2014

Marine environment protection from offshore oil and gas : activities in Sri Lanka

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MARINE ENVIRONMENT PROTECTION FROM OFFSHORE OIL AND GAS ACTIVITIES IN SRI LANKA

By

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Sri Lanka

A dissertation submitted to the World maritime University in partial Fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

In

MARITIME AFFAIRS

(MARITME SAFETY AND ENVIRONMENTAL ADMINISTRATION)

2014

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views and not necessarily endorsed by the University.

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ACKNOLEDGEMENT

Firstly, I would like to express my sincere gratitude to Dr. Yohei Sasakawa, the Chairman of Nippon Foundation for endowment of Sasakawa Fellowship and to my organization, the Marine Environment Protection Authority for giving this valuable opportunity to enhance my knowledge of maritime field by studying in the World Maritime University.

I would like extend my gratitude to my supervisor Professor Olof Linden who provided his valuable guidance in leading me in the accomplishment of the study. I further wish to thank Mr. Jagath Gunasekara, the Manager of the Marine Environment Protection Authority, for his advice and encouragement to join and study in the World Maritime University.

A special thanks also due to all the officers from different institutes who shared information through the questionnaire.

I would like to thank to the library staff for their assistance to collect information and research materials. I also thank my colleagues who encourage and help me to complete this dissertation.

Finally I would like to extend my deepest appreciated to my parents for their love and blessing, and to my wife Upulee and son Janindu for their patience during my studies in Sweden.

ABSTRACT

Title of Dissertation: Marine Environment Protection from Offshore Oil and Gas ACTIVITIES in Sri Lanka

Degree: M Sc

Offshore oil and gas exploration in Sri Lanka is a relatively recent which started in last decade. Following the discovery of two natural gas reservoirs in the Mannar Basin Sri Lanka sector in 2011 the exploration activities accelerated and international oil companies came into the scene. The government of Sri Lanka plans to extend the exploration, beyond the Mannar Basin to other areas including the Cauvery Basin. Therefore considering the impacts on the marine environment from exploration and exploitation, and the need to minimize and control these impacts, appropriate laws and regulations are vital in this initial stage of exploration.

The dissertation is a study of the likely future impacts on the marine environment of offshore oil and gas exploration and exploitation in Sri Lanka. The research is focusing mainly on the legal and regulatory regime and gaps and weaknesses in these areas.

Forecasts and trends in the international oil and gas industry and shifts in the demand for oil and gas are analyzed. The environmental impacts in various stages of the oil and gas exploration and production are examined. Furthermore, the marine environment of Sri Lanka and threats to this environment are discussed.

The gaps in the present regulation of Sri Lanka are identified by a comparison with selected regulations from Australia and New Zealand. In addition, other weaknesses are investigated by examining each part of the regulation. Furthermore the challenges in enforcement of Sri Lankan regulations are identified based on information from officers involved enforcement activities of these regulations.

The concluding chapter discusses the results and makes recommendations to overcome the identified gaps and weaknesses in the regulation and discuss how the enforcement of the regulations can be improved.

Key Words: Offshore, Oil, Gas, Exploration, Exploitation, Regulation, Marine Environment, Impacts

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ABBREVIATION

APPEA	- Australian Petroleum Production and Exploration Association
BOBLME	- Bay of Bengal Large Ecosystem Project
BOP	- Blow Out Preventer
CAPP	- Canadian Association of Petroleum Producers
CCD	- Coast Conservation Department
CLPL	- Carin Lanka Private Limited
CPC	- Ceylon Petroleum Corporation
CZMP	- Coastal Zone Management Plan
E&P Forum	- Oil Industry International Exploration and Production Forum
EIA	- Energy Information Administration
EIA	- Environmental Impact Assessment
GOAU	- Government of Australia
GONZ	- Government of New Zealand
GOSL	- Government of Sri Lanka
IEA	- International Energy Agency
IHS	- Information Handling services

IPIECA	- International Petroleum Industry Environmental Conservation Association
ITOPF	- International Tanker Owner Pollution Federation Ltd.
MEPA	- Marine Environment Protection authority
NOPEC	- Norwegian Petroleum Consultants
OPEC	- Organization of Petroleum Exporting Countries
PRDC	- Petroleum Resources Development Committee
PRDS	- Petroleum Resources Development Secretariat
TGS	- Tomlinson Geophysical Service
UNCLOS	- United Nations Convention on the Law of the Sea
UNEP IE	- United Nations Environment Programme - Industry and Environment
UNEP	- United Nations Environment Programme
USGS	- United States Geological Survey
WEO	- World Energy Outlook

Chapter 1

Introduction

1.1 Background

Energy is one of the main driving factors of the world's economy. In addition, sometimes it significantly impacts on international political decisions and events. Within the primary energy sources oil, natural gas and coal are dominant in the world energy supply and this is unlikely to change till 2035. (IPIECA, 2014). Due to the increase in the price of oil, which is driven by growing demand, many countries involve in oil and gas exploration and receive considering able economic benefits from it.

Sri Lanka is a developing country with a growing economy, and spent nearly $ 3.4 billion importing crude oil and petroleum products in 2012. This was close 20% of the total imports of Sri Lanka. Furthermore the total petroleum imports have doubled from 2009 to 2012. The Sri Lankan government started to explore the oil reservoirs in the late 1960's. However, before 2011 all the efforts were on finding deposits on land and in shallow waters. However, these efforts ended in failure. Offshore oil exploration was started in 2011 and two natural gas discoveries in the Mannar Basin gave evidence of liquid hydrocarbons (Yew, 2014). These discoveries accelerated the exploration activities in the Mannar Basin and attracted the attention of international oil companies to come to Sri Lanka. However, since oil and gas exploration may significantly affect

the marine environment, the government of Sri Lanka should consider it from this initial stage of oil and gas exploration and even before any such activities are started.

There are many reports regarding the significant environmental impacts as a result of pollution incidents from oil and gas exploration, exploitation and transport worldwide. Blowouts have occurred, sometimes with disastrous consequences. However, there are many other forms of pollution from oil and gas production in addition to blowouts which can result in environmental and socio-economic impacts. The risk of pollution is dependent on the possibility and consequence of the incident. Therefore, identification of those possibilities and consequences in advance are vital factors for protecting the marine environment. Measures must be both proactive and reactive. It is essential that there should be regulatory mechanisms to ensure the application and assignment of responsibilities the both proactive and reactive measures.

Sri Lanka has established a legal regime to regulate environmental impacts of offshore oil and gas exploration and exploitation in Sri Lankan waters in accordance with the Marine Pollution Prevention Act No.35 of 2008 and Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011. There is an institutional structure to enforce the relevant Act and regulations. However, these regulations have only been in force for the last few years and have note really been tested. The development of the oil and gas industry in Sri Lanka is a new experience for the country. Therefore there are still unidentified gaps and weaknesses in the regulations and enforcement activities. Identification of these gaps and weaknesses is essential in protecting the marine environment.

1.2 Objectives of the study

1. To evaluate future trends in offshore oil and gas exploration and exploitation, using the forecasts of the International Energy Organization and major oil

companies and identify possible environmental consequences due to the offshore oil and gas exploration and exploitation activities in Sri Lanka.

2. To analyze the national legal regime of Sri Lanka in order to identify risk for environmental impacts due to oil and gas exploration and exploitation activities. The purpose is also to assess their implementation locally.

3. To assess weaknesses and gaps in marine ecosystem protection as a result of oil and gas exploration and production, analyze the regulations for pollution prevention. Furthermore the objective is to propose what measures can be taken to overcome the identified problems.

1.3 Methodology

The study was done mainly as a desk study. Information was collected from international and national sources regarding the trends of the offshore oil and gas industry, the impacts of oil and gas industry on the environment, national regulations of Sri Lanka and a few other a other countries, and the marine ecosystems of seas around Sri Lanka. The information regarding the national enforcement of marine environmental protection regulations was collected through a structured questionnaire. This information was obtained from officers and experts who are involved in enforcement and implementation activities representing different agencies and organizations involved in the country. However, the number of officers and experts involved in the above activities is low in Sri Lanka because until now only one project which started in 2011 is ongoing. However, it is expected that further development of exploration will take place in the next few years.

To identify the weaknesses and gaps in "Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011," a gap analysis was done through a comparison with "Offshore Petroleum

and Greenhouse Gas Storage (Environment) Regulation 2009" of Australia and the "Marine Protection Rules Part 200: Offshore Installation- Discharge" of New Zealand. Furthermore, Sri Lanka regulation was reviewed in detail in order to identify the weaknesses which could not be identified in the comparison with Australian and New Zealand. The weaknesses of enforcement and implementation were identified through analyzing the information collected from officers and experts who are involved in enforcement and implementation activities. Recommendations are made regarding how to overcome the identified gaps and weaknesses through the above analysis.

1.3.1 Data collection

Data were collected using two methods. Mainly information collecting was done through the literature survey. In addition, primary data regarding to the enforcement and implementation activities of the regulations were collected through a structured questionnaire from the officers and experts involved in the above activities representing different institutes.

1.3.2 Gap analysis

To identify the gaps and weaknesses of "Offshore Exploration for and exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011", a comparison review was done with "Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulation 2009" of Australia and "Marine Protection Rules Part 200: Offshore Installation- Discharge" of New Zealand.

1.4 Structure of the Dissertation

The dissertation consists to seven chapters. The first chapter covers the background of the topic and research methodology. The second chapter reviews the future trends of the oil and gas industry. The impacts of offshore oil and gas exploration and exploitation are assessed in chapter three. Chapters four and five turn to Sri Lanka and explain the development of oil and gas exploration and exploitation in the country and the state of the marine environment respectively. Chapter four covers the history of oil exploration

in Sri Lanka, the future plans regarding offshore oil and gas exploration, and the existing legal regime relevant to offshore oil and gas industry. Chapter five is a detailed review of the marine environment of Sri Lanka. Chapter six focuses on gaps and weaknesses in the regulation marine environment protection from offshore oil and gas industry. Chapter seven presents the author's conclusions which are made after the review and analysis of the information and legal documents. At the end of this chapter the author presents recommendations to overcome the identified gaps and weaknesses in the Sri Lankan regulations.

Chapter 2

International Oil and Gas Industry

2.1. Trends of developing the offshore oil and gas industry

The offshore oil and gas industry has developed through decades while making a significant contribution to global energy demand. The future of the offshore oil and gas industry is determined by the world energy market and the technological development of the industry.

2.1.1 World energy demand and oil and gas industry

As a result of increasing population and income in emerging economies in China, India and Middle East, world energy demand is increasing rapidly and continuously (IPIECA, 2014). On the other hand world primary energy supply will grow only by 1.5% per annum in the period of 2012 to 2035 (BP, 2014). Global energy polices encourage the low carbon energy technologies and it is expected that the use of modern energies will almost triple by 2035 to about 14% of total energy supply. However, the production of this renewable energy is not enough to satisfy the growing global energy demand. Therefore the oil and gas industry will be further developed to satisfy the future demands. Figure 1 illustrates the world energy demand and projection produced by the International Energy Agency. (IPIECA, 2014)

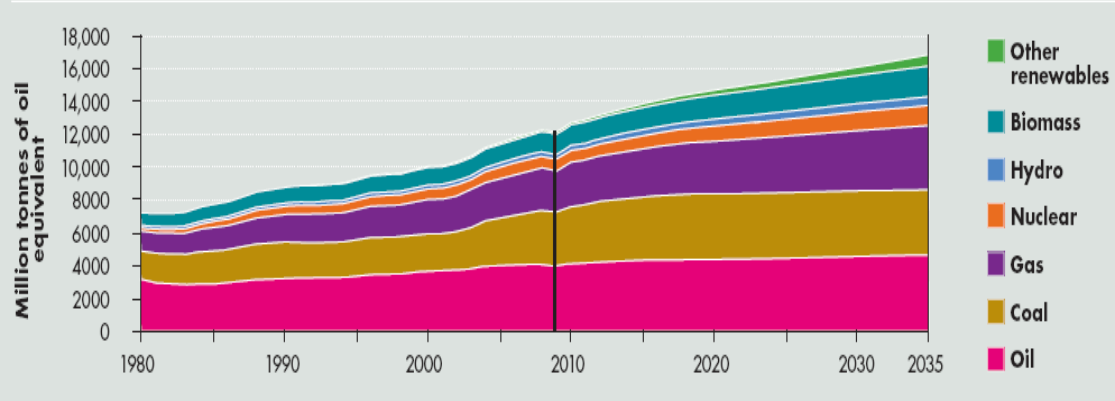

Figure-1; World primary energy demand in the WEO -20011 New Polices Scenario

Sources: IPIECA (2014) Energy outlook: Progressing All sources of Energy to Meet Growing Demand. http://rio20.ipieca.org/fact-sheets/energy-outlook

According to the IEA prediction world primary energy demand will grow between 20% and 40%, between 2009 and 2035 mainly due to the growing income and population. IEA has done that projection based on following scenarios.

1) 450 Scenario, "a scenario in the World Energy Outlook that sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO_2."

2) New Policies Scenario*:* "A scenario in the World Energy Outlook that takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced. This broadly serves as the IEA baseline scenario." (IEA, Publications: Scenarios and Porjection, 2014)

Oil and gas are predicted to fulfill 50% of the energy demand in 2035 in both the above scenarios.

According to World Energy Outlook 2011 the following factors will determine the role of oil and gas in the next 25 years.

- The demand of natural gas will increase due to its low cost and environmental advantage when compared with other fuels.
- The oil demand will increase due to the increase in number of passenger vehicles which will double by 2035.
- The usage of modern renewable energy such as wind, solar, geothermal, marine, bio mass and hydro, will increase by 2035. However, these sources will provide only 14 -27% of the total energy supply.
- Energy efficiency measures contribute for the half of cumulative CO_2 abatement achieved in 450 Scenario compared to the New Policies Scenario over the outlook period. That efficiency will be achieved through many tools including building standards, vehicle fuel economy mandates and the best technology (IPIECA, 2014).

2.1.2. Future Changes in the world's oil and gas market

The world energy map is changing due to the dynamic nature of energy demand and supply. Therefore major importers sometimes become exporters while some exporting countries become centers of energy demand. World Energy Outlook (2013) indicates that emerging economics like China and India and the countries in Middle East drive world energy use one third higher. According to the same report China will be the largest oil importing country while India will be the largest coal importer in 2020. Furthermore, India will become the largest single source of world oil demand growth after 2020. On the other hand the United States will move towards the domestic resources to fulfill its energy requirements by 2035. Oil consumption will be concentrated to support the transport and petrochemical sectors in 2035. Oil demand for transport and petrochemicals will reach 58md/d and 14mb/d respectively. One third of the increase of the demand for oil for the transport sector will support road freight in

Asia and the petrochemical industry in the Middle East, China and North America. As cumulative effect of the above changes the energy trade will move from Atlantic basin to Asia Pacific region (IEA, Executive Summary :World Energy Outlook -2013, 2013).

The price of crude oil is relatively uniform worldwide, but other than that all other fuel prices show significant price difference region-wise. The price of natural gas in the United States compared to most of the rest of the world can be taken as an example. The import price in the USA is one-third of import price to Europe and one-fifth of import price to Japan. The cost differences in the gas market could be minimized by moving towards a global gas market.

In addition, there is potential in some region like China, parts of Latin America and parts of Europe to develop unconventional gas resources. However, there is uncertainty over the quality of these resources, production costs and sometimes public acceptance of their development.

Since the growth of the emerging markets, China and the Middle East will have increased gas usage by 2035 while the European Union gas usage will decrease due to the growth of renewable energy and the use of coal in power generation. Therefore, gas consumption in the European Union is expected to return to the 2010 level (IEA, Executive Summary :World Energy Outlook -2013, 2013).

Global oil demand will rise to 101mb/d while production will fall to 65mb/d in 2035. Increasing the supply of unconventional oil and natural gas liquid will meet the above gap. Since the rise of oil supply from the United States and oil sands in Canada, the contribution of OPEC to fulfill the world energy requirement will be temporary reduced in the mid 2020's. However in mid 2020s non-OPEC production will start to fall while OPEC will provide more supply (IEA, Executive Summary :World Energy Outlook -2013, 2013).

