An Objective Approach to Evaluate Environmental Management in the Offshore Oil industry in Timor Sea, East Timor

José Lucas Do Carmo Da Silva, M.Sc.

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School for Life Sciences

Heriot-Watt University

Edinburgh EH14 4AS

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ABSTRACT

This research is undertaken as a new venture to explore potential environmental management approaches for the development of the oil industry in East Timor. Particular focus will be given to environmental legislations in order to assess the possible impacts and control of oil industry development in East Timor. The country has newly emerged in the past decade and is still heavily reliant on immediate development of oil resources in order to boost the country's economic prospects. Environmental laws and regulation are, however, still in an embryonic stage. This research begins with a review of the Timor Sea environment, focusing on the natural resources of the region. This is followed by a review of the potential environmental impacts of the oil industry, as well as an assessment of the importance of Timor Sea habitats and the possible threats posed by the oil industry. Of course, oil industry development mostly takes place offshore therefore the second part of the study involved a pilot study to evaluate stakeholders' views on the possible impacts of an oil refinery along the South Coast of Timor. Stakeholders were interviewed to gain insight into opinions on how the Timor Sea environment should be managed, and how a new country can raise the living standards of its people in equilibrium with the natural environment of the region. International and national environmental regulatory frameworks were reviewed, including numerous case studies from selected regions. Data collected from stakeholders was analysed, with multivariate and univariate statistical tests employed to assess the significance of differences in responses. Moreover SWOT analyses methods were employed to analyse different environmental frameworks and regulations discussed. The main discoveries of the study include: 1) Mangroves, shallow deep-water coral reefs, seagrass, intertidal shelter sediment and rock are of high value to the Timor Sea and South Coast. In terms of animal groups turtles, dugongs, cetaceans and seabirds are considered to be of high conservation importance, 2) As environmental data or information is limited secondary data was also sourced for this study, 3) Development of the oil industry poses possible threats to the marine environment in the Timor Sea region, although it is localised and transitory in nature, 4) Stakeholders suggested that development of the oil industry should go ahead, but environmental regulations should be in place, 5) Environmental regulations must be adequate and include essential legal components such as clear responsibility, flexible

environmental permit system, as well as adequate sanctions for non-compliance and effective monitoring and enforcement processes.

The bottom line conclusions of this study is that while economic development should go ahead, measures for environmental protection should also be in place.

DEDICATION

I would like to dedicate this work to my wife Ilota Maria Bifunu Vidal Lopes and my children: Zolla, Jessica, Josezinho and my baby Lucas Scott. Thank you for supporting me in difficult times throughout my studies. Your presences and smiles constantly encouraged me, particularly during times of stress and frustration.

I would also like to dedicate this work to my family Do Carmo Da Silva. They are my rock. My mother Isabel da Silva (mae Iza), father Jose da Silva (pai Ze) and five brothers: Manuel Jucelino do Carmo da Silva, Dom Virgilio do Carmo da Silva, Sdb, Eng. Gualdinho do Carmo da Silva, Hons, Fr. Gui do Carmo da Silva, Sdb and dr. Nilton do Carmo da Silva. This thesis represents the culmination of many things and, as such, is a product of the selflessness and support they have all provided throughout my life.

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Table of Contents

LIST OF ABREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AFMA	Australian Fisheries Management Authority
AGDS	Acoustic Ground Discrimination Systems
ANOSIM	Analysis of Similarity
ANP	Autoridade Nacional do Petroleo
APP	Areas of Permanent Preservation
APPEA	Australian Petroleum Production and Exploration Association
ARPEL	Regional Association of Oil and Natural Gas Companies in Latin America and Caribbean
ATSEF	Arafura and Timor Sea Expert Forum
ASMO	Assessment and Monitoring Committee
BAT	Best available Techniques
BATEA	Best available Technology Economically Achievable
BCPCT	Best Conventional Pollutant Control Technology
BEP	Best Environmental Practice
BERR	Department for Business Enterprise and Regulatory Reform, Former DTI
BTEX	Benzene, Ethylbenzene, Toluene and Xylenes
CAA	Clean Air Act
CAC	Control and Command
CASI	Compact Airborne Spectral Imager

