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# **Developing an Environmental Management Approach to Libya's Upstream Petroleum Industry**

By  
Ehmiada Emhmed

A thesis submitted in partial fulfilment of the requirements of  
Sheffield Hallam University for the Degree of Doctor of Philosophy

December 2008



## **Declaration**

In accordance with the regulation for presenting theses and other work of higher degrees, I hereby declare that this thesis of Doctor of Philosophy is entirely my own work and that it not has been submitted for a degree at any university.

December 2008

## Dedication

*To my family, who have continuously supported me throughout  
the course of this thesis.*

## Acknowledgments

*I owe an enormous debt of gratitude to my supervisors, Dr Ernie Jowsey and Dr Mike Heath. Their invaluable advice and careful guidance are highly appreciated.*

*I would also like to thank those who agreed to be interviewed and the respondents of the questionnaire for their time and cooperation.*

*A special thanks as well to all those who assisted me with this project.*

*Finally, to my country I pledge my loyalty and devotion. May ALLAH grant her peace and prosperity.*

*To all of those, I extend my deepest gratitude.*

## **ABSTRACT**

Concern about environmental impacts of the upstream oil and gas industry in Libya, which is an essential part of the national economy, is increasing following more intensive development of the country's petroleum reserves. The petroleum industry recognises that potential environmental impacts and consequences are associated with their exploration and production activities.

This thesis seeks to examine the environmental impacts and performance of the upstream oil and gas industry in Libya in order to establish an efficient environmental management approach to this important industry sector.

The current environmental management approach to dealing with the environmental impacts of the Libyan upstream oil and gas industry is investigated. The research investigates the implementation of and compliance with environmental regulations. The research also investigates whether the Libyan National Oil Corporation (LNOC's) recently established environmental department and the Environment general Authority (EGA) can be regarded as competent bodies in dealing with environmental issues. Management of the petroleum sector is also reviewed, especially the relationship between the LNOC and its subsidiaries. In addition, the effect of sanctions, which were imposed upon the country for more than a decade, on the environmental performance of the oil and gas industry is investigated.

The research comes to conclusions and makes recommendations for environmental management of the Libyan oil and gas industry sector. These include recommendations about implementation of the existing environmental regulations. The environmental policies and management systems adopted by the industry should be greatly influenced by this work.

## List of Abbreviations

ADMA OPCO	Abu Dhabi Marine Operating Company
ADNOC	Abu Dhabi National Oil Company
CEF	Communication Environmental and Fisheries
CFC	Chlorofluorocarbon
CH <sub>4</sub>	Methane
CO <sub>2</sub>	Carbon dioxide
EBS	Environmental Baseline Studies
EDM	Environmental Decision-Making
EIA	Environmental Impact Assessment
EMS	Environmental Management System
E&P	Exploration & Production
EPSA	Exploration and Production Sharing Agreements
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
HC	Hydrocarbons
HFCs	Hydrofluorocarbons
HSE	Health, Safety & Environment
IAOGP	International Association of Oil and Gas Producers
IOCs	International oil companies
ISO	International Standards Organisation
LIPETCO	Libyan General Petroleum Corporation
LNOC	Libyan National Oil Corporation
LPG	Liquefied petroleum gas
LPI	Libyan Petroleum Institute
NDC	National Drilling Company in (UAE)
NGOs	Non-government Organisations
N <sub>2</sub> O	Nitrous oxide
NORM	Naturally Occurring Radioactive Materials
OBM	Oil-Based Mud
OPEC	The Organisation of the Petroleum Exporting Countries
PFCs	Perfluorocarbons
SBM	Synthetic Based Mud
SF <sub>6</sub>	Sulphur hexafluoride
SPSS	The Statistical Package for the Social Sciences
UAE	United Arab Emirate
UK	United Kingdom
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environmental Programme
US	United States
VOC	Volatile Organic Compound
WBM	Water-Based Mud
WHO	The World Health Organisation
ZADCO	Zakum Development Company in (UAE)

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## Chapter One

### Introduction

#### **1.1 The Research Topic**

Environmental problems occur in many countries due to their industrial development. Some of problems have become global as the earth is a single system and any event anywhere affects the whole system. Steffen *et al* (2004) believe as many others that:

*“The Earth behaves as a system in which oceans, atmosphere and land, and the living and non-living parts therein, are all connected”.*

Changes in the tropical rain forest, for example, cannot be approached in isolation from the rest of the global ecosystem. Environmental contamination, therefore, has global implications wherever it occurs and is no longer a local phenomenon.

Thus, understanding environmental problems requires a cross-national mode of analysis, mainly because the environment is a single, interrelated phenomenon and environmental problems are not encapsulated within national borders. Wells (1996) also states that:

*“Human beings are biological creatures living in a single, complex, and interrelated environment”.*

Therefore, multinational cooperation where nations can learn from each other is essential, as humans live in different nations with different cultures, laws, and policies relative to the environment. Managing environmental problems requires an intergenerational mode of thinking because decisions and actions which are taken now have intergenerational consequences. Accordingly, solutions should not be only at the local level but must have global aspects.

It is widely thought that industrial development including the upstream oil and gas industry, has caused serious environmental problems in many parts of the world. Awareness of the importance of environmental issues has become more and more central to the thinking of the oil industry and regulators in recent decades. Integration of development and environment, approached in partnership between stakeholders, was the theme of the United Nations Conference on Environment and Development (UNCED) in Rio in 1992. Increasing attention has been paid to environmental issues therefore, as a result of growing public and governmental concerns and influence of Non-government Organisations (NGOs) and pressure groups. The United Nations Environmental Programme (UNEP) has raised global awareness of environmental issues by providing technical and public information to encourage nations and people to take environmental action by promoting concepts such as:

*“Saving the Environment is Your Business Too”* (UNEP, 1992).

New regulations and legislation are now being enacted by governments at both national and international levels. A number of international agreements and conventions are widely verified such as The Kyoto Protocol 1997. The July 2008 G8 summit in Hokkaido agreed to reduce carbon dioxide emissions by 50% by 2050. Environmental protection should constitute an integral part of any development process to achieve sustainable development. It is clear that preventing or minimising potential environmental impacts cannot be achieved in the absence of government action in relation to policy and regulation.

### **1.1.1 Aims and Objectives**

This research aims to determine the existing situation and practice of environmental policy in the Libyan upstream oil and gas industry and to develop a more effective regulatory environmental approach to govern the environmental impacts associated with upstream oil and gas activities.

The objectives below outline how this aim will be pursued:

1. To review the relevant literature of the environmental impacts of the exploration and production operations in order to identify the main potential impacts of these operations.
2. To investigate current environmental policy in Libya relating to the upstream oil and gas industry in order to determine its shortcomings.
3. To explore the management structure of the oil and gas industry sector which is represented by the Libyan National Oil Corporation (LNOC) and its affiliates and how the environmental issues associated with upstream activities are dealt with.
4. To examine the role of the US and UN sanctions and how the sanctions affected the upstream oil and gas industry in Libya from an environmental perspective.
5. To make recommendations for developing an environmental management approach to the Libyan upstream oil and gas industry.

## ***1.2 The Research Context***

The use of energy is fundamental to human development and has changed the human living system. This is associated with the rise of pollution locally and globally. The balance between the importance of energy and its adverse environmental consequences may be considered as the hardest challenge in the search for sustainable development (Schmidheiny, 1992).

Petroleum as a source of energy was chosen for investigation for a number of reasons. First, petroleum is currently the main source of energy in modern societies. Second, there are considerable environmental impacts associated with exploring and producing petroleum. Third, the long term concern about the affects of the petroleum industry's activities upon the environment has been increasing. Finally, constant change and



stricter controls affect the petroleum industry's activities and products worldwide.

The upstream oil and gas industry in Libya was considered to be very suitable for this research as the country is a developing country that depends on the upstream petroleum industry of its economy and it does not have suitable infrastructure for a downstream petroleum industry. The upstream oil and gas industry is responsible for the implementation of policies and standards changes required in order to comply with the environmental and economic demands of the most important industry in the country. In 1992 international sanctions were imposed on the country which greatly affected the petroleum industry sector. The external environmental controls on emission and contamination generated by the upstream industry directly affect the upstream activities' strategies and management systems.

The oil and gas industry faces challenges as well as opportunities. The environmental management of the environmental impacts of the oil and gas industry is the broad field of this research. However, there could be serious adverse environmental impacts if appropriate protection and restoration measures are not taken.

For the purpose of this research, the increasing trend towards the introduction of environmental legislation is considered relevant to the strategic environmental issues of the upstream oil and gas industry. Accordingly, the research will be concentrating on the following elements:

1. Commitment to environmental protection;
2. Compliance with environmental laws, policies and programmes;
3. Implementation of environmental laws and regulations;
4. Monitoring of the implementation of the environmental regulations;
- and
5. Evaluation and improvement of environmental performance.

### **1.3 The Libyan Petroleum Industry**

Libya is a petroleum producing and exporting country and the upstream petroleum industry is the key to its economy. Blair (1977) mentioned that:

*"By 1970, Libya had become the fourth largest producer among The Organisation of the Petroleum Exporting Countries (OPEC), ranking only slightly below such long-established producers as Saudi Arabia, Iran, and Venezuela".*

The petroleum industry in Libya is controlled by the state-owned Libyan National Oil Corporation (LNOC). The corporation has some subsidiary companies. Libya's oil reserves are located mainly onshore and on the relatively narrow continental shelf and slope in the Mediterranean and the Gulf of Sirte. The country is reliant on foreign investment to keep the industry active. Foreign involvement in Libya was severely reduced as a result of the United Nations (UN) sanctions and embargoes placed upon it in 1992. Thus, access to petroleum industry equipment and technology was restricted. (Hallett, 2002) concluded that:

*"The depressed state of the industry in Libya during the 1990s and the price collapse of 1998, in which Libya's oil revenues fell to \$ 5.6 billion dollars, perhaps had some influence on the government's decision in April 1999 to hand over the Lockerbie suspects for trial".*

With the suspension of the sanctions in 1999, oil companies have shown an eagerness to invest in the country. This began even before September 2003 when the UN sanctions were lifted completely. Libya is a preferred location for oil exploration and production for a number of reasons. Libya is both Africa's largest oil producer and Europe's largest North African oil supplier. It provides extremely high grade, sweet crude. It has very low production costs and the oilfields are close to the refineries and markets of Europe. In addition, Libya remains largely unexplored with vast oil and gas potential. Libya would like to increase production and wants to attract foreign investment to the oil and gas industry.

Libya found itself in a weak bargaining position in relation to the imposition of environmental regulation on these foreign investors. Thus, environmental management in exploration and production in Libya was chosen as the focus topic of this research.

### ***1.4 Structure of the Thesis***

Chapter 2 discusses environmental impact theory in detail, with relevant aspects of the sustainable development concept. It also examines the Environmental Impact Assessment (EIA) technique. The processes of the EIA are explained in this chapter. A brief introduction to the importance of EIA in oil and gas development projects is introduced in this chapter.

Chapter 3 is in 2 sections. Section one is dedicated to the oil and gas exploration and production operations and their potential environmental impacts. This includes all phases of the upstream oil and gas industry from desk studies of the exploration phase to the decommissioning phase. Section two is a study of the environmental impacts of the Libyan upstream petroleum industry. This contains an investigation of the main environmental impacts of the upstream operations in Libya.

Chapter 4 addresses the research method of the study. In this chapter, the research strategy is presented. The sources of data and methodological approach adopted for data collection are explained.

Chapter 5 presents the development of the oil and gas industry in Libya and the related laws and regulations pertaining to this important industry since the independence of the country. This includes the examination of the current relevant environmental regulations.

Chapter 6 aims to address the current environmental management approach to the Libyan oil and gas industry sector and identifies its shortcomings.

Chapter 7 presents the analysis of the data collected by the interviews and the questionnaire survey. Two computer software programmes were used in order to analyse the interviews and the questionnaire survey. NVivo software was used to code and categorise the interview responses and SPSS software was used to analyse the questionnaire responses statistically. The questions of the questionnaire survey were classified according to the categories of the interviews to enable a logical comparison between these two sources of data.

Chapter 8 contains the discussion and interpretation of evidence emerged from analysis to multiple sources. This includes evidence from questionnaire, interviews, photos and notes from oilfields. A table of cross-referencing evidence is created to provide concise and comparison of the evidence.

Chapter 9 comprises final conclusions of this research. This includes the limitations of the research and the significance of the research. Suggestions for further research are also provided in this chapter.

## Chapter Two

### Environmental Impact Theory and EIA

The aim of this chapter is to examine the concept of 'environmental impact' and apply it to the upstream oil and gas industry. This will be achieved by examining the theory of environmental impact, outlining the technique of EIA as a mean of predicting and mitigating impacts, and applying the theory and practice of EIA to projects in the upstream oil and gas industry.

#### **2.1 Environmental Impact**

Environmental impact can be described as:

*"The change in an environmental parameter over a specified period and within a defined area, resulting from a particular activity, compared with the situation which would have occurred had the activity not been initiated". (Wathern, 1988).*

Environmental impacts and their consequences are likely to be more complex today than about three decades ago when the EIA process was first established. Good understanding of the concept of environmental impact will lead to better prediction and identification of the expected impact.

In fact, the perception of the concept of environmental impacts is not always the same in all countries. Dealing properly with these impacts involves improving environmental management to establish environmental approaches to minimise the adverse environmental impacts of a development's products, processes and services.

Figure 1 gives a simple illustration of the concept of environmental impact.

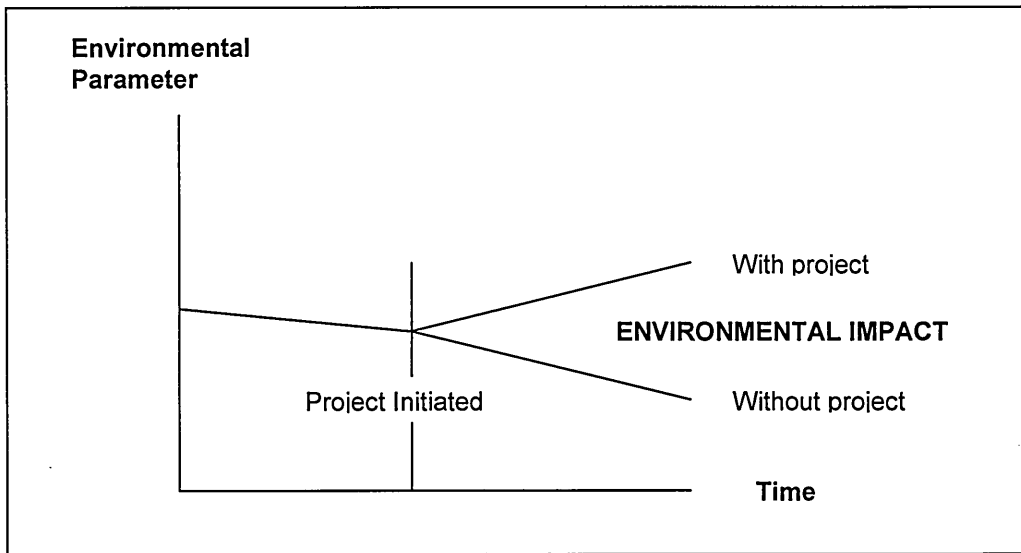


Figure 1 Illustration of the Concept of Environmental Impact (Wathern, 1988).

The concerns about the environmental impacts are now at or near the top of the international and political agendas. Each impact on the environment could be positive or negative; a beneficial change to the environment is a positive impact, whereas an adverse change is a negative impact. Table 1 gives some examples of the environmental impacts as a result of some environmental aspects.

Environmental Aspects (Cause)	→	Environmental Impacts (Effect)
Emissions of volatile organic compounds	→	Air pollution, smog
Discharges to stream	→	Degradation of aquatic habitat and drinking water supply
Spills and leaks	→	Soil and groundwater contamination
Electricity use	→	Air pollution, global warming
Use of recycled paper	→	Conservation of natural resources

Table 1: Some Environmental Impacts as result of Environmental Aspects.

Essentially, all human activities have an effect on the environment, and attention is generally best concentrated upon preventing or minimising environmental damage, rather than cleaning it up afterwards taking into account the principle: "*prevention is better than cure*".

Accordingly, the first step is to determine whether or not a project may result in significant adverse environmental effects. This is one of the key aspects of EIA. However, many methods can be used to identify the major impacts of a proposed development. These methods differ from country to country because of economic and social factors.

However, the priority of people in most developing countries is to find adequate food, shelter, health care, education, and security rather than concern about the environmental impacts of any development. The impacts resulting from this situation in less developed countries have been spoken of as the "*pollution of poverty*" (Munn, 1979). Thus, the environmental consequences of development in this case may be tolerated. In fact, environmental obstacles in less developed countries are related to many problems including unplanned development. This emphasises the importance of the EIA as a protective component in these countries. It is also likely that less developed countries face many problems such as lack of finance, infrastructure and trained scientists to fulfil their needs for vital environmental change.

Bongaarts (1992) partitions CO<sub>2</sub> emissions into components for population, affluence, energy intensity due to affluence and the carbon intensity of energy. He finds that in the less developed nations, affluence changes will dominate the growth in emissions, with population growth the second most important factor. In the more developed countries, growing affluence also drives emissions but changes in energy intensity are more

important than changes in population (Bongaarts, 1992 Cited in Dietz & Rosa, 1994).

Therefore, different value judgments of environmental, economic and social impacts should be considered when making a decision. Thus, development can be planned to make best use of environmental resources and to avoid environmental degradation.

### 2.1.1 Conceptual Model of the Environmental Impact

The concept of the model "source-pathway-receptor" has been developed internationally as an assessment model to help establish impact relationships. As Stewart, (2005) states:

*"Modelling is the process by which conceptual models are developed into formal, consistent descriptions of the relationship between important aspects of the system (variables, their dependencies and consequences)".*

The aim of modelling in this case is to identify and predict the environmental impacts associated with actions anticipated under a plan or strategy and based on a synthesis of available knowledge. Figure 2 shows the impact relationships.

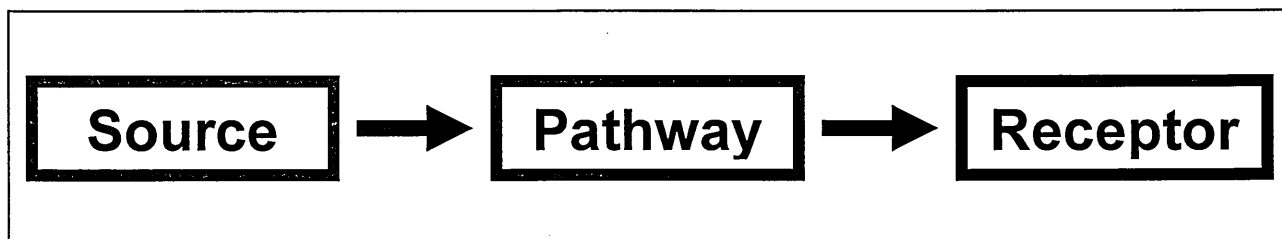


Figure 2 Impact Relationships

Using this concept, categories are determined by the following factors:

1. Source: the origin of an environmental impact.
2. Pathway: the physical route which an impact takes from the source to the receptors.



3. Receptors: can include people, living organisms, ecosystems, buildings or groundwater, which are or can be affected by the impact.

### **2.1.2 Environmental Impact and Sustainability**

Sustainable development is often seen as an environmental issue. It is just as much about wealth creation and tackling poverty and injustice. Sustainable development as a concept contains social and economical aspects. Sustainable development is the internationally adopted principle that, social, economic and environmental issues should be considered at the same time during the planning stage and the decisions should be taken accordingly. Thus, development cannot be sustainable unless its environmental impacts are considered. Vitousek *et al* (1986) indicated that the environmental impacts are at the core of sustainability.

#### **2.1.2.1 Sustainable Development**

Sustainable development is about meeting the needs of both present and future generations. The Brundtland Report concluded that:

*“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. (World Commission on Environment and Development, 1987).*

Thus, natural resources which have essential economic value must be sustained, as many are not inexhaustible. Environmental issues are strongly related to the economic and social priorities. Glasson *et al*, (1999) for example, believe that:

*“Economic development and social development must be placed in their environmental contexts”.*

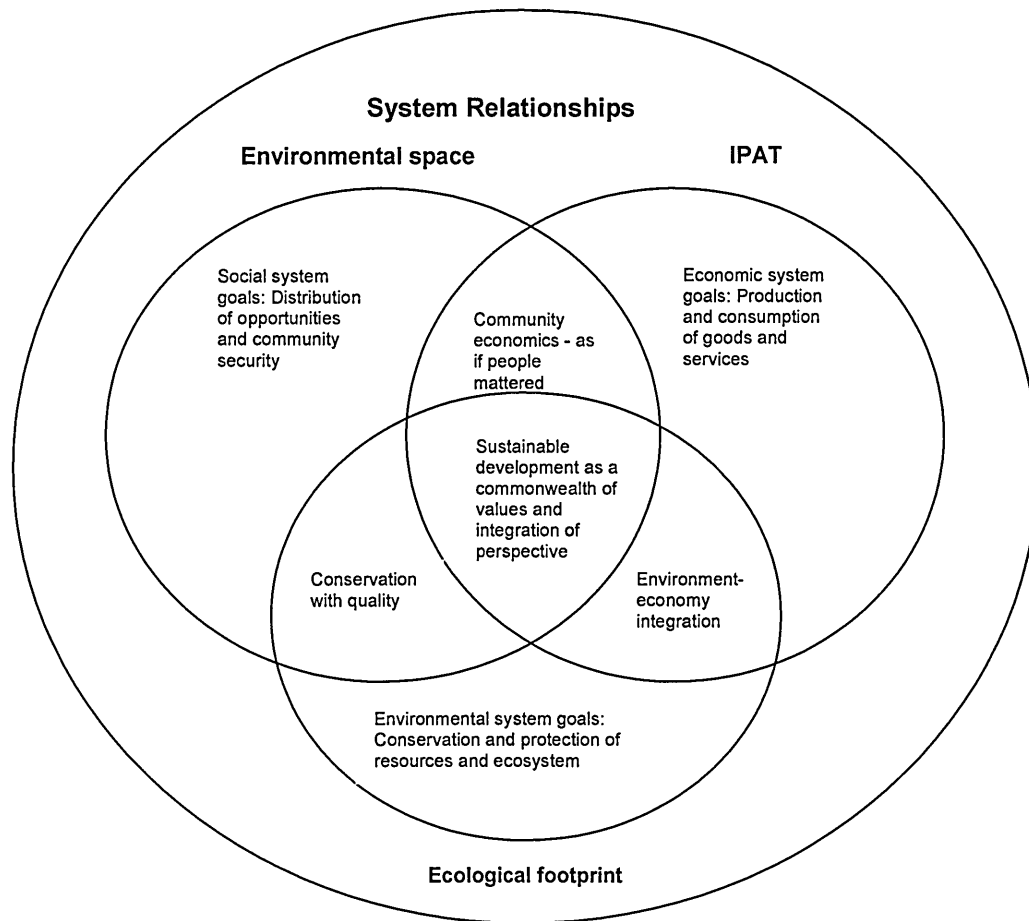
As a result, the concept of sustainable development has become internationally accepted as a way to address environmental issues and relate them to their relevant economic and social issues. Jacobs & Sadler,

(1989) identified the key goals of sustainable development as the following:

- Meeting basic human needs for material welfare;
- Maintaining the ecological integrity of natural systems; and
- Providing for equity, social justice, and choice of lifestyle.

In order to increase production, more inputs are required to produce more goods and services; the output, however, will be not only more goods and services, but also more waste products. Thus, increasing inputs demands more resources and produces more wastes, and the natural environment is the sink for the wastes and the source for the resources (Glasson *et al*, 1999).

In fact, the natural environment has limited capacity to absorb waste products. It is widely thought that this capacity is less than the current rate of production of waste. The relationship between the social, economic and environmental spheres, which reflects the origins of environmental impact, is explained by this trio of concepts in Figure 3.



**Figure 3 The Interaction between Social, Economic and Environmental Systems (Petts, 1999).**

- **Urbanisation and Population Growth:** Population growth and urbanisation are repeatedly implicated in environmental change. Their impact is often represented as strongly negative.  
IPAT ( $I = P \times A \times T$ ): where net environmental impact (I) can be recognised by a single identity: population (P) x affluence (A) x technology (T) (Ehrlich & Holdren, 1971).
- **Ecological footprint:** the actual area that is occupied by a country or city at national or regional scale which is necessary to continuously provide their resource supplies and absorb their wastes, using

prevailing technology. The resources use and wastes generated are aggregated into a single indicator of total hectares of land used to produce food and wood and absorb pollution for a given population.

- Environmental space: refers to the amount of energy, raw materials, water, wood and land that can be used without lasting damage and consistent with equal rights to resource access and use. In other words it includes an equity conversion of resource indicators of production and consumption.

### ***2.1.2.2 Human Imprint***

As the world has become more industrialised, the impact on the environment has increased. Most human activities, including modern industry, have adverse impacts on the environment. Thomas (1956) mentioned that:

*“A biohistory of the human tenure on earth shows a massive recent expansion in the nature, magnitude, and scale of environmental impacts”.*

Environmental damage such as climate change and loss of biodiversity are probably the most pressing challenges of these impacts. Schmidheiny, (1992) acknowledged that:

*“The greater the rate of materials throughput (population x per capita resource consumption), the larger the environmental damage, although technology can moderate this relationship by reducing resource inputs and pollution outputs”.*

<p><b>Atmosphere</b></p> <ul style="list-style-type: none"> <li>• Intensification of greenhouse effect</li> <li>• Ozone depletion in the stratosphere</li> <li>• Changes in the troposphere (photochemical, smog, acid rain)</li> </ul> <p><b>Climate change</b></p> <ul style="list-style-type: none"> <li>• Global surface warming of +2.5 °C (?) by 2050; greatest [+8 °C] in subarctic winters</li> <li>• redistribution of precipitation</li> <li>• Rise of sea level (non-tectonic) of 65cm by 2100</li> </ul> <p><b>Hydrosphere</b></p> <ul style="list-style-type: none"> <li>• Horizontal and vertical changes of ocean circulation (weaker Gulf Stream, stronger Kuroshiro)</li> <li>• Changes in Antarctic and Greenland ice-caps</li> <li>• Changes in flood regimes, sedimentation/ erosion, delivery of pollutants</li> <li>• Changes in groundwater and recharge (quantity and quality)</li> </ul> <p><b>Lithosphere and pedosphere</b></p> <ul style="list-style-type: none"> <li>• Increased erosion, material redistribution</li> <li>• Reduction of organic content of soils</li> <li>• Widespread breakdown of soil structure, due to forest changes and cultivation</li> <li>• Increased nutrient mobility and loss due to use of soluble fertilizers</li> </ul>	<p><b>Biosphere</b></p> <ul style="list-style-type: none"> <li>• Forests: removal, loss of diversity, increased susceptibility to fire, trace gases feedback</li> <li>• Grasslands and farmlands: loss of diversity, soil and run-off changes, encouragement of pests</li> <li>• Drastic reduction in coastal vegetation</li> <li>• Pelagic and benthic biomass: changes in community structure</li> </ul> <p><b>Human Population</b></p> <ul style="list-style-type: none"> <li>• Net increase of 100 million per year, mostly in subtropics</li> <li>• Increases urbanization, especially growth of mega-cities</li> <li>• Local concentration of chemicals, refined materials, wastes; regional drawdown of fertility by 2100</li> <li>• Increased encouragement for new parasites and viruses</li> </ul> <p><b>Economic, Energy and Transport</b></p> <ul style="list-style-type: none"> <li>• Regional and global economic linkage increasingly prevent self-correcting feedbacks to balance resources or ecological deterioration</li> <li>• Increased use of high-quality energy and long-distance transport of organic products and chemicals is a major global change</li> <li>• Regional 60 Hz electrical fields on all continents except Antarctica</li> </ul> <p><b>Social Factors</b></p> <ul style="list-style-type: none"> <li>• Mismatch between causes by humans, effect on humans and human responses</li> <li>• Economical and cultural obstacles to "environmental consciousness" in society</li> <li>• Inability of individuals to be convinced of the magnitude of the problem</li> <li>• Breakdown of "inter-generational contract" that controlled most behaviour in all cultures until the 20<sup>th</sup> century</li> </ul>
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**Figure 4 The Elements of Global Change (German Advisor Council on Global Change, Cited in Sadler, 1996).**

Figure 4 summarises the agenda of global change issues resulting from human activities on planetary systems. The awareness of achieving sustainable forms of development has increased among the world societies. In order to achieve this, many national and international, governmental and non-governmental organisations are calling for a reduction in the burden of environmental impacts. Identifying the scientific, technological, and institutional changes would be necessary in order to assess these environmental impacts. Therefore, improving the structure processes and procedures for decision-making, and methods which shape the definition of problems to deal with these problems might be the best effective approaches in support of that goal. Thus environmental assessment and related procedures have been identified as key-mechanisms for predicting and evaluating the environmental impacts.

Devising methods to prevent, minimise or mitigate adverse impacts has become a major concern for the international community. Many initiatives have been pursued in order to reduce the adverse impact and to enhance the desirable impacts. Many of these are encompassed within EIA. Hence, EIA is the most powerful tool available to deal with the environmental impacts of a proposed development.

## ***2.2 Environmental Impact Assessment (EIA)***

Environmental Impact Assessment (EIA) is a technique designed to predict, investigate and record the types of impact of a proposed development on the environment during its life-cycle, to ensure that the environmental consequences of all development policy, programme or project options are understood and adequately considered during the planning process. This not only includes environmental impacts such as air pollution or noise impact, but also the economic implications for the development and its location. Therefore, EIA is about protecting the environment and achieving sustainable development by avoiding or

mitigating the environmental impacts of new developments. Munn, (1979) concludes that:

*“EIA is an activity designed to identify and predict the impact on the bio geophysical environment and on man’s health and well-being of legislative proposals, politics, programmes, projects and operational procedures, and to interpret and communicate information about the impacts”.*

EIA is seen as a rational and systematic process which is often held to be holistic and proactive in its approach to environmental protection (Glasson *et al.*, 1999). Before the nineteen-sixties, environmental problems were generally perceived as local incidents of pollution, in terms of both causes and cures. Better understanding of the environmental issues led to a growth in modelling methods to tackle these issues. Thus, EIA was established in 1970 in the US and designed to prevent environmental degradation by giving decision makers better information about the possible environmental consequences of development actions. Table 2 shows the development of the EIA process.

The procedure of EIA is governed by Government regulations when EIA is required. In some cases EIA may suggest that the proposed development should not be carried out as the outcome would be unacceptable environmental damage.

Pre 1970	<ul style="list-style-type: none"> <li>- Project review based on technical/engineering and economic analysis.</li> <li>- Little or no consideration given to environmental consequences.</li> </ul>
Early/mid-1970s	<ul style="list-style-type: none"> <li>- Introduction of EIA principles, guidelines and procedures (NEPA 1970) in US.</li> <li>- Standard methodologies for impact analysis developed (e.g., matrix, checklists, networks).</li> <li>- Other countries adopt EIA (e.g., Australia New Zealand).</li> </ul>
Late 1970s to early 1980s	<ul style="list-style-type: none"> <li>- More formalised guidance (e.g., CEQ regulations).</li> <li>- Use of EA by developing countries (e.g., Brazil, Philippines, China, Indonesia).</li> <li>- SEA, risk analysis included in EA process.</li> <li>- Programme EISs prepared in US.</li> <li>- Environmental inquiries in several countries. Encompass policy review aspects.</li> </ul>
Mid-1980s to end of decade	<p>EC Directive on EIA establishes basic requirements for member states.</p> <ul style="list-style-type: none"> <li>- Increasing efforts to address cumulative effects.</li> <li>- Development of follow-up mechanisms (e.g., compliance and effects monitoring).</li> <li>- Ecosystem and landscape level approaches applied.</li> <li>- World Bank and other international lending and aid agencies establish EA requirements.</li> <li>- Increasing number of developing countries carry out EIA (e.g., Asia).</li> </ul>
1990s	<ul style="list-style-type: none"> <li>- Requirement to consider trans-boundary effects under Espoo Convention.</li> <li>- EIA identified as implementing mechanism for UN conventions on climate change and biological diversity.</li> <li>- SEA systems established in an increasing number of countries.</li> <li>- Sustainability principles and global issues receive increased attention (some EA guidance but still limited).</li> <li>- Increasing use of GIS and other information technologies.</li> <li>- Greater corporate use of EA, including screening of investment and loan decisions and undertaking site and property assessment to establish liabilities - rapid growth in EIA training, networking and co-operation activities enactment of EA legislation by many developing countries.</li> </ul>

Table 2: EIA Process Development (Sadler 1998).



### 2.2.1 The Aims and Objectives of EIA

If it is properly applied, the EIA process should lead to improved decision-making by providing better information for the development control process. The aims of EIA can be divided into two categories: immediate and long term. The immediate aim of the EIA is to inform the process of decision-making by identifying the potentially significant environmental affects and risks of development proposals. The long term aim is to promote sustainable development by ensuring that development proposals do not undermine critical resource and ecological functions or the well being, life- style and livelihood of communities and people who depend on them. Lohani, *et al*, (1997) state that:

*“The main goal of EIA is to influence development decision-making by providing sound information on environmental impacts and the means of preventing or reducing those impacts”.*

EIA is not only about determining whether or not a proposed development should be permitted, but also to suggest planning conditions and legal agreements in order to avoid or mitigate adverse effects and enhance beneficial effects. Therefore, integrating EIA into the decision and evaluation process will improve the environmental quality of new development and increase its sustainability by:

1. Taking the environmental issues into consideration in preparing a development proposal;
2. Examining alternatives;
3. Highlighting the environmental effects of the proposed project; and
4. Suggesting appropriate mitigation and monitoring measures.

The realisation of these goals and achieving EIA processes properly requires the preparation and review of environmental statements to be managed efficiently during all stages of the project.

EIA is a reasonably well tried and tested instrument for project planning and impact mitigation, yet the process, in its current form, may not be sufficient to ensure sustainable development. For example, it applies only to individual projects and so may be too narrow in focus and restrictive in scope of application to capture cumulative environmental and social effects.

### ***2.3 The Environmental Impact Assessment Process***

As EIA is an anticipatory and participatory environmental management tool, its purpose is to assist in shaping the development process, not simply to prevent inappropriate development from taking place. It consists of a number of stages which should be conducted sequentially and properly to achieve the best outcome. It is widely agreed that EIA should involve the following steps:

- Description of the proposed action as well as alternatives to the project;
- Estimation of the nature and magnitudes of the likely environmental changes;
- Identification of the relevant human concerns;
- Definition of the criteria to be used in measuring the significance of environmental changes, including the relative weighting to be assigned in comparing different kinds of changes;
- Estimation of the significance of the predicted environmental changes; and
- Recommendations regarding the overall environmental burden of the project, environmental remediation actions, and alternatives, as well as monitoring required during operation of the project.

Figure 5 explains the main EIA process for planning decisions in diagrammatic form.

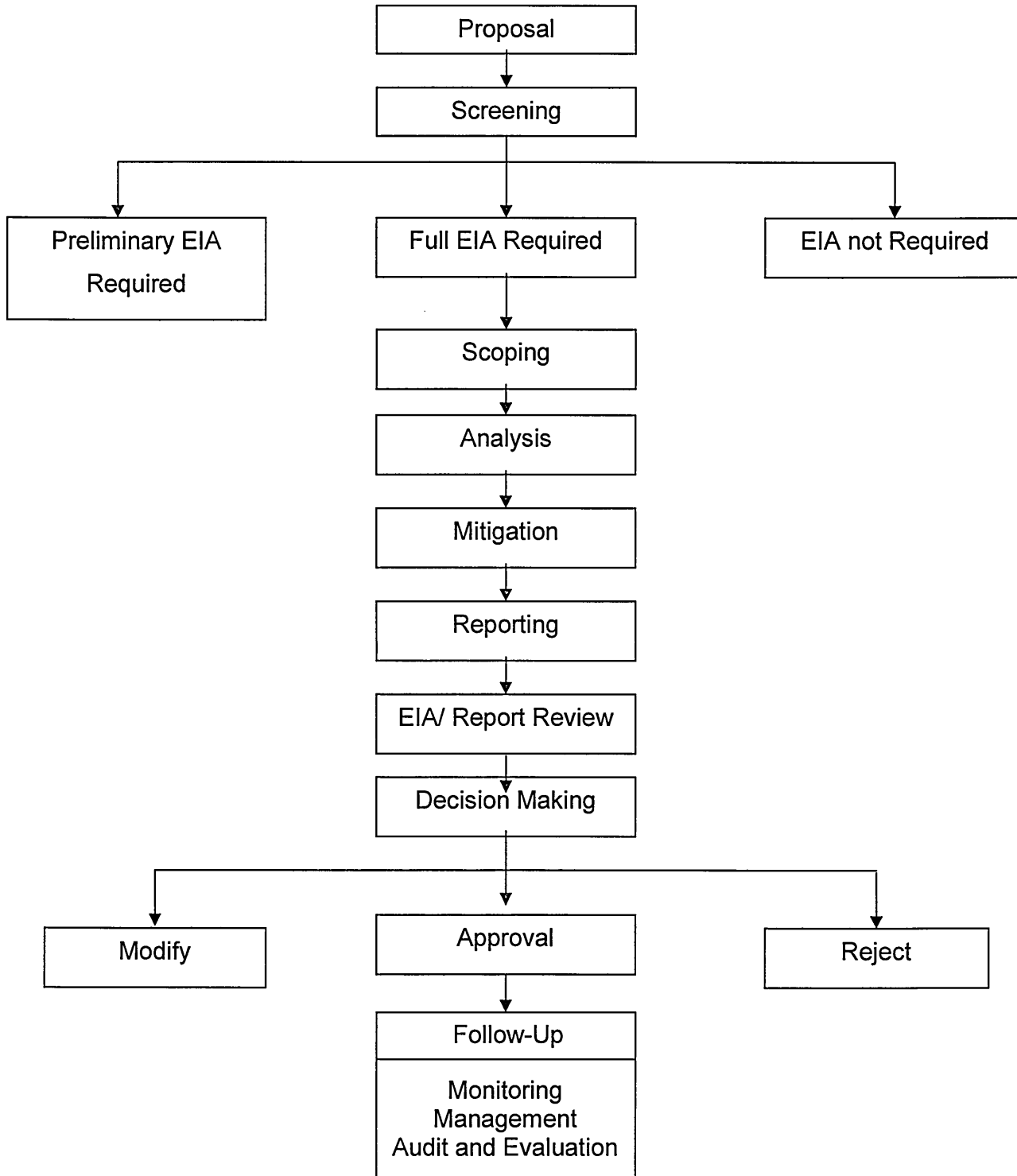


Figure 5 EIA Process Schematic (Sadler, 1996).

### 2.3.1 Screening

Before conducting an EIA there is a fundamental question. Is EIA required? The answer is provided by application of the screening mechanism.

The purpose of screening is to screen out the projects with few or no environmental impacts and allow them to proceed to the normal planning permission without additional loss of time and the expense of an EIA, leaving projects with potentially significant adverse environmental impacts (or whose impacts are not fully known) requiring EIA. It is intended to ensure that the form or level of any EIA is commensurate with the likely importance of the issues raised by a proposal.

In the case of the UK, screening regulations are laid down in European Community Directive 85/337/EEC on the Assessment of the Effects of Certain Public and Private Projects on the Environment (the EIA Directive), as amended by Council Directive No. 97/11/EC. Figure 6 illustrates whether a development requires EIA or not, according to these regulations. Note that they differentiate between two Schedules or Annexes:

- **Schedule 1 development;** EIA is Mandatory for all Schedule 1 developments.
- **Schedule 2 development;** development listed in Schedule 2 requires EIA if it is likely to have significant effects on the environment by virtue of factors such as its size, nature or location.

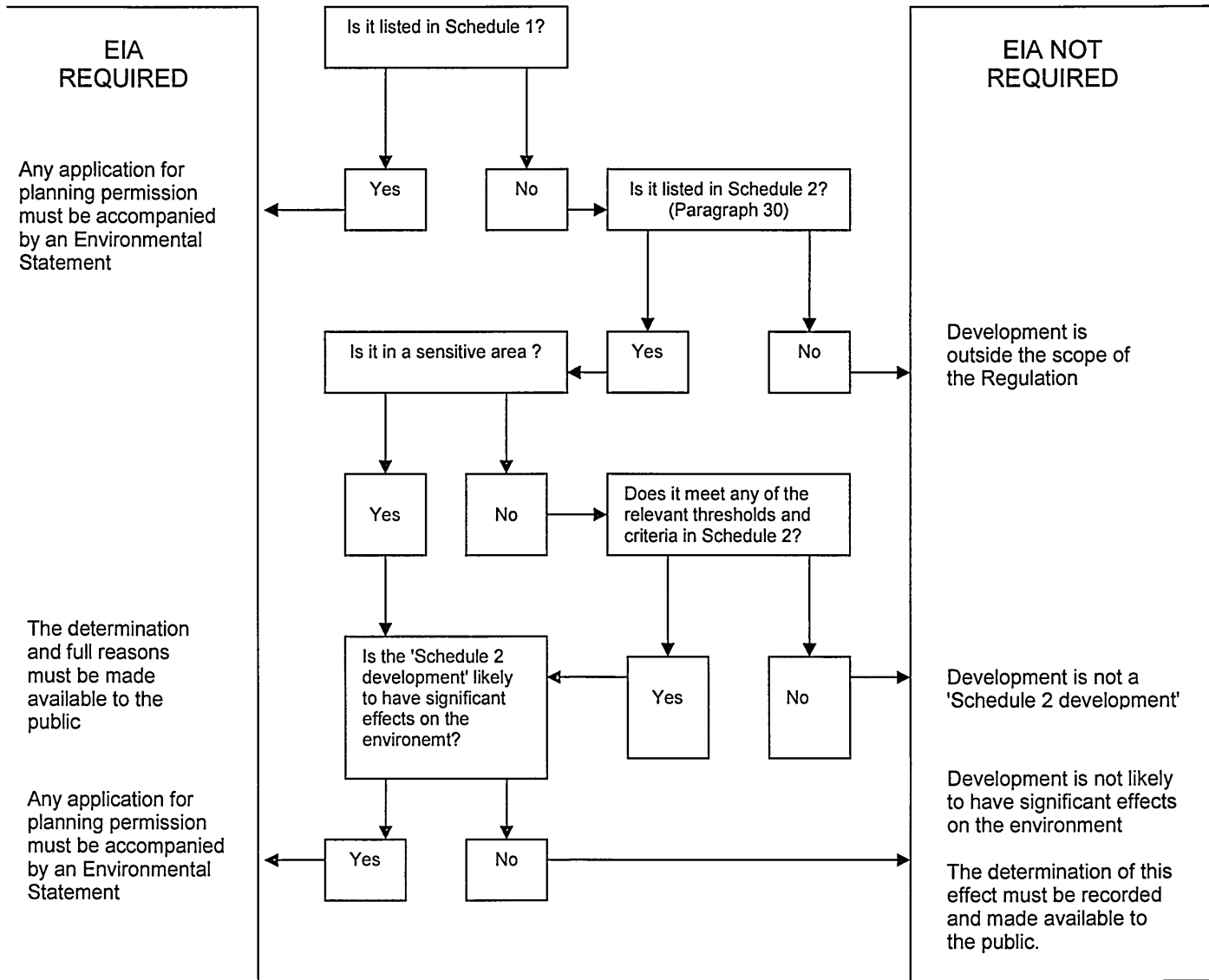


Figure 6 Shows Whether EIA is Required or not ( DETR Circular 02/99, 1999).

### 2.3.2 Scoping

Scoping is the initial process of identifying and addressing all of a project's possible impacts and issues. Scoping aims to focus resources and time on the important impacts, receptors and project alternatives, and to build an early communication between the developer, competent authority and other relevant parties, including the public. This will determine the priority

of the society of any proposed development, as Wathern (1988) mentioned:

*“Determining the priority values of society with respect to the potential effects of a particular development proposal is a major concern”.*

Scoping is an important step because resources are always limited and must therefore be used to best effect. Scoping begins with the initial identification of impacts.

### **2.3.3 Impact Prediction and Identification**

The prediction of the development's impact should consider the change in the baseline conditions that may occur in its absence before and during the lifetime of the development.