2.2. The future of oil and gas exploration

Although renewable energies are promoted as environment friendly energy sources, their contribution to the global energy supply is significantly low. As mentioned in World Energy Outlook 2011 the contribution will not be significant even by 2035. Therefore, the exploration for oil and gas as the two main energy sources is vital to meet the world energy demand. Daly (2013) has mentioned that global discovered resources of are 4.5 trillion barrels of oil equivalent (tnboe) and the amount of yet-to-find (YTF) estimation is approximately 1 tnboe as shown in figure 2. Furthermore he mentions that the significant amount of resourses out of YTF is in deep water and onshore.

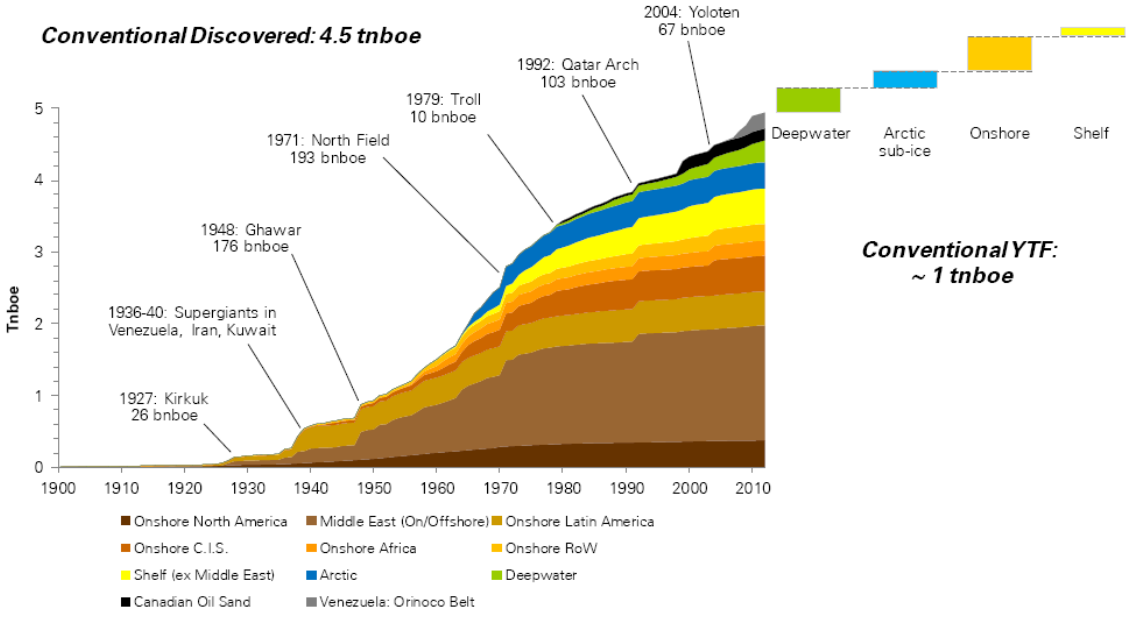

Figure- 2; Global discovered and yet-to find oil resources. Source; IHS EIA and CAPP

Daly (2013) http://www.bp.com/en/global/corporate/press/speeches/future-trends-in-global-oil-and-gas-exploration.html

Daly (2013) pointed out that most of the discoveries (volume) made over last decade are from deep water. The largest discovery at the Brazilian pre-salt play and the Paleogene

play of Gulf of Mexico are deep water exploration. Meanwhile the Rovuma Delta gas discoveries of Mozambique, the Krishna Godavari gas of East India, the Congo fan oil discoveries of West Africa and the greater Nile fan gas discoveries reported from young delta systems. Future oil exploration will into unexplored deep and "ultra-deep" (below 3000 m) areas. There will also be significant re-exploration of onshore and shallow water field with new more efficent tchnology (Daly, 2013).

The continental shelf and slope of the Artic Ocean is at present the major unexplored area with significant potential for hydrocarbon resources in the world as shown in Figure 3.

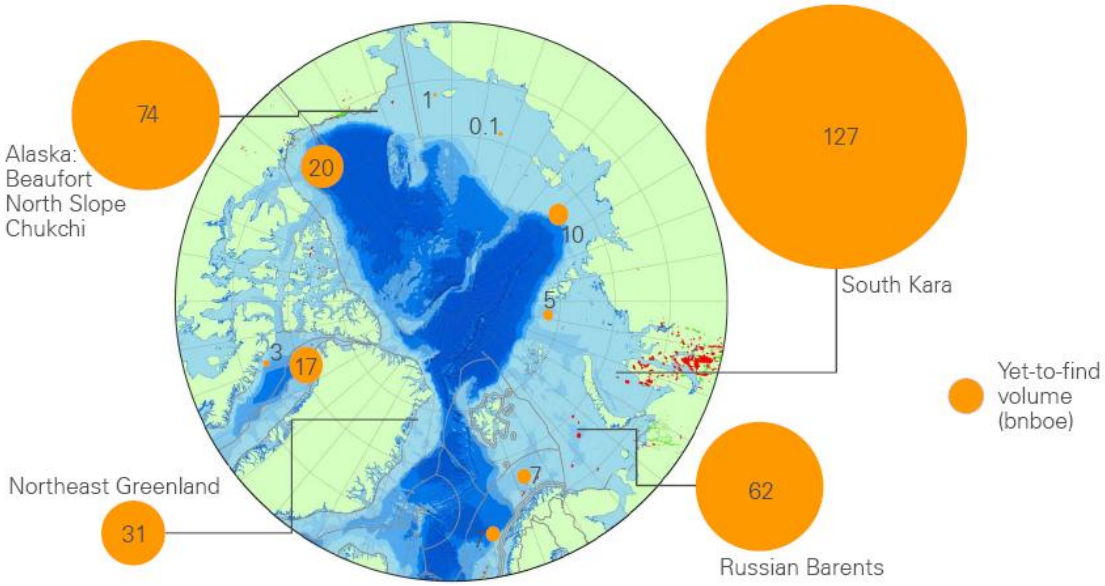

Figure-3 ; Yet-To-Find oil and gas resources in the Arctic region.
Source: United State Geological Survey 2008. Bp (2014)
http://www.bp.com/content/dam/bp/pdf/investors/SRI_Global_Trends_Influencing_Exploration_Nov13_2.pdf

Russia is the dominant country in Arctic Ocean as 60% of continental margin is in Russian waters. Figure 3 shows that the largest volume of YTF (south Kara) in Russian waters while another large field is present in the waters of Alaska.

However, there are very significant challenges for exploration in this region. The difficult environmental conditions in this area makes engineering and technical issues in the exploration activities a major challenge. In some areas with potential for oil and gas such as Beaufort Sea offshore northern Canada, the ice cover remains through 9 months of the year. Therefore, all operations including seismic surveys and drilling need advanced technology and supporting resources such as ice breaking. Furthermore, the public response to full-scale Arctic exploration can be a critical issue for the industry. Environmental mitigation including stringent antipollution measures should be developed to match with the Arctic environment (Daly, 2013).

The re-exploration of the onshore and shallow water is the next trend in oil exploration. This concerns unexplored rock volume in established basins. Since these are unexplored due to pressure ramps, poor imaging and limitation like tight rock, advanced technology is essential to overcome these issues. According to the BP “Yet-to-find” projection onshore exploration will be sustained in next 15-20years with re-exploration. (Daly, 2013).

Chapter 3

Environmental impact of offshore oil and gas exploration and exploitation

3.1. Marine pollution and oil and gas exploration and exploitation

The contribution of oil and gas exploration and exploitation to marine pollution is low when compared with other sources. However, the consequence of an oil spill from an oil rig is sometimes very high due to the release of huge amounts of oil to the marine environment. On the other hand an oil spill is the most reported pollution incident among many polluting incidents that have happened in the oil exploration and exploitation business because of resulting observable consequence in a short period of time. Major blowout incidents reported in the history of oil exploitation and exploitation are briefly discussed in below to identify the consequence of pollution occurred relevant to oil rigs.

Funiwa No. 5 Well Blowout

The blowout incident of Funiwa No.5 well which occurred on January 17 1980, is the worst pollution incident in the history of Nigeria. The owner company of the well, Texaco Overseas Petroleum Company of Nigeria could not control the situation and oil was released into the sea until January 30, 1980 when finally the well caught fire. The oil industry sources reported the amount of oil spilled into the marine environment in the range of 200 000 barrels. However, it was reported as 400 000 barrels by the Department of Petroleum Resources. The application of dispersants under rough sea conditions

reduced the amount of oil reaching the shore. However, oil was found on the beach even five months after the incident. The spill adversely impacted on the mangroves in Sangama and 836 acres of mangroves were killed by the spill. Furthermore the death of molluscs and crabs that lived in that ecosystem was reported after the spill. It impacted on the fishery industry in the region and consumers complained the taste of kerosene was noticeable in the fish. This was due to oil in the water. (Aghalino & Eyinla , 2009)

Ekofisk Bravo Platform Blowout

The Ekofisk Bravo platform was located on the Norwegian Continental Shelf and operated by Phillip Petroleum Company. The blowout was occurred on April 22 1977 as the largest oil spill in the North Sea. When the blowout happened the Blow Out Preventer (BOP) had not been established and the failure of an incorrectly installed downhole safety valve resulted in the blowout. All personnel were evacuated without any injury but the blow-out resulted in a significant oil spill. The total release of oil was estimated to be about 200 000 barrels and according to the Norwegian Petroleum Director it was 80 000 to 126 000 barrels. Up to 30-40% of spied oil volume evaporated and the remaining part was broken up by wave action which reduced the impact on marine environment and shoreline (EU Offshore AuthoritiesGroup, 2014).

Sedco 135F- Ixtoc I Blowout

The blowout was reported on June 03, 1979 from well Sedco 135F in the Gulf of Mexico, which was operated by the state-owned Mexican Petroleum Company Petroleos Mexicanos (PEMEX). It had been drilled to 3657m when the blowout occurred due to loss of mud circulation. Although the platform personnel closed the BOP, they could not prevent the discharging of oil and gas due to the extremely high pressure and the failure to cut the thicker drill collars. The rig caught fire and sank with the 3000 m pipe. Oil was flowing at an estimated rate of 30 000 barrels/day at an initial stage of the blowout after several months it was reduced to 10 000 barrels/day by drilling two relief wells to

relieve pressure. However, the spill continued to occur through nine months and a total of 3.5 million barrels of oil was released to the sea. The coast of Maxico, particularly the shore between Veracruz and Tempico were severely damage by the spill (Jernelov and Linden 1981). Some oil spills also affected the coast of Texas. The incident was reported as the biggest spill up to that time in the world (EU Offshore AuthoritiesGroup, 2014). The impacts on species such as fish, shrimp, crabs, turtles and molluscs due to chemical toxicity were reported. On the other hand, fishing was restricted or band in some severely contaminated areas (Jernelov and Linden, 1981).

Macondo well blowout Gulf of Mexico.

The accident at the exploratory well "Macondo" of the Deepwater Horizon rig in Mississippi Canyon block 252 was reported to have resulted in the biggest peace-time oil spill in the world when it occurred on April 20, 2010. According to the National Commission on the BP Deep water Horizon Oil Spill and offshore Drilling (2011) the blowout happened during the temporary abandonment of the well as it was difficult to contain the hydrocarbon pressure in the well. The rig caught fire and the oil spill continued until the well was capped on July 15, 2014. The estimated amount of oil released into the sea was near 5 million barrels (National Commission on the BP Deep water Horizon Oil Spill and Offshore Drilling, 2011). Eleven deaths and 17 injuries were reported due to the accident and more than 650 miles of Gulf coastal habitats were polluted by oil to a greater or lesser extent. The oil slick at times covered 40% of the offshore area which is used by larvae of the northern Gulf's estuarine dependent species such as prawns. However, surprisingly low numbers of animals were affected and according to the records of wildlife responders, 8 183 birds, 1 144 sea turtles and 109 marine mammals were affected by the oil through November 01, 2010. The pollution affected commercial fisheries in the Gulf and the tourism industry along the coastline and caused adverse impacts on the local economy (National Commission on the BP Deep water Horizon Oil Spill and Offshore Drilling, 2011).

3.2 Environmental impact of oil and gas exploration and production

An oil spill is the most highlight pollution incident in the offshore oil and gas industry. However there are many impacts on the marine environment due to activities of oil and gas exploration and exploitation.

3.2.1 Potential Impact of Seismic surveying

Seismic surveys are used to determine the hydrocarbon deposits below the sea floor through the identification of geological features. Identification is done by sending acoustic sound waves into various rock layers under the sea bed and then recording the time it takes for each wave to return and measuring the strength of returning waves. The survey is conducted using a vessel towing number of percussion devices which are submerged in 6-10 m below the sea surface. Sound is produced by an underwater piston in each device driven by compressed air. Return sound waves which are reflected from different rocks type under the sea bed are detected and recorded by microphones called hydrophones as shown in figure 4. Next the recorded signals are translated into a geological cross section along the lines being worked. In the regional survey referred as 2-D survey, the vessel sails along grid lines that can be 5 km up to100 km apart. At a survey in a smaller area for more detail investigation, called a 3-D survey, the vessel sails along grid lines that sometimes are only about 100 m apart. (APPEA, 2014)

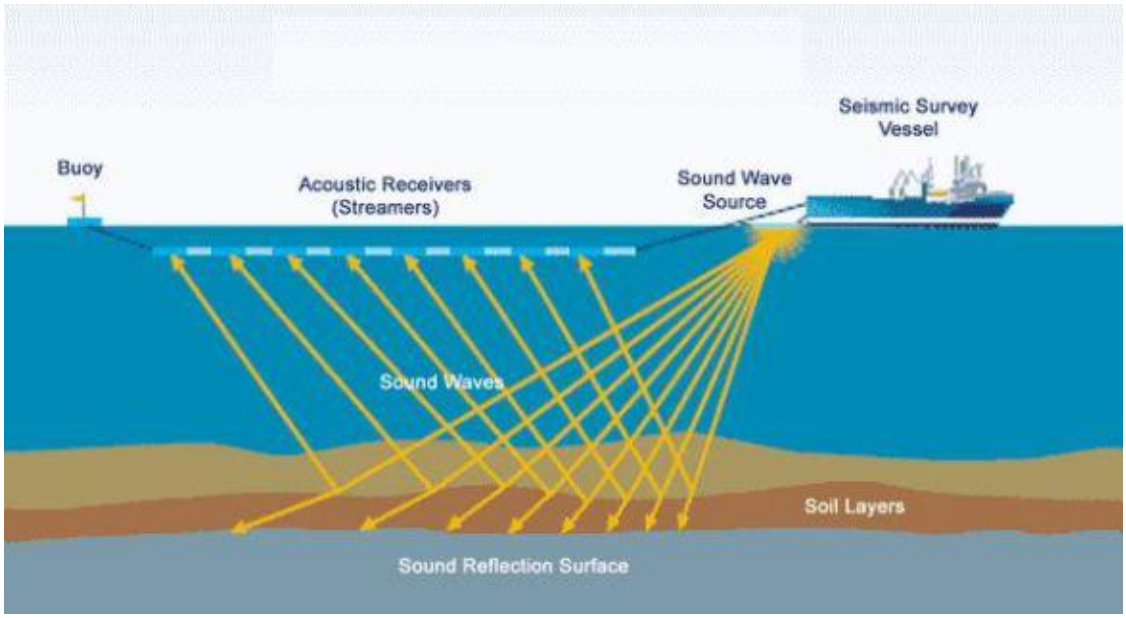

Figure - 4; Seismic survey
Source; Massebeau (2012), B P makes Bid for Arctic oil
http://championsforcetaceans.com/tag/oil-exploration/

Sound waves which are emitted to the sea can impact adversely on marine animals. There is evidence of the change of whales' behaviour during the seismic survey. (McCauley et al. 2000) explained the relationship of the behaviour of humpback whales and seismic surveys. They found that male humpbacks are attracted to survey ship and they explain that behaviour was due to the identification of gun signals as a breaching signal. Normally male humpback whales generate songs to attract females or to signal other males as to their presence and breeding interactions. During the seismic survey the male humpback, can miss-identify the sound signals as signals of a competitor. On the other hand, whales are dislocated from their migratory routes, feeding grounds and calving grounds by the interruption of the seismic survey. The same research group (McCauley et al. 2000) mentioned that repetitive displacement or disruption to animals at the calving ground may seriously impact on the population level.