CFR	Code of Federal Regulations
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CONAMA	Council of the Environment
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTI	Coral Reef Triangle Initiative
CV	Covenant
CWA	Clean Water Act
DETR	Department of Environment, Transport and the Regions
DIT	Dili Institute of Technology
DC	Digital Camera
DNE	Direção Nacional de Estatística
DNSMA	Direção Nacional do Servicos do Meio Ambiente
DOI	Department of Interior
DPRC	Democratic People’s Republic of Korea
DTI	Department of Trade and Industry.
EC	European Commission
FD	Field Data
FDTL	Forças Armadas Defesa de Timor Leste.
FOKUPERS	Forum of East Timorese Women’s
FONGTIL	Forum NGO Timor Leste
EC	European Commission
EIA	Environment Impact Assessment
EIS	Envirnmental Impact Statement
ENE	East North East

EPA	Environment Protection Agency
E & P	Exploration and Production
EPBC Act.	Environmental Protection and Biodiversity Conservation Act.
GTI	Greater Tumen River Initiatives
HABURAS	Environmental Advocacy and Monitoring
HASATIL	Sustainable Agriculture Development
IBAMA	Institute of Environment and Renewable Natural Resources.
IAGC	International Association of Geophysical Contractors
INGO	International Non-Governmental Organization
ITOPF	International Tanker Owners Pollution Federation Limited
JNCC	Joint Nature Conservation Committee
JPDA	Joint Petroleum Development Area
IPPC	Integrated Pollution Prevention and Control
ICAP	Infrared Colour Aerial Photography
ISO	International Standards Organization
ITF	Indonesian Through Flow
IUCN	International Union for Conservation of Nature
IUU	Illegal Unregulated and Unreported
LAO HAMUTUK	Working Together
LIDAR	Laser Induced Detection and Ranging
LPG	Liquid Petroleum Gases
LTA	Long Term Agreement
LUTA HAMUTUK	Fighting Together
MAFF	Ministry of Agriculture Fisheries and Forestry
MARPOL	Convention for the Prevention of Pollution from Ships
MEA	Multilateral Environmental Agreement
MMS	Mineral Management Service
MPRM	Ministry of Petroleum and Mineral Resources
MPRSA	Marine Protection, Research and Sanctuaries Act

MBES	Multibeam Echo -Sounders
MRC	Mekong River Committee
NCA F	Natural Colour Aerial Photography
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazards Air Pollutants
NOGEPA	Netherlands Oil and Gas Exploitation Association
NGO	Non- Governmental Organisation
NMC	National Mekong Committees
NPA	National Petroleum Authority
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
OBM	Oil Based Mud
OCNS	Offshore Chemical Notification Scheme
OGP	International Association of Oil and Gas Production
OLF	Norwegian Oil Industry Association
OPA	Oil pollution Act
OPOL	Offshore Pollution Liability Agreement
OSCLA	Outer Continental Shelf Lands Act
OSPAR	Convention for the Protection of the Marine Environment of the North East Atlantic.
PAH	Polycyclic Aromatic Hydrocarbons
PARCOM	Paris Commission
PIMU	Project Implementation Units

PNG	Papua New Guinea
PNTL	Police National Timor Leste
PRAM	Programme and Measures Committee
PSA	Petroleum Safety Authority
PSC	Production Sharing Contract
REDE FETO	Women's Network
ROVs	Remote operated vehicles
SBM	Synthetic Based Mud
SEA	Strategic Environmental Assessment
SEIS	Shared Environmental Information System
SOAEFD	Scottish Office Agriculture Environmental and Fisheries Department
SSS	Sea Surface Salinity
SSS	Side Scan Sonar
SST	Sea Surface Temperature
SWOT	Strengths, Weaknesses, Opportunities and Threats
TEIA	Transboundary Environmental Impact Assessment
TID	Timor Institute for Development
TSDA	Timor Sea Designated Authority
UC	Conservation Units
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNCBD	United Nations Convention on Biodiversity

UNFCCC	United Nations Framework Convention on Climate Change
UNCCD	United Nations Convention to Combat Desertification
UNTL	East Timor National University
UIC	Underground Injection Control
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKOOA	UK Offshore Operators Association
US	United States of America
US EPA	United States Environmental Protection Agency
AFMA	Australian Fisheries Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTI	Coral Reef Triangle Initiative
DNE	Direção Nacional de Estatística
ENE	East North East
EPBC Act.	Environmental Protection and Biodiversity Conservation Act.
ITOPF	International Tanker Owners Pollution Federation Limited
JPDA	Joint Petroleum Development Area
ITF	Indonesian Through Flow
IUCN	International Union for Conservation of Nature
IUU	Illegal Unregulated and Unreported
PNG	Papua New Guinea
SSS	Sea Surface Salinity
SST	Sea Surface Temperature

WSW West South West

Chapter 1 INTRODUCTION

1.1 Background

The development of the oil industry in the Timor Sea and south coast of East Timor is an immediate demand and is necessary to stimulate the country's economy. East Timor has one of the lowest incomes per capita in the world (World Bank, 2004) and its immediate challenge to develop its oil and gas resources in a sustainable manner.

