution Act of 1990 was enacted by the U.S. Congress to strengthen oil spill prevention, planning, response, and restoration efforts. Under its provisions, the Oil Spill Liability Trust Fund provides cleanup funds for oil pollution incidents.

Responsibility for the prevention of oil spills falls upon individuals as well as on governments and industries. Because the sources of oil waste in the ocean are generally careless, rather than accidental, truly effective prevention of oil spills involves everyone.

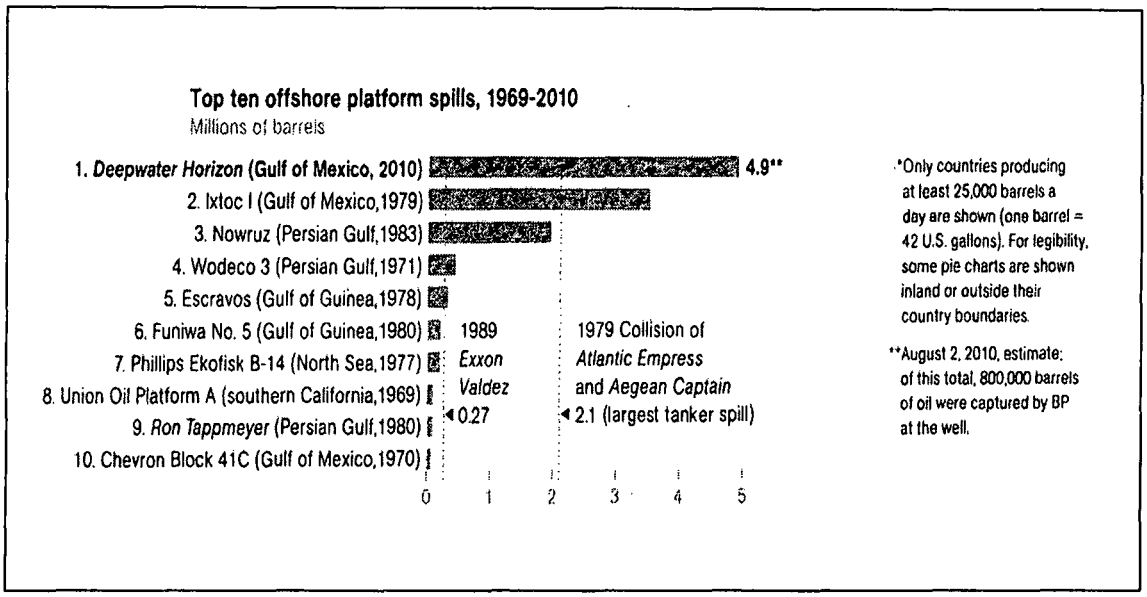

Figure: 2.3: Top ten offshore oil platform spills.

Source: Bourne, J. K. (2010), "The Deep Dilemma", *National Geographic*, 218(4): 40-53.

Oil Spill Incidents:

The following list includes major oil spills since 1967. The circumstances surrounding the spill, amount of oil spilled, and the consequent environmental damage is also given.

1967

March 18, Cornwall, England.: *Torrey Canyon* ran aground, spilling 38 million gallons of crude oil off the Scilly Islands.

1976

Dec. 15, Buzzards Bay, Mass.: *Argo Merchant* ran aground and broke apart southeast of Nantucket Island, spilling its entire cargo of 7.7 million gallons of fuel oil.

1977

April, North Sea: blowout of well in *Ekofisk* oil field leaked 81 million gallons.

1978

March 16, off Portsall, France: wrecked supertanker *Amoco Cadiz* spilled 68 million gallons, causing widespread environmental damage over 100 miles of Brittany coast.

1979

June 3, Gulf of Mexico: exploratory oil well *Ixtoc 1* blew out, spilling an estimated 140 million gallons of crude oil into the open sea. Although it is one of the largest known oil spills, it had a low environmental impact.

July 19, Tobago: the *Atlantic Empress* and the *Aegean Captain* collided, spilling 46 million gallons of crude. While being towed, the *Atlantic Empress* spilled an additional 41 million gallons off Barbados on Aug. 2.

1980

March 30, Stavanger, Norway: floating hotel in North Sea collapsed, killing 123 oil workers.

1983

Feb. 4, Persian Gulf, Iran: Nowruz Field platform spilled 80 million gallons of oil.

Aug. 6, Cape Town, South Africa: the Spanish tanker *Castillo de Bellver* caught fire, spilling 78 million gallons of oil off the coast.

1988

July 6, North Sea off Scotland: 166 workers killed in explosion and fire on Occidental Petroleum's *Piper Alpha* rig in North Sea; 64 survivors. It is the world's worst offshore oil disaster.

Nov. 10, Saint John's, Newfoundland: *Odyssey* spilled 43 million gallons of oil.

1989

March 24, Prince William Sound, Alaska: tanker *Exxon Valdez* hit an undersea reef and spilled 10 million–plus gallons of oil into the water, causing the worst oil spill in U.S. history.

Dec. 19, off Las Palmas, the Canary Islands: explosion in Iranian supertanker, the *Kharg-5,* caused 19 million gallons of crude oil to spill into Atlantic Ocean about 400 mi north of Las Palmas, forming a 100-square-mile oil slick.

1990

June 8, off Galveston, Tex.: *Mega Borg* released 5.1 million gallons of oil some 60 nautical miles south-southeast of Galveston as a result of an explosion and subsequent fire in the pump room.

1991

Jan. 23–27, southern Kuwait: during the Persian Gulf War, Iraq deliberately released 240–460 million gallons of crude oil into the Persian Gulf from tankers 10 miles off Kuwait. Spill had little military significance. On Jan. 27, U.S. warplanes bombed pipe systems to stop the flow of oil.

April 11, Genoa, Italy: *Haven* spilled 42 million gallons of oil in Genoa port.

May 28, Angola: *ABT Summer* exploded and leaked 15–78 million gallons of oil off the coast of Angola. It's not clear how much sank or burned.

1992

March 2, Fergana Valley, Uzbekistan: 88 million gallons of oil spilled from an oil well.

1993

Aug. 10, Tampa Bay, Fla.: three ships collided, the barge *Bouchard B155,* the freighter *Balsa 37,* and the barge *Ocean 255.* The *Bouchard* spilled an estimated 336,000 gallons of No. 6 fuel oil into Tampa Bay.

1994

Sept. 8, Russia: dam built to contain oil burst and spilled oil into Kolva River tributary. U.S. Energy Department estimated spill at 2 million barrels. Russian state-owned oil company claimed spill was only 102,000 barrels.

1996

Feb. 15, off Welsh coast: supertanker *Sea Empress* ran aground at port of Milford Haven, Wales, spewed out 70,000 tons of crude oil, and created a 25-mile slick.

1999

Dec. 12, French Atlantic coast: Maltese-registered tanker *Erika* broke apart and sank off Britanny, spilling 3 million gallons of heavy oil into the sea.

2000

Jan. 18, off Rio de Janeiro: ruptured pipeline owned by government oil company, Petrobras, spewed 343,200 gallons of heavy oil into Guanabara Bay.

Nov. 28, Mississippi River south of New Orleans: oil tanker *Westchester* lost power and ran aground near Port Sulphur, La., dumping 567,000 gallons of crude oil into lower Mississippi. Spill was largest in U.S. waters since *Exxon Valdez* disaster in March 1989.

2002

Nov. 13, Spain: *Prestige* suffered a damaged hull and was towed to sea and sank. Much of the 20 million gallons of oil remains underwater.

2003

July 28, Pakistan: The *Tasman Spirit,* a tanker, ran aground near the Karachi port, and eventually cracked into two pieces. One of its four oil tanks burst open, leaking 28,000 tons of crude oil into the sea.

2004

Dec. 7, Unalaska, Aleutian Islands, Alaska: A major storm pushed the M/V *Selendang Ayu* up onto a rocky shore, breaking it in two. 337,000 gallons of oil were released, most of which was driven onto the shoreline of Makushin and Skan Bays.

2005

Aug.-Sept., New Orleans, Louisiana: The Coast Guard estimated that more than 7 million gallons of oil were spilled during Hurricane Katrina from various sources, including pipelines, storage tanks and industrial plants.

2006

June 19, Calcasieu River, Louisiana: An estimated 71,000 barrels of waste oil were released from a tank at the CITGO Refinery on the Calcasieu River during a violent rain storm.

July 15, Beirut, Lebanon: The Israeli navy bombs the Jieh coast power station, and between three million and ten million gallons of oil leaks into the sea, affecting nearly 100 miles of coastline. A coastal blockade, a result of the war, greatly hampers outside clean-up efforts.

August 11th, Guimaras island, The Philippines: A tanker carrying 530,000 gallons of oil sinks off the coast of the Philippines, putting the country's fishing and tourism industries at great risk. The ship sinks in deep water, making it virtually unrecoverable, and it continues to emit oil into the ocean as other nations are called in to assist in the massive clean-up effort.

2007

December 7, South Korea: Oil spill causes environmental disaster, destroying beaches, coating birds and oysters with oil, and driving away tourists with its stench. The *Hebei Spirit* collides with a steel wire connecting a tug boat and barge five miles off South Korea's west coast, spilling 2.8 million gallons of crude oil. Seven thousand people are trying to clean up 12 miles of oil-coated coast.

2008

July 25, New Orleans, Louisiana: A 61-foot barge, carrying 419,000 gallons of heavy fuel, collides with a 600-foot tanker ship in the Mississippi River near New Orleans. Hundreds of thousands of gallons of fuel leak from the barge, causing a halt to all river traffic while cleanup efforts commence to limit the environmental fallout on local wildlife.

2009

March 11, Queensland, Australia: During Cyclone Hamish, unsecured cargo aboard the container ship *MV Pacific Adventurer* came loose on deck and caused the release of 52,000 gallons of heavy fuel and 620 tons of ammonium nitrate, a fertilizer, into the Coral Sea. About 60 km of the Sunshine Coast was covered in oil, prompting the closure of half the area's beaches.

2010

Jan. 23, Port Arthur, Texas: The oil tanker *Eagle Otome* and a barge collide in the Sabine-Neches Waterway, causing the release of about 462,000 gallons of crude oil. Environmental damage was minimal as about 46,000 gallons were recovered and 175,000 gallons were dispersed or evaporated, according to the U.S. Coast Guard.

April 24, Gulf of Mexico: The *Deepwater Horizon,* a semi-submersible drilling rig, sank on April 22, after an April 20th explosion on the vessel. Eleven people died in the blast.

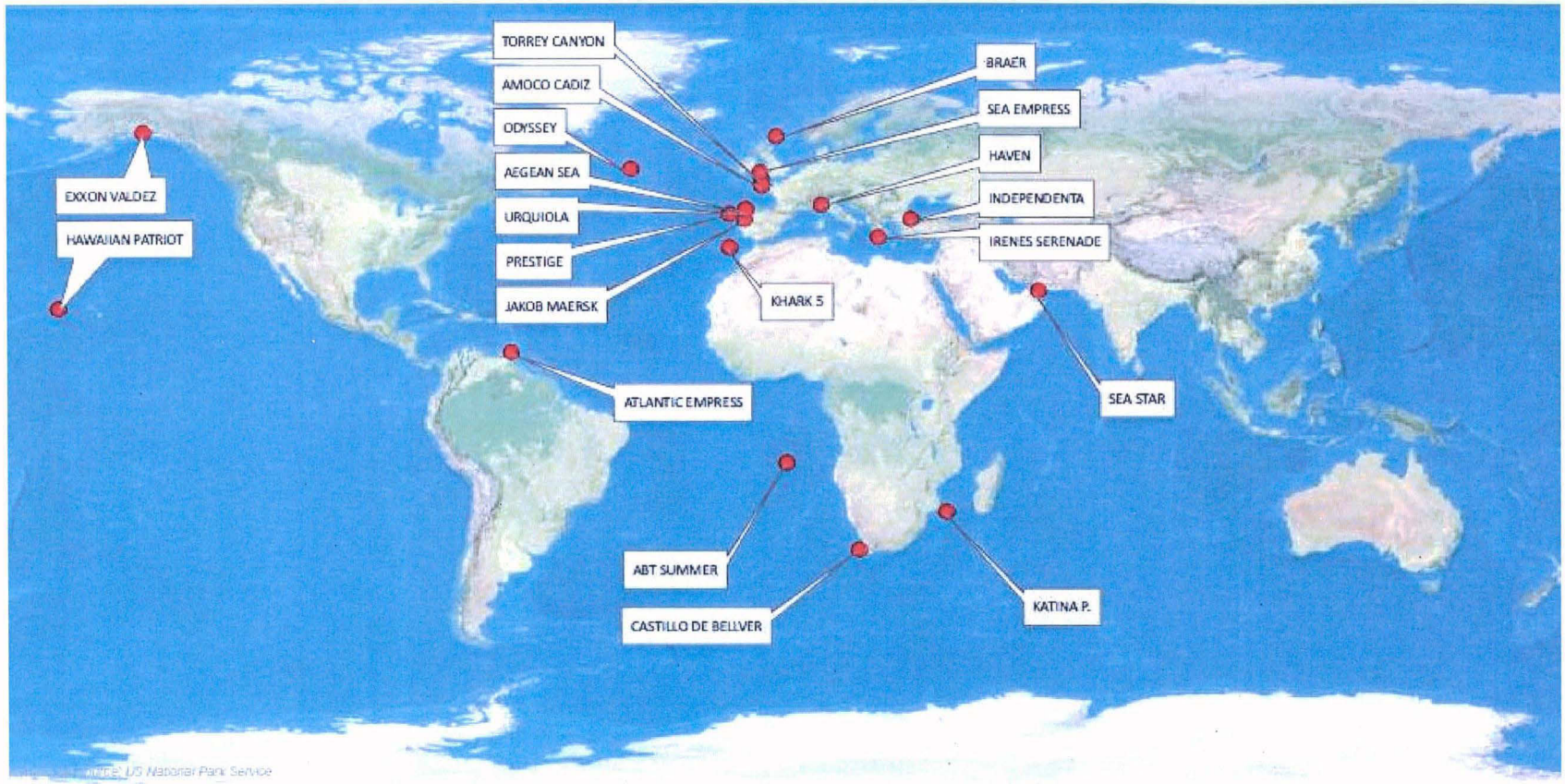

Figure 2.4: Location of the major oil spills of the world. (Source: Oil Spill Statistics 2010, ITOPF)

The *Deepwater Horizon*Oil Spill :(also known as the Gulf of Mexico Oil Spill or the BP Oil Spill) is the largest marine oil spill in history, and was caused by an explosion on the *Deepwater Horizon* offshore oil platform about 80 km. southeast of the Mississippi River delta on April 20, 2010 (28.74°N, 88.39°W). When the rig sank, the riser—the 5,000-foot-long pipe that connects the wellhead to the rig—became detached and began leaking oil. In addition, U.S. Coast Guard investigators discovered a leak in the wellhead itself. As much as 60,000 barrels of oil per day were leaking into the water, threatening wildlife along the Louisiana Coast. Homeland Security Secretary Janet Napolitano declared it a "spill of national significance." BP (British Petroleum), which leased the *Deepwater Horizon,* is responsible for the cleanup, but the U.S. Navy supplied the company with resources to help contain the slick. Oil reached the Louisiana shore on April 30, affected about 125 miles of coast. By early June, oil had also reached Florida, Alabama, and Mississippi. Most of the 126 workers on the platform were safely evacuated, and a search and rescue operation began for 11 missing workers. The *Deepwater Horizon* sank in about 5,000 feet (1,500 m) of water on April 22, 2010. On April 23 the U.S. Coast Guard suspended the search for missing workers who are all presumed dead. After a series of failed efforts to plug the leak, BP said on July 15 that it had capped the well, stopping the flow of oil into the Gulf of Mexico for the first time in 86 days.

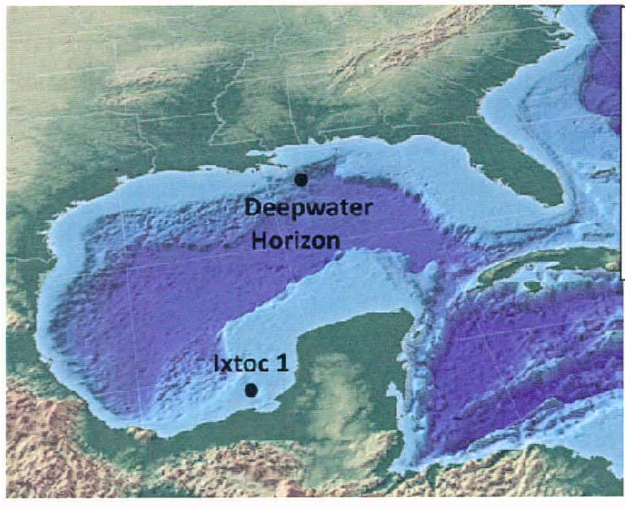

Figure 2.5: The Gulf of Mexico in 3D perspective indicating the location of two marine blowouts.Source:NOAA(http://oceanexplorer.noaa.gov/technology/tools/mapping/media/gis_gulf.html)

Attempts to shut down the flow failed when a safety device called a blowout preventer (BOP) could not be activated. The rate of oil release became the subject of intense debate. Throughout the first month of the spill, government responders officially adhered to low and inaccurate estimates. Non-governmental scientists, on the other hand, used the small amount of publicly available flow data to generate estimates that have proven to be much more accurate. Live video feeds of the leak from the ocean floor fuelled the controversy over the magnitude of the leak.

The emerging consensus is that roughly five million barrels of oil were released by the Macondo well, with roughly 4.2 million barrels pouring into the waters of the Gulf of Mexico.

The oil slick produced by the *Deepwater Horizon* oil spill covered as much 28,958 square miles (75,000 square kilometres), an area about the size of South Carolina, with the extent and location of the slick changing from day to day depending on weather conditions. By the first week in June, oil had come ashore in Louisiana, Mississippi, Alabama and Florida, with significant wildlife fatalities in Louisiana. In the weeks following the accident, scientists discovered enormous oil plumes in the deep waters of the Gulf of Mexico, raising concerns about ecological harm far below the surface that would be difficult to assess.

Prior to the *Deepwater Horizon*, the largest oil spill in U.S. waters was in 1968 when the tanker *Mandoil II* spilled about 300,000 barrels into the Pacific Ocean off Columbia River near Warrenton, Oregon. The 1989 wreck of the *Exxon Valdez* released about 261,905 barrels (11 million gallons) of crude oil into Prince Williams Sound in Alaska. In 2005, Hurricane *Katrina* caused a spill of eight million gallons of crude and refined oil products from many different point sources into the southern corridor of the Mississippi River and the Gulf of Mexico. In 1979-80, the *Ixtoc 1* exploratory well operated the PEMEX, the Mexican national oil corporation, experienced a blowout and ultimately released about 3.3 million barrels (140 million gallons) of crude oil into the Bay of Campeche in Mexico.

The surface slick threatened the ecosystems and the economy of the entire Gulf Coast region. The U.S. Fish and Wildlife Service reported that up to 32 National Wildlife Refuges were potentially affected by the spill. Concerns were raised about the environmental impacts of chemicals known as dispersants that have been used to dissipate the oil slick. By June 2, 2010, the National Oceanic and Atmospheric Administration (NOAA) had banned fishing in about 36% of federal waters, or 86,895 sq mi (229,270 sq km) of the Gulf.