Changes of sea turtle behaviour have also been observed in seismic surveys at a certain level of sound produced by the air gun. McCauley et al (2000) observed that turtles avoided seismic vessels in the first presentation of the air gun exposure. However it was not observed in the further trials. Fish change their behaviour by increasing the swimming speed at the seismic survey. Next, they swim to a deeper water column and at the high air gun level (high level of sound) they compact schools probably near the bottom of the continental shelf depth. Finally the startle response as the form of C-turn can be expected (McCauley et al, 2000).

3.2 .2 Potential Impact of Exploration and Production

After the identification of oil or gas reservoirs, exploratory wells are drilled to ensure the presence of hydrocarbons, thickness and internal pressure of a reservoir. Offshore drilling is done by using various mobile offshore drilling units (MODUs) as illustrated in figure 5. The type of drilling unit depends on the depth of water, seabed conditions and prevailing meteorological conditions. (UNEP, 1997)

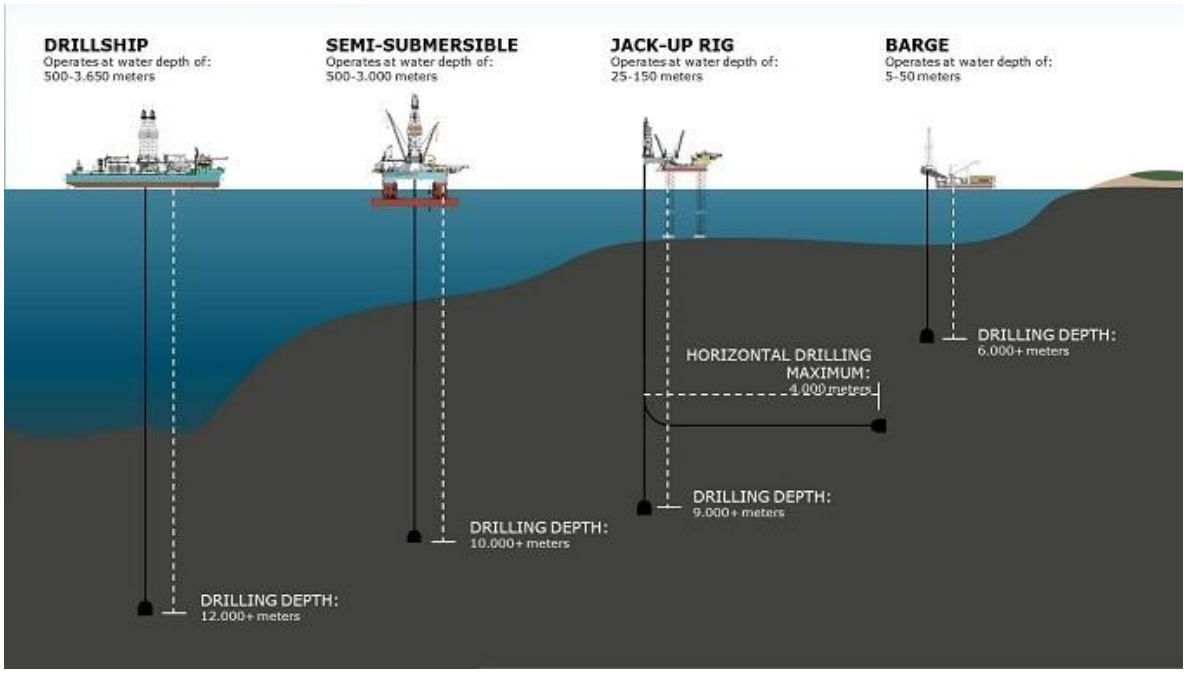

Figure -5 ;Types of offshore drilling units

Source: Maersk Drilling http://www.maerskdrilling.com/aboutus/the-drilling-industry/pages/the-drilling-industry.aspx

In the exploratory drilling the drilling fluid is continuously circulated through a drill pipe from the surface to the well and back to the surface. The drilling fluid is used to bring drill cuttings to the surface, balance the underground pressures and cool the drilling bit (UNEP, 1997) **.**

Residual drilling fluid and rock cuttings, oil, wastewater, air emission, and solid household waste are the main pollutants in the operation of an exploratory well.

I). Residual Drilling Fluid and Cutting

There are two types of drilling fluids used in exploratory drilling named Water Based Fluids (WBF's) and Non Aqueous drilling Fluids (NAF's). NFA's are also called Synthetic Based Fluids (SBF's). WBFs contain approximately 75% of water and the

other portion contains chemical additives and barite to obtain the desired properties and density. Comparatively, WBF's are less harmful to the marine environment because clay and bentonite are chemically inert and non-toxic. Furthermore, since heavy metals such as Ba, Cd, Zn and Pb are bound to particles they are less bioavailability. However, discharges of WBFs in to the sea have shown impact of temporary smothering to benthic organisms which are approximately 100 to 300 feet from the discharge. Although WBF's impact less on the environment and are cheaper than NAF's they are not suitable for faster drilling.

NAFs are used for faster drilling and they reduce drill solids and liquid waste volume because they are more recyclable than WBF's. As shown in table 1 below NAF's are divided in to three groups according to their content of aromatic hydrocarbon.

Table -1; Groups of the NAF's

	Group I NAF	**Group II NAF**	**Group III NAF**
Oil based fluid	Diesel and conventional mineral oil-based fluid	Low toxicity mineral oil-based fluid	Highly processed mineral oils and synthetic based fluid
PAH* %	2-4%	0.35%	<0.001%
Toxicity	High	Low	Lowest

* - Polycyclic Aromatic Hydrocarbon

Sources: Offshore operations subgroup of the operation and environment task group (2011) *Subsea Drilling, Well Operations and Completions* http://www.npc.org/prudent_development-topic_papers/2-11_subsea_drilling-well_ops-completions_paper.pdf

Since group I NAF's contain diesel and conventional mineral oil-based fluids, discharging of Group I NAF into the sea is harmful to the benthic community. Group III NAF's, the new generation of NAFS's have the lowest toxicity and impact less on the benthic organisms than other groups. The effects of them are rarely seen beyond 750 to

1500 feet from any discharge. (Offshore Operation Subgroup of the Operation and Environment Task Group, 2011)

II) Spilled Oil

Although a blow-out may cause a major oil spill, spills may occur from a number of other sources during offshore drilling and production. Oil rigs may spill smaller volumes of oil in connection with drilling and production. Also, in connection with transfer of oil to barge or other vessels spills may occur. There is also a risk due to collisions between supply or oil transporting vessels. Even through spills from these sources are likely to be smaller in volume compared to full scale blow-outs they may cause significant adverse impacts on marine animals and their habitat in the marine environment. Spilled oil can impact on the marine environment as follows.

1. Physical smothering with impacts on the physical functions.

2. Chemical toxicity.

3. Ecological changes; the loss of key organisms may lead to outbreaks of invasive alien species.

4. Indirect impacts such as the loss of habitat and elimination of ecologically important species.

Sea birds are one of the main victims of almost all oil spills. Birds like the sea ducks and auks which raft together in flocks on the sea surface are at most risk. Their feathers are covered by oil and the fouling of their plumage damages both their insulating mechanism and buoyancy. Therefore, birds succumb due to hypothermia and drowning. Furthermore, since oiled plumage reduces the ability to fly, birds cannot find food and escape predators. On the other hand, oil can enter the bird when cleaning itself daring preening and the ingested oil can seriously damage the lungs, liver and kidneys.

Sometimes oil can be transferred to eggs or youngsters in the nest through oiled birds and can result in the thinning of the eggshell and develop other of abnormalities.

Floating oil harms to nasal tissues and the eyes of whales, dolphins and other cetaceans because they have contact with the oil when they surface to breath or breach. Seals, otters and other marine mammals are unable to regulate their body temperatures when their fur is covered by oil and they may die from hypothermia or overheating. When beaches are polluted by oil during the nesting season, turtles lose their eggs and hatching on those beaches. Furthermore adult turtles can suffer mucus membrane inflammation due to the contact with oil.

Marine ecosystems with habitats for many animals are damaged by spills. The mangrove is a highly vulnerable ecosystem for oil because of its muddy and anaerobic condition. When oil covers the mangrove growing area it blocks the oxygen supply of root system and may cause the mangrove to die. In addition, the toxic compounds of oil interfere with the mangrove plant's salt balancing system and affect the ability to tolerate salt water. Coral reefs are rich in biological diversity with high productivity and which are affected by oil. Since corals are highly sensitive organisms they take a long time to recover from the oil damage. Furthermore, oil spill dispersant which are used in oil spill combat operations impacts on the communities of corals. The impact of oil on the sea grass ecosystem is less than the mangrove and corals because floating oil passes over the submerged sea grass without any harm. However, if oil mixed with water in shallow areas where sea grass is dominant then the sea grass and associated organisms can be affected.

Spilled oil finally reaches the shore and pollutes damaging the flora and fauna on the beaches. The damage and recovery period vary according to the types of beaches. Sheltered rocky shores and salt marsh take more time to recover than sand and exposed

rocky beaches (ITOPF, 2011). Table 2; below shows the recovery period for the marine habitat after oil pollution.

Table -2: Recovery period of marine habitats

Habitat	Recovery period
Sand beaches	1-2 years
Exposed rocky shores	1-3 years
Sheltered rocky shores	1-5 years
Salt marsh	3-5 years
Mangroves	10 years and greater

Source: ITOPE (2011) Effects of oil pollution on the marine environment http://www.itopf.com/knowledge-resources/documents-guides/document/tip-13-effects-of-oil-pollution-on-the-marine-environment/

III) Waste water

Generated waste water during the oil and gas exploration and production phases includes domestic and sanitary waste water, deck drainage water, once – through fire water, non-contact cooling water, bilge water and ballast water. Waste water is less harmful to the marine environment when compared to drilling fluid and drillings cutting because of its smaller quantity and dissolved waste. However when waste water comes in contact with oil or other hazardous waste, it may be of risk to the environment. Especially drain water from areas near to the rig floor and mud pump is mixed with oil and should be sent through an oil water separator before being discharged into the sea (Offshore Operation Subgroup of the Operation and Environment Task Group, 2011).

IV) Solid waste

Solid waste in drilling rigs or production wells can be grouped as-non hazardous and hazardous solid wastes. Non-hazardous solid wastes such as general garbage are less harmful to the marine environment, but wastes like oil, oil rags, paint cans, used oil

filters and spent paints, which are categorized as hazardous wastes are harmful to the marine environment, because these wastes bring oil and pollute the sea (Offshore Operation Subgroup of the Operation and Environment Task Group, 2011).

V) Air emissions

Air emissions from offshore rigs are due to following operations.

- The combustion of power generation equipment
- The mobilizing and demobilizing of helicopters and supply vessels
- The well clean up and well testing
- The venting of storage vessels, bulk material transfer, drilling fluids circulation and water treatment
- The fugitive emissions from equipment.

The most significant emissions are from the combustion of fuel for power generation, transport and well testing. Emissions generated by the operation of a rig are nitrogen oxide (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter (PM), volatile organic compounds (VOCs), carbon dioxide (CO_2), and methane (CH_4) (Offshore Operation Subgroup of the Operation and Environment Task Group, 2011). Those emissions contribute to the green house gas effect, depletion of the ozone layer, and acid rains.

3.2.3 Potential impact of oil and gas transport vessels and supply vessels

Supply vessels are used to transport fuel, chemicals, foods and other materials on oil rigs. On the other hand, oil transport is done by ships from offshore loading platforms or storage to the refinery and from the refinery to other regions or countries. The oil spill is the main threat for the marine environment in these operations. In addition, emissions from ships also lead to air pollution. The impact of both of these pollution types has been explained in section 3.2.2. The introduction of invasive species through ships is

another threat to the marine environment which can occur is associated with the supply vessels and the oil and gas transport vessels of oil and gas industry.

Non-indigenous species can be introduced by ballast water and the hull fouling of ships. Some of these species adapt to the new environment and act as invasive species. They impact on native species through competing food and space and sometimes they prey upon the native species. Therefore, they alter the food web and lead to the displacement of native species from the environment. Meanwhile invasive species spread rapidly over the area within a short period of time. Therefore, biodiversity is reduced in the ecosystem due to the introduction of invasive species (GloBallast Patnerships, 2014).

In addition to above impacts from the oil and gas exploration and production phases, there may be impacts due to the well decommission phase, because marine pollution can be occurred due to the oil and toxic material in the rig. On the other hand, sound generated from under water activities and using of explosives in the well decommission stage can be adversely affected on animals such as cetaceans. Therefore, rig to reef programme which promotes abundant rigs use as artificial reef is used to avoid these environmental impacts. However there is argument that these artificial reefs cause to relocate habitats from the normal living areas. On the other hand, moving of the rig to the place where artificial reef establish, causes to damage to the sea bed and emits toxic and harmful substance into the sea (Clark, 2013).

3.3 Mitigation Measures

Mitigation for the environmental impact of oil and gas exploration and exploitation should be done through regulatory and management tools and operational procedures with the contribution of regulatory bodies, oil companies, well owners, contractors and other stakeholders.

National regulations are the main regulatory tools for offshore oil and gas exploration and production. National Acts, regulations and guidelines are used to ensure

environmental protection at the initial stage of the process. Submission of the following documents is a requirement to granting approval for the application of oil and gas exploration and exploitation under the many regulatory bodies.

- Environmental assessment
- Plan for waste disposal and control of emissions and discharge
- Emergency preparedness plan
- Control of hazardous substances
- Reclamation and rehabilitation of site at completion of the operation and following the accident

The guidelines and format for these documents should be provided in national Acts and regulations. Important procedures such as the Environmental Impact Assessment (EIA) should be prescribed. Furthermore the environment monitoring procedure should also be decided at the beginning of the operation. National regulations should maintain proper monitoring mechanisms to ensure the mitigation procedure during the operation (E&P Forum and UNEP IE, 1997).

However environmental monitoring before and during offshore oil and gas activities is not carried out properly in Sri Lanka due to many reasons including weaknesses in the Acts and regulations, lack of resources and lack of baseline data. Therefore, taking action to overcome the above limitations is vital to improve the marine environmental protection in connection with offshore oil and gas activities.

Sri Lanka has national oil spill contingency plan covering all oil spills including the oil spills from oil rigs. The required equipment for oil spill response is provided by Sri Lanka Navy, Sri Lanka Coast Guard, and some government and private organizations. However, these equipment are not adequate to contain even medium size oil spill. Therefore, the oil spill contingency plan should be updated and all relevant organizations should acquire additional equipment to be able to respond to different levels of oil spills.

Furthermore, there is currently no implementation of ballast water and hull fouling management. It is expected that the number of vessels in the Sri Lankan waters will increase as a result of the development of the oil and gas industry and this increases the threat of alien species invasions. Therefore, in order to deal with these issues policies for ballast water and hull fouling management should be formulated and implemented urgently.

In addition to national legal framework the international industry of oil and gas has formulated its own self regulation and principle of goal setting to ensure the protection of the environment. It takes independent actions to introduce good environmental performance through industry guidelines and international business charters such as the International Chamber of Commerce and E&P Forum. However these guidelines are not always applicable in every region due to the ecosystem and regional variations (E&P Forum and UNEP IE, 1997). The implementation of Health, Safety and Environment (HSE) policy on the rig and continuous monitoring of the policy are important management principles for environment protection in this industry.

At the operational level mitigation measures are vital for preventing the pollution incidents and protecting the environment as with as human lives. Using effective and efficient proactive prevention techniques is the key factor to minimize the possibility of accidents. However the reason for most accidents is not technical failure but human error. Therefore, the training and capacity building of the crew regarding prevention of accidents is essential to ensure safety and environmental protection. All approved plans and procedures such as waste and discharge management should be implemented with appropriate technology and equipment at the operational level. Finally, at the pollution incident reporting, recording and implementing of emergency plans should be done to minimize the impact (E&P Forum and UNEP IE, 1997). Identification of the environmental risk from oil and gas exploration and exploitation activities and mitigating potential impacts through regulatory, management and operation tools ensure

protection of the marine environment as does the uninterrupted utilization of those valuable energy sources.