According to the EIA legislation in the UK, impact prediction should include an assessment of:

- Direct (primary) impacts: which directly result from the proposed development;
- Indirect (secondary) impacts: which are often produced in other locations and/or as a result of a complex pathway; and
- Cumulative impacts: this may occur over time, and/or as a result of impacts acting in combination with each other.

The Royal Town Planning Institute (2001) concludes that:

*“The predicted effects of a development may be international or local, adverse or beneficial, temporary or permanent, intermittent or continuous”.*

The net result of any new development is very difficult to predict. For example, building a new highway will change the landscape, which in turn may affect the habitat of some species, which will modify the biological system in the area. On the other hand, the value of the land, recreational

habits, locations, work-residence and the regional economy will also be affected by the same highway. Thus, a variety of factors are interrelated, making the prediction of overall impact more difficult.

However, it is possible to summarise the requirements of impact prediction regardless of the type (Morris & Therivel, 2001):

- A good understanding of the nature of the proposed project, including project design, construction activities and timing;
- Knowledge of the outcomes of similar projects and EIAs, including the effectiveness of mitigation measures;
- Knowledge of past, existing or approved projects which may cause interactive or cumulative impacts with the project being assessed;
- Predictions of the project's impacts on other environmental components that may interact with that under study; and
- Adequate information about the relevant receptors and knowledge of how these may respond to environmental changes/disturbances.

Impact identification is a critical step in an EIA, and commences at an early stage. In fact, not only is the early identification of a proposed development important, other environmental considerations also persist at all stages of the project cycle. The impacts predicted during scoping may be confirmed or new impacts may be identified as requiring investigation.

Many methods to identify the major impacts of a proposed development can be used. Munn (1979) and Canter (1996) divided these methods as follows:

- *Ad hoc* approaches (e.g. project, sector or environment specific guidelines);
- Checklists (i.e. the listing of potential impacts);

- Matrices (e.g. the Leopold Matrix); which was developed by Dr. Luna Leopold and his colleagues at the United States Geological Survey (Leopold *et al*, 1971).
- Networks (i.e. the presentation of higher order impacts and linkages using directional diagrams);

Shopley and Fuggle's (1984) classification includes both methods and techniques. Their impact identification categories list includes:

- Overlay Maps (e.g. the McHarg technique); and
- Modelling procedures (i.e. computerised, mathematical, physical scale models or descriptive models).

### ***2.3.3.1 Biological and Physio-chemical Impacts***

This category includes affects on biological resources such as vegetation, wildlife and aquatic life, as well as affects on soil and land, and chemical impacts related to the project activities that affect air, water and soil quality. Thus, any change in the interaction of biological systems with physical elements such as air, water, soil, rocks and solar radiation, caused by the project, may give rise to ecosystem impacts.

### ***2.3.3.2 Social Impacts***

This category includes alterations to the existing social and economic conditions of communities affected by the project. These impacts may be either adverse or beneficial, and can be subdivided into the following:

1. Demographic - the project may result in displacement or relocation effects, and also changes in population characteristics,
2. Socio-economic - including income effects, employment rates and patterns, prices of local goods and services, and taxation effects,
3. Cultural - traditional patterns of life and work, family structures and authority, religious and tribal factors, archaeological features, social networks and community cohesion,



4. Institutional - including demands on the government and social service, NGOs housing, schools, criminal justice, health, welfare and recreation, and
5. Gender - the effects of the project on the roles of women in society, income-generating opportunities, access to resources, employment opportunities and equity.

#### ***2.3.3.3 Cultural Impacts***

This includes the impacts of the proposed project on cultural heritage. Sites of cultural heritage are points of reference and identity for culture and tradition. There should be a general presumption in favour of their protection and conservation.

The study therefore should include historic sites, religious shrines or areas, or traditional practices that may be affected.

#### ***2.3.3.4 Health Impacts***

The World Health Organisation (WHO) defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. The links between health and social impacts are apparent here. In many cases, health and social impacts are closely linked with environmental impacts. Environmental health action should work in three dimensions. First, it must work to repair past damage, second, to control present risks, and third, to prevent future problems.

#### ***2.3.3.5 Economic Impacts***

This includes all changes in the economic situation as a result of the proposal. This usually principally includes the effects of:

1. Project construction and operation;
2. Workforce requirement and the workers' earned income;
3. Materials and other inputs for the project, and
4. Capital investment.

In developing countries, when development activities are going on, a large number of people may be attracted in search of employment. This aggregation of people can cause significant additional strains on the local infrastructure, environment and local government resources such as energy, raw materials, and types of waste produced by human activities.

### 2.3.4 Magnitude and Significance of the Impacts

*“It is necessary to distinguish between impact magnitude and impact significance. Impact magnitude is determined by prediction based on empirical measurements, while impact significance is an expression of the cost of a predicted impact to society”. (Thompson, 1988).*

In general, all EIA methods are developed in order to:

1. identify the potential impacts of a proposed development on the environment;
2. quantify the predicted nature and magnitude of such impacts; and
3. evaluate the significance of the potential impacts.

The following generic criteria can be used to describe magnitude and significance of impacts in a systematic manner:

- Extent or spatial scale of the impact;
- Intensity or severity of the impact;
- Duration of the impact;
- Mitigatory potential;
- Acceptability;
- Degree of certainty;
- Status of the impact; and
- Legal requirements. (Rossouw, 2003).

Given this, it is important to distinguish between the magnitude of the physical changes which are predicted to occur, and the significance of the consequent effect(s) on natural systems, human interests and concerns.

#### **2.3.4.1 Magnitude of Impact**

The magnitude of impact refers to the quantity of the impact. Any impact can be defined in quantitative terms. Quantifying impacts is mainly an objective, technical task.

Magnitude involves measuring intensity (e.g. frequency, duration, spatial extent, population extent) and considering direction of change (i.e. positive or negative).

The prediction of the magnitude is to quantify the impact. In order to achieve this, appropriate units in which to quantify the impact should be chosen. Clearly, these units differ according to the type of impact. For example, quantifying noise requires different measurement units from landscape.

#### **2.3.4.2 Significance of Impact**

'Significance' as a concept in EIA is essential to impact prediction, identification, evaluation and decision-making despite its theoretical and practical difficulties.

Environmental significance remains a largely undefined concept, without clear international definition or consensus, in spite of its prominence in decision-making. Canadian Environmental Assessment Agency, (2003) acknowledged that:

*“Deciding whether a project is likely to cause significant adverse environmental effects is central to the concept and practice of environmental assessment”.*

Whatever adverse environmental effects are addressed and whatever methods are used, the focus of environmental assessment always narrows down to a decision about whether the project is likely to cause significant adverse environmental effects. However, evaluating

significance is subjective and political. It requires reference to the affected environment in terms of its value.

Table 3 contains some examples of definition of environmental significance.

Source	Definition or interpretation
Haug <i>et al.</i> (1984)	Determining significance is ultimately a judgement call. The significance of a particular issue is determined by a threshold of concern, a priority of that concern, and a probability that a potential environmental impact may cross the threshold of concern.
Duinker and Beanlands (1986)	Significance of environmental impacts is centred on the effects of human activities and involves a value judgement by society of the significance or importance of these effects. Such judgements, often based on social and economic criteria, reflect the political reality of impact assessment in which significance is translated into public acceptability and desirability.
Council on Environmental Quality (1987)	The United States' National Environmental Policy Act requires significance to be determined within the framework of context and intensity. <i>Context</i> : The significance of an action must be analysed in several contexts such as society as a whole, the affected region, the affected interests, and the locality. <i>Intensity</i> : This refers to the severity of impact.
Thompson (1988, 1990)	The significance of an impact is an expression of the cost or value of an impact to society. The focus of EIA must be a judgement as to whether or not impacts are significant, based upon the value-judgements of society, or groups of people chosen to represent the wishes of society.
Canter and Canty (1993)	Significance can be considered on three levels: (1) significant and not mitigatable, (2) significant but mitigatable, and (3) insignificant. Significance is sometimes based on professional judgement, executive authority, the importance of the project/issue, sensitivity of the project/issue, and context, or by the controversy raised.
US Environmental Protection Agency (1993)	Determination of significance requires predicting change. These impact predictions are along with societal values, the major input to significance determination. Ideally, change should be compared against thresholds of concern, some of which may be legally mandated and others, which may be levels or states of valued components determined by the public, authorities or the EIA team.
Sadler (1996)	The evaluation of significance is subjective, contingent upon values, and dependent upon the environmental and community context. Scientific disciplinary and professional perspectives frame evaluations of significance. Scientists therefore evaluate significance differently from one another and from local communities.
Sippe (1999)	Environmental significance is an anthropocentric concept, which uses judgement and values to the same or greater extent than science-based criteria and standards. The degree of significance depends upon the nature (i.e. type, magnitude, intensity, etc.) of impacts and the importance communities place on them.

**Table 3: Selected Examples of Definitions or Interpretations of the Concept of Significance (Rossouw, 2003).**

There are some common elements in the above definitions. Combining these with similar work elsewhere (Petts, 1999), the common features of definitions of 'significance' in this context can be summarised as follows:

- Environmental significance is a judgment (which is generally relative);
- The degree of environmental significance depends upon the nature (type, magnitude, extent, duration, intensity, etc) of environmental impact and its importance in that specific physical and human context;
- Importance is rated in terms of biophysical, cultural, economic and socio-economic values; and
- Significance should encompass the amount of environmental change perceived to be acceptable to the community, including cumulative change.

Sadler (1996) identifies several general principles for significance interpretation. He suggested, for example, that significance thresholds, criteria and methods be explicit, easy to use, traceable, substantiated, readily understandable and relevant to the problem undertaken.

### **2.3.5 Determination of Significance**

Determining the significance of impacts is a critical component of impact analysis. It involves making judgment about importance. Sound and systematic significance interpretation is conducive to better decision-making. Hamed & Davy (1996) agreed that:

*“Significance should be determined on the basis of biophysical context and sensitivity of receptors; socioeconomic and cultural context; characteristics of the impacts such as magnitude, duration, and reversibility; and applicable environmental laws and regulations”.*

Assessing the significance of effects must be based on a range of scientific criteria; on comparison of the predicted change with established national and international environmental quality standards and thresholds; on established cultural and/or social values; and/or on interpretation of planning and other environmental policies. It should be based as far as

possible on information which is objective and evidential, such as standards, factual data, legal requirements and records of social acceptability. The significance of an action should be analysed in several contexts, including society as a whole, the affected region, the affected interests, and the locality. Figure 7 explains the determination of environmental acceptability.

There is no fixed standard or criteria to determine whether an impact is significant and how significant it is; for example, Rossouw (2003) argues that:

*“Different stakeholders may have widely diverging views of what significance means”.*

Those who are affected directly by a proposed development may regard any identifiable impact as highly significant. In contrast, certain stakeholders who are far removed and interested in environmental issues such as biodiversity may consider only impacts on those elements as highly significant.

Methods that are used to identify, predict and evaluate impact significance have been designed for application in specific contexts. For example, the method for determining the impact significance of routing of roads is different from the method to evaluate the impact of a water resource project. Using only experts to determine the significance of impacts is a major problem because it can result in expression of values from a solely professional perspective. In this case the views and values of the public, which are also important, are absent. Thus, impact significance should ideally involve a process of determining the acceptability of predicted impact on society. Therefore, it is essential to find a way to involve the public, so that a greater cross-section of views and values are obtained.

The determination of impact significance is usually related to the degree of effect on the environmental resource measured against some standard or threshold. This requires definition of the magnitude, prevalence, duration, frequency and likelihood of potential change, and establishing a threshold of significance at which point a project's potential environmental effects are considered significant.

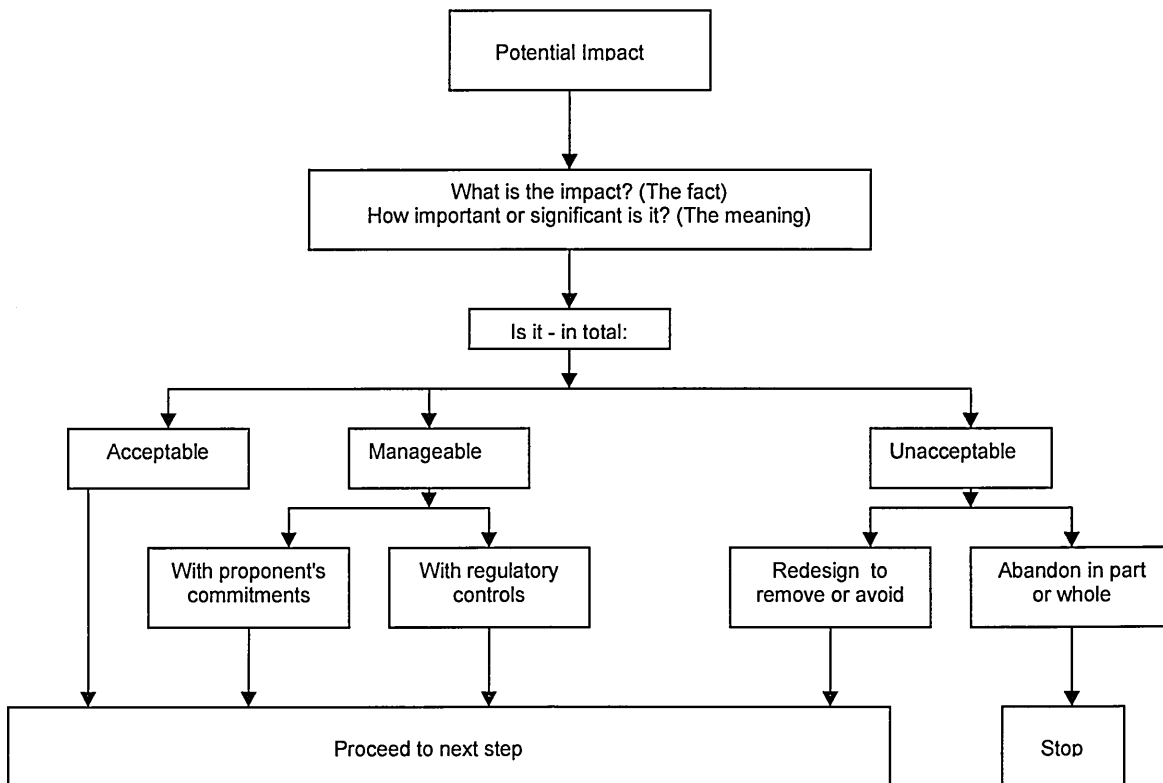


Figure 7 Determining Environmental Acceptability (Petts, 1999).

### 2.3.6 Mitigation

Mitigation of potential impacts is about aiming to avoid, minimise or remedy adverse impacts, ensuring that the residual impacts are within acceptable levels and enhancing the environmental and social benefits.

The key to achieve this is early consultation between developers, planning authorities and other interested parties. The precision of impact prediction

is particularly important for prescribing mitigation measures. Morris & Therivel (2001) also state that:

*“Different mitigation measures will be needed in relation to specific impacts on different environmental components and receptors”.*

Inadequate information provided on mitigation measures is often related to the fact that specific impacts are not always known. Furthermore, specialists often require considerable design and engineering input to be able to recommend effective and feasible mitigation measures. This information is often not available at the stage in the project cycle at which the EIA is undertaken. In such cases, mitigation may be considered to be one of the weakest areas of EIA practice.

Figure 8 shows the three-step process of mitigation. The first step, avoidance, is likely to be the most effective in environmental impact reduction because it can be applied at the early stage of project planning, so projects that will have adverse impacts can be avoided, or sensitive areas can be avoided.

Minimisation of impact is usually undertaken during impact prediction and identification to limit or reduce the degree, extent, magnitude or duration of adverse impact. This step includes scaling down or relocating the project, redesigning elements of the project and taking supplementary measures to manage the impacts.

Compensation actions are usually applied to remedy unavoidable adverse impacts, for example, by rehabilitation of the affected site or environment or restoration to the previous state. Another option may be provision of alternative environmental benefits at another location. In general, as the development becomes more detailed, the opportunity for impact



avoidance narrows and the concern is to minimise and compensate for unavoidable impacts.

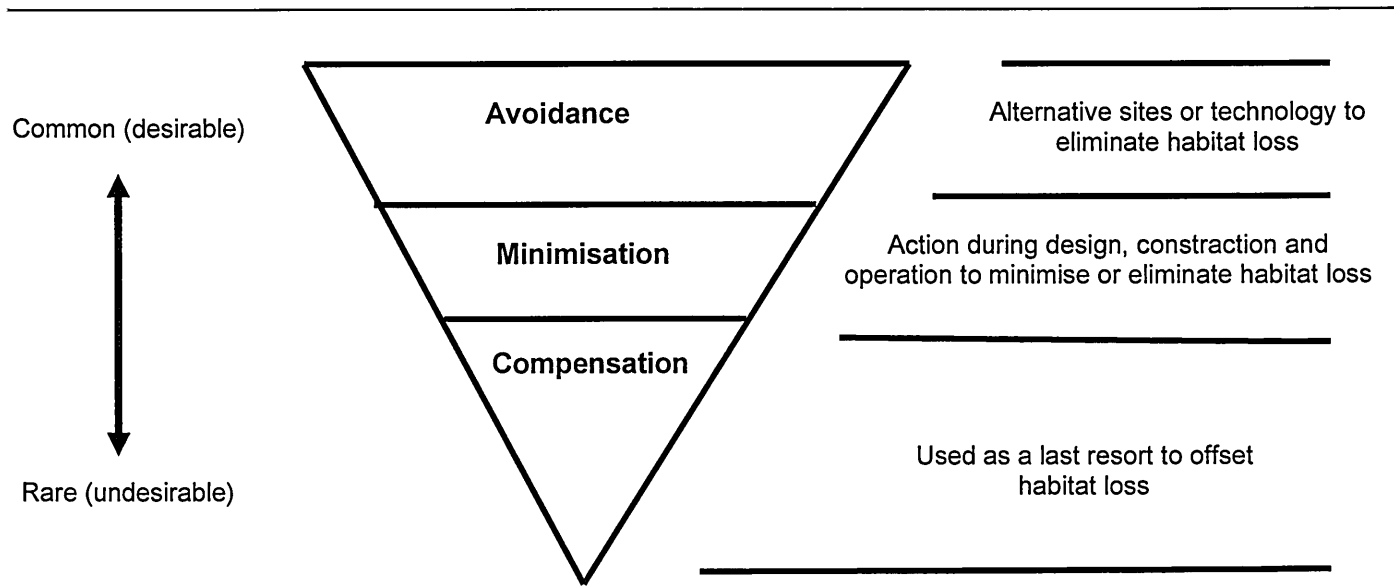


Figure 8: The Elements of Mitigation (Sadler *et al*, 2002).

### 2.3.7 Monitoring

Monitoring simply means observation and measurement over time. Morris & Treivel (2001) defined monitoring as:

*“the continuous assessment of environmental or socio-economic variables by the systematic collection of specific data in space and time”.*

Through monitoring, the environmental impacts can be better understood and this can lead to better management of the land, water, air quality and other living resources. The main aim of EIA monitoring is to provide the information required to ensure that project implementation has the least possible negative environmental impacts on the people and ecology.

Hilary, Terezinha & James (2003) agreed that:

*“Stewardship of the environment requires the development and /or adoption of cost-effective environmental monitoring*

*systems to provide data for planning at national, regional and local scales”.*

Major projects such as mineral developments and airports have a life-cycle which may cover a very long period of time (e.g. 40-70 years) from planning to decommissioning. Therefore, EIA should not stop at the point of obtaining planning permission. It should allow the implementation of good environmental management over the life of the development. However, effective monitoring involves sufficient data and information.

Environmental monitoring is essential to the oil and gas industry and any other industries or organisations for efficient environmental management. Environmental monitoring enables the oil and gas companies to achieve their targets to eliminate or reduce the environmental impacts to the targeted levels. Environmental monitoring involves gathering detailed background information about the environment before starting a new project to identify any changes and evaluate the risk after the operations have been started. This provides important information that can be used to calibrate risk models to predict and control the impacts whether they are emissions or discharges. Environmental monitoring, therefore, can provide a mechanism for establishing whether mitigation measures have been carried out and whether predictions were accurate. Environmental monitoring is therefore one of the most important components of an EIA.

Monitoring is practically important when potential impacts are significant or uncertain and/or mitigation measures are untried, and so outcomes are uncertain.

Sadler, *et al* (2002) summarise some key aims of monitoring:

- Ensure the implementation of conditions attached to a decision;
- Verify that the impacts are as predicted or permitted;
- Confirm that mitigation measures are working as expected; and
- Take action to manage any unforeseen changes.

## **2.4 EIA and Upstream Petroleum Industry**

EIA is an important tool to predict the impacts of proposed petroleum exploration and development projects. Understanding the activities involved in the upstream oil and gas industry can obviously help to appreciate the origins of the potential impacts of these activities on the environment. EIAs are an integral part of project development and implementation and are commonly applied throughout the oil and gas industry to establish the potential impacts of the exploration and production activities. Many oil and gas companies conduct assessments as a routine requirement wherever they operate. Rugman & Verbeke (1998, p 369) mentioned that a study of MNE (Multinational Enterprise) concluded that:

*“Environmental strategies are particularly significant because MNEs dominate pollution- intensive industries such as chemicals, petroleum and heavy manufacturing”.*

Potential impacts, therefore, must be addressed through the application of appropriate prevention, mitigation, control and management measures to achieve any project or conduct any activity environmentally. There are some available mechanisms such as checklist to rank these impacts to focus resources efficiently on the highest priority issues.

Sustainable development of petroleum resources requires appropriate management of all environmental, social and economic issues over the entire life cycle of the development beginning with initial planning of a project to decommissioning and site restoration. The upstream oil and gas industry operations have the potential of significant environmental impacts on the environment at many different levels and can lead to environmental damage. These operations include seismic survey, construction and installation of infrastructure, drilling, production, maintenance, tanker operations and oilfield decommissioning.

The oil and gas upstream industry has been operating in many different parts of the world including sensitive and heavily populated urban environments. The upstream oil and gas industry recognises that it must operate safely and responsibly, protecting the natural environment and addressing concerns about its social and economic impacts on local communities. The potential impacts must be considered nationally and globally, especially, as petroleum development activities are expected to grow to meet the rapid demand of industrialising countries. Therefore, it is essential to include the environmental impact in the context of protection policies and legislation to minimise adverse environmental impacts. Policies and guidance should provide clear assessment of the relative importance of potential impacts. Thus, EIA is one of the instruments which can be applied in this context.

Traditionally, EIA has applied to major projects (Glasson *et al*, 1999). However, most oil and gas exploration and production projects are considered major projects, as they involve enormous investment and have significant environmental impacts.

## **2.5 Conclusion**

In this chapter environmental impact theory is examined with illustrations of its definition and concept. The conceptual model of impact relationships from source to receptor has been discussed. The sustainable development concept is also defined and discussed in this chapter. This concentrates on the balance between the needs of current generations without compromising the needs of future generations. The interaction and/or relationship between the social, economic and environmental spheres, which reflects the origins of environmental impact, are explained.

This chapter also includes the Environmental Impact Assessment (EIA) as an anticipatory and participatory environmental management technique to

predict, investigate and record the types of impact of a proposed development on the environment. The aims and objectives of the EIA, which is widely considered as the most powerful environmental management tool, and its processes are considered in detail. All the stages of the EIA process are discussed in detail with reference to the UK regulations which are laid down in European Community Directive 85/337/EEC on the Assessment of the Effects of Certain Public and Private Projects on the Environment (the EIA Directive).

Finally the importance of the EIA to the petroleum industry is covered in this chapter. EIA cannot be ignored in predicting the environmental impacts of petroleum exploration and production projects which usually have high potential impacts on the environment. The next chapter discusses petroleum exploration and production operations and their potential impacts on the environment in detail.

## **Chapter Three**

### **Exploration & Production (E&P) Operations and their Environmental Impacts**

This chapter is divided into two sections. The first section explains the E&P processes and their potential environmental impacts. These processes are divided into four phases. The first phase is the exploration phase; the second is the appraisal phase; the third is the development and or production phase and finally the decommissioning phase. All these phases will be discussed with their potential environmental impacts. Section two is a study of the actual environmental impacts of the E&P operations in Libya which was prepared by the researcher during his fieldwork study in the summer of 2006.

#### ***3.1 E&P Process and their Potential Environmental Impacts***

Oil and gas exploration and production (E&P) activities have the potential for a variety of impacts on the environment. These impacts depend on factors such as the stage of the process, the size and complexity of the project and the nature of the surrounding environment. It is widely agreed by workers such as Patin (1999) and O'Rourke & Connolly (2003): that the physical alteration of environments from exploration, drilling, and extraction can be greater than from a large oil spill.

Major impacts include deforestation, ecosystem destruction, chemical contamination of land and water, long-term harm to animal populations (particularly migratory birds and marine mammals), human health and safety risks for neighbouring communities and oil industry workers, and displacement of indigenous communities.

The processing of the upstream petroleum industry is usually divided into four main phases; exploration, appraisal, development (production) and decommissioning. Each of these will be discussed later in this section.

Upstream petroleum activities are mainly associated with two environmental problems: normal discharges and accidental releases.

Normal discharges can be considered to comprise (i) atmospheric emissions such as flaring, vents and exhausts (ii) liquid effluent such as drilling mud and produced water (iii) solid waste (cuttings). While accidental releases may include oil spills, gas leak, fire and blowout. It is acknowledged that oil spills, accidents, and fire, damaged lands, air and incidents of water pollution have all occurred at various times and places.

In Canada, for example, Timoney and Lee (2001) mentioned that the impacts of the oil and gas industry on Alberta's ecosystems are manifold and include: loss and disturbance of habitat, landscape fragmentation, wetland and riparian degradation, disturbance of wildlife, increased poaching and hunting on access roads; oil spills; salt-water spills, aquifer depletion and pollution, health and ecological effects of flaring of sour gas and greenhouse gas production. In the US, Otton *et al* (2002) state that:

*"A total of about 3.5 million oil and gas wells have been drilled to date in the United States, but currently, only about 900,000 are in production".* Cited in Kharaka (2005).

Thus, the cumulative impacts from exploration and production operations are often high.

Table 4 summarises the exploration and production processes and their requirements.

Activity	Potential requirement on ground
Desk study: identifies areas with favourable geological conditions ↓	None
Aerial survey: if favourable features revealed, then ↓	Low-flying aircraft over study area
Seismic survey: provides detailed information on geology ↓	Access to onshore sites and marine resource areas Possible onshore extension of marine seismic lines Onshore navigational beacons Onshore seismic lines Seismic operation comps
Exploratory drilling: verifies the presence or absence of a hydrocarbon reservoir and quantifies the reserves ↓	Access for drilling unit and supply units Storage facilities Waste disposal facilities Testing capabilities Accommodation
Appraisal: determines if the reservoir is economically feasible to develop ↓	Additional drill sites Additional access for drilling units and supply units Additional waste disposal and storage facilities
Development and production: produces oil and gas from reservoir through formation pressure, artificial lift, and possibly advanced recovery techniques, until economically feasible reserves are depleted ↓	Improved access, storage and waste disposal facilities Wellheads Flow-lines Separation/treatment facilities Increased oil storage Facilities to export product Flares Gas production plant Accommodation, infrastructure Transport equipment
Decommissioning and rehabilitation may occur for each of above phases	Equipment to plug wells Equipment to demolish and remove installations Equipment to restore site

**Table 4: Summary of the exploration and production process and their requirements (E&P Forum and UNEP, 1997).**

### 3.1.1 Exploration Phase and its Environmental Impacts

#### 3.1.1.1 Exploration Survey

The first step of searching for petroleum involves a review of a geological map to identify major sedimentary basins. The geologists may use aerial photography to identify promising landscapes. Faults or anticlines may indicate promising areas. This can be done as a desk study followed by gathering more information using a field geological assessment.



Seismic methods are used for identifying the geological structure of the earth where seismic images are produced by generating, recording, and analysing sound waves that travel through the Earth. Seismic technology has been long used. Miligan (2004) mentioned that:

*"Seismic technology had been used since the early 1900s to measure water depths and detect icebergs, and by 1924, crude seismic data were first used in the discovery of a Texas oil field".*

Explosives or vibrating plates generate the waves and a line or grid of geophones records them. Density changes between rock or soil layers reflect the waves back to the surface, and how quickly and strongly the waves are reflected back indicates what lies below. Figure 9 is a schematic diagram of seismic survey.

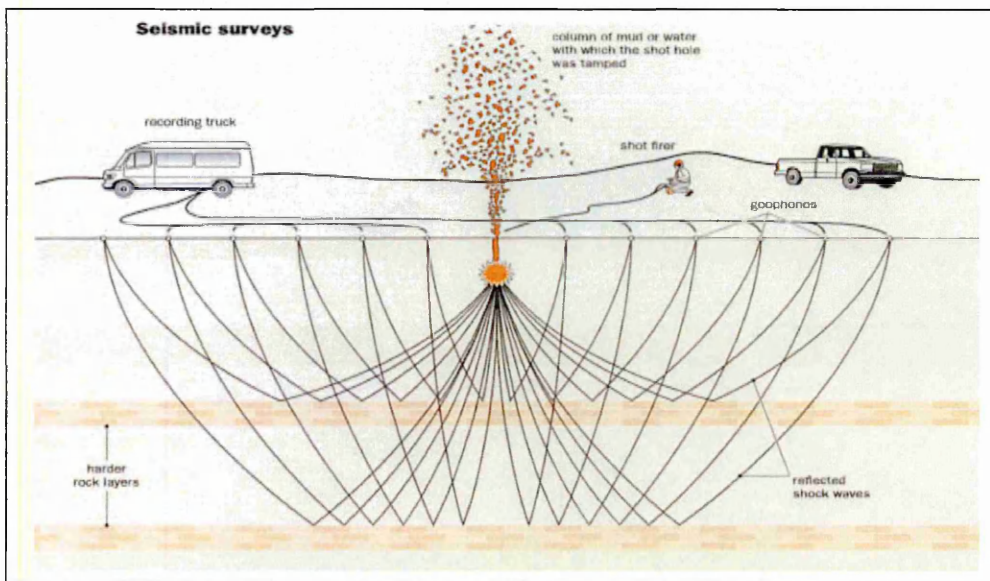


Figure 9 Seismic Surveys (E&P Forum and UNEP, 1997).

In the case of offshore exploration, geophysicists set off powerful sound sources in the ocean and record the echoes as they bounce back from rock layers beneath the sea floor. The time for each echo to return depends on the depth and properties of the rock layers.

*“A typical seismic survey lasts 2-3 weeks and covers a range of about 300-600 miles. The intensity of sound waves produced by the firing of seismic air guns can reach up to 250 decibels (dB) near the source and can be as high as 117 dB over 20 miles away” (Alaska Marine Conservation Council, 2005).*

Typical seismic surveys can map rock layers over 10 kilometres into the seabed (CEF\*, 1998). Modern resources of sound are explosive devices such as air guns, gas explosives, gas sleeve explosives, or sparkers which involve small, controlled charges of chemical explosives, gas or air, or electrical discharges.

### **3.1.1.2 Environmental impacts of exploration survey**

The exploration survey of oil and gas using seismic operations can generate significant environmental impacts both offshore and onshore.

Offshore: experimental studies and field monitoring of effects of sound, particularly seismic sound, on marine organisms were evaluated by a group of scientists from international agencies, the hydrocarbon exploration industry and environmental groups. These show that the issue of concern is the effects of sound, particularly seismic sound, on marine organisms.

Experiments on the effects of seismic shooting on abundance and catch of Cod and Haddock were conducted in the Barents Sea. The effects of air gun were examined by a combination of scientific-survey and commercial-fishing techniques.

Ona *et al.*, (1996) concluded that acoustic density of cod and haddock decreased over the entire study area by 45% during the shooting and 64% during the 5-day period after shooting ceased. More than 90% of the catch

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\* Communication Environmental Fisheries (Consultants Limited) Canada

was cod. During shooting, catch in the shooting area decreased by 60% and catch in the other areas (up to 18 km from the exploration area) decreased by 45-50%. Catch rates did not recover during the 5-day period after shooting ended. The long line catch decreased by 45% in the exploration area, but the decline was smaller with increasing distance from the exploration area; with no reduction in catch at distances of 16-18 nautical miles from it. Catches increased after cessation of shooting.

Patin (1999) mentioned that during the 1960's he was a member of the Special Government Committee and he witnessed a catastrophic ecological situation in the Caspian Sea. He witnessed first hand the dramatic ecological consequences of explosive use, including mass mortality of Caspian sturgeons (up to 200,000 large specimens). He added that even the modern technology of generating seismic waves poses a certain threat to marine biota, including commercial species. For example:

*"Sound pressure from the air gun can kill or injure fish with swim bladders, and damage the hearing of marine mammals and other animals, if either is within a few metres of it. Fish eggs and larvae can be killed or mortally damaged in a radius of 1.5 to 6.5 m". (CEF, 1998).*

Boudreau *et al* (2001) concluded that seismic exploration has been known to give rise to the following impacts such as:

- Decreased catch rates due to scaring of fish;
- Interference with fish spawning;
- Space conflicts with existing fishing activities;
- Mortalities in a number of species and a number of life stages and
- Possibly changed marine mammal movements.

Onshore: Exploration operations have inevitable impacts on the area of exploration and its ecosystems. The direct fragmentation by seismic lines, disturbances originating from noise and the movements of people and

vehicles associated with petroleum extraction activities can modify the behaviour of wildlife species with broad distribution ranges. Exploration surveying also has the other potential impacts which will be discussed in the development phase.

### ***3.1.1.3 Exploration Drilling***

Drilling a well into the promising site is the next stage for searching for oil and gas. It is the only way to confirm whether there are hydrocarbons in the field or not. Oil well drilling operation is part of the global process implemented to localise and extract from the reservoir the hydrocarbons lying underground. Several wells are necessary to exploit an oil field: exploration wells to confirm the presence of oil, evaluation wells to estimate the economic viability of the project and development wells which lead to the production of the field.

The drilling process needs to be understood to fully appreciate the environmental effects associated with it. In the upper layers of the earth drinkable water normally exists. In a typical drilling operation, the ground water must be protected from drilling and production fluids. Therefore, the first hundred metres to several hundred metres are drilled with a large diameter bit. This allows a steel pipe to go into the ground and protect the fresh water. This casing pipe is set in permanent place with cement under pressure. As drilling proceeds, drilling fluid is pumped from the mud tanks through the centre of the drill pipe, and through nozzles in the drill bit. The flowing mud sweeps the crushed rock cuttings to the surface between the casing and the drill pipe. Before recirculation, drilling mud is passed to an integrated system for screening and treating to remove the drilled cuttings.

### ***3.1.1.4 Drilling Discharges and their environmental impacts***

During drilling, drilling fluids and cuttings are discharged overboard. As Patin (1999) states:

*“Drilling wastes and their components have been the object of especially detailed and extensive ecotoxicological studies both in the laboratories and on the shelves of many countries”.*

It is clear that they have impacts on the surrounding environment. Routine drilling wastes, such as drilling muds, cuttings, and produced waters, may contain both profuse and varied toxic chemicals that pose significant risks to the environment. These risks to wildlife include developmental defects, shortened lifespan, and physiological changes.

Clark and Dutzik (2002) agreed that many of the toxic chemicals associated with oil and gas drilling can accumulate in the food chain. This poses a risk to aquatic organisms higher in the food chain, such as fish and birds. Furthermore, many of these chemicals tend to persist in the environment, leading to long-term, chronic exposure for aquatic organisms. Thus, with increasing incidents of environmental degradation from toxic chemical waste disposal, recent concerns have been raised over the disposal of drilling fluid and cuttings. Major concerns were first focused on the offshore segment of this industry as drilling fluids and cuttings were discharged directly into the marine environment. Considerable research efforts have been devoted to evaluate the potential adverse effects of these disposal practices on the major marine ecosystems (Khondaker, 2000).

#### ***3.1.1.5 Drilling Muds and their impacts***

Drilling muds (also known as drilling fluids).

Neff *et al* (2000) state that:

*“Drilling fluids are an essential component of the rotary drilling process used to drill for oil and gas on land and in offshore environments. The most important functions of drilling fluids are to transport cuttings to the surface; to balance subsurface and formation pressures preventing a blowout; and to cool, lubricate, and support part of the weight of the drill bit and drill pipe”.*

Different types of chemicals and polymers are used to meet some functional requirements. Salt and organic compounds for example, are added to reduce sloughing of shale, minimise dissolution of evaporates and to control fluid loss properties of drilling muds. There are different types of drilling muds. To reduce the impacts of drilling fluids in drilling operations to zero, drilling fluids must not be used at all in the drilling operation. In fact, all drilling techniques including modern methods use drilling fluids. Hence, to mitigate the adverse impacts of drilling fluids, the petroleum industry is improving the drilling fluids so that they are less damaging to the environment. Thus, many types of drilling fluids are designed for environmental and performance purposes. The choice of the mud formulation will depend on the nature of the rock formation, the environmental and economic constraints as well as the possibility of supplying on site.

#### **3.1.1.5.1 Water-Based Mud (WBM)**

*“Water based fluids consist of water (fresh or salt), baryte, clay, caustic soda, lignite, lignosulfonates and/or water-soluble polymers. They may also contain low concentrations of specialty chemicals added to solve some particular problem that is affecting mud properties”. (Neff et al, 2000).*

The use of water based drilling muds barely shows an impact beyond that of physical disturbance in which smothering by the cutting pile appears to be the most important factor. (Davies & Kingston, 1992) stated that residual toxicity and organic enrichment of water based mud may have a significant effect. Patin (1999) also thought that using water-based formulations does not fully eliminate the environmental hazards. The contents of some barytes have some chemical elements such as mercury which may be harmful to some organisms.

#### **3.1.1.5.2 Oil-Based Mud (OBM)**

Oil-based muds are invert-emulsions of brine into an oil phase stabilised by surfactants. Various additives are added as organophilic polymers, organophilic surface modified clays, solids and other additives. Clark & Dutzik (2002) agreed that:

*“Oil-based drilling fluids released into a coastal march or wetland would have significant impacts on fish eggs and larvae known to be sensitive to oil and oil-based chemicals”.*

When released into the environment, oil based fluids have been shown to inhibit the number and diversity of bottom-dwelling species up to 500 metres from the point of discharge. This effect can last for several years. The experiments showed that, 180 days after the discharge of oil-based drilling wastes, they had biodegraded less than 5% according to Patin, 1999). Oil-based muds have resulted in rigorous restrictions of their use in many parts of the world and have led to the development of more environmentally friendly, “synthetic-based drilling fluids”.

#### **3.1.1.5.3 Synthetic Based Mud (SBM)**

Synthetic based drilling fluids SBF are a relatively new class of drilling muds that are particularly used for deepwater and deviated drilling holes.

SBF are free of inherent contaminants, unlike conventional oil-based drilling fluids. As a result, they are more benign environmentally, as demonstrated by aquatic toxicity testing. SBF were developed to combine the technical advantages of oil based fluids OBF with the low persistence and toxicity of water based fluids WBF. As Unocal (1995) mentioned:

*“A health-based risk assessment was recently performed to further confirm the reduced environmental impact of this innovative drilling fluid”.*

This mud has been in use for the last decade for drilling, particularly in the North Sea and Gulf of Mexico. Cuttings generated during drilling with this mud are re-treated and the mud is used again and not discharged or disposed.

#### ***3.1.1.6 Drilling discharges disposal***

During the drilling process, drilling fluids flow into the wellbore and return to the surface with drilling cuttings. Drilling cuttings are removed from drilling fluids. Whilst drilling fluids are usually reused, drilling cuttings become a waste and then disposal begins. Disposal options for the waste solids comprise; offshore discharge, offshore re-injection and onshore disposal. Figure 10 shows separation of cuttings from drilling fluids and options for drill cuttings disposal.

Treated cuttings have been used in various ways:

- Fill material,
- Daily cover material at landfills,
- Aggregate or filler in concrete, brick, or block manufacturing.

However, before the cuttings can be reused, it is necessary to ensure that the hydrocarbon content, moisture content, salinity, and clay content of the cuttings are suitable for the intended use of the material.



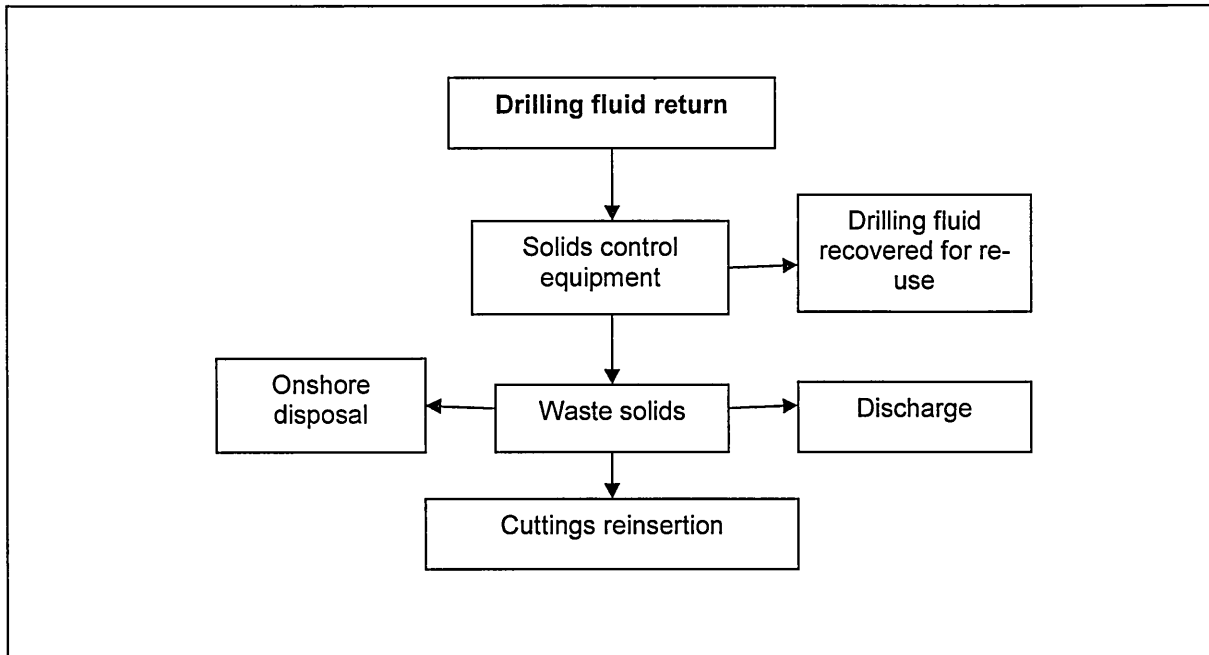


Figure 10 Separation of cutting from drilling fluids and disposal options of drill cuttings disposal (IAOGP, 2003)

### 3.1.1.7 Environmental impacts of drilling fluids

Drilling fluids enter the environment by: being directly discharged into a body of water; seeping into groundwater or other surface water from a land-based impoundment; accidental release from on or offshore holding facilities; absorbing to soils or sediments; and vaporisation of volatile components from on or offshore.

The environmental concerns are a major driving force behind current drilling fluids research and development. This includes reducing toxicity to fish, algae and zooplankton in the marine environment and the amount of waste generated in the first place. Most contaminant exposure in the field is not acutely lethal but is long term, sublethal exposure. The toxicant or its effects may accumulate in the organism over time and may result in effects than are not seen in shorter exposure. The components of drilling muds, therefore, should be selected, so that any discharge of mud or

cuttings has the minimum possible environmental impact. International Association of Oil and Gas Producers, (2003) confirmed that:

*“The development of more environmentally friendly fluids has been undertaken to reduce the environmental impact associated with the discharge of drill cuttings”.*

Environmental impacts from drilling muds onshore can range from disruption of wildlife reproduction and accumulation of toxic materials to wildlife habitat destruction and significant wildlife population mortality rates. For example, U.S. EPA studies concluded that the routine discharge of any drilling mud can adversely impact bottom-dwelling species. (Thomas & Patrick 1994).

These impacts range from burial of species to disruption of basic life functions such as reproduction, eating patterns, and life span. Water based drilling fluids may pollute the wildlife and the accumulation of pollution may in turn move up the food chain.

The marine environment has vital resources other than the hydrocarbons. Consequently, the exploration and production of hydrocarbon from the marine environment should be conducted with consideration of the existing ocean wealth. Discharge of drilling fluid in the marine environment can change the pH of the seawater and smother bottom-dwelling (benthic) organisms, by reducing light necessary for plankton growth or by releasing toxic chemicals that are lethal or can elicit sublethal responses such as reproductive impairment or inhibited growth.