Liability Issues Related to the *Deepwater Horizon* Oil Spill:

BP was principal developer of the Macondo Prospect oil field where the accident occurred. The *Deepwater Horizon*, owned by Transocean Ltd., was under a contract with BP to drill an exploratory well. BP was the lessee and principal developer of the Macondo Prospect oil field in which the rig was operating. At the time of the explosion, BP and Transocean were in the process of closing the well in anticipation of later production. Halliburton had completed cementing of casings in the well. The U.S. Government named BP as the responsible party in the incident and will hold the company accountable for all cleanup costs resulting from the oil spill. BP has accepted responsibility for the oil spill and the cleanup costs. However, in a report issued on September 18, 2010, BP clearly indicated its view that Transocean and Halliburton deserved considerable blame for the disaster, allegations vehemently denied by those companies. However, B.P. has promised to cover all damage, with a new ceiling of about $10 billion. There were others who were to share the costs. Transocean owned the rig. Halliburton was pouring the slurry. B.P. shared the enterprise with Japan's Mitsui and Texas' Andarko. Although B.P. was paying $6 million a day on the clean-up, it was a fraction of the total cost. But B.P. had a vast exchequer. In the first three months of 2010, its revenue was $5.6 billion.[4]

According to BP, the cost of the response to September 29 amounted to approximately $11.2 billion, including the cost of the spill response, containment, relief well drilling, static kill and cementing, grants to the Gulf States, claims paid and federal costs. It is important here to remember that after the Exxon Valdez leaked its oil cargo

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[4]Prashad, Vijay (2010), "Deadly spill", *Frontline,* 27 (11): 34-38.

into the Alaskan waters in 1989, the company did not pay full price for the damages. The original settlement of $5 billion in 1994 came down to $1 billion in 2009.[5]

In conclusion, the chapter can be summarized by saying that various oil spill incidents demonstrated the severity of oil spills as a great hazard to marine environment and that oil spills can be prevented through the precautions regarding accidents and operations related to the oil industry. Oil spills can have devastating effects on coastal and marine ecology; and the cleanup processes may be very time-taking. Thus, there is a pressing need of international consensus about the environmental legislation in this regard.

[5] Prashad, Vijay (2010), "A Disaster Foretold", *Frontline,* 27 (14): 25-29.

Chapter 3: The Impact of Oil Spill upon Marine Ecosystems

The impact of oil spill upon marine ecosystems varies from place to place and time to time. The extent and severity of damage depends upon a gamut of factors. Not only the spilled oil, but oil removers like dispersants and detergents also may cause considerable damage to marine communities.

This chapter intends to describe the basic concepts of marine ecology, mechanism (oil components and processes) of the impact of oil spill on marine biological processes, its various dimensions (effects on populations, communities, trophic structure, biochemical cycles etc), the factors which determine the nature, extent and persistence of detrimental effects on marine ecology.

A separate section is going to be devoted to the damage caused to intertidal mangrove ecosystems, as these are most vulnerable to oil spill damages. Further, this chapter would elaborate various methods and dimensions of recovery from "disaster" of oil spill.

The next section of the chapter would cover the effectiveness, mechanism and harmful effects of commonly used oil spill removers. Additionally, various aspects of bioremediations are also dealt with.

The impact of oil spill upon human communities, however indirect, is not less significant. Loss to human economy due to oil spills will be covered in the next section of the chapter.

Finally, the inadequacies and problems related to the research regarding oil spill impact on marine ecosystem are highlighted.

Marine Ecology: Basic Concepts

The oceans can be subdivided into a number of marine environments (Figure 3.1). The most basic division separates the pelagic and benthic realms. The *pelagic environment* (pelagic meaning 'open sea') is that of the water column, from the surface to the greatest depths. The *benthic environment* (benthic meaning 'bottom') encompasses the seafloor and includes such areas as shores, littoral or intertidal areas, coral reefs, and the deep seabed.

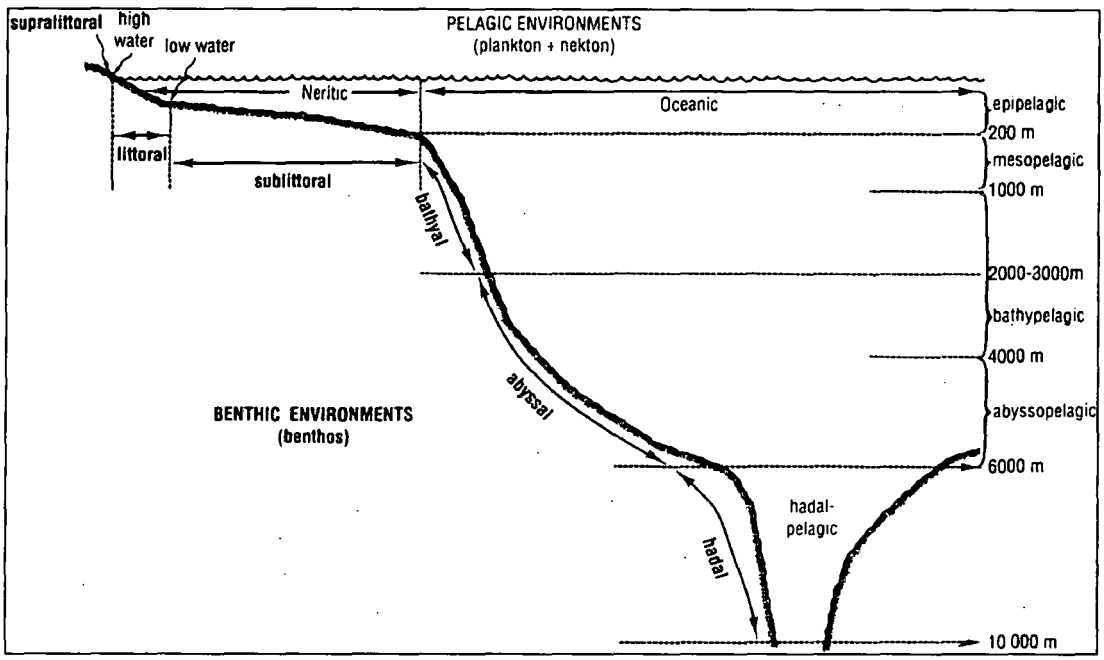

Figure: 3.1: The basic ecological divisions of the ocean. The neritic (or inshore) pelagic zone is separated from the oceanic (or offshore) pelagic zone by the edge of the continental shelf, which is generally at about 200 metre depth. Benthic habitats are in bold type; pelagic divisions are in blue. (Not to scale.)

Another basic division separates the vast open ocean, the *oceanic*environment, from the inshore *neritic*zone. This division is based on depth and distance from land, and the separation is conventionally made at the 200 m depth limit which generally marks the edge of the continental shelf (Figure 3.1). In some areas like the west coast of South America where the shelf is very narrow, the neritic zone will extend only a very slight distance from shore. In other areas (e.g. off the north-east coast of the United States), the neritic zone may extend several hundred kilometres from land. Overall, continental shelves underlie about 8% of the total ocean, an area equal to about that of Europe and South America combined. Many of these continental shelves are important for offshore oil drilling.

Further divisions of the pelagic and benthic environments can be made which divide them into distinctive ecological zones based on depth and/or bottom topography.

Marine organisms can be classified according to which of the marine environments they inhabit. Thus there are *oceanic species* and *neritic species* depending upon whether the organisms are found in offshore or coastal waters, respectively. Similarly, plants or animals that live in association with the seafloor are collectively called *benthos.* The benthos includes attached seaweeds, sessile animals (animals that are permanently attached to something rather than free-moving) like sponges and barnacles, and those animals that crawl on or burrow into the substrate.

The pelagic environment supports two basic types of marine organisms. One type comprises the *plankton,* or those organisms whose powers of locomotion are such that they are incapable of making their way against a current and thus are passively transported by currents in the sea. The word plankton comes from the Greek *planktos,* meaning that which is passively drifting or wandering. Depending upon whether a planktonic organism is a plant or animal, a distinction is made between *phytoplankton* and *zooplankton.* Although many planktonic species are of microscopic dimensions, the term is not synonymous with small size as some of the zooplankton include jellyfish of several metres in diameter. All plankton are not completely passive; most, including many of the phytoplankton, are capable of swimming. The remaining inhabitants of the pelagic environment form the *nekton.* These are free-swimming animals that, in contrast to plankton, are strong enough to swim against currents and are therefore independent of water movements. The category of nekton includes fish, squid, and marine mammals.

It is necessary to explain the meaning of some ecological terms used in this chapter. The understanding of these terms will be helpful for a better insight of the marine processes and the impact of oil spills on these processes.

A *species* is defined as a distinctive group of interbreeding individuals that is reproductively isolated from other such groups. A *population* refers to a group of individuals of one species living in a particular place, and *population density* refers to the number of individuals per unit area (or per unit volume of water). The various populations of micro-organisms, plants, and animals that inhabit the same physical area make up an ecological *community.* The *habitat* of an organism is the place where it lives, but the term also may refer to the place occupied by an entire community. The

environment consists of both nonliving *abiotic* (physical and chemical) components like temperature and nutrient concentrations, and *biotic* components that include the other organisms and species with which an organism interacts (e.g. predators, parasites, competitors, and mates).

The highest level of ecological integration is the *ecosystem,* which encompasses one or more communities in a large geographic area and includes the abiotic environment in which the organisms live. Examples of ecosystems could include estuaries, or the total pelagic water column (with different communities at different depths). *Species diversity* is often used to describe the simplicity (or complexity) of communities and ecosystems; it can be defined in several ways but used generally to mean total number of species.

Pathways of Oil after the Spill:

Before embarking upon the impact of oil spill upon marine life, it is appropriate to understand what happens to the spilled oil when it touches the sea surface or marine habitats. This section deals with the various ways through which hydrocarbon pollution can enter marine ecosystem.

Crude oil is a foul-smelling viscous (thick) liquid that can quickly contaminate the environment. Since oil is less dense than water, it tends to float on the surface; this is particularly true with the salty water that comprises the oceans. An oil spill spreads out rapidly across the water surface to form a thin layer referred to as an oil slick. As the spreading process continues, the layer becomes thinner and thinner, finally becoming a very thin layer called a sheen, which often looks like a rainbow. Sheens can often be seen on roads after a rainstorm or in rivers or ponds where motor craft are present.

The oil forms of a few millimetres thick layer (called slick) immediately after spreading over the water surface. Since majority of the toxic components of oil or oil products are soluble in the water, biological damage can start at the very moment of the accident. However, many other factors work simultaneously to complicate the situation. The toxic volatile (the substances that readily evaporate at ambient temperature

and pressure) components of crude oil may evaporate after the spill, subject to weather conditions. For instance, liquids that evaporate easily and rapidly at normal temperature according to an estimate (Kingston, 2002)[1] as much as 30% of the oil spilled by *Exxon Valdez* (35000 tonnes) evaporated into the atmosphere. Some of the components are oxidized in presence of ultraviolet radiation of the sunlight. This process is called "photolysis". The products of photolysis, though potentially toxic, are in so low concentrations that they are of very less significance to ecological impact.

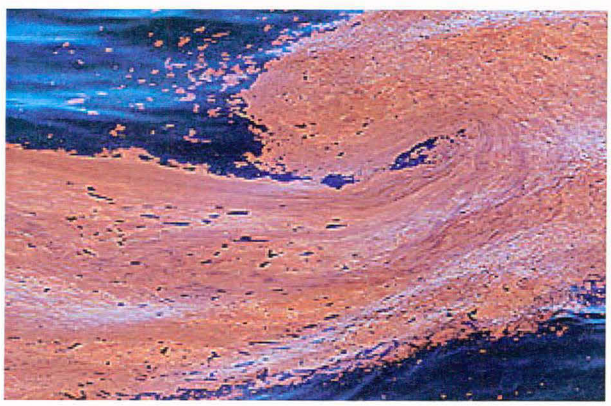

Figure 3.2: a layer of oil over sea water.

The dissolved content of oil tends to disperse, depending upon sea currents, wind conditions and wave action (near shores). In stormy conditions, oil partly emulsifies (oil droplets in water), thus, offering greater surface area to water. This process accelerates dissolution of oil into water. We have to bear in the mind that it is this process which is harmful for micro-organisms like phytoplankton and zooplankton, because oil is now available to them in greater concentrations, leaving them few chances to escape the oil. This oil is finally degraded by bacterial action. But for this, mechanical agitation (by waves etc.) is required to break oil droplets into the size of 0.01-1 mm before the bacteria could work upon the oil droplets.

If oil is carried to seabed with other substances in water column, such as sinking clay or sand, these small quantities of oil are quickly biodegraded by benthic (bottom dwelling) organisms. Clay minerals with adsorbed organic matter become excellent adsorbent for hydrocarbons; they tend to retain oil and may transport it to areas distant from the primary spill. For example, oil at the sea bottom was found even after the

ten months of accident of *Torrey Canyon* at Santa Barbara near Cape Cod (Massachusetts, US), pollution of the bottom sediments covering an area much larger than immediately after the spill.

A "water-in-oil" emulsion may also form in turbulent sea conditions. This process involves incorporation of water droplets into floating oil, thereby forming a viscous substance called "**mousse**" which may contain 20-28% sea water.

If the spill occurs far from the shore, there is some delay between the accident and its impact on the shore. Much of the oil evaporates or disperses during this delay. Thus, it is clear that most of the damage to marine life occurs during initial stage because toxic substances within oil tend to evaporate or disperse during later stages. The figure 3.3 shows various pathways of spilled oil.

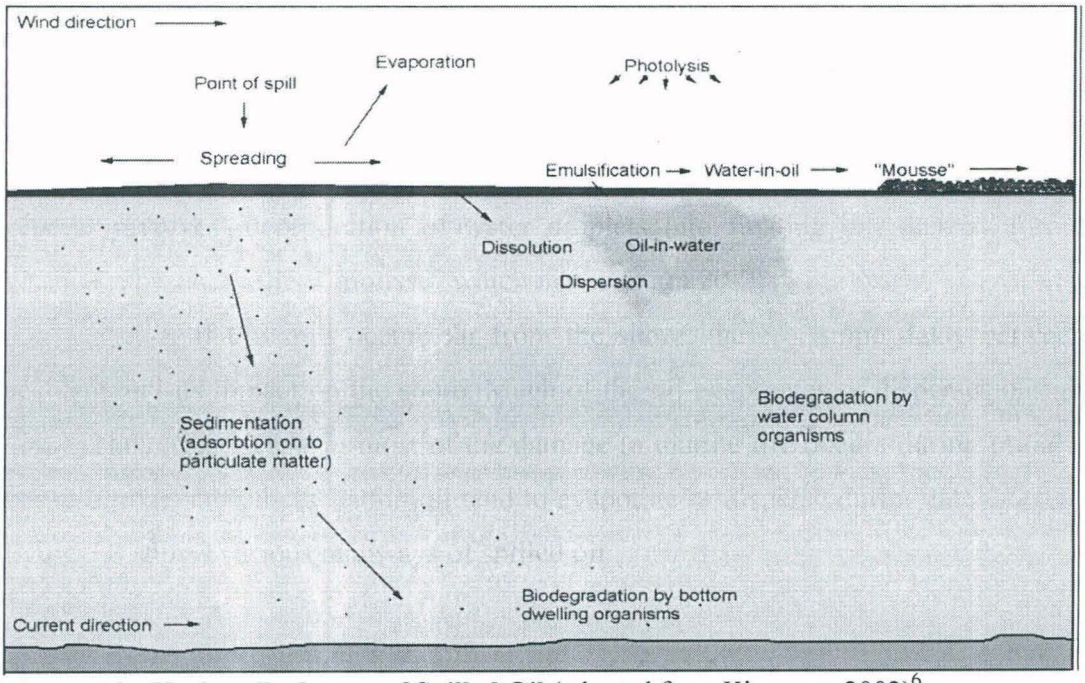

Figure 3.3: Various Pathways of Spilled Oil (adopted from Kingston, 2002)[6]

Components and Processes of Oil Affecting Marine Life:

[6]Kingston, Paul F. (2002),"Long-term Environmental Impact of Oil Spills", *Spill Science & Technology Bulletin*, 7(1–2):53–61.

As Blumer (1971)[7] points out, all crude oils and fractions of these oils are poisonous to all marine organisms, except some highly purified materials made of oil. However, only three complex fraction of oil are primarily responsible for acute toxicity to marine life forms. These are:

1. Low-boiling saturated hydrocarbons:

These are readily soluble in seawater, and cause anaesthesia and narcosis at low concentrations. However, they can cause cell damage and death if exposure is in great concentrations, especially in young forms of marine life.

2. Low boiling aromatic hydrocarbons:

These are more soluble and toxic than the saturated hydrocarbons. Of these, benzene, toluene and xylene are acutely poisonous for humans and others organisms. They can kill marine organisms either by direct contact or through contact with their dilute solutions in the sea water.

3. Olefinic Hydrocarbons:

These are absent in crude oil but are found in refined products of petroleum (gasoline etc.). Their properties and toxicity are in between those of saturated and aromatic hydrocarbons.

Other Components: These are highly soluble in water, in addition to being toxic. Some examples are: cresols, xylenols, naphthols etc. There is a consensus among scientific community that the toxicity of the petroleum is proportional to the soluble hydrocarbons (e.g., benzene, naphthalene, phenanthrene etc.) present in it. The toxicity effect caused by petroleum in water is mainly due to *n-alkane* and monocyclic aromatic hydrocarbon with strong water-solubility and relatively low molecular weight (Gao *et al.*, 2005)[8]

[7] Blumer, Max (1971), "Scientific Aspects of the Oil Spill Problem", *Environmental Affairs*, 1(2): 54-73.

[8] Gao, Z. H., Yang, J. Q., and Cun, W. L.(2005), *On Evaluation Technologies and Applications to Environmental and Ecological Damages Caused by Marine Oil Spills.*, Beijing: China Ocean Press (pp. 11-15).

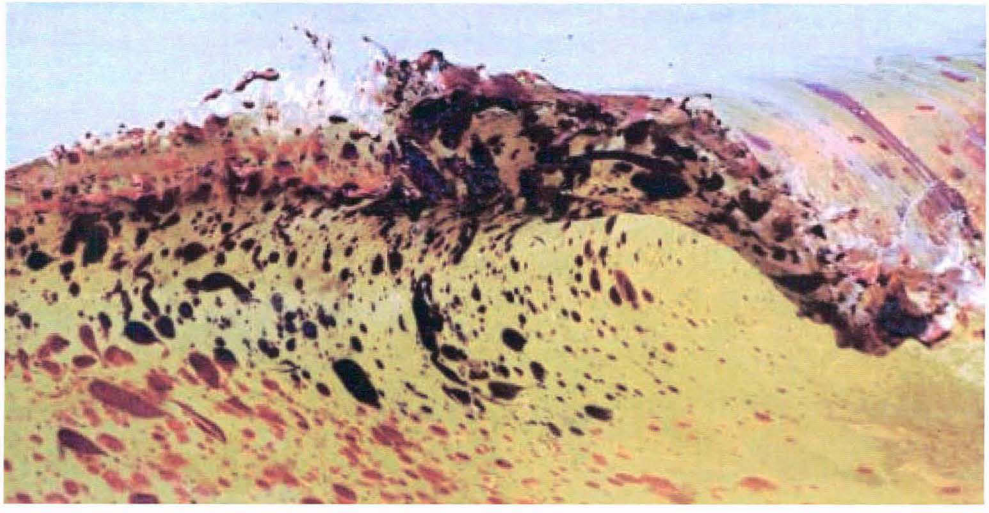

Figure 3.4: crude oil from the deepwater horizon oil spill ashore in Orange Beach, Alabama.

Effects of oil spills upon marine organisms:

The effect on marine lives caused by oil spills can be divided into physical and chemical ones. The physical effects include crude oil stick or covering the surface of living creatures that can lead to the loss or weakening of their abilities in movement. Crude oil particles may block up living creatures' respiratory system and water-entering system (such as gills *etc.*), and therefore make them suffocated. Absorbing suspended matters to intertidal zones and sea floor in shallow water can be harmful for some larvae and algae spores and may cause the loss of proper settlement in the lower layers. Oil is found to occur even in the stomach of surface feeding fishes and finely dispersed hydrocarbons occur in marine plants (*e.g.*, sargassum) and in the fatty tissues of fish and shellfish (Blumer, 1971).

Figure 3.5:an oil-covered brown pelican at the Queen Bess Island Pelican Rookery, north-east of Grand Isle, Louisiana.

Max Blumer (1971) [2] outlines various ways/processes through which oil pollution can cause threat to marine life:

1. Direct kill of organisms through coating (causing flying disability and hypothermia due to loss of insulating effects in seabirds) and suffocation.
2. Through contact poisoning of organisms.
3. Destruction of more sensitive juvenile forms of organisms (such as larvae etc.)
4. Destruction of food sources of higher species.
5. Incorporation of sublethal amounts of oil and oil products into organisms resulting in reduced resistance to infections and other stresses. This is the principal cause of death of birds surviving the immediate exposure to oil.
6. Incorporation of carcinogenic (cancer-causing) and potentially mutagenic (capable of causing genetic changes) chemicals into marine organisms.
7. Low level effects that may interrupt any of the numerous events necessary for the propagation of marine species (like mating and reproduction) and for the survival of those species which stand higher in the marine food web.
8. **Bioaccumulation:** Some non-degradable substances such as phenanthrene, a toxic component of crude oil can reach dangerous levels of concentrations as they are passed

up the food chain into the bodies of successive organisms in trophic structure in marine ecosystem.