Chapter 4

Oil exploration in Sri Lanka

4.1 History of Sri Lankan oil exploration

Natural gas discoveries with the potential of liquid hydrocarbon were reported from Sri Lanka in 2011. The findings were the result of an extensive effort from the late 1960's. In the 1967-68 the Compaign General de Geophysicque collected 420 km of onshore and 75 km of offshore seismic data on behalf of Ceylon Petroleum Corporation (CPC). After that experts from the Soviet Union produced seismic data under an agreement with the Sri Lankan government in 1972-1975. They collected 4837 km of marine seismic data and some onshore data in Cauvery Basin and drilled the first exploratory well called Pesalai 1 in Mannar Island. This resulted in small amounts of dissolved gas which encouraged them to drill another 2 wells named Pesalai 2 and Pesalai 3. However both of the wells failed.

In 1976 Western Geophysical produced 2D seismic data around Sri Lanka and recorded 1947 km data around the country and 2829 km data in Palk Strait and the Gulf of Mannar. They signed a contract with CPC which involved further exploration. Marathon Petroleum drilled two exploratory wells (Palk Bay 1 and Delft 1) in Cauvery Basin in 1976 but both failed. The next attempt was made by Cities Services who collected 1556 km of seismic data including 1289 km data in Gulf of Mannar and 267 km data in Palk

Bay in 1981. Furthermore, they drilled an exploratory well called Pearl 1 which was drilled to 3050 m depth in the northeast shelf of Gulf of Mannar. Although it also ended in failure, the company reported a volcanic sill in the bottom. This was the first time such a sill was reported in the Sri Lankan portion of Mannar. The Oil and Natural Gas Cooperation of India made the PH-9 discovery about 30 km north of the maritime boundary of India- Sri Lanka in that time period. Therefore, Cities Services drilled another well called Pedro 1, but it ended at 1437m without any discovery. Under the tripartite agreement between Phoenix Canada Oil Company, Petro- Canada and CPC, 980 km of 2D seismic data were collected by Petro-Canada as a comprehensive seismic programme for the first time in 1984.

There are no reports regarding oil exploration attempts in Sri Lanka for 17 years after 1984. As a result of an assessment report made by the University of New South Wales evaluating the petroleum potential of Sri Lanka in 2001, TGS NOPEC, a Geophysical Company from Norway signed an agreement with CPC for a speculative seismic data programme in Mannar Basin in the same year. They acquired 1100 km of 2D seismic data and the interpretation report highlighted the petroleum potential of Mannar Basin. Therefore the company collected additional data of 4600 km in 2005.

Attempts made by the Government of Sri Lanka and TGS NOPEC to attract exploration companies to Sri Lanka from 2002 to 2006 were not successful. The Government of Sri Lanka bought 2D data of Mannar Basin from TGN NOPEC under the Cabinet decision in 2007 and Mannar basin was divided in to 9 exploration blocks ranging 3340 to 6640 km^2 as shown in figure 6 below. Three of those blocks were offered exploration in the first international licensing round by Petroleum Resources Development Secretariat in the September of 2007. However three bids were received only for one block (SL 2007-01- 001) and the other two received one for each. According to the decision of the Cabinet Ministers' bid, evaluation was done for only block SL 2007-01-001 (shown in

figure 7 below) since the number of bids was inadequate for others. Cairn India Limited was the winning bidder and, according to the technical evaluation committee and cabinet, appointed a negotiation committee. In 2008 the Government of Sri Lanka singed a petroleum resources agreement with Carin Lanka (Private) Limited (CLPL) and this was the beginning of a successful exploration attempt (PRDS, Exploration History, 2013)

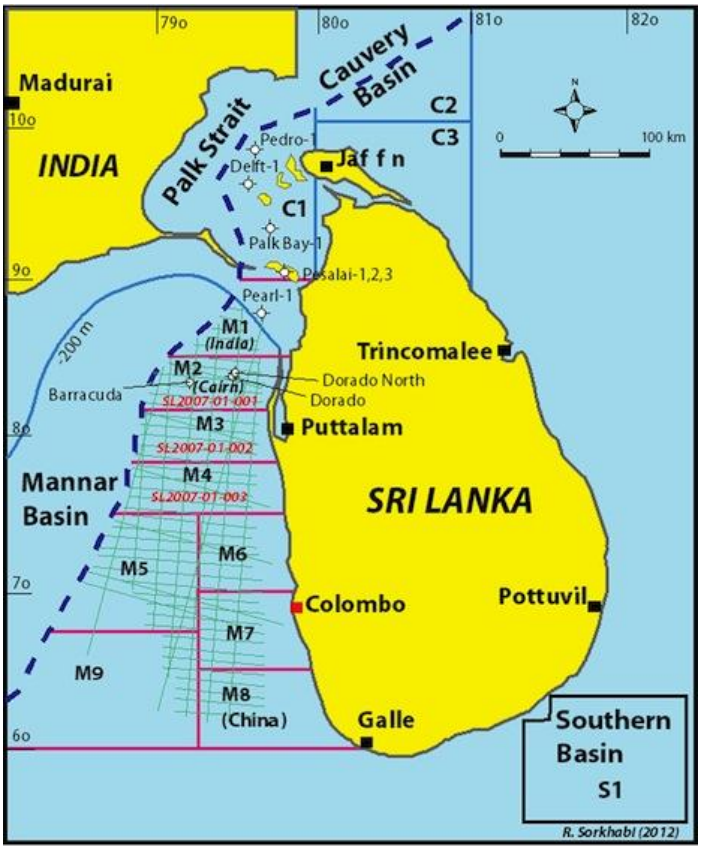

Figure-6 ; Exploration blocks of Sri Lanka
Source: Sorkhabi (2013) Cairn Discovers gas Offshore Sri Lanka
http://www.geoexpro.com/articles/2013/02/cairn-discovers-gas-offshore-sri-lanka

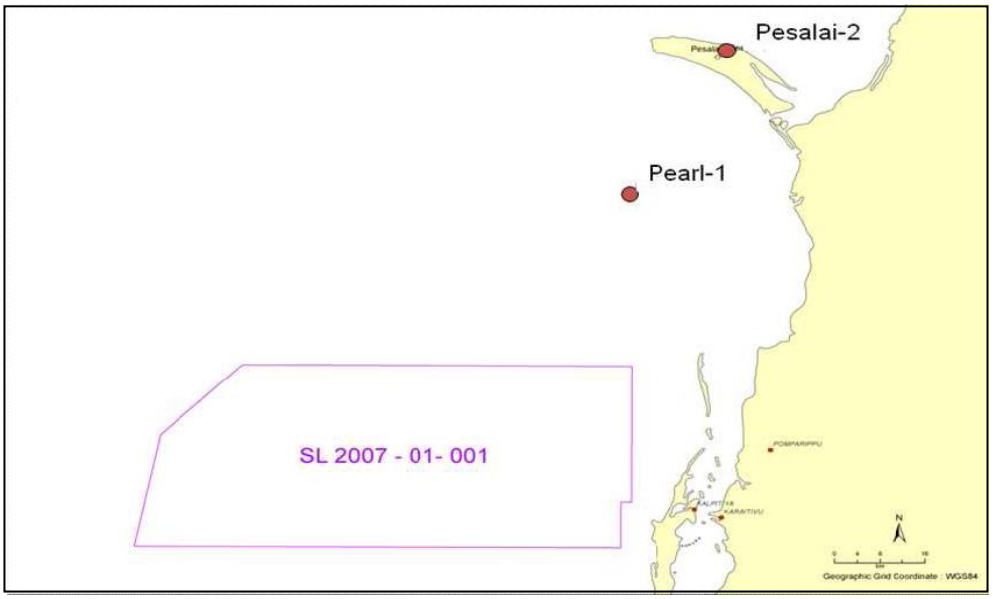

Figure -7; Exploratory block SL 2007-01-001 in the Mannar basin
Sources: CLPL (2011) Environmental Impact assessment Report

4.2 Oil and gas exploration in Mannar Basin by Carin Lanka (pvt) Limitet (CLPL)

SL 2007-01-001 block is approximately 3000 km^2 in size with a water depth of 600m to 1800m. The 3D seismic survey for the block was carried out during the period of December 2009 to January 2010 which acquired more than 1750 km^2 data. After that an exploratory drilling programme was started in 2011 with a plan to drill three wells in the identified location at the seismic survey and additional wells in accordance with the results of the first there wells. (CLPL, 2011)

CLPL made two discoveries in Mannar basin in 2011. The first discovery was reported from the exploratory well Dorado 91 H/1z that 30 km from the Sri Lanka coast at 1354m water depth. It encountered 24m of gas bearing sandstone. The next discovery was from the Barracuda -1G/1 well located 38 km west of Dorado, at 4741 m total depth including 1509 m water depth. It also encountered three similar gas paying zones. Although these

sand stones were mainly bearing natural gas there were potential indications for some liquid hydrocarbons too. Dorado North 1-82K/1 was the third well that proved to be dry and was abandoned in December 2011 (Sorkhabi, 2013). The Director General of PRDS disclosed to the media that PRDS had made a formal recommendation in May 2014 to enter into a conditional Gas Purchase Agreement with Cairn (India) for the production of gas. He further mentioned that PRDS expected the first gas delivery from Cairn at the end of 2017 or beginning of 2018. Cairn India has reported to the media that after the development of the field work, Sri Lanka would have access to an estimated 73 million barrels of oil equivalent hydrocarbon in the block of the Mannar basin (Yew, 2014).

4.3 Regulating mechanisms of offshore oil and gas exploration in Sri Lanka

4.3.1 Petroleum Resources Act No.26 2003

Petroleum Resource Act No.26 2003 regulates all petroleum exploration and exploitation activities in Sri Lanka. The petroleum Resources Development Committee (PRDC) has been established under section 5 of this Act and is the main regulatory body in petroleum exploration and exploitation. PRDC consists of the following members:

- The Secretary to the Ministry of the Minister in charge of the subject of Petroleum Resources Development, as chairman
- Secretaries of Ministries of the Ministers in charge of the subjects of Power, Energy, Finance, Environment, Natural Resources, Fisheries, Ocean Resources and Defences
- The chairman of The Board of Investment of Sri Lanka
- A nominee of the Ministry of Minister in charge of the subject of Policy Development and Implementation
- A nominee of the Minister in charge of the subject of Petroleum Resources Development with qualifications and experience in the field of petroleum resources.

PRDC is the authorizing committee and for regulating policy formulation regarding petroleum resources and license issuing processes including calling bids and negotiations on behalf of the State and preparing agreements. Furthermore, it monitors the petroleum exploration and exploitation. It has the authority to collect, compile, and published geological, geophysical, engineering and economic data relevant to the petroleum resources of Sri Lanka and to ensure the application of the laws relating to intellectual property to the collected data.

According to the Petroleum Resources development Act No.26 of 2003, no person shall conduct petroleum operations in Sri Lanka without entering into a petroleum resources agreement or any other appropriate agreement with the State. Applications for petroleum agreement of the defined block shall be made to the PRDC and forward them to Cabinet of Ministers for selection. The selection is done by considering qualification, experience with technical capacity of the applicant and the greatest economic benefit to the country. The selected applicant shall submit a project development and investment proposal for the approval of PRDC. If the proposal is accepted, the PRDC issue a Development License for the recovery of petroleum resources within a designated area of the exploration block with conditions. PRDC has the power to supervise the license and if necessary to cancel it.

The Act provides provision to establish a secretariat called the Petroleum Development Secretariat (PRDS) headed by the Director General of Petroleum Resources. PRDS shall act on behalf of the State for all purposes regarding petroleum resources agreements. It approves the annual work programmes and budgets submitted by contractors and manage the sale, storage and transportation of the State share of petroleum resources. In addition, it involves other functions regarding the contractual and operational interests of the country.

4.3.2 Geophysical, Geological, Environmental and Geotechnical Programme Guidelines

Based on the petroleum Resources Development Act No.26 of 2003, PRDS published Geophysical, Geological, Environmental and Geotechnical Programme Guidelines in 2008. It provides guidelines covering all phases of petroleum exploration and exploitation. According to the above guidelines, application should be made to PRDC for authorization on the relevant application format given by Appendix 1 of the guidelines. PRDC reviews the applications concerning programme description, safety of operations, benefits for Sri Lanka and environmental protection. When all of these have been addressed by the contractor or operator to a satisfactory level, PRDC approves the application and grants authorization which is valid for six months from the authorization date. Any amendment and additions of the programme require additional authorization.

There is a requirement of reporting mentioned in the guideline for the survey and other field work. The conductor or operator of the survey is responsible for reporting on the commencement and completion of the survey to PRDC. In addition to that, weekly progress reports must be made with the information listed in the guidelines. Furthermore, any accidents or hazards must be reported to the PRDC in accordance with the contractor's or operator's contingency plan. A complete investigation report regarding the incident also must be provided within 14 days to the PRDS. A Final report of the sea bed survey must be submitted within one year of the completion of field work or before to an application to drill a well on the surveyed location. An additional final report of the geophysical, geological or environmental programme involving field work must be submitted within one year of completion of the field work. However a geotechnical final report must be submitted within 90 days of rig release or completion of field work. Final reports of programmes without field work must be submitted to PRDC within one year of the estimated completion date in the approval form and all required information asked in the guidelines must be included in all the reports.

4.3.3. Marine Pollution Prevention Act No.35 of 2008

The Marine Pollution Prevention Act No.59 of 1981 was the first act regarding marine pollution prevention in Sri Lanka. Due to changes in the offshore industries and shore based activities there was a requirement to strengthen the legal authority to deal with marine pollution incidents and implement international conventions. Therefore that Act was replaced by the Marin Pollution Prevention Act No.35 of 2008 and came into force January 01, 2009 (MEPA, 2011). The Marine Environment Protection Authority (MEPA) that was called Marine Pollution Prevention Authority according to the previous Act is the responsible authority to implement the provisions of the Act and the regulations. Therefore, MEPA is the regulatory body regarding marine pollution prevention from oil exploration and exploitation of Sri Lanka.

The functions of the authority are mentioned in the section 6 of the Act. Sub section -h of that section explains the responsibility of the authority to oversee, regulate and supervise the conduct of the contractors, sub contractors, and persons conducting or engaged in the exploration of natural resources including petroleum. Furthermore, according to section 26 the discharge of oil or any other harmful substance from offshore installation the owner or operator shall be guilty and liable on conviction to fine not less than rupees four million and not exceeding rupees fifteen million. In addition to the above criminal liability of that pollution the operator is liable for all damages and the costs of any measures taken for preventing, reducing or removing damage caused by oil or harmful substance under the section 34 of the Act as civil liability. Pollution incidents due to any reason in the offshore installation for oil or natural resources exploration, the owner or operator is liable to report it to MEPA in accordance with section 38 of the Act and if he or she fails to do it, shall be liable on conviction to a fine not less than rupees one million and not exceeding rupees five million. An oil spill contingency plan for offshore installation should be submitted to MEPA within three months of the coming into operation according to section 39 of the Act and furthermore it mentions that failing

to submit such a plan is liable on conviction to a fine not less than rupees seven hundred and fifty thousand and not exceeding rupees fifteen hundred thousand.

Part X of the act is entitled "Prevention of pollution when engaged in exploration of natural resources including petroleum or any related activities" and is contained section 40 and 41. Section 40 presents provisions for;

- Conforming to national standards and install and maintain prescribed anti-pollution equipment
- Disposal of industrial garbage.
- Conforming to standards of the MEPA regarding the use of oil storage installation and oil pipelines.
- Obtaining a written approval for using chemical dispersant from MEPA
- Obtaining a license for using dynamite or similar harmful explosives

Section 41 regards to the fines for the guilty of contravention of those provisions.

Accordance with provision of section 51 of the Act, "offshore exploration for and exploitation of natural resources including petroleum regulation No.1 of 2011" has been formed for regulating pollution from natural resources offshore Sri Lanka.