The development of oil and gas in the Timor Sea will potentially bring major benefits to the economy of East Timor. Particularly, offshore exploration and production activities serve as the foremost engine to generate the early period of the development compared with onshore oil production or other (non oil) sectors. Recent estimations revealed that the sector has been contributing 69,83% its economy in 2010 and 86% from the 2009 total states budget (GDP) (Ministry of Finance, 2008).

There are various possible alternative options for the development of the oil industry in the Timor Sea and the south coast of East Timor. 1) Floating platforms which could be unloaded by tankers and taken to remote refineries without the need for any onshore development in the local area. 2) Floating platforms which could be unloaded by tankers and the cargo delivered to new refineries on the south coast of East Timor and 3) the development of a sub-sea pipeline to carry oil or gas to the north coast of Australia.

The Timor Sea Designated Authority's (TSDA) 204 annual report points out that no serious environmental problems have occurred so far in Timor Sea. However, currently very few laws and regulations deal with environmental management for the oil and gas industry in East Timor and all existing laws lack detailed guidelines and standards. Since 2004 only Environmental Impact Assessment (EIA) and Pollution Control laws have been drafted, but both have not yet been enacted by Parliament. Meanwhile, in the absence of these two laws the Timor Leste Constitution permits the use of Indonesia EIA law. The newly established National Petroleum Authority (ANP) is the key government agency responsible for petroleum exploration and exploitation. While the ANP has increased attention on environmental protection from the oil and gas industry, it is limited by the lack of regulations, rules, and standards for environmental management. At present, ANP seems to rely on rules and standards brought in and exercised by international petroleum development operators.

In order to effectively and efficiently oversee matters on environmental protection from the oil and gas industry in Timor Leste the Ministry of Petroleum and Mineral Resources (MPMR) and the ANP need to revise their roles and existing rules and regulations. The researcher is convinced that an effective environmental management system needs to be developed based on the specific features of the regulatory and institutional machinery. Successful environmental management can only be achieved by giving a proper level of consideration to these factors as these are very important in determining 'specific environmental management strategies' which must be taken into account.

1.2 Objective of Study

The main objective is to identify suitable environmental strategies for East Timor, and specifically to identify the most appropriate environmental management system for the management of offshore oil and gas development in the Timor Sea. Key components include:

1. Assessment of specific risks and threats to the natural environment of East Timor.
2. Assessment of the views and priorities of stakeholders in relation to the natural environment and oil industry developments.
3. Critical assessment of existing regulatory frameworks both within the region and in other geographic areas, encompassing both national and international arrangements.

1.3 Methodology of Study

The methodology of study is based upon the following approaches;

1. Reviewing the literature; desk-based studies to consider all possible sources of data and information available on relevant environmental protection by assembly, review, and summary of relevant country literature (including many unpublished documents);

2. Direct inquiry with stakeholders such as government authorities, businesses and industries, local communities and environmental groups at national and international levels.
3. Analyses of data and information by:
    - Stakeholder analyses approach using the case study “Perspective of stakeholders in environmental management: Timor Sea and South Coasts of East Timor” (Chapter 4).
    - Investigation in to selected countries experiences on international or transboundary environmental management, Exploration and Production regulatory frameworks in selected countries, and environmental monitoring policies in selected countries (Chapters 5, 6 and 7).
4. Recommend practical approaches to these issues and formulate of preliminary guidelines for the establishment of an environmental management system relating to Exploration and Production activities in East Timor (Chapter 8).

1.4 Analysis points*:*

The analysis components below are points for individual chapters prior to being compiled in the novel discovery in Chapter 8.

1. Stakeholder perspectives and different views according to regions, occupation, education, gender and age.
2. Environmental agreement policy system (Petroleum Act, enhancement and conservation of offshore),
3. Comparison of environmental compliance and effluent waste regarding East Timor and other countries,
4. Comparison of the Exploration and Production industry development characteristics between East Timor and other countries,
5. Comparison environmental legislative control inputs and disturbances,
6. Comparison of EIA systems in different countries,
7. Application of the countries environmental compliance and enhancement in East Timor, and
8. Evaluation of the vulnerability of the existing natural environment or the specific hazards of oil development in the Timor Sea.