Related to this is another phenomena called *persistence* of oil in the environment. Successful demonstrations have proved that hydrocarbons are transferred from prey to predator and that they may be retained in organisms for long periods, although such retentions are not persistent throughout the life. Even transplanting an oil-polluted fish to clean waters does not remove the hydrocarbons from the tissues of such fish and organisms. Thus, oil may contaminate organisms not only at the time of the spill; oil-loaded sediments continue to pollute environment for many months after the accident.

Before coming to effects of oil spill on marine life forms and processes, it would be pertinent to have a close look on various factors determining the extent and severity of the damage caused to marine ecology. These factors can be clubbed into three board categories.

(a) Factors related to oil itself.

(b) Factors related to marine communities.

(c) Environmental factors.

1. **Type of Discharge:** there can be three type of oil discharge related to oil spills :

(a) "one-off" oil spills (single time).

(b) Successive small spillages, but in large numbers.

(c) Continuous oily effluents like refinery waste effluents.

Shores affected by "one-off" spills are observed to be recovered within a period ranging between two to ten years, thus exhibiting "good" recovery period.

Large number of small spillages is often observed in estuaries used as oil ports. When the same area of estuary is hit by oil spills, biotic life on the shore may never get a chance of proper recovery. Experimental studies (Baker, 1971)[9] also support the notion that small successive spillages in the same place are likely to be more damaging than one larger spill.

Great oiling frequencies and continuous discharge, such as waste effluents from refineries may cause greater damage to salt marsh area. In calm weather conditions,

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[9] Baker, Jenifer M. (1978), "Marine Ecology and Oil Pollution", *Journal of Water Pollution Control Federation*, 50 (3): 442-449.

oil may deposit to the shore while tide subsides. After repeated exposure to the sticking oil (which is easily trapped on the marsh vegetation) marsh plants may die in large numbers.

2. Volume of Oil: Although it is obvious that the damage to marine life is directly proportionate to the volume of oil spilled, the fact is that the actual amount which sticks to the shore (and thereby affecting coastal communities) depends upon the density (whether spilled oil is light or heavy) of oil. Light crude oils and products such as gasoline stick to the shore in very less quantities and much of it is carried away from shore by tide or winds.

On the other hand, viscous and thick oil, like heavy fuel oils and mousses stick to the shore and may eventually lead to the smothering of organisms and hindering their re-colonization for prolonged periods.

3. Type of Oil: Although toxicity of oil is not found to vary consistently with oil properties, generally low boiling compounds and aromatics are proved to produce severe acute toxic effects.

4. State of Oil: Different effects can be produced by a given amount of spilled oil, depending upon whether it comes into contact with living organisms as thin oil films, thick oil films, water in oil emulsion, or oil in water emulsions.

Direct toxic effects or physical smothering may be caused by water in oil emulsions (called "mousse") or thin oil films. Oil in water emulsions can be caused by use of dispersants and are found in industrial and refinery effluents. Such dilute forms of oil are available to bacterial degradation process, but on the other hand, they are more likely to be ingested by planktons and larvae of other organisms, due to their smaller droplet size. Consequently, they are more readily available to successively high levels of marine food chain.

5. Chemical Interaction with Other Compounds:

Various components of oil may produce variety of new chemical products while in contact with sea water. This phenomenon is particularly crucial in case of refinery effluents because they contain variety of mixed discharges. The chemical factors which may cause toxicity to marine life are salinity, pH, sulphides, phenols, ammonium compounds, suspended material, dispersants and temperature. More studies are required

to established many chemical reactions which are involved in toxic effects on marine organisms.

6. Cleaning Treatments: The clean-up of oil spills is a costly and time-consuming business. Hence, the problems of oil spills are generally reduced to one common denominator – economics. Three approaches are generally practiced in treating with oil spill on the shores. These are: physical removal, dispersal and cutting of oily vegetation.

Physical removal, though ecologically safest option, is appropriate only for sand or shingle beaches. The method is not suitable for rugged rocky shores, soft mud or salt marshes. Problems related to machinery are also faced.

Dispersants, on the other hand, can cause great damage to marine biota if used inappropriately. Many of the dispersants have proved to be less toxic than others, but their use on salt-marsh areas is likely to cause problems. The massive use of the dispersant *Corexit 9500* in the Mexican Gulf after the *Deepwater Horizon* blow out (in April 2010) is thought to be catastrophic for the phytoplankton, zooplanktons and larvae.[10] Additionally, dispersed oil is incorporated in bottom sediments of salt-marshes more readily, and may remain there for very long time with unknown effects.

Although the toxic, solvent based detergents and dispersants are in limited use in present times, however, the term "non-toxic" is also misleading. Actually, these chemicals are non-toxic for a limited number of species, that too in laboratory conditions.

Dispersant, in fact, lowers the surface tension of the oil to a certain limit so that it disperses in the form of small droplets. Thus, instead of removing the oil, these dispersants push the oil actively into the marine environment. In effect, the finer degree of dispersion causes the toxic fractions dissolve rapidly and reach to higher concentrations in the sea water than it would if the dispersal were allowed through natural process. In this chain, the long term poisons like carcinogens can eventually reach the human body via food-chain.

Cutting the oiled vegetations does not have harmful effects on marine life, although it may cause loss of the habitat for *epibiota* (organisms dwelling upon vegetation).

7. Topography, Hydrography and Climate:

[10] Bourne, J. K. (2010), "The Deep Dilemma", *National Geographic*, 218(4): 40-53.

Shoreline morphology has a direct impact on the degree of ecological damage and recovery time. Exposed shores are reported to recover far more quickly than do protected coasts. Shore energy levels (wave action) are related to biological recovery time. Subtidal communities (like mangrove etc.) take longer time to recover because these sublittoral habitats get contaminated by sedimentation of oiled particulate matter, which is almost impossible to clean manually.

Well-circulated habitats are provided with fresh supply of nutrients and oxygen, which in turn expedite the process of recovery and bacterial action. Figure 3.6 shows the general relationship between shore energy levels and recovery time. The figure is adopted from Baker (1978).

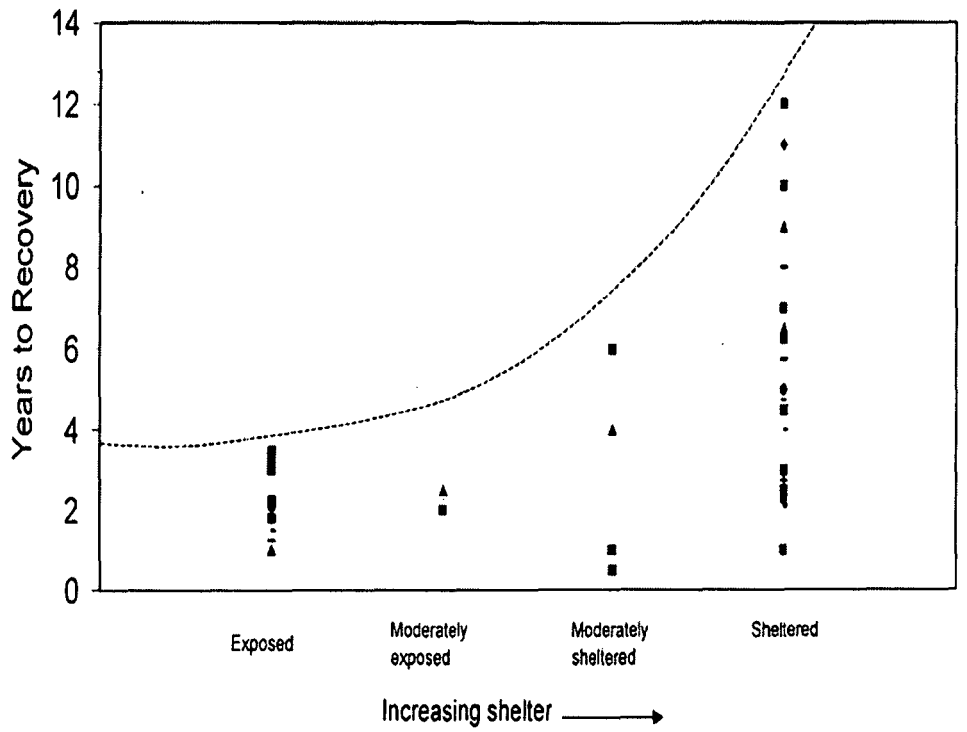

Figure 3.6: relationship between recovery time and coastal morphology.

Climatic or weather condition during or immediately after the oil spill can have dramatic effects on vulnerability of coastal environments to the damage caused by oil spill. Factors affecting the impact are wind directions and speed, temperature, cloud cover etc. These factors decide how much oil readily reaches the coast in order to have

appreciable impact on communities there. Following example is worth mentioning here. Most of the oil spilled by *"Jessica"* near Galapagos islands in 2001 (which was diesel – a light oil) was driven away from the coast as an "oil slick" under the influence of prevailing winds and currents. Moreover, hot tropical sun caused almost the entire diesel to evaporate quickly. Thus, the island escaped a great ecological disaster, this is important because about 40 % of the species found on the Galapagos are unique to the habitat. Lava gull (only 400 breeding pairs known to exist), the Galapagos penguin and marine iguanas can be cited as examples.

Before dealing with specific ecological impacts of oil spill on marine life, it would be useful to elaborate the concepts of **"clean"** and **"recovery"**.

"Clean" in the context of oil spill does not mean the complete absence of hydrocarbons in marine environments, because naturally occurring biogenic (produced by biological processes) and petrogenic (present in rocks, such as shale etc.) hydrocarbons are found ubiquitously. Thus, *"clean"* in relation to an oil spill, may be defined as the return to a level of petroleum hydrocarbons that has no detectable impact on the function of ecosystem (Kingston 2002)[1].

As far as biological recovery of an ecosystem is concerned, it begins as soon as the toxicity of oil declines to the levels which are tolerable to most robust colonizing organisms (Baker *et. al.*, 1990). Thus, possible definitions of *"recovery"* can be established as follows:

> "Recovery of an ecosystem is characterized by the re-establishment of a biological community in which the plants and animals characteristic of that community are present and functioning normally." –Paul F. Kinston (2002)

There are two aspects of recovery in this sense:

(1) Recovery of human resources, such as fisheries and recreational amenities.

(2) Recovery of biological communities.

It has been observed that availability of human services (*e.g.*, amenities beaches) is not closely related to biological recovery and is usually more rapid than

biological recovery, because active human effort is involved in the recovery of amenities and services.

The mention of a classification of coastal environments based on vulnerability to oil spills is relevant here. Gundlach and Hayes (1978)[11] developed a 10-point index based on extensive study of following aspects:

(a) Shoreline interaction with the physical processes controlling oil deposition.

(b) Observed persistence or longevity of the oil in that environment.

(c) Extent of biological damage to life forms and habitats.

Table 3.1: Vulnerability Index of Coastal Environments.

Vulnerability Index	Shoreline Type	Comments
1.	Exposed rocky headlands	Wave reflection keeps most of the oil off-shore. No clean up is within weeks.
2.	Eroding wave-cut platforms	Wave swept. Most oil removed by natural processes within weeks.
3.	Fine-grained sand beaches	Oil doesn't penetrate into the sediment, facilitating mechanical removal if necessary. Otherwise, oil may persist several months.
4.	Coarse-grained sand beaches	Oil may sink and/or be buried rapidly making clean up difficult. Under moderate to high energy conditions, oil will be removed naturally within months from most of the beach face.
5.	Exposed, compacted tidal flats	Most oil will not adhere to, nor penetrate into, the compacted tidal flat. Clean-up is usually unnecessary.

[11] Gundlach, E. R, and Miles O. Hayes (1978), "Vulnerability of Coastal Environments to Oil Spill Impacts", *Marine Technology Society Journal*, 12 (4): 18-27.

6.	Mixed sand and gravel beaches.	Oil may undergo rapid penetration and burial. Under moderate to low energy conditions, oil may persist for years.
7.	Gravel beaches	Same as above. Clean-up should concentrate on the high-tide swash area. A solid asphalt pavement may form under heavy oil accumulations.
8.	Sheltered rocky coasts	Areas of reduced wave action. Oil may persist for many years. Clean-up is not recommended unless oil concentrations are very heavy.
9.	Sheltered tidal flats	Areas of great biological activity and low wave energy. Oil may persist for years. Clean-up is not recommended unless oil accumulations are very heavy. These areas should receive priority protection by using booms or oil sorbent materials.
10.	Salt marshes and mangroves	Most productive of aquatic environments. Oil may persist for years. Cleaning of salt marshes by burning or cutting should be undertaken only if heavily oiled. Mangroves should not be altered. Protection of these environments by booms or absorbent material should receive first priority.

Effects of Oil Spills on Marine Biological Processes: the introduction of oil into the marine ecosystems can have far reaching consequences. It can adversely affect the greenhouse effect of oceans, biochemical cycles, species, communities and overall

trophic structure of marine ecosystem. As Mei Hong (2009)[12] rightly points out, oil film can cover the ocean surface; impede sea-air material exchange, heat exchange, *etc.*, to a great extent. It may also influence the environmental factors such as oxygen content, oxygen demand, density and temperature. Also, oil components are likely to affect the photosynthesis of phytoplankton and their physiological and biochemical functions.

Oil pollution hampers marine carbon dioxide absorption mechanism, decreases the pH value and therefore destructs the balance and cycle of carbon dioxide. This process can even alter the regional climate as well (Mei Hong, 2009).

Nutrient cycling, that is fixation and cycling of nitrogen, phosphorous and other nutrients, is affected by oil spill in many ways. Nutrient cycling is an essential mechanism of a marine ecosystem since it promotes the conversion between nutrients' inorganic form and organic form and is an important link of sea-continent cycling. Microbes and planktons are the main participants of nutrient cycling, which are damaged when a sea area is polluted by oil, thereby rendering marine nutrient recycling ineffective.

Pollution by oil spills can change the trophic structure of marine ecosystem in many ways. Deterioration of biological control functions in the lower levels of marine food chain leads to the corresponding decline in the quality and quantity of the marine lives in the higher ranks of such food chain. Disproportionate growth of some species is another interesting impact of oil pollution in marine environments. For example, after the famous *Torrey Canyon* incident of oil spill, massive amounts of green algae were reported to grow in the affected area. The unexpected growth of the algae was later explained in terms of disturbance in marine food chain. Actually, the oil poisoned snails and other organisms, who were principal grazers of the algae. Thus, the green algae had a period of unimpeded growth because their main "predators" were absent.

Ecological Damage to Mangrove Ecosystems:

[12] Hong, Mei and Yanjie Yin (2009), "Studies on Marine Oil Spills and Their Ecological Damage", *Journal of Oceanic and Coastal Sea Research,* 8(3): 312-316.

Coastal swamps, mangroves and wetlands are not only more sensitive but they are all of high resource value. Therefore, damage caused by oil spill to them is almost inestimable. Since these areas are "sheltered", damage by oil is likely to be greater, because oil is trapped in the marsh vegetation, and owing to spreading of oil films at high tide.

Not only oil and its derived products but dispersants can also cause damage to marsh vegetation. Their use on mud and salt-marsh areas is likely to cause problem because the dispersed oil sinks much more readily into soft sediments and may persist there for long times.

Bruce Barcott (2010)[13] demonstrates the intensity of damage to Gulf of Mexico Marshes by the *Deeparter Horizon* oil spill in 2010-

> "Cleaning oil from marshes is one thing. Cleaning the wild life that lives in the marshes is another thing entirely. Dozens of wildlife professionals hired by BP were often overwhelmed by workload of collecting oiled birds and turtles. That led to frustration and sometimes improvisation."

Consequences to mangrove ecosystems are long term ones. Mangroves often grow in muddy areas in the mouths of rivers, and the mud, rich in organic material, is often anaerobic (deficient in oxygen). For the roots to survive, they often have pneumatophores (a type of tube that grows vertically from the horizontal roots). They look like chimneys, but actually serve to aerate the root system. If they are clogged by oil, mangroves may die. Oil interferes with the oxygen diffusion pathways from the shoots down to the roots in their anaerobic environment.

As the mangrove root system helps stabilize the mud they live in, after their death the mud they held is often flushed out into the sea. This makes recolonization a very slow process.

[13] Barcott, Bruce (2010), "Forlorn in the Bayou", *National Geographic*, 218(4): 62-74.

Figure 3.7: Mangroves entangled with spilled oil.

Paul F. Kingston (2002) observes that subtidal communities (especially mangroves) take little longer to recover from the impact of oil spill since these sublittoral habitats are generally contaminated by sedimentation of oiled particulate material for which there is no practical cleanup.

Mangrove epibiota (communities living on the mangrove vegetation) are also greatly affected by oil spills. Normally, mangroves are overgrown by various algae and invertebrates like oysters, mussels etc. In various habitats, these epibiota is reported to be damaged by oil spills, to a great extent.

Bioremediation :

It is defined as the use of microorganisms, such as bacteria, to remove environmental pollutants from oil. The *Exxon Valdez* spill saw the first large scale application of bioremediation agents. In the context of oil spills, mainly two approaches are practiced. First of these is *biostimulation.* This is done by spraying dispersants to encourage the oil to disperse as tiny droplets in water column, dramatically enhancing the

surface area for microbial colonization. If oil reaches a shoreline, biodegradation can be stimulated by delivering biologically available nitrogen and phosphorous to help microbial growth.

The second approach, *bioaugmentation* aims to add exogenous cultures in the hope that they will "jump-start" biodegradation.

Of these two, biostimulation has had well documented success, but bioaugmentation has not yet received quantitative demonstration, and may be unnecessary because of the ubiquitous distribution of oil-degrading bacteria in the sea.

Research Problems Related To Oil-Spill Impact:

Although oil pollution in the sea has been a major environmental problem for several decades, our knowledge is remarkably limited about the effects of oil on natural population and communities. Uptake of oil by marine organisms and their physiological responses have been studied in controlled situations of laboratory or field. Most of the monitoring of communities or oil amounts is of short-term, if any. Moreover, investigations relating to oil spills generally begin only after some initial damage has occurred. Normal functioning characteristics of the marine habitats are hardly known. In other words, there is a lack of baseline ecological data. Due to this lacuna, little is known about natural ecological variations of particular habitats. Also, knowledge is limited about the chemical reaction within oil components and their interaction with biotic components of marine ecosystems.

In a nutshell, the crude oil, and its various products can be very harmful for the coastal and marine biological processes, depending upon the number of factors. Various studies have been conducted to determine the extent of damage to marine processes, habitats, and organisms; there is still a huge gap in the ecological research in the context of oil spill damage assessment. Not only the spilled oil, but removal operations may also prove detrimental to the marine organisms, especially in the mangrove ecosystems.

Chapter 4

International Regimes Addressing the Liability Fixation for Oil Spill Damage

The need for an international regime for liability and compensation of the damage caused by oil spills was not felt seriously until late 1960s. In fact, until 1969, there was no international convention addressing the liability for ships that caused marine pollution.

Earlier, liability for oil pollution damage was limited to the vessel's liability tonnage in which amounts were limited under the 1957 International Convention relating to the Limitations of Liability of Sea-going Ships (Brussels, 10 October 1957). Liability was limited to the total value of ships and cargo in countries not a party to the convention.

The provisions of UNCLOS:

The current status of international law with regard to responsibility and liability for damage to the marine environment is reflected in Article 235 of the United Nations Convention on the Law of the Sea 1982 (UNCLOS), which reads as follows:

> "Article 235:
> Responsibility and liability:
> 1. States are responsible for the fulfilment of their international obligations concerning the protection and preservation of the marine environment. They shall be liable in accordance with international law.
> 2. States shall ensure that recourse is available in accordance with their legal systems for prompt and adequate compensation or other relief in respect of the damage caused by pollution of the marine environment by natural or juridical persons under their jurisdiction.
> 3. With the objective of assuring prompt and adequate compensation in respect of all damage caused by pollution of the marine environment,

States shall cooperate in the implementation of existing international law and the further development of international law relating to responsibility and liability for the assessment of and compensation for damage and the settlement of related disputes, as well as, where appropriate, development of criteria and procedures for payment of adequate compensation, such as compulsory insurance or compensation funds."