4.3.4 Offshore exploration for and exploitation of natural resources including petroleum regulation No.1 of 2011

This regulation shall apply to any person who enters into agreement with GOSL for exploration and exploitation natural resources including petroleum and covers all the environmental aspects regarding natural resources exploration and exploitation offshore in Sri Lanka. The regulation introduces a Marine Environment Protection License and any person who applies to PRDC for oil exploration should apply for such a license issued by MEPA. The follow shall be submitted with the application:

- Discharge Management Plan including the details of steps to be taken to mitigate, control or manage the discharge of any pollutant.
- Payment of the required fee
- An Environmental Impact Assessment report
- Adequate security or insurance cover to cover the cost of damage.
- A conformation letter issued by the Director General of PRDS

The contents of the Discharge Management Plan have been given in the first schedule of the regulation. It shall be included in a plan for environmental monitoring, a plan for prevention of an oil spill, a plan for storage, transportation, cleaning, refining and location of oil extracts and finally the procedure for rehabilitation of the area after completion of the operation of exploration or exploitation. Furthermore, a completed chemical data sheet according to the format in the second schedule of the regulation shall be included. If all the above requirements are fulfilled a Marine Environment protection license is issued by MEPA for two years, subject to the terms and conditions. It can be renewed by making an application to MEPA less than thirty days before the expiry.

In accordance with the regulation the owner or operator of any offshore installation shall maintain an oil record book and a garbage record book according to the format given in the third schedule of the regulation. In addition, the regulation mentions that the owner of offshore installations shall maintain a valid International Oil Pollution Prevention Certification.

The regulation also provides for the composition of a Risk Assessment Committee which consults MEPA to assess the marine environment risk regarding using oil dispersant in the oil spill, as follows.

- The General Manager of MEPA
- A senior member of the National Aquatic Resources Research and Development Agency
- A senior member of Department of Fisheries and Aquatic Resources
- The Director General of ORDS or a representative.

No person shall use oil spill dispersant in Sri Lankan waters without the approval of MEPA. However, an application for the approval of using dispersant can be done using the form of the ninth schedule of the regulation. Received applications are forwarded to Risk Assessment Committee by MEPA for recommendations. The committee assesses the risk and makes recommendations to MEPA. Then MEPA approves or rejects based on the recommendation of the Rick Assessment Committee.

4.3.5 Approving of Environmental Impact Assessment

Regulations regarding the Environmental Impact Assessment (EIA) in Sri Lanka are covered by the National Environmental Act No 56 of 1988. As the responsible authority for approving the EIA, MEPA follows a procedure as mentioned in the above Act. This process contains six steps.

1. Screening

Screening is done by a committee which is represented by every institute relevant to the field and environment of the project. In as screening meeting the committee decides the requirement of Environmental Impact Assessment (EIA) or Initial Environmental Examination (IEE) based on the preliminary information submitted by the project proponent and nature of the project. IEA is selected for a project with more significant impacts on the environment.

2. Scoping

The scope of the IEA or IEE is determined in the Scoping meeting. Furthermore the terms of reference of the EIA or EEI are issued at this stage.

3. Preparation of an EIA or EEI

After receiving the terms and reference, the project proponent should prepare an EIA or IEE report and submit it to the project approving agency for approval.

4. A review of EIA or IEE report.

A technical Evaluation Committee is appointed by MEPA representing all relevant institutes of the marine environment and experts in the marine environment to review the EIA or IEE report. The time allocation for technical review is 21 days for the IEE report and 30 days fort the EIA report. Meanwhile the EIA report is opened for public review for 30 days.

5. An EIA or IEE decision.

Based on the technical and public review, approval is granted with conditions or rejected with reasons. If the EIA or IEE is rejected the project proponent has the right to appeal against such decisions to the Secretary of the Ministry of Environment and the decision of the Secretary regarding such appeal shall be final according to the National Environmental Act No 56 of 1988.

6. Post approval monitoring

Post approval monitoring is vital for environmental management and MEPA appoints an environmental monitoring committee representing all institutes relevant to the marine environment and expert in marine environment field. The committee review the monthly

environmental monitoring report prepared accordance with the environmental monitoring plan of the project.

The above EIA approval procedure is common for all projects on land, shallow water and offshore and generally requires post approval monitoring to ensure compliance. However, in the offshore oil and gas exploration and exploitation activities, post approval monitoring is more complex than on land project. Such monitoring needs vessels and possibly even air crafts to transport compliance officers and for the collection of samples for monitoring of the marine environment. Since MEPA does not have these resources it relies on the project proponent for the provisions of necessary vessels and other means. Monitoring activities should be carried out by third party under contract with the project proponent. In order to concern about the independence and objectivity of monitoring results, the obligations to provide MEPA with the necessary resources and carry the cost for the monitoring should be prescribed in the regulation.

There are number of authorities involved in regulatory activities for oil and gas exploration and exploitation in Sri Lanka. This present coordination challenges between the different authorities and often results in unnecessary delays.

4.4 Offshore oil and gas exploration in Cauvery and Mannar Basins by India

The marine boundary between the Sri Lanka and India go through the Cauvery and Mannar Basins dividing both basins in to two parts (See the figure 6). Therefore the understanding of the oil and gas exploration in the Indian side is important to identify the potential of the oil and gas in Mannar and Cauvery Basins in the Sri Lankan side.

India made its first discovery of oil and gas in 1985 in the Cauvery Basin and after that a number of discoveries were reported (Shanker, 2013). Recent discoveries were done by The British Company Hardy Oil (2007), Reliance Industries (2007 and 2011) and Oil and Natural Gas Corporation Ltd. India (ONGC) (2012). However, only ONGC

discovered oil and gas in one of their three discoveries. All the other discoveries were only gas. The Associate Director, Energy and Power Systems Practice, quoted on The Hindu web site that "There definitely is potential in the Cauvery Basin to become a major hydrocarbon producing centre". Furthermore, with these discoveries, the Oil India Ltd has issued tenders to drill three wells in shallow water block (CY-OSN-2009/2) in the Gulf of Mannar (Ramesh, 2013). Yet-to-find petroleum resources in Mannar and Cauvery Basins have assessed by US Geological Survey in 2012 as shown in table 3.

Table- 3: Yet to find petroleum resources in Cauvery and Mannar Basins

Assessment Unit	Oil MMB	Gas BCF	NGL MMB
Northern Cauvery Basin	458	12.979	337
Mannar Basin	483	12.23	322
Total	941	25.21	654

Sources: USGS: Assessment of Undiscovered Oil and Gas Resources of the Assam, Bombay, Cauvery, and Kirshna- Godavari Geologic Province, South Asia 2011 (2012)
http://pubs.usgs.gov/fs/2012/3059/contents/FS2012-3059.pdf
MMB-Million barrels BFC-Billion Cubic feet

4.5 Future plan of oil and gas exploration of Sri Lanka

PRDS expects to start at least one appraisal well in block SL 2007-01-001 in 2015 as a short term plan. Meanwhile, a second offshore licensing round was conducted in November 2013 for 13 blocks. Three bids were received for two blocks in Cauvery Basin (C2, C3) and one block in Mannar Basin (M5). Singapore-based Bona Vista Energy Company is bidding for blocks C2 and C3 while Cairn India is bidding for block M5. The Director General PRDS quoted on the Rigzone web site that "bidders are expected to carry out a work programme including 7 committed wells, several thousand kilometres 2D and 3D seismic and estimated cost is around $ 190 million for that programme". Meanwhile, discussions are ongoing regarding the next licensing round for offshore blocks (Yew, 2014).

PRDS plans to expand oil exploration in Cauvery Basin and unexplored area of the Mannar Basin, with the confirmation of oil on the Indian side of the marine boundary. Since Sri Lanka needs more data in other areas of the Sri Lankan waters, PRDS encourages foreign companies to provide joint studies in deep water exploration. Total S. A. (France) has agreed to study on Block JS-5 and JS-6 off the east and northeast coast of the country. PRDS expects to cover that area within 2-3 years. Meanwhile, companies including Exxon Mobil Corp, Eni S.p.A (Italy) and Indian's state-owned Oil and Natural Gas Crop (ONGC) have requested specific information regarding such studies (Yew, 2014).

In view of the above, there is a need to enhance and build local skills and capacity for the various aspect of the oil and gas industry in Sri Lanka. There are currently few local experts in this industry and it is anticipated that the demand for experts will be increased with the development of the industry. Expertise is needed both in the government sector and as technical experts in institutions supporting the industry as well as the government. However there is no national skills development plan regarding to offshore industries in Sri Lanka.

Chapter 5

Marine Environment of Sri Lanka

5.1 Maritime Zones of Sri Lanka

Sri Lanka is a small island in the Indian Ocean with high biological diversity. It has sovereignty on three maritime zones (Figure-8) according to the provisions of Maritime Zone Law No.22 of 1976 of Sri Lanka and Presidential Proclamation thereunder of 15th January 1977 and United Nations Convention of the Law of the Sea.

The Territorial zone extends seaward 12 nautical miles from the low water-line along the coast as the first Zone. Sri Lanka has sovereignty on all living and non living resources in the water column, sea bed sub soil and air space over the zone. The Contiguous Zone is next to it which extends seaward 24 nautical miles from the low water-line. Sri Lanka can exercise control to prevent violation of customs, fiscal, immigration or sanitary laws and regulations within the above two zones. The third maritime zone is The Economic Exclusive Zone (EEZ) which extends 200 nautical miles seaward from the low water-line. However, the EEZ extend up to maritime boundary between India and Sri Lanka in the Gulf of Mannar, Polk Strait and Polk Bay. In the area outside the territorial zone but inside the EEZ Sri Lanka has the right to use all living and non living resources in the water column, sea bed and subsoil. It also has the sovereignty rights to authorize, regulate and control marine scientific research and other rights recognized by the international law (CCD, Act & CZMP, 2011).

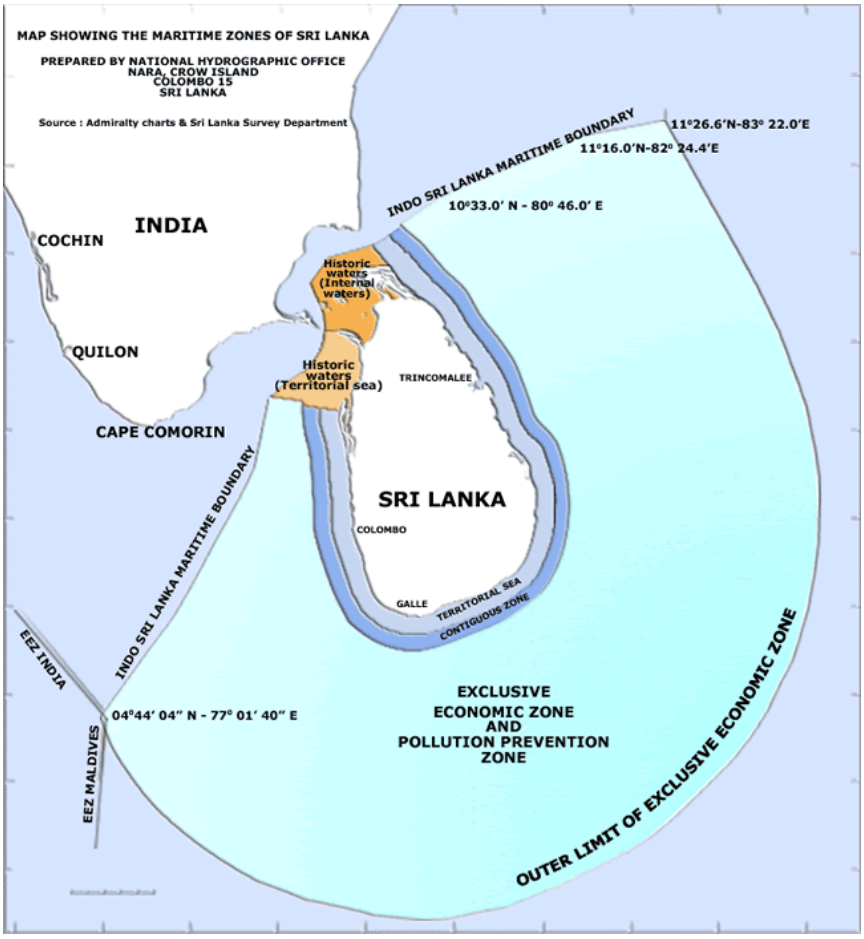

Figure-8: Maritime Zones of Sri Lanka

Source: Peoples' policy for sustainable fisheries in Sri Lanka
http://advocacypolicyandlobbying.blogspot.se

5.2 Coastal and Marine Ecosystems of Sri Lanka

Sri Lanka has various ecosystems along the coastline and marine area including beaches, reefs (coral reefs and other reefs), mangroves, sea grass beds, estuaries and lagoons, and salt marshes.

5.2.1 Beaches

Wide sandy beaches are common in many areas of the Sri Lankan coast and they are vital in ecologically and economic activities such as the tourism industry. Three types of beaches can be identified in Sri Lanka as barrier beaches, spits and dunes. Barrier beaches are in between lagoons or swamps and sea as barriers. Spits are associated with estuaries and are common along western and eastern coasts. Dunes can be observed as three types. The first type is low, flat to slightly undulating isolated platforms of sand and their height is normally less than one meter. A transverse primary dune is the second type and they consist of ridges of undulating sand masses associated with stable beaches with a height of more than five meters. The third type is transverse secondary dunes and their height normally exceeds three meters. Dunes are prominent along Northeastern, Northwestern and Southeastern coasts of Sri Lanka (Climate Change Secretariat, 2013). Spites and dunes cover 2521 ha and 15546 ha are of coast respectively (BOBLME, 2013)

5.2.2 Reefs

Corals reefs, sandstones reefs, and rocky reefs are common in Sri Lankan coastal and marine ecosystem. The coral reef is the most important among them because of the high biodiversity and productivity. They are also sensitive to various stresses including increasing temperatures, turbidity and nutrient pollution. Coral reefs provide breeding grounds and foods for a large number of marine species. Furthermore, it provides protection from the predators of many species. In addition, reefs protect the coast from storms and waves and reduce coastal erosion.

Fringing reefs cover 2% of the Sri Lankan coastline and apart from this there are some barrier reefs in Vankalai, Silavatturai and the Bar Reef of the northwestern coast. Furthermore, in the Southeast, coral has colonized the offshore ridges at Great Basses and Little Basses. Between the Mannar Island and Kalpitiya Peninsula in the northeast

of the country, the best coral growing area (680 km^2) in Sri Lanka can be found (Spalding, Ravilious and Green, 2001).

5.2.3 Mangroves

The mangrove ecosystem is found in the intertidal area and river mouth of the coastal region of Sri Lanka. Since the intertidal area is narrow in Sri Lanka, distribution of the mangrove is limited to only about 6000 ha. However, about 25 true mangrove species are reported in this ecosystem with various adaptations for the environment of muddy soil and brackish water. This ecosystem has high biodiversity and is a habitat for many species of fish, birds, and reptiles. Mangroves serve as breeding and nursery areas for fish and shellfish. Furthermore, it retains sediment and acts as a filter for sediment and polluted water from the land (Climate Change Secretariat, 2013).Mangroves occur extensively in the estuaries of the Putalum Kalpitiya area, Southern, South western and the North eastern coasts such as the lagoons of Kalamatiya, Koggala and Kokilai (CCD, Downloads- Sri Lanka's Mangroves, 2013).

5.2.4 Sea Grass beds

Sea grass beds are associated with the coral reefs or within lagoons and estuaries as sub tidal wet lands. They are reported in Puttalam, Nigambo, Mawella , Koddala, Kokilai, (lagoons and estuaries) Dutch Bay, from Manna to Rameswaram Island of India, western end of Jaffna Peninsula and South and Southwestern coast. This ecosystem is important as a habitat for endangered dugong and turtles and acts as a breeding ground for many species (Climate Change Secretariat, 2013)

5.2.5 Lagoons and Estuaries

Lagoons and estuaries are a complex ecosystem which is associated with mangrove, sea grass beds, salt marshes and mud flats. There are 28 riverine type estuaries and 17 basin type estuaries covering 2110 ha and 90 965 ha in the Sri Lankan coastal region. The lagoons sizes are varied from 3 ha to 7589 ha and only 8 of them exceed 1000ha. The

total area covered by lagoons is 36 000 ha (Climate Change Secretariat, 2013). Many of these are estuaries are heavily polluted by intensive agriculture in the drainage areas (Lundin and Linden 1993).