1.5 Organization of Thesis

The thesis is divided into two main parts, with an introductory and concluding chapter. An overview of the thesis structure is provided in Figure 1.1.

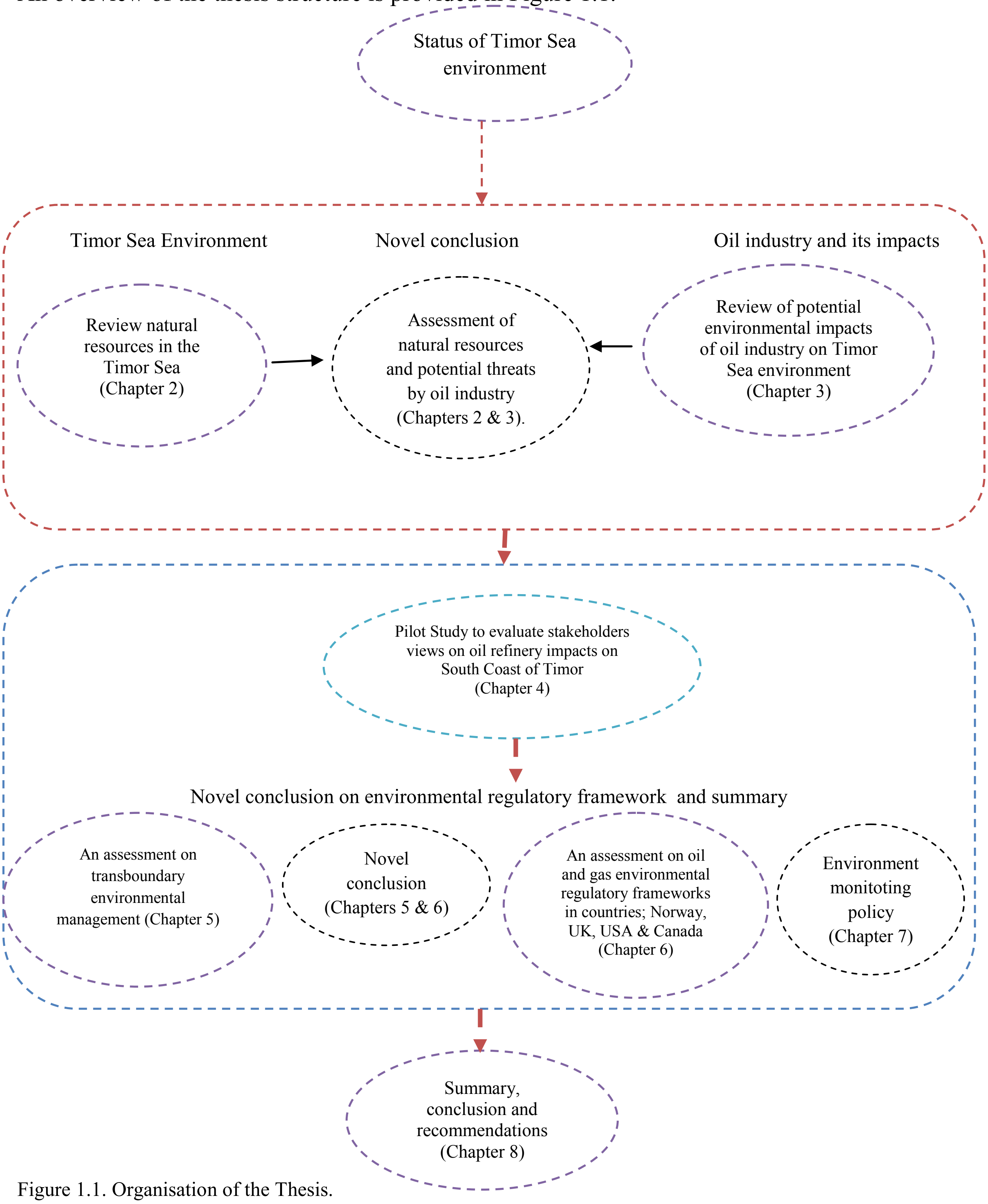

Figure 1.1. Organisation of the Thesis.