#### **3.1.1.7.1 Toxicity of Drilling Mud**

It is widely agreed that drilling muds contain certain toxic chemicals, and non-toxic chemicals which can cause damage. They contaminate the immediate area being drilled and are often dumped nearby, causing more environmental contamination. This was proved by experiments as Patin (1999) mentioned that:

*“The overwhelming majority of studies on the toxicology of drilling fluids are based on acute experiments”.*

These impacts can include some toxic biocides and heavy metals in their components. Compared with oil-based fluids, water-based fluids display a higher capacity for dilution in the marine environment, and also large amounts of water-based fluids are disposed of compared with oil-based fluids which are largely recycled. According to Patin (1999), experimental and field studies showed that acute toxic effects of water-based drilling muds can be manifested only at high concentrations.

The toxicity of synthetic based fluids has also been examined and water and sediment toxicity tests have shown that such fluids have much lower toxicity than oil based mud. Neff *et al* (2000) stated that several studies were conducted to monitor the biological effects of SBF cuttings discharges on the benthic environment. These studies show that accumulating high concentrations of SBF in sediments, result in adverse effects in benthic communities.

#### **3.1.1.8 Drilling Cuttings and Environmental Impacts**

As the well is drilled, the “cuttings”, consisting of crushed rock and clay, are brought to the surface by the drilling fluid and discharged overboard. As cuttings are pieces of rock crushed by the drill and brought up to the surface, they do not pose any special threat (Patin, 1999).

However, cuttings discharge from the offshore oil activities can be very hazardous and toxic due to their components and they can increase the turbidity and smother benthic organisms. Research programmes have, therefore, been initiated to assess the effects of drill-cutting discharges (e.g. Hartley & Ferbrache (1983); Davies *et al* (1984); Gray *et al* (1990); Kroncke *et al* (1992); Daan *et al* (1992); Daan & Mulder (1994) & Breuer *et al* (1999). Patin (1999) mentioned that hundreds of tons of oil and

dozens of tons of chemicals for each drilled well can enter the marine environment with these discharges.

Large cutting piles are considered likely to be a source of chronic low level hydrocarbon seepage into the marine environment and may be taken up by sediment reworker species (Daan *et al*, 1994 & Munroe, 1997).

### **3.1.2 Appraisal Phase and its Environmental Impacts**

Successful exploratory drilling leads to more drilling of wells to determine the size and extent of the field. This stage aims to evaluate the size and nature of the reservoir, to determine the number of appraisal wells required. These wells which are drilled to quantify the found hydrocarbon reserves are called 'appraisal' wells. They are drilled in the same way as exploration wells.

The environmental impacts of this appraisal phase are a result of drilling more wells to confirm if the discovery is of a commercial quantity or not. However, the environmental impacts of drilling wells are already discussed in the earlier exploration phase in this chapter.

### **3.1.3 Development Phase and its Potential impacts**

This is the longest phase as it will continue as long as the well produces commercial quantities of oil or gas. When the reservoir is evaluated in terms of its size and nature and the size of the field is established, the subsequent wells drilled are called 'development' wells. This phase also includes pipeline and facilities such as accommodation, roads and offices which occupy an area of several hectares, depending on the capacity of the field and offshore platforms.

As mentioned above the development phase is the longest stage in time scale and, therefore, its impacts such as gases emission and produced water discharge last longer. Impacts such as ecological and physical

impacts have the potential to occur in exploration, development or at any stage. Figure 11 explains the development phase processes of crude oil and gas.

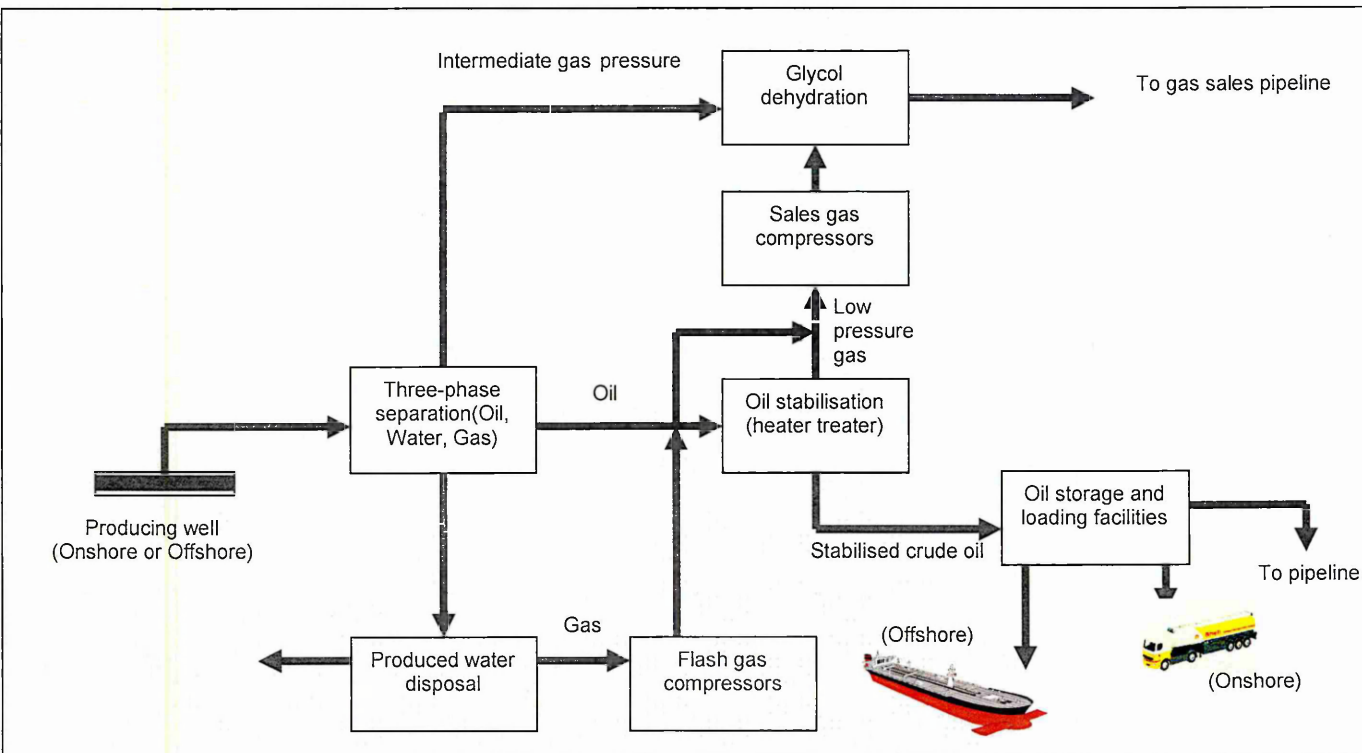


Figure 11: Crude Oil and Gas Processing (Development Phase) (Adopted from E&P Forum and UNEP, 1997).

### 3.1.3.1 Production Wells

Drilling production wells involves similar techniques to the exploration and appraisal wells which were previously described. After completing the drilling, the well sites are considerably smaller than when the drill rig was on the site. It is considered that each well requires an area of some 10 square metres surrounded by a security fence.

However, a small reservoir may be developed using one or more of the appraisal wells, while a large reservoir will require the drilling of additional production wells. Drilling large numbers of wells obviously increases the

activities on the field, which will be occupied for longer. Correspondingly, the support services workforce accommodation, water supply, waste management, and other services will increase.

### **3.1.3.2 Site Facilities**

The location of the well site is often in the central area, which includes processing facilities, offices and workshops as UNEP and E&P Forum (1997) states:

*“A typical field occupies an area of several hectares, depending upon the capacity of the field”.*

The temporary facilities used in exploration will be replaced by permanent facilities based on detailed planning of designing, engineering and construction as the production operation is a long-term development. In offshore production developments, permanent structures are necessary to support the required facilities, as exploration units are not designed for full scale production operations.

### **3.1.3.3 Pipelines**

Pipeline transport is the only economic way to transport large quantities of oil or natural gas over land. There are thousands of kilometres of oil pipelines in all parts of the world. Pipeline has lower cost per unit and also higher capacity compared with other land transporting means such as railway or tankers. However, it is important to recognise a balance needs to be achieved between protecting the important landscapes and ecosystems, and delivering oil to domestic markets.

Although pipelines can be built even under the sea, the cost of doing so is very high, as economically and technically it is very demanding. Therefore, the majority of oil at sea is transported by tanker ships. Oil pollution from shipping accidents, leaks from platforms and refineries and tanker loading/unloading is considered a key threat to marine biota. However,

pipelines conveying flammable or explosive material such as natural gas or oil pose special safety concerns.

Oil pipelines are made from steel or plastic tubes with inner diameter from 30 to 120 cm. Where possible, they are built above the surface. However, in more developed, urban or environmentally sensitive areas they are buried underground at a typical depth of about 1 metre. For natural gas, smaller feeder lines are used to distribute the fuel to homes and businesses.

An EIA study is important to consider the impacts of the pipeline operations which range from the potential environmental damage from an accidental oil spill to the economic benefits of the operation.

#### **3.1.3.4 Ecological Impacts**

The physical consequences of human actions upon the ecological system can no longer be disregarded, especially after great loss of habitats as Mandula & Blockstein (1992) concluded that:.

*"Habitats throughout the world have been losing their biodiversity at unprecedented rates, with some estimates suggesting about 20.25 percent of the earth's biological resources may be extinct in the next few decades".*

Some of these ecological problems are caused by petroleum related industries. Cahoon (1989), for example, stated that the oil and gas development-related impacts have caused multiple ecological consequences to onshore and offshore ecosystems, through all stages of oil and gas development which includes exploration, site access, site preparation, drilling, production, pipeline installation, spill control and cleanup, and site closure. Wildlife is severely affected by noise, lights, transport, movement and toxic wastes. Vulnerable species might become extinct due to disturbing their habitats. Oil and gas exploration and production in the United States, for example, have caused damage to the

local environment in the thirty-six producing states. The damage includes local detriment to soils, surface and groundwater and ecosystems (Kharaka & Dorsey, 2005). However, ecological impacts can be associated with any phase of exploration of the oil and gas industry not just the production phase.

#### **3.1.3.4.1 Oil Spills**

No country or province which has been exposed to a prolonged history of offshore hydrocarbon exploration has been left untouched by the inevitable accidents and unforeseen consequences of the petroleum industry (Lincoln, 2002). One of the first major oil spills to receive world-wide attention, from the press and scientific community alike, was the stranding of the “Torrey Canyon” in the western approach to the English Channel on March 18, 1967. During March and April her 29.4 million gallon load of Kuwaiti crude oil was released, and much of it reached the beaches of England and France (Middleditch, 1981 p2).

Oil spills can have significant short-term and long-term impacts on coastal ecosystems, due to oil’s physical effects and chemical toxicity. Oil and gas operations released significant quantities of petroleum hydrocarbons as Natl (2002) states that:

*“In 2002, the National Academy of Sciences estimated that 38,000 tons of petroleum hydrocarbons were released into the world’s oceans each year during the 1990s as a result of oil and gas operations”. Cited in O’Rourke & Connolly, (2003).*

Since the 1960s, large-scale oil spills have occurred almost every year. Transport by water is currently more likely to result in a spill than transport by pipeline. Caswell, (1993) figured out that:

*“Ocean transport of crude oil and petroleum products accounted for 3000 gallons spilled per billion ton-miles in 1983 and nearly 8000 gallons per billion ton-miles in 1984. Pipeline spills contributed less than 100 gallons per billion ton-miles for both years”. Cited in O’Rourke & Connolly, (2003).*



One of the worst oil spills happened in Alaska in the US, on 24 March, 1989 when the tanker vessel *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, spilling an estimated 42 million litres of Prudhoe Bay crude oil (Monson *et al*, 2000). About 1,500 miles of Alaska's coastline were contaminated. That accident killed birds, mammals, and fish, and disrupted the ecosystem in the path of the oil. Grazing limpets, periwinkles, mussels and barnacles were killed or removed. Subsequent indirect effects included colonisation of the upper shore by ephemeral algae and an opportunistic barnacle.

Another result of the *Exxon Valdez* oil spill in Alaska, was the closing of the fisheries in Prince William Sound which resulted in a season's loss of income for commercial fishermen and an estimated \$135 million in lost revenues (Burger, 1997).

In 1998, there were 560 observed cases of soil pollution by accidental oil spills in Mangystau in Kazakhstan around oil wells and also at industrial enterprises (Dahl & Kuralbayeva, 2001).

In Nigeria, oil spillage and its consequent environmental problems are prominent features of petroleum exploration, and this is true especially in the Niger delta area (Jaiyesimi & Thomas, 1994 cited in Ogri 2001). Oil spill also is one of the main sources of air pollution. The U.S. government, in its National Energy Policy, acknowledges that inland oil spills are a major source of oil emissions and that these spills appear to be on the rise (O' Rourke & Connolly 2003, p. 601). Table 5 shows the largest oil spills over the world.

The largest oil spills in history ranked by volume:

Rank	Name	Year	Volume in gallons
1	Persian Gulf: tankers, pipelines and terminals, offshore Saudi Arabia	1991	240,000,000
2	Ixtoc I oil well, Ciudad del Carmen, Mexico	1979-1980	140,000,000
3	Nowruz Field, Persian Gulf	1983	80,000,000
4	Fergana oil well, Uzbekistan	1992	80,000,000
5	Castillo de Bellver, offshore cape Town, South Africa	1983	78,000,000
6	Amoco Cadiz tanker, offshore Brittany	1978	68,000,000
7	Aegean Captain tanker, offshore Tobago	1979	48,800,000
8	Production well D-103, Tripoli, Libya	1980	42,000,000
9	Irenes Serenade tanker, Pilos, Greece	1980	36,600,000
10	Kuwait storage tanks	1981	31,170,000

**Table 5: The largest oil spills over the world (Welch 1994 p.600 Cited in O'Rourke & Connolly 2003).**

### ***3.1.3.5 Physical Impacts***

Physical disturbance is an inevitable impact of the oil and gas upstream industry in both onshore and offshore environments. Land disturbances can arise as a result of activities such as site preparing, building roads, tank batteries and other land modifications which are necessary for drilling wells and construction of production facilities.

Offshore physical disturbance results from platform structure, seismic survey, pipeline structure, drilling waste, produced water and human wastes. This is beside the direct harmful impacts of drilling operations on the onshore and offshore ecosystems as discussed earlier (see exploration drilling and their impacts in this section).

### 3.1.3.5.1 Produced Water

Patin (1999) defines produced water as the formation water produced along with oil during petroleum extraction. During oil production, water from the reservoir containing low levels of petroleum is pumped to the surface. Produced water, which is mostly a problem in old fields, usually includes dissolved salts and organic compounds, oil hydrocarbons, trace metals, suspensions, and many other substances that are components of formation water from the reservoir or are used during drilling and other production operations. During oil production, water from the reservoir containing low levels of petroleum is pumped to the surface. Recent studies show broad spatial impacts in the marine environment due to the dissolved components of produced water (Washburn *et al*, 1999). Oil and grease are the constituents of produced water that receive the most attention in both onshore and offshore operations, while salt content is a primary constituent of concern in onshore operations.

Produced water worldwide is estimated from different resources as 4 billion square metres in 1993, 12 million square metres in 1999 and 7 million square metres in 2003 (TIFETOG, 2006). However, water handling costs are increasing due to regulatory development by recommending a zero discharge goal with regards to the maximum allowable hydrocarbon concentration in discharged water.

Produced water is the largest wastewater stream in the oil exploration and production process (Utvik 1999; Jinren *et al*, 2006). Wells may start out producing little water but sooner or later all oil wells produce a much larger volume of water than oil. Following its separation from oil, produced water is often discharged directly into the marine environment through submarine outfalls. Patin (1999) estimated that:

*"Every day volumes of produced waters discharged from a single platform can reach 2,000-7,000 m<sup>3</sup> and total hundreds of thousands of tons a year".*

Produced water associated with oil production usually differs from produced water associated with gas production as Sadiq *et al* (2005) concluded:

*“Water from gas production fields generally has a higher content of low molecular weight aromatic hydrocarbons than water from oil production platforms. However, the total amount of water produced from gas fields is considerably smaller than oil production fields”.*

The chemistry of the produced water is dependent upon the underground geological formation of origin. Studies in many parts of the world show that produced water can contain heavy metals, organic molecules and toxic compounds. In the North Sea, oil reservoirs' produced water contains substantial amounts of non-hydrocarbon organic matter, largely as salts of acetic, propionic and butyric acids and dissolved hydrocarbons such as benzene, toluene and xylene (Somerville *et al*, 1987). However, typical produced water contaminants are; salt, oil droplets, wellsite chemicals, drilling muds, particulates, heavy metals and Naturally Occurring Radioactive Material (NORM) (TIFETOG, 2006).

#### **3.1.3.5.2 Environmental impacts of produced water**

Produced water is probably one of the major sources of pollution associated with oil production. Produced water contains many contaminants including hydrocarbons, heavy metals, and chemical additives such as corrosion inhibitors to prevent damage to refinery equipment (Higashi *et al*, 1992; Witter & Jones, 1998). Since the chemical composition of produced water varies widely, it is not surprising that the toxicity of these discharges also varies within very wide limits (Patin, 1999). The constituents of produced water are determined by the nature of the oil and gas reservoir and field maturity. Additionally, the processes used to treat water produced from the reservoir will also influence the composition of discharged produced water and its potential impact on the receiving environment.

As Sadiq *et al* (2005) mentioned, three methods are used to reduce and control potential environmental impacts of produced water (i) avoid water production from the well. The production of formation and connate waters may be controlled, but equilibrium water due to condensation cannot be avoided. (ii) re-injection. After surface separation of the water from the hydrocarbons, the water may be re-injected back into the formation. This technique is only possible when a well is available for disposal. (iii) removal of hydrocarbons from the water. This can be done at several steps between the well bottom and discharge point.

However, in desert areas which are mostly arid, the produced water was not a big issue especially when the amount of produced water is small. Produced water is easily evaporated by sun heat following its separation from the oil. Hubail & El-Dash (2005) mentioned that disposal of produced water had, for 40 years, never been a problem for the petroleum industry in Kuwait. The problem occurred when the produced water incrementally increased due to the large content of water associated with the oil at the late stages of the oil field production.

#### ***3.1.3.6 Atmospheric Impacts***

On- and offshore oil production can also create significant air pollution. The principal source of atmospheric emissions is flaring, venting, exhausts, fugitive emissions and the release of Halons and Chlorofluorocarbons (CFCs). The main types of gaseous emissions are carbon dioxide, carbon monoxide, nitrogen oxides, nitrous oxide, methane, volatile organic compounds, halon, hydrogen sulphide, sulphur dioxide. These emissions severely reduce air quality and cause air pollution. Thus, as a result of petroleum exploration and production operations, the atmosphere in the operational areas is affected by some toxic emissions. It is widely believed that this poses a serious risk to

human health. For example, Caswell (1993) and O'Rourke & Connolly (2003) mentioned that:

*"Emissions from drilling equipment, hydrocarbons escaping from wells, flaring of natural gas, and emissions from support vehicles can degrade local air quality".*

Environmental concern for air quality, therefore, has increased. This led to intensified researches on solid particles introduced into the atmospheric–planetary boundary layer.

Bosco *et al* (2004) and others, agreed that pollution derived trace elements may be absorbed by the human respiratory tract and deposited deeper in the pulmonary region. Also, plants may be affected by aerial deposition of xenobiotic elements, which inhibit photosynthesis, respiration, and other life functions (Fluckinger *et al*, 1979; Kukkola *et al*, 1997 & Rautio *et al*, 1998a, b.) Cited in Bosco *et al* (2004).

#### **3.1.3.6.1 Flaring and Venting of Associated Gas**

Undoubtedly flaring and venting provide the most significant source of air emissions in the petroleum industry. Associated gas is usually much smaller than the total amount of oil. According to Svalheim (2003):

*"When oil is produced from the subsurface, it is accompanied by associated natural gas. In some parts of the world this gas is released directly into the atmosphere (cold venting) or burnt off in a gas flaring system (flaring). These methods result in large amounts of energy being wasted, as well as the emission of greenhouse gases into the atmosphere".*

Drilling companies regularly flare or vent associated gas to dispose of flammable gases that are either unusable or uneconomical to recover. It is also used to reduce the pressure of gas processing during maintenance and emergencies. However, flaring and venting is also used where no infrastructure exists to bring it to market. Christen, (2004) states that:

*"In spite of efforts by countries and companies to capture more of this gas for energy use, global flaring and venting levels have remained fairly constant over the past 20 years".*

In fact, recently this practice has been considerably curbed in developed countries, especially after the rise in the price of energy.

Flaring is generally undertaken only for larger amounts of gas, whereas companies routinely vent smaller quantities that are not sufficient to be conserved or to support combustion in a flare. This leads to gas being released into the air as methane. The World Bank (2004) has estimated that the annual volume of associated gas being flared and vented is about 110 billion cubic metres (bcm), enough fuel to provide the combined annual natural gas consumption of Germany and Italy.

The flaring system normally consists of stack and pipes which collect the gases to be burnt. For improving the burn efficiency, a flare tip is usually fitted at the end of the stack. The stack also has a seal to prevent flashback of the flame. A vessel is fitted at the base of the stack to remove and conserve any liquids from the gas passing to the flare. There are a number of technical papers discuss the venting and flaring system and its operation in detail, one of them is Shore's paper "*Making the Flare Safe*" (Shore, 1996), which gives a broad introduction to flaring in the oil and gas industry.

#### **3.1.3.6.2 Environmental impact of flaring and venting**

Since the issue of global warming has become more high profile in the world, there has been more attention paid to gas flaring, which produces enormous amounts of greenhouse gases (GHGs) including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and propane (Kaldany, 2001). There are various impacts of direct venting of natural gas into the environment, both in the upstream and downstream petroleum operations (Akeredolu & Sonibare, 2004).

Although it is in the petroleum companies' interest to gain as much value as possible from the accumulations of hydrocarbon, oil companies in some developing countries determine it to be beneficial to flare associated gas. It is widely believed that there are two main reasons for this; first, lack of infrastructure needed for adequate use of the natural gas that is associated with oil, as this gas depends on a developed pipeline system to make it available for export or use. Secondly, lack of any strictly enforced mechanism to ensure compliance by all members in the industry. However, the importance and increased use of potential liquid gas as a source of energy may help to reduce flaring and venting it.

Flaring and venting also have potential risks to health and environment. Moreover, the noise, odor, and smoke produced from flaring activities can interfere with nearby residents and their enjoyment of the outdoors. Some gases are more likely to be smoky because they contain a greater proportion of carbon than others or because their cracking temperature is lower than others (Shore, 1996).

#### **3.1.3.6.3 Greenhouse Gases**

According to the Kyoto Protocol, there are six gases listed as greenhouse gases, namely carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), sulphur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) families. Doucet (2004) agreed that:

*"When pure natural gas is burned, it primarily produces carbon dioxide and water vapour. This alone can have the effect of raising the ambient temperature on Earth, causing the greenhouse effect to take place".*

#### **3.1.3.6.4 Volatile Organic Compound (VOC) Release**

Globally, considerable concern has been expressed regarding the atmospheric impact of the emission of volatile organic compounds



(VOCs). The 1991 UN/ECE\* *“VOC Protocol”* required contracting parties to reduce VOCs emissions considerably, to 30% of 1988 levels by 1999.

There are several sources of VOCs release from the operations, including; Unburnt HC (Hydrocarbons) in flares, turbine exhaust, process venting, fugitives, and tanker loading. When VOCs release into the environment, they can become soil and groundwater contaminants. VOCs are also important in outdoor air pollution; vapours of VOCs escaping into the air contribute to air pollution.

#### **3.1.3.6.5 Halons and other CFCs.**

Large volumes of halon (an ozone-depleting chlorofluorocarbon) are currently being used in oil and gas production as a fire and explosion suppressant. Halon and CFCs are also used in process refrigeration, air conditioning, and domestic freezers and refrigerators. Losses occur from leaks and during the replacement of the refrigerant in process systems. This is only discharged when necessary and sometimes through malfunction or during maintenance of the equipment or detection systems.

#### **3.1.3.6.6 Acid Rain**

Acid rain is a broad term that is used to describe all forms of acid precipitation such as rain, snow and fog. It is widely thought that acid rain is damaging lakes, forests, plants and animals that live in these ecosystems.

Acid rain is caused by the transformation of the acidic combustion products sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and hydrogen chloride (HCl) (Labandeira, 1996). Recently, acid rain has become one of the major environmental concerns as UNEP (2002) confirmed:

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\* (United Nations Economic Commission for Europe)

*"Acid precipitation has been one of the most prominent environmental concerns over the past decades, especially in Europe and North America, and more recently also in China". (UNEP 2002).*

Acidic deposition is a cross-border environmental problem, in which location of the pollution sources matters, and it affects both plant and animal life, as well as buildings. Atmospheric pollutants such as oxides of sulphur can cause precipitation to become more acidic.

Thus, acid rain causes acidification of lakes and streams and contributes to damage of trees and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings.

#### **3.1.4 Decommissioning**

*"Sooner or later (most often after 20-40 years) the hydrocarbon reservoir within any field becomes depleted". (Patin, 1999).*

Therefore, when the oil and gas installations are reaching the end of their economic production life, proposals for decommissioning them are being prepared by the operators. These proposals of abandonment procedures should be consistent with industry-wide practices and procedures to ensure safety and environmental protection. However, early planning for decommissioning is necessary to carry out the oil and gas projects as a long time is required to secure associated equipment and services.

### **3.2 Environmental Impacts of the E&P Operations in Libya**

This section includes the researcher's own study about the environmental impacts of petroleum exploration and production operations in Libya. He visited the area of the study for this purpose. The environmental impacts of the oil and gas industry occur in all the producing oil countries including the advanced countries. Each country has its own way to deal with these

impacts. Libya is a developing country and a petroleum producing country. Its petroleum industry has faced some difficulties including international sanctions which restricted its development as will be explained later in Chapter 5. Several environmental impacts of the Libyan upstream petroleum industry have occurred and accumulated over time since petroleum exploration and production began. These impacts are various, including gas emissions, land contamination, ground water pollution and loss and disturbance of habitat. Some of these impacts are still occurring even though the country has developed substantial environmental regulations to reduce the environmental impacts as it will be illustrated in chapter 5. One reason for that according to Hallett (2002) is:

*“Libya is very backward technologically compared with areas like the North Sea”.*

Thus, the country suffered from lack of investment and lack of access to modern equipment. Moreover, information about these impacts is very limited. Therefore, the fieldwork study was the main source of information in this regard. The fieldwork study includes collecting existing available data and documents and visiting oilfield sites. This section presents in detail the environmental impacts of the Libyan upstream petroleum industry with concentration on onshore operations.

### **3.2.1 The Impacts of Exploration Operations**

Most of the oil and gas exploration operations in Libya are conducted in the desert where petroleum companies have gained concessions to search for petroleum without clear environmental restrictions. In the southwestern region, for example, most of the damage already done to the Messak Settafet Plateau (part of Hamada Murzuq) is irreversible. Anag *et al* (2002) (Department of Antiquities, Tripoli, Libya) confirmed that:

*“An immense oil field (Elephant Field) has recently been discovered by the LASMO Grand Maghreg Limited. In fact, after years of seismic surveys, which inflicted dramatic damage on the landscape, the environment, and the*

*archaeological heritage, drilling and exploitation are really upon us”.*

This happened in spite of the Antiquities Law of Libya, which protects the country's cultural heritage. In 1997, with the discovery of the F-NC174 oil field, activities intensified in the area of Wadi Inhagalas and the level of damage and disturbance increased (Anag *et al*, 2002).

Total Oil Company has conducted a seismic survey in the Murzuq Basin in the south-west of Libya (IPIECA, 2003). The desert landscapes in the Murzuq Basin are extremely varied and exceptionally beautiful. Biological diversity is concentrated in wadis, and includes some rare flora and fauna, and a number of rich archaeological sites have been found.

As a first step, Total carried out Environmental Baseline Studies (EBS) to determine the benchmark 'point zero' of the zone, from both environmental and archaeological perspectives. The main aim of the survey was to assess the density of archaeological sites in all the domains and to develop methodologies for scouting of the seismic lines.

Potential impacts from usual seismic acquisition include damage to archaeological sites, altering the wadi hydrological regime and visual impairment of the local landscape. To minimise these impacts, Total has undertaken a number of measures including: modification of seismic routes; prohibiting removal of any archaeological artifacts, flora and fauna; limiting access to single tracks; implementing waste management plans; and restoration of seismic line paths. Thus, Total successfully minimised environmental impacts, and carried out an on-site assessment in 2002 to verify that EIA measures had been completed effectively.

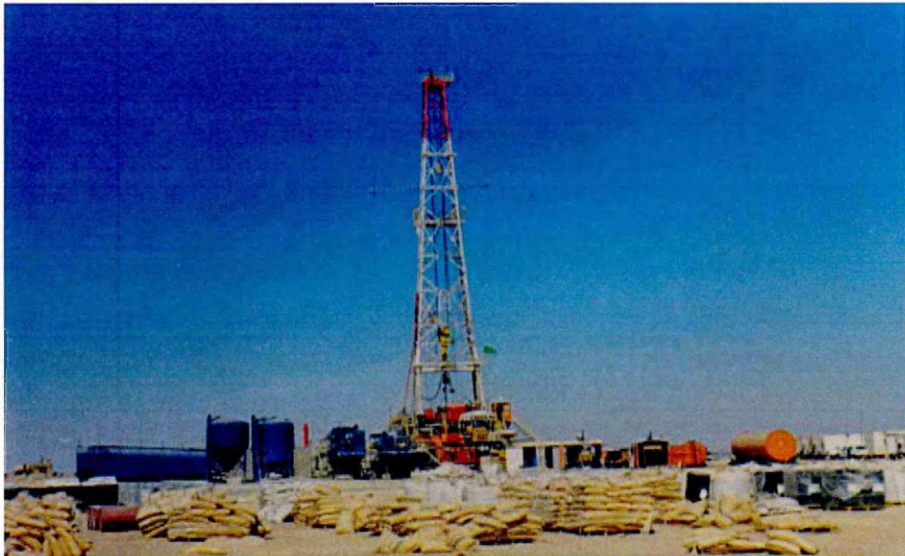
Since 2003, extensive seismic operations have been started which may unearth some promising new prospects. These exploration operations will be associated with inevitable environmental impacts. In spite of that, the available publications and studies dedicated to the environmental impacts of the operations of the upstream oil and gas industry in the country are not sufficient. More studies must be conducted before the operations in order to minimise these impacts in the future.

### **3.2.1.1 The Impacts of Drilling Operations**

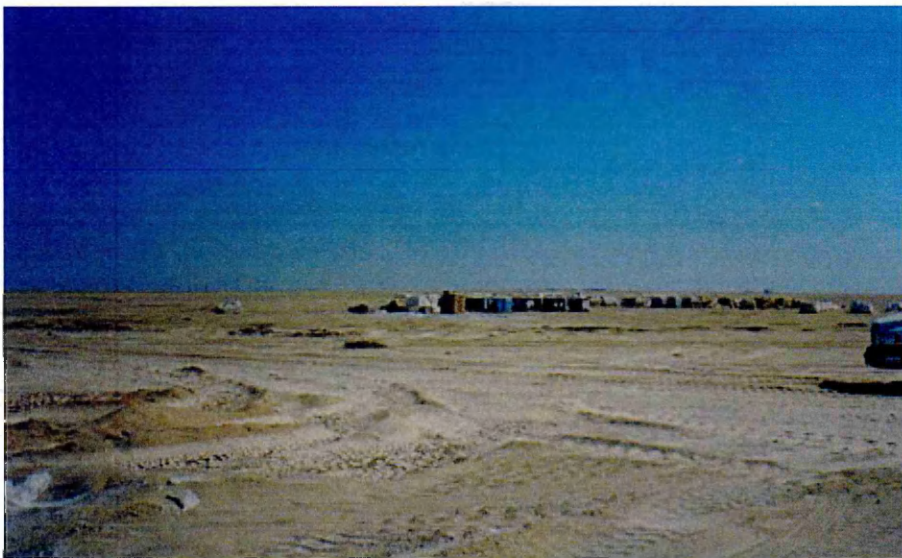
Most drilling operations in Libya are conducted without proper environmental management. Some companies do not yet have any environmental policy, as one interviewee told me: *his company currently does not have an environmental policy*. Thus, the environmental impacts of the drilling operations are neglected where none of the environmental measures were taken in many drilling sites. This was confirmed by observing a drilling operation on a drilling site during the fieldwork visit and the figures below were taken from the same oilfields. It was very clear that there is not any kind of environmental policy or management in these operations.

As can be seen from Figures 12 and 13 below drilling sites are not environmentally managed where the drilling materials are left on open space and are not stored in proper stores. These materials contain chemicals and other dangerous materials which are usually used in drilling operations. Figure 13 also shows the impact of heavy vehicles on the drilling site which cause disturbance to the land surface.

Figure 12 below shows a drilling site during drilling operations in an oilfield in the country of study.



**Figure 12 Drilling Rig and drilling materials left behind it in open space.**



**Figure 13 Impact of heavy vehicles and drilling materials on the drilling site.**



### ***3.2.1.2 The Impacts of Drilling Fluid and Cuttings***

Drilling fluid and cuttings which contain poisonous chemicals are seeping into the earth's surface. This will not only contaminate the land but will also contaminate the ground water. This is because there is no waterproofing to prevent the infiltration of this liquid to the ground water. It also poses dangers to the birds and wildlife animals. Figure 14 shows the drilling fluids and cuttings of a drilling site.



**Figure 14 Drilling fluids and cuttings are seeping on the land surface**

Drilling fluids are usually re-treated and reused not because they cause damage to the environment but because they are expensive. The cuttings are frequently analysed. In fact, the analysis does not include the radioactive or any other poisoning materials which may pose dangers to the employees. After the end of the drilling operations the fluids and the cuttings will be buried in the same site which means only covering them with a layer of soil during the restoration of the site.

### **3.2.2 The Impacts of the Development Operations in Libya**

The development (production) phase of the Libyan petroleum industry is associated with some environmental impacts. These impacts are

accumulating since the first production of the petroleum in the country. Essential steps need to be taken to minimise these impacts. This may include urgent actions in order to prevent the situation from deteriorating. Some of these impacts are discussed below:

### **3.2.2.1 Produced Water issue**

Produced water is one of the major environmental impacts of the Libyan upstream oil and gas industry especially in the old fields which produce more water than oil. This contaminated water is seeping into the earth's surface and infiltrating to the groundwater. This is a particular problem in the old oil fields where the volume of produced water is very large. I have been advised during my fieldwork study that some wells produced about 20% crude oil and 80% produced water. Produced water, therefore, is a major issue in the Libyan upstream oil and gas industry as large areas around the oilfields are contaminated by produced water.

What exacerbates the problem is the fact that most of the Libyan Desert where the oilfields exist contains fresh water and is characterised by high porosity and permeability which allows the produced water to infiltrate to the ground water. Bearing in mind that the country is suffering from shortages of fresh water, the impacts of the produced water on the ground water are considerable.

The researcher did not find any data or information about the volume of produced water that associates the oil and gas production operations in the country or any poisonous materials or gases that might be contained in the associated water.

Figure 15 shows a lake of produced water near to an oilfield, as the contaminated water is floated on the land surface. The water should be filtered and desalinised and used for irrigation or another purpose.





**Figure 15 Lake of produced water in the Libyan Desert.**

Figure 16 shows crude oil separated from a produced water lake and gathered into a pit as it will be returned to the separation unit. The pit is just a hole in the ground without any waterproofing to prevent the filtration of the oil through the ground.



**Figure 16 Crude oil separated from produced water and gathered in a pit in the ground.**

Hydrocarbon sulphite ( $H_2S$ ), which comes out with the produced water, is also a major problem in that area. The odour of  $H_2S$  can be smelt several miles from the produced water lakes. Towns which are located adjacent to the oilfields are affected by this gas.

In fact, since the establishment of the LNOCs' Environmental Department in 2002, water resources have received more attention. According to Benrageb, 2005):

*"Another issue of key importance for Libyas' environment is the efficient use of water resources, so it is a condition that wherever exploration and production activities produce usable water that should not disposed of in the desert or other open space, but should be recuperated or used in an environmentally acceptable way".*

Figure 17 shows a long stream of produced water moving through a sandy soil land to end at a huge lake of produced water in the desert. This stream can cause:

1. Land contamination;
2. Land disturbance;
3. Ground water contamination; and
4. Ecological damage and danger to birds and animals in that area.



**Figure 17 Very long stream of produced water moving through the desert.**

Figure 18 below shows land contaminated by produced water in the Libyan Desert. This land can not be planted in the prospective future without intensive remedy and reclamation.



**Figure 18 Huge area of land contaminated by produced water in the Libyan Desert.**

In 2003 a specialist team from the General Water Authority in the country conducted a study about the produced water in Alhamada oilfield (about four hundred kilometres south of Tripoli), which belongs to Arabian Gulf Oil Company (AGOCO). The proportion of the oil to the produced water is



25% oil and 75% produced water. The report, which is in Arabic, concluded that the destructive environmental impacts of those lakes of produced water are:

1. Killing the plant cover because of the poisonous content and salinity of the water;
2. Filtering of this water to the groundwater and contaminating it;
3. Contaminating the layer of the land so it cannot be used for agriculture or grazing; and
4. Causing death to many animals like camels due to drinking from these lakes.

The report also recommended further studies of this issue to find the best possible solution to this real problem.

A study by Alfakhri *et al* (2004) about Naturally Occurring Radioactive Materials (NORM) in field TV9, noticed that crude oil contains a lower rate of radioactive dose than produced water because of the additive materials which means that particular field does not contain high concentration of NORM. The study also concluded that deeper wells contain higher concentrations of NORM. However, the current exposure of radioactivity to the employees is considered low due to the low concentrations of NORM in that oil field.

In 2005, Wintershall Oil Company, which is operating in Libya, prepared a study for LNOC to remedy produced water ponds in concession 96 near Jakhira town in the country. The study suggested *In-situ* remediation of the drain pits by relocation of contaminated material from the surrounding areas into pits. In fact, the study which was implemented later is the first serious trial in the country to remedy the produced water impacts on groundwater and the surrounding area from radioactive materials (which may affect the employees and local people who live in that area).

### **3.2.2.2 Gas Flaring**

Libya implements gas projects to exploit its gas resources and export it to Europe via undersea pipeline. According to Benrageb (2005) nowadays a far smaller percentage of gas is being flared than was the case in the past, with more than 85 percent being taken up by power generation and other domestic consumption or being exported via the 'Greenstream' pipeline to Italy and European markets and that trend is expected to continue.

However, burning gases in the atmosphere is still a big concern of the Libyan upstream oil and gas industry because this gas needs investment capital to take advantage of it economically and to prevent air pollution at the same time. Figure 19 below shows flaring of gas in an oilfield.

Considerable quantities of gas are burnt around the clock.



**Figure 19 Gas flaring from oilfield with black smoking into the atmosphere.**

The flare is usually associated with black smoke due to incomplete burning. Black smoke releases hazardous unburned hydrocarbons into the atmosphere despite the environmental legislation and LNOC regulations prohibit incomplete burning at flare. In fact, in some oil fields a small

proportion of the associated gas is used to provide energy to the power stations on the site.

There are several reasons for burning associated gas:

- The associated gas which is flared is scattered in many oil fields in the desert where it does not have direct impacts on the public and at the same time it needs huge investment to exploit it.
- The country needs foreign investment, which is now possible after the sanctions have been lifted, to provide facilities such as building gas plants and pipelines.
- The price of energy was cheap and as the price increased it has become beneficial to exploit the associated gas instead of burning it.

The head of the Environmental department of the LNOC Mr Benrageb (2005) states that:

*"We are now seeking to minimise the flaring of gas wherever that is economically viable so as to reduce levels of carbon emissions". (Benrageb, 2005).*

However, the research did not succeed to find statistical data if there is any to show the volumes of gas which are burned from the country's oil fields.

### **3.2.2.3 Pipelines**

Pipelines are the most important way to transport crude oil and natural gas from the oilfields to industry and shipping units in the north of the country. Compared to tankers, pipelines have lower cost per unit and also higher capacity. In fact, many of the pipelines in the country are very old and are laid over the land surface, especially those pipelines which connect the wells with the station units in the oilfields. The pipelines should be buried in the ground whenever possible to avoid disturbance.

Figure 20 shows a net of pipelines laid above the land surface.



Figure 20 Pipelines laid on the surface of the land.

#### **3.2.2.4 Solid waste and sewage**

Waste management to minimise the health, environmental and aesthetic impacts of solid wastes seemed completely absent in the Libyan oilfields. Solid waste (garbage) is thrown and spread on an open dumping site in the desert. The garbage includes containers of chemical materials and oil which seeps into the land surface and contaminates the land. These materials also pose a danger for animals and birds in those areas. Many citizens complained about these wastes to the courts and other related bodies including the oil and gas companies and asked for compensation from the polluters (as I have been told by several interviewees).

The garbage should be gathered in a proper place and transferred to proper disposal facilities not just for environmental reasons but also for economic reasons as these materials have high economic value. For example, hundreds of tons of solid materials are disposed of in the desert as can be seen in Figure 21.





**Figure 21 Solid waste spread over the land in an oilfield site.**

Figure 22 shows a sewage waste dump in one oilfield in the Libyan Desert where it can be seen that the human waste also is not managed properly. For example, the sewage waste is discharged on an open space near to the camp site of the oilfield. This waste should be refined from the solid and unwanted materials to clear water and then reused for the irrigation of the trees and the gardens in the camp sites of the oilfields.



**Figure 22 Sewage discharge at an oilfield camp in the desert.**



Thus, open dumps, where the waste is unloaded, make very uneconomical use of the available space, allow free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fires.

### **3.3 Conclusion**

This chapter consists of two sections. The first section discussed upstream petroleum industry processes and their potential environmental impacts and the second section is a study of the current environmental impacts of the Libyan upstream oil and gas industry.

In the first section all the phases of the petroleum exploration and production processes are explained in detail where each phase is associated with some potential impacts on the environment. The first phase which was the exploration operations is one of the most sensitive phases to the environment. It necessitates some harsh operations against the environment such as seismic explosions and drilling.

The second phase, which is just to evaluate the reserves of the discovered reservoirs by drilling more wells, is explained. This phase probably has less potential impacts on the environment as it is short and only requires drilling operation. This stage is conducted only if there is promising discovery of petroleum.

The third phase which was undertaken in this section is the development phase. This phase follows the appraisal phase if a promising discovery is found. This phase is continuing to the end of the production of the reservoir, which may last for four decades. Therefore, the processes of this phase and its potential environmental impacts were discussed in detail.

The final phase of the upstream petroleum exploration and production was also considered. This phase involves decommissioning of the facilities and rehabilitating the sites.

The second section of this chapter is dedicated to the current environmental impact of the petroleum exploration and production processes in Libya. This section was prepared by the researcher after his fieldwork visit where evidence including notes and photographs were collected from the oilfield. This section therefore, includes all the important impact aspects of the Libyan oil and gas upstream industry. Each impact issue is presented with evidence to explain and illustrate the actual impact on the ground.

## Chapter Four

### Research Methodology

#### 4.1 Research Strategy

Research strategy as many researchers agree, for example, (Morse & Field, 1995) is determined by the nature of the research question. Williams & May (1996) also agreed that most social research is conducted through the following methods of data collection; social survey, field observation, interviews and the use of existing data.

It is widely thought, for example (Yin, 1994; Robson, 1993 & Blaikie, 2000) that the purpose of the research and the type of the research questions should shape the research approach adopted as there is no specific method of social research that can be defined as right or wrong. Sayer (2000) indicated that:

*“Social systems are always open and usually complex and messy. Unlike some natural sciences, we cannot isolate out these components and examine them under controlled conditions”.*

Choosing an appropriate method of research should ensure the most accurate results. Certain methods will be more suitable for certain research projects. Thus, there are several ways to conduct social science research. Yin (1994) pointed out that each strategy is dependent upon three conditions; (a) the type of research question, (b) the control of the investigator over the actual behavioural events, and (c) the focus on contemporary as opposed to historical phenomena. The different types of research methods or strategies are commonly put into five major categories; experimental, survey, archival analysis, historical and case study (Yin, 1994 & Walliman, 2001).