These provisions clearly manifest the scope and limits of the existing international legal framework in this field. The first paragraph of Article 235 acknowledges that States are responsible for compliance with their international obligations concerning the protection and preservation of the marine environment in accordance with international law (Juste-Ruiz, 2007).

Actually, in cases of pollution damages, the increasingly accepted solution is to transfer the question from the field of public international law (State responsibility) to the field of private international law (civil liability of private parties). In doing so, as recalled in Article 235, paragraph 2, States shall ensure that their legal systems would provide resources to enable prompt and adequate compensation or other redress for pollution damage of the marine environment by natural or juridical persons under their jurisdiction. In the event of oil tanker accidents the above mandate does not seem primarily addressed to the coastal States suffering pollution damage but rather to the States whose ships have provoked it. In any case, unless special arrangements are made, the victims of pollution would be prone to seek redress before the courts of the flag State, often a distant and hardly accessible forum.

Besides this, claimants for pollution damage were dependent solely on ordinary civil liability law, which was usually based on the fault of the responsible party. This provision obviously had two problems:

1. It was very difficult for affected persons to prove such fault, including intention.
2. Jurisdictional uncertainty due to global nature of oil transportation.

In 1967, *Torrey Canyon* incident, which spilled 60,000-80,000 tonnes of oil cargo off the English coast proved to be an eye-opener for international community. In the wake of this accident, it became clear that no proper legislation governing liability and compensation for such events existed either nationally or internationally.

This resulted in intense activity at national and international levels. The International Maritime Consulative Organisation (IMCO, now IMO) produced two international conventions: the civil liability convention (the CLC 1969) and the Fund convention, 1971. This step was a milestone in the journey towards creating a compensation regime to ensure that victims would be able to get compensation for those who suffered from such oil spills. The CLC 1969 and the Fund convention of 1971 created the required regimes.

The objectives of CLC 1969 and Fund convention 1971 were mainly to provide quick and sufficient compensation for oil pollution damage to claimants without resorting to the law courts, because it was evident from the *Torrey Canyon* incident in 1967 that existing conventions for the compensation of oil pollution damage could not provide enough, speedy and smooth compensation without going through legal obstacles.

Before coming to the liability regimes *per se*, it is pertinent to throw some light on the concepts of liability, damage and compensation. *Liability*, in the context of oil spills, is an important incentive based instrument for preventing oil spills and providing a sustainable approach for the restoration of resources injured by the spills.

Other approaches have also been adopted to prevent oil spills. For example, double hulled tankers and other safety measures, such as electronic mapping and vessel transit systems. These are collectively called *structural approaches*. Such approaches are not proved to be successful in past few decades, since profit maximization, and not the environmental concerns have been the prime goal of shipping and oil industries.

At this juncture, it is important to know the meaning of liability and civil liability. The inquiry here relates to the civil liability of private actors; the questions of state liability are not to be examined. *'Liability'* thus refers to the conventional regime of civil liability facilitating the compensation of pollution damage victims by private, non-state interests, particularly the shipowner and his insurer. The issue of criminal liability under the national laws of states where pollution is suffered falls outside the present inquiry.

Liability, i.e., the responsibility to compensate pollution victims, is an agreement based policy option to prevent and manage oil spills. The principle of "polluter pays" is in the origin of articulation of civil liability regimes.

Two main objectives of the regimes emerge after an analysis of the liability regimes related to oil pollution damage:

1. To compensate the victims of oil pollution damage.
2. To deter involved parties from polluting.

Pointing out the importance of the incentive based liability approach, Grigalunas, et.al. (1998)[14] opine that liability is not only a deterrent to pollution, but it can also serve as a "market" based policy instrument for protecting marine environment. In fact, Agenda 21 of the United Nations Conference on the Environment and Development recognizes this aspect when it calls for the use of market based principles in the framing of economic instruments whenever appropriate.

Many challenges and problems have been faced while fixing liability, such as assessment of costs of damage, legal complexities, determination of indirect losses and environmental degradation etc. However, the concept of liability is significant in relation to oil spills-at least in three ways already mentioned:

1. Liability compensates injured parties.
2. Financial liability is an incentive for oil-ship-companies to handle the oil carefully.
3. It helps in the restoration of damaged environments, especially the coastal ones.

Damages, in principle, can be defined as the amount of money that, when paid to the parties suffering losses due to an oil spill, would make them "whole" (i.e., no worse off than they would be without the spill). However, the word "pollution damage" has specific connotations when it comes to the liability regimes. The original CLC, 1969 and Fund Convention (1971) define pollution damage in the following manner:

> "Pollution damage means loss or damage caused outside the ship carrying oil by contamination resulting from the escape or discharge of oil

[14] Grigalunas, T.A. et al. (1998), "Liability for Oil Spill Damages: Issues, Methods, and Examples", *Coastal Management*, 26 (2): 61-77.

from the ship, wherever such escape or discharge may occur and includes the costs of preventive measures, and further loss or damage caused by preventive measures."[15]

However, this definition of pollution damage was amended under the 1992 protocol to the 1969 convention and 1971 Fund. The 1992 protocol now defines the pollution damage as,

(a) Loss or damage caused outside the ship by contamination resulting from the escape or discharge of oil from the ship, wherever such escape or discharge may occur, *provided that the compensation for impairment of the environment other than loss of profit from such impairment shall be limited to costs of reasonable measures of reinstatement actually undertaken or to be undertaken;*

(b) The cost of preventive measures and further loss or damage caused by preventive measures[16]

Thus, it is clear from the above discussion that the convention recognizes following types of damage:

1. Property damage.
2. Costs of clean up.
3. Economic losses for fisheries, mariculture and tourism sectors.
4. Environmental damage.

Compensation, Injury and Penalty: In terms of jurisprudence, *compensation* is the cost of restoration and "making whole" the parties suffering losses. *Injury*, on the other hand, is an impairment of a resource due to exposure to an oil spill. The scope of compensable injuries varies from regime to regime. For example, it is very broad under Oil Pollution Act 1990, as compared to CLC 1992 and subsequent amendments.

Penalties are deterrent and punitive amounts and therefore, are not necessarily related to actual losses.

[15] CLC Art 1 (6), Fund Convention, Art 1 (23).
[16] 1992 Liability Protocol, Art 2 (3).

Key Actors in the Framework of Liability Fixation:

This section intends to describe major parties and actors involved in the dynamics of liability fixation. Primarily, these are the shipowner and operators, the cargo owners and charterers, P and I Clubs and marine insurers. A brief discussion of these is as follows:

The Shipowners and Operators: This first group of relevant actors comprises the individuals, companies and state-owned enterprises which own, manage and operate the commercial shipping fleets of the world. In maritime parlance, they are collectively referred to as *'shipowners'*, even though professional ship operators and managers are often distinct from their owner-clients. In order to operate, all ships are customarily registered with a state registry (the *flag state*), thereby assuming that state's nationality and enjoying its protection. The flag state's laws thus apply to the concerned ship with regard to all operational aspects such as taxation, the registration of mortgages and the hiring of crew. The entity that appears in the registry as the 'owner' is taken to be the ship's registered legal owner.

The Cargo Owners and Charterers: The next major group of maritime actors consists of the owners or shippers of goods carried on board ships. In relation to vessel-source pollution control, the shipowner has traditionally been the primary target of regulation by virtue of his direct operational role in transporting cargoes that are potential pollutants. At the same time, regulators have tried to impose responsibility on cargo owners based on the argument that the owners of polluting cargoes must share in the costs of preventive and remedial action as well as of compensation to pollution victims.

By their nature, cargo owners are extremely diffused in number and locality, given the huge variety and amounts of cargoes shipped throughout the world. Imposing responsibility on the cargo owners would thus present an administrative problem, except perhaps for bulk cargoes like oil for which the owners, shippers or receivers are relatively easy to identify. In contrast, shipowners are a discrete, identifiable group that can be subjected to regulation more easily.

At first glance, the interests of shipowners and cargo owners coincide substantially. Both industries typically resist expensive pollution control measures since

these tend to result in higher transportation costs reflected in higher freight and consumer prices. While the bulk of world oil tanker tonnage is owned by the so-called 'independent' owners, the rest are owned by states, state-linked entities and private oil companies. Thus, the oil companies (both state owned and private) are concurrently shipowners as well, using their own tankers and those chartered from the independents.

The Protection and Indemnity (P&I) Clubs and the Marine Insurers: Shipowners customarily insure their operations against two types of risks – hull and machinery (H&M) and third party liability risks. H&M coverage protects a shipowner against losses to his own ship and its equipment resulting from collisions, groundings and other accidents. In contrast, third party liability coverage indemnifies an owner against claims by third parties for damage incurred to their interests arising from the operation of the ship. Such parties include other owners whose ships may have been damaged by the insured ship during a collision, port authorities whose installations suffer damage or victims of pollution caused by the insured ship.

The Military Interests: The departments or ministries of defence in states with significant naval capabilities have traditionally been staunch supporters of the right to free navigation. From their perspective, this right affords military vessels exemption or immunity from the jurisdiction of any state apart from the flag state. This position has existed for centuries, and is often justified on security grounds. The military interests were extremely active at the negotiation of the LOSC (Law Of the Sea Convention) in the 1970s, with many delegations having strong participation by their defence ministries.

With regard to vessel-source pollution, the military interests succeeded in exempting their vessels from any pollution control rules enacted by coastal states even if these rules are consistent with the international conventions to which the vessel's flag state is party. Thus, the LOSC, together with the relevant IMO conventions, explicitly gives sovereign immunity to all military vessels in relation to pollution control. In this regard, the only obligation on flag states is to ensure that their military vessels act in a manner consistent, so far as is reasonable and practicable, with the LOSC. Hence, the flag state's application of pollution control rules to their military vessels is a matter of voluntary compliance and good faith. Consequently, such vessels have an effective licence to pollute, and many in fact do engage in intentional marine pollution.

Evolution of Liability Regimes for Oil Pollution Damage: Following the serious oil spill incidents from tankers such as *Torrey Canyon*, various international conventions came into existence. On the basis of their purpose and function, they can be categorized as:

1. Safety regulations designed to prevent oil spills.
2. Contingency plans
3. Compensation schemes for the victims of marine oil pollution.

The last type of conventions is mainly dealt with in this chapter.

Civil Liability Convention, 1969 and the Fund Convention of 1971: Its formal name is International Convention on Civil Liability for Oil Pollution Damage, 1969. Although it was later superseded by the CLC protocol 1992, the CLC 1969 remains the core of oil pollution liability laws in many parts of the world. Some primary details about the conventions can be obtained from table 4.1.

Table 4.1:

Acronym	Formal name	IMO/official citation
Civil liability Convention (CLC) (1969),EIF, 1975	International Convention on Civil Liability for Oil Pollution Damage, 1969	IMO (1969)
Fund Convention (FC) (1971),EIF, 1978	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971	IMO (1972)
Civil Liability Convention (CLC) (1993),EIF, 1996	International Convention on Civil Liability for Oil Pollution Damage, 1992	IMO (1993)

Fund Convention (FC) (1992),EIF, 1996	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971	IMO(1993)

EIF: Entry into force.

Source: Chao Wu (2002).

After the *Torrey canyon* disaster, the International Maritime Organization convened a Diplomatic conference in Brussels in 1969, which adopted the Civil Liability Convention. The CLC 1969 was a revolutionary convention in maritime law because of the nature of liability it created and the compulsory insurance it established. The CLC placed the liability of oil pollution damage on the owner of the ship from which the polluting oil escaped or was discharged. It is worth mentioning that CLC 1969 entered into force in 1975 whereas Fund Convention of 1971 entered into force in 1978.

The CLC 1969 deals with the issue of which party is liable and how to compensate for pollution damage caused by persistent oil carried on board a laden tanker. The convention has set up strict liability for the owner of a tanker that causes the pollution. However, under certain circumstances, the owner enjoys limitation of liability. Requirement of a compulsory insurance is a basic principle of the convention. As a corollary to this, claims for pollution damage under the convention, may be brought directly against the insurers.

Although CLC 1969 chooses the shipowner as the party liable for oil pollution damage resulting from oil spills from ships, it was considered necessary to share some of the burden of compensation with the oil industry, which is the other main party involved in the transportation of oil by sea. This was done through the 1971 international convention on the establishment of an International Fund for compensation for Oil Pollution Damage (IOPC Fund). The IOPC Fund provided supplementary compensation to be paid in cases where the total claims exceed the shipowner's liability limit or where shipowner is exempted from liability, or is financially incapable of meeting his or her CLC obligations.

Following are the main features of the regime created by the 1969 CLC and the 1971 Fund Conventions.

1. **Membership:** It must be noted that only countries which were parties to the CLC could join Fund Convention of 1971. Membership details of these conventions can be obtained from table 4.2 and table 4.3[17].
2. **Source of Finance for CLC and FC:**

While the finance source for CLC is the insurance cover of the shipowner, that for the Fund is the contribution from *"contributing oil member states"*. The meaning of the term "contributing oil" is that the Funds are financed by contributions levied on all entities in member states that receive more than 150,000 tonnes of crude or heavy fuel oil per year through sea transport. The Fund Convention refers to such oil as "contributing oil". Member states are required to submit annual reports to the Funds on the quantities of contributing oil received. [18]

[17] Source: ITOPF website.
[18] 1992 Fund Convention, Art 15 (2).

Table 4.2:

States Parties to the 1969 Civil Liability Convention As at 31 March 2011 States Parties 37 States	1992 Fund Member States which are Party to the Supplementary Fund Protocol As at 31 March 2011 Supplementary Fund Member States 27 States	States Parties to the 1992 Civil Liability Convention but not the 1992 Fund Convention As at 31 March 2011 States Parties 18 States
Azerbaijan	Australia	Azerbaijan
Benin	Barbados	Chile
Brazil	Belgium	China
Cambodia	Canada	Egypt
Chile	Croatia	El Salvador
Costa Rica	Denmark	Indonesia
Côte d'Ivoire	Estonia	Kuwait
Dominican Republic	Finland	Lebanon
Ecuador	France	Mongolia
Egypt	Germany	Pakistan
El Salvador	Greece	Peru
Equatorial Guinea	Hungary	Republic of Moldova
Gambia	Ireland	Romania
Georgia	Italy	Saudi Arabia
Ghana	Japan	Solomon Islands
Guatemala	Latvia	Ukraine
Guyana	Lithuania	Vietnam
Honduras	Morocco	Yemen
Indonesia	Netherlands	
Jordan	Norway	
Kazakhstan	Poland	
Kuwait	Portugal	
Lebanon	Republic of Korea	
Libyan Arab	Slovenia	
Jamahiriya	Spain	
Maldives	Sweden .	
Mauritania	United Kingdom	
Mongolia		
Nicaragua		
Peru		
Saint Kitts and Nevis		
Sao Tome and Principe		
Saudi Arabia		
Senegal		
Serbia		
Syrian Arab Republic		
Turkmenistan		
United Arab Emirates		

Table 4.3[19]:

States Parties to both the 1992 Civil Liability Convention and the 1992 Fund Convention As at 31 March 2011 Total 105 States				
Albania	Cook Islands	Ireland	Namibia	South Africa
Algeria	Croatia	Islamic Republic of Iran	Netherlands	Spain
Angola	Cyprus	Israel	New Zealand	Sri Lanka
Antigua and Barbuda	Denmark	Italy	Nigeria	Sweden
Argentina	Djibouti	Jamaica	Norway	Switzerland
Australia	Dominica	Japan	Oman	Syrian Arab Republic
Bahamas	Dominican Republic	Kenya	Panama	Tonga
Bahrain	Ecuador	Kiribati	Papua New Guinea	Trinidad and Tobago
Barbados	Estonia	Latvia	Philippines	Tunisia
Belgium	Fiji	Liberia	Poland	Turkey
Belize	Finland	Lithuania	Portugal	Tuvalu
Benin	France	Luxembourg	Qatar	United Arab Emirates
Brunei Darussalam	Gabon	Madagascar	Republic of Korea	United Kingdom
Bulgaria	Georgia	Malaysia	Russian Federation	United Republic of Tanzania
Cambodia	Germany	Maldives	Saint Kitts and Nevis	Uruguay
Cameroon	Ghana	Malta	Saint Lucia	Vanuatu
Canada	Greece	Marshall Islands	Saint Vincent and the Grenadines	Venezuela
Cape Verde	Grenada	Mauritius	Samoa	
China (HKSAR)	Guinea	Mexico	Seychelles	
Colombia	Hungary	Monaco	Sierra Leone	
Comoros	Iceland	Morocco	Singapore	
Congo	India	Mozambique	Slovenia	

[19] Source: ITOPF website.

Here, the term *"received"* means the receipt into tankage or storage immediately after carriage by sea. The place of loading is immaterial in this context. Secondly, oil received for transshipment for another part or received for further transport by pipeline is also considered as "Received" for contribution purposes.

There are two types of contributions to the IOPC Fund: *Initial* contributions and *Annual* Contributions. The former is payable when a state becomes a members of the IOPC Fund. Annual contributions are levied to meet the anticipated payments of compensation by the IOPC Fund and of the administrative expenses for that year. Each year, the amount of annual contributions is decided by the IOPC Fund Assembly. Each contributer, thus, pays a specific amount per tone of contributing oil received. Following are the shares of contribution of the leading contributors to the Fund[20]:

Table 4.4:

Member State (Oil Industries)	**Share of Contribution**
Japan	18%
Italy	10%
India	8%
The Republic of Korea	8%
The Netherlands	7%
France	7%
Canada	6%
Singapore	5%
Spain	5%
United Kingdom	4%

It must be noted that 90.5% of the total contribution in 1992 were payable by the contributors in only 10 of the Fund's 56 member states.

The fund calculates annual contribution for oil companies by dividing the total amount of contributions required by the total amount of contributing oil (including

[20] Source : International Oil Pollution Compensation Fund, Annual Report, 2006 (p. 72)

crude oil and fuel oil) received by oil companies.[21] Thus, it is a kind of mutual insurance company for oil pollution compensation set up by governments but financed by the oil company.

It is clear from the table that Japan has been the greatest contributor to the Fund. At the time of introduction to the 1992 Protocol to the Fund, while establishing a new 1992 Fund, it was necessary to have contribution from Japan in the new Fund. However, as a member of 1971 Fund, it was having a huge economic burden in terms of contribution to the Fund. So, in order to facilitate early ratification of the 1992 protocols by Japan, the 1992 protocol to the 1971 Fund convention introduced a system of "capping" contributions, such that the aggregate amount of contributions payable in respect of a given calendar year by oil receivers in a particular state would not, during a transitional period, exceed 27.5% of the total amount of contributions levied.[22]

Apart from the skewed distribution of contribution to the Fund, the contribution system of the Fund has been facing several other problems. Firstly, a number of member states do not fulfill their treaty obligation to present to the Fund Secretariat the annual reports which are required to be submitted by the governments of member states providing information on various entities (public or private) which receive oil after sea transport, making it impossible to levy contributions with respect to these states.

Secondly, the Fund conventions do not contain any provision of imposing sanction on such (those failing to submit reports) states, such as withholding compensation for pollution damage in the defaulting states.

In spite of all these minor problems related to the Fund, It has been observed that the payment rate has been around 99.8% despite the doubts regarding the workability of the Fund.[23]

3. Organization of the IOPC Fund: The IOPC Funds is made up of an Assembly, an Executive Committee and a Secretariat. The Assembly is supreme organ governing

[21] Art XII 1,2,3 1992 Fund Convention.

[22] Art. 36, note 3, 1992 Fund Convention

[23] Note 20, IOPC Funds, Report on the Activities of the IOPC Funds in 2006.

the 1992 Fund and it holds regular sessions once a year. The Assembly is composed of the representatives of the governments of all member states.

The Executive Committee is elected by the Assembly. This is compsed of 15 member states. The main function of the Executive Committee is to approve settlements of claims against the IOPC Fund.