5.2.6 Salt Marshes

Salt marshes are located near to the landward margins of the intertidal zone with high soil salinity. Extensive salt marshes are found along the coast line of Mantai to Vankalai. In addition, patchy salt marshes are in sedimented lagoons and estuaries in Hambanthota, Putalam, Kalpitiya, and Mundel. This ecosystem covers 23 800 ha and it is important as a habitat for brine shrimps, wading and migratory birds and some fish like milk fish fry (Climate Change Secretariat, 2013) .

5.3 Threat to the Marine Environment

As results of increasing population, intensive fisheries and other utilization of the marine resources and development activities in the marine environment of Sri Lanka is subjected to pollution and habitat alteration (Dayaratne et al.1995, Lundin and Linden 1995). These are the main threats to the marine environment as explained below.

5.3.1 Marine pollution

Marine pollution is divided into land-based and sea-based pollution. Solid waste, sewage, chemicals, heavy metals and nutrients which enter the marine environment from the coast via rivers and other water streams, are the main land-based pollutants in the marine environment of Sri Lanka. Oil spills, waste and ballast water discharge from vessels are the cause of marine pollution as sea-based sources.

Out of 25 administrative districts in Sri Lanka 14 districts are coastal districts. Many cities including the capital city are located on the coast. The population density of six coastal districts is higher than the national average (323 persons per km^2). It is significantly different in a district like Colombo (3417 persons/km^2) and Gampaha (1711 persons/km^2) (Department of Census and Statistics, 2012). Due to the high population density and insufficient waste management practices, waste water and solid waste

including non-gradable waste accumulate in the marine environment outside coastal cities. In addition, rivers from the central hilly areas bring waste and waste water to the sea which increases the severity of the problem. According to the International Coastal Cleanup Day 2013 prepared by Ocean Conservancy, the most common solid waste found in Sri Lankan coast was plastic from food packing.

Most industries including high and medium pollution potential industries are located in three coastal districts of the western province of the Sri Lanka due to port and other infrastructures. Some small and medium industries have no capacity to maintain waste water treatment plans and they release effluents into the water bodies and these effluents accumulate in the marine ecosystem eventually. Although there are regulations for preventing industrial effluent discharge, they have not succeeded to eliminate the discharging of effluents yet. Since there is no 24 hours monitoring system in Sri Lanka some factory owners discharge effluent at night into rivers or other water bodies. Therefore, the swveilance and monitoring systems should be improved to prevent these pollution activities.

The tourism industry is one of the main industries in the coastal zone of Sri Lanka and 70% of hotels registered under the Tourist Board are located in the coastal region. Apart from that there are a large number of restaurants, guesthouses and other tourist centres which release untreated sewage, sludge, waste water and solid waste into coastal waters. This is the main reason for shore water quality degradation in the Hikkaduwa, Beruwala and Unawatuna coastal areas (CCD, Act & CZMP, 2011). Due to the rapid development of tourism industry in the last few years a number of small and medium sizes restaurants and guesthouses can be seen in the most of coastal areas now. However, there is no proper regulating mechanism for them. Therefore, water pollution and waste management issue are growing problems related to this expanding sector.

Agriculture and aquaculture are sources for discharging chemicals and nutrients into the sea. Due to the heavy use of agrochemicals in agriculture, they are accumulated in ground waters, inland water bodies and finally end up in the sea. On the other hand, the heavy use of synthetic fertilizers increases the level of N, P and K in soil and these nutrients are added to water bodies through runoff. The amount of synthetic fertilizer used in Sri Lanka is 2 to 8 times more than the usage of other Asian countries (CCD, Act & CZMP, 2011). In addition, shrimp farms in North Western Province discharge effluents including nutrients, which case for ground water and coastal water pollution (Dayaratne et al.1995). According to the government agricultural policy, there is a fertilizer subsidising programme and it encourages the famers to apply more synthetic fertilizer. However, the intensive uses of such fertilizers result in increasing problems with surface water and ground water pollution. Therefore this policy should be revised to minimize the water pollution.

Since Sri Lanka is situated close to the East-West shipping routes in the Indian Ocean, there is an increased risk of oil and chemical spills in Sri Lankan waters. Expansion of the ports of Colombo, Hambanthota and oil exploration and exploitation activities will further increase the risk for oil spills in future. Therefore adequate preparedness for detailing with spills of oil and other harmful substances is vital for the protection of the marine environment, fisheries and coastal tourism. However, the current National Oil Spill Contingency Plan does not make provision for combating spillages of chemicals or other harmful substances and therefore need to be updated accordingly.

In addition, lack of resources limit the capacity and ability to protect the marine environment from oil spill in Sri Lankan waters. In the absence of sufficient governmental spending on these issues, an alternative, sustainable and independent funding mechanism should be established. Hence it is suggested that a Marine Environment Protection Fund is establish to enable the building of the necessary capacity in terms of equipment and trained personnel. This fund can be established and

funded from penalties and fines charged to companies and individuals that are causing pollution and environmental degradation according to the "Polluter Pay" principle. The fund may also receive funding from fees charged to companies applying for a Marine Environment Protection License. The size of such a fee should be related to the scale of investment. The relevant regulations should be revised to provide provision for such a fund.

5.3.2 Habitat alteration /Destruction

Habitat alteration and destruction in the marine environment adversely impacts on marine bio-diversity and the economic benefits such as the fish harvest. Sedimentation due to poor agricultural practices and deforestation is one of the main factors for the degradation of the habitats of the coral reef, mangrove and sea grass bed ecosystem. Apart from this, human activities such as reef fishery, coral mining, coir industry, coral trampling and bottom set and gill net fishing methods significantly impact on the coral reefs. This has been clearly observed in coral reefs in Bandaramulla, Madiha and Polhena (Kumara et al, 2008).

Invasive species introduced through ballast water is another factor which is not clearly identify in Sri Lankan waters due to the lack of data. However two investigations done in the Colombo Port by Chanddrasekare, and Fernando (2009) and Siyabalapitiya et al (2010) have reported new plankton species from these areas.

5.4 Challenges for marine environment protection

There are Acts, and regulations to protect marine environment and there are institution set up to enforce these regulations in Sri Lanka. However there are challenges to ensure marine environment protection within this legal regime and institutional framework.

Lack of information and data

Information and data relevant to the marine environment and marine pollution are significant factors to implement protecting measures. However there is no adequate

central data and information repository and the existing data are dispersed in various institutions as isolated project output. In addition there is a lack of a central coordination system and consequently there are limitations to use even these existing data. Furthermore, studies regarding offshore environment are very few and data are unavailable from such areas (BOBLME, 2013).

Overlapping mandates.

Following institutes and organizations are involving regulating and managing activities in coastal and marine environment in Sri Lanka.

- The Marine Environment Protection Authority
- The Coast Conservation and Coastal Resources Management Department
- Sri Lanka Coast Guard
- The Department of Wildlife Conservation
- The Department of Fisheries and Aquatic Resources
- The Forest Department

In addition to these institutes provincial and local governments have jurisdiction over coastal zone. Therefore coordination of all institutes for a major management plant is a challenge (BOBLME, 2013).

Implementation issues

Lack of policies, resources and proper procedures are constrains for implementation of marine environment protection activities. In addition, there are no adequate human resources some fields such as offshore environment. Therefore monitoring of environment impact of offshore activities is very difficult and is only carried out on an ad-hoc basis. Furthermore due to legal gaps and loopholes, implementation process is not efficient (BOBLME, 2013).

Chapter 6

Identification gaps in "Exploitation Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011"

6.1 Background

The Marine Pollution Prevention Act No.35 of 2008 is enforced for the prevention marine pollution from land-based and marine based activities including offshore oil and other natural resources exploration and exploitation. Subsection 2 of section 51 of the above Act mentions the matters so that the minister in charge of the subject to marine environment may initiate new or sharper regulations. Among these matters following four are directly relevant to offshore oil and gas exploration.

1. Specifying the procedure to be adopted in respect of the exploration of natural resources in Sri Lankan waters.

2. Specifying the standards to be maintained by the contractors and operators conducting of engaged in the exploration of natural resources.

3. Specifying the standards, the quality of the equipment used, the type of mobile platforms and other related anti-pollution equipment, to be utilized for offshore and shore based petroleum operations.

4. Specifying the terms and conditions required to be adhered to, by a contractor relating to off shore oil storage installation and oil pipe lines, and off shore testing of oil wells

and the measures to be taken for the disposal of oil, or mixtures of oil released into the sea (GOSL, Marine Pollution Prevention Act No.35 of 2008, 2008).

Furthermore, section 40 of the Act is relevant to the standards, conditions, and manner which should be followed by those who engage in the exploration of natural resources including petroleum. Therefore, the Minister of Environment made the first regulation regarding marine pollution from offshore oil and gas exploration and exploitation under the provision of section 51 of Marine Pollution Prevention Act No.35 of 2008. It is cited as the "Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011"and it came into force on 26th May 2011.

The contribution of that regulation for marine environment protection has been explained in chapter 4 and the gaps in the regulation which impact on the enforcement of the regulation are identified in this chapter. Gaps identification is done by comparing the Sri Lankan regulation with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulation 2009 of Australia (hereafter referred to as "Australian regulations") and Marine Protection Rules Part 200: Offshore Installation- Discharge of New Zealand (hereafter referred as "New Zealand rules").

6.2 Identification gaps in the Regulation

Sri Lankan regulation consists of four parts as follow.

Part I- Requirements for the granting of the Marine Environment protection license

Part II- Marine Environment Protection License for Exploration for or Exploitation of Natural Resources Including Petroleum

Part III - International Oil Pollution Prevention Certificate

Part IV- General

The next part of this section explains the gaps regarding marine environment protection in each part.

Part I- Requirements for the granting of the Marine Environment protection license

This part includes regulations to follow any persons who make an application for the Marine Environment protection license for oil exploration or exploitation activity. These applicants shall submit a detail of steps to be taken to mitigate, control or manage the discharge of any pollutant in accordance with a plan called The Discharge Management Plan to the Marine Environment Protection Authority (MEPA). Furthermore the applicant shall also submit an Environment Impact Assessment (EIA) to MEPA which was carried out by a classification society approved by MEPA (Regulation 2 and 3).

a) Environment Impact Assessment (EIA)

There are no provisions regarding EIA in Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011. However MEPA follows the EIA approval procedure in accordance with the National Environmental (Procedure for Approval Projects) Regulation No.1 of 1993 of Sri Lanka as all other project approving agencies of Sri Lanka. However, the monitoring procedure of the approved EIA is not clearly mentioned in National Environmental (Procedure for Approval Projects) Regulation No.1 of 1993. Therefore, planning and implementation of the monitoring activities are challenges for the Project Approving Agency.

In the Australian regulation an EIA is done through the project proposal in accordance with regulation 5. It mentions the following information which is relevant to the EIA and must be included in the project proposal.

1. Description of the existing environment that may be affected

2. Values and sensitivities of the environment

3. Environment performance outcome for the project

4. Feasible alternative to the project including a comparison of the environmental impacts and risks. (Sub regulation 5 of regulation 5A)

Based on the all information including the above information and public comments, Project Approving Agency takes decision regarding project approval. The monitoring of the environment mitigation measures is incorporated within the Environmental Plan. In Sri Lanka the project proposal should be submitted to Petroleum Resources Development Committee (PRDC) which is the authorized committee for issuing development licenses. But it is not the EIA approving agency. The approving of the EIA is done by MEPA. Therefore the EIA procedure cannot be incorporated with the project proposal in Sri Lanka. But it should be improved for ensuring the monitoring.

b) Discharge Management Plan

The Discharge Management Plan is the other requirement mentioned in regulation 2 of the Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011. In accordance with sub regulation 2 of regulation 10, the Discharge Management Plan should be approved by MEPA and an application shall be made two months prior to the commencement of exploration or exploitation activities for approval. MEPA may call for additional information if necessary and approve the Discharge Management Plan being satisfied by content of the plan. The required content is given in the first schedule of the regulation. It contains two parts:

1. Risk identification, assessment and prevention

2. Emergency response procedures for spills of oil and harmful substance.

Under the first part (risk identification, assessment and prevention), all details regarding the location, operation, stores, and harmful substances to be used shall be included in the plan. Furthermore, the manner of managing production water, displacement water, offshore processing drainage and other water emanating from the well product shall be specified in this part. Oil and harmful substance spill response plans and details of the response structure with an inventory of relevant equipment shall be included in the second part of the discharge Management Plan.

According to Sub regulation 14 of regulation 14 of Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011, the alteration or modification to the approved Discharge Management Plan cannot be done without prior approval of MEPA. Furthermore, this sub regulation mentions changes can be made only for the purposes of decreasing the risk of the spill of oil or any harmful substance or utilize harmful substance not specified in the Discharge Management plan.

The Discharge Management Plan has been included in the New Zealand rules and the content is also almost the same as in the Sri Lanka regulation. However some important differences can be identified between the two set of regulations. The rule of approval and duration of a Discharge Management Plan (200.7) of the New Zealand rules mentions that approval is granted for a period not exceeding 3 years, but the validity period or duration of the approval is not mentioned in the Sri Lankan regulation. In addition to the above two reasons to modify the Discharge Management Plan, the New Zealand rules has mentioned that "make any changes as result of training or review of the emergency spill response" also as a reason for modifying the Discharge Management Plan (200.9.1(c)). Such, details should be included in the application for approval and modification of the Discharge Management Plan as clearly mentioned in rules 200.5 and 200.9 of the New Zealand regulation respectively. These are not clearly mentioned in Sri Lankan regulation. Division 2.4 of the Australian regulations provides

conditions for revise of the environmental plan. Accordingly revisions of the Environmental Plan can be done due to new activities, modification of the existing activity, new or increased environmental risk, change in title holder and transitional arrangements. Other than that it mentions that the plan must be revised at the end of each 5 year period. The summary of the comparison regarding EIA and the Discharge Management Plan is shown in table 4.

Details of measures to be taken to avoid environmental impacts from discharges during commissioning and decommissioning are not included in the content of the Discharge Management Plan in the Sri Lankan regulation but it is mentioned in the New Zealand rules. Regulation 4 of the Sri Lankan regulation mentions that the environmental monitoring plan shall be included in the Discharge Management Plan, but there is no regulation to ensure the environmental monitoring and reporting. 200.25 rule of the New Zealand rules clearly mentions that the owner of a controlled offshore installation must conduct the environmental monitoring programme and the results must be reported to the regulatory authority at the earliest opportunity. Under the regulation 14 of the Australian regulations (Implementation strategy for the environment plan) the titleholder shall report to the regulator regarding to the environmental performance for the activity and report providing the interval should not be more than one year. The Environment plan explained in the Australian regulation is more detailed and the broad plan contains the environment assessment and implementing strategy.