Table 6 illustrates the relation between each condition to the five major research strategies in the social sciences.

Strategy	Form of research Question	Requires control over behaviour of events?	Focus on contemporary events?
Experimental	How, Why, What if?	Yes	Yes
Survey	Who, What, Where, How many, How much?	No	Yes
Archival analysis	Who, What, Where, How many, How much?	No	Yes/no
Historical	How, Why?	No	No
Case study	How, Why?	No	Yes

**Table 6: The relation between each condition to the five major research strategies in the social sciences, (Yin, 1994)**

The advantages and disadvantages of different research strategies depend upon the characteristics of the topic under investigation (Yin, 1994).

A research strategy as Bryman (1989) asserted, provides:

*“the overall structure and orientation of an investigation”.*

The strategy of this research is to apply multiple methods including interviews and an observation of the oilfield area. In fact, the main methodology is a questionnaire survey with the oil and gas industry in Libya and the UAE. This questionnaire was designed after close exploration of the oil and gas industry in Libya in terms of its environmental performance via conducting several interviews with selected figures in the environmental affairs of this sector and from the Environment General Authority (EGA) in the country. The questionnaire was also designed after a review of environmental impact theory and the potential environmental impacts of the upstream petroleum industry.

### **4.1.1 The Research Questions**

This research is driven by two main questions:

1. Is the current environmental management approach to the Libyan upstream oil and gas industry effective?
2. How can this approach be improved?

### **4.1.2 The Choice of the Exploration and Production (E&P) of the LNOC for this Study**

LNOC is the governmental owned oil corporation in Libya which is responsible for all upstream and downstream oil and gas industrial activities and marketing in the country. LNOC controls and drives the oil and gas sector in Libya mainly via its affiliate companies.

LNOC was chosen for the following reasons:

1. The LNOC is the backbone of the oil and gas industry in Libya, which is the main driver of its economy, and the owner of all national oil companies operating in the country.
2. The LNOC is the responsible institution to deal with any foreign oil company that wants to invest in this industry in Libya.
3. The LNOC's managers and employers are relatively stable and usually specialists in the oil industry and not like other organisations in the country where the managers and other staff are less stable.
4. The LNOC should be aware of its operation's environmental impacts more than other organisations in the country.
5. The LNOC is one of the most organised institutions in the country with large facilities compared with other sectors and institutions.

The LNOC, therefore, is the key organisation in the field of environmental management of the upstream oil and gas industry sector.

## **4.2 Research Scheme**

The scheme of this research is to achieve the objectives of the research and use the most suitable means to achieve them.

The first objective is to review the relevant literature on the theory of the environmental impact with special reference to the exploration and production operations to identify the main potential impacts of these operations; for this objective, a desk-based study was undertaken which included:

1. Reviewing the literature, to consider all potential environmental impacts with concentration on the EIA.
2. Determining the potential impacts of the upstream oil and gas industry.

The second objective is: investigating the current environmental management in Libya related to upstream oil and gas industry. This was achieved by:

1. Determining the processes by which the regulation and legislation are enacted according to the political system in Libya.
2. Reviewing the development of the Libyan petroleum laws and environmental protection legislation.
3. Reviewing the available resources which include any related documents, information, published data and reports.
4. Investigating the current approach to environmental management in Libya.
5. Conducting several interviews with selected staff from the Libyan oil and gas industry sector and from the Environment General Authority in Libya.
6. Conducting a questionnaire survey with the oil and gas industry sector in Libya and comparing the results with same questionnaire from the United Arab Emirates.

7. Visiting oilfields to collect all available evidence by observation in the oilfield and taking notes and photographs.

The third objective is: exploring the structure of the LNOC and investigating its environmental policy, its relationship and links with the relevant bodies such as the ministry of energy and the environmental agency, and how it handles the environmental issues associated to its upstream activities. This involved:

1. Reviewing the available resources which include any related documents, information, publishing data and reports.
2. Determining the relationship between LNOC and the relevant stakeholders (i.e. Ministry of Energy, The Environmental Agency and non-governmental institutions where they exist) and evaluating their roles and influence in the process of enacting and implementing environmental policy.
3. Conducting several interviews with selected staff from the Libyan oil and gas industry sector and from the Environment General Authority in Libya.
4. Conducting a questionnaire survey with the oil and gas industry sector in Libya and comparing the results with same questionnaire from the United Arab Emirates.

The fourth objective is: examining the role of the US and UN sanctions and how the sanctions affected the upstream oil and gas industry in Libya from an environmental perspective;

1. How the sanctions and the restriction of multinational oil companies from investing in the oil and gas industry in Libya and prohibiting it from modern technology, affected the state of the environment in the upstream oil and gas industry.

2. Conducting several interviews with selected staff from the Libyan oil and gas industry sector and from the Environment General Authority in Libya.
3. Conducting a questionnaire survey with the oil and gas industry sector in Libya and comparing the results with same questionnaire from the Environment General Authority in Libya.
4. Visiting oilfields for collecting all available evidence such as observation of the oilfield, taking notes and photographs.

This has been conducted in a trial to answer the research questions which are; whether the current environmental management approach to the Libyan upstream oil and gas industry is effective or not? And how this management approach can be improved?

### **4.3 Data Sources**

The sources of data and information available on the subject (Libyan environmental management policy) and on the place of the research (Libya) are very limited. This is because:

1. The country does not have long-established institutions such as research centres and environmental agencies to plan effective environmental policies to deal with environmental issues in the country.
2. LNOC which is the most important industrial institution in the country recently created an environmental department which indicates that environmental issues cannot be ignored and have been receiving increasing attention.
3. The US and UN sanctions which affected not just the oil industry but communications and the relationship between the country and the rest of the world.



The data of this research was collected from four sources via four methods described here:

#### **4.3.1 Secondary Data**

The secondary data includes relevant literature such as the related legislation, environmental reports and environmental policies which have been collected from the targeted organisations to obtain basic background information about these organisations and to identify the issues considered relevant by these organisations concerning the environment.

#### **4.3.2 Interviews**

Semi-structured interviews regarding the topic of study were conducted with two interviewees from two national affiliates of the LNOC, two from two other sharing companies and four staff members of the Environment General Authority (EGA). These interviews enhanced the researcher's background about the subject of the study and formed alongside the other environmental knowledge the bases of the questionnaire which is the main source of data to this research. In other words, the interviews were used as a channel to explore and focus on the relevant issues to the research in the area of study.

#### **4.3.3 Questionnaire Survey**

Building on the interviews, a questionnaire survey was designed to explore the opinions of the employees who are working with national affiliates and foreign sharing companies of LNOC about the environmental management issues. The survey also includes a number of staff of the Libyan Petroleum Institute (LPI), which is also an affiliate of the LNOC, and some academic experts who have been working with the oil and gas industry in Libya.

The results of the survey of the organisations' representatives are compared with the information provided in environmental policies and other relevant literature.

Similar questionnaire surveys were conducted in the United Arab Emirates (UAE) which is also an oil producing country to compare the outcome from both countries. There are several reasons for the choice of the UAE, among them:

1. UAE shares many aspects with Libya where both are Arab countries with a similar culture, political history and level of modernisation.
2. There are many Libyan professionals working in the petroleum sector in the UAE, some of them are friends of the researcher, who facilitated the achievement of the survey on his behalf.
3. It seems that the UAE has been developed very rapidly and transferred from a developing to a developed country in the last three decades.

#### **4.3.4 Oilfield Visit**

A visit to petroleum fields for observation, observing the situation on the ground and collecting other possible evidence such as photos of some environmental aspects.

#### **4.3.5 Data Collection**

The researcher has visited Libya three times for fieldwork study: October 2005, 21 June – 15 September 2006 and 30 June – 12 September 2007. This allowed him to collect and complement all possible required data that is pertinent to this research. The first trip was not solely for the fieldwork study but the researcher took the opportunity of his first visit to Libya since he started his research to visit the Libyan National Oil Corporation (LNOC) and Environment General Authority (EGA) to explore the environmental aspects of the petroleum industry and to establish relationships with

relevant personnel. The second trip was dedicated to the fieldwork study where the main data was collected during that trip. A total of sixty-five questionnaire responses were also collected from the petroleum industry and twenty responses from the EGA. More questionnaire responses were collected during the last fieldwork trip to make a total of eighty-eight responses from the petroleum industry and forty-four from the EGA. This was designed to correspond with the responses from the UAE, which were forty-four forms, as the researcher thought that this may be needed for statistical processing during data analysis.

Taking the opportunity of my short visit to Libya in October 2005 I visited the LNOC and met a few key managers. I briefly told them about my research after giving them a letter from my supervisor and asking their assistance for access to conduct my fieldwork in the next fieldwork trip. I felt that I found them helpful and I established a personal relationship with at least one high level manager. Generally, this would facilitate my field work study in terms of the access to information and data, conducting the interviews with relevant staff in the affiliates of the LNOC and other companies which work with it by sharing agreement and visiting the oil field. Unfortunately by the time of my field work in the summer 2006 dramatic changes occurred in the LNOC as a result of the change of its chairman and those changes included the person who I established good relationship with. Therefore, I struggled to collect the required data. A personal relationship was used to facilitate the fieldwork study and collect that data. Friends and relatives helped me to find some data and convinced some relevant staff to be interviewed.

#### **4.3.6 Data Access Difficulties**

Collecting data from the oil and gas sector in general is very difficult as oil and gas organisations are described as being “*pretty cagy*” about their strategies for competitive reasons and to avoid confidential information

being exposed. This was very noticeable especially because the oil industry sector in the country of study does not have a strong environmental record of their activities.

The researcher did not gain access to all resources of information that he wanted. He was only directed to the environmental departments of the affiliates of the LNOC who were very cautious and some of them refused to answer some questions. As there is not any legislation which guarantees freedom of information, it was impossible to gain all available information which was needed for the research and to interview all relevant personnel at the oil and gas companies. This was the main reason which led to designing a questionnaire survey to collect primary data from the workforce with different backgrounds.

#### **4.4 Methodological Approach**

The approach of this research takes into consideration the limitation of obtaining data, access to it, and its reliability. A multiple-method in this case was employed to collect the required data to fill the huge gap in the data needed for conducting this research. Table of Cross-Referencing evidence is produced in Chapter Eight to triangulate the sources of evidence. The analysis of the data is introduced in chapter seven.

##### **4.4.1 Documented Data**

*“Except for studies of preliterate, documentary information is likely to be relevant to every case study topic”. (Yin, 2003).*

Analysis of documents can be an invaluable source of information; such documents might include official records, and reports, as well as the published data used in a review of literature. The researcher tried to find all relevant documents available in the affiliates of the LNOC as an important source of secondary data.

In this regard, the researcher asked for access to the LNOC affiliates' documents to examine the environmental information including published environmental policies, annual reports or any environmental reports. This includes the following elements:

- The regulations, laws and legislation which affect the upstream activities of the affiliates of the LNOC. (The regulations are listed and discussed in Chapter 5).
- Documented environmental policy.
- Documented quality management systems. (For example, ISO 14001) or any other standards and guidelines.
- Documented Health and Safety policy, including monitoring and internal audits of Health and Safety arrangements.
- Monitoring system for the operations.
- Internal audits of environmental events and accidents.
- Any environmental plan that reflects objectives and targets for improving the environmental performance.
- Environmental training/ awareness programmes for the staff especially the fieldworkers.

In fact, as expected there was very limited data found for just some of the targeted companies. None of the companies produced any annual environmental reports. The environmental regulations were collected from many sources including the LNOC, Environment general Authority (EGA). The only documents which were available to the researcher during the fieldwork trips to the research area (Libya) are shown in Table 7.

Document	Type of Document
Libya : Survey of Upstream Opportunities	Report
Effects of TE-NORM on Workers and Environment Within and Around Oil and Gas Production Fields	Conference paper
Environmental policy statement	Policy Statement (Document)
Loss prevention manual	Document
Environmental policy statement	Policy Statement (Document)

Table 7: Documents from Libya

Table 8 shows the documents from the United Arab Emirates (UAE), which are all published on the companies' websites.

Document	Type of Document
HSE Commitment & policy of the Abu Dhabi National Oil Company (ADNOC). <a href="http://www.adnoc.ae/Content.aspx?mid=127&amp;newid=127">http://www.adnoc.ae/Content.aspx?mid=127&amp;newid=127</a>	Policy Statement
ADNOC strategic objectives for health, safety and environment. <a href="http://www.adnoc.ae/content.aspx?newid=255&amp;mid=255">http://www.adnoc.ae/content.aspx?newid=255&amp;mid=255</a>	Policy Statement
ADNOC 2003 Annual HSE report, ADNOC 2004 Annual HSE report, ADNOC 2005 Annual HSE report and ADNOC 2006 Annual HSE report <a href="http://www.adnoc.ae/Content.aspx?mid=307&amp;newid=307">http://www.adnoc.ae/Content.aspx?mid=307&amp;newid=307</a>	Reports
ZADCO Total Commitment to HSE <a href="http://www.zadco.com/CMS/EnvironmentSociety/TotalCommitmenttoHSE/tabid/264/Default.aspx">http://www.zadco.com/CMS/EnvironmentSociety/TotalCommitmenttoHSE/tabid/264/Default.aspx</a>	Policy Statement
ZADCO 2004 Annual HSE report <a href="http://www.zadco.com/cms/portals/0/repository/HSEAnnual2004.72e157fa-3ec7-40ec-b945-2fb656e3acdf.pdf">http://www.zadco.com/cms/portals/0/repository/HSEAnnual2004.72e157fa-3ec7-40ec-b945-2fb656e3acdf.pdf</a>	Report
NDC Environmental policy statement <a href="http://www.ndc.ae/pdf/NDC_ENV_Policy.pdf">http://www.ndc.ae/pdf/NDC_ENV_Policy.pdf</a>	Statement
NDC Corporate Policy <a href="http://www.ndc.ae/pdf/hsepolicy1.pdf">http://www.ndc.ae/pdf/hsepolicy1.pdf</a>	Statement
NDC Land transportation policy <a href="http://www.ndc.ae/pdf/NDC_Land_Transp_policy.pdf">http://www.ndc.ae/pdf/NDC_Land_Transp_policy.pdf</a>	Statement
ADMA-OPCO HSE Policy <a href="http://www.adnoc.ae/content.aspx?newid=127&amp;mid=127">http://www.adnoc.ae/content.aspx?newid=127&amp;mid=127</a>	Policy Statement
Access date of these websites was March 2008	

Table 8: Documents from UAE

#### 4.4.2 Semi-Structured Interviews

Representatives from LNOC affiliates were interviewed about the relevant issues. The manager of or representative from each environmental department in the four oil companies and four staff members from the EGA were interviewed.

The main purposes of conducting these interviews were to explore the environmental management approach of the oil and gas industry sector in Libya to provide the basic ground to design the questionnaire survey to collect the main primary data for this research. Thus the interviewees were asked to propose their insights and their propositions regarding the environmental management issues. Moreover the interviews were also aiming to investigate the current management structure of the oil and gas sector and how this structure can impact on environmental performance.

The effect of the UN sanctions which were imposed upon the country in 1992 was covered in the interviews. The sanctions were suspended in 1999 and completely lifted in 2003. Before the UN sanctions the US had withdrawn its oil companies from Libya and imposed its own sanctions against Libya's petroleum sector from the middle of the 1980s to 2004. The effects of these sanctions were raised in the interviews.

The interviewees were also asked to suggest any other possible sources of evidence. These sources could be any reachable key persons from any institution who could provide valuable information and were initially not targeted because the researcher was not aware of their relevance.

An interview guide, which is shown in Appendix 3, was used to ensure good use of limited interview time and to make interviewing multiple subjects more systematic and comprehensive. An academic expert reviewed the guide and provided his comments, which were considered. The interview guide was helpful in conducting the interviews and especially in keeping interactions focuses on the targeted issues.

The questions of the interviews were open-ended which means that the researcher asked key respondents about the facts of a matter as well as their opinions about events.

### 4.4.3 Questionnaire Survey

#### ***4.4.3.1 Choosing the Questionnaire as the Main Method***

The questionnaire survey was designed to collect the main primary data. The decision to use a questionnaire survey was taken according to the experience of the researcher from the initial interviews which he had conducted. Several limitations emerged from those interviews. Some of these limitations are:

- Generally, people in the country of the field study are not familiar with these types of investigation, especially as the oil and gas industry is considered one of the most sensitive sectors in the country and this was reflected in the responses of the interviewees;
- The researcher felt that the participants were very cautious and they may not have given true information about their organisation's activities;
- The researcher was allowed to interview only the selected staff from the oil and gas organisations which would give very limited views about these organisation's activities; and
- Time constraints for collecting data, analysing and interpreting it.

Burns (2000) agreed that:

*"Perhaps one of the major limitations of qualitative research and evaluation is the time required for data collection, analysis and interpretations".*

Accordingly the questionnaire survey was thought to be more appropriate and was, therefore, chosen for primary data collection as no names were required and the participants would only choose the answers from the choices that were given. Thus, questionnaire participants can give their views without reservation and the responses would be more reliable.



#### **4.4.3.2 Pilot Study**

Before the main survey was conducted, a small-scale pilot study had been conducted for three main reasons:

1. To reveal any unanticipated difficulties of the questionnaire;
2. To clarify any questions that may not be understandable by some employees in the oil and gas industry; and
3. The Libyan version included Arabic translation beside the English, which may incur translation problems.

Many of the Libyan participants in the oil and gas industry and in the EGA cannot read English. The questionnaire was written in both languages which may include some risks when the translation does not reflect the accurate meaning. Accordingly, copies of the questionnaire which includes two languages were sent to seventeen Libyan postgraduate students who are sponsored by the Libyan oil and gas industry and studying in the United Kingdom. The responses were very encouraging and a few amendments were made after these responses and discussion with some other Arab students.

The UAE version was written only in English which is the main language of communication in the oil and gas industry and all the participants can read and write in the English language.

#### **4.4.3.3 Population of the Samples**

*“All the research design models that have been and will be considered depend to some extent upon appropriate identification of populations, the selection of representative sample(s), and sometimes suitable assignment of subjects to groups”.* (Black, 1999)

The decision on the sample of the survey had to be based on constraints of time and accessibility. In order to define a practical and significant grouping that represents the population of oil and gas industry, two from

the biggest national companies which are 100 per cent owned by the LNOC and two other important companies that are also affiliates of LNOC with foreign partners were chosen for this research. Those companies represent more than 70 per cent of oil and gas production in the country to ensure that the samples represent the upstream oil and gas industry sector in Libya. The choice of these two kinds of companies allows a comparison between them in terms of their environmental policies, commitments and performance. The survey also includes a number of staff of the Libyan Petroleum Institute (LPI), several independent academic personnel who have been working with the oil and gas industry in Libya and other experts from other oil companies to increase the reliability of the responses as can be seen in Table 9.

Samples from the EGA were also collected to represent the environmental regulatory organisation which is responsible for monitoring the implementation of the environmental legislation in all aspects of production and services activities in the country. However, the population of the sample is relatively small, because the total employees in the EGA are smaller than the Oil & Gas industry employees.

The Libyan questionnaire version included two more questions to cover the effect of the sanctions, which were imposed on the country. These two questions were also asked to the Libyan EGA participants to explore the opinions of the staff of the Environment General Authority (EGA) in the sanction issue and to compare their responses with the responses from the oil and gas participants.

Table 9 introduces the number of participants from each company or institute and the Environment General Authority (EGA) which were included in the questionnaire survey in Libya. For reasons of confidentiality the Libyan oil companies cannot be identified.

<b>LIBYA</b>	
<b>Company</b>	<b>Number of Responses</b>
AC	8
AG	17
BH	2
D	4
Ei	9
EiG	7
LPI	11
R	12
W	17
Z	1
<b>Total</b>	<b>88</b>
<b>EGA</b>	<b>44</b>

**Table 9: The Numbers of Libyan Participants**

Due to logistical reasons, the sample which was obtained from the UAE's petroleum industry consisted of forty-four forms. Therefore, the responses from the UAE were fewer than the responses from Libya. A personal relationship was used whereby the questionnaire surveys were circulated and collected via e-mail by a relative who works in the oil sector in the UAE. The UAE questionnaire respondents represent almost all major subjects in the major national and mixed oil companies that operate in the UAE. The questionnaire questions are exactly the same for the both countries. However, the difference between the samples' sizes does not have any effect of the analysis as the results are represented by percentages. Table 10 shows the number of participants from the UAE oil and gas companies.

<b>UAE</b>	
<b>Company</b>	<b>Number of Responses</b>
AD	9
AM	11
ND	7
ZD	17
<b>Total</b>	<b>44</b>

**Table 10: The Number of UAE Participants**

#### **4.4.3.4 Selection of the Samples**

Selecting the samples through a research design is very important as this influences the subsequent statistical analysis and may result in bias and greater variance of estimators. Black (1999) thought that:

*“Sampling is an essential consideration when carrying out most designs”.*

The samples were randomly selected and at the same time it was taken into account that they represent all relevant departments in each company to reflect the greatest possible width of the activities in these companies.

#### **4.4.4 Visiting Oilfields**

The researcher visited one of the oldest, largest and most important oilfields where he spent three days in September 2006. This gave the researcher a real opportunity to observe the situation on the ground and gather information from the site during the process of the activities. Several photos of environmental aspects were taken to explain the real situation in the oilfields.

### **4.5 Conclusion**

This chapter is dedicated to the research methods of this research. The research strategy used in this research is, therefore, described in this chapter. Multiple methods were used including a questionnaire survey, interviews, fieldwork visit and onsite observation. As the topic of this research is a contemporary issue, an exploratory approach was proposed for the investigative research. Taking into consideration the research topic, data availability and access, bias avoidance, reliability and verification of the responses multiple methods were chosen.

The choice of the questionnaire survey as the main research strategy was due to lack of the required information to conduct this research. The

questionnaire survey in such circumstances was considered the most suitable method to collect the data required. The use of other multiple sources of evidence is to improve the validity and reliability of the research.

The development of the Libyan upstream oil and gas industry regulations is discussed in the next chapter.

## **Chapter Five**

### **Development of Libyan Petroleum Exploration and Production (E&P) and Related Regulations**

#### ***5.1 Introduction***

This chapter reviews the history of the Libyan oil and gas industry with concentration on the relevant laws and regulations. It introduces the legislation that allows exploration and production of petroleum in the country and how these regulations have been changed. The chapter also presents the structure of the Libyan petroleum industry and its development to the current position of being completely owned and controlled by the Libyan government via its LNOC. The environmental regulations related to the oil and gas industry are discussed. Finally, the effects of the UN and US sanctions on this sensitive industry are also reviewed in this chapter.

#### ***5.2 Development of Libyan Petroleum E&P Laws***

The history of the Libyan petroleum activities started soon after the country's independence in 1951. The country at that time was extremely poor and lacked almost all components such as finance resources, management skills, health services and education to build a modern country. The easiest way to exploit oil resources, therefore, was to encourage international companies to search for oil especially following exploration activities in Egypt and the discovery of petroleum in Algeria (both neighbouring countries).

##### **5.2.1 Minerals Law**

Only two years after Libya's independence in 1951 the Minerals Law was issued on 5<sup>th</sup> of September. It was the first step towards regulating the exploration and exploitation of Libya's natural resources. The law clearly

declared that all sub-surface minerals in the country were state property. Minerals Law permitted the allocation of preliminary prospecting permits to foreign oil companies. The law also clarified that the word “*mineral*” means all materials that have economic value and are part of the Libyan land including oil and natural gas (Law No 9, 1953). The law did not permit drilling. Drilling operations were deferred until the government issued “*Petroleum Law*” and considered the reaction of the oil companies to it. At the same time the government expressed its willingness to issue licenses to oil companies for petroleum exploration in the country.

### **5.2.2 The Law and International Oil Companies**

International oil companies (IOCs) were totally controlling the petroleum industry and prices and clearly priced the oil in their favour. Moreover, the UK monopolised the Iranian oil industry. This caused a crisis between the petroleum producing countries especially Venezuela, Iran and Saudi Arabia and the IOCs. According to Ghanem (1985):

*“IOCs accepted the sharing of profits with the producer countries according to the UK and US consortium convention”.*

The government aimed by this law (Law No 9, 1953) to attract the IOCs to the country to search for oil. The negotiations about drilling and development operations were left until the results of the initial exploration and the end of that crisis.

Soon after the minerals law, nine IOCs gained permissions to search for oil. These companies were:

1. Canadian Mobile Oil- Libyan branch;
2. Standard Oil of New Jersey;
3. Shell Oil Company;
4. Total Oil Company (France);
5. British Petroleum;

6. American Oil Company;
7. Oasis Oil Libya;
8. Nelson Bunker Hunt; and
9. American Libyan Oil Company.

Minerals law lasted for only two years. Meanwhile, the government was preparing new petroleum legislation to govern oil exploration and production in the country. IOCs at that time were controlling the petroleum industry worldwide.

#### ***5.2.2.1 Preparation of the Petroleum Law***

Libya was in a very difficult situation economically, politically and in terms of government management. Politically, the country has three regional governments and one central government and natural resources were shared accordingly. Economically, the country was very poor with a very high level of unemployment and its management was very weak. Gurney (1996) mentioned that:

*“Some 90 per cent of Libyan people were illiterate and lived on a subsistence level with an estimated per capita income of \$35 per annum. Of the handful of university graduates, none were doctors”.*

Petroleum industry facilities were severely weak or not existent. This situation was taken into consideration so the terms and conditions were made very flexible to attract foreign oil companies (Ghanem, 1985). Therefore, IOCs in the country were consulted about the new law in order to know their opinions as they were requested to give written feedback. Several meetings were organised between Libyan policy-makers and representatives from the IOCs in the country and all opinions were considered in the final draft of the law.



### 5.2.3 Petroleum Law

Laws and regulations which include economic, legal, financial and technical aspects of upstream petroleum activities are essential documents in the oil and gas business. They define the relationship between host governments and oil companies which are mostly multinational. The scope of any petroleum legal system therefore, should be comprehensive in order to cover all issues related to the upstream operations.

The Libyan Petroleum Law No. 25, which replaced the Minerals Law, was issued in April 1955. It was the first legislative framework for the Libyan petroleum industry to control the relationship between the government and the oil companies. Hallett (2002) acknowledged that the law established the rules under which concessions could be awarded. Cattani (1967) also agreed that:

*“Libyan Petroleum Law was considered the first integral petroleum legislative in the Middle East”.*

The intention of the drafters of the law was to encourage an open-door policy in regard to exploration and develop a competitive attitude between companies.

In the first article, the law confirmed the possessing of the petroleum in its natural state in the sub-surface of Libyan land as stated in the Minerals Law. Article one also made it clear that no body is allowed to survey, search or drill for it without permission. Almost all countries in the world use this principle except the US which considers the owner of the land is the owner of the sub-surface of this land unless otherwise stated in any contracts or conventions. Therefore, in the US any minerals which are discovered in the land including petroleum are owned by the land owner.

### **5.2.3.1 *Petroleum Law and the Environment***

Petroleum laws rarely impose detailed requirements for environmental control programmes; they do provide the framework for subordinate regulations incorporating, for example, a requirement to prepare environmental assessment plans for waste disposal and control of emissions and discharges, preparation of emergency plans and control of hazardous substances. In fact, this was not the case in the Libyan Petroleum Law. The word “*Environment*” was not mentioned in the Petroleum Law and the law did not consider these issues in detail.

However, this may be attributed to many reasons:

- The impacts of the operations were far less than now as, for example, new wells produce less associated water than old wells;
- The materials that were used in drilling operations did not contain the same components as the current materials which contain very complex chemicals with highly poisonous components;
- Drilling operations were conducted in the desert so their impacts did not directly affect the public;
- The impacts on the environment and on human health did not have priority; and
- Worldwide, environmental issues at that time (1950s) were not fully recognised.

In fact, article nineteen in schedule number two of the Petroleum Law, states that the operating company must prepare proper instruments for liquid wastes such as produced water and used oil and restore the site before leaving, according to the standards that are used in the oilfields. There is no mention of gas emissions or control.

The environmental issues were not considered in the Law nor in its amendments in May 1955, July 1961, and November 1961, 1962, 1963,

1965 and 1968. The exception to that is article nineteen in schedule number two as mentioned above, which did not directly relate to the environment. This clearly means that the environmental issues at that time seemed to be completely neglected.

### **5.2.3.2 Petroleum Sections**

Petroleum law divided Libyan territory into four petroleum zones.

1. Tripolitania zone;
2. Cyrenaica zone north of the latitude 28;
3. Cyrenaica zone south of latitude 28; and
4. Fezzan zone.

Each zone carried different rental charges and work commitments. The reconnaissance operations were concentrated on the north east which was the most favorable area, and adjacent to the Algerian border where exploration operations by French companies were very active.

### **5.2.4 First Oil Discovery**

The government of the new kingdom gave every encouragement to overseas oil companies to come and explore for and obtain oil from Libya in terms highly attractive to the companies. Therefore, as *Waddams (1980)* put it:

*“the Minerals Law of 1953, granting survey and exploration facilities, was passed less than two years after independence, and the Petroleum Law of 1955 within four years”*

Thus, the history of exploration operations in the country started in 1953 after oil was discovered in neighbouring Algeria. The first well was drilled on 30<sup>th</sup> of April in 1956 in the concession number 18 petroleum section number two. Despite of the fact that well was dry, it was the beginning of the drilling operation and the first oil was struck in September 1957 from the well number (b2-1) in the petroleum section number four but not with commercial quantities according to Ghanem (1985).

Two concessions were awarded on 20<sup>th</sup> of November 1955. The first concession was awarded to Esso in the first petroleum section with a total area of 20,788 square km adjacent to the Algerian border where Esso discovered the first oil well in the country on 6<sup>th</sup> of January 1958 with production rate of 508 barrels per day (Ghanem 1985).

The second concession was awarded to Nelson Bunker Hunt in northern Cyrenaica with a total area of 11357 square km. After that many other concessions were awarded to many other oil companies (ibid). Thus, in the first decade of petroleum production in Libya, newcomers to the world international oil were given access to exploration and production. All of the *seven sisters*\* were granted concessions in Libya. The history of Libyan petroleum E&P shows that Esso Oil Company, which is one of them was the first discovering and exporting Libyan oil.

In addition to the seven sisters the open door policy allowed any capable oil company to gain concessions and many independent oil companies were awarded concessions. According to Blair (1977) the Libyan former Prime Minister, Mustaba Halim said concessions were awarded in such a way as to avoid making the country overly dependent on the seven sisters. Halim added; I did not want my country to be in the hands of one oil company. However,

*“In July 1968, the Idris government announced that it would not make any more concession agreements and that all new acreage would be awarded within the framework of joint ventures with LIPETCO”* (Gurney, 1996).

### 5.2.5 Exporting Libyan Oil

The most important oil discovery in the oil industry of the country was the fifth oil discovery achieved by Esso in the Zalten field (Petroleum Section No: 2) on 13<sup>th</sup> June 1959 with production rate of 17,500 barrels per day.

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\* American & European Consortium of Seven Giant Oil Companies

Accordingly Libya entered the petroleum production club (Gurney 1996). On 12<sup>th</sup> of September 1961 the first oil shipment was deported from Al Brayqah Oil Seaport.

Many important oil discoveries were made subsequently. Shortly after the first oil was exported by Esso in 1961, the number of companies who exported Libyan oil increased and in 1965 twelve oil companies were exporting oil. By 1965 Libya was producing more than one million barrels per day. Table 11 shows oil production from 1961 to 1965.

Year	Daily production Thousand barrels	Yearly production Thousand barrels
1961	18.3	6.642
1962	183.9	67.133
1963	463.6	169.235
1964	864.7	315.622
1965	1.220,2	445.374

**Table 11: Libyan oil production from 1961-1965 (Ghanem, 1985).**

Table 12 shows a comparison between Libyan oil production and some other important producers from 1961 to 1965.

Country	Date of first production	1961	1962	1963	1964	1965
Abo-Dabi	1962	-	14,20	48,2	186,8	282
Algeria	1958	330,-	436,9	504,-	557,8	558,7
Indonesia	1893	424,3	453,4	444,-	456,-	480,6
Iran	1913	1202,2	1334,5	1491,3	1710,7	1908,3
Iraq	1928	1007,-	1009,2	1161,9	1255,2	1312,6
Kuwait	1946	1735,-	1957,8	2096,3	2301,-	2360,3
Libya	1961	18,2	182,3	441,8	862,4	1218,8
Nigeria	1958	46,-	67,5	76,5	120,2	274,2
Qatar	1949	177,2	186,2	191,5	215,3	232,6
Saudi Arabia	1938	1480,1	1642,9	1786,-	1897,-	2206,-
Venezuela	1917	2919,9	3199,8	3247,9	3392,8	3472,9

**Table 12: Comparison between Libyan oil production and some other important producers from 1961 to 1965 (Ghanem, 1985).**

### 5.2.6 Quality of Libyan Oil

Libyan oil is distinguished by two main features from oil produced in the Middle East and Africa:

1. Its proximity to the market ( Europe and the US); and
2. Its quality; Libyan oil contains low sulphur which means better quality especially after increasing environmental concern as importing countries standardised the level of sulphur allowed in the industry.

Table 13 shows the sulphur content of Libyan crude oil comparing with the same element in the crude oil of the Middle East producers and the cost of reducing the sulphur percentage of the same countries to the level of percentage of sulphur in the Libyan oil according to a study conducted in 1968 (Ghanem, 1975).

Country	Sulphur %	The cost of reducing the Sulphur % to the Libyan oil level in US \$
Libya	%0.45	—
Kuwait	%2,48	31,6
Saudi Arabia	%1,60	25,1
Iran	%1,40	19,4
Iraq	%1,95	28,2
Qatar	%1,05	18.7

**Table 13: The percent of Sulphur in Libyan oil compared with Middle East exporting countries (Ghanem, 1975; 1985).**

### 5.2.7 Libyan Gas Production

Libya also has vast natural gas reserves and is looking to increase its gas exports, particularly to Europe. Proven reserves in 2003 are estimated at 46.4 Trillion cubic feet (Tcf), but the country's actual gas reserves are largely unexploited and unexplored, and thought by Libyan experts to be

considerably larger, possibly 70-100 Tcf. Continued expansion of natural gas production remains a high priority and this is to be achieved in two main ways. First, there is a policy to use natural gas instead of oil domestically to free up more oil for export. Second, there is a policy of gas production expansion, along with increased marketing and distribution in which Libya is looking to foreign participation and investment.

Table 14 show the gas production, used (domestic or exports abroad) and flared for the period from 1999 to 2003 (In billions of cubic feet).

	1999	2000	2001	2002	2003
Gas produced	486	490	484	464	494
Gas Used	371	388	406	391	365
Gas Flared	115	102	78	73	128

Table 14: IMF 2005

In recent years, large new discoveries have been made in the Ghadames and el-Bouri fields, as well as in the Sirte basin. Libya also produces a small amount of liquefied petroleum gas (LPG), most of which is consumed by domestic refineries.

### ***5.3 Changing the Petroleum Policy in Libya***

The overthrow of King Idris in 1969 due to the September revolution led to the establishment of the revolutionary government under Colonel Qaddafi.

As one author put it,

*“The result was the strongest political action by a single oil-producing country against the oil companies to which it had granted concessions since Mexico’s nationalisation of its oil in 1938”* (Odell, 1986).

The new government told the representatives of the oil companies that Libyan oil was priced too low in relation to its production cost. Libya’s oil industry now is run by the state-owned National Oil Corporation (LNOC),

along with smaller subsidiary companies, which together account for around half of the country's oil output. Several IOCs are engaged in exploration/production agreements with LNOC. The leading foreign oil producer in Libya is Italy's Agip-Eni, which has been operating in the country since 1959.

### **5.3.1 New form of Contracts**

Libya has changed its contracting system with the foreign oil companies as a new form of contracting was applied. In July 1973, the Libyan government issued a decree announcing that all future arrangements with foreign oil companies would be in the form of production-sharing agreements (Gurney, 1996).

Since then, petroleum rights have been granted under a series of Exploration and Production Sharing Agreements (EPSA). In 1974, the government announced that it would not make any more concession agreements and that all new acreage would be awarded within the framework of EPSA with the responsible state body for petroleum activities. In this way, EPSA was designed to give more control powers to the Libyan Government in the conduct of petroleum operations.

### **5.3.2 New Petroleum Law under Development**

Currently, Libya is considering changing the 43-years old hydrocarbon legislation to improve terms for foreign investment as a new draft of Petroleum Law is now prepared. When this draft is formally issued, it will replace the existing Petroleum Law. It will deal with all aspects of the petroleum upstream and downstream industry including environmental issues. The Law is taking advantage of past experience and the evolution of the modern development of this industry and its impacts on the surrounding environment. Abdulhafid Alzlitnei the chairman of LNOC (2002) said the draft law is now in the process of revision, passing several legal and technical tests, and then it will be presented to the Legislative



Congress. The Law must be approved from the “General People’s Congress” the responsible body issuing laws in the country.

#### ***5.4 Management Hierarchy of the Libyan Petroleum Industry***

The management structure of the petroleum industry of the petroleum producing countries varies from country to country. Most developing countries have national petroleum organisations. These national organisations are controlling the oil and gas industry sector and responsible for its planning and policies. These organisations usually work through their affiliates or sharing with foreign oil companies.

Despite the fact that Libya has had an established national oil corporation for more than thirty years, the managerial hierarchy of its petroleum industry is considered inconstant due to creating, dissolving and restoring the Ministry of Energy to be responsible and oversee the petroleum industry sector. For example, Zaslavsky (2006) noticed that the high rank of the Libyan hierarchy has seen regular reshuffles as ministries were created and dissolved (e.g. the Energy Ministry was dissolved in 2000 and re-established in 2004) and the most recent government reshuffle came in march 2006 where the Energy Ministry was abolished only two years after it was reinstated. Thus, the managerial hierarchy of the petroleum industry experienced some conflict of power. In fact, the National Oil Corporation (LNOC) has been the most powerful institution during that conflict. LNOC is now the only controlling and managing body to the petroleum industry, which is the lifeblood of the Libya’s economy. Otman (2006) argued that: the conflict of power between the LNOC and the Ministry of Energy led to unwanted consequence as the LNOC existed pre sanction era as a massive organisation. He thought that LNOC is not inefficient and unprofitable, and seems to lack accountability.

### **5.4.1 Libyan National Oil Corporation (LNOC)**

In April 1968, the government established the Libyan General Petroleum Corporation (LIPETCO). Its functions at that time included the negotiation and supervision of oil concession agreements. LIPETCO negotiated four agreements during the next 2 years. On the 5th March 1970, LIPETCO was replaced by the Libyan National Oil Corporation (LNOC). LNOC therefore, is a state-owned integrated oil company. It now controls Libya's petroleum industry.

The General Secretariat of the General People's Congress (Libyan Parliament) reorganised the LNOC later under Decision No: 10/1979, to undertake the realisation of the objectives of the development plan in the areas of petroleum. It is responsible for developing and exploiting the oil reserves and operating and investing in those reserves, to realise optimum returns. It has upstream as well as downstream activities. LNOC operates through its affiliates and with Exploration and Production Sharing Agreements (EPSA) with foreign oil companies which are active in various areas of the oil industry, lubricant base oil production and in the petrochemicals sector. There have been four exploration and production sharing agreements issued. EPSAs remain the model contract in use until now.

### **5.4.2 LNOC Affiliates and Sharing Companies**

LNOC subsidiaries are: Arabian Gulf Oil Company, Sirte Oil Company for Production and Manufacturing of Oil & Gas, Waha Oil Company, Azzawiya Oil Refining Company, Ras Lanuf Oil & Gas Processing, National Oil Wells Drilling & Workover Company, Jowef Oil Technology, Hamada Pipe Line Company, Umm Al Jawaby Oil Company, Zueitina Oil Company, National Oil Fields & Terminals Catering Company, Brega Oil Marketing Company, Specific Training Centre of Petroleum Industrial and Libyan Petroleum Institute.

The foreign companies who operate in the country either by Joint Venture (JV) or Exploration and Production Sharing Agreements (EPSA) are: AGIP (Azienda Generale Italiana Petrli), Veba Oil Company, Wintershall Oil Company, Aquitaine Oil Company, Total Oil Company, O.M.V Oil Company and Repsol Oil Company.

### ***5.5 Sanctions and the Petroleum Industry***

On April 15, 1992, U.N. Security Council Resolution 748 imposed economic sanctions against Libya. Before the UN sanctions were imposed, the US had imposed its own sanctions against the Libyan petroleum industry and had already withdrawn its oil companies from Libya. The sanctions badly affected the country's petroleum sector development. Access to oil industry equipment and technology was restricted and Libya is reliant on foreign investment to keep the industry active. American companies withdrew from the Libyan oil upstream industry as a result of the sanctions imposed by the U.S in 1982. In 1986, five remaining American companies were forced to stop their activities and pull out of Libya. During the US oil sanctions, Libya increased the number of its oil contracts with European companies in order to resist these sanctions. Thus, important exploration and production sharing Agreements (EPSAs) were signed with both European and Canadian companies. Through that, Libya was able to partly resolve the problems stemming from the sanctions and to defy the US sanctions. Despite that, the rate of oil activities of the country experienced a yearly downward trend of 7 to 8 per cent, according to the LNOC's statistics.

The UN sanctions were imposed upon the country in 1992 (relating to the Lockerbie issue). Those sanctions had serious financial consequences for the country's economy especially its oil industry as they were imposed by the UN. The Libyan oil industry endured the largest sum of financial losses. According to a Libyan report about the impact of the UN sanctions

of the period between 1992 and 1995 which was transmitted to UN Secretary General in (1996), the substantial damage caused in the humanitarian, economic and social spheres by the coercive and unjust measures taken against the Libyan Arab people under Secretary Council resolutions, 748 (1992) and 883 (1993) continues to worsen day by day. The report mentioned that the energy sector has suffered considerable material losses and negative repercussions have been felt in most the vital facilities and economic entities of the sector.

Alavi (2003) pointed out that:

*“The trend of development and progress in the areas of exploration and production were substantially damaged”.*

Moreover, the gas development to meet increase in demand domestically and the demand for export slowed down tremendously. Thus Libya's ability to increase its oil production has been hampered by the sanctions. Despite the sanctions, Libya exported more than 1 million bbl/d of crude oil during the sanction period.

However, UN sanctions were suspended in 1999 and completely lifted in 2003 after almost a decade. American sanctions were lifted on 2004.

Figure 23 shows Libyan oil production since it began in 1961 until 2003.

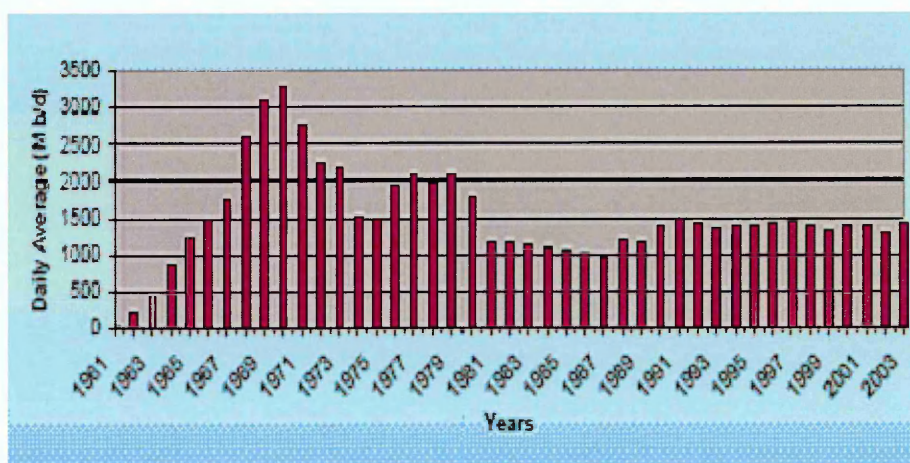


Figure 23: Libyan oil production since it began in 1961 until 2003 (LNOC)

However, in some way the Libyan oil industry has become more robust because of the sanctions, as the LNOC survived and had been producing substantial quantities of oil mainly by the available old technology and national personnel. According to the Chairman of the Liquefied natural Gas Development Agreement (LNGDA) from the LNOC, El Shahab (2007):

*“Libya’s oil and gas sector has suffered from 20 years of sanctions, but we are proud that, despite this, we have been able to maintain the country’s oil and gas production levels over the years”.*

During that period, the upstream oil and gas industry mainly depended on the national skills that became creative and experienced in such circumstances.