The Secretariat is situated in London and is headed by a Director, assisted by a staff of 27 members.[24]

Amendments to the Conventions through the Protocols:

No regime can be and should be static in this changing world. Various protocols have been arranged to meet the requirements and the threats posed by new incidents of oil spills.

Besides the continuous inflation, which caused a substantial erosion of the liability limits, two important oil spill incidents in France, the *Amoco Cadiz* in 197 and the *Tanio* in 1980 revealed the shortcomings of the international regime based on the 1969 Civil Liability and 1971 Fund convention. These incidents, in fact, demonstrated the insufficiency of compensation amounts under existing regimes. In the wake of these events, An International Conference was held in London in 1984 and two protocols to amend the then Civil Liability Convention and Fund Convention were adopted with the following objectives in view:

(a) To broaden the scope of both geograpichal applicability and recoverable damages.

(b) To raise the limits of liability substantially.

The protocols indeed increased the financial limits of the liability.

These protocols of 1984 had a good intent, but failed to enter into force due to lack of American participation, since the conditions for their entry into force could not be meet. The main objection from the US was the idea of limited liability, however

[24] Refer to the Fund's website: http://www.iopcfund.org .

increased. It believed that the polluter should be subject to absolute liability for the pollution damage, without any limit (i. e. cap) on liability.

Japan, the largest contributor to the Fund at that time was also not willing to ratify these 1984 Protocols to the two conventions in the absence of an offer by the US to share the heavy financial burden. Consequently, these two protocols failed because of insufficient support from the two largest economies in the world-US & Japan.

In spite of the rejection from the US and Japan, a number of countries considered it very important that the substantive content of the 1984 Protocols be brought into force as a matter of urgency.

Following Problems in the existing 1969 CLC regimes were also a factor behind the need of a new protocol to the regimes.

a. Problem of insufficient compensation.

b. Refusal by the IOPC Fund to cover environmental damages, and

c. Lack of effective sanctions to the pollution prevention system.

In fact, several significant oil spills during short time period (The *Haven* in Italy in 1991, the *Aegean Sea* in Spain in 1992 and the *Braer* in the United Kingdom in 193) demonstrated the political and economic urgency of a new working protocol to the conventions.

The 1992 Protocols to the 1969 CLC and 1971 Fund Conventions:

In 1992, the IMO created new protocols to the two conventions (CLC 1969 and FC 1971) which were identical to the 1984 Protocols except for the requirements for the entry into force. In fact, the main purpose of the new protocols was to facilitate the fulfilment of the requirements for the entry into force of 1984 protocols. This change was necessary to make the conventions effective without the US participation. The new Protocols (of 1992) eventually entered into force on 30 May 1996.[25]

[25] Brans, E.H.P. (1994), "Liability for Ecological Damage under the 1992 Protocols to the Civil Liability Conventions and the Fund convention, and the Oil Pollution Act of 1990," *Environmental Liability Law Review*, 1 (3): 61-67.

In the 1992 convention, Japan's demand of "cap on contribution" was acceded because Japan had been the largest contributing state to the Fund. This cap was fixed by the conference at 27.5% of the total annual contributions to the IOPC Fund. This capping system was to cease to apply when the total quantity of contributing oil received during a year in all member states of the new fund (1992 protocols) exceeds 750 million tonnes, or at the expiry of a period of 5 years from the entry into force of the 1992 Protocol to the Fund convention, whichever is earlier.

Ratification Requirements of the 1992 Protocols:

The 1992 Protocol to CLC required for its entry into force that it be ratified by 10 states, including 4 states each with not less than one million units of gross tanker tonnage, contrary to the requirement of 1984 Protocol to that convention which was 6 such states. On the other hand, the 1992 Protocol to the Fund convention required ratification by at least 8 states for coming into force, provided that the total quantity of the contributing oil received during a given calendar year in all the ratifying states is not less than 450 million tonnes (this figure was 600 million tonnes, as laid down by the 1984 protocol).

The main amendments which were adopted by the 1992 Protocols were as follows:

a. Liability limits under CLC were substantially increased.

b. There was an increase in the limit of compensation payable by the IOPC Fund.

c. Gegoraphical scope of application of the conventions was extended so as to include EEZ (Exclusive Economic Zone) established under the UNCLOS (United Nations Convention on the Law Of the Sea).

d. Pollution damage caused by persistent oil spills from unladen tankers was also to be covered by the 1992 Protocol.

e. Expenditure made for preventive measures were to be recoverable even in the absence of oil spill, in case of a grave and imminent danger of pollution damage.

f. A modified definition of pollution damage was adopted with regard to the environmental damage, including only the cost incurred for reasonable measures to restore the affected environment.

g. More protection was given to persons other than the shipowner. The CLC 1992 broadened the category of people who are exempted from the liability, including now the crew and pilots, charteres, operators, salvors, except when the damage is caused by them deliberately or with the knowledge that such damage will probably result.

End of 1969/1971 Regime: In 1998, parties to the 1992 Protocols ceased to be parties to the CLC 1969 and the Fund convention due to a mechanism of compulsory denunciation of the old regime. However, the two regimes continued to co-exist, because many states party to the 1969 and 1971 conventions had not yet ratified the 1992 protocols. In 2002, the Fund convention of 1971 ceased to be in force.

Amendments made in 2000: Two major incidents of oil spills expedited the discussions over the need to increase the liability limits under the existing regimes. The wreck of the *Nakhodka* in 1997 off Japan and the *Erika* disaster off the coast of France were a prelude to the IMO Legal Committee meeting which was convened in October 2000.

Two main proposals were adopted in the committee meeting of 2000.

a. Phasing out of single hull tankers (this was a structural measure).

b. Increase in the liability limits (up to 50%) of the 1992 Protocols. The compensation limits set by the 2000 amendments are as follows:

(i) For a ship less than 5000 gross tonnage, liability is limited to 4.51 million SDR (about US Dollars 5.78 million). Under the CLC Protocol 1992, this limit was 3 million SDR (an increase of 50%).

(ii) For a ship of 5000-1,40,000 gross tonnage, liability is limited to 4.51 million SDR (about US Dollars 5.78 Million) plus 631 SDR (about US $807) for each additional gross tone over 5000 tonnes. Under the CLC Protocol 1992, this limit was 3 million SDR plus 420 SDR for each additional gross tone.

(iii) For a ship over 140,000 gross tonnage, liability is limited to 89.77 million SDR (about US $ 115 million). Under the CLC protocol 1992, this limit was 59.7 SDR.

Scope of Civil Liability Convention and Fund Convention:

It is necessary to enumerate fundamental elements and types of cases covered by these conventions. The civil liability convention is applicable to the damage caused by oil spills from laden tankers which are suffered in the territory and territorial sea (later extended upto the EEZ by 1992 protocol) of a contracting state. Following points would help clarify the scope of the convention:

(1) Convention covers only *laden* ships; oil rigs, pipeline spills, marine blowout oil spills and other offsnore operations are not included in the convention.

(2) Only registered ships are included in the definition of ship under the convention.

(3) Civil liability convention does not cover non-persistent oil. Thus, spills of gasoline (petrol), light diesel oil and kerosene do not fall within the scope of the convention.

(4) Only spills from tankers carrying persistent oil *as cargo* are covered in the convention. Thus, the spills from the *ballast water*[26] and *bunker oil*[27] of ships are outside the purview of the Convention.

(5) Measures taken for damage caused only after an incident (of oil spill) are taken into consideration. Just 'pure threat removal' measures in absence of an actual oil spill are not payable under the convention.

(6) Compulsory insurance is an essential feature of the civil liability convention. The tanker owner, who carries more than 2000 tonnes of persistent oil cargo, is obliged to maintain insurance to cover his or her liability under the convention. In fact, during the

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[26]. After unloading of the cargo oil, some water is filled in the chambers of the tanker, in order to maintain the mass balance of the vessel. This is called the ballast water.

[27]. Fuel oil of the ships is called bunker oil. This oil has different physical and chemical properties than crude oil.

journey, the tankers must carry a certificate which attests the insurance cover of the ships. This provision is made to facilitate the victims to make legal action directly against the insurer. P and I clubs are the traditional insurers to cover the ship owners' CLC liability. Thus, claimants can bring a direct action against the P and I Club insuring the responsible ship owner.

(7) It must be noted that all claims to the convention and the fund are subject to time –bar. Claimants are denied their right of compensation if they fail to lodge their claims before the third anniversary of the date on which the damage occurred.

(8) **Claims Covered:** The following points cover the criteria of admitting the claims by the Fund:

(a) Claimant has to prove that a real expenditure is made and there was a causal linkage between the damage and the incident of oil spill.

(b) The IOPC Fund admits claims related to expenses for clean-up operations at sea or on the beach. There may include deployment of vessels, the salary of the crew, the use of booms and the spraying of disperants.

(c) The cost of preventive measures is also accepted as a valid claim provided that the cost must come under the definition of "reasonable" cost, as codified by the convention.

(d) Damage to property owned by the claimant is also compensable in two form: cost of cleaning polluted property; and cost of replacement of such property, if it is not possible to clean the polluted property.

(e) Economic loss suffered by those dependent directly upon the earnings by sea-related activities is also compensable. For example, unemployment related to fisheries and hotel industries.

(f) Only quantifiable damage claims are accepted by the fund. Thus, abstract quantification based on theoretical models and assumptions are to be rejected.

(9) A shipowner is exempt from liability only if he proves that the damage

(a) resulted from an act of war, hostilities, civil war, insurrection or a natural phenomenon of an exceptional, inevitable and irresistible character, or

(b) was wholly caused by an act or omission done with intent to cause damage by a third party, or

(c) was wholly caused by the negligence or other wrongful act (by public authorities) for the maintenance of lights or other navigational aids.

Nature of liability under the convention and the Fund:

As the objectives of the provision of liability already have been pointed out in a previous section, compensation for sufferers and deterrence from pollution are two prime goals.

In the context of the convention and the Fund, the shipowner's liability is *strict* in the sense that the claimant only has to demonstrate that he or she suffered damage as a result of the spill, without the need of proving fault or negligence on the part of shipowner, a condition in the earlier conventions. This is why the convention's liability is also called "*no-fault liability.*" To make it more clear, the shipowner is liable on a strict basis, irrespective of the existence of any fault. He or she is liable simply because of the fact that his or her ship has spilled persistent oil, carried as cargo. (Chou Wu, 2002).

The concept of strict liability (i.e., the liability even in the absence of fault or negligence) was extraordinary and innovative introduction by the CLC 1969. The intention behind this concept was to provide quick and equitable compensation payments to the sufferers of oil pollution damage.

Limitation of Liability: The CLC does not make it obligatory for shipowner to be insured for an unlimited amount.[28]

The shipowner, under certain conditions, is entitled to limit his or her liability, subject to certain exception. It must be mentioned in this context that the doctrine of limitation of liability was conceived by Grotius as early as 1625 AD.[29]

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[28] Article V (1), CLC 1969.

The basic objective behind the concept of limitation of liability is to make the insurance coverage (for pollution damage) possible. The limits on liability under the convention are as follows:

Table 4.5: Limitations on Liability in the Conventions

Maximum Amounts of Compensation Available under the Conventions
(Expressed in US$ Millions - rates as at July 2010)

TANKER'S GROSS TONNAGE	1969 CLC	1992 CLC (post-Nov 2003)	1992 FUND (post-Nov 2003)	Supplementary FUND
5,000	1	6.7	302.9	1119
25,000	5	25.5	302.9	1119
50,000	10	49.1	302.9	1119
100,000	19.8	96.2	302.9	1119
140,000	20.9	134	302.9	1119

Note: The limits of liability under the various regimes are based on specified units of account (Special Drawing Right - SDR). The value of an SDR in terms of a national currency varies. For the purpose of this composition all the limits are expressed in US dollars, based on a rate of exchange of 1 SDR=US $ 1.49 (July 2010, International Monetary Fund). The maximum amount of compensation potentially available under each of the various regimes is, in many cases, inclusive of amounts that would be payable under another regime. For example, the maximum amount of compensation available under the 1992 Fund Convention is inclusive of compensation payable by the tanker owner under the 1992 CLC. The maximum amounts listed above should therefore not be aggregated when determining the total amount of compensation which may be available in a specific incident.

Arguments for and against the limitation on liability:

[29] Gissberg, J.G.(1971), "Civil liability for Oil Pollution Damage from Tankers and Other Ocean-Going Vessels, Ph D dissertation, University of Michigan, p93.

The limitation on liability has been subject to many debates and discussions especially after the 1969 convention. Following justifications and criticism are made in the context of limitations:

(a) Since shipping is a risky business, provisions of limitations on liability of shipowners of limitations on liability of shipowner can be necessary incentive for keeping the potential entrepreneurs in the shipping industry. Thus, the objective of the limitation of liability is to attract people to invest in the industry, to make it competitive.

On the contrary, it can also be argued against the above mentioned justification, that such incentives may have been necessary in the early days of the industry, but nowadays, widespread insurance provisions have lowered the risk factor to a great extent.

(b) Another justification in the favour of the limitations is that the very provision of limitation of liability makes it possible to make the claim protected under insurance coverage. In fact, the insurance industry is supposed to rely on the principle of limitation of liability by its proponents. This argument can also be refuted on the basis of the fact that the introduction of unlimited liability would cause only a little increase in the costs, if any.[30]

(c) It is argued that the concept of limitation of liability exists in the context other than shipping also. But at the same time, it can not deny the fact that it is an institution which is legally unjustifiable and discriminatory. In fact a number of US States such as California impose unlimited liability on tanker owners covering clean-up costs and costs for natural resource damages.[31]

(d) Proneness of shipping to dangers of accidents is often presented as a justification for limitation. But by thinking in another way, it can also be argued that this danger indicates the insufficiency of safety standards followed in marine shipping. In fact,

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[30] Gauci, Gotthard (1995), "Limitation of Liability in Maritime Law: an Anachronism?", *Marine Policy*, 19 (1): 65-74.

[31] *Ibid.*

unlimited liability for shipowners can be an effective incentive to ensure safety in the sea transport.[32]

(e) The argument that limitation of liability is conducive to the uniformity of maritime law worldwide[33] seems to be valid but ubiquity of application of an anachronistic law can hardly justify such a law (Gauci 1995). Limited liability conflicts with the principle of "Polluter Pays".[34]

It must be mentioned in this context that oil pollution Act, 1990 of the US provides for unlimited liability in relevant cases, whereas the 1992 protocol to the CLC strengthens the position of the shipowner who is trying not to lose the privilege of right to limit liability.

Channelling of Liability:

This means *only the ship owner* is liable for the damage. In other words, channeling entails the exclusivity of liability. Its advantage is that it avoids an economically wasteful duplication of exposure to claims and thus saves the claimants from the lengthy procedure of multiplicity of claims and facilitates quick settlement of claims.

However, the provision of channeling of liability in the convention of 1992 excludes from liability persons other than the ship owner, e.g., employees, the charterer or other third parties who may be involved in the incident of oil spills. This *"de-responsibilization"* feature dilutes their (parties other than the ship owner) incentives for prevention of oil spills.

Cost of Damage and their estimation:

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[32] *Ibid.*

[33] Roberts, K.E., "For Retention of Limitation of Liability for shipowners", *American Bar Association Section of Insurance, Negligence and compensation Law*, 1967 proceedings 1968, p. 421.

[34] Wilkinson, David (1993), "Moving the Boundaries of Compensable Environmental Damage Caused by Marine Oil Spills: the Effect of Two New International Protocols", *Journal of Environmental Law*, 5 (1): 71-90.

From the analysis of the conventions, various protocols to these conventions and numerous claims related to oil spill damage, two types of economic losses are brought into light: consequential economic loss, and pure economic loss.

Consequential economic loss claims are made by persons whose property has been contaminated by the oil and who, as a result, have suffered loss of earning. For example, contamination of the gear of a fisherman who suffers loss of income for the period during which they are jobless while their fishing gear is being cleaned or replaced. The funds' authorities have always accepted such claims, in principle.

Second type of economic loss can be explained with the help of the continuation of preceding example. Fishermen, whose gear did not become polluted, may have to abstain from fishing for a time period to avoid the contamination of their nets. Likewise, a hotel's income may be affected badly due to a decrease in the number of visitors to the polluted beach. This latter type of economic loss is called *pure economic loss*. The mention of ***"bright line" test*** is pertinent here. It is the principle that *pure economic loss is recoverable only if it is a result of physical damage*. Under the 1992 conventions, claims for pure economic loss are acceptable only if they are for loss or damage caused by contamination.[35] The fund adopts the basic criterion of sufficiently close link of causation (between contamination and damage) for the admissibility of claims made by injured parties.

Approaches to the estimation of damage caused by oil spills:

A number of economic models have been proposed to analyse and determine the cost of the damages caused by oil spills. In this context, following three approaches have been used for estimation of costs of the damage: contingent valuation method, restoration method and compensation formulas.

(1) Contingent Valuation Method (CVM):

This approach is based on surveys and is mainly used for "non use" expenses (expenses for which data related to market transaction are not available). The survey

[35] Funds' Claim Manual, note 31, pp 25-26.

adopts a carefully structured random sample to obtain responses regarding the individual's willingness to pay for the concerned environmental commodity. Thus, it creates a *"constructed market"* for environmental and natural resources, for which there is no market in the real sense of the term. The CVM was used in the estimation of "non use" value losses in the *Exxon Valdez* case.

(2) Restoration:

This approach focuses upon the "making whole" affected parties. Two elements of restoration are included in OPA 1990. The first is called *primary restoration*, which aims at restoration of environment to the baseline. The other one, called *compensatory restoration* relates to the interim loss incurred before the environment is restored to baseline. For example, the cost of replacement of contaminated sand with clean sand on the beach relates to primary restoration, but if the beach has been unusuable for one month before the restoration (to the baseline) could be done, the loss relating to such unusability refers to compensatory restoration.

In dealing with the restoration approach, several problems have been faced:

(a) It is difficult to determine the precise nature of baseline, i.e., what would have existed if the spill had not occurred.
(b) Restoration itself may not be feasible or may be excessively costly.
(c) The nature and extent of injury and restoration may be very difficult or impossible to define.

Restoration costs are covered under the Civil Liability Convention and the Fund convention only if they have actually occurred and such costs must be reasonable (although definition of *reasonableness* is not clearly enunciated under the convention).

(3) Compensation Formula:

Most formulas use a base monetary amount per unit of oil spilled. Various factors may be considered while using a formula for estimation of oil pollution damage for example:

(a) Whether the affected area is off shore or near shore or inshore;

(b) Number of affected habitats;

(c) Characteristics of pollutants (e.g., toxicity, solubility, persistence, and dispensability).

(d) Administrative costs.

The reasonableness, validity and reliability of the formula used are the major problems of this approach. Further, this approach fails to provide incentives (for spill response actions) to liable parties if they know that costly actions reducing impact of spill will not lower the liability.

In general, irrespective of the approach used for the assessment of the damage costs, three challenges still persist.

(a) Quantification of damage in monetary terms.

(b) Difficulty in separating out the genuine claims from unnecessary claims.

(c) Valuation of the services which have no commercial value in the market.