Table- 4: Comparison between of Sri Lankan regulations with the corresponding regulations of New Zealand and Australian regarding EIA and the Discharge Management Plan

Requirements for granting the Marine Environment Protection License- The EIA			
Sri Lankan Regulation	**New Zealand Rules**	**Australian Regulation**	**Comments**
An EIA is a requirement for applying for the Marine Environment Protection License		An EIA is included in project proposal and monitoring of environmental mitigation measures is done accordance with the Environment Plan	Monitoring of the environmental mitigation measures is not addressed in the Sri Lankan regulation and it is not covered by the National Environmental (Procedure for Approval Projects) Regulation No.1 of 1993 of Sri Lanka.
Requirements for granting the Marine Environment Protection License- The Discharge Management Plan			
Validity Period of the Discharge Management Plan is not mention in the regulation	Validity Period of the Discharge Management Plan is not exceeding 3 years	The Environmental Plan should be revised at the end of each 5 year period.	Validity period should be included in the regulation in Sri Lanka

Requirements for granting the Marine Environment Protection License -The Discharge Management Plan Continued …			
Sri Lankan Regulation	**New Zealand Rules**	**Australian Regulation**	**Comments**
Discharge management at the commission and decommission stages are not included in the Discharge Management Plan	Discharge management at the commission and decommission stages are included in the content of the Discharge Management Plan		Commission and decommission phases are missing in the Sri Lankan regulation and should be included
There is no regulation to ensure environmental monitoring	There is a rule to ensure the environmental monitoring and reporting	There are regulations to ensure monitoring and reporting accordance with the Environmental Plan	Environment monitoring and reporting should be include to the Sri Lankan regulation

Requirements for granting the Marine Environment Protection License - The Discharge Management Plan Continued …			
Sri Lankan Regulation	New Zealand Rules	Australian Regulation	Comments
There are provisions to modify the Discharge Management Plan.	In addition to provisions in the Sri Lankan regulation there is a provision to modify the Discharge Management Plan concerning training and the existence of an updated Emergency Plan	There are provisions to revise the Environmental Plan	Training and updating of the Emergency Plan should be included as a reason to modify the Discharge Management Plan in the Sri Lankan regulation

Part II - Marine Environment Protection License for Exploration for or Exploitation of Natural Resources Including Petroleum

There are four topics are included in this part namely the Marine Environment Protection License, Oil and Garbage Record books, Reporting of spills and Accident Reporting.

a). Marine Environmental Protection license

The Marine Environmental Protection license is issued by MEPA for the exploration and exploitation of natural resources in Sri Lankan waters as the provision of Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011. Sub regulation 1 of regulation14 of the above regulation mentions the following requirement to be completed for in application for the Marine environmental Protection License.

1. Submitting Discharged Management Plan approved by MEPA

2. Paying of the required fee

3. Submitting the EIA report

4. Submitting adequate security or Insurance cover to defray unforeseen damage

5. Submitting the confirmation letter issued by the Director General of PRDS

Considering the submitted documents and other requirements, MEPA may either issue or refuse to issue the license. This license is issued for a period of two years and can be renewed by making an application to MEPA less than thirty days before the expiry of the license. In the case of refusing of issuing a license or granting approval for a renewed license by MEPA, the applicant has the right to appeal regarding the decision of

MEPA to the Secretary to the Ministry of the Minster in charge of the subject of Marine Environment Protection. The decision of the Secretary shall be final.

b). Oil and garbage record books

In accordance with regulation 21 of the Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011, the owner or operator on any installation shall maintain oil and garbage record books according to the formats given in the third schedule of the regulation. The Oil record book covers the records of loading, unloading and internal transfer of oil, discharge of oil mixed water, production water, displacement water, offshore processing drainage and the disposal of sludge. At the completion of the entire oil record book the owner of the installation shall send a certified copy of all completed pages of the oil record book to the MEPA within 15 days of the date of completion (regulation 22 (7)).In the New Zealand rules more details are included regarding the oil record book than in the Sri Lankan regulation, but both regulations cover the same topics and procedures.

c) Reporting of spills

Regulation 23 of the Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011, is regarding to the reporting of the oil and harmful substance spill. It mentions the responsibility of the owner of installation to report spills of oil and harmful substances to MEPA by the fastest means of communication available and with the highest possible priority. If oil spill occurs out of territorial limits of the MEPA, it should be reported to MEPA by written communication also in the form specified in the seventh schedule in regulation, using procedure in the Discharge Management Plan. In the case of a spill of harmful substances, written communication should be done using same procedure. When the oil spill cannot be contained or cleanup with available resources in the installation cannot be done, the responsible person for implementing the emergency

response plan shall report it to MEPA by the fastest means communication using same procedure.

c) Accident reporting

According to regulation 24 of above Sri Lankan regulation in case of any accident or defect which relate to the installation and its operations, the owner of the installation shall reported it to MEPA immediately and a detail report shall be submitted as soon as possible. After the receiving of detail report, an authorized officer of MEPA may require the installation to implement a survey to ensure compliance with the requirement of regulations and the International Oil Pollution Prevention Certificate.

In the Australian regulations, incidents are explained as two categories named reportable incidents and recordable incident. These are defined as following.

"Reportable incident, for an activity, means an incident relating to the activity that has the potential to cause, moderate to significant environmental damage"

"Recordable incident, for an activity, means a breach of an environmental performance outcome or environmental performance standards, in the environment plan that applies to the activity, that is not reportable incident" (GOAU, 2009)

The significant difference in the Australian regulations is the mentioning of the time schedule for reporting in both type of incident. At the reportable incident titleholder must notify the regulator as soon as practicable as and not later than within 2 hours. The notification must contain all information mentioned in sub regulation 4(d) of regulation 26. Furthermore, titleholder must submit a written report to the regulator not later than 3 days after the first occurrence of the reportable incident or within time period specified by the regulator including information mentioned sub regulation 4 (d) of regulation 26A. According to the sub regulation 5 of the same regulation the titleholder must submit copies of that report to the title Administration and the Department of the responsible

State Minister or the responsible Northern Territory Minister. In addition, regulator may require the titleholder to submit one or two additional reports by notice in written (sub regulation 2 of regulations 26AA).

At the recordable incidents the titleholder must send only written report as soon as practicable after the end of the calendar month, and not later than 15 days after the end of calendar month. It must be contained information mentioned in the sub regulation 4(d) of the regulation 26B. The summary of the comparison regarding reporting spills and accidents is shown in table 5.

Table-5; Comparison between Sri Lankan regulations with those of New Zealand and Australian regarding reporting spills and accidents

Sri Lankan Regulation	New Zealand Rules	Australian Regulation	Comments
Reporting procedure is explained in the regulation	Reporting procedure is explained in the rules	Reporting procedure is explained in the regulation with the time schedule.	Time schedule should be included in the Sri Lankan regulation

Part III International Oil Pollution Prevention Certificate

Valid International Oil pollution Prevention certificate shall be maintained and ensured that it held in the installation by the owner of offshore installation as per the regulation 25 of Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011. The certificate can be issued or renewed in accordance with the relevant law or issued by or on behalf of a state party to MARPOL Convention, other than Sri Lanka. The owner of the installation shall ensure that the installation undergoes the following surveys regarding the International Oil Pollution Prevention Certificate.

I) Initial survey

This survey shall be implemented to ensure that the structure, equipment, systems, piping, fittings, arrangement, record books, emergency response procedures, and material are compliance with the requirements of regulations in part III of the regulation. This shall be done before the issuing of International Oil Pollution Certificate.

II) Annual survey

The Annual survey shall be carried out for all aspects covered by initial survey to ensure they have been properly maintained, have not been altered without approval of MEPA and remains providing satisfactory service to control and reduce pollution. This shall be done within three months before or after every renewal date of certificate.

III) Intermediate survey

This survey shall be done within the tree months before or after either second or third renewable date of the certificate. One objective of intermediate survey is ensuring that good working order and compliance with the regulations of part III, of the equipment and associated pump and piping systems, including oil discharge monitoring and control systems, oil water separating equipment and oil filtering systems. Ensuring that the structure, equipment, systems, piping, fittings, arrangements, record books, emergency response procedures and materials have not been altered without the approval of MEPA is the other objective of the survey.

In addition to above surveys, renewable survey shall be carried out at every five year interval or any lesser period specified by MEPA. The surveyor who conducted the above surveys shall be an approved surveyor by the Director of Merchant Shipping. When the owner of an installation applies for the issuance, renewal or endorsement of an International Oil Pollution Prevention Certificate, MEPA shall issue renewal or endorse the certificate after been satisfied by the meets of requirement in part III of the

regulation and the approval of the surveyor. The approval of the certificate is issued for less than three years. New Zealand rules relevant to the International Oil Pollution Prevention Certificate are more similar as the Sri Lankan regulations. However the approval for certificate may be issued for period of not exceeding 5 year period. The summary of the comparison regarding the International Oil Pollution Prevention Certificate is shown in table 6.

Table- 6; Comparison between Sri Lankans regulations with those of New Zealand and Australian regarding the International Oil Pollution Prevention Certificate

Sri Lankan Regulation	New Zealand Rules	Australian Regulation	Comments
Validity period of the certificate is less than 3 years	Validity period of the certificate is not exceeding 5 years.	No mentioning of the International Oil Pollution Prevention Certificate in this regulation	Three year period is probably suitable for Sri Lankan regulation

Part IV- General

As per the regulation 31 of Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011, MEPA shall act in consultation with PRDS in giving effect to the provisions of the regulation in part IV. Regulations in this part are relevant to using oil dispersant and explosives and claiming for damage of discharging oil or oil spill.

The Risk Assessment Committee for regulating the use of dispersants in an oil spill incident at an offshore installation shall be established and composition of the Committee is explained regulation 32 of the regulation. (The composition of the committee has been explained in section 4.3.4 of chapter 4). The Risk Assessment Committee consults and gives recommendation to approve the using of dispersant in Sri Lankan waters to MEPA. The Provisions for procedures including making application to

use dispersant, testing and approving of dispersant are in this part of the regulation with detail and the time schedule. According to the regulation 41, an applicant who disagrees with the decision of the MEPA can appeal to the Secretary to the Ministry of the Minister in charge of the subject of Marine Environment. The decision of the Secretary may be the final.

Regulation 43 in part VI of the regulation provides provisions to take measure to avoid the use of dynamite or other explosives for exploration and production during spawning, breeding and fishing seasons as such methods can be negatively affect fish and other organisms in the sea. However, there are no provisions to prevent the use of explosive in offshore area.

Any person adversely affected due to discharge oil or oil spills from offshore installation, according to regulation 47 of the regulation can recover the cost of elimination of pollution from the owner or operator of the installation by making application to MEPA with all information mentioned in sub regulation 2 of the regulation 47.

6.3 Gaps in the regulation

Analyzing the Offshore Exploration for and Exploitation of Natural Resources including petroleum (Marine Environment Protection) Regulation No.1 of 2011 and according to above comparison, the following gaps were identified.

1. Some phases of oil and gas exploration and exploitation has been missed in the regulation

For ensuring the marine environment protection from offshore oil and gas exploration and exploitation, the regulations should cover all phase of the process. However the following important phases are not covered in the regulation.

a) Seismic survey

The seismic survey includes activities which can negatively affect the marine environment, particularly whales and dolphins, and fishing activities (e.g. using under water piston driven by compressed air and vessel with long streamers). Therefore for regulating the sound level and ensure the protection of sound sensitive animals, seismic survey should be covered in the regulation.

b) Well decommission

Well decommission is a separate process and most of the time a specialized contractor must be become involved in this process which require vessels and equipment relevant to decommission. There is a possibility that pollution may occur during the decommissioning which involves removal of possibly contaminated material and the transportation of such material for recycling or destruction. Therefore well decommission is also topic that should be address in the regulation.

2. Some important activities are not addressed adequately

There are activities which directly impact on marine environment in oil and gas exploration and exploitation. However some of them are not address adequately in the regulation:

a) Ballast water and hull fouling management.

Drilling vessels, semi-submersible drilling units, barges and supply vessels are commonly used in offshore oil and gas exploration and exploitation. Therefore ballast water and hull fouling management is vital for the protection of marine environment. There is no mentioning hull fouling issues in the regulation and ballast water management is not addressed adequately. Hence ballast water and hull fouling management should be included and addressed adequately.

b) Use of drilling fluid

Discharging drilling fluid is a critical issue in offshore oil and gas industry. There is provision to ensure prevention of using oil based fluid in the regulation. However there should also be a requirement to address sampling, testing, monitoring and reporting of the use of any drilling fluid.

c) Using of dynamite or other explosives

There is a provision to take measures to protect fish and fisheries when dynamite is used. However there are no provisions to control or minimize the use of dynamite or other explosives in the regulation.

d) Reporting of incidents and oil spills

Reporting of incidents and oil spill is vital to take preventive action and rapid and correct reporting of such information is important for future planning. Fast and efficient reporting significantly improves the success of all aspects of environmental management. There is not mentioning of the time and frequency for reporting an oil spill or any other incidents except the wording “as soon as possible” in the regulation.

3. Gaps in the Discharge Management Plan

Discharge Management plan is the main tool for control and minimization of pollution. Therefore it should be detailed and well organized. There are some weak nesses relevant to the Discharge Management Plan in the regulation which should be eliminated:-

a) Monitoring and reporting

Monitoring and reporting procedures have not been included in the content of the Discharge Management Plan in the regulation. If it is in the content of the plan, the

approving agency can ensure environmental monitoring and reporting at the approving stage of the plan.

b) Validity period of the Discharge Management Plan

Although the approving procedure of the plan has been addressed in the regulation, the validity period has been not mentioned. This is an issue in long term projects.

c) Modification of Discharge Manage plan

There are provisions regarding how to modify the Discharge Management Plan with approval of regulatory authority. In addition there should be an opportunity to modify this plan in accordance with the changes of the environment training and review of the emergency plan.

6.4 Issues relevant to the enforcement of the regulation

The issues in the enforcement stage of the regulation are as important as the gaps in the regulation for ensuring marine environment protection in the offshore oil and gas industry. The issues explained here are identified based on the information given by officers involved in enforcement activities, through the structured questionnaire.

1. Lack of data regarding to the marine environment

Without baseline information on the state of the marine environment it is often extremely or impossible to establish exactly what damage a spill or an illegal activity has caused. Therefore the establishment of a baseline before any operations are allowed to start is essential. Regular monitoring should then be carried out regulatory and the results of this monitoring should be compared to the baseline. This is an issue to be dealt with by the project proponent, also when preparing the Discharge Management Plan, and Emergency Preparedness Plans including Oil Spill Response Plan.

2. Lack of dispersant policy

Until now no policy has been formulated for the use of dispersant in Sri Lanka. Therefore, the approving of dispersant takes more time than the time schedule mentioned in the regulation. Research to identifying the toxicity level of dispersants under Sri Lankan conditions and to local marine organisms should be done in order to establish a local dispersant policy

3. Lack of experience / expertise

Previous exploratory drilling has been done on shore or in land before 2011. As offshore exploratory drilling is new to Sri Lanka, officers who are in enforcement of the regulations have little experience regarding offshore exploration and exploitation.

4. Lack of resources

The regulatory authority and other relevant agencies and institution have not enough resources for enforcing the regulation efficiently. The provision of such resources to the regulatory agency is essential in order to enable the personnel to enforce the regulations.

Chapter 7

Conclusion

This research has been an attempt to respond to three objectives outlined earlier. Firstly, it reviewed the future trends in offshore oil and gas exploration and production. Next it identified the possible environmental consequences due to offshore oil and gas exploration and exploitation. Finally it reviewed and analyzed the legal regime of Sri Lanka in order to minimize the impact identified and highlight the weaknesses and gaps in marine environment protection relevant to offshore oil and gas exploration and production in the country.

7.1 Future trends in offshore oil and gas exploration and exploitation

According to the prediction of IEA, the global energy demand will increase by 20 -40 % between 2009 and 2035. Globally, for the coming 25 years, the following trends can be identified when it comes to the demand for oil and gas. Low cost and environmental advantage of natural gas:-

- A growth in the market of natural gas due to low cost as a result of good supply and an environmental advantage compared to the other fossil fuels.
- Increasing of number of passenger vehicles where the larger portion will depend on gasoline gas
- Usage of modern renewable energy is rapidly increasing in most sectors

- Some progress in the attempts to lower CO_2 releases.

As a result of the cumulative impact of the above factors, oil and gas is likely fulfilling about 50% of the global energy demand in 2035. Due to the rapid development in emerging economies such as China, India and the Middle East, energy trade will move from the Atlantic basin to the Asia Pacific region.

The total global discovered oil and gas resources are 4.5 tnboe (trillion barrels oil equivalents) and the Yet-To-Find (YTF) amount is approximately 1 tnboe. Furthermore, the significant amount of YTF is in deep and ultra-deep waters and onshore and many large discoveries have been reported from deep sea and onshore delta systems over the last decade. Over the next decade oil and gas exploration will move along three routes; i) as exploration of the unexplored deep water areas ii) re-exploration of onshore and shallow water and iii) further utilization using new techniques in "old" deposits.

The continental shelf and slop of the Arctic Ocean which is dominated by Russia is the main unexplored area in the world today. However, exploration in this area is a challenge due to the environmental conditions and public response relevant to exploration in such a special ecosystem. Re-exploration requires advanced technology to overcome pressure rams, poor image and other limitations existing in explored areas.