## **5.6 Legislation for Environmental Protection in Libya**

### **5.6.1 Environmental Regulations**

According to the Libyan political system, the laws are promulgated by the General People’s Congress (Libyan Parliament), which concludes the decision after consulting the people who are members of the local popular congresses by distributing the schedule of the issues that need to be discussed and gathering the decision from the public about these issues. Therefore, the decision should reflect the Libyan people’s attitude about the issues undertaken. The role of the General People’s Committee (the Government) is to implement these decisions and to suggest the ideal solutions to any issue according to the available resources. Therefore, The General People’s Committee is responsible in front of the General People’s Congress and regularly questioned by the General People’s Congress about its performance.

The country’s record in this regard shows that it has a considerable number of environmental legislations to protect the environment. In the

last three decades, Libya has promulgated several laws that relate to the environment directly and/or indirectly as a result of increasing awareness of the environmental implications that may arise from the vigorous pursuit of its developmental policies.

The concentration in this research is on the laws that relate directly to environmental protection. Accordingly the Environment Protection Act No 7/1982 and the Environment Protection Act No 15/2003 will be discussed. Table 15 shows all national legislations which are related to environmental protection in Libya.

<b>The Law</b>	<b>Subject</b>
Environment Protection Act No. 7 year 1982	Comprehensive Environmental Act
Environment Protection Act No. 15 year 2003	Comprehensive Environmental Act
Libyan Maritime Law 1958	Sea Collision
Law No. 62 of 1976	Amending Maritime Law
Law No. 3 year 1982	Utilisation of Water Resources
Law No. 8 year 1973	Sea Water Pollution Prevention by Oil (Derived from 1954 London Convention)
Law No. 14 year 1989	Utilisation of Marine Wealth
Law No. 13 year 1984	General Cleanliness
Health Law No.106 year 1973	Health Act & its Implementing Regulations
Law No. 15 year 1992	Protecting Agriculture Land
Law No. 15 year 1989	Protecting Animals and trees
Law No. 5 year 1982 Amended 1992	Protecting forests and Grazing Areas
Law No. 81 year 1971	Concerning Seaports
Law No. 2 year 1982	Concerning Protection from Ionising Radiation
Law No. 2 year 1971	Concerning Mines and Quarries
Law No. 3 year 1995	Protection of Antiquities
Law No. 55 year 1955	Petroleum Law

**Table 15: Laws Related to Environmental Protection in Libya**

### **5.6.1.1 Legislative Act.No.7 of 1982 Concerning Protection of the Environment**

This was the first comprehensive legislative act in the country to protect the environment. The aim of this act is stated in article 2,

*“The aim of the Act is to ensure that the habitat of man and all living creatures, including the air, water, soil and food, is protected from pollution, and to find appropriate ways of measuring such pollution with a view to the formulation of general plans and programmes to curb environmental pollution”.*

Although this law was issued in 1982, its executive regulation was issued in 1999, after about seventeen years from the issue of the Act. However, it can be understood from the long period between the issue of the Act and its executive regulation, that the Act was not implemented immediately, especially since these kind of laws are usually explained by an executive regulation to illustrate the Act's articles.

The law was considered an advance step as it was comprehensive and generally it covered most of the environmental aspects that are known in the country. This includes air pollution, land contamination, solid waste, sea water protection from oil, and ground water.

However, the law did not dedicate particular space to the environmental aspects of oil and gas exploration and development as Libya is a petroleum producing country and has been under huge exploration and development of petroleum projects by national and international companies. The law did not refer to how to manage poisonous and dangerous waste under technical conditions and controls, especially as these kinds of waste are usually generated by the oil and gas industry operations. A few years after the issue of its executive regulation in 1999, the law was replaced by new environmental protection law No. 15 in 2003.

### ***5.6.1.2 Legislative Act.No.15 of 2003 Concerning Protection of the Environment***

This is the current comprehensive environmental protection act in Libya which built on and replaced the law No. 7/1982. The executive regulation of this law is still under preparation. The law is dedicated to protect and improve the environment. It comprises eleven chapters with seventy nine articles and the following is a summary of the important issues in this act: Chapter one contains general provisions starting in article one by definition of some used terms such as the environment, pollutants and sustainable development. It also explains the purpose of the Act which is the same as the Act 7/1982 and calls for sustainable development to exploit and use the natural resources properly. Therefore, it calls on all public and private, local and foreign companies, institutions and individuals to do their best to stop the pollution phenomena and clear any pollution that they cause. Article six, seven and eight of this chapter give the Environment General Authority (EGA) powers to monitor and improve the state of the environment.

Chapter Two in the law is dedicated to air pollution. Article one of this chapter states that it is not allowed for any factory or institution to emit any pollutants to the air in contrast to the implemented standards according to this law. This also includes vessels in Libyan seaports and prevents these vessels from emitting any dust, heavy or light oil or any other pollutants.

Chapter Three which contains 21 articles is dedicated for marine and marine wealth protection pointing to the necessary means and procedures for the protection of fish stock, banning throwing oils and other pollutants from vessels to the sea and the discharge of sewage and industrial water, explosives, radioactive and other harmful substances.



Chapter Four includes nine articles about the protection of water sources. It is noticeable that this chapter left important details to the executive regulation to deal with the water resource pollution issues.

Chapter Five comprises three articles about the protection of food and nutrition materials. The law emphasises monitoring of the effect of pesticides on plants including vegetables and fruits to limit poison levels.

Chapter Six is dedicated to environmental development. This chapter includes one article which has twenty six general points to improve the environment where the public communities live. It is important to note, however, that these points cannot be implemented unless put in an applicable manner to determine the cause, the effect and the penalty.

Chapter Seven includes several points about protection from common diseases to prevent these diseases being transmitted from animals to humans.

Chapter Eight is about the protection of soil and plants to increase the area of agriculture and grazing and to prevent soil erosion.

Chapter Nine is about wildlife and birds. The law talks about locating national preserved areas for wildlife animals and organising hunting.

Chapter ten is about genetic modification. The law considers that genetically modified breeds are dangerous to the environment and its natural resources and prevents their import and use.

Finally chapter eleven is dedicated to the penalties. This law contains the penalties for the direct offences to the environment. The law left some

complex issues and their penalties to the executive regulation, which is under preparation, as mentioned earlier, to complement this law.

No doubt this Act has the advantage from the past experience of the previous law to improve environmental legislation. The current environment protection law No15 which was issued in 2003 therefore, avoided the weaknesses and the shortcomings of the old environment protection law No 7 which had been issued in 1982. The executive regulation of this new law, which is now under preparation, is subject to feedback from many interested parties including the oil and gas sector.

#### ***5.6.1.3 Law No. 13 of 1984 on public cleaning***

This law is mainly about household waste. However, chapter one of this law applies to all residents in the country, corporations, institutions, or companies, which are prohibited from dumping waste outside the designated places, or exposed burning, and to dispose of waste in defined technical ways.

### ***5.7 Conclusion***

In this chapter the history of Libyan petroleum development since its beginning is introduced. This includes all petroleum Laws and regulations which allowed searching for and exploiting mineral resources in the country. The country's circumstances in which these laws were enacted are explained. Libya at that time was one of the poorest countries and had just gained its independence. The role and effect of the foreign oil companies in formatting the early petroleum law is investigated. The foreign companies played a vital role in enacting the early petroleum laws. The development of Libya as an oil producing country is described.

Changing Libyan petroleum policy after the September revolution 1969 is also discussed where the form of contracting was changed. A new form of

Exploration and Production Sharing Agreements (EPSA) with the foreign oil companies was used instead of the concession system. This enhanced the country's share in its natural resources and increased the country's revenue from its petroleum production.

The effect of sanctions on the production of the petroleum is also described in this chapter as the sanctions caused serious reduction of production of oil in the country. The sanctions badly affected the petroleum industry's development which depended on foreign advanced technology and investment. The environmental regulations and laws are presented in this chapter with concentration on the main environmental legislations. The review of these regulations includes their purposes and elaboration of their articles. These laws are the cornerstone of the environmental framework of the Libyan environmental management approach which will be discussed in the next chapter.

## **Chapter Six**

# **The Current Approach to Environmental Management in Libya**

### **6.1 Introduction**

In general, developing countries are usually suffering from clouds of political uncertainty. Environmental concern in some developing countries is also still weak at governmental, non-governmental and public levels. Libya is a developing country that shares some of the common problems of these countries, such as uncertainty about laws and regulations, poor institution management, non-compliance with and improper implementation of the regulations, bad communication systems and banking services, and external political problems. In fact, this situation seems now to be changing and improving. This is due to the resolution of external political disputes and internal reform.

Libya has had rapid economic growth in the last three decades, but concern about environmental issues is still not being voiced by an environmental movement. The country still lacks strong environmental institutions capable of formulating and implementing effective environmental policy.

Environmental management, a term used in this research to describe a more environmentally responsible and encompassing approach to oil and gas industry decisions and activities, requires a number of conditions to fulfil its potential. In broad terms, environmental management can be viewed as an organisational change process (Roome, 1992; Post & Altman, 1994, 1998; & Jorgensen, 2000).

This chapter is dedicated to investigating the current environmental approach in Libya in the light of the environmental regulations and their implementation. The Libyan approach to environmental management is discussed under four main headlines: firstly, the shortcomings of the environmental regulatory framework are determined: secondly, the effectiveness of the responsible environmental bodies is investigated: thirdly, the training efforts are explained and finally, the level of environmental awareness is discussed.

## **6.2 *Libyan Environmental Regulatory Framework***

In the previous chapter, all related Libyan environmental regulations were covered with special reference to the most important laws relevant to environmental management and control of the oil and gas industry's impacts.

Environmental regulation may be the main driver of managerial action to deal with environmental concerns. Henriques & Sadorsky (1996) demonstrated that government regulation does represent the single most important source of pressure on firms to consider environmental issues. Hutchinson (1996) stated that environmental regulations have been the single most important driver of environmental strategies. However, environmental regulations mainly deal with issues such as air and sea pollution, land and groundwater contamination and landfill waste, which usually do not receive adequate attention in many developing countries.

Bell & Russell (2002) mentioned that, while most developing countries have long established laws and formal governmental structures to deal with their environmental problems, only a few of them have been successful in alleviating those problems:

*“Developing-world regulators, already marginalised in their own countries, will have little to show for their efforts in terms of a cleaner environment”.* (Bell & Russell, 2002).

Some of these countries have, as asserted by UNCTAD (1998), far fewer restrictive regulations or none at all:

*“In developing countries the lack of appropriate institutions capable of effectively enforcing environmental legislation is of paramount importance”. (United Nations Conference on Trade and Development, 1998).*

Thus, in developing countries where the regulatory mechanisms are relatively weaker it is apparent that multinational companies in the extractive industry usually have a harmful effect on the environment and the local community. Thus, the host country usually lacks the capacity or the political will and, therefore, incapable to effectively regulate the huge Multinational Companies (MNCs) in order to protect the environment and the local population (Mujih, 2008). However, Libya is one of the earliest African countries that adopted environmental legislation as UNEP/UNDP/ DUTCH (1999) acknowledged that:

*“Libya was the very first African country to adopt framework legislation on environmental management, when in 1982; it enacted a legislation concerning protection of the environment”.*

Surprisingly, a review of the relevant literature has confirmed that Libya is poorly represented in environmental management literature especially with regards to the upstream oil and gas industry. Environmental regulations, therefore, have existed in Libya since the issue of Environmental Law No 7 of 1982. However, the executive regulation to illustrate the law's articles was issued only on 1999. The law was replaced in 2003 and the executive regulation for its illustration is still under preparation. This indicated that the environmental regulations contain general outlines only and are now under development to be more clear and precise and in turn more applicable (see Chapter 5 for the environmental regulations).

In fact, four interdependent evolving elements form the regulatory cycle to any governmental effort to protect the environment (Figure 24). These

elements are: legislation and standard setting, permitting, implementing (including monitoring) and compliance enforcement, (UNEP, 1992). Each of these elements needs to be continuously evaluated and the lessons learned from the evaluation need to be fed back into the decision-making process. Accordingly, any necessary modification to legislation, permitting, implementing or enforcement systems can be made.

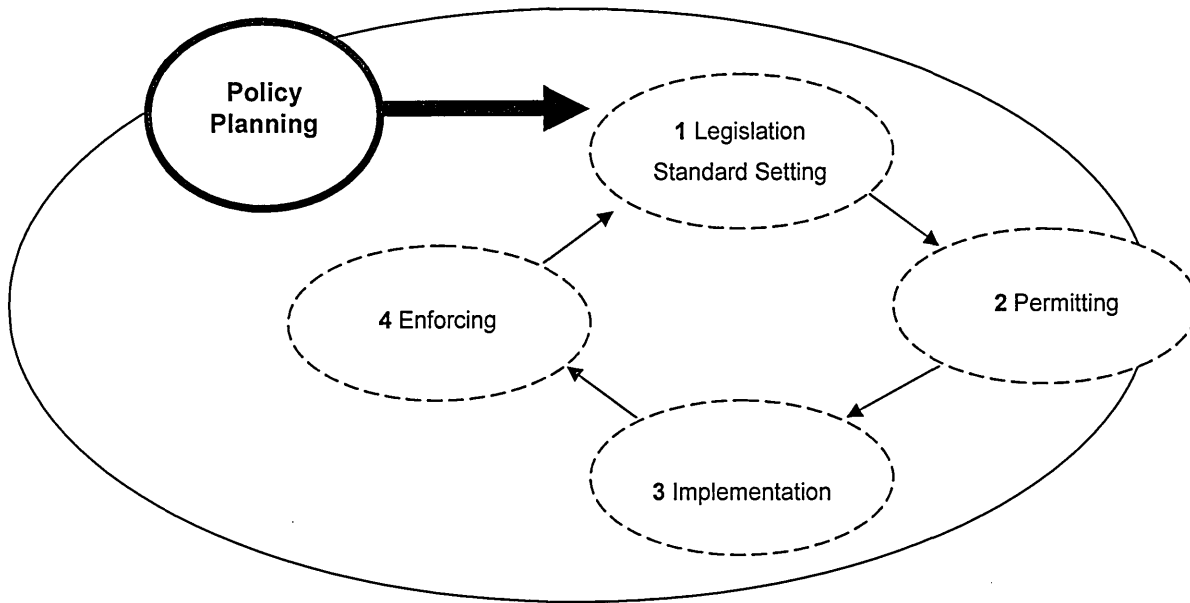


Figure 24 Regulatory Cycle (UNEP, 1992)

However, Libyan regulations have been reviewed and improved as in 2003 when the new environmental act replaced the previous one as explained earlier. Unfortunately, this improvement was not a result of evaluating the regulatory cycle's elements and improving them as the other elements have not seen visible improvement. In the oil and gas sector, compliance with and implementation of environmental regulations have been improving only since 2003 when the LNOC created its environmental department and asked its affiliates to improve the sector's environmental performance.

### 6.2.1 Weak Compliance with and Enforcement of the Existing Regulations

Priyadarshini & Gupta (2003) like many others believe that:

*“Though environmental laws are in place, firms display a very low level of compliance in developing countries”.*

Despite the legislative improvement, the real challenge of Libyan environmental legislations in general and the new law in particular, is implementation. The current enforcement of and compliance with environmental legislation is very poor. This in turn reflects inefficient environmental performance. As Jha & Whalley (1999) stated, the environmental regime in developing countries is characterised by policy measures which frequently exhibit lax enforcement.

Generally, there are three major problems related to enforcement:

1. Society does not tend to consider breaking the law as reprehensible; therefore, the law is not fully respected;
2. The people do not tend to report infractions against the environment; and
3. The enforcement institutions face problems mainly related to management.

These problems are due to several reasons; some of them are:

1. The public sector is usually unsuccessful especially in management issues compared with the private sector;
2. The generally low level of environmental awareness and concern in all segments of society;
3. The managerial culture which has prevailed in the last three decades as a result of the implementation of a public management system in Libya negatively affected the management system in the country; and



4. Uncertainty in the direction of local affairs at personnel and institutional levels.

However, the country has recently been experiencing significant development of its oil and gas industry. The environmental concern associated with this development is also increasing. This is reflected in the establishment of the environmental department of the LNOC which will be responsible for the implementation of the related environmental regulations. The main aim of this new department is to tackle the environmental impacts of this important industry by setting goals and establishing plans to comply with the environmental laws and legislation.

Proper implementation of the regulations will lead to better environmental performance and will demonstrate how effective the regulations are, expose any weaknesses and enable them to be amended.

### **6.2.2 Weak Environmental Policies and Management Systems**

It has become a requirement for the industry or any other business to set up management systems to meet their increasingly heavy burden of responsibility for the future condition of the world as Sheldon & Yoxon (2002) thought:

*“At the strategic level, management systems both formal and informal are simple things. They are mechanisms for moving information around inside an organisation in order to facilitate a better quality of decision making”.*

The introduction of an environmental management system (EMS) can reduce both costs and environmental liability. As Welford (1996) pointed out:

*“Inadequate management systems have been the cause of environmental damage and have cost firms and organisations heavily in terms of clean-up costs and damaged reputations”*  
(Welford, 1996).

This would suggest that EMS should be adopted by the organisations for both the environment and for their own benefit and that environmental management systems are crucial to any practical and workable environmental framework. However, a brief summary of the EMS is introduced in Appendix 1 as it is not the purpose of this research to address the EMS.

In fact, environmental management systems are not present in some important companies operating in the Libyan oil and gas industry. For example, one of the biggest oil companies in the country does not have any written environmental policy or any environmental management system at the time of the fieldwork which was conducted during the summer of 2006. Thus,

*“One of the characteristics of many organisations is that environmental management has not been integrated throughout the organisational structure” (Anthony, 2002).*

ISO14001 is the only system that a few companies are trying to implement in some and not all of their industry sites. Furthermore, even the companies that have a written environmental policy and environmental management system do not implement these policies and systems on the ground.

To succeed in implementing a successful environmental management system, the literature suggests the importance for members of the organisation of understanding the environmental impacts and policies of the organisation through participation in environmental initiatives.

### **6.3 Effectiveness of the Environmental Governance Bodies**

The environmental governance bodies in the country are few and in general do not have constant hierarchy managerial structure. For

example, the Environment General Authority (EGA) which is the most important environmental monitoring body in the country lost its independence and has now become part of the government following its merger with the Health Ministry.

Environmental departments in the oil and gas industry lack skills and facilities as they have been recently established and are still understaffed (see 6.3.2). The EGA is also suffering from lack of skills and facilities as will be seen later from Mosrata's seaport accident. However, the last four years have witnessed increasing concern for improving the environmental performance in the oil and gas industry.

### **6.3.1 Environment General Authority (EGA)**

The Environment General Authority (EGA) was established in Libya in 2000 according to the resolution of the General People's Committee (No. 263) of 1999 to replace the Technical Centre for Environmental Protection which had been established in 1984. EGA is the national environmental protection responsible body. It has nine regional branches. The EGA is an executive tool for the enforcement of the environmental laws and legislations. Its duty is to follow scientific process in the environmental field to monitor the implementation of the environmental laws. The EGA has been given sufficient power to enforce these laws and legislations in a manner defined by law and required for public interest, in coordination with all relevant parties to protect the environment.

Although the Legislative Act No 15/2003 gave the EGA huge authority and sufficient power to enforce the environmental legislations, the EGA is still not strong enough in practice to face institutes such as the LNOC which has a very strong position due to its importance to the country's economy.

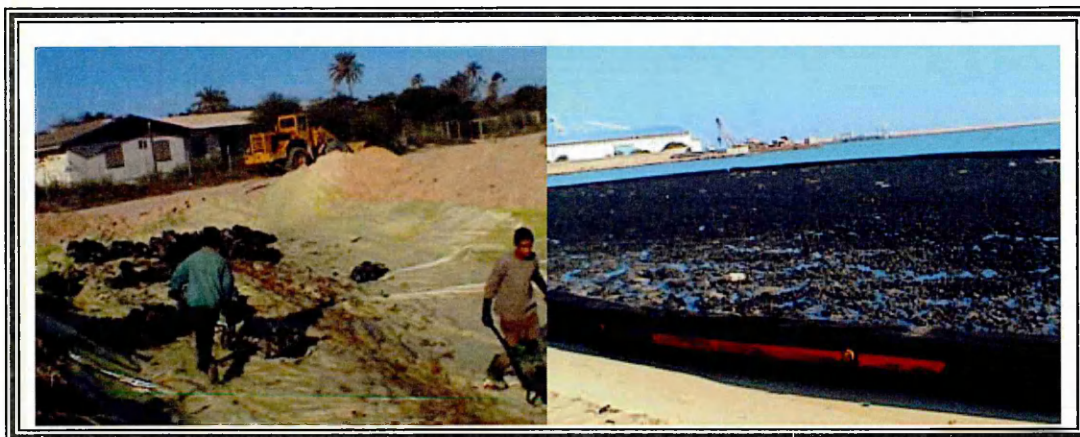
The EGA has witnessed significant improvement in the last three years and has become far more active than ever before. EGA is now more organised and performs its duties through the implementation of plans and policies rather than reacts to the accidents. During the fieldwork in the summer of 2006, the researcher briefly met Abdul Hakim Alwaer the head of the EGA, who said:

*“We agreed with the LNOC that by the end of the year 2007 all operating oil and gas companies in the country must be EMS; ISO 14001 certified”.*

However, unfortunately this is not achieved despite the efforts of the EGA to implement the environmental regulations.

Despite its improvement, the EGA still lacks experts, equipment and other resources. Mosrata’s seaport accident is a good example for both the improvement of the EGA in implementing the environmental regulations and the lack of facilities and skills. In that accident about 200 cubic metres of fuel oil spilled from a shipment tanker on 26/01/2006 (EGA, 2007).

The EGA dealt properly with the accident and charged the owner of the shipment tanker who paid the penalty that was stated in the regulations. The accident also reflected the lack of facilities to face such emergencies. Traditional methods and simple equipment were used to isolate and remove the heavy oil from the sea, as can be seen in Figure 25. Despite the shortage of facilities, the team who dealt with that accident performed quickly and effectively to remove the polluted materials.



**Figure 25: Oil spill isolated and moved by traditional methods and simple equipments in Mosrata seaport (EGA, 2007)**

This example illustrates how the EGA is currently trying to fulfil its role and it has taken important steps on this track. However, the EGA was integrated with the Ministry of Health in March 2006 and this may negatively affect its performance as it lost its independence in setting and achieving its targets.

### **6.3.2 Environmental Protection Department of the LNOC**

The LNOC, which is the driver of both upstream and downstream oil and gas industry, established its Environmental Protection Department in 2002. This was partly due to the recognition of the need to improve the environmental performance of the oil and gas industry sector during a period of significant development. The LNOC also ordered or recommended its affiliates to establish environmental protection departments. Benrageb (2005), the head of the Environment Protection Department of LNOC stated that:

*“With the opening up of Libya’s enormous oil and gas potential to foreign investment and joint ventures, the LNOC established the Environmental Protection Department three years ago in order to provide adequate safeguards for the environment and promote best practice among companies operating in Libya. Our role is to contact these companies directly and provide whatever advice and assistance is*

*necessary so that they can comply with Libya's environmental law and standards".*

This clearly reflects the recent increase in the importance of environmental issues to the LNOC. This might also suggest that, before the establishment of the environmental protection department, environmental issues were either neglected or at least not properly considered.

However, since the establishment of the Environment Protection Department of LNOC, international oil companies coming into Libya are required to carry out a baseline environmental survey of the areas where they will be operating according to Benrageb (2005), and measures necessary to protect any environmentally sensitive areas or any archaeological sites within the block must be taken. This is considered remarkable progress for the country's petroleum industry in terms of the environmental performance of the LNOC. Moreover, the LNOC established an Environment and Archaeology Committee to discuss the optimal ways and means for the foreign companies to perform their exploration, production and other activities.

### **6.3.3 Characteristics of the Environmental Bodies**

#### **6.3.3.1 Instability**

The managerial hierarchy of the Libyan public sectors including the ministries and other important institutes such as the EGA is unstable. The history of the management structure of the ministries and other public institutions in the country illustrates this phenomenon. The Environment General Authority, which was an independent institute, was integrated with the Ministry of Health. This has been recognised as a phenomenon and considered as one of the obstacles to stable and competent management.

### **6.3.3.2 Lack of sufficient funds and staff**

The environmental departments in developing countries are often understaffed, underfinanced, and lack public support (Blackman & Winston, 2000). This fairly describes the environmental departments of Libya. Employees are an essential part of the implementation process as their support of the initiative will increase the probability of a successful implementation. Before 2003, some oil and gas companies had not had specific environmental departments with adequate budget and officers, to plan and implement effective environmental policies. Even after the establishment of environmental departments in most oil and gas companies, they are still suffering insufficient budgets and a lack of trained staff.

### **6.3.3.3 Absence of environmental information**

Environmental information is essential for effective environmental management, protection and coordination. It is an integral part of ensuring the implementation of environmental standards and legislation. The availability and accessibility of such information allows for prevention and mitigation. It also facilitates compliance monitoring and successful participation by interested parties. Information may influence consumer behaviour and raise public and business awareness, encouraging the prioritisation of environmental issues and compliance.

According to UNEP (1992):

*“The public, if given access to information and an opportunity to review companies’ plans and activities, can also play an important role in persuading companies to reduce their impacts on the environment and to comply with laws”.*

Sheldon & Yoxon (2002) agreed that mechanisms for making information available systematically inside the organisation will be helpful for decision makers.

Records of environmental information serve two main purposes:

1. Providing data necessary for a national state of the environment report and fulfilling the function of an ongoing environmental census; and
2. Providing a mechanism for monitoring industry's compliance with legislation and standards.

In Libya, the environmental information that is so important for reporting and publication, monitoring and public education, awareness and debate, is usually not available and, if it does exist, it is insufficient and the analytical framework for this information is poor.

Any information in the possession of government agencies and oil companies is not accessible as such documents or information are regarded as classified. The situation is made worse by the absence of any legislation which guarantees freedom of information. Moreover, the country severely lacks reliable environmental records and references such as reports, studies, books, papers or other documentary materials. None of the institutions which were contacted during this study were able to provide any reliable environmental record of their operations or monitoring system, simply because they do not conduct environmental auditing and do not keep such records.

#### **6.3.3.4 Lack of an environmental monitoring system**

An effective monitoring system is essential in order to ensure compliance with and implementation of the environmental regulations. As Tinsley (2001) stated:

*"The environmental aspects need to be controlled and monitored in order to develop the positive and reduce the negative impacts. Such changes will ensure continuing environmental improvement"* (Tinsley, 2001).



Currently the EGA is incapable of implementing an effective monitoring system. The LNOC also still needs to develop an effective environmental monitoring system for the petroleum industry's activities, as the monitoring systems in most of the national oil companies are completely absent or not efficient. The EGA and the oil and gas industry sector in Libya lack advanced sophisticated equipment and skilled personnel to enable them to implement an efficient environmental monitoring system.

## **6.4 Environmental Training**

Libya's education system is generally capable of producing good and qualified nationals but nevertheless the country still needs the experience of training abroad and further studies.

With particular reference to the petroleum industry, the country has made considerable efforts to develop productive manpower. Unfortunately the environmental training is not adequately considered in this development. The country, therefore, lacks staff with environmental management skills in the petroleum industry sector, which is probably the most significant source of pollution in the country.

### **6.4.1 National Educational Petroleum Institutes**

According to (Ghanem\*, 2007):

*"Our local educational institutes are capable of producing very good and qualified nationals but nevertheless we still need the experience of training abroad and further studies".*

In order to develop manpower in the petroleum industry sector, the following institutions have been established:

- 1- College of Higher Technical Studies, 1961 which is the first engineering college in the country.
- 2- Institute of Petroleum Affairs, 1970, Tripoli.

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\* Chairman of LNOC

- 3- Higher Petroleum Institute in Tobruk, 1971.
- 4- Faculty of Petroleum and Mining Engineering, which established in the University of Al Fateh in Tripoli, 1972.
- 5- The Libyan Petroleum Institute (LPI) “The Petroleum Research Centre (PRC) *now Libyan Petroleum Institute(LPI)* of the LNOC was founded in 1977 to undertake the responsibility of technical and scientific support needed by Libyan oil and gas, upstream and downstream industry” (Belgasem, 2005).
- 6- Higher Centre of Occupational Safety and Health 2004.
- 7- Bright Star University of technology, City of Brega, 1980, which is solely serving the oil and gas industry and comprises:
  - The faculty of petroleum and mining engineering;
  - The higher petroleum institute;
  - The higher institute of electronics;
  - The higher institute of electricity and mechanics; and
  - The higher institute of technology.

Further to that, LNOC annually send dozens of its affiliates’ employees for training and postgraduate studies abroad (mainly to the UK). This provides the country with qualified personnel in the oil and gas industry who contribute effectively to the petroleum industry’s development. In spite of that, the technological capability in the implementation of pollution control and environmental protection in Libya is still insufficient. It seems that environmental training is not adequately considered along with the technical programmes to deal with the environmental impacts of the industry.

#### **6.4.2 Weakness in Environmental Training**

There are several reasons behind the shortcomings of environmental training; the following are among them:

1. Unprecedented rapid economic growth where there has been an upsurge in the demand for trained, skilled and experienced manpower. The priority, therefore, is given to increase exploration & production operations as well as to improve the economics of the country.
2. Libya is a developing country and does not have advanced technology or long experience in this complex technology.
3. UN sanctions, which were imposed against Libya for almost a decade as a result of the Lockerbie affair, were a crucial reason for the lack of modern technology as the oil and gas industry was the main target of the sanctions. As a result the priority was given to maintaining development operations and the economics of the petroleum industry.
4. Lack of research centres to develop scientific knowledge about the environmental impact of oil and gas operations which led to lack of environmental training programmes at almost all levels.
5. Environmental training is not fully considered when people are sent abroad for technical training.
6. Significant numbers of qualified and trained staff have left the oil and gas sector. According to Otman (2006), in the period from 1998 to 2002, a total of 1964 national employees left the petroleum sector.

So, environmental training seems not to have been fully considered, and the petroleum industry's skilled employees are not environmentally trained.

### **6.5 *Environmental Awareness***

The importance of environmental education and awareness training in organisations has been well established in the literature (Beard, 1996; Bird 1996; & Tietenberg, 2003). For proper implementation of an environmental

management system in any organisation, it is essential for each of the managerial staff to have high and constant environmental awareness. In fact, environmental awareness and education in Libya are still weak despite the efforts that have been made to improve environmental awareness, such as national and international environmental conferences. The country has recently developed systems of environmental management that control emissions, treat waste, and otherwise abate environmental damage. This is demonstrated by recent legislation to protect the environment and recent environmental measures that have been taken by the EGA and the LNOC and its affiliates. These measures include creating an environmental department in the LNOC and its affiliates and activating the role of the EGA in protecting the environment.

### **6.5.1 Environmental Education**

Effective environmental education and awareness training initiative can provide employees, at all levels of an organisation, with the tools and understanding necessary to perform in an environmentally aware manner and make environmentally responsible decisions in their companies (Hale, 1995; Daily & Huang 2001). However, many companies consider education to be the key to inducing long-lasting environmental change (Saunders & McGovern, 1993).

Environmental education is now introduced to all education stages in many parts of the world. In Libya, however, a national curriculum including environmental education is not adequately introduced to primary and secondary schools. Environmental education is also absent in most of the universities in the country. Therefore, environmental education and environmental training is needed for many sections of Libyan society including the youth, environmental professionals, politicians, and workers.

### **6.5.2 Lack of Public Awareness of environmental issues**

Environmental awareness among the public is generally weak, especially as the country does not have any significant environmental problems that directly affect the residents. The environmental impacts of the oil and gas exploration and production are mainly located far away from residents' areas and their water resources. However, this does not mean that these impacts are not significant but the public are usually concern with environmental problems that directly affect them. In fact, there is not any effective environmental policy that has been established to increase public environmental awareness. However, high public awareness can be reflected positively among the decision-makers.

### **6.5.3 The Role of the Media**

In general, there is very limited coverage of environmental issues, which is absent or neglected in a media controlled by the government. For example, the television only broadcasts programmes about environmental issues once a week. Thus, the available media in the country does not play a vital role in raising environmental awareness which could be seen as its responsibility.

### **6.5.4 Public Participation in the Environmental Debate**

Emerging from the Earth Summit in 1992, Agenda 21 called for increased public participation in environmental decision-making (EDM). Since then, public participation is a growing part of environmental decision-making. In Libya, however, the level of participation of the private sector, general public and other environmentally-concerned bodies is still low. There are no environmental interest groups that can effectively participate in the decision-making processes or promote environmental considerations in policy-making. In such circumstances, it is difficult to implement successful environmental management and policies because an environmental

awareness and culture among community members are the main drivers of successful environmental programmes and performance.

## **6.6 Conclusion**

In this chapter, the current environmental performance in Libya is discussed with special reference to the environmental management of the oil and gas industry which is the specific area of this study. The discussion has focused on four key factors influencing environmental performance in Libya: the environmental regulatory framework, the effectiveness of the environmental bodies, environmental training and environmental awareness.

The environmental regulatory framework is reviewed. This includes an investigation into the enforcement of and compliance with environmental regulations and the current environmental policies and management systems of the petroleum industry. The compliance with and implementation of the environmental regulations is fragile. The petroleum industry has not implemented a clear planning policy with respect to the regulatory cycle, which was shown earlier in Figure 24 to improve the industry's environmental performance. Furthermore, the sector generally has not implemented an efficient Environmental Management System (EMS) to mitigate the environmental impacts of the petroleum industry's operations.

The second main aspect considered in this chapter is the effectiveness of the environmental governance bodies, the EGA and the Environmental Department of the LNOC and its affiliates. Four main characteristics of these environmental bodies are identified. These characteristics are constant changing of the managerial structure, lack of sufficient funds and staff, absence of environmental information and auditing and, weak environmental monitoring.

The third aspect which is discussed in this chapter is environmental training. In this regard, the effort of the country to provide capable and qualified skills to the oil and gas industry sector is explained. The priority is given to technical skills, such as mechanical, electrical, geological and drilling engineering, which directly relate to production, and environmental science is not fully considered. Shortcomings in environmental training are also examined.

The last aspect of the environmental approach considered in this chapter is environmental awareness. Four issues related to environmental awareness are considered. These issues are environmental education, public awareness of environmental issues, the role of the media, and public participation in environmental debates. Figure 26 summarises the Libyan approach to environmental management.

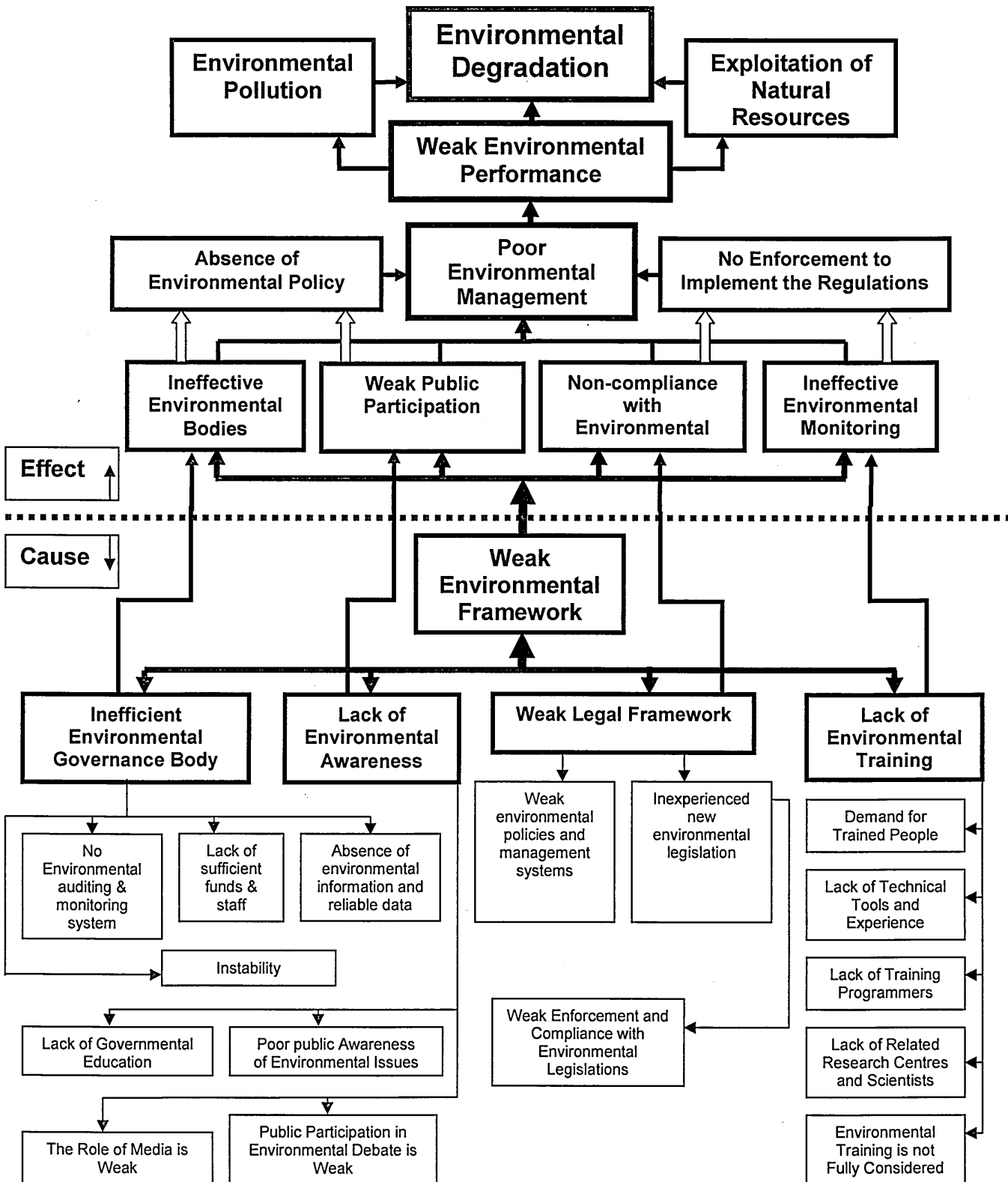


Figure 26: Current Libyan Environmental Management Framework



## **Chapter Seven**

### **Data Analysis**

#### ***7.1 Introduction***

This chapter includes the analysis of the interviews and questionnaire survey which were conducted in order to fulfil the researches' aims and objectives. At the beginning eight interviews were textually analysed by the NVivo software to index and retrieve all data relevant to the investigation. The questionnaire survey was analysed statistically. The SPSS computer programme (Statistical Package for the Social Sciences), which is a powerful statistical package with high quality graphics and tabulation facilities, has been used to process the data from the questionnaire surveys. Different statistical operations including comparison, cross-tabulation and graphics have been conducted to explore and summarise the data and to make it more meaningful. Similarly, the effects of the sanctions on the Libyan petroleum industry are also analysed and taken into consideration to investigate to what extent these sanctions have affected the state of the environment in the country.

#### ***7.2 Analyses to the Interviews***

The interviews were the first step in the fieldwork study to explore the opinions of managerial staff of both the oil and gas industry and the Environment General Authority about the environmental impacts of petroleum exploration and production in Libya and how they are managed or being dealt with. The questions in the interviews were open-ended which means that the respondent was asked open questions about the environmental issues and the management of these issues.

At the beginning, the interviews were classified into two groups, one group containing the interviews 1 to 4, represents the oil and gas industry, and

the other group, which contains interviews 5 to 8, represents the Environment General Authority. Then they were subdivided into many categories, and responses related to specific categories were coded and collected from each interview. NVivo software was used to analyse the interview data qualitatively.

### **7.2.1 Categorising and Coding the Interviews**

Data from the interviews were coded and grouped into ten categories, each representing an environmental or environmental management issue. Therefore, all issues relevant to the Libyan petroleum industry's environmental management were considered. These Categories are:

1. Environmental impacts of the oil and gas industry
2. Efficiency of the environmental regulations
3. Current implementation of the environmental regulations
4. Compliance with the environmental regulations
5. Environmental performance
6. Environmental monitoring
7. Environmental training
8. Environmental awareness of the managerial staff
9. Management structure of the petroleum industry
10. The effect of the sanctions

Table 16, which was produced by the NVivo software, shows the number of interviewees who responded to each category and their place of work and qualifications.

<b>STAFF PROFILE</b> <b>CATEGORIES</b>	<b>Work Place: Oil &amp; Gas</b>	<b>Work Place: EGA</b>	<b>Undergraduate Qualification</b>	<b>Postgraduate Qualification</b>
<b>1- Environmental Impacts</b>	4	4	2	6
<b>2- Effectiveness of the Environmental Regulations</b>	4	3	2	5
<b>3- Current Implementation of the Environmental Regulations</b>	4	4	2	6
<b>4- Compliance with the Environmental Regulations</b>	4	4	2	6
<b>5- Environmental Performance</b>	4	4	2	6
<b>6- Environmental Monitoring</b>	4	4	2	6
<b>7- Environmental Training</b>	4	1	1	4
<b>8- Environmental Awareness of the managerial Staff</b>	4	4	2	6
<b>9- Management Structure of the Petroleum Industry</b>	3	4	2	6
<b>10- The Effect of the Sanctions</b>	4	4	2	6

**Table 16: The number interviewees who responded to each category and their place of work and qualifications**

As can be seen from Table 16, most of the interviewees hold postgraduate degrees and some hold undergraduate degrees. This reflects a reasonable level of education of the interviewees in both oil and gas industry and the EGA. It can also be noticed that one interviewee did not mention the effectiveness of environmental regulations, three of the EGA staff did not mention training and one oil and gas staff did not mention the relationship between the LNOC and the EGA.

### 7.3 Analysis of the Interviews

Responses under each of the categories listed in Table 16 are presented below.

#### 7.3.1 Environmental Impacts of the Oil and Gas Industry

The starting point and the lead issue of the interviews were the environmental impacts of the petroleum industry. They are the cornerstone of this study. Accordingly, responses about the impacts on the environment were coded and collected at the beginning of this analysis.

Unsurprisingly, the significance of the environmental impacts of the petroleum industry was acknowledged by all interviewees in both the oil and gas industry and the EGA. Table 17 summarises all responses related to the environmental impacts of the oil and gas industry.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> We suffer from these impacts like any other operators and our commitment is to reduce these impacts. As an environmentalist, I consider it very significant especially as these impacts have accumulated over a period of time without any management in the past.</p> <p><b>O&amp;G Interview 2</b> There are several environmental impacts such as produced water, gas emissions, and drilling and solid waste.</p> <p><b>O&amp;G Interview 3</b> In some sites the impacts are significant, especially produced water and gas emissions.</p> <p><b>O&amp;G Interview 4</b> The company is becoming more concerned about the environmental impacts.</p>	<p><b>EGA Interview 5</b> Oil and gas industry is probably the biggest source of pollution and contamination in the country.</p> <p><b>EGA Interview 6</b> The environmental impact of the oil and gas industry is a big issue. The oil and gas industry has significant impacts on the environment.</p> <p><b>EGA Interview 7</b> The oil and gas industry sector does not have proper policies and plans to deal with the impacts that are caused by the industry.</p> <p><b>EGA Interview 8</b> The impacts of the oil and gas industry are great.</p>

Table 17: The Significance of the Environmental Impacts

### 7.3.2 Effectiveness of the Environmental regulations

Table 18 summarises the opinions of the interviewees about the effectiveness of the environmental regulations,

O&G Interviews	EGA Interviews
<b>O&amp;G Interview 1</b> Environmental regulations were introduced to protect the environment. These regulations are applicable and modern.	<b>EGA Interview 5</b> (No answer).
<b>O&amp;G Interview 2</b> The regulations related to the environment are good if they are fully implemented.	<b>EGA Interview 6</b> The environmental regulations are now under revision.
<b>O&amp;G Interview 3</b> There are environmental regulations for controlling the environmental impacts in the country.	<b>EGA Interview 7</b> The environmental regulations in general and the new environmental law No15/2003 are satisfied. The new law has taken into account all the mistakes of the old law.
<b>O&amp;G Interview 4</b> The environmental regulations if implemented properly they will improve the state of the environment and performance.	<b>EGA Interview 8</b> The environmental regulations existed more than a decade ago and now are improving and can be effective if they are seriously implemented.