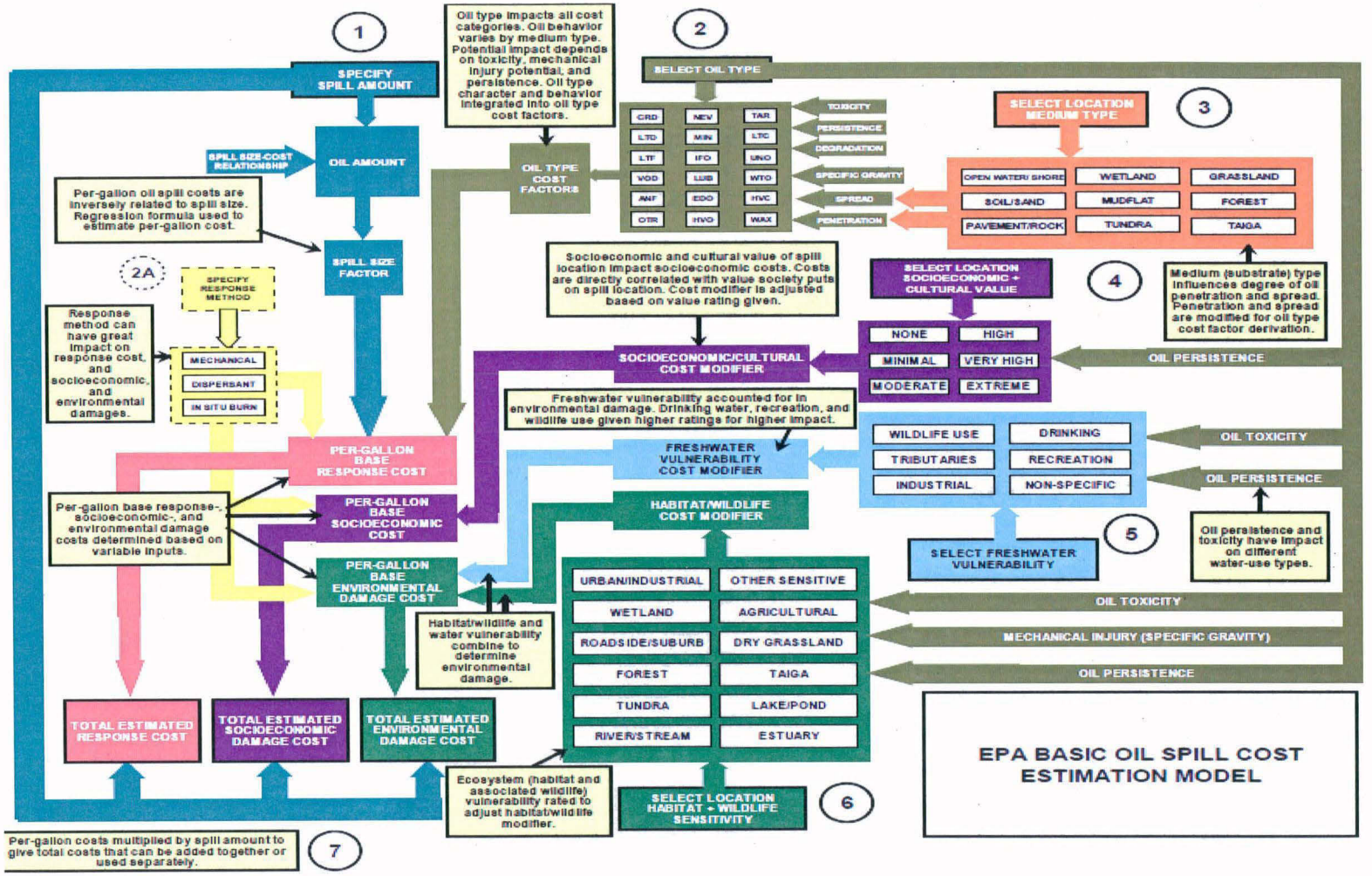

Figure 4.1: Factors taken into account while assessing the oil spill damage. (Source: Etkin, 1997).

Voluntary Schemes: TOVALOP and CRISTAL

It was clear in 1969 that the international regimes like the Convention will take several years to become effective, the oil and shipping industries came up with two voluntary schemes – TOVALOP and CRISTAL, to provide adequate and timely compensation like the CLC and the Fund convention. The system of these two voluntary schemes involved two steps. In the first step, the individual tanker owner is responsible whose tanker causes spill. The second step makes the oil cargo-owner responsible when tanker owner's stipulated limit of liability is crossed. The division was, thus, worked out in two separate schemes: Tanker Owners Voluntary Agreement concerning Liability for Oil Pollution (TOVALOP) and Contract Regarding an Interim Supplement to Tanker Liability for oil Pollution (CRISTAL).

TOVALOP was an entirely voluntary agreement entered into by participating tanker owners for the benefit of a third party, i.e. the polluted coastal state. It effectively guaranteed governments that their preventive and clean-up expenses following oil spill would be reimbursed. The scheme was decided to be administered by a new entity created specifically for this purpose, the International Tanker Owners Pollution Federation (ITOPF).

Both TOVALOP and CLC are based on no-fault, i.e., strict liability. However, there are several **differences between the voluntary and the legal regimes.** Firstly, while payments related to TOVALOP are *gratuitous* (this means that although the contracting ship owners are bound contractually among themselves, victims have no legal right to enforce payment), where as the compensations under the CLC are legally binding under the international law.

Secondly, under the TOVALOP, persons other than the shipowner are responsible, but CLC provides for strict channeling of liability against the ship owner only.

Thirdly, TOVALOP is applicable to the oil spills world wide, whereas the CLC provides for compensation only where pollution damage is caused in the territory (or territorial sea and EEZ) of a party to the convention. (Art. II, CLC).

Fourthly, TOVALOP covers the spills from tankers 'in ballast' whereas liability under the CLC applies only to spills from tankers carrying persistent oil in bulk as cargo (Art VI, TOVALOP Standing Agreement).

Although TOVALOP was originally formulated as a provisional measure to be phased out once the CLC to be ratified by the majority of maritime nations, it continued to be in force till 1997 since it covered significant gaps existing in the liability provisions of CLC.

Encouraged by TOVALOP's impact on CLC 69, the oil companies realized that another early initiative on their part would help influence negotiations on the supplementary fund. With millions of tones of oil being transported each day over the oceans, the oil interests were greatly concerned over the costs of the new levy to be imposed under the fund. Pre-emptive action was thus needed not only to dictate future agreement on the topic but also to avoid unilateral coastal state action. As their first step, the oil majors created the Oil Companies International Marine Forum (OCIMF) to represent their interests at international organisations.

OCIMF's first mandate was to create a functioning industry fund as a model for the upcoming conference. In January 1971, a new voluntary scheme – the Contract Regarding an Interim Settlement of Tanker Liability for Oil Pollution (CRISTAL) – was concluded among thirty eight participating oil companies. CRISTAL came into force by April 1971, well ahead of the inter-governmental conference scheduled for November of the same year. A new company – the Oil Companies Institute for Marine Pollution Compensation Ltd ('the Institute') – was to administer CRISTAL.

In essence, CRISTAL was designed to supplement TOVALOP compensation for oil pollution claims. Responsibility for paying claims would lie with the Institute with the financial burden being spread out among CRISTAL members in

proportion to the quantities of oil which they received by sea transport. In seeking to influence the Conference, CRISTAL completely omitted to deal with the issue of shipowner indemnification. It is worth remembering that this had been one of the promised aims of the 1969 Fund resolution. Instead, CRISTAL concentrated on supplementing TOVALOP, under which the shipowner's liability was limited to only US$100 per ton of the vessel. On this score, CRISTAL's main aim was to provide compensation for governments' preventive and clean-up expenses beyond what was available under TOVALOP. In addition, CRISTAL would compensate for private damage claims which had not been admissible under TOVALOP.

With CRISTAL acting as a supplement, many of TOVALOP's deficiencies were overcome. Pollution damage was now a recognised head of claim together with preventive and clean-up expenses. A larger maximum amount was now available for governmental and private claims.

In concurrence to the 1992 protocols the CLC, industry groups reshaped the voluntary schemes by adopting TOVALOP supplement and by improving CRISTAL. Thus, although the CLC and the fund convention 1992 took effect from 1996, the benefits of these revised conventions were made available to claimants almost ten years earlier, via these two voluntary agreements- TOVALOP and CRISTAL.

Revision of TOVALOP and CRISTAL:

In the mid-1980s, the reluctance of the US Congress in approving the 1984 Protocols gave rise to concerns that their entry into force could take years to achieve. Accordingly, the shipping and oil industries supported a continuing role for TOVALOP and CRISTAL. Unlike the inter-governmental conventions, these agreements were simple contracts between the industry interests which could be easily amended. Thus, it was proposed that TOVALOP and CRISTAL be brought in accordance with the 1984 Protocols. This would make equivalent compensation quickly available to potential claimants pending the Protocols' entry into force.

There were additional benefits in revising TOVALOP and CRISTAL. Ever since the original CLC/FUND regime became widely adopted, the industry schemes had typically served to re-adjust and fine-tune the burden of claim settlements between

the shipowning and oil interests *inter se*. This had been done in 1978, for instance, in relation to the 'small tankers' issue. Readjustment of liabilities did not disturb the total amounts of compensation available to injured third parties under the CLC/FUND conventions; it merely sought to re-distribute the liabilities of the industries as between themselves.

In the wake of the 1984 Protocols' adoption, some sectors of the oil industry were dissatisfied that the shipowners had not been made to assume an even greater proportion of costs, though the shipowners already bore the burden of increased first-tier limits. In essence, the oil industry felt that the new FUND 84 Protocol's limits exposed it to disproportionately high liabilities. The oil industry thus proposed to revise CRISTAL and to re-adjust the respective industries' liabilities such that the shipowners would now contribute a larger fractional share than required of them under the 1984 Protocols. At the same time, CRISTAL's overall maximum limits could be brought closer to that of the FUND 84 Protocol.

Naturally, the proposal was resisted by the tanker owners. Following protracted discussions, a compromise was eventually reached in 1987. TOVALOP would be split into two versions existing alongside each other. Where a tanker involved in an accident was not carrying oil belonging to a CRISTAL member, compensation remained available from the shipowner under the prevailing version of TOVALOP last adopted in 1978. This version would henceforth be known as the *'TOVALOP Standing Agreement'*. Here, compensation remained limited to US$160 per ton, subject to a maximum ceiling of US$16.8 million.

However, if the vessel was carrying a CRISTAL cargo, the owner's liability would be governed by a new Supplement to TOVALOP. This would provide a new and higher limit of US$3.5 million for tankers of 5,000 tons or less, plus US$493 for each ton in excess of 5,000 tons up to an increased maximum of US$70 million. Beyond this limit, a revised CRISTAL scheme would become applicable, paying additional compensation which likewise depended on the tanker's tonnage. Inclusive of the amount

payable under the TOVALOP Supplement, the new CRISTAL limits were set at US$36 million for tankers up to 5,000 tons, plus US$733 for each ton in excess of 5,000 tons up to a aximum of US$135 million.

The new limits were significantly higher than the corresponding amounts under the old versions of the schemes as well as CLC 69 and FUND 71, but were deliberately set slightly lower than the limits of the 1984 Protocols. This was done presumably to reiterate the *interim* nature of the industry arrangements as well as to avoid usurping the Protocols. A new company called Cristal Ltd was incorporated in Bermuda to administer and pay claims under the new scheme ('the CRISTAL Contract').

In a nutshell, the 1987 revisions to TOVALOP and CRISTAL were meant to meet the shipowners' concern that the schemes should not be a financial disincentive to the adoption of the 1984 Protocols. At the same time, the revisions re-adjusted burden-sharing between the shipowning and oil interests to address the latter's concern that it was meeting a disproportionate share of liabilities in cases of major accidents falling under the 1984 Protocols. Throughout the negotiations, the superior bargaining position of the oil companies *vis-à-vis* the shipowners was evident.

The new TOVALOP Supplement and CRISTAL Contract thus came into effect for all incidents occurring after 20 February 1987 involving a CRISTAL cargo. In the meantime, the maritime world awaited the long-promised acceptance of the 1984 Protocols by the US. However, for reasons described in a later section below, US ratification of the Protocols never materialised. By 1990, it became clear that the US would not accept the Protocols. Consequently, another IMO Conference had to be convened in 1992 to delete the requirement for US participation in the regime.

Since the entry into force of the 1992 protocols of CLC and FC fulfilled their intended purpose, TOVALOP and CRISTAL were abrogated in February 1997.

STOPIA 2006 and TOPIA 2006:

These are voluntary compensation package (involving two agreements) initiated voluntarily by the International Group of protection and indemnity clubs, i.e., the insurance sector. The two agreements are

(1) Small Tanker oil pollution Indemnification Agreement 2006 (STOPIA 2006); and
(2) Tanker Oil Pollution Indemnification Agreement 2006 (TOPIA 2006)

These voluntary but contractually binding agreements entered into force in February 2006.

STOPIA provides for compensations greater than 4.5 million SDR (for ships up to 5000 gross tonnage) but upto 20 million SDR for the damage in 1992 Fund member states. Thus, TOPIA 2006 functions like a supplement to Fund of 1992. (Art.IX, International Oil Pollution Compensation Funds, 2006 Amendmnt).

Supplementary Fund: The need for a "third tier" supplementary fund was being felt (after the 1992 protocols) in order to a address the claims amounting beyond the limit of CLC and Fund Convention 1992.

In 2001, to improve regime provided by the 1992 conventions, the Fund Assembly adopted a draft protocol to establish an optional third tier of compensation through a Supplementary Compensation Fund, which was to provide additional compensation over the limits under 1992 conventions. This supplementary fund protocol entered into force in 2005. The supplementary fund is a separate legal entity and is financed by the contributions from oil receivers in the states party to the protocol. The supplementary fund protocol applies to pollution damage in the territory, including the territorial sea, of a state party to the protocol and in the Exclusive Economic Zone or equivalent area of such a state. (Art 2 (1), Supplementary Fund Protocol). The total compensation amount payable for any one incident is 750 million SDR (US $ 1.7 billion), including the amount payable under the 1992 convention, which is 203 million SDR (US $ 317 million(Ibid).

Mention of some other conventions, such as BUNKER and HNS Conventions is also pertinent here. Although these are related to the damage caused by oil spills, their degree of applicability in such cases is somewhat different in context of the substances carried by the ships.

International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER):

Besides the CLC 1969, this is another important international convention regarding oil pollution damage. During the negotiations leading up to the CLC1969 it was recognized that there was a gap in the pollution liability and compensation regime. The CLC applied to tankers only and covered pollution from persistent oil carried as cargo and from persistent oil carried in the form of bunkers but only if the tanker was laden at the time of the incident. This provision was necessary in view of the interests of the oil companies because they were the contributors to the IOPC Fund. It was realistic to expect cargo to contribute to the losses caused by the escape of cargo (and also to losses caused by the escape of bunkers) but only when the tanker was laden. This is on the basis that where a tanker is in ballast (not laden by cargo oil) its bunkers are, by definition, being used exclusively for *ship's* purposes, and not for *oil companies*. Bunkers on non-tankers continued to fall outside the compensation regime. That is why an international regime for spills from bunker oil was strongly needed.

Thus, the International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER) was adopted on 23 March 2001 and finally entered into force on 21 November 2008. The Convention was adopted to ensure that adequate, prompt, and effective compensation is available to persons who suffer damage caused by spills of oil, when carried as fuel in ships' bunkers. The convention is modelled on the CLC 1969. As with that convention, a key requirement in the bunkers convention is the need for the registered owner of a vessel to maintain compulsory insurance cover.

For the sake of the ease of understanding, it is useful to understand the sense of the terms "ship", "bunker oil", "shipowner" and "pollution damage" as is used in the Bunker Convention. For purposes of the Convention a *"ship"* is broadly defined as including "any seagoing vessel and seaborne craft, of any type whatsoever"[36]. This is a broad definition and covers a large number of floating objects as well as traditional ships. However, the Convention will not apply unless the vessel in question is carrying *"bunker*

[36] Article 1 (1), BUNKER Convention.

oil" which is defined as "hydrocarbon mineral oil, including lubricating oil used for the operation or propulsion of the ship, and any residues of such oil"[37].

It should also be noted that in the CLC *"owner"* is defined as the "person or persons registered as the owner of the ship" thus channelling all responsibility under the CLC to that person[38]. But, the concept of the *"shipowner"* in the Bunker Convention embraces "the owner, including the registered owner, bareboat charterer, manager and operator of the ship" - a much more extensive group of persons than found in the CLC. It follows that wherever else in the Convention a liability is imposed on the "shipowner" (see in particular Article 3) all those listed in the definition of shipowner are embraced.

The only other definition that needs attention is the definition of "pollution damage"[39]. *"Pollution damage"* means "loss or damage ... by contamination resulting for the escape or discharge of bunker oil". Compensation for impairment of the environment "other than loss of profit from such impairment" is limited to the cost of *reasonable* measures of reinstatement". (This definition agrees with the redefinition of pollution damage in the CLC 1992)[40].

Another key provision is the requirement for direct action - allowing a claim for compensation for pollution damage to be brought directly against an insurer. The Convention requires ships over 1,000 gross tonnage to maintain insurance or other financial security, such as the guarantee of a bank or similar financial institution, to cover the liability of the registered owner for pollution damage in an amount equal to the limits of liability under the applicable national or international limitation regime, but in all cases, not exceeding an amount calculated in accordance with the Convention on Limitation of Liability for Maritime Claims, 1976, as amended.

International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea:

[37] Article 1 (10), BUNKER Convention.
[38] CLC Article 1 (3), BUNKER Convention.
[39] Article 1 (9), BUNKER Convention.
[40] Protocol to the International Convention on Civil Liability for Oil Pollution Damage – 1992.

This convention was designed to deal with the issues related to the pollution by hazardous and noxious substances (HNS). In the aftermath of the *Torrey Canyon* incident in 1967, it had been envisaged that the new CLC 69 proposed by IMCO for oil pollution would embrace pollution caused by hazardous and noxious substances (HNS) as well. However, it was readily acknowledged by IMCO at the time that the carriage of chemical substances by sea entailed far more difficulties and complexities than oil transportation.

The differing types and sizes of ships used to carry HNS also posed difficulties for the uniform imposition of compulsory insurance requirements. Moreover, since the different types of HNS cargoes were received in port by different receiving parties, it was extremely difficult to devise any compensation system which could effectively levy contributions from the cargo interests.

After more than a decade's worth of fresh negotiations, agreement was finally reached in 1996 on an International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNSC).

After the compromise reached at the 1996 Conference, the HNSC adopted a two-tier compensation system largely similar to that employed by the CLC/FUND regime. Thus, the HNSC provided for the imposition of strict first-tier liability on the shipowner, the requirement of compulsory insurance and certificates evidencing such insurance, direct action against insurers, channelling of liability to owners and their insurers, limitation funds to be constituted by the shipowner, conduct barring limitation and the establishment of a second-tier HNS Fund financed by the cargo interests. In addition to compensating for pollution damage caused by HNS, the convention also extends to non-pollution damage resulting from incidents such as fires or explosions.

The term 'hazardous and noxious substances' was defined by reference to a comprehensive list of substances and materials which, when carried as cargo or as residues from their previous carriage in bulk, triggers the applicability of the convention. The number of substances covered by the list (estimated to exceed 6,000) represents one of the most difficult aspects of the convention in terms of its implementation.

The inclusion of oil in this list is to provide for the risks of fire and explosion (i.e. non-pollution) damage arising from the carriage of oil as well as for pollution damage caused by non-persistent oil.

As regards limitation, the HNSC conferred the right to limit upon shipowners in recognition of their submission to strict liability as well as to apportion the burden of compensation between the shipping and cargo interests. Hence, the Conference settled on provisions inspired by CLC 92 – independent first-tier limits for the shipowner, with second-tier liability borne by an HNS Fund financed by cargo interests.

International Regimes and Great Powers: Position of US and European Union:

An analysis of international regimes and their compliance will be incomplete without the knowledge of the position and stakes of the US and European Union. The US has not ratified the Civil Liability Conventions and the Fund Conventions. It is interesting to mention that the US has played a major role in the creation of the original international regime of the 1969 Civil Liability Convention and the 171 Fund Conventions. In fact the United States has signed both conventions and was a major force behind their revision, subject to ratification. However, the conventions (of 1969 & 1971) are not ratified, and not likely to be ratified by the US because it believed that the compensation amounts under the compensation amounts under the conventions are low or insufficient. But in spite of this fact, there have always been useful exchange of information between the US National Pollution Funds Centre (NPFC) and the IOPC Fund.

It will be useful to mention the reasons for the US denial for the compensation regime. Various social, economic and political considerations had dictated the position of the US in the context of the international regimes established by the Convention and the Fund.

First and foremost reason for the unilateral approach of the US was the inadequacy of compensation coverage under the CLC and the Fund conventions. The

liability limit under the CLC was approximately US$ 14 million, although the US sought minimum US$ 50-60 million.[41]

Another reason was ambiguous definition of pollution damage under the international conventions. Since the notion of the pollution damage was different for different member states, the convention could no reach upon a clear definition of pollution damage.

The third reason for rejection of ratification of the convention by US was related to the preemption of US state laws by the convention regime. The main contention was around the issue whether the US state laws to be excluded from application if the convention was ratified by the US.