7.2 Possible environmental consequences due to offshore oil and gas exploration and exploitation in Sri Lanka

In the process from seismic survey to the production well, there are many activities which impact on the marine environment. Sound waves produced during the seismic surveys cause behavioral changes in whales, sea turtles and fish. Normally they avoid the area but some time humpback whales are attracted to the vessels due to the misidentification of the sound signals as breaching signals.

Residual drilling fluid and cutting discharges to the sea from the exploratory wells lead to an impact on benthic organisms by smothering. Water Based Fluids are less harmful than Non Aqueous drilling Fluids (NAF) which are used for faster drilling. However, Group I NAF is the most toxic within the three groups (groups I, II, and III) of NAF.

Oil spills may cause major damage to the environment and to fishing and the tourism industry. Even small spills may cause large damage and should be avoided. Oil can impact on the marine environment by physical smothering, chemical toxicity, changing ecological conditions, and by indirect impacts such as losing habitats and eliminating important species. Birds, whales, dolphins, seals, otters and turtles are affected by floating oil and the large numbers of sea birds die every year at sea because of oil spills. In addition, mangroves and coral reefs are more vulnerable for spilled oil. Finally spilled oil reaches to the beach and pollutes that ecosystem.

Waste water and solid waste from oil rigs pollute the sea water and the air emissions of nitrogen oxides (NO_x), carbon oxides (CO, CO_2), sulphur oxide (SO_x), particulate matter (PM), volatile organic compounds (VOCs), and methane (CH_4) lead to the greenhouse gas effects and depletion of the ozone layer and acid rain.

There is the possibility to spill oil from supply vessels and oil and gas transporting vessels. Furthermore, vessels involved in the offshore activities may introduce invasive species through ballast water and hull fouling.

The National oil spill contingency plan of Sri Lanka covers all oil spills in Sri Lankan waters. But it is not capable to contain even medium size spill due to lack of resources. Therefore there is a requirement to update this plan and strengthen relevant organization by providing additional equipments. Moreover, lack of policies for managing ballast water and hull fouling is a limitation to protect the marine environment from alien invasive species.

7.3 The legal regime of Sri Lanka for minimizing the environment impact of oil and gas exploration and exploitation

The Marine Pollution prevention Act No.35 of 2008 is the main regulating tool for preventing marine pollution in Sri Lanka. The Marine Environment Protection Authority (MEPA) has been established based on that Act and has mandate to enforce it. The Act addresses offshore oil and gas exploration and exploitation in section 40 and 41 in part X. In accordance with the provisions of the Act, Offshore Exploration for and Exploitation of Natural Resources including Petroleum (Marine Environment Protection) Regulation No.1 of 2011 has been developed and it is the only existing regulation regarding the environmental management of offshore oil and gas exploration and exploitation in Sri Lanka.

MEPA acts as the approving agency for Environmental Impact Assessment (EIA) of offshore oil and gas projects which is one requirement in order to obtain the Marine Environment Protection License in accordance with the provision of the above regulation. MEPA approves the Discharge Management Plan which is another requirement for obtaining the Marine Environment Protection License. If the applicant has fulfilled the requirement of the above two documents relevant to the marine environment protection and other legal and financial documents, MEPA issues the Marine Environment Protection License for the project. In addition the owner of the offshore installation shall maintain a valid International Oil Pollution Prevention Certificate as stipulated in the regulation. MEPA does all the inspection and monitoring activities according to the regulation, the above certificate and the Discharge Management plan. The regulation provides provision to establish a Risk Assessment Committee to consult and make recommendations to MEPA regarding the use of dispersant in connection with an oil spill.

7.4 Weaknesses and gaps in marine environmental protection relevant to oil and gas exploration and exploitation.

As a main regulatory tool specific for the marine environment protection from offshore oil and gas exploration and exploitation in Sri Lanka, that above described regulation shall cover all the phases of exploration and exploitation. However, the seismic surveys, well completion and well decommission are not addressed in the regulation. In addition, ballast water and hull fouling management, the use and type of drilling fluids, dynamite and other explosives and reporting incidents and oil spills, are not addressed adequately. On the other hand the Discharge Management Plan contains gaps when it comes to monitoring. Furthermore there are gray areas regarding validity period and the modification of the plan.

Enforcing the regulation has become a challenge due to the lack of environmental baseline data, lack of relevant policies and lack of experience, experts and resources.

7.5 Recommendations

Based on the gap analysis and information collected from officers involved in enforcement process the following recommendations can be given in order to improve the enforcement of the regulations of offshore oil and gas exploration and exploitation in the Sri Lanka.

1. Capacity building

The capacity building of officers through training and awareness building programs is very important in order to achieve better enforcement of the regulations. Universities and other research institutions should be encouraged to engage in these areas. Universities may adapt their curriculums to match with these topics. In addition, research projects for gathering knowledge and building a baseline of environmental information is needed. Also research related to policy making and development of guidelines are main requirements in this field in Sri Lanka.

2. Institutional strengthening

The institutions and agencies relevant to overseen and enforcement should be strengthened through capacity building and targeted training and the organizations be provided necessary technical resources. In addition, a central repository for data and information related to offshore activities should be developed. Such information should be made available to all relevant institutions.

3. Review of the regulation

A review of the regulations for eliminating identified gaps and other weakness is essential. Such a review should be a comprehensive revision in order to develop comprehensive and more up-to-date regulations which addressees all local conditions.

4 Establishment of a Marine Environment Protection fund

The establishment of a Marine Environment Protection Fund based on Polluter Pay principle may be a suitable solution considering multitude of demands for funding in a developing country like Sri Lanka. Therefore it is recommended that decision makers should consider the establishment of such a found to improve marine protection in Sri Lanka.

5. Formulate policies and national plans

In view of the identified gaps and weaknesses, it is recommended that policies such as the Dispersant Policy, Ballast Water Management Policy, and Hull Fouling Management Policy should be formulated. In addition, establishing a National Chemical and Harmful Substances Spills Contingency Plan is vital to prepare to future threats. Furthermore the National Oil Spill Contingency Plan should be updated to match with the increasing threat of oil spills in future.

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Appendix A

Summary of potential environmental impacts of offshore oil exploration and exploitation activities (from Joint E&P Forum / UNEP Technical Publications (1997) "Environmental management in oil and gas exploration and production")

Activity	Source	Potential impact	Comments
Seismic operation	Seismic operation	Noise	Acoustic sources, disturbance to marine organisms (may need to avoid sensitive areas and consider seasonality). Short-term and transient.
	Vessel operation	Emissions and discharges	Atmospheric emissions from vessel engines; discharges to ocean; bilges, swage; spillages; waste and garbage disposal to shore. Low-level, short-term, transient.
		Interference	Interaction with other resource users (e.g. fishing). Short-term, transient.
Exploratory and appraisal drilling	Site selection	Interactions	Consider sensitivities in relation to biota, resource use, cultural importance, seasonality. Secondary impacts related to support and supply requirements and potential impact on local port and infrastructure.
	Operation	Discharge Emissions Wastes	Discharge to ocean- muds, cuttings, wash water, drainage, swage, sanitary and kitchen wastes, spillage and leakage. Emissions from plant equipment; noise and light; solid waste disposal onshore and impact on local infrastructure. Disturbance to benthic and pelagic organisms, marine birds. (Continued……..)

Activity	Source	Potential impact	Comments
			Changes in sediment, water and air quality. Loss of access and disturbance to other resource users. Emissions and discharges from well test operations, produced water discharges, burning and flare, additional noise and light impact, Short-term and transient. Effects of vessel and helicopter movements on human and wildlife.
	Decommissioning	Footprint	Proper controls during operations and carful decommissioning should effectively remove risk of long-term impact. Improper controls can result in sediment and water contamination, damage to benthic and pelagic habitats, organisms, biodiversity. Onshore in terms of solid waste disposal, infrastructure and resource conflicts
Development and production	Site selection	Interactions	Long-terms site selection based upon biological and socio-economic sensitivities and minimum disturbance. Rick of impact to sensitive species, commercially important species, resource conflict, access. Long-term support and supply base requirement and impacts on local port infrastructure.
	Operations	Discharges Emissions Waste	Long-term chronic effects of discharges on benthic and pelagic biota; sediment and water quality. Impact of drill cutting and mud discharges, produced water, (Continued……..)

Activity	Source	Potential impact	Comments
			drainage, sewage, sanitary and kitchen wastes, spillage and leakage. Emissions from power and process plant and impact on air quality. Noise and light impact from facilities and flaring. Solid waste disposal and impact on the shore infrastructure. Increased vessel and helicopter movements.
		Socio-economic Cultural	Loss of access and resources use interactions. Local port, harbour and community interactions related to supply and support functions.

Sources: Joint E&P Forum /UNEP technical Publication (1997) Environmental management in oil and gas exploration and production

Appendix B

Summary of Environment protection measures in offshore oil and gas exploration and production (from Joint E&P Forum / UNEP Technical Publications (1997) "Environmental management in oil and gas exploration and production")

Activity	Source of potential impact	Environmental protection measures
Seismic operations	Seismic equipment	Use environmental assessment to identify protected area and local sensitivities. Schedule operations during least sensitive period.
	Vessel operation	Consult local authorities and other stakeholders regarding survey programme, permitting and notifications.
		Remain on planned survey track to avoid unwanted interaction
		Dispose all waste materials and oil water properly to meet local, national and international regulations
		Apply proper procedures for handling and maintenance of cable equipment particularly cable oil
		All towed equipment must be highly visible
		Make adequate allowance for deviation of towed equipment when turning
		Prepare contingency plans for lost equipment and oil spillage
		Attach active acoustic location devices to auxiliary equipment to aid location and recovery
		Label all towed equipment
		Store and handle explosives according to operators' procedures and local regulations
		Consider using guard boat in busy areas
		Report all unplanned interactions which other resources users
		Use local expertise to support operations

Activity	Source of potential impact	Environmental protection measures
Exploration and appraisal drilling	Site selection	Use environmental assessment to identify protected area and local sensitivities. Schedule operations during least sensitive periods.
		Consult with local authorities regarding site selection and support infrastructure- ports, vessels and air traffic.
		Select least sensitive location within confines of bottom target/ drilling envelope. Consider directional drilling to access targets beneath sensitive areas. Consider cluster well drilling.
		Local conditions must be fully assessed- wave, wind and currents.
		In coastal areas, select site and equipment to minimize disturbance, noise, light and visual intrusion.
	Access	Exercise strict control on access and all vessel and rig activity.
		In coastal areas where sensitivities dictate use vessels in preference to helicopters.
	Operations	Consult with local authorities regarding emissions, discharges and solid waste disposal/notifications in regard to other resource users.
		Requirements specified in planning process must be met including supply vessel operations.
		Aqueous discharges. Oily water from deck washing, drainage system, bilges etc. should be treated prior to discharge to meet local, national and international consents.
		Sewerage must be properly treated prior to discharge to meet local and international standards. Treatment must be adequate to prevent discolouration and visible floating matter.
		Biodegradable kitchen wastes require grinding prior to discharge, if permitted under local regulations.

(continued)

Activity	Source of potential impact	Environmental protection measures
Exploration and appraisal drilling (continued)	Operation (continued)	Most spills and leakage occur during transfer operations- ensure adequate preventative measures are taken and those spill contingency plan requirements are in place.
		Store oils and chemicals properly in contained, drained areas, Limit quantities stored to a minimum level required for operational purpose. Ensure proper control documentation and manifesting and disposal. Do not dispose of waste chemicals overboard.
		Produced water from well test must meet local regulations or company specified standards prior to discharge.
		Preferentially separate and store oil from well test operations. If burnt, ensure burnt efficiency is adequate to prevent oil fallout onto sea surface.
		Solid wastes. Ensure requirements specified in the planning process are met with regard to waste treatment and disposal.
		Collect all domestic waste and compact for onshore disposal .Ensure proper documentation and manifesting. Ensure onshore receiving and disposal meet local requirement.
		Consider waste segregation at source for different waste types- organic, inorganic industrial waste ect.
		No debris or waste to be discarded overboard from rig or supply vessels.
		Waste containers must be closed to prevent loss overboard.
		Spent oils and lubes should be containerized and returned to shore.
		Consider bulk supply of materials to minimize packaging wastes.
		Muds and cutting. Preferentially use low toxicity water- based drilling muds. Minimize use of oil-based mud (OBM). (Continued)

Activity	Source of potential impact	Environmental protection measures
Exploration and appraisal drilling (continued)	Operation (continued)	Mud make-up and mud and cuttings disposal requirements address in the planning process must be met.
		Do not dispose of whole OBM to sea. Any oily cuttings discharged must meet local regulations or company specified standards.
		Consider downhole disposal of OBM waste.
		Atmospheric emissions/noise/light. Ensure requirements address in the planning phase is met with regard to emissions noise and light.
		Well test burners must be efficient, maintained and effectively burn gas and oil.
		H_2S emissions must be effectively controlled.
	Decommissioning and restoration	All debris must be removed from seabed.
		Decommissioning of onshore support facilities must meet planning requirements.
Development and production	Site selection and access	Long-term occupation of sites, including supply and support base, will require detailed assessment of environmental implications, particularly where resource use conflicts arise and commercially important species may be affected.
		All aspects identified for exploration drilling should be applied to permanent sites.
		Consult with local authorities.
		Consider site and route selection for flowlines and pipelines.
	Operations	Evaluate construction and drilling activities and impacts separately from operational activities.
		Maximize use of central processing facility and use of satellite and cluster wells to minimize footprint.
		All aspects identified for exploration drilling should be applied to permanents sites.
		Consults with local authorities. (Continued)

Activity	Source of potential impact	Environmental protection measures
Development and production (Continued)	Operations (Continued)	Assess full implications of well treatment and workover, process, storage, power generation and other support and accommodation facilities in terms of long-term disturbance and impact.
		Evaluate implications of development on local infrastructure, in particular, infrastructure related to onshore services functions- port and harbour operations, resource use conflicts, waste treatment and disposal, socio-economic implications, employment, local services and supply, support infrastructure for employee and family accommodation etc.
		Incorporate oily water treatment system for both produced water and contaminated water treatment to meet local, national and international discharge limits.
		Include sewerage treatment system, particularly if close to shore, to meet local requirements.
		Assess treatment of waste gases and emission limits. Particularly where gas is flared. Avoid gas venting.
		Treatment and disposal of solid, toxic and hazardous wastes onshore will require proper planning, particularly if local infrastructure is limited in capacity and capability. A detailed waste management plan will be required.
		Prepare detailed contingency plans, personnel training and regular exercise of response, taking into consideration storage and export systems.
		Establish consultation and local liaison activities.
		Monitor waste streams in order to meet compliance requirements. (Continued)

Activity	Source of potential impact	Environmental protection measures
Development and production (Continued)	Decommissioning and rehabilitation	Develop a full decommission and rehabilitation plan in consultation with local authorities.
		Any facilities and infrastructure handed over to local authorities must include proper instructions for use, maintenance and include proper training procedures.
		Decommissioning of offshore structures is subject to international and national laws, and should be dealt with on a case by case basis with local authorities.
		Record and monitor site as required after appropriate decommissioning activities.

Sources: Joint E&P Forum /UNEP technical Publication (1997) Environmental management in oil and gas exploration and production

Appendix C

Questionnaire

Survey of environmental issues in the Oil and gas industry in Sri Lanka

Part o1: This part include information of the Institute

1. Name	
2. Address	
3. Telephone No.	
4. Fax	
5. Email	

Part 02: which part of enforcement phase of regulation of oil exploration and exploitation you involve? Please mark "yes" in relevant stage/stages

EIA process	
Approving of EIA report	
Issuing Marine Environment Protection License	
Monitoring environment impact mitigation	
Providing expertise advice	
Participate as observer	
Other (Please mention)	

Part 03: What were the limitation/ constrains for your above duties

Part o4: Please comment on the environmental regulation enforcement process. Your opinion was it efficient and covers the all aspect of environment impact? Was it practicable? Did company follow the instructions which regulatory agency gave? Any other comments are welcome

Part: 05 .Your comments/ proposal to improve the enforcement of environmental regulation relevant oil exploration and exploitation.