Table 18: The Effectiveness of the Environmental Regulations According to the Interviewees

### 7.3.3 Implementation of the Environmental Regulations

The implementation of the environmental regulations was among the important issues in the interviews. All the interviewees responded to this question and their opinions were summarised in Table 19.

O&G Interviews	EGA Interviews
<b>O&amp;G Interview 1</b> The implementation of the environmental regulations in the country in general is too weak, but recently is improving.	<b>EGA Interview 5</b> In the past there was not any real monitoring of their operations and the environmental laws were not implemented.
<b>O&amp;G Interview 2</b> There is weak implementation of the environmental regulations and laws.	<b>EGA Interview 6</b> The main problem is that the petroleum industry has not implemented the environmental regulations in the past.
<b>O&amp;G Interview 3</b> Implementing the environmental regulations is big issue.	<b>EGA Interview 7</b> Historically, the environmental regulations and laws have not been properly implemented.
<b>O&amp;G Interview 4</b> ISO14001 which is a management system will be implemented in the near future. The company is determined to expand and improve its environmental management system.	<b>EGA Interview 8</b> In spite of the recent improvement, the implementation of the environmental regulation is still unsatisfied.

Table 19: The Opinions of the Interviewees about Implementation of the Environmental Regulations

### 7.3.4 Compliance with the Environmental Regulations

The oil and gas industry's compliance with the environmental regulations is also among the main issues in the interviews. The need for compliance with the environmental regulations is not satisfied according to the interviewees as can be seen in their responses summarised in Table 20.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> Oil companies did not fully comply with the environmental regulations, but we have now entered a new stage where all oil companies are asked to perform environmentally and comply with the environmental regulations</p> <p><b>O&amp;G Interview 2</b> Unfortunately, there is not any competent enforcing or monitoring body to the compliance with and implementation of the environmental regulations. Sadly compliance with environmental regulations is very rare.</p> <p><b>O&amp;G Interview 3</b> There are environmental regulations for controlling the environmental impacts in the country. Unfortunately these regulations are rarely implemented in a proper way.</p> <p><b>O&amp;G Interview 4</b> The compliance with the environmental regulations and any other environmental guidelines or policies is also weak and is still a big challenge to the oil and gas industry.</p>	<p><b>EGA Interview 5</b> May be the absence of environmental policies and the neglect of the environmental laws are the main obstacles that made enforcement more difficult with the oil and gas industry.</p> <p><b>EGA Interview 6</b> The petroleum industry just recently is trying to comply with the environmental regulations and perform environmentally.</p> <p><b>EGA Interview 7</b> The focus should be on the implementation of environmental regulations to enforcement of the regulations in the oil and gas industry. Recently the compliance with and the environmental performance of the oil and gas companies is improving slightly</p> <p><b>EGA Interview 8</b> Most oil companies do not comply with the environmental regulations.</p>

**Table 20: The Opinions of the Interviewees about the Compliance with the Environmental Regulations**

### 7.3.5 Environmental Performance

Environmental performance of the petroleum industry was also considered in the interviews and the opinions of the interviewees are presented in Table 21.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> The company knows that its environmental performance is poor.</p> <p><b>O&amp;G Interview 2</b> The compliance with the environmental regulations is very rare and most companies neglect them. There is no real monitoring or pressure from the government or any other monitoring bodies.</p> <p><b>O&amp;G Interview 3</b> Unfortunately it can be said that the environmental performance of the oil and gas industry in general is poor.</p> <p><b>O&amp;G Interview 4</b> The environmental performance of the petroleum industry is not satisfactory.</p>	<p><b>EGA Interview 5</b> Actually we are not satisfied with the oil companies' environmental performance especially, that some companies still do not have any environmental policy.</p> <p><b>EGA Interview 6</b> The environmental performance of the oil and gas industry is bad.</p> <p><b>EGA Interview 7</b> In the past the oil industry did not pay adequate attention to the environmental regulations. Recently the environmental performance is slightly improving.</p> <p><b>EGA Interview 8</b> Some national companies do not have environmental policies and others still have a lot to do for better performance.</p>

**Table 21: The Opinions of the Interviewees about the Environmental Performance of the Oil and gas Industry**

### 7.3.6 Environmental Monitoring

Environmental monitoring is one of the measures that can be efficient in implementing the environmental regulations. Therefore, the interviews included an essential question about the environmental monitoring. Table 22 introduces the opinions of the interviewees in the current environmental monitoring system of the oil and gas industry in Libya.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> There was not any real monitoring of the environmental performance.</p> <p><b>O&amp;G Interview 2</b> Unfortunately, there is not any competent enforcing or monitoring body. There is no real pressure from the government to monitoring the environmental situation.</p> <p><b>O&amp;G Interview 3</b> There is no real pressure or monitoring to force the oil and gas companies to comply with the environmental regulations.</p> <p><b>O&amp;G Interview 4</b> The company does not have an environmental monitoring system as we suffering lack of skilled staff and equipment. The role of the LNOC in monitoring is very weak or absent.</p>	<p><b>EGA Interview 5</b> Weak monitoring of the implementation of the environmental laws.</p> <p><b>EGA Interview 6</b> The LNOC, which is the mother of the oil and gas industry, just recently established environmental affairs department. I can say that the petroleum industry is recently trying to improve its environmental performance.</p> <p><b>EGA Interview 7</b> In the past, there was no real monitoring of the state of the environment in the whole country.</p> <p><b>EGA Interview 8</b> The absence of any real monitoring of environmental performance of the petroleum industry's operations.</p>

**Table 22: Environmental Monitoring as seen by the Interviewees**

### 7.3.7 Environmental Training

Environmental training can reflect concern about environmental issues. Accordingly, the interviewees were asked about environmental training in the oil and gas industry. All the interviewees from the oil and gas industry answered this question but only one from the EGA did, as can be seen in Table 23.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> Before the company did not have any kind of environmental programme, but now the company is giving some short environmental training and it plans to send a number of its employees for environmental training.</p> <p><b>O&amp;G Interview 2</b> Currently the company does not have such environmental programmes. This will be included in the future plans where selected members of staff will be trained to gain environmental knowledge and skills.</p> <p><b>O&amp;G Interview 3</b> In the company we have some programmes to increase the staff's environmental awareness by giving them some courses and training in this field.</p> <p><b>Interview 4</b> Contract for training and auditing will be signed with specialist company. There are environmental training programmes and courses for environmental awareness we have currently twelve people being trained for ISO14001.</p>	<p><b>EGA Interview 5</b> Lack of environmental training and motivation to behave more environmentally.</p> <p><b>EGA Interview 6</b> (No answer).</p> <p><b>EGA Interview 7</b> (No answer).</p> <p><b>EGA Interview 8</b> (No answer).</p>

**Table 23: Interviewees' Opinions about Environmental Training in the Libyan Petroleum industry**

### 7.3.8 Environmental Awareness of the Managerial Staff

Environmental awareness is likely to have an influence on the environmental behaviour of decision makers. Accordingly, the interviewees were asked their assessment of the environmental awareness of managerial staff of the oil and gas industry, as in Table 24.



O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> The environmental issues are not the top priorities of the public or managers due to lack of the environmental awareness.</p> <p><b>O&amp;G Interview 2</b> The environmental awareness of the environmental impacts of the oil and gas industry among the staff of the petroleum industry is good.</p> <p><b>O&amp;G Interview 3</b> We have some programmes to increase the staff's environmental awareness which is currently poor.</p> <p><b>O&amp;G Interview 4</b> The environmental awareness of the public and the staff of the oil and gas industry is generally weak.</p>	<p><b>EGA Interview 5</b> Lack of the environmental awareness among the decision makers and the public.</p> <p><b>EGA Interview 6</b> May be the lack of an environmental culture is the main barrier to improving the environmental performance, as the decision makers do not show a high level of concern about environmental protection.</p> <p><b>EGA Interview 7</b> Environmental awareness among the decision makers and the public is also still weak.</p> <p><b>EGA Interview 8</b> Weak environmental awareness and education are also barriers to improving environmental performance.</p>

**Table 24: The Assessment of the Interviewees of the Environmental Awareness of the Oil and Gas Industry's Managerial Staff**

### 7.3.9 Management Structure of the Petroleum Industry

The management structure of the oil and gas industry in Libya is included in the interviews. Table 25 presents a summary of the opinions of the interviewees.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> The current management hierarchy of the sector is effective. The existence of the LNOC is very important to the country. It should outline the energy policy and play a coordinating and advisory role for the national companies.</p> <p><b>O&amp;G Interview 2</b> Ministry of energy was established and abolished several times. The transient nature of the managerial structure of the oil and gas sector and environmental monitoring body.</p> <p><b>O&amp;G Interview 3</b> (No answer).</p> <p><b>O&amp;G Interview 4</b> LNOC should draw-up a strategic policy for the sector in our country. The greatest weakness of the sector, however, was the temporary nature of its structure as it was confused by the repeated appearance of the Ministry of Energy.</p>	<p><b>EGA Interview 5</b> The oil and gas industry is controlled by the LNOC. Such a leading corporation may facilitate the relationship between the industry and the others.</p> <p><b>EGA Interview 6</b> The structure of the oil and gas industry has some complexities that impede its performance. The financial legislation that governs the employment salaries is also controversial and the industry itself as a governmental sector does not perform sufficiently.</p> <p><b>EGA Interview 7</b> Oil and gas industry is better organised than many other sectors in society.</p> <p><b>EGA Interview 8</b> Oil and gas sector suffers transient nature of its management structure and its management hierarchy needs to be more constant. The governmental ownership of the industry is also controversial.</p>

**Table 25: Interviewees' Opinions about the Management Structure of the Oil and Gas Industry**

### 7.3.10 The Effect of the Sanctions

The effect of the UN & US sanctions on the state of the environment and performance of the oil and gas industry was considered in the interviews. The opinions of the interviews are summarised in Table 26.

O&G Interviews	EGA Interviews
<p><b>O&amp;G Interview 1</b> The company was affected by the sanctions like all other companies working in the country at the time. Environmentally, using old technology caused many environmental impacts such as oil spills but as the oil production is severely reduced so less production may mean less pollution and contamination.</p> <p><b>O&amp;G Interview 2</b> The sanctions in fact, affected all aspects of the petroleum industry including the environmental field. The sanctions were one reason for the environmental problems that we suffer now.</p> <p><b>O&amp;G Interview 3</b> The sanctions badly affected the oil and gas industry in general including the environmental performance as the sanctions disturbed the development of the industry.</p> <p><b>O&amp;G Interview 4</b> The sanctions had direct and indirect effects on the whole sector including the state of the environment.</p>	<p><b>EGA Interview 5</b> The sanctions which were imposed on the country's petroleum industry affected it very badly.</p> <p><b>EGA Interview 6</b> The sanctions made the situation worst due to the severe lack of the new technology and professional skills. The sanction prevented the industry from developing environmental management policies.</p> <p><b>EGA Interview 7</b> The sanctions prevented the country from obtaining new technology, skilled employees and experience from advanced companies.</p> <p><b>EGA Interview 8</b> The state of the environment was indirectly affected by the sanctions due to the need to use all means, including old technology, to continue the production of the oil.</p>

**Table 26: The Opinions of the Interviewees about the Effect of the Sanctions on the State of the Environment and Performance**

The interviews informed the basic background of the questionnaire survey which was designed accordingly.

## 7.4 Statistical Analysis of the Questionnaires

### 7.4.1 Data Handling and Classification

The petroleum industry in general and oil companies in particular are very sensitive about releasing information, for competitive, reputation and other reasons. In a country like Libya, where there is no evidence of reasonable

environmental record, the questionnaire survey is probably the most suitable means to gain reliable data. One advantage of the questionnaire is that the participants are anonymous and their answers would be more reliable and credible. In this fieldwork study, all of the questionnaires (132 forms), circulated in both countries were fully answered without a single question being avoided.

In the Libyan petroleum industry, more than 95 per cent of the employees are Libyan nationals, the rest are foreign partners or individual technicians, whereas in the UAE more than 95 per cent of the employees in the oil and gas industry are foreign nationals from several countries covering all aspects of workforce. However, this should not affect the results of the study as (i) the intention of the researcher is not to study the effect of this situation, but to concentrate on the environmental policies and regulations and how they are implemented (ii) the oil and gas industry in the UAE is also controlled and monitored by the government via its national oil company and its affiliates which are usually led by national personnel.

The raw data, which were collected using two versions of the questionnaire, were initially transferred into Microsoft Excel software and classified according to the respondents into four categories: country, company type, organisation and department, as in Table 27. Data entry processes were carefully conducted and double checked to avoid any error.

<b>Country</b>	<b>Company Type</b>	<b>Organisation</b>	<b>Department</b> (See Table 28)
Libya	National company or organisation	Company	Department
United Arab Emirates (UAE)	Mixed company or organisation	Agency Institution	Subject (Occupation / position / job)

**Table 27: Initial Classification of the Data**

Respondents are classified according to their departments, position, occupation or subject as in Table 28.

Symbol	Occupation / Dept
A	Administrative Department
E	Engineer
E&S	Environment and Safety
L	Legal Department
SM	Site manager

**Table 28: The Abbreviations of the Departments**

As planned, the respondents were randomly selected among different departments and covered almost all major areas of the activities in both countries (Libya and UAE).

#### **7.4.1.1 Coding**

For confidentiality reasons, the names of the oil companies or any personnel do not appear in this study. This was a condition of the participants and an ethical and moral obligation the researcher has made to enable them to participate in this questionnaire.

The answers of the participants were also coded as they converted from nominal to numerical to be understood by SPSS.

#### **7.4.1.2 Comparison Analysis**

The main analysis stage of this research is a cross-tabulation comparison of the questionnaire results between Libya (L) and United Arab Emirates (U). In this comparison, the Libyan questionnaire sample consists of 88 forms whereas the United Arab Emirates questionnaire sample consists of 44 forms. The sizes of the samples are not the same and the Libyan sample is twice the UAE sample due to logistic reasons as mentioned earlier but this should have no significant effect as the results were presented by percentage.

The researcher intended to compare the results of the questionnaire survey between the Libyan national companies (totally owned by the LNOC) and companies with foreign partners operating in Libya. This was decided to determine any differences between the two kinds of companies that may significantly affect the results. For this reason and to truly represent the oil and gas industry in Libya, the data were collected from both kinds of oil company. However, as the results of the questionnaire survey in both kinds of company are very similar and the results are not affected by their ownership, there is no need for a comparison between them.

### ***7.5 The Analysis to the Questions of the Questionnaire***

The same categorisation scheme used for the interviews is used in this analysis. Accordingly the same ten categories, which were used for the interviews, are used for this questionnaire (see 7.2.1). Some categories are covered by more than one question where one question cannot provide a sufficient answer to categories (e.g. the first and third category). Two main data analysis procedures were implemented in this research to analyse the data collected by the questionnaire survey from the two countries.

The two main procedures are:

1. Frequency tables to summarise the data by counting the numbers and representing them in percentages; and
2. Charts to represent the data in graphical presentation.

The data, therefore, are presented in tabular form followed by discussion on the salient features. The tables give the frequency distribution in the form of the number and percentage for each class of answer and the total number of the sample. For further explanation, bar charts are produced in graphical form. Presenting data in such a manner may help the reader to appreciate visually the salient characteristics.

### 7.5.1 Environmental Impacts of the Oil and Gas Industry

As said earlier, this category is the most important one as it reflects the core issue of the research. The impacts of the petroleum industry's activities on the environment have become a concern to many parties such as the industry, environmentalists and the governments. This category is explored through two questions to reach as reliable an answer as possible: (1) the current state of the environment; and (2) the magnitude of the environmental impacts.

#### ***7.5.1.1 State of the Environment in the Oil and Gas industry in Libya and the UAE:***

In order to evaluate the current state of the environment in the oil and gas industry in the two countries, respondents to the questionnaire in both countries were asked a direct question about it. This will help to point out the importance of the environmental impacts to the oil and gas sector. The results are presented in Figure 27.

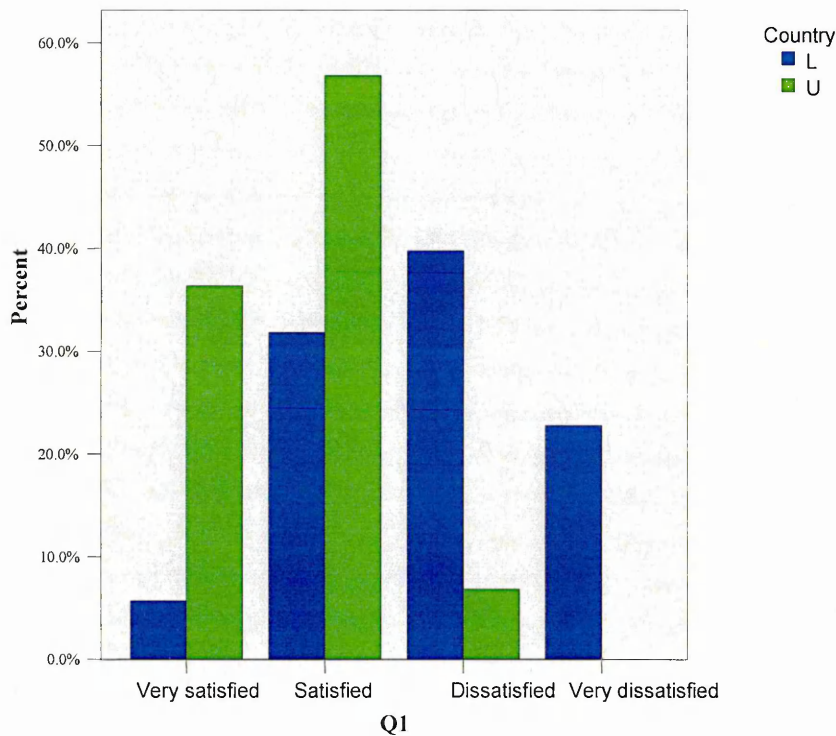
How do you describe the current state of the environment in the petroleum industry sector in the country?			Country		Total
			L	U	
Q1	Very satisfactory	Count	5	16	21
		% within Country	5.7%	36.4%	15.9%
	Satisfactory	Count	28	25	53
		% within Country	31.8%	56.8%	40.2%
	Dissatisfactory	Count	35	3	38
		% within Country	39.8%	6.8%	28.8%
	Very dissatisfactory	Count	20	0	20
		% within Country	22.7%	0.0%	15.2%
Total		Count	88	44	132
		% within Country	100.0%	100.0%	100.0%

**Figure 27: Responses about the Current State of the Environment**

As can be seen, only about a third of the Libyan respondents were either very satisfied or satisfied about the state of the environment in the oil and gas sector in Libya, whereas the majority of the UAE respondents were very satisfied and more than half were satisfied. The majority of the Libyan

respondents were dissatisfied or very dissatisfied, whereas there is only a very low percentage of the UAE respondents dissatisfied and none were very dissatisfied.

Accordingly it can be concluded that there is a very significant difference between the responses about this issue in Libya and the UAE. The difference between them shows that environmentally the Libyan oil and gas industry is much worse than that of the UAE. The state of the environment of the Libyan oil and gas industry, therefore, needs to be improved to a reasonable level. Figure 28 was produced for visual reading to the results.



**Figure 28: Responses about the Current State of the Environment**

### 7.5.1.2 Assessment of the Magnitude of the Environmental Impacts

The environmental impacts are in fact, environmental issues. Therefore, to investigate the environmental issues, the magnitude of the environmental impacts should be evaluated. Thus, the magnitude of the environmental impacts in both countries was initially assessed by question 2 as can be seen in Figure 29. This provides the respondents' understanding of the impacts of the petroleum industry on the environment and how these impacts are considered by the sector's employees.

How do you consider the magnitude of the environmental impacts of the oil and gas industry operations in the country?			Country		Total
			L	U	
Q2	Significant	Count	75	16	110
		% within Country	85.2%	36.4%	37.3%
	Insignificant	Count	13	28	22
		% within Country	14.8%	63.6%	73.7%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

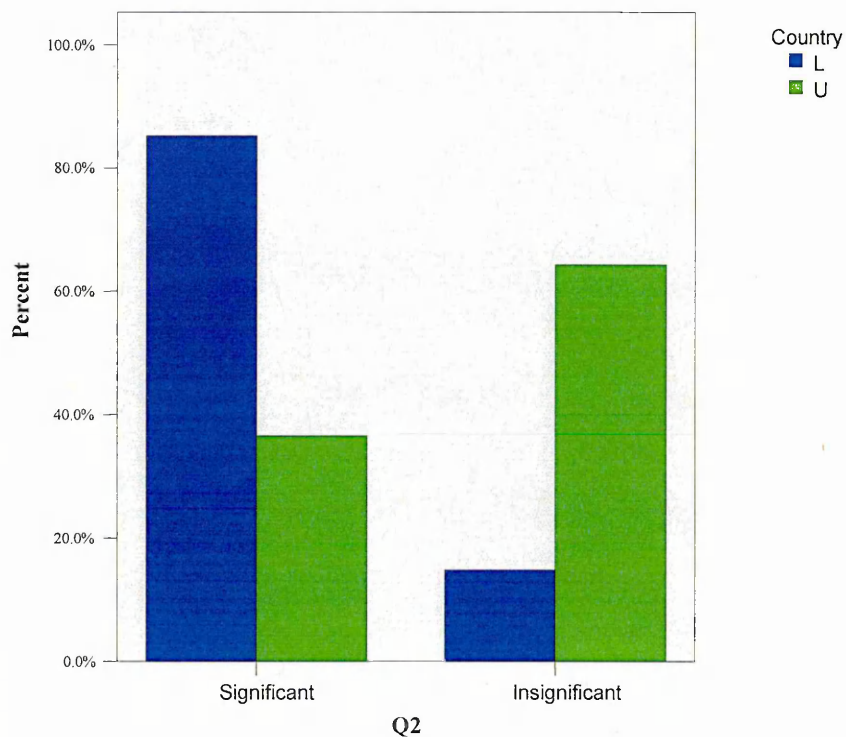
**Figure 29: Responses about Assessing the Magnitude of the Environmental Impacts of the Oil Industry**

The results show a considerable difference between the respondents of the two countries. The majority of Libyan respondents considered the magnitude of the environmental impacts due to the upstream petroleum industry are significant, whereas about only a third of the UAE respondents considered it significant.

Though this assessment is a subjective, it can indicate that the scale of the environmental impacts in Libya is greater than it is in the UAE.

Therefore, efficient environmental management systems to tackle these impacts might be more required in Libya than the UAE. The bar chart in Figure 30 shows that difference between the respondents' in both countries graphically.





**Figure 30: Responses about Assessing the Magnitude of the Environmental Impacts of the Oil Industry**

### 7.5.2 Effectiveness of the Environmental Regulations

Environmental regulations exist almost in all countries over the world in one way or another. However, the effectiveness of these regulations differs from country to country. Therefore, Question 3 was formed in order to explore the participants' opinions about the effectiveness of the current environmental regulations in both countries. The results are presented in Figure 31.

How do you see the environmental regulations related to the environmental impacts of the petroleum industry?			Country		Total
			L	U	
Q3	Very effective	Count	9	10	19
		% within Country	10.2%	22.7%	14.4%
	Effective	Count	17	12	29
		% within Country	19.3%	27.3%	22.0%
	Satisfactory	Count	42	17	59
		% within Country	47.7%	38.6%	44.7%
	Weak	Count	20	3	23
		% within Country	22.7%	6.8%	17.4%
	Very weak	Count	0	2	2
		% within Country	0.0%	4.5%	1.5%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 31: Responses about Environmental Regulation**

As can be seen no significant differences can be observed from the responses about the effectiveness of the environmental regulations in Libya and the UAE. Respondents who considered the environmental regulations very effective are generally low in both countries. The highest percentage of responses from both countries considers the environmental regulations are satisfactory.

It seems that both countries have satisfactory environmental regulations as can be concluded from the responses from both countries where more than two third of the respondents in each country considered the environmental regulations are at least satisfactory.

However, the overall results indicated that the environmental regulations of the UAE are slightly more effective than the Libyan regulations.

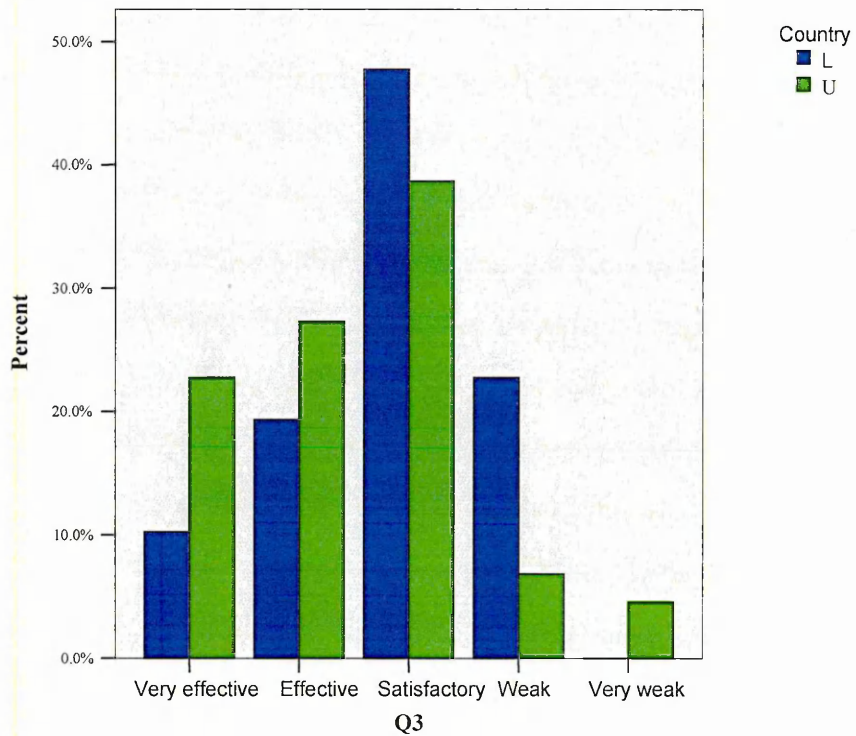


Figure 32: Responses about Environmental Regulation

### 7.5.3 Implementation of the Environmental Regulations

The implementation of the environmental regulations in Libya and the UAE has been investigated. The survey of the employees' opinions about the implementation of the environmental regulations can shed light on the status of the current implementation of these regulations. The results are shown in Figure 33.

What is your opinion about the implementation of environmental regulations by the petroleum industry in the country?			Country		Total
			L	U	
Q4	Excellent	Count	0	12	12
		% within Country	0.0%	27.3%	9.1%
	Very good	Count	0	16	16
		% within Country	0.0%	36.4%	12.1%
	Good	Count	8	16	24
		% within Country	9.1%	36.4%	18.2%
	Poor	Count	43	0	43
		% within Country	48.9%	0.0%	32.6%
	Very poor	Count	37	0	37
		% within Country	42.0%	0.0%	28.0%
Total	Count	88	44	132	
	% within Country	100.0%	100.0%	100.0%	

**Figure 33: Responses about the Implementation of the Environmental Regulations**

There is a great contrast between the responses from the two countries, which reflects the attitude to the implementation of the environmental regulations in each country.

It is evident that Libyan environmental regulations are not considered by respondents to be properly implemented as can be concluded from this comparison. On the other hand, the environmental regulations in the UAE seem to be strictly implemented according to these results. Thus, comparing with the UAE, Libyan implementation of the environmental regulations appears to be far behind and considerable improvement may be needed to compete with the UAE in this field.

The bar chart in Figure 34 illustrates the contrast between Libya and the UAE more clearly in graphical form.

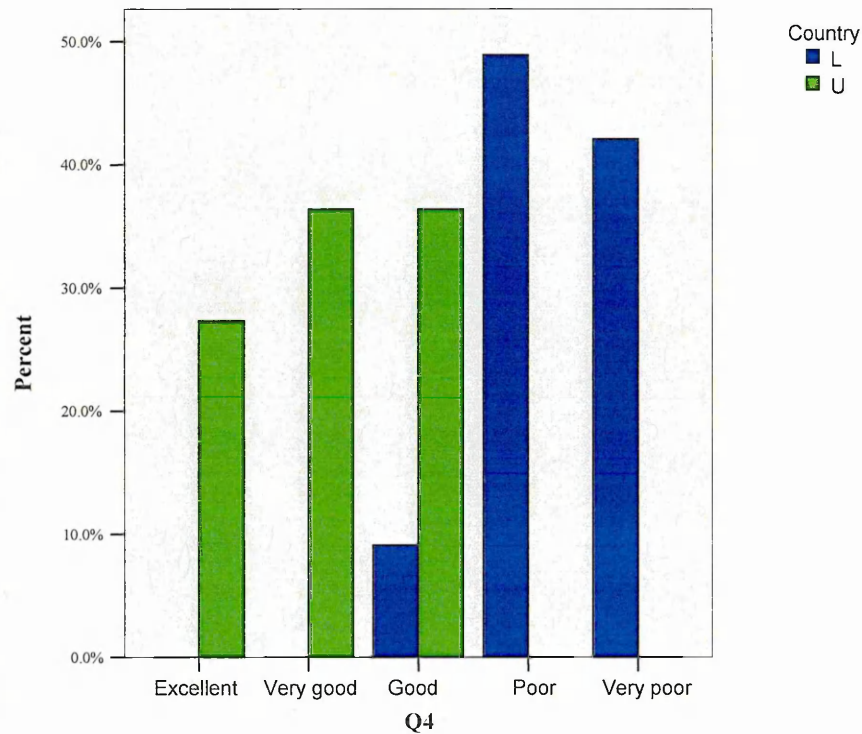


Figure 34: Responses about the Implementation of the Environmental Regulations

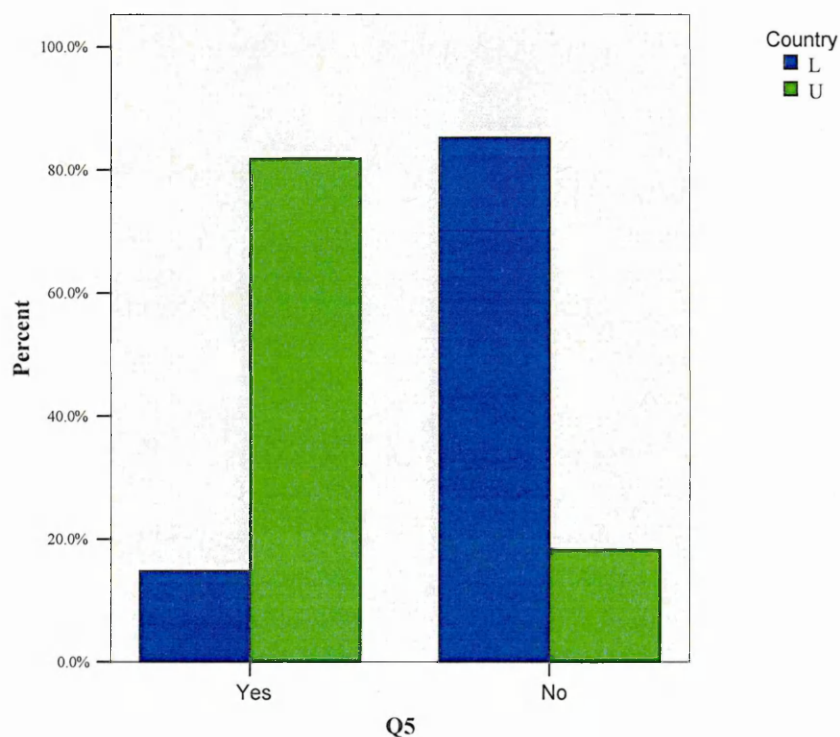
#### ***7.5.3.1 Governmental Pressure to Implement Environmental Regulations***

The government's position in implementing the environmental regulations is also one of the supposed indicators of protecting the environment. Asking the respondents in both countries their opinion about whether or not their governments put pressure on the oil and gas industry to implement the environmental regulations, gives an indication of how serious these governments are in implementing these regulations. Question 5 was formed to explore the employees' opinions about the governmental pressure to implement the environmental regulations and the results are shown in Figure 35.

Is there any pressure from regulators (the government) to implement environmental regulations?			Country		Total
			L	U	
Q5	Yes	Count	13	36	49
		% within Country	14.8%	81.8%	37.1%
	No	Count	75	8	83
		% within Country	85.2%	18.2%	62.9%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 35: Governmental Pressure to Implement Environmental Regulations**

There is a contrast in the respondents' opinions between the two countries about the governmental pressure to implement the existing environmental regulations. The Libyan and UAE governments are considered by respondents to differ dramatically in their attitude towards implementing environmental regulations. It seems that the environmental regulations in Libya are apparently neglected by the government. This encourages the companies in the country not to comply with these regulations. This contradiction is presented graphically in Figure 36.



**Figure 36: Governmental Pressure to Implement Environmental Regulations**



### 7.5.3.2 Environmental Policy Documents

A written environmental policy is now essential to any petroleum organisation, especially to those organisations which conduct big projects with potential impacts on the environment. Therefore, it is useful to know whether oil companies in both countries have written environmental policies or not. Accordingly, Question 6 was asked to find out whether the employees in the targeted companies are aware of any written environmental policies in their organisations. Figure 37 shows the results.

Are you aware that your organisation has any written Environmental Management System (EMS) or a written environmental policy statement in place?			Country		Total
			L	U	
Q6	Yes	Count	21	44	65
		% within Country	23.9%	100.0%	49.2%
	No	Count	67	0	67
		% within Country	76.1%	0.0%	50.8%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 37: Responses about the Environmental Policies**

It can be seen that all UAE respondents are aware that their companies have written environmental policies. This indicates that all employees have been informed about these policies. Surprisingly, most of the Libyan respondents said their companies do not have written environmental policies. This indicates that even if these written policies exist, they are not implemented and many employees have not heard about these policies. Figure 38 gives graphical indication.

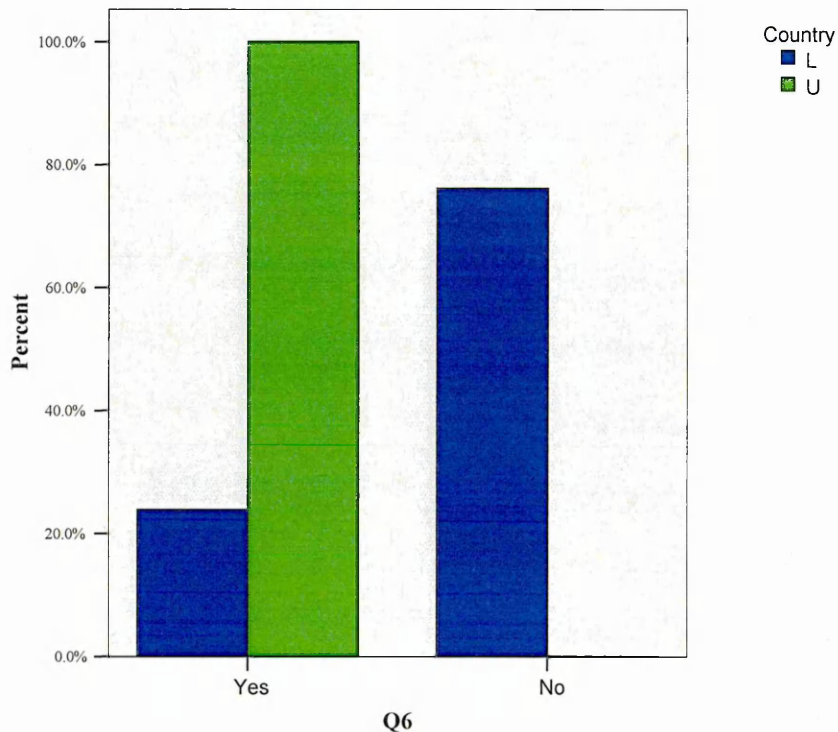


Figure 38: Responses about the Environmental Policies

### 7.5.3.3 Environmental Management System (EMS)

EMS is defined as a set of processes and practices that enable an organisation to reduce its environmental impacts and increase its operating efficiency. The legal implications of not having an EMS are compelling. Thus, EMSs are critically important especially to the industries that have high potential environmental impacts such as the petroleum industry.

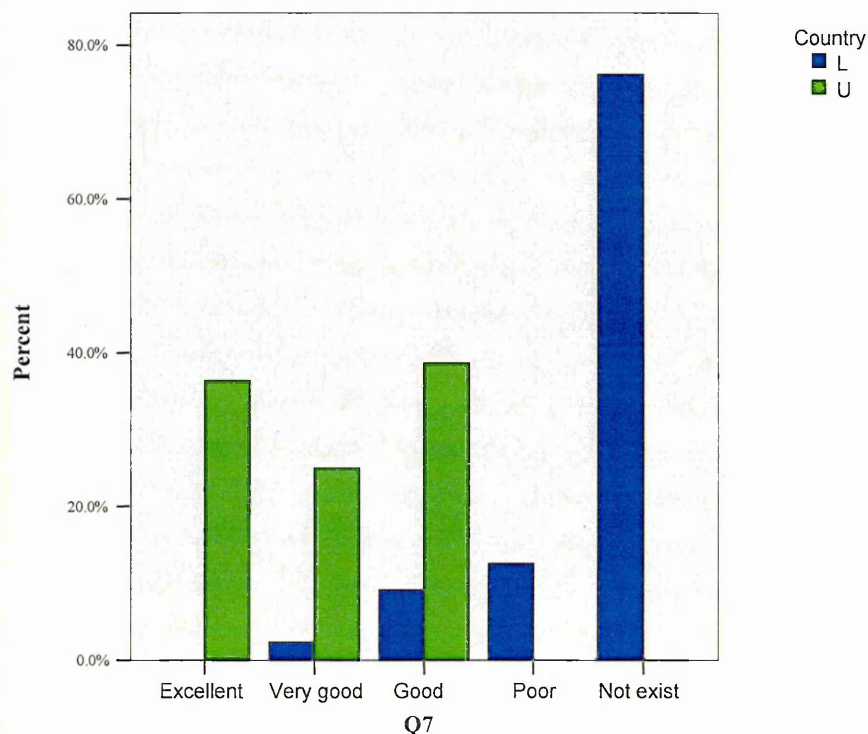
Figure 39 shows that all UAE respondents are aware that their organisations have environmental management systems in place whereas the majority of the Libyan respondents thought that their organisations do not have an environmental management system. None of the Libyan respondents considers his/her organisation to have an excellent environmental management system.



How do you see the environmental management system in your organisation?			Country		Total
			L	U	
Q7	Excellent	Count	0	16	16
		% within Country	0.0%	36.4%	12.1%
	Very good	Count	2	11	13
		% within Country	2.3%	25.0%	9.8%
	Good	Count	8	17	25
		% within Country	9.1%	38.6%	18.9%
	Poor	Count	11	0	11
		% within Country	12.5%	0.0%	8.3%
	Not exist	Count	67	0	67
		% within Country	76.1%	0.0%	50.8%
Total		Count	88	44	132
		% within Country	100.0%	100.0%	100.0%

**Figure 39: Employees' assessment of the EMS**

It can be concluded from the responses to Question 7 that the oil and gas industry in the UAE adopted, developed and implemented adequate EMSs, whereas the same industry in Libya faces a real challenge to implement EMSs. In Figure 40 which shows the results graphically a visible contrast can be seen.



**Figure 40: Employees' assessment of the EMS**

### 7.5.4 Compliance with the Environmental Regulations

To evaluate the oil and gas industry's compliance with the environmental regulations in both countries, the participants were asked to give their views about this issue. Figure 41 presents the results.

Do you consider the compliance of the oil and gas industry with environmental regulations is:			Country		Total
			L	U	
Q8	Very satisfactory	Count	3	12	15
		% within Country	3.4%	27.3%	11.4%
	Satisfactory	Count	7	30	37
		% within Country	8.0%	68.2%	28.0%
	Not satisfactory	Count	41	2	43
		% within Country	46.6%	4.5%	32.6%
	No compliance at all	Count	37	0	37
		% within Country	42.0%	0.0%	28.0%
Total	Count	88	44	132	
	% within Country	100.0%	100.0%	100.0%	

**Figure 41: Responses about Compliance with Environmental Regulations**

The UAE oil and gas industry demonstrates a high level of compliance with environmental regulations. In contrast, the Libyan oil and gas industry shows a very low level of compliance according to the questionnaire's respondents.

From the Libyan responses and comparing with the UAE responses, undoubtedly the Libyan petroleum industry's compliance with the environmental regulations is deplorable. It seems that the oil and gas industry in Libya does not face any real pressure and does not consider any self-commitment to comply with these regulations.

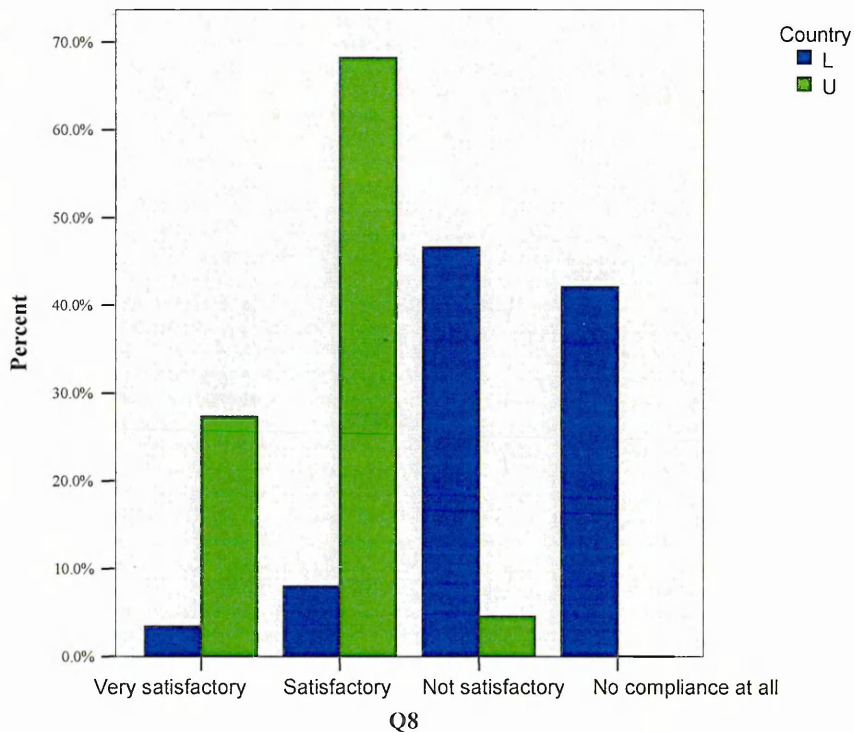


Figure 42: Responses about Compliance with the Environmental Regulations

### 7.5.5 Environmental Performance

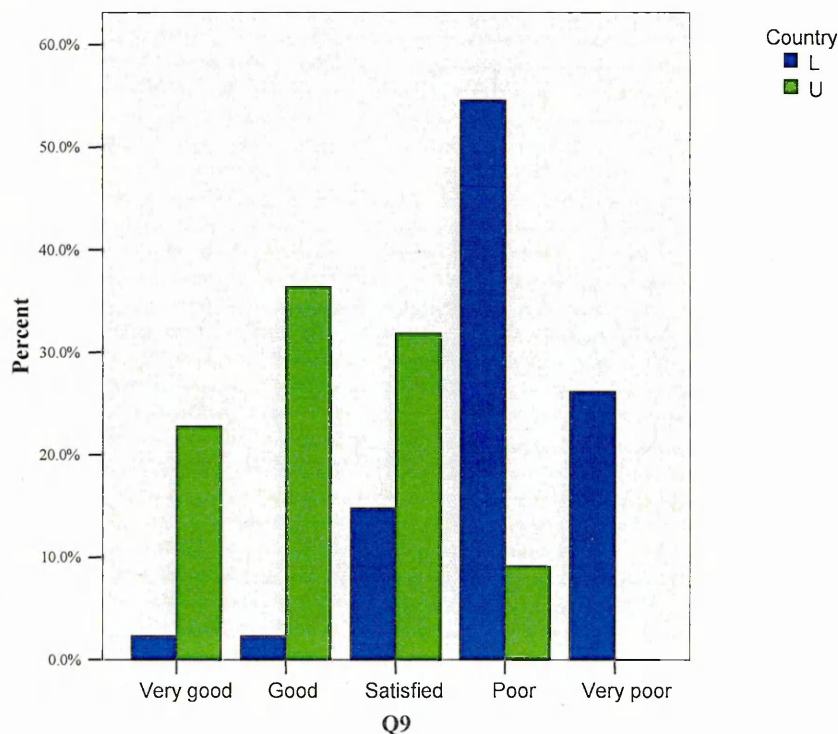
Environmental performance of any organisation reflects its concern about the environment and can be an indicator of successful environmental management. However, good environmental performance cannot be achieved without proper environmental management and poor environmental performance reflects poor environmental management.