Fourthly, the American oil industry argued that it should not be obliged to contribute to the international fund for damages which occur outside the territory of the United States.

The fifth reason for American denial for the CLC was the US opinion that the international regime should be extensive enough to cover the cases beyond tanker spills and persistent oil.

Sixthly, the US Congress believed that the scope of CLC was very narrow in terms of the type of damage it covered. Lastly, the provision of limit on limitation of ship owner in the international regime was perceived by the US as unjust and discriminatory for the cause of pollution victims.

Oil Pollution Act 1990: the magnitude of the *Exxon Valdez* oil spill in 1989 compelled the US to enact its own liability and compensation regime, Oil Pollution Act 1990 (OPA 1990), like the international convention, has two tier compensation structure a liability scheme and a fund scheme OPA 1990 is a more comprehensive oil pollution regime than the international regime. In contrast to the 1992 conventions, OPA 1990 covers not only the liability and compensation, but also deals with a number of other issues related to oil spills, e.g., prevention, enforcement and restoration etc. Moreover, several differences exist between the two compensation regimes regarding the legal complexities. Also, OPA 1990 contains provisions for ecological remediation that are stronger than those of the

[41] Kim, Inho (2003), "A comparison between the International and US Regimes Regulating Oil Pollution Liability and Compensation", *Marine Policy*, 27: 265-279.

CLC, thus, making it more effective than the CLC. The international regime, which is based upon the concept of limited liability, is basically a compromise between commercial and environmental interests. The OPA 1990, on the other hand imposes practically unlimited liability on responsible parties and additional liability under the state legislation. Another difference can be enumerated in this regard: not only the limit of liability in OPA 1990 is higher than that in CLC 1969; the mechanism for the loss of the right to limit the liability is also different. In OPA, the ship owners are provided lesser protection than is available to them in CLC. (Art V, CLC and section 1004, OPA 1990).

A comparision between the international and US regimes (regarding oil pollution liability) is presented in the following table:

Table 4.6: A Comparison between CLC 1992 and OPA 1990.

Source: Inho Kim (2003)

	92 CLC	OPA 90
Responsible parties	Shipowner	Any person owning, operating, or demise chartering the vessel
Basis of liability	Strict Defenses: an act of war, hostilities, civil war or insurrection, a natural phenomenon of an exceptional, inevitable and irresistible character/an act or omission of a third party with intent to cause damage/the negligence or other wrongful act of any government or other authority responsible for the maintenance of lights or other navigational aids, in the exercise of that function	Strict, joint, and several Defenses: act of God, act of war or an act or omission of a third party Limiting defenses: failure or refusal to report the incident or to provide reasonable assistance and cooperation in removal activities or to comply with any applicable orders issued/an act or omission of a third party in connection with any contractual relationship with the responsible party unless that party demonstrates due care and precautions against foreseeable acts or omissions of any such third party/ omission of negligence of the US Government

Liability limits	Ships of 5000 tons or less: 3 million SDRs ($4 million) [4,510,000 SDRs ($6 million) under the 2000 Amendments Per additional ton: 420 SDRs [631 SDRs ($840) under the 2000 Amendments] (maximum: 59.7 million SDRs ($79.9 million)) [89,770,000 SDRs ($120 million) under the 2000 Amendments]	Tank vessels over 3000 tons: $1200 per ton or $10,000,000 which is greater Tank vessels 3000 tons or less: $1200 per ton or $2,000,000 which is greater Any other vessel: $600 per ton or $500,000 which is greater Unlimited liability by violation of a federal safety, construction or operating regulation/ failure or refusal to report the incident or to provide reasonable assistance and cooperation in removal activities or to comply with any applicable orders issued
Recoverable damages	Loss or damage caused outside the ship by contamination resulting from the escape or discharge of oil from the ship Compensation for impairment of the Environment limited to costs of reasonable measures of reinstatement undertaken or to be undertaken The costs of preventive measures and further loss or damage caused by preventive measures The IOPC Fund practice: loss of earnings suffered by persons who depend directly on earnings from coastal or sea-related activities such as fishermen, hoteliers and restaurateurs recoverable/loss of tax revenues not recoverable/claims for non-economic environmental damage not recoverable	Damage to natural resources (the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of, the damaged resources/the diminution in value of those natural resources pending restoration/the reasonable costs of assessing those damages) Injury including economic losses from destruction of real or personal property Damages for loss of subsistence use of natural resources, even though not owned Damages for net loss of taxes, royalties, rents, fees, or net profit due to injury to property or natural resources, recoverable by the US, a state, or political subdivision Loss of profits or impairment of earning capacity due to injury to property or natural resources, recoverable by any claimant Damage for net costs of providing increased or additional public services caused by oil discharges, recoverable by a state or subdivision
Financial responsibility	Ships carrying more than 2,000 tons of persistent hydrocarbon mineral oil in bulk as cargo	Any vessel over 300 tons (except non-self-propelled vessels that do not carry oil as cargo or fuel) Any vessel in EEZ to transship or lighter oil
Fund	Maximum: 200 million SDRs ($268 million) [300,740,000 SDRs ($400 million) under the 2000 Amendments Supplementing the 1992 CLC (no liability under the CLC/ the shipowner's incapability or insufficiency of insurance/ damages exceeding the liability limit	Maximum: $1 billion per incident (damages for injury to natural resources: $500 million) Supplementing (claims to responsible party first) Direct access (in case of denied or delayed liability) Available to the public authorities for removal costs in relation to the natural resource damages

	under the CLC) Subrogation Contributing oil (1995): 1.1 billion tons Annual contribution (1995): d43 million ($69 million) Levy/ton (1995): d0.03 ($0.04) Compensation payments (1997): d33.3 million ($54.5 milslion)	Subrogation $0.05/barrel fee (ceased on Dec. 31, 1994) Revenue (1997): $78 million Amount of claims paid (1997): $4.5 million

European Union's Inclination toward the International Regime:

Before the 2000 amendments to the CLC and Fund Conventions could take place, European Commission took an initiative to establish a European Fund (Compensation for Oil Pollution in Europe: COPE) in order to provide compensation for oil spills from tankers. The reason for the Commission's such initiative was its belief that the provisions under the CLC were insufficient to compensate the damage caused in the territory of European Community.

Clearly, this was a threat to the global character of the international regime established by the CLC. However, some member states of the European Union opined that the issues related to the liability and compensation should be dealt with through *global* approach, and not through *regional* approach. Consequently, after the adoption of the supplementary Fund Protocol which entered into force in 2005, European Commissions initiative did not proceed. The unbreakable limitation rights of the shipowners and the central role played by private organizations under the CLC were the two main reasons for EU's dissatisfaction for the international regime.

In the end, the chapter can be summarized by concluding that the CLC 1969 and FC 1971 were the first international regimes to meet the growing need of a legal framework addressing the issues related to oil spill damage liability. Subsequently, other private agreements and intergovernmental conventions were convened to remove the shortcomings of the earlier regimes. Although regional powers like the EU and the US perceive their own interests as diverging from the international regimes, the international conventions have proved to be the only satisfactory solution to the problem of liability fixation.

Chapter 5:

CONCLUSION

After having analysed the details of the conventions and regimes related to damage caused by oil spills, it is necessary to delve into the working of the regimes in the practice, *i.e.*, an appraisal of the performance, strengths and weaknesses of such regimes. In the context of liability and compensation regimes related to oil spill damage, the main criterion for judging whether a compensation regime is satisfactory is the extent to which it is successful to deter the parties involving the shipping of oil from polluting the environment. Following is a brief mention of the issues often criticized regarding the international regimes.

The amount, nature and insufficiency of the liability limits are often criticized. These arguments are valid to a certain extent, in the sense that the need and existence of certain other tiers and regimes of compensation demonstrate the shortcomings the international regime. In fact any international regime is far from being ideal and usually is a balance of compromises of economic, political and commercial interests of several parties. Numerous violation and deviations, especially in relation to the fund contributions, have been observed. In this context, Morgenthau's quotation can be suitable mentioned here: "considerations of power rather than of law determine compliance."

However, the Civil Liability Convention was the first international convention compatible to the United Nations Convention on the Law Of The Sea. Together with the fund convention of 1971 and 1992, its performance has been satisfactory in most of the cases. It has played a significant role in the settlement of worldwide claims over the compensation damage related to oil spills. Since their establishment, the 1971 and 1992 Funds have been involved in approximately 135 incidents and have settled payments of compensation of a total of US$ 1.2 billion. Majority of these incidents has been settled out of courts. The cases related to the largest total payments are following:

Table 5.1: Various large oil spill incidents and related compensation payments.

Incident	Payments to (as of 20 October 2007) Claimants in Million US Dollars
Antonio- Gramsci (Sweden, 1979)	18
Tanio (France, 1986)	37
Haven (Italy, 1991)	61
Aegean Sea (Spain, 1992)	68
Braer (UK,1993)	92
Keumdong No.5(Republic of Korea, 1993)	22
Sea Prince (Republic of Korea, 1995)	42
Yuil No.1 (Republic of Korea, 1995)	32
Sea Empress (UK, 1996)	62
Nakhodka (Japan, 1997)	221
Nissos Amorgos (Venezuela, 1997	22
Osung No.3 (Republic of Korea, 1997)	16
Erika (France, 1999)	171
Prestige (Spain, France, Portugal, 2002)	163

Source: Jacobsson, Mans (2007), "The International Liability and compensation Regime for Oil Pollution from ships: International Solutions for a Global Problem", *Tulane Maritime Law Journal*, 32(1): 1-33.

In the light of above data, it can be said that liability and compensation provisions under the 1969, 1971 and 1992 convention and fund are normally sufficient to cover most of oil spill incident claims. According to ITOPF, over 95% of the non US tanker spills during a period of 190-1999 were fully compensated under the 1992 CLC alone, let alone the 1992 Fund Convention (Source: www. itopf.com). The convention and the fund together have provided satisfactory and prompt compensation to the claimants in the great majority of tanker pollution cases. In fact, before the *Erika* oil spill incident of 1999, the *Nakhodka* (Japan, 1997) was the only incident resulting in the

admissible claims exceeding the limits decided by the 1992 civil liability convention and the fund convention. (Chao Wu, 2002).

Although the provision of the limitations on the liability limits in the CLC 1982 and FC 1992 are the most critical aspect of it, the very provision of the limitation makes it possible for the insurer and the shipowner to arrange for an insurance cover for oil tanker. In fact the limitation has been proved to be the greatest incentive for the insurance sector to seek opportunities in the risky business of shipping.

Another significant advantage of the limitation provision in the convention is that the claimants, who have suffered the damage, can claim their damage amounts directly to the insurer, without having to take recourse of the lengthy litigation process.

The process of the settlement of the claims under the international regime has proved very quick as compared to the regimes established by the state laws, such as Oil Pollution Act of 1990 (US). The provisions regarding the channelling system of claim settlement can be attributed for this ease because claimants can avoid the complex procedure of multiplicity of liability. This is compounded with the fact that ascertaining the extent of liability for a number of persons has proved very difficult and time-taking.

The outstanding feature of the international regime (CLC and FC 1992) is the avoidance of litigation in the domestic courts. Incompatibility of various domestic legislations and time-taken in the domestic courts are the major problems with the domestic regimes dealing with the claims of oil pollution damage.

Another significant contribution of the CLC and Fund regime to the international legal framework is the uniformity of compensation laws applicable to the shipping industry-which is essential for the efficient international transport of the oil. This is particularly important in a regime where many States happen to be the member of the convention and where shipping industry of one member state pays for the damage occurred in another member state. In view of the claim settlements cleared, it can be safely concluded that the Civil Liability Convention and the Fund Convention have been a major success.

Territorial Scope of the Conventions: Various Dimensions-

The spatial delimitation of oil pollution liability under the international conventions has always related to the sovereign rights of contracting states: CLC 1969 (Article II) and the Fund Convention 1971 (Article 3) both apply only to pollution damage caused or impacting on the territory, including the territorial sea, of member states. At the time of the original conventions, there was no international consensus on the breadth of the territorial sea, which was against the uniformity of geographical application of the liability regime. Article 3 of the LOS Convention 1982 set the limit of the territorial sea of a state at 12 nautical miles, which is now widely accepted as the international norm, although both CLC 1992 and the Fund Convention 1992 do not refer to the 12-mile limit in reference to the autonomy of state maritime claims. Nevertheless, at the 1984 IMO London conference on maritime liability and compensation, developing states successfully lobbied for an amendment to the oil pollution liability conventions to recognize the EEZ rights accorded to coastal states by the LOS Convention (Part V): these entitlements extend up to 200 nautical miles from the baseline from which the breadth of the territorial sea is measured (Article 57).

The broadening of the geographical scope of the liability conventions was reinforced at the 1984 conference by international agreement clarifying that the liability conventions cover measures, *wherever taken*, to prevent oil pollution damage *within* a territorial sea or EEZ.

As eventually incorporated into CLC 1992 as Article II, and the Fund Convention 1992 as Article 3, the oil pollution liability conventions are geographically defined as applying exclusively:

(a) to pollution damage caused;

(i) in the territory, including the territorial sea, of a Contracting State, and

(ii) in the exclusive economic zone of a Contracting State, established in accordance with international law, or, if a Contracting State has not established such a zone, in an area beyond and adjacent to the territorial sea of that State determined by that State in

accordance with international law and extending not more than 200 nautical miles from the baselines from which the breadth of the territorial sea is measured;

(b) to preventive measures, wherever taken, to prevent or minimize such damage.

In respect of geographical coverage, OPA 1990 is broadly in conformity with the international regime, applying to internal navigable rivers and lakes, bays and lakes, coastal waters and the 200-mile EEZ of the United States. This is in accordance with a global recognition that (environmental) liability rules for oil pollution extend coastal state jurisdiction beyond territorial waters.

The political pressure on the oil pollution liability regime to acknowledge the distinctive legal import of the EEZ must be placed in the context of its wider geopolitical significance as a reflection of the aspiration of the developing countries for economic development and their desire to gain greater control over the economic resources off their coasts, particularly fisheries, which in many areas were largely exploited by the distant-water fleets of developed States.

With several Latin American and African countries pushing for 200-mile territorial seas in the 1970s, the EEZ represented the political compromise extracted from states in the global North who viewed the extension of coastal state sovereign powers as a threat to their maritime freedoms. EEZ entitlements, as codified in the LOS Convention, granting coastal states:

> 'sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or nonliving, of the waters superjacent to the sea-bed and of the sea-bed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone' [Article 56(1)(a)].

Moreover, Article 56(1) (b) (iii) of the LOS Convention recognized for the first time coastal state jurisdiction in the EEZ over protection and preservation of the marine environment, raising the prospect of the environmental liability provisions within CLC 1969 and the Fund Convention 1971 falling behind the evolution of international maritime law on extra-territorial rights.

While the extension of the geographical coverage of the oil pollution liability regime is generally acknowledged by member states to enhance the rights of victims by admitting extra-territorial claims (impacting on the EEZ), its spatial dimension to transnational harm may still be questioned in relation to (i) marine protected areas and (ii) marine common spaces.

Marine protected areas:

In recent years, the notion of marine protected areas has gained growing currency in international law. Article 211(6) of the LOS Convention allows coastal states to designate special areas allowing them to prescribe particular standards and navigational practices to prevent ship-source pollution. Within the United Nations Environment Programme, the Regional Seas Programme has advanced specially protected marine areas through protocols to its East African, Mediterranean, South-East Pacific and Caribbean Conventions.

In addition, Annex. I of the International Convention for the Prevention of Pollution from Ships (MARPOL) has facilitated the designation of extensive Special Areas where oil discharges are strictly controlled or prohibited— for example, the North West European Waters Special Area created in 1999. Lastly, there has been the parallel development by IMO of the Particularly Sensitive Sea Areas (PSSAs) designation— marine protected areas established to protect recognized ecological or socio-economic or scientific values. An important catalyst for the current activity on marine protected areas came from the 1992 United Nations Conference on Environment and Development (UNCED), notably the Convention on Biological Diversity and Chapter 17 ('Protection of the Oceans') of the sustainable development programme, Agenda 21. The UNCED Rio Declaration provided an endorsement of precautionary norms and the concept of common but differentiated responsibility, which explicitly guided subsequent IMO work, including that on marine protected areas.

The range of marine protected areas—all with different geographical scope, criteria for designation and protective measures—has undoubtedly caused

confusion, but consolidation work within IMO has now clarified at least the respective roles of MARPOL, Special Areas and PSSAs. If, as is likely, the global network of marine protected areas expands further, their impact on oil pollution liability claims has still to be systematically examined, both for the CLC/Fund Convention executive bodies and member states. The IOPC Funds have in practice acknowledged the need to meet more demanding cleanup standards in areas identified with high tourism and/ or wildlife values.

While oil spill damage in ecologically sensitive PSSAs has so far not been an issue for the 1992 Fund Executive Committee (the only two PSSAs currently designated are the Australian Great Barrier Reef and the Cuban Sabana-Camaguey Archipelago), the committee is likely to take a more generous view of reasonableness in order to meet stringent environmental recovery costs. If it happens so, the preventive environmental rationale of marine protected areas would encourage a sympathetic readjustment in the economic compensation system for oil pollution damage.

Marine common spaces:

Outside territorial seas and exclusive economic zones, use of the high seas is above all governed by open access and the near-exclusivity of flag state jurisdiction over maritime vessels. This *laissez-faire* regime has generated widespread over-fishing and marine pollution. For the oil pollution liability system, the collective action problem resides in the absence of incentives for actors to mitigate damage not affecting any state rights or interests. According to the IOPC Fund 1992 Claims Manual, responses on the *high seas* to an oil spill would in principle qualify for compensation only if they succeed in preventing or reducing pollution damage *within* the territorial sea or exclusive economic zone of a contracting state. The Fund position is that, given world shipping lanes, such spills are rare.

Furthermore, the difficulty of response to an oil discharge on the high seas means that natural dispersal is normally relied on for such incidents. Any adverse

consequences would result in national claims systems—e.g. the pure economic loss of a reduced fish catch in the EEZ of a member state. Nevertheless, there is a preventive need for oil pollution liability mechanisms to cover significant harm in marine common spaces.

Regardless of the practical rationale for restricting liability for high seas oil pollution damage to its impact on national interests, the LOS Convention gives states the right of intervention on the high seas in the case of maritime casualties threatening harmful pollution [Article 221(1)] and, more radically, the right of port states to take legal proceedings against visiting vessels alleged to have illegally discharged oil outside the state's own maritime zones, including the high seas [Article 218(1)]. An increasing reliance on port state enforcement in maritime governance is evident in the evolving network of regional Memoranda of Understanding which coordinate port state regulation of safety and environmental rules—including MARPOL provisions on oil pollution discharges. Port state control has established a significant precedent for the development of transnational accountability for marine pollution, acknowledging situations where states can take action against polluters for non-national harm. This renders the oil pollution liability regime open to question for its confinement of environmental liability to damage in coastal state maritime zones.

A conclusion will be incomplete without examining the hypothesis proposed in the beginning. It is evident from the literature that although US was one of the major forces behind the initiation of the Civil liability convention of 1969 and (its subsequent protocols), it has not ratified it and not likely to ratify it in the near future.

It is important to know that the world's major oil and shipping companies hail from the US. Since the US has not ratified the international convention for oil pollution compensation, the oil and shipping companies from the US are free from contributing into the compensation fund created by the regime of CLC 1969 and Fund Convention, 1971. Thus, the US approach deprives the Fund of a major financial contribution for oil spill damage.

But at the same time when it comes to the territory of the US itself, it is not prepared to abandon a liability regime which favours the domestic laws providing for unlimited liability. Oil Pollution Act, 1990 is such a law.

To make it more clear, the double standards of the US environmental policy are evident from the analysis of compensation regimes. The US avoids providing financial assistance to the IOPC Fund of 1971 and 1992, but at the same time, when it comes to the oil spill damage within its own territory, it advocates for a regime which provides for unlimited liability.

Another issue worth discussing is the approach of the United States regarding the position of its state laws *vis-à-vis* the international law. One of the reasons why the US is not joining the international regime of oil pollution is that if US ratifies the CLC and FC, its state laws will be pre-empted from application. In other words, the state laws of the US will be excluded from application according to the provisions of the CLC if the CLC is applicable to a case where pollution damage occurs within the territory of the United States.