Chapter 2 is dedicated to understanding the status of the Timor Sea's natural environment including an assessment of natural resources and the encompassing physical, social and economic features of the region. Chapter 3 provides an assessment of potential environmental impacts of oil industry activities. The information reviewed in these chapters is then assessed with a view to reaching conclusions on the specific environmental risks posed by oil industry development in the Timor Sea.

The second main part of the thesis begins with an evaluation of the views of stakeholders regarding relative priorities and expectations in relation to potential environmental damage and potential economic benefits of oil industry development. This analysis is covered by Chapter 4 which describes a Pilot Study to evaluate stakeholder's views on the impact of the oil refinery on the South Coast of Timor. Chapter 5 provides an assessment of Transboundary Environment Management. The chapter reviews and discusses existing international and transboundary environmental management regulatory frameworks from selected regions. Chapter 6 provides an assessment of oil and gas environmental national regulatory frameworks in selected countries including Norway, UK, USA and Canada. The information reviewed in Chapters 5 and 6 is then assessed with a view to evaluating the relative merits of different approaches to environmental management and considering the most appropriate approaches for the specific situation in the Timor Sea. Chapter 7 focuses on assessing the effectiveness of environmental monitoring in the offshore oil and gas industry. It also considers how compliance with and effectiveness of environmental management policies might be monitored in the Timor Sea. Chapter 8 provides a summary of conclusions and recommendations derived from the earlier chapters in this thesis.

Chapter 2 A REVIEW OF THE NATURAL ENVIROMENT OF THE TIMOR SEA

2.1 Introduction

Timor Sea is an area of the Indian Ocean located between the island of Timor and northern Australia. The sea comprises about 75 percent of the Australian shallow continental shelf, reaching depths of about 200m and gradually increasing in steepness to approximately 3000m in the Timor Trough. A relatively narrow shallow continental shelf within the East Timor jurisdiction extends to South Coast (Figure 2.1). There is a general lack of high quality information on the biological and physical environment of the sea. However, recent recognition of a major offshore hydrocarbon province in the Joint Petroleum Development Area (JPDA) (Figure 2.1) has led to numerous preliminary surveys and awareness of the region's biodiversity (CSIRO, 1999, Heyward, 1997a, Wyatt, 2004). The findings from the Timor Sea in the JPDA revealed that the area includes deep-water coral reefs in sparse or patchy distribution on the Australian shallow continental shelf, extending to the Timor Trough (Gorham, 2001 and Heyward, 1997a). In contrast, Australia has reviewed frequent studies and provided plenty of information on both biological (Gorham, 2001, Heyward, 1997a) and physical features (Audley-Charles, 1966, Charlton, 1989, O'Brien, 1993, O'Brien, 1995).