From this perspective, the environmental performance was among the main questions.

How do you describe the environmental performance of your organisation?			Country		Total
			L	U	
Q9	Excellent	Count	2	10	12
		% within Country	2.3%	22.7%	9.1%
	Very good	Count	2	16	18
		% within Country	2.3%	36.4%	13.6%
	Good	Count	13	14	27
		% within Country	14.8%	31.8%	20.5%
	Poor	Count	48	4	52
		% within Country	54.5%	9.1%	39.4%
	Very poor	Count	23	0	23
		% within Country	26.1%	0.0%	17.4%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 43: Responses about the Environmental Performance**

The environmental performance of the oil and gas industries in Libya and the UAE according to these results is significantly different. In general, Libyan respondents reflected poor environmental performance, whereas UAE respondents indicated good environmental performance. The bar chart in Figure 44 presents the results in graphical manner.



**Figure 44: Responses about the Environmental Performance**

### 7.5.5.1 Dealing with the Environmental Impacts

Every organisation has its way of handling the environmental impacts resulting from its operations. Handling the environmental impacts reflects not only the understanding of these impacts but also the concern about them. Therefore, examining this issue is vital to such research. On this basis, the participants were asked to give their opinions about how their organisations handled the environmental impacts. This was obtained by Question 10 which is presented in Figure 45.

Do you consider that the environmental impacts of the upstream oil and gas industry in the country are dealt with:			Country		Total
			L	U	
Q10	Very properly	Count	4	10	14
		% within Country	4.5%	22.7%	10.6%
	Properly	Count	8	29	37
		% within Country	9.1%	65.9%	28.0%
	Improperly	Count	36	5	41
		% within Country	40.9%	11.4%	31.1%
	Completely neglected	Count	40	0	40
		% within Country	45.5%	0.0%	30.3%
	Total	Count	88	44	132
		% within Country	100.0%	100.0%	100.0%

**Figure 45: Responses about Dealing with the Environmental Impacts**

The results reflect an enormous gap between the two countries' petroleum industries in undertaking the environmental issues. Libyan responses illustrate inappropriate handling of the environmental impact. It is considered by the respondents that the environmental impacts in the UAE are dealt with much more properly than they are in Libya.

The chart in Figure 46 shows the enormous deviation between the countries' responses graphically.

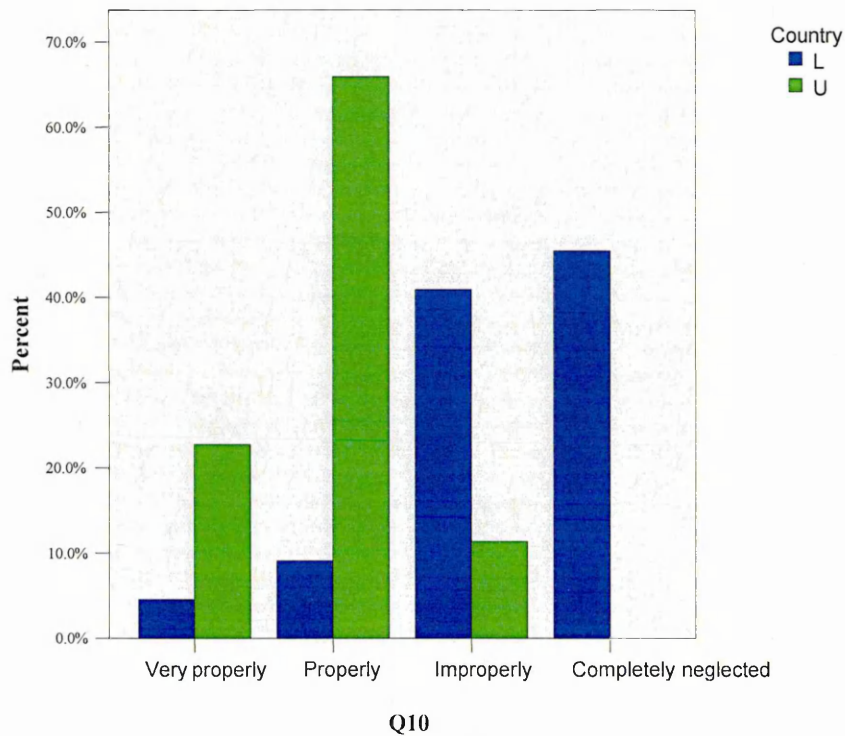


Figure 46: Responses about Dealing with the Environmental Impacts

#### ***7.5.5.2 Financial Incentives to Employees to Improve Environmental Performance***

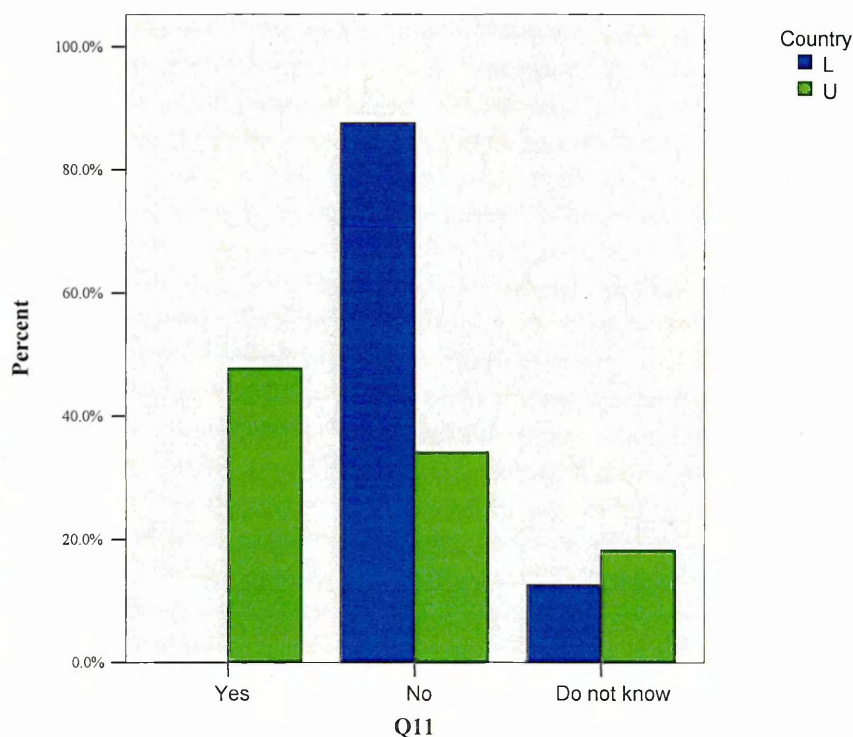
Motivating and encouraging the employees to improve their environmental performance can result in better environmental condition. The respondents from both countries were also asked whether they have been motivated or encouraged by financial or any other incentives to improve their environmental performance. The answers enhance the survey's results about the environmental management in both countries as any encouragement to improve environmental performance can be a sign of environmental concerns.



Is there any noticeable encouragement and/or incentive (financial or any other) is given to the employees to participate in improving the environmental performance of your organisation?			Country		Total
			L	U	
Q11	Yes	Count	0	21	21
		% within Country	0.0%	47.7%	15.9%
	No	Count	77	15	92
		% within Country	87.5%	34.1%	69.7%
	Do not know	Count	11	8	19
		% within Country	12.5%	18.2%	14.4%
Total		Count	88	44	132
		% within Country	100.0%	100.0%	100.0%

**Figure 47: Responses about the Financial or any other Incentives**

The responses to this question suggest a significant difference between oil and gas companies in the two countries in motivating their employees to perform environmentally. It seems that the oil and gas industry in Libya have not encouraged or motivated employees financially to improve their environmental performance. Figure 48 displays the results graphically.



**Figure 48: Responses about the Financial or any other Incentives**

### 7.5.6 Environmental Monitoring

An environmental monitoring system is a vital and an integral part of the environmental management system. The efficiency of the environmental monitoring system of the oil and gas companies in Libya and the UAE is, therefore, considered. Figure 49 presents the results about the environmental monitoring in the oil and gas companies in these two countries.

Do you consider the environmental monitoring system of the country's petroleum industry operations:			Country		Total
			L	U	
Q12	Very efficient	Count	0	11	11
		% within Country	0.0%	25.0%	8.3%
	Efficient	Count	14	26	40
		% within Country	15.9%	59.1%	30.3%
	Inefficient	Count	74	7	81
		% within Country	84.1%	15.9%	61.4%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 49: Responses about the Environmental Monitoring**

The comparison of the respondents' results presents a significant difference between Libya and the UAE in terms of their petroleum industries' environmental monitoring. As found in most other previous comparisons, the UAE monitoring system was considered by the respondents to be more efficient than it is in Libya. It appears that there is a failure of the environmental monitoring system of the oil and gas industry in Libya as can be concluded from the results of the questionnaire. The bar chart in Figure 50 shows the difference between the two countries graphically.



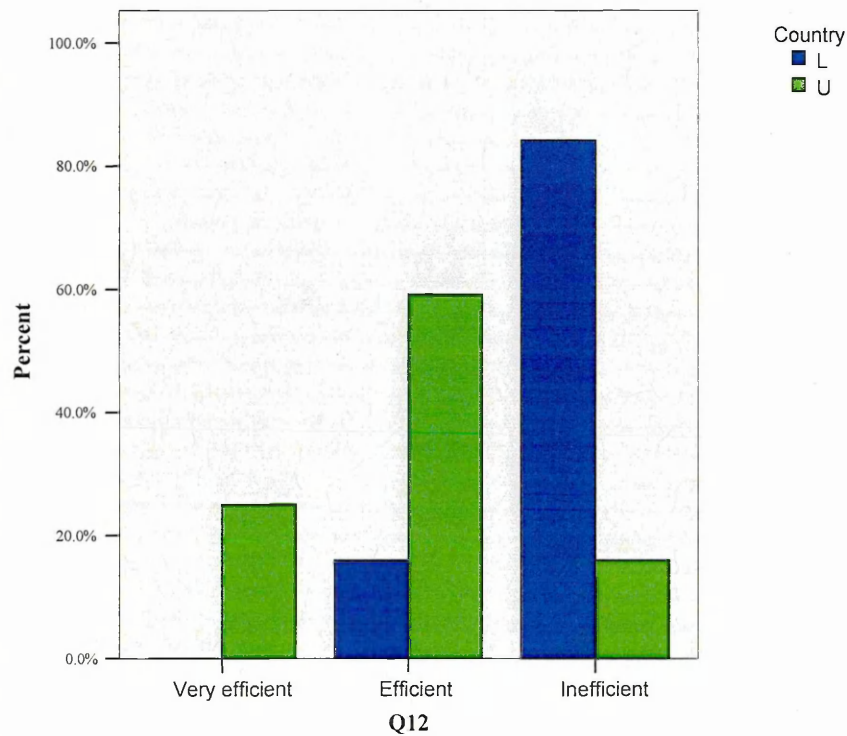


Figure 50: Responses about the Environmental Monitoring

### 7.5.7 Environmental Training

Recently many countries established national training organisations and some countries have training centres for oil and gas industries to ensure that environmental education and training arrangements are in place. These organisations are specialists in providing such trainings to all kinds of professionals. Thus, environmental training is now widely considered all over the world. Environmental training can be particularly important to the oil and gas industry, which has high potential environmental impacts due to exploration and production activities.

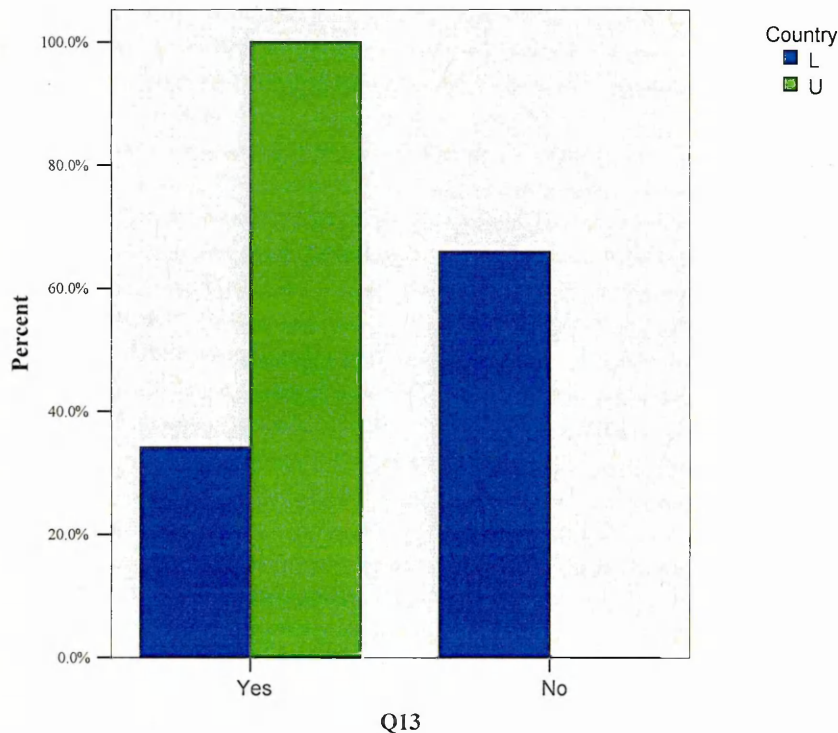
Accordingly, participants in the questionnaire survey were asked whether they have been given environmental training by their oil and gas companies or not.

From Figure 51, it can be recognised that all the UAE respondents have been given environmental training, whereas the majority of the Libyan respondents have never been given any kind of environmental training.

Have you ever taken any environmental training?			Country		Total
			L	U	
Q13	Yes	Count	30	44	74
		% within Country	34.1%	100.0%	56.1%
	No	Count	58	0	58
		% within Country	65.9%	0.0%	43.9%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 51: Responses about the Environmental Training**

The results show a significant difference between the respondents from the oil and gas industry from the two countries regarding the environmental training. Environmental training is highly considered by the UAE oil and gas industry compared with the same industry in Libya. A visual indication is presented in Figure 52.



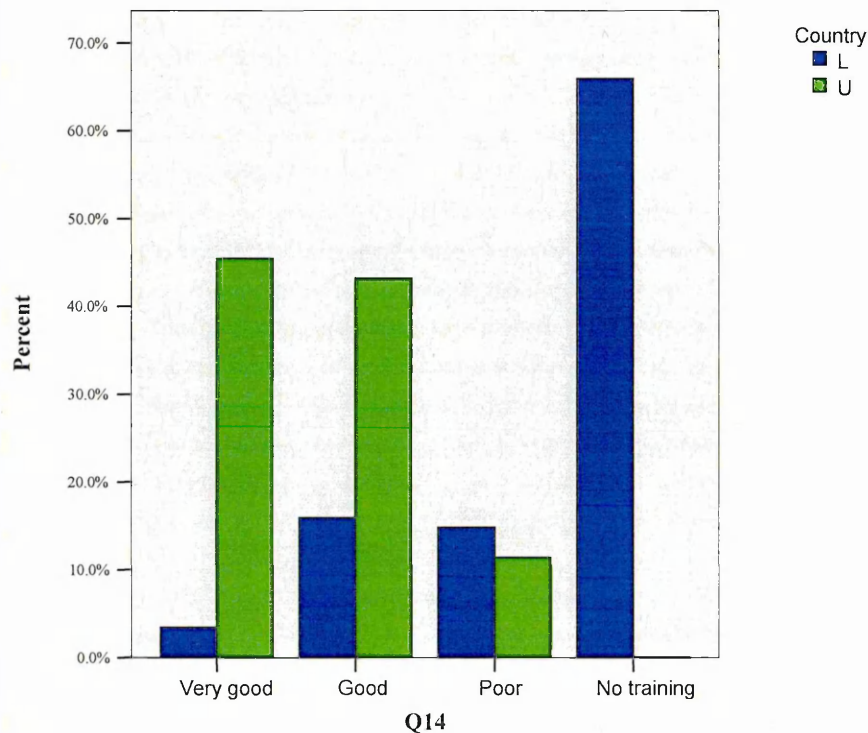
**Figure 52: Responses about the Environmental Training**

The respondents were asked about the quality of the training that they have been given. Figure 54 shows that the majority of Libyan trained employees said that they have been given poor training. By contrast, the majority of the UAE respondents said they have been given either good or very good training.

How do you see the environmental training programmes for the employees if any?			Country		Total
			L	U	
Q14	Very good	Count	3	20	23
		% within Country	3.4%	45.5%	17.4%
	Good	Count	14	19	33
		% within Country	15.9%	43.2%	25.0%
	Poor	Count	13	5	18
		% within Country	14.8%	11.4%	13.6%
	No training	Count	58	0	58
		% within Country	65.9%	0.0%	43.9%
	Total	Count	88	44	132
		% within Country	100.0%	100.0%	100.0%

**Figure 53: Responses about the Quality of Environmental Training**

In conclusion, it can be easily recognised that environmental training of the Libyan oil and gas industry is absent or very poor according to the questionnaire's results. Comparing these results it is clear that the Libyan petroleum industry has not provided adequate environmental training to its employees. This exposes the weakness of environmental management in the Libyan petroleum industry, especially since environmental training along with health and safety training in such an industry sector is essential. Environmental training and its quality is shown graphically in Figure 54.



**Figure 54: Responses about the Quality of Environmental Training**

### 7.5.8 Environmental Awareness of the managerial Staff

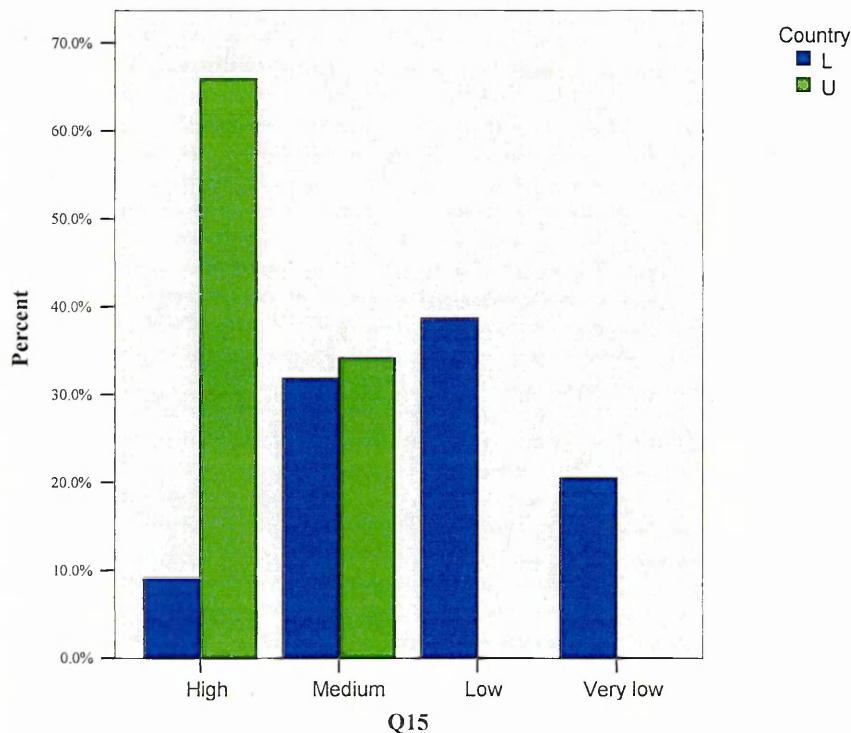
The environmental awareness of the staff is important as it can influence the environmental behaviour of the staff. The higher the environmental awareness the greater the opportunity to perform better environmentally. To explore the managerial staffs' environmental awareness in the oil and gas industry in both countries, the questionnaire survey includes this issue to compare the level of the environmental awareness between them.

The results show significant difference in environmental awareness between the managerial staff of the petroleum industry in Libya and the UAE as can be seen from Figure 55.

Do you think the environmental awareness of the managerial staff of your organisation:			Country		Total
			L	U	
Q15	High	Count	8	29	37
		% within Country	9.1%	65.9%	28.0%
	Medium	Count	28	15	43
		% within Country	31.8%	34.1%	32.6%
	Low	Count	34	0	34
		% within Country	38.6%	0.0%	25.8%
	Very low	Count	18	0	18
		% within Country	20.5%	0.0%	13.6%
Total	Count		88	44	132
	% within Country		100.0%	100.0%	100.0%

**Figure 55: Responses about the Environmental awareness of the managerial staff**

The majority of the UAE respondents considered the environmental awareness of the managerial staff is high, whereas Libyan respondents considered it between medium and very low. However, Figure 56 reflects these results graphically.



**Figure 56: Responses about the Environmental awareness of the managerial staff**



### 7.5.9 Management Structure of the Petroleum Industry

A well structured petroleum industry with adequate environmental departments can lead to successful management which in turn leads to better environmental performance. Accordingly, the management structure of the Libyan petroleum industry is considered in order to identify its influence on the environmental performance. Thus, investigating the structure of the Libyan oil and gas industry was one of the objectives of this research.

Both Libya and the UAE have a national oil organisation, which controls and owns the oil and gas industry via a number of affiliates and agreements with a number of foreign international companies. Thus, the main framework of the petroleum industry is extremely similar in both countries.

According to the respondents from both countries there is a different attitude about the managerial hierarchy of the oil and gas industry as can be seen from Figure 57.

What is your opinion of the current management structure of the petroleum industry:			Country		Total
			L	U	
Q16	Very good	Count	6	12	18
		% within Country	6.8%	27.3%	13.6%
	Good	Count	23	26	49
		% within Country	26.1%	59.1%	37.1%
	Bad	Count	38	2	40
		% within Country	43.2%	4.5%	30.3%
	Very bad	Count	21	4	25
		% within Country	23.9%	9.1%	18.9%
	Total	Count	88	44	132
		% within Country	100.0%	100.0%	100.0%

**Figure 57: Responses about the Petroleum Industry Structure**

The respondents show apparent variation towards the petroleum management structure as Libyan respondents are more pessimistic than the UAE respondents. Figure 58 shows the result graphically.

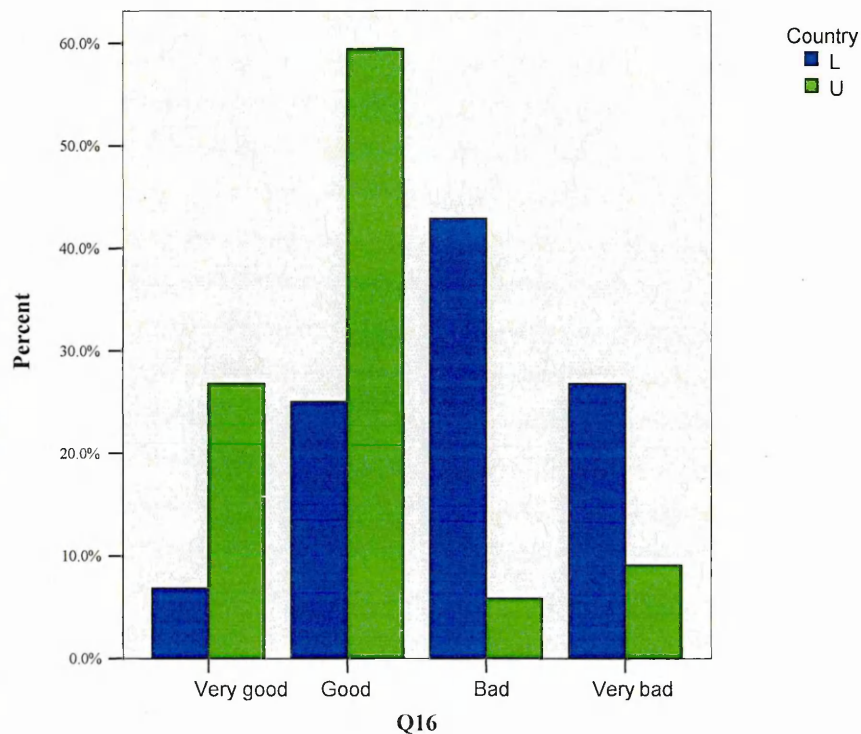


Figure 58: Responses about the Petroleum Industry Structure

#### 7.5.10 The Effect of the Sanctions

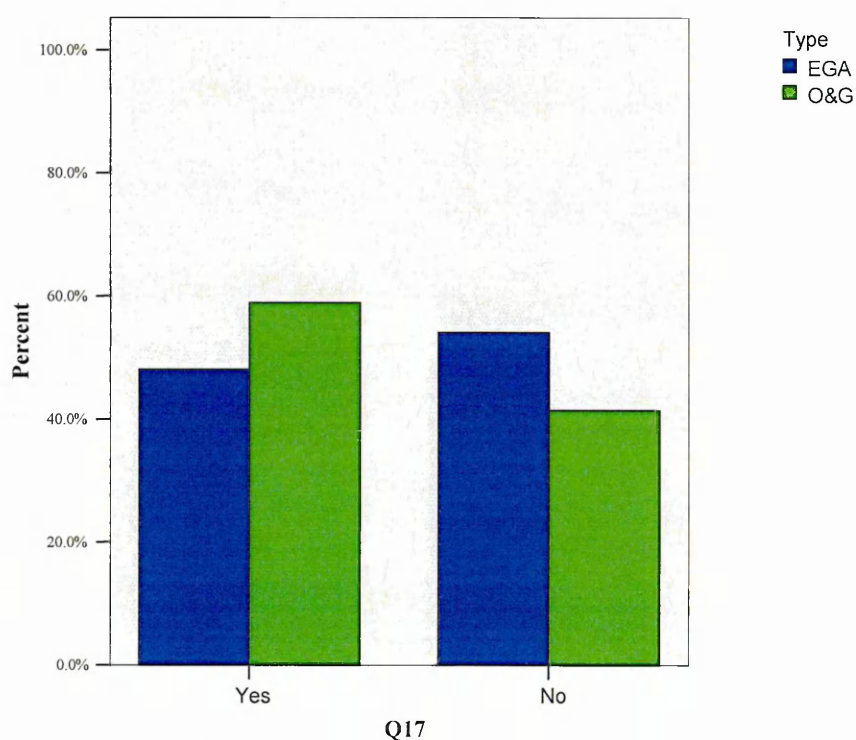
Two additional questions about the effect of these sanctions, which were imposed against the country, were asked to the Libyan oil and gas respondents and also asked to a random sample of 44 respondents from the Environment General Authority (EGA) in Libya. Therefore, the comparison is between the respondents of the Libyan oil and gas employees and Libyan members of staff at the EGA in Libya.

Figure 59 show that the majority of the oil and gas respondents thought that the sanctions had an effect on the environmental performance of the oil and gas industry. A smaller proportion of the respondents from the EGA thought that the sanctions had an effect on the environmental performance of the oil and gas industry.

Did the sanctions affect the environmental performance of the petroleum industry?			Type		Total
			EGA	O&G	
Q17	Yes	Count	21	52	73
		% within Type	47.7%	59.1%	55.3%
	No	Count	23	36	59
		% within Type	52.3%	40.9%	44.7%
Total		Count	44	88	132
		% within Type	100.0%	100.0%	100.0%

**Figure 59: EGA and O&G Responses about the Sanctions**

It can be concluded that respondents from both the Oil & Gas industry and EGA were considerably divided in their answers regarding the effect of the sanctions on the environmental performance. Surprisingly, significant proportions from both oil and gas industry and EGA respondents thought that there was no effect of the sanctions on the environmental performance of this industry. Figure 60 illustrates the results graphically.



**Figure 60: EGA and O&G Responses about the Sanctions**



Respondents who answered “Yes” there was an effect of the sanctions on the environment were asked whether that effect was negative or positive. From all respondents from both EGA and the Oil & Gas industry who said that there was an effect of the sanctions, only one respondent from EGA said the effect was positive towards the environment. This may be because he thought that the reduction of petroleum production led to less environmental pollution.

## ***7.6 Summary of the Questionnaire Analysis***

In this section, collected data from the oil and gas industry from Libya and the UAE about the environmental management issue by a questionnaire survey was analysed by SPSS software. Responses of a total of 16 identical questions from both countries about the environmental management issues such as environmental impacts, policies, performance, compliance and monitoring of the oil and gas industry were analysed. Each question of the questionnaire addressed an environmental or related managerial issue of the oil and gas industry. The results of each question were presented in tables and bar charts to explore and compare the differences between the responses from the two countries.

The respondents from Libya and the UAE admitted the existence of environmental impacts due to the petroleum industry in both countries. However, the comparison between the two countries showed significant differences almost in all questions of the questionnaire. These differences indicated that the UAE has a much more advanced position over Libya in this field. This can demonstrate poor environmental management of the Libyan oil and gas industry. Thus, it can be concluded that the environmental management issues of the Libyan oil and gas industry is not receiving adequate attention from the decision makers of this important industry sector in the country.

The impacts of the sanctions on the Libyan oil and gas industry were considered in the questionnaire. The Libyan questionnaire version included two additional questions about the sanctions, which were also included in the interviews with the staff from the EGA. In these questions the comparison was between the responses from the oil & gas industry in Libya and the responses from the Libyan Environment General Authority (EGA).

The effect of sanctions on environmental performance was acknowledged by more than half of the respondents from the oil and gas industry. A considerable proportion of the respondents thought that these sanctions did not have a direct effect on the environmental performance. EGA responses did not significantly differ from the responses from the oil & gas industry.

The results of the analysis above will be discussed and interpreted in the next chapter.

## **Chapter Eight**

### **Interpretation and Discussion of Evidence**

#### **8.1 *Introduction***

This chapter is devoted to discussing the results that were presented and analysed in the previous chapters and to trying to provide a logical interpretation of the evidence that emerged as an outcome of the analysis.

A cross-referenced table has been created (Table 29) to provide a summary of the evidence from multiple sources to facilitate the extraction of evidence to the reader. The table includes four sources of evidence: questionnaire survey, interviews, fieldwork evidence (photos, observation notes and quotations), and evidence from the literature reviewed.

The interpretation and discussion include the issues that were categorised and analysed in Chapter 7. Therefore, the results of all the ten categories are discussed and the most important implications for the understanding of the environmental issues related to the oil and gas industry in Libya are highlighted. Most of the issues were explored using at least three sources of evidence.

Finally, the main shortcomings of the oil and gas industry's environmental management which emerged from the discussion are summarised at the end of the chapter.

## 8.2 Cross-referencing of the Evidence

The key findings of the study are summarised in Table 29 allowing triangulation of the evidence relating to each of the ten key issues. These ten areas are then discussed in the following sections.

**Table 29: Cross-referencing of the evidence**

Main Issue	Evidence from the Questionnaire	Evidence from Interviews	Fieldwork Evidence Photographs Observation Quotation	Evidence from the Literature
<b>1- Environmental impacts of the oil and gas industry</b>	The significance of the environmental impacts of the Libyan upstream oil and gas industry are evident. More than 80% consider the environmental impacts of the exploration and production (E&P) operations are significant. See questions 1 and 2 in Section 7.5.1. (Chapter 7).	The environmental impacts of the Libyan oil and gas industry are significant and are not considered as they should be. All the interviewees acknowledged the significance of the E&P operations' impacts on the environment. See 7.3.1. (Chapter 7).	The photographs from the oilfields reflect the E&P operations' impacts on the environment. See Figures 12 to 21. (Chapter 3, Section 2). The researcher has also observed the impacts in the area of study.	There is a massive literature about the environmental impacts of the oil and gas activities. Thomas (1956) pointed out that: "A biohistory of the human tenure on earth shows a massive recent expansion in the nature, magnitude, and scale of environmental impacts". See (Chapter 3).
<b>2- Effectiveness of the environmental regulations</b>	In spite of that the majority see the regulation as not very effective, considerable numbers of respondents considered the regulations to be satisfactory in protecting the environment. See question 3 in 7.5.2. (Chapter 7).	Environmental regulations exist and have been recently revised. They can improve the state of the environment if they are properly implemented. See 7.3.2. (Chapter 7).	As one lawyer put it "The environmental regulations and laws are satisfactory. What is not satisfying and needs improvement is the implementation of these regulations".	The country has comprehensive environmental laws regardless of its effectiveness. See the Environmental Regulations, particularly Legislative Act No.7 of 1982 and Legislative Act No.15 of 2003.

\* The locations of the photos cannot be identified for reason of confidentiality.

<p><b>3- Implementation of the environmental regulations</b></p>	<p>It is evident that Libyan environmental regulations are not properly implemented. Implementing the environmental regulations is a big challenge to the petroleum industry in the country. More than 90% of the respondents considered the implementation of the environmental regulations either weak or very weak. See questions 4, 5, 6 and 7 in 7.5.3. (Chapter 7).</p>	<p>The Libyan environment is suffering from improper implementation of the environmental regulations by the oil and gas industry. All interviewees admitted that the implementation of the related regulations is weak. See 7.3.3. (Chapter 7).</p>	<p>The photos indicate weak implementation of the regulations. See the photos in Figures 14, 18, 20 and 22. (Chapter 3 section 2). The situation on the ground as seen by the researcher did not indicate proper implementation of the regulations.</p>	<p>Recently some signs have appeared indicating that the oil and gas sector is more serious about implementing the environmental regulations. Establishing an environmental department in the LNOC is the most significant sign in this regard. Benrageb (2005): <i>"the LNOC established the Environmental Protection Department three years ago in order to provide adequate safeguards for the environment"</i>.</p>
<p><b>4- Compliance with the environmental regulations</b></p>	<p>The petroleum industry sector does not adequately comply with the national environmental regulation. The majority of respondents think the oil and gas industry's compliance is unsatisfactory. See questions 8 in 7.5.4. (Chapter 7).</p>	<p>Until recently the oil and gas industry sector did not have plans for self-compliance with the regulations. The interviewees agreed that the compliance with the regulations is weak. See 7.3.4. (Chapter 7).</p>	<p>The photos indicate poor compliance with the regulations. See the photographs in Figures 15 to 22. (Chapter 3 section 2). The researcher has also observed poor compliance on site.</p>	<p>As in many other developing countries, the compliance with the environmental regulation in Libya still seems to be poor. Priyadarshini &amp; Gupta (2003): <i>"Though environmental laws are in place, firms display a very low level of compliance in developing countries"</i>.</p>
<p><b>5- Environmental performance of the petroleum industry</b></p>	<p>The environmental performance of the Libyan oil and gas industry is considered by the majority of the respondents to be poor. See question 9, 10 and 11 in 7.5.5. (Chapter 7).</p>	<p>The environmental performance is still considered insufficient by all interviewees including those from the oil and gas industry sector. See 7.3.5. (Chapter 7).</p>	<p>The photos from the oilfield confirm poor environmental performance. See the photographs in Figures 12 to 22. (Chapter 3 section 2).</p>	<p><i>"Developing-world regulators, already marginalised in their own countries, will have little to show for their efforts in terms of a cleaner environment"</i>. (Bell and Russell, 2002). The environmental performance can be considered as poor.</p>

<b>6- Environmental monitoring</b>	Most of the respondents considered that the environmental monitoring system is inefficient. See question 12 in 7.5.6. (Chapter 7).	Monitoring the environmental impacts of the oil and gas industry does not meet the international standards in this field. There is a consensus among the interviewees that the monitoring system is ineffective. See 7.3.6. (Chapter 7).	It seems that the environmental monitoring system is completely absent and the researcher did not find any environmental monitoring system or equipment in the oilfield. See the photos in Figures 12 to 22. (Chapter 3 section 2).	Hilary, Terezinha & James (2003): "Stewardship of the environment requires the development and/or adoption of cost-effective environmental monitoring system to provide data for planning at national, regional and local scales". Benrageb (2005): <i>the LNOC established the Environmental Protection Department three years ago in order to provide adequate safeguards for the environment</i> ".
<b>7- Environmental training</b>	Environmental training is not adequately considered in the oil and gas sector. A few companies have started to provide some environmental training but it is still inadequate. Most employees have not taken environmental training and the others were given poor training. See questions 13 and 14 in 7.5.7. (Chapter 7).	Some oil and gas companies do not have environmental training programmes and some have recently started to give short training courses. See 7.3.7. (Chapter 7).	During his visit to the oilfield, the researcher did not find a single person who has taken an environmental training. The researcher noticed that all trained employees are mainly trained in technical and managerial subjects.	The petroleum sector has qualified personnel who are trained in the country and abroad. (Ghanem 2007): "we still need the experience of training abroad and further studies". According to Otman (2006): "in the period from 1998 to 2002, a total of 1964 national employees left the petroleum sector".
<b>8- Environmental awareness of the managerial staff</b>	Some of the managerial staff are aware of the environmental impact of the petroleum industry but in general environmental awareness among the managerial staff ranges between medium and low. See question 15 in 7.5.8. (Chapter 7).	The environmental culture of the oil and gas industry's staff is poor. EGA interviewees considered the awareness of the oil and gas industry managerial staff is not very high. See 7.3.8. (Chapter 7).	Environmental awareness is expected to rise due to the environmental measures that have been taken by the LNOC (creating environmental department) and the EGA (giving environmental courses).	Environmental awareness is an integral part of the environmental management system. "The importance of environmental education and awareness training in organisations has been well established in the literature" (Beard 1996; Bird 1996; Hart 1996; Tietenberg 2003).

<p><b>9- Management structure of the petroleum Industry</b></p>	<p>The environmental performance of the UAE, which has a very similar structure to that in Libya, is far better than the environmental performance of the Libyan oil and gas industry according to the questionnaire. This means that the management structure of the petroleum sector is unlikely to obstruct the improvement of the environmental performance. However, the managerial structure of the oil and gas sector in Libya is seen by considerable proportion of the respondents as not very good. See question 16 in 7.5.9. (Chapter 7).</p>	<p>The managerial structure of the oil and gas sector suffers some managerial weaknesses such as constant change according to three interviewees. (one refused to talk about this issue) See 7.3.9. (Chapter 7).</p>	<p>The researcher noticed that the current management structure of the oil and gas industry sector is suffering from bureaucracy and an inconsistent relationship between the LNOC and its affiliates.</p>	<p>Zaslavsky (2006), noticed that the high rank of the Libyan hierarchy has seen regular reshuffles as ministries were created and dissolved (e.g. the Energy Ministry was dissolved in 2000 and re-established in 2004) and the most recent government reshuffle came in march 2006. Otman (2006) argued that: <i>"The conflict of power has led directly to two undesirable consequences, Firstly, the LNOC itself emerged in the post-sanctions era as a massively complex organisation which is not only inefficient and unprofitable, but appears to lack accountability to any other Libyan government institution to benchmark or judge its performance"</i>.</p>
<p><b>10- The effect of the sanctions</b></p>	<p>The sanctions affected the oil and gas industry's environmental performance. Nearly half of the respondents thought that the sanctions had negative environmental impacts. See questions 17 in 7.5.10. (Chapter 7).</p>	<p>The sanctions rigorously obstructed the development of the oil and gas industry. All interviewees thought that the sanctions had negative impacts on the state of the environment. See 7.3.10. (Chapter 7).</p>	<p>The researcher has been told during his oilfield visit that old technology is used. The separators, which separate oil from water, are out of date and some modifications had been done to keep them working. The researcher has also observed this in the oilfield.</p>	<p>The petroleum industry was affected. <i>"The trend of development and progress in the areas of exploration and production were substantially damaged"</i>. (Alavi 2003). <i>"Libya's oil and gas sector has suffered from 20 years of sanctions, but we are proud that, despite this, we have been able to maintain the country's oil and gas production levels over the years"</i>. (El Shahab, 2007). See 5.5. (Chapter 5).</p>

Table 29: Cross-referencing of the evidence

### **8.2.1 Environmental impacts of the oil and Gas Industry**

The awareness of the environmental impacts of the oil and gas industry has been increasing at all levels locally, nationally and internationally over the last three decades. Considerable studies have been conducted and several techniques have been designed to predict, investigate and record the types of impact of a proposed development on the environment. Understanding the environmental impacts is the key to achieving sustainable development. Environmental Impact Assessment (EIA), which was discussed in Chapter Two, is one of the most powerful techniques to predict and suggest mitigation measures or alternatives to the proposed projects. Oil and gas development projects which have high potential environmental impacts are now not conducted without considering their impacts on the environment.

As the Libyan oil and gas exploration and production industry began in the nineteen-fifties, environmental impacts have accumulated over a very long period of operation. However, the state of the environment and performance of the Libyan petroleum industry have not seen any significant improvement even after the environmental management techniques have been introduced. This means these techniques are not adopted and implemented in a way that can significantly reduce the environmental impacts and improve environmental performance. All evidences, including the comparison with the UAE, indicate that the state of the environment due to the environmental impacts of this industry is unsatisfactory.

Every country is unique in the way it deals with their circumstances. Just recently the Environment General Authority (EGA), which is Libya's environmental monitoring and permitting body, is not permitting any development with potential environmental impacts without an environmental impact assessment. Moreover, the companies that operate or will operate in the field of oil and gas exploration and production must have ISO 14001 by 2008 to be able to operate in the country, according to the head of the EGA. EIA has recently been adopted by the LNOC's affiliates, and any operating oil companies in Libya now have to conduct an EIA before the beginning of their operations. These recent steps by the EGA and the LNOC mark a new approach to translate the environmental concerns into real actions on the ground. However, despite these steps, the evidence from all sources suggests that the



environmental impacts of the Libyan oil and gas industry are still significant. This means that they need to be further encouraged and continuously supported by plans and policies to mitigate these impacts and to improve environmental performance and achieve more sustainable development through exploiting and developing the country's natural resources.

### **8.2.2 Effectiveness of the Environmental Regulations**

Initially, any regulations or laws to protect the environment reflect awareness and recognition of the environmental issues regardless of the effectiveness of these laws and regulations in protecting the environment. However, legislation and laws can be adopted from other countries and amended to be applicable and suitable to the adopter. The international community has also provided some important agendas and basic guidelines, which can be considered nationally and even locally, about issues that concern the whole international community. Environmental issues such as global warming, depletion of the ozone layer, acid rain and gas emissions are transboundary issues which affect mankind on the earth (see Figure 4, in Chapter 2). Thus, almost all countries over the world have adopted environmental legislation.

The effectiveness of the regulations can only be assessed after serious implementation. Some developing countries have adopted modern environmental regulations but have failed to reach good results. Bell & Russell, (2002) emphasised that most developing countries have long established laws and formal governmental structures to deal with their environmental problems, but only a few of them have been successful in alleviating those problems.

Although almost all respondents to the questionnaire survey thought that the Libyan environmental regulations are not implemented, the majority of respondents are satisfied with the current regulations themselves. Interestingly, the results from Libyan and the UAE respondents show similar results about this point which implies that the problem is the implementation and not the regulations. Most of the interviewees also think that these regulations would be effective if they were properly implemented. The regulations are now being revised and amended and this will make them more effective and it is possible that these regulations, especially the

Environment Protection Act No 15/2003, can alleviate the environmental impacts of any development activities in the country.

The Petroleum Law is very old as it dates from 1955 and does not include any environmental considerations. The petroleum industry sector is preparing a new petroleum law which is expected to concentrate on a new form of contracts for exploration and development of the oil and gas industry in the country. The new law is expected to be much more effective as environmental protection is expected to be included in this modern law. However, this will not replace the national environmental laws, particularly the Environment Protection Act No 15/2003.

### **8.2.3 Implementation of the Environmental regulations**

Well-designed environmental regulations can be beneficial but without proper implementation they will not improve performance. The implementation of the legislation and laws in many developing countries is generally weak, especially when the legislation deals with issues such as environmental protection. Singh & Brown (1999) stated that most developing countries have introduced several environmental regulations, but the implementation has been weak. Enforcement of the standards among developing countries is usually feeble due to inadequate infrastructure and lack of stake in the process as they are *standard-takers* rather than *standard-makers*. This may partly explain the currently weak implementation of the environmental regulations in Libya. Unambiguous evidence, including interviews and questionnaire survey responses, photographs from oilfield sites and personal observations, all demonstrate weak implementation of the environmental regulations in Libya. Lack of competency and fragmentation of responsibility has also led to problems of implementation of existing laws. The researcher did not find any signs of strict implementation of the regulations in the past. Furthermore, some of questionnaire respondents were not aware of any written environmental policy despite their companies having such policies in written documents. There is a big difference, therefore, between what is on paper and what is happening on the ground.