The United States is not likely to put its own state laws into inferior position in relation to the international regime. Therefore, it is concluded that the United States will stay aloof from such an international compensation regime that focuses on the principle of limited liability.

An examination of another hypothesis, that "regional approaches will never be sufficient in dealing with oil pollution" is also necessary in this regard. It is important to note that although regional efforts have been made to establish a regional compensation fund for oil spill damage; these efforts have not gone much far in the path of success.

In fact, the European Commission in 1990s felt that the existing limits of liability the CLC were insufficient, and indeed proposed for a separate European Community compensation fund, the COPE (Compensation for Oil Pollution in Europe) Fund, consisting of a third tier of compensation (up to one billion Euros). However, such

initiative could not proceed due to the lack of support from some members of the European Union itself.

So, it can be safely concluded that separatist and regional approaches to deal with the oil pollution compensation fund are not sufficient. The reasons for such a conclusion are inherent in the nature of oil production and transport.

Firstly, the oil companies and shipping companies have stakes worldwide. Therefore, regional efforts to deal with the global complex problem of liability of such companies are not likely to succeed sufficiently.

Secondly, the shipping industry requires a worldwide network of communication lanes. Even a single sea route may pass through the territory of several countries. Moreover, such parties may be responsible for the pollution that do not belong to a member state of a separate regional regime. Therefore, such regional approaches to solve the oil pollution problem may create further problems.

Thirdly, unlike the road transport, the international oil pollution transport is carried upon a medium which is a global interconnected whole and a single water body – the world ocean. Any impact on the marine environment of a part of this ocean is likely to affect environmental processes in another part of it, though both places may be situated thousands of miles apart.

In view of these global and complex interconnections, regional efforts cannot manage international problems.

In spite of all these regional deviations, the international regime for oil pollution damage compensation established by the CLC 1969 and subsequent protocols has proved to by dynamic in the sense that it was transformed and modified according to the need of the time. After the oil spill incidents, it kept evolving its principles for damage compensation and the corresponding limits for liability thereof.

The true worth of the CLC/FUND, HNSC and Bunkers Convention regimes lies in their creation of a uniform international system providing incentives for compliance with standardized rules. For most cases, this guarantees the consolidation of

pollution claims under one jurisdiction, the ease of administering limitation funds and the mutual recognition and enforcement of judgments in all contracting states.

From the perspective of oil spill victims, the regimes guarantee prompt and adequate compensation with direct action against insurers. In particular, claims can be brought in the courts of the victims' own countries without their having to pursue the shipowner elsewhere.

The regimes also render it unnecessary for claimants to bear the expenses of arresting vessels and enforcing judgments following spill incidents. This benefits not only claimants but also shipowners who can avoid delays to their trading schedules. In addition, the regimes provide for the application of strict liability; this allows for agreeable resolution of cases without the expense and delay of litigating fault. Moreover, the operation of the second-tier IOPC Fund (and the proposed HNS Fund) has greatly facilitated claims settlement, often without resort to litigation.

In sum, features such as strict liability, compulsory insurance, limitation funds, direct action against insurers and cargo-financed supplemental funds have all benefited pollution victims immensely.

As examined, most of the CLC/FUND regime's weaknesses relate to CLC 69 and FUND 71. These have now been largely redressed by the 1992 Conventions. Pollution damage in the EEZ is now covered, as are preventive measures in 'pure threat' situations and damage caused by tankers in ballast. However, the continued exemption of non-persistent oils is problematic given that such oils are equally capable of causing serious damage to the marine environment. Also, the exemption of unidentified operational spills (like the *Deepwater Horizon* case) causes especial concern for coastal states, given that such incidents remain major sources of pollution.

The channelling of liability to the shipowner has also proven too rigid in some cases with the result that joint and several liability cannot be imposed on other parties who may be equally responsible for pollution incidents. In this regard, the imposition of civil liability on actors such as charterers may actually be desirable if it can deter these actors from using sub-standard ships.

Thus, there is a need for the CLC/FUND, HNSC and Bunkers Convention regimes – originally meant for compensation purposes – to be redesigned to promote deterrence, behavioural change and incentives for compliance. This is consistent with the idea that a more widely distributed burden-sharing regime (both in relation to pollution control equipment as well as liability for claims) can better promote an industry-wide standards for quality shipping.

Challenges to the International Regimes:

As seen in the last chapter, in the wake of the oil spill disasters in Europe, the European Commission had begun to question the efficacy of the CLC/FUND regime in deterring negligent practices which caused serious pollution incidents. In the Commission's view, the current focus of the regime is too much on the compensation of victims, as opposed to the liability of the actual polluter. Thus, liability can almost always be avoided by virtue of the owner's right to limitation, the difficulty in breaking this right and the general immunity of non-owner actors. In the forthcoming revisions of the CLC and FUND Conventions, it can be expected that the Commission will press for unlimited shipowner liability in cases of gross or serious negligence and the removal of immunity for non-owner actors such as charterers and ship managers, particularly when sub-standard vessels are implicated.

Another challenge for the international regimes appears to be the increasing tendency of national legislatures and courts to widen the scope of 'pollution damage'. This is not helped by drafting weaknesses in CLC 92 which do not seem to preclude domestic legislation allowing recovery for matters falling outside the convention's definition of 'pollution damage'. Already, jurisdictions including the US and some European countries have begun to recognise claims such as 'natural resource damage' or 'harm to the environment', the assessment of which may be conducted using theoretical models leading to substantial judgment sums. Consequently, the IOPC Fund's established practice of excluding speculative claims in respect of natural resource damage assessment, *i.e.* claims that fall outside recovery in respect of restoration or reinstatement, may soon have to be reviewed.

The liability and compensation regimes have also had significant cost impact on the shipowning, insurance and cargo-owning industries. In particular, the imposition of strict liability, the requirement for compulsory insurance and the entrenchment of direct action against insurers must rank as among the most dramatic changes to affect the shipowners and P&I Clubs in the past 50 years. On its part, the second tier liability funds financed by the cargo interests can be seen as an attempt to rearrange the primary burden on shipowners. Yet, the fact that the Supplementary Funds are designed to be applicable only in the more serious pollution incidents testify to the greater relative influence of the cargo interests. The same is true in relation to minimum liability thresholds on small tankers.

Future Prospects:

Based on the trends at IMO over the years, it is likely that with increasing environmental concerns in the developed states and the growing application of the 'polluter pays' principle, greater costs will progressively be imposed on the shipping industry. Along with stricter and more vigilant port state enforcement, stronger liability and compensation regimes mark an increasing erosion of the traditional right of free and unhindered navigation.

At the same time, the imposition of liability on the non-shipowning interests is likely to provide greater incentives for these actors to promote the use of well-maintained ships and to suppress the market for sub-standard ones. To such extent, there exist prospects for more equitable burden-sharing arrangements to be instituted among all maritime actors.

So, in the end it can be concluded that the CLC and FC regime has been successful in maintaining a balance between the interests of public and private stakeholders and among the various member states themselves.

BIBLIOGRAPHY:

(* Indicates primary sources)

Baker, Jenifer M. (1978), "Marine Ecology and Oil Pollution", *Journal of Water Pollution Control Federation*, 50 (3): 442-449.

Barcott, Bruce (2010), "Forlorn in the Bayou", *National Geographic*, 218(4): 62-74.

Blumer, Max (1971), "Scientific Aspects of the Oil Spill Problem", *Environmental Affairs*, 1(2): 54-73.

Bourne, J. K. (2010), "The Deep Dilemma", *National Geographic*, 218(4): 40-53.

Brans, E. H. P. (2005), "Estimating Damages under the 2004 EC Directive on Environmental Liability" in Frank Maes (ed.), *Marine Resource Damage Assessment,* Dordrecht: Springer.

Brans, E.H.P. (1994), "Liability for Ecological Damage under the 1992 Protocols to the Civil Liability Conventions and the Fund convention, and the Oil Pollution Act of 1990," *Environmental Liability Law Review*, 1 (3): 61-67.

Chen, X. (2001), *Limitation of Liability for Maritime Claims: A study of US Law, Chinese Law and International Conventions,* London: Kluwer Law International.

*Civil Liability Convention, 1969. Contained in an International Maritime Organization Publication 'Civil Liability for Oil Pollution' (1996 ed.) Sales No. 473 E.

Clark, R. B. (1982), *The Impact of Oil Pollution on Marine Populations, Communities and Ecosystems: A Summing Up,* London: Collins.

Connel, D. W. And G. J. Miller (1981), "Petroleum Hydrocarbons in Aquatic Ecosystems: Behaviour and Effects of Sublethal Concentrations", *Critical Review of Environmental Control,* 11: 37-62.

Dunford, R.W., and M.L. Freeman (2001), A Statistical Model for Estimating Natural Resource Damages from Oil Spills. *Proceedings of the 2001 International Oil Spill Conference:* 225-229.

Etkin, D. M. (1997), *Oil Spill from Vessels (1960-1995): An International Perspective,* Cambridge, MA: Oil Spill Intelligence Report.

Eweje, Gabriel (2006), "Environmental Costs and Responsibilities Resulting from Oil Exploitation in Developing Countries: The Case of the Niger Delta of Nigeria", *Journal of Business Ethics*, 69:27–56.

Faure, Michael and Wang Hui (2008), "Financial Caps for Oil Pollution Damage: A Historical Mistake?" *Marine Policy,* 32(4): 592-606.

Fingas, M. (2001), *The Basics of Oil Spill Cleanup.* Second Edition., Washington DC: Lewis Publishers, pp. 233.

Gao, Z. H., Yang, J. Q., and Cun, W. L. (2005), *On Evaluation Technologies and Applications to Environmental and Ecological Damages Caused by Marine Oil Spills.*, Beijing: China Ocean Press (pp. 11-15).

Gauci, G. M. (1999), "Protection of the Marine Environment through the International Ship-Source Oil Pollution Compensation Regimes", *Review of European Community and International Environmental Law,* 8: 29-36.

Gauci, Gotthard (1995), "Limitation of Liability in Maritime Law: an Anachronism?", *Marine Policy*, 19 (1): 65-74.

Gissberg, J.G. (1971), *Civil Liability for Oil Pollution Damage from Tankers and Other Ocean-Going Vessels*, Ph D dissertation, University of Michigan.

Grigalunas, T.A. et al. (1998), "Liability for Oil Spill Damages: Issues, Methods, and Examples", *Coastal Management*, 26 (2): 61-77.

Grolin, Jasper (1988), "Environmental Hegemony, Maritime Community and the Problem of Oil Tanker Pollution" in Michael A. Morris (ed.), *North-South Perspectives on Marine Policy*, Boulder, Colo.: Westview Press.

Gundlach, E. R, and Miles O. Hayes (1978), "Vulnerability of Coastal Environments to Oil Spill Impacts", *Marine Technology Society Journal*, 12 (4): 18-27.

Hay, Julian (2010), "How Efficient can International Compensation Regimes be in Pollution Prevention? A Discussion of the Case of Marine Oil Spills" *International Environmental Agreements*, 10: 29-44.

Hong, Mei and Yanjie Yin (2009), "Studies on Marine Oil Spills and Their Ecological Damage", *Journal of Oceanic and Coastal Sea Research,* 8 (3): 312-316.

Hui, Wang and Michael Faure (1996), "The International Regimes For The Compensation of Oil Pollution Damage: Are They Effective?", *Review of European Community and International Environmental Law,* 12 (3): 242-253.

Ibrahima, D. (2005), " Recovering Damage to the Environment per se Following an Oil Spill: The Shadows and Lights of the Civil Liability and Fund Conventions of 1992", *Review of European Community and International Environmental Law,* 14(1): 63–72.

*IMO News (1990), "Cleaner Oceans: the Role of IMO in the 1990s", 3: 6-12.

*Inter-governmental Maritime Consultative Organization (1978), Official Records of the Conference on the Establishment of an International Compensation Fund for Oil Pollution Damage, 1971.

*International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (1996), International Maritime Organization.

*International Oil Pollution Compensation Fund (2002), *Report on the Activities of the International Oil Pollution Compensation Fund in 2001*, London, 192 p.

*International Oil Pollution Compensation Fund, Annual Report, 2006 (p. 72)

*IOPC Funds (April 2005 Edition) 1992 Fund Claims Manual, p 31. http://en.iopcfund.org/npdf/claimsman-en.pdf (last visited 10 August 2010).

*IOPC Funds (July 2009) The International Regime for Compensation for Oil Pollution Damage, Explanatory note prepared by the Secretariat of the International Oil Pollution Compensation Funds. http://en.iopcfund.org/npdf/genE.pdf (last visited 10 August 2010)

Jackson *et al,* (1989), "Ecological Effects of a Major Oil Spill on Panamanian Coastal Marine Communities", *Science,* New Series, 243 (4887): 37-44.

Jacobsson, Mans (2007), "The International Liability and compensation Regime for Oil Pollution from ships: International Solutions for a Global Problem", *Tulane Maritime Law Journal*, 32(1): 1-33.

Jacobssons, Mans (1994), "Compensation for Oil Pollution Damage Caused By Oil Spills from Ships And The International Oil Pollution Compensation Fund", *Marine Pollution Bulletin,* 29 (6-12): 378-384.

Jensen et al., (1998), "A System Approach To Environmental Sensitivity Index (ESI) Mapping for Oil Spill Contingency Planning and Response", *Photogrammatic Engineering and Remote Sensing*, 64 (10): 1003-1014.

Jernelov, A. (2010), "The Threat from Oil Spill: Now, Then, and in the Future", *Ambio*, 39: 353-366.

Jones, W. (1989), "Oil Spill Compensation and Liability Legislation: When Good Things don't Happen to Good Bills", *Environmental Law Reporter*, 10: 333–335.

Jose´ Juste-Ruiz (2010), "Compensation for Pollution Damage Caused by Oil Tanker Accidents: from *''Erika''* to *''Prestige''*, *Aegean Review of the Law of the Sea*, 1: 37-60.

Ketkar, K. W. and A. J. G. Babu (1997), "An Analysis of Oil Spills from Vessel Traffic Accidents", *Transportation Research,* 2 (1): 35-41.

Kim, Inho (2003), "A Comparison between the International and US Regimes Regulating Oil Pollution Liability and Compensation", *Marine Policy,* 27(3): 265-279.

Kinako, P. D. S. (1981), "Short Term Effects of Oil Pollution on Species Numbers and Productivity of a Simple Terrestrial Ecosystem", *Environmental Pollution* 29: 87–91.

Kingston, Paul F. (2002), "Long-term Environmental Impact of Oil Spills", *Spill Science & Technology Bulletin*, 7 (1–2): 53–61.

Lloyd, P.E., and P. Dicken (1977), *A Theoretical Approach to Economic Geography*, New York: Harper and Row.

Low, Luan and David Hodgkinson (1994), "Compensation for Wartime Environmental Damage: Challenges to International Law after the Gulf War", *Virginia Journal of International Law,* 35: 405-483.

M. Mason (2002), *Transnational Compensation for Oil Pollution Damage: Examining Changing Specialties of Environmental Liability* (Environment and Society Research Unit Seminar, University College London.

Mensah, Thomas A. (2010), "Can the SLOPS be Considered as a Ship for the Purposes of the 1992 Civil Liability Convention and the 1992 Fund Convention?", *Aegean Review of the Law of the Sea*, 1: 145-155.

Merrill, Thomas W. (1997), "Golden Rules for Trans-Boundary Pollution", *Duke Law Journal*, 46 (5): 931-1019.

Michael Mason (2003), "Civil Liability for Oil Pollution Damage: Examining the Evolving Scope for Environmental Compensation in the International Regime", *Marine Policy*, 27: 1-12.

Mironov, Oleg G. (1968), "Hydrocarbon Pollution of The Sea And its Influence on Marine Organisms", *Helgolander wiss. Meeresunters*, 17: 335-339.

Mitchell, Ronald B. (1994), "Regime Design Matters: Intentional Oil Pollution and Treaty Compliance" *International Organization*, 48 (3): 425-458.

Mitchell, Ronald B. (1994), "Regime Design Matters: Intentional Oil Pollution And Treaty Compliance", *International Organization,* 48 (3): 425-458.

Morgenthau, H.J.(1978), *Politics Among Nations. The Struggle For Power And Peace*, 5th ed., New York: Alfred A. Knopf, p.299.

Mostafawi, Nasser (2001), "How Severely Was the Persian Gulf Affected by Oil Spills Following the 1991 Gulf War?", *Environmental Geology,* 40: 1185-1191.

*National Academy of Sciences (1975), *Petroleum in the Marine Environment,* Washington, D.C.: National Academy of Sciences.

*National Research Council (1991), *Tanker Spills: Prevention by Design*, Washington D C: National Academy Press.

*Official Report, *Torrey Canyon,* (1967), Command Paper 3246, London: Her Majesty's Stationery Office.

*Oil Pollution Deskbook, Environmental Law Institute, 1991.

*Oil Tanker Spill Statistics. 2010. The International Tanker Owners Pollution Federation. http://www.itopf.com/information-services/data/documents/Statspack2010-FINAL.pdf.Accessed 20 June 2011.

Ottway, S. (1971), "The Comparative Toxicities Of Crude Oils." in E. B. Cowell (ed), *The Ecological Effects of Oil Pollution on Littoral Communities*, London: Applied Science Publishers Ltd, Institute of Petroleum.

Prashad, Vijay (2010), "A Disaster Foretold", *Frontline,* 27 (14): 25-29.

Prashad, Vijay (2010), "Deadly spill", *Frontline,* 27 (11): 34-38.

Redgwell, Catherine (1992), "Compensation for Oil Pollution Damage: Quantifying Environmental Harm", *Marine Policy*, 16(2): 90-98.

Roberts, K.E., "For Retention of Limitation of Liability for Shipowners", *American Bar Association Section of Insurance, Negligence and compensation Law*, 1967 proceedings 1968, p. 421.

Ronald B. Mitchell (1993), "Intentional Oil Pollution of the Oceans," in Haas, Keohane, and Levy (eds.), *Institutions for the Earth*, Cambridge: Cambridge University Press, pp. 183-248.

Smets, Henri (1983), "The Oil Spill Risk: Economic Assessment and Compensation Limit", *Journal of Maritime Law and Commerce,* 14 (1): 425-431.

Smith. S. T. (1991), "An Analysis of Oil Pollution Act of 1990 and the 1984 Protocols on Civil Liability for Oil Pollution Damage", *Houston Journal of International Law,* 14: 115-124.

Suchanek, T. H. (1993), "Oil Impacts on Marine Invertebrate Populations and Communities", *American Zoology,* 33: 510-523.

*U.S. Congress (1990), *Oil Pollution Act of 1990,* U.S. Public Law 101-380, 104 Stat. 484, 18 August.

*U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (1983), *Assessing the Economic Damages from Oil Spills: the Amoco Cadiz Case Study,* Washington, D.C.: U.S. Government Printing Office.

*United Kingdom Royal Commission on Environmental Pollution (1981), *Eighth Report: Oil Pollution of the Sea*, London: Her Majesty's Stationery Office.

Wall, James F. (1993), "Intergovernmental Oil Pollution Liability and Compensation: Theory and Practice", *Marine Policy*, 17 (5): 473-478.

Wilkinson, David (1993), "Moving the Boundaries of Compensable Environmental Damage Caused by Marine Oil Spills: the Effect of Two New International Protocols", *Journal of Environmental Law*, 5 (1): 71-90.

Wren, John (2000), "Overview of the Compensation and Liability Regimes under the International Oil Pollution Compensation Fund (IOPC)"s, *Spill Science & Technology Bulletin*, 6 (1): 45-58.

Wu, Chao (2002), "Liability and Compensation for Bunker Pollution", *Journal of Maritime Law and Commerce*, 33(5): 553-567.

Wu, Chao (2002), "Liability and Compensation for Oil Pollution Damage: Some Current Threats to the International Convention System", *Spill Science & Technology Bulletin*, 7 (1-2): 105-112.

Xin Liu and Kai W. Wirtz (2006), "Total Oil Spill Costs and Compensations", *Maritime Policy & Management*, 33 (1): 49-60.