Recently, there has been an improvement in terms of implementation of the environmental regulations by both the EGA and the oil and gas industry

sector. As a sign of significant improvement, the EGA has successfully dealt with the accident involving an oil shipment tanker belonging to Aegean Shipping Management when about 200 cubic metres of oil spilled into the Mosrata seaport (as described in Section 6.2.1 in Chapter 6). LNOC has also become more concerned about its environmental performance since the establishment of its Environmental Protection Department in 2003. Despite this improvement, it can be said that the affiliates of the LNOC still need facilities such as technical equipment, financial support and trained staff. This was confirmed by one interviewee from the environmental department of one of the oil companies who said:

*"We are suffering lack of skilled staff and equipment".*

This was also observed by the researcher during his oilfield visit in the desert where there was no sign of proper implementation of the environmental regulations.

Surprisingly, despite its recent efficacy, EGA is still in reality unable to force the LNOC to implement all the environmental regulations, as illustrated in Chapter 6. This improvement may still not be tangible to many of the employees in the oil and gas industry sector as the meetings between the EGA and the LNOC are only between the senior managerial staff. More effort and time are needed to change the performance and the situation on the ground.

#### **8.2.4 Compliance with the Environmental regulations**

Compliance with environmental regulations in many developing countries is always problematic, even by the international companies which completely comply with regulations and implement self-compliance plans in the developed world.

Priyadarshini & Gupta (2003) stated that: Though environmental laws are in place, firms display a very low level of compliance in developing countries. For example, the compliance of the Shell Oil Company with the national regulations in Nigeria differs from its compliance with the British regulations in the UK. Morris (2007) states that:

*"Shell Nigeria obviously used lesser operating standards than used by Shell in developed nations, demonstrated by the fact that forty per cent of its total worldwide spills occurred in Nigeria over a ten-year period".*

This may indicate that the same company complies with the regulations differently in different countries. This also means that companies may not comply with the regulations when they expect that they will not be enforced to do so.

Compliance with environmental regulations may incur some additional expenses that the companies spend in the short term. In the situation when there is no enforcement, and penalties will not be imposed by the monitoring bodies, such as the environmental agencies, the companies may not be willing to spend money to protect the environment as this will reduce its profit. However, compliance with environmental regulations can benefit the oil companies and retain their right to operate. Thus, environmentally respected oil companies consider compliance with the environmental regulations to be one of their goals.

Regarding the national companies operating in their countries the scenario should differ. In this case the national companies are ultimately owned by the public. Therefore, as the public are the shareholders, complying with environmental regulation is in the interest of the shareholders. From this perspective, publicly-owned companies are expected to be more careful towards the environment and should implement self-compliance programmes with the environmental regulations.

Devoting a budget to implementing environmental regulation does not necessarily lead to reduction of the profit of the shareholders. The benefit from protecting the environment to the shareholders may be worth more than the cost of the environmental protection. Thus, Stout (2005) argued that:

*“Other-regarding shareholders might prefer to sacrifice at least some corporate profits in order to benefit (at least avoid harming) employees, consumers, society, or the environment”.*

However, despite the establishment of the environmental protection department in the LNOC whose role according to Benragab (2005) is to provide advice and assistance to companies operating in Libya to comply with the Libya’s environmental law, the evidence, presented in Table 29, indicates poor compliance with the environmental regulations in the oil and gas industry sector in Libya. Evidence from the questionnaire and interviews suggests that there is no real governmental

enforcement pressure imposed upon this sector to comply with the environmental regulations (see 7.3.5, 7.3.6 and 7.5.3.1 in Chapter 7).

### **8.2.5 Environmental Performance of the petroleum industry**

The environmental performance reflects the environmental behaviour and management of an organisation. Therefore, the environmental performance cannot be improved without implementing environmental policy and a commitment to a systematic approach to an environmental management system. This requires implementing an Environmental Management System (EMS) model such as ISO14001, the general purpose of which is to provide assistance to implement or improve the EMS. In fact, the majority of the questionnaire respondents thought that their companies did not implement any EMS.

The situation on the ground indicates that the environmental performance of the petroleum industry sector is very poor despite the LNOC's recent measures such as the creation of the Environmental Protection Department. This can be clearly understood from many sources of evidence. For example, the questionnaire survey shows stark contrast between the responses of Libya and UAE. The majority of the Libyan respondents considered the environmental performance of the Libyan oil and gas sector to be bad whereas the majority of the UAE respondents considered their oil and gas industry's environmental performance to be good. The majority of the Libyan respondents were not aware of any written environmental policies or any environmental management systems in their companies, while all UAE respondents confirmed that their companies have written environmental policies and environmental management systems.

Abu Dhabi National Oil Company (ADNOC) and all oil companies in the UAE, produce environmental reports. These reports, which are available in their websites in both Arabic and English languages, include their environmental policies and plans and all related environmental activities and information. The researcher did not succeed in finding any environmental reports from any Libyan oil companies during his fieldwork and no such reports are published on their websites, which mostly are still under construction (including the LNOC website).

The LNOC requires any operating company to conduct an EIA for any new development project which should be permitted by the EGA. These measures are expected to improve the environmental performance of the oil and gas industry in Libya especially as this sector is witnessing significant development after the end of the sanctions.

### **8.2.6 Environmental Monitoring**

An environmental monitoring system is a vital process of EMS which is built on the "Plan, Do, Check, Act" model and leads to continual improvement (see Figure 1 in Appendix 1 for the "Plan, Do, Check, Act" model). Environmental monitoring helps in detecting problems resulting from day-to-day operation and allows prompt implementation of effective corrective measures. As mentioned in Section 2.3.7, projects such as oil and gas exploration and development require the setting up of an environmental monitoring system to cover all their life-cycle. This requires accurate monitoring data and should be planned before the beginning of the project. As Hilary, Terezinha & James (2003) stated:

*"Stewardship of the environment requires the development and /or adoption of cost-effective environmental monitoring system to provide data for planning at national, regional and local scales".*

Most of the petroleum industry's activities in Libya do not have an environmental monitoring system to take suitable measures to mitigate the environmental impacts. This can be clearly noticed from the situation on the ground. The researcher also failed to access any environmental monitoring data if there were any. Moreover, the majority of the Libyan questionnaire respondents thought that the environmental monitoring of their companies is ineffective and that some oil companies have not had environmental monitoring systems or even environmental policies, as was stated by one interviewee. In contrast, the majority of the UAE respondents thought that the environmental monitoring systems of their companies are effective.

It is obvious that in the absence of environmental policy and poor environmental management it cannot be expected that there is a good environmental monitoring system. The environmental policy must state the objectives in terms of compliance with environmental regulations and pollution prevention, and commitment to improve environmental performance. This includes establishing an effective environmental

monitoring system to monitor and measure the performance and take corrective action when necessary.

An environmental monitoring system should, therefore, be integrated into any EMS adopted by any Libyan oil company to fulfil the objectives of the environmental policy. Monitoring should be regular and performed over the life time of the operation to collect and measure the environmental impacts of exploration and development in order to draw accurate conclusions concerning these impacts.

### **8.2.7 Environmental Training**

Enabling an organisation's personnel to perform environmentally requires effective environmental training. This is particularly important in developing countries. It is more important in sectors such as the oil and gas industry where potential environmental impacts are high. Training is one of the most critical tools to allow employees to learn and adopt new mindsets, skills, and attitudes. Therefore, environmental training should receive adequate attention in order to increase the environmental performance of the employees.

As explained in chapter 6.4.1, the Libyan petroleum industry has made considerable efforts to train its employees, though environmental training has not been given the attention that it should receive. Most of the trainees in the country and abroad have received training related directly to exploration and production, such as mechanical, chemical, drilling and electrical subjects. Some staff were also sent abroad to study subjects related to management and marketing, such as management, computing and accounting as well as the English language. All these subjects are receiving considerable attention and the sector has highly qualified staff at the individual level compared with other public sectors. However, many Libyan qualified engineers have left the Libyan petroleum industry, as stated in Chapter 6.4.2, seeking better financial conditions elsewhere. Many of them went to the Arabian Gulf Countries.

Environmental training may be the weakest link in the overall management of this industry in Libya. The questionnaire results clearly indicate that environmental training in the Libyan petroleum industry is completely absent in most oil companies

and poor in other companies. This can be also concluded from the absence of the environmental protection department of the LNOC for the past period until recently. This contrasted with the results of the UAE respondents who all said that they have been given environmental training and generally evaluated that training as good.

It seems that environmental performance is now improving, as demonstrated by the establishment of an environmental department at the LNOC. The aim of the environmental department is to improve environmental performance. This has required environmentally qualified staff and plans to provide environmental training to employees. In addition, international oil companies in Libya will operate under the supervision of the environmental protection department of the LNOC. This may force these companies to comply with the environmental regulations more rigorously. One condition for these international companies is to provide training to Libyan employees and that includes environmental training.

### **8.2.8 Environmental Awareness of the managerial Staff**

The environmental awareness of all members of the managerial staff is important in order to realise sustainable environmental management. High levels of environmental awareness among the management staff can increase the participation in environmental activities. As an integral part of the organisation, not just the management staff but all employees need to be allowed and encouraged to participate in the environmental management initiatives. Energy companies' responsibility towards the environment is considerable as these companies produce considerable waste and pollution. Oil and gas companies are usually powerful and profitable. This should encourage such companies to deal with environmental issues seriously and effectively. Therefore, increasing environmental awareness among the oil and gas industry's employees in general and among management staff in particular is necessary to formulate and implement successful EMS.

According to the evidence collected from several sources including the questionnaire and interviews, it cannot be said that the environmental awareness of the managerial staff of this industry in Libya is high. The UAE responses indicated higher environmental awareness of the managerial staff of the UAE oil and gas industry. This may be attributed to the environmental training that they have been given



according to their answers to the questionnaire. However, as mentioned earlier, petroleum companies usually have considerable resources and this assists the oil companies to attract and prepare highly educated and skilled managers.

The global oil industry has many interrelationships, often taking the form of international organisations and forums such as The International Petroleum Industry Environmental Conservation Association (IPIECA) and Organisation of the Petroleum Exporting Countries (OPEC). These relationships play a positive role in organising conferences and exchanging ideas and information, and increasing environmental awareness among the participating managers. Thus, the oil company managers in Libya are affected by these relations and the industry's world environment, and are usually aware of the environmental impacts of their industry. However, this is not reflected effectively on the ground due to other factors that may be out of their hands, such as their limited authority or the priority of production over environmental performance.

Recent signs indicate increased concern about environmental issues, the results of which include the provision of awareness training to the employees of the oil and gas industry. The responsibility of the recently established environmental protection departments of the LNOC and its affiliate companies is to integrate EMS into oil and gas operations and this includes raising environmental awareness among the employees and incorporating it into the total management of their operations.

### **8.2.9 Management Structure of the Petroleum Industry**

The oil and gas sector in the country is the most important sector of the economy.

*"Oil exports account for 95 per cent of foreign-currency earnings and about 30 per cent of the nation's gross domestic product (GDP)". Marshall Cavendish Corporation (2006).*

Therefore, it is not surprising that this sector is receiving more governmental consideration than other sectors in such a developing country. This does not mean that this sector is perfectly structured and managed. It simply means that compared with other public or governmental sectors, the petroleum industry sector in Libya seems to be better structured and equipped by funds and skilled staff because the LNOC, which is the country's petroleum industry arm, is a very powerful institution.

The power of the LNOC exceeds what it has been given by the law. This is because of its strong position and contribution to the country's economy.

Efficient structural hierarchy and successful total management of this sensitive sector undoubtedly increase the chance of better environmental management. However, the success of the petroleum sector's management and structural hierarchy can be evaluated by several means such as comparing this sector with the same sectors in other countries.

Thus, in order to assess the management structure of the Libyan oil and gas industry and identify any shortcomings occurring in this sector's management structure, a comparison with the UAE's petroleum management structure was conducted. The reason for choosing the UAE's petroleum industry (which was explained in Chapter 4, Section 4.3.3) is that the two countries have a very similar management structure (hierarchy) in their oil and gas industry. Despite that, the answers to the same question about the management structure of the sector in each country were significantly different. Moreover, according to the questionnaire results, there is an enormous gap between the overall environmental performances of the petroleum sectors in the two countries (Chapter 7, Section 7.5.9). This means that the management hierarchy of the Libyan petroleum industry itself does not constrain the improvement of the environmental performance. This also suggested that the total management, including environmental management, of the Libyan oil and gas industry can be improved, as suggested by the UAE's success. The management hierarchy of this important sector, therefore, may be suitable for Libya. This can be understood from the experience of UAE, which has similar management hierarchy with successful management.

Thus, it can be argued that Libyan environmental management has the chance to be improved without dramatic change to the current structure of its petroleum industry. Taking advantages from the experience of the UAE will help the Libyan petroleum industry in this field. However, this structure may still be the most suitable for developing countries to take advantages from foreign companies in order to gain the technology and skills that foreign companies employ.

However, there are some weaknesses of the management structure of the Libyan oil and gas industry. The main obstruction might be the constant change to which it has been subjected, as elaborated in Chapter 6, Section 5.4, and as confirmed by the evidence (see the interviews in Chapter 7, Section 7.3.9). LNOC governs its subsidiaries in an unproductive manner, as LNOC affiliates are restricted by the LNOC and all strategies, budgets and plans must be approved by the LNOC. For example, LNOC's subsidiaries do not have enough power to make decisions about their budgets or to obtain technology that is necessary to comply with environmental demands and other internal affairs. They only suggest the budget but the decision is taken by the LNOC. The evidence suggested that these circumstances restrict the LNOC affiliates from taking the necessary measures to operate environmentally.

The employees' financial position including their salaries have been frozen since 1981 as a result of the Government Decision No. 15 of 1981 about the national employment wages, which affected all Libyan employees. Accordingly, some very highly skilled national employees have left the oil sector after they trained at the expense of the LNOC, seeking better jobs abroad, leaving the industry weakened. According to Otman (2006), in the period from 1998 to 2002, a total of 1964 national employees left the petroleum sector. However, this situation recently seems to be improving.

However, it seems that the management of the oil and gas industry sector has recently been improving under the current management led by Dr Shukri Ghanem a former Prime Minister who led a reform programme trying to modernise the economy and liberalise the trade environment. In November 2005, Shukri Ghanem carried out a major reshuffle of NOC and its subsidiaries, replacing several senior officers. The reshuffle is thought to be part of a wider plan to reform the industry and attract overseas investment.

LNOC has recently been very successful in attracting foreign investment to the Libyan petroleum sector where many international companies have competed to win and sign exploration and production sharing agreement (EPSA) contracts with the LNOC. The improvement includes many management aspects such as the internal

management of the LNOC and its subsidiaries, the communications and even the employees' salaries. There is a tangible improvement to the website of the LNOC (<http://en.noclibya.com.ly>) and its affiliates although these websites are still under construction.

### **8.2.10 The Effect of the Sanctions**

The UN sanctions which were imposed on the country between 1992 and 2003 had a substantial impact on the country's economy in general and on the oil and gas industry in particular as mentioned in Chapter 5, Section 5.5. The oil and gas industry was targeted by the sanctions and negatively affected. (Alavi, 2003) stated that:

*"The trend of development and progress in the areas of exploration and production were substantially damaged".*

The dramatic development of the Libyan petroleum sector after the end of the sanctions indicates the substantial impact that the sanctions had. Most likely, those sanctions had an impact on the environmental performance of the petroleum industry directly or indirectly. Under the sanctions, environmental performance was not expected to be a priority to the Libyan petroleum industry's decision makers. Under those circumstances, priority was given to maintain the production of the main commodity, which the country's economy depends on, by the available means of technology and personnel skills.

During that time, environmental issues have received international concern through Agenda 21 for sustainable development which emerged during the United Nations Conference on Environmental and Development which took place from 3-14 June 1992 in Reo de Janeiro, Brazil. Its goal was to outline a vision for sustainable development in the North and the South during the twenty-first century and to initiate concrete plans.

The results of the questionnaire shows close answers from both the oil and gas industry and EGA respondents. A considerable proportion of both the oil and gas and EGA respondents considered that the sanctions did not have an impact on the environmental situation of the oil and gas industry. Moreover, the questionnaire results show that more oil and gas industry respondents held this view than EGA

respondents. This may be attributed to poor environmental performance before the sanctions as those respondents did not witness any changes of the environmental performance before and after the sanctions. Interestingly, only one respondent from the oil and gas industry sector thought that the sanctions had a positive impact (less production means less pollution).

The sanctions might have indirectly worsened the state of the environment and put enormous pressure and burdens on the management of that important sector. Using modified and old technology in such an industrial field is not an easy task. Using old technology and modify the available old parts in a creative effort was the only way available to maintain oil production from the Libyan oil field. This includes all aspects of production such as drilling, separating and shipping the oil to the market.

### **8.3 Conclusion**

The Libyan oil and gas industry has entered a new era of development with tangible improvement in the environmental field although the improvement is slow and the environmental impacts of the industry on the environment are clear from the evidence presented. The state of the environment of the Libyan oil and gas industry is negatively affected by the exploration and production operations. It is clear that the state of the environment has not been adequately considered. The environmental impacts have not been dealt with properly until recent times. The country has had environmental regulations which are being revised and can now deal with the current environmental issues. However, the implementation of these regulations has been very weak. Until recently some big oil companies did not have any kind of written environmental policy or environmental management system to implement and comply with the environmental regulations.

Thus, the environmental performance of the oil and gas industry is poor. This was concluded from the available evidence even without comparison with another country. The industry also lacks procedures for effective environmental monitoring and environmental training of its employees. It is important to raise environmental awareness of managerial staff as environmental awareness among them is not high and they are responsible for setting environmental plans and policies.

The management structure (hierarchy) of the petroleum sector is reasonable and its weaknesses can be overcome by taking advantage from the UAE experience. Although the Libyan economy in general and its oil and gas sector in particular have been suffering from the sanctions, the evidence suggested no direct impacts of the sanctions on environmental performance of the oil and gas industry.

Finally, the main shortcomings of the oil and gas industry's environmental management which have emerged from the above discussion can be summarised in the following points:

1. The government's attitude towards the environmental impacts of the oil and gas industry is negligent.
2. Libya lacks effective regulatory bodies with enough experience and other facilities to tackle these environmental issues in accordance with UNEP and Agenda 21.
3. Poor compliance with the environmental regulations.
4. Weak implementation of existing environmental legislation and laws.
5. Absence of the Health Safety and Environmental Management System (HSEMS).
6. Absence of any effective environmental monitoring system.
7. Environmental awareness among employees is generally low and is not fully addressed by management.

## **Chapter Nine**

### **Conclusions**

#### ***9.1 The Research Problem***

Petroleum exploration is rapidly increasing in many regions of the world including Libya. This has been evident in Libya especially after the UN sanctions were lifted. The upstream oil and gas industry is the main driver of the country's economy, and like any other industry, environmental impacts are unavoidable.

The environmental issues, which are often associated with the development of oil and gas reserves, are a concern for both the petroleum industry and regulators. Integrating these issues in the regulatory and business processes that control the exploration and production of the oil and gas in order to protect the environment is a big challenge. Therefore, the application of comprehensive management systems and best practice by petroleum companies in every situation is essential.

##### **9.1.1 Findings of the Research**

Although Libya is a petroleum producing country and depends very heavily on the revenue from petroleum for its economy, it displays little evidence of government action in relation to environmental policy and regulation in this important field. Compared with some developing countries such as the UAE, Libya's environmental performance in the petroleum sector is considered weak as can be concluded from the respondents to the questionnaire.

This research has confirmed that the environmental problems associated with the exploration and production of petroleum in Libya are evident.

Although it appears that Libya has sufficient environmental regulations, it seems that the actual environmental management policy is still poor and in its early stages as the country is very young in this field, especially when comparing it with developed countries. Therefore, it does not have a long history or large literature which can accumulate considerable experience in environmental management in general and the impacts of oil and gas exploration and production in particular.

The research has found a gap between the existing legislation and laws (which require EIA studies, commitment, compliance, monitoring and evaluation) and the implementation of this legislation. Consequently, control of environmental problems and compliance with and enforcement of the legislation is often problematic.

The lack of skills and facilities of the environmental departments in the oil and gas industry and the EGA are also barriers to improving the efficiency of these environmental bodies. Considerable efforts, therefore, are needed to build capable environmental bodies to manage and deal with the environmental issues. Thus, the current Libyan environmental approach to the upstream oil and gas industry is ineffective.

### **9.1.2 Limitations of the Research**

This research is limited by the constraints imposed by the availability of information and data, as Libya like most other developing countries, lacks many sophisticated facilities including the skilled and well-qualified personnel to compile more comprehensive data that would serve the purposes of environmental, social and economic development.

In order to reduce data interpretation problems, multiple sources of evidence were used. This allows a comparison of the information provided in environmental policies and any other documentation with the views of organisations' representatives. This also increases the opportunity for checking interpretations and identifying patterns.

The areas of evidence investigated were:

1. Commitment to environmental protection;
2. Compliance with environmental laws, policies and programs;
3. Implementation of environmental laws and regulations;
4. Monitoring of the implementation of the environmental regulations; and
5. Evaluation and improvement of environmental performance.

Due to the gap between the existing legislation and laws which require EIA studies, and the implementation of this legislation, the research has concentrated on elements related to environmental management in general and the environmental legislation and laws in particular for the upstream petroleum industry in Libya. Consequently the suggestions will be limited to these elements.



Although any suggestions and recommendations will be exclusively limited to this sector in this particular country, they may be applicable to similar industries in other countries.

## **9.2 Research Significance**

This study is significant because of its unique nature, its relevance and its contribution to knowledge.

### **9.2.1 Uniqueness of the Research**

Recently petroleum industry activities in Libya have increased rapidly. This gives extraordinary value to such research about the environmental management of this important field, especially since there have been no published studies dealing in depth with the environmental impacts of the petroleum operations. Although the petroleum industry sector in Libya is very important, the researcher did not find any published or unpublished studies referring to the environmental management issues of the Libyan petroleum industry. Accordingly, this research is probably the first attempt to deal with the environmental management issues in this particular field and hopefully it will provide a basic background to this neglected but important subject.

### **9.2.2 Relevance of the Research**

Environmental concerns about the regulatory/governance dynamics are commonly linked to the globalisation process. However, implementation of environmental regulation issue remains largely an empirical question. This work, therefore, will enhance the academic literature regarding environmental governance in host developing countries, which is relatively lacking in extended research. Local and international environmental bodies and oil companies in Libya will be interested in the findings of this research in setting their goals and objectives. In addition, the research relevant to similar developing countries that produce oil and are interested in developing environmental management of their upstream petroleum industry.

Worldwide organisations also might find this thesis useful as environmental problems are now not only local but are becoming global issues. The research is extremely relevant to environmental planning and policies in Libya in general and in the petroleum industry sector in particular. It is therefore, significantly important to

organisations such as LNOC and its affiliates, the EGA and foreign oil companies which operate or intend to operate in Libya.

The relevance of this research is also due to the current significant development of the oil and gas industry in general and the upstream phase in particular after the UN and US sanctions were lifted in 2000 and 2003 respectively. Since then, many international oil companies have signed Exploration and production Sharing Agreements (EPSAs) with the LNOC and gained concessions to explore and develop the potential oil and gas resources.

### **9.2.3 Contribution to Knowledge**

This research describes and analyses the environmental management issues in the upstream petroleum industry in Libya and makes this knowledge available to interested organisations and individuals. These issues are usually common among the petroleum producing developing countries. The outcome of the research will contribute to an understanding of Libya's problems in improving its environmental management approach, and help in its aspirations for better environmental performance of its main industry. The approach might be applicable in similar developing countries aiming to develop their petroleum industry in an environmentally and socially responsible and sustainable way.

As the key aspect of environmental management is the knowledge of the environment local to the industry activity in question, this research provides fundamental information about the environmental issues in the petroleum industry of the country of the study. This research, therefore, explores the interactions between the environment and the upstream petroleum industry in developing countries. It identifies the major environmental management problems in relation to the legal environmental framework and attempts to look at the perception of environmental issues by the industry's workforce from a social dimension.

Investigating these important issues in a sensitive industry in such countries leads to a substantial contribution in an area in which there has been little previous research. The contribution of this work is strengthened through categorising and investigating the legal environmental framework and determining its weaknesses. The

multidisciplinary nature of the study, involving both social and technical sciences and dealing with shared problems of similar industries in many parts of the world, represents a further contribution of the study.

#### **9.2.4 Research Recommendations**

After determining the main weaknesses of the environmental management approach of the Libyan oil and gas industry sector, this research provides several recommendations in order to tackle these weaknesses and improve the environmental performance of the Libyan upstream oil and gas industry. New environmental management approaches therefore, should be adopted to achieve the most sustainable development in exploiting the country's main natural resources. This is the right time to act towards this valuable aim as the country is entering a new era in terms of the petroleum industry's development.

It is essential to integrate environmental management and planning for all activities that are likely to have an adverse effect on the environment to give the decision makers adequate information detailing the possible adverse environmental effects of the activity, as well as possible policies, programmes and alternatives.

Environmental impact assessment (EIA) and other environmental techniques to predict and assess the potential impacts on the environment must be conducted before the launching of such projects in order to encourage sustainable development. Environmental management systems (EMSs) must be implemented at all phases of the project life-cycle.

The following therefore, are some recommendations to the oil and gas sector in Libya:

- First, is to give top priority to the environmental impacts associated with the Libyan upstream oil and gas industry as significant environmental impacts of this industry have been confirmed. This requires an efficient environmental policy with achievable goals and targets to be integrated into the management of this important sector.
- Second, it is important to adopt and implement an environmental management system (EMS) in the oil and gas companies in order to implement and comply with the environmental regulations even if there is no

enforcing pressure to do so. This includes all requirements of EMS such as environmental planning for continuous; implementation, monitoring and evaluation. All sources of evidence including the questionnaire results and the interviews have suggested weak or absence of effective environmental management systems in most of the oil and gas companies operating in the country.

- Third, the oil and gas industry should become a leading sector in implementing the environmental regulations with coordination from the EGA as this sector is the driving force of the Libyan economy and the most supported sector financially and technologically.
- Fourth, the EGA must exercise its authority on the ground and force all operators in the country to implement the country's environmental regulations. The findings of the research including the factual state of the environment of the upstream oil and gas industry on the ground have shown that the EGA is currently incapable of enforcing the environmental regulations on the ground.
- Fifth, more efforts are needed to increase the environmental awareness. The public should know the adverse impacts of the petroleum industry to increase the pressure towards achieving balance between the people's desire and environmental protection. It was very difficult for the researcher to find information about the environmental issues of the upstream oil and gas industry which should be made available to the public.
- Finally, environmental training should be provided to all levels of managerial staff and all other employees. This should aim to involve all employees to participate in the environmental initiatives by creating and spreading an environmental culture among all the workforces of oil and other industries, especially the research has found that the environmental training is not adequately considered by the oil and gas industry in Libya.

### ***9.3 Suggestions for Further Research***

Environmental management techniques are still underdeveloped despite considerable efforts in recent years. This is partly because environmental management is a relatively new subject that needs continuous research and updating over time. However, the environmental impacts of any services or

production should not be ignored any longer, especially in the oil and gas industry which has high potential environmental impacts.

Many environmental aspects of the Libyan petroleum industry have still to be investigated. The concern of these issues has just recently increased. Therefore, serious research should be conducted in the environmental field to assist establishing efficient environmental policies and performance. This requires forming multidisciplinary teams to conduct such research. The area of this research should be explored and investigated by different industries and institutions such as local universities, research centres, environmental bodies and must importantly the oil and gas industry itself.

This research opens the broad area of the environmental management of the oil and gas industry in Libya and provides the basic background to this important field as such studies are still very limited. The research includes only the main issues that have affected the environmental performance of the oil and gas industry in Libya. Building on this research, each identified issue (category) of it, comprises a separate research question for further studies and the information in this thesis provides a starting point for much more research in the future.

Applied science can play a vital role for more accurate assessment as many environmental aspects such as air pollution, contaminated land and ground water contamination can be scientifically measured. This will provide magnificent data and information for the decision makers to take the right decision regarding these important issues.

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## Appendix 1

### Environmental Management System (EMS)

#### ***Environmental Management System (EMS)***

There is wide recognition of the benefits of objective or goal-setting approaches to safety, a fundamental principle of the Safety Management Systems (SMS) approach which draws on the management principles of the International Standard on Quality Systems, ISO 9000. Similarly, environmental aspects are subject to extensive regulation and Environmental Management Systems (EMS) is used to control and manage environmental impacts.

In the early 1990s, an environmental management system was originally introduced as BS 7750 (British Standard) and has developed into ISO 14001 (International Standard).

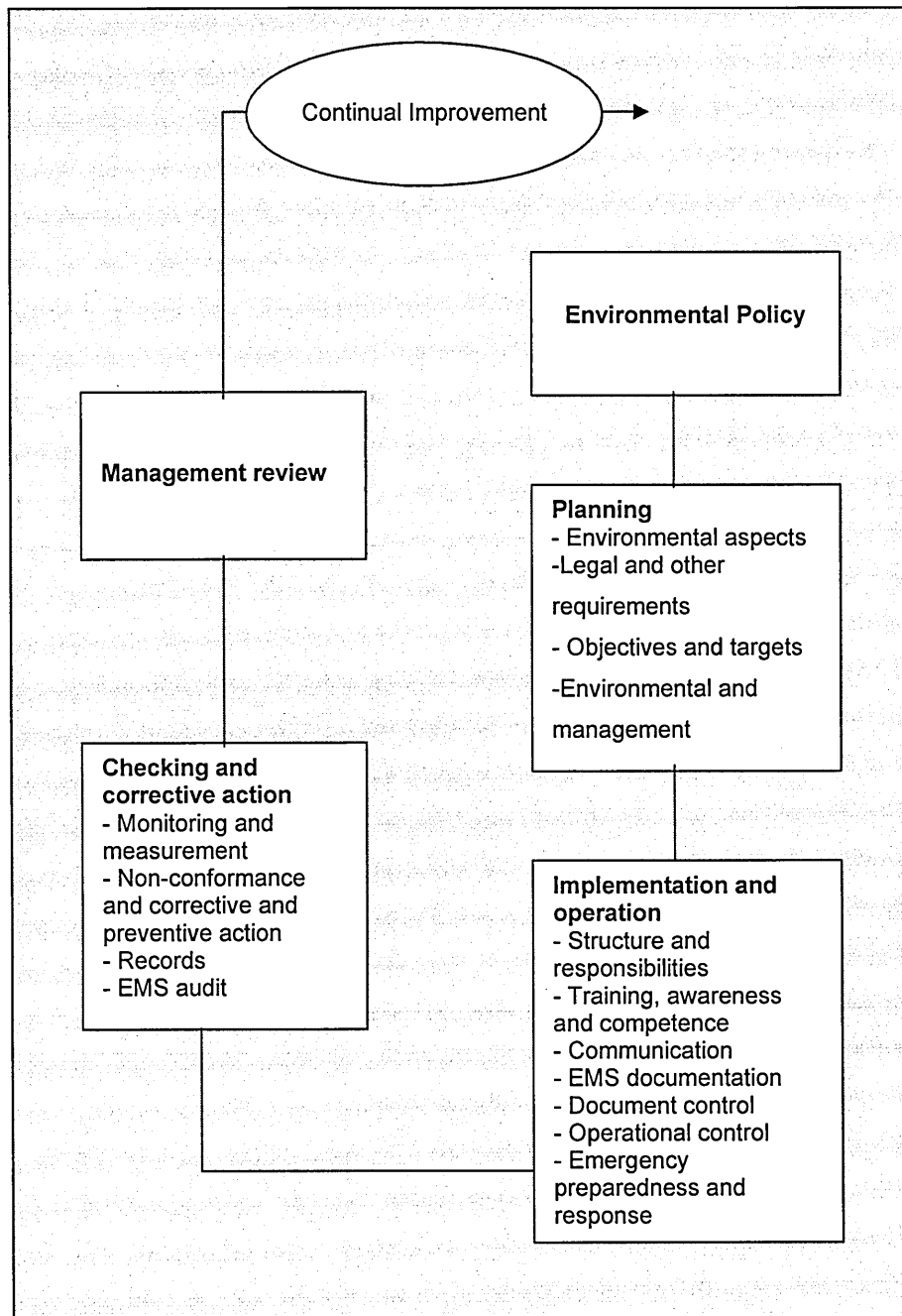
An environmental management system is defined by the British Standards Institute (1994) as:

*the organisational structure, responsibilities, practices, procedures, processes, and resources for determining and implementing environmental policy.*

Environmental management system standards have been proposed to enable organisations to develop an integrated system to manage environmental issues (Welford 1994). In particular, standards for EMS have been developed by the International Organisation for Standardisation (ISO) and by the European Commission – Eco-Management and Audit Scheme (EMAS). Figure 26 outlines the environmental management system model.

There is wide recognition of the benefits of objective or goal-setting approaches to safety, a fundamental principle of the SMS approach which draws on the management principles of the International Standard on Quality Systems, ISO 9000. Similarly, environmental aspects are subject to extensive

regulation and Environmental Management Systems (EMS) is used to control and manage environmental impacts.



**ISO 14001 Environmental Management System Model**

Thus, this model as most EMS models is built on the "Plan, Do, Check, Act" model and leads to continual improvement.

### **Key Elements of the EMS Model**

Undertake an initial environmental review;

Define an environmental policy;

Develop an environmental action plan and define environmental responsibilities;

Develop internal information and training courses;

Audit the environmental management system and conduct an environmental management review.

### **Benefits and costs of EMS**

#### **Benefits**

EMS can result in both business and environmental benefits. For example, an EMS may help to:

Improve environmental performance;

Enhance compliance;

Prevent pollution and conserve resources;

Reduce/mitigate risks;

Attract new customers and markets (or at least retain access to customers and markets with EMS requirements);

Increase efficiency;

Reduce costs;

Enhance employee morale and possibly enhance recruitment of new employees;

Enhance image with public, regulators, lenders, investors;

Achieve/improve employee awareness of environmental issues; and responsibilities.

#### **Costs**

Developing and implementing an EMS will also have some associated costs including:

An investment of internal resources, including staff/employee time;

Costs for training of personnel;

Costs associated with hiring consulting assistance, if needed;

Costs for technical resources to analyse environmental impacts; and improvement options, if needed.

## Appendix 2

### Libyan Questionnaire Survey

Company/Institution المؤسسة أو الشركة	Department القسم	Qualification المؤهل	Occupation الوظيفة

- 1- How do you describe the current state of the environment in the petroleum sector in Libya?

كيف تصف الحالة أو الوضع البيئي لقطاع النفط والغاز ؟

1 Very satisfactory مقبولة جدا	2 Satisfactory مقبولة	3 Dissatisfactory غير مقبولة	4 very dissatisfactory جدا غير مقبولة

- 2- How do you consider the magnitude of the environmental impacts of the Libyan oil and gas industry operations:

كيف تقيم الاثر البيئي لعمليات النفط والغاز في ليبيا ؟

1 Significant impacts تأثيرات هامة	2 Insignificant impacts تأثيرات بسيطة

- 3- How do you see the current environmental regulations related to the environmental impacts of the petroleum industry?

كيف ترى التشريعات الحالية للتعامل مع التأثيرات البيئية ؟

1 Very effective in protecting the environment فعالة جدا لحماية البيئة	2 Effective in protecting the environment فعالة لحماية البيئة	3 Satisfactory that the environment is protected مقبولة لحماية البيئة	4 Weak in protecting the environment ضعيفة لحماية البيئة	5 Very weak in protecting the environment ضعيفة جدا لحماية البيئة

- 4- What is your opinion about the implementation of environmental regulations by the petroleum industry in the country?

كيف ترى التطبيق العملي للتشريعات البيئية في مجال النفط ؟

1 Excellent ممتاز	2 Very good جيد جدا	3 Good مقبول	4 Poor ضعيف	5 Very poor ضعيف جدا

- 5- Are there any pressure form regulators (the government) to implement environmental regulations?

هل هناك ضغوطات من المشرعين (الدولة) لتطبيق نظام ادارة بيئي؟

1 Yes نعم	2 No لا

- 6- Are you aware that your organisation has any written Environmental Management System (EMS) or a written environmental policy statement in place?

هل للشركة او المؤسسة نظام ادارة بيئي او اى سياسة بيئية مدونة ؟

1 Yes نعم	2 No لا

- 7- How do you see the environmental management system in your organisation?

كيف ترى نظام الادارة البيئية فى الشركة او المؤسسة ؟

1 Excellent ممتاز	2 Very good جيد جدا	3 Good جيد	4 Poor ضعيفة	5 Not exist لا توجد نظم ادارة بيئية

- 8- Do you consider the compliance of the Libyan oil and gas industry with environmental regulations is:

كيف تصف التزام قطاع النفط و الغاز بالتشريعات البيئية ؟

1 Very satisfactory مقبول جدا	2 Satisfactory مقبول	3 Not satisfactory غير مقبول	4 No compliance at all القطاع لا يمتثل للتشريعات البيئية

- 9- How do you describe the environmental performance of your organisation:

كيف تصف الاداء البيئي للشركة او المؤسسة ؟

1 Excellent ممتاز	2 Very good جيد جدا	3 Good جيد	4 poor ضعيف	5 Very poor ضعيف جدا

- 10- Do you consider that the environmental impacts of the Libyan upstream oil and gas industry are dealt with:

هل تعتبر ان التأثيرات البيئية الناتجة عن استكشاف و انتاج النفط و الغاز يتم التعامل معها بصورة

1 Very properly بصورة ملائمة جدا	2 Properly بصورة ملائمة	3 Improperly بصورة غير ملائمة	4 Completely neglected مهملة تماما

- 11- Is there any noticeable engorgement and/or incentive (financial or any other) is given to the employees to participate in improving the environmental performance of the organisation?

هل توجد اى حوافز مادية او غيرها لتحسين الاداء البيئي لدى العاملين بالشركة او المؤسسة ؟

1 Yes نعم	2 No لا	3 Do not know لا ادري

- 12- Do you consider the environmental monitoring system of the Libyan petroleum industry's operations?

هل تعتبر نظام مراقبة البيئة بقطاع النفط و الغاز ؟

1 Very efficient فعال جدا	2 Efficient فعال	3 Inefficient غير فعال	4 Not exist غير موجود

13- Have you ever taken any environmental training?

هل تلقيت يوما أى تدريبات بيئية ؟

1 Yes نعم	2 No لا

14- How do you see the environmental training programmes for the employees if any?

كيف رأيت برامج التريبات البيئية ؟

1 Very good training تدريبات جيدة جدا	2 Good training تدريبات جيدة	3 Poor training تدريبات ضعيفة	4 No training لم اتلقى تدريب بيئي

15- Do you think the environmental awareness of the managerial staff of your organisation:

هل تعتقد ان الوعي البيئي لدى العاملين بالشركة ؟

1 High عالي	2 Medium متوسط	3 Low ضعيف	4 Very low ضعيف جدا

16- What is your opinion of the current management structure of the petroleum industry (the LNOC and its Affiliates):

ما رأيك فى تركيبة قطاع النفط و الغاز (المؤسسة الوطنية للنفط و شركاتها)

1 Very good جيد جدا	2 Good جيدة	3 Bad سيئة	4 Very bad سيئة جدا

17- Did the sanctions affect the environmental performance of the petroleum industry?

هل اثر الحصار على الاداء البيئي لقطاع النفط و الغاز ؟

1 Yes نعم	2 No لا

18- How do you see the effects of the sanction on the state of the environment of petroleum industry?

اذا كان الجواب نعم: كيف تصف تأثير الحصار على الوضع البيئي لقطاع النفط و الغاز ؟

1 Negative effect تأثير سلبي	2 No effect لا تأثير يذكر	3 Positive effect تأثير ايجابي

## UAE Questionnaire Survey

Company/Institution	Department	Qualification	Occupation

1. How do you describe the current state of the environment in the petroleum sector in the country (UAE)?

1 Very satisfactory	2 Satisfactory	3 Dissatisfactory	4 Very dissatisfactory

2. How do you consider the magnitude of the environmental impacts of the UAE oil and gas industry operations:

1 Significant impacts	2 Insignificant impacts

3. How do you see the environmental regulation related to the environmental impacts of the petroleum industry in the UAE?

1 Very effective in protecting the environment	2 Effective in protecting the environment	3 Satisfactory that the environment is protected	4 Weak in protecting the environment	5 Very weak in protecting the environment

4. What is your opinion about the implementation of environmental regulations by the petroleum industry of the UAE?

1 Very good	2 Good	3 Satisfied	4 Weak	5 Very weak

5. Are there any pressure from regulators (UAE government) to implement environmental regulation?

1 Yes	2 No

6. Are you aware that your organisation has any written Environmental Management System (EMS) or a written environmental policy statement in place?

1 Yes	2 No

7. How do you see the environmental management system in your organisation?

1 Excellent	2 Very good	3 Good	4 Poor	5 Not exist

8. Do you consider the compliance of the oil and gas industry in the UAE with environmental regulations:

1 Very satisfied	2 Satisfied	3 Not satisfied	4 Not comply at all

9. How do you describe the environmental performance of your organisation:

1 Excellent	2 Very good	3 Good	4 Poor	5 Very Poor

10. Do you consider that the environmental impacts of the UAE upstream oil and gas industry are dealt with:

1 Very properly	2 Properly	3 Improperly	4 Completely neglected

11. Is there any noticeable engorgement and/or incentive (financial or any other) is given to the employees to participate in improving the environmental performance of the organisation?

1 Yes	2 No	3 Do not know

12. Do you consider the environmental monitoring system of the UAE petroleum industry's operations:

1 Very efficient	2 Efficient	3 Inefficient	4 Not exist

13. Have you ever taken any environmental training?

1 Yes	2 No

14. How do you see the environmental training programmes for the employees if any?

1 Very good training	2 Good training	3 Poor training	4 No training

15. Do you think the environmental awareness of the managerial staff of your organisation:

1 High	2 Medium	3 Low	4 Very low

16. The current structure of the petroleum industry (relationship between ADNOC and its group):

1 Very good	2 Good	3 Bad	Very bad



# Appendix 3

## Interview Guide

### ***Introduction***

- 1- Consider the time (the period of the interview).
- 2- Emphasise the confidentiality.
- 3- Explain the purpose of the research.
- 4- Note and describe the interviewee's behaviour and note anything can be linked to the environmental issues.

### ***Main Questions of the interview:***

- 1- Brief description of the interviewee's main activities, qualification and experience?
- 2- The current state of the environment and major environmental aspects of the oil and gas industry sector?  
The objective is to understand and assess the environmental issues of oil and gas industry sector.
- 3- Is there any written Environmental Management System (EMS) or a written policy statement on environmental management in place?  
The objective is to know whether there is any environmental policy and environmental management system is implemented.
- 4- The environmental regulatory monitoring process within the company; is there any pressure from regulators to implement EMS? Any other external and internal bodies involved in monitoring of the company's performance?  
The objective is to understand the monitoring system of the company and the external forces which might be involved.
- 5- The current structure of the petroleum industry.  
The objective is to explore the staff's opinions about the LNOC's structure.
- 6- What are the main environmental programmes the company has implemented recently?  
The objective is to determine the issues that have the priority for the company and link them to the stakeholders' environmental concern.
- 7- The internal environmental monitoring system and any monitoring forces affecting the company?  
The objective is to explore the Monitoring system of the oil and gas sector.
- 8- Description of the implementation and compliance with the environmental regulations and the environmental bodies.  
The objective is to assess the implementation and compliance with the environmental regulations.
- 9- Environmental training programmes for the employees.  
The objective is to know the level of environmental training that the employees are receiving.
- 10- Description of the effects of the sanctions on the environmental situation of the country.  
The objective is to know to what extent the US and UK sanctions affected the state of the

environment of the oil sector.

11- The role and performance of the stakeholders such as government, public, other oil companies and environmental interest groups regarding environmental management.

The objective is to know the influence that the stakeholders have over the organisation.

12- The environmental awareness among the staff and the public?

The objective is to gain adequate information about the environmental awareness.

13- The barriers and drivers to improve the environmental performance.

The objective is to determine these barriers and drivers.

14- Could the environmental management system in the company be better? How and why?

The objective is to determine the weaknesses of the environmental management system.

15- Any comments or other useful sources can enrich the study?

The objective is to consider any useful advice and to cover all important sources that can be reached.

16- Not forget to thank the interviewee and ask him/her if willing to see the results of the research.