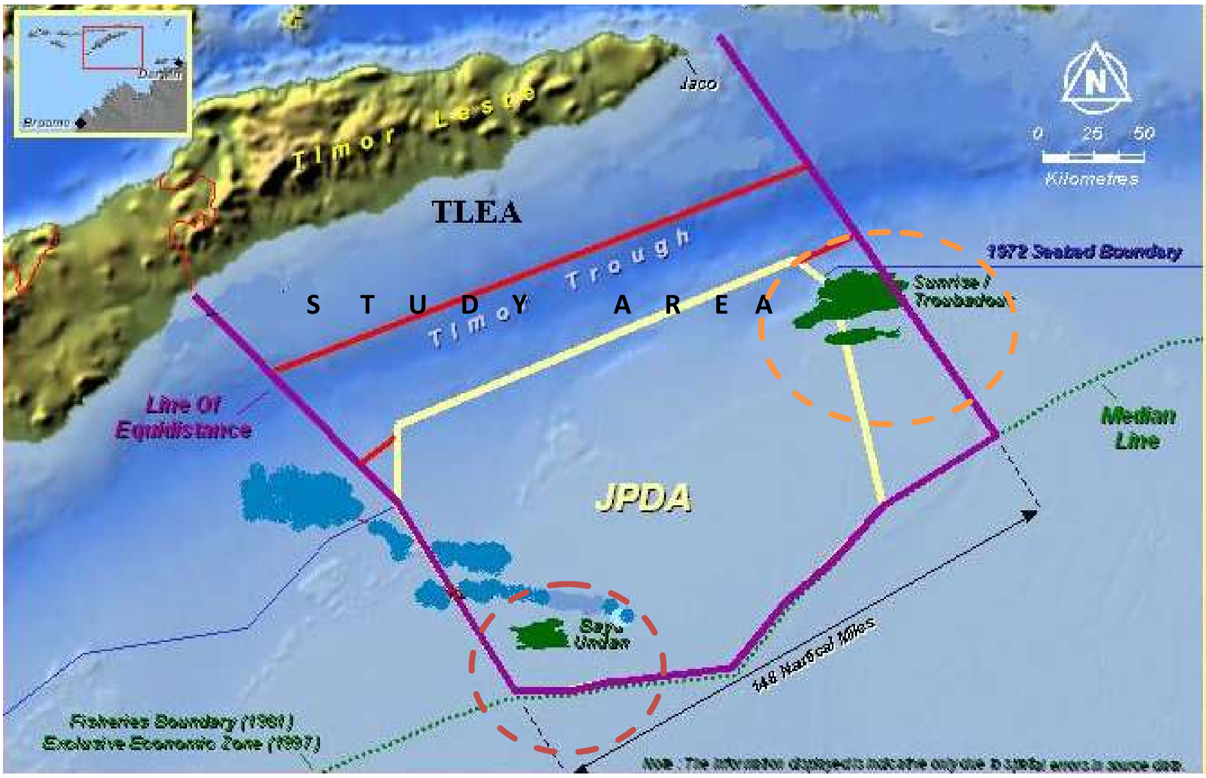

Figure 2.1. A map of the Timor Sea continental shelf and Timor Trough. Source: (AIMS, 2008). The study area was classified into three parts: Timor Leste Executive Area (TLEA), Timor Trough and the JPDA.

The sea constantly receives flows from Pacific waters throughout the year (Wyrtki, 1987). This combination of physical and oceanographic characteristics provides an extremely favourable environment to support biological communities in the region (Gordon et al., 2010). The sea is also home to numerous globally endangered species and habitats such as mangroves (Boggs, 2009) and coral reefs (Heyward, 1997a). Green turtles *(Chelonia mydas)*, hawksbill turtles (*Eretmochelys imbricate)* and loggerhead *(Caretta caretta)* are also to be found (Sandlund, 2001), as well as the Christmas Island frigatebirds *(Fregata ariel)* and *(Fregata andrews)* (Trainor, 2007) and whale blue whales (*Blaenoptera musculus)* (Boggs, 2009).

Existing human pressures on the environment in the Timor Sea and the South Coast are currently negligible in nature. Activities such as subsistence fishing activities on the north-west coastline of Australia and on the South Coast of East Timor are generally limited to the shorelines. Boats on identified commercial shipping routes pass through the vicinity of the development area with uncertain frequency and size. Agriculturally activity on the South coast of East Timor through slash and burning which possibly contribute to increased soil erosion, larger sediment land in the rivers and hence increased turbidity and sedimentation at river mouths which appear localised on the coastal waters. The South Coast of East Timor is undeveloped and coastal populations live scattered in small groups and villages along the coast.

2.1.1 Objective of the Study

The objectives of this chapter are: 1) to assess the physical environment such as geological features, climate and oceanography forming the marine habitats, 2) to assess biological features, including biodiversity and habitats found in areas where oil industry development is occurring in the Timor Sea and 3) to assess existing human pressures on the marine environment likely to occur in the oil industry development area and South Coast of the Timor Sea.

2.1.2 Methodology of the Study

The objectives of the study will be achieved through;

1. Literature reviews (through web of knowledge, Athens and technical reports) on the physical environment of the Timor Sea and similar regions.
2. Reviews of available literature (through web of knowledge Athens and technical reports) on biological features of the Timor Sea and a comparison of data from other similar bio-geographical regions to assess knowledge of the natural environment in the Timor Sea.
3. Review existing literature and studies on potential human pressures on the natural environment of the Timor Sea and South Coast and compare these with the experiences of other selected regions (see Tables 2.6 and 2.7).

2.2 Physical Environment of the Timor Sea

2.2.1 Geographical features

For the purpose of this study, the Timor Sea has been divided in three important morphological divisions from the north to south (Figure 2.1). The first part of the sea consists of a relatively narrow shallow continental shelf in the East Timor jurisdiction, which extends along the South Coast of East Timor. The second part gradually increases in steepness towards the continental slope to approximately 3000m in the Timor Sea, which is called the Timor Trough. The third part – accounting for about

75% of the study area – is the Australian shallow continental shelf, with maximum depths of < 200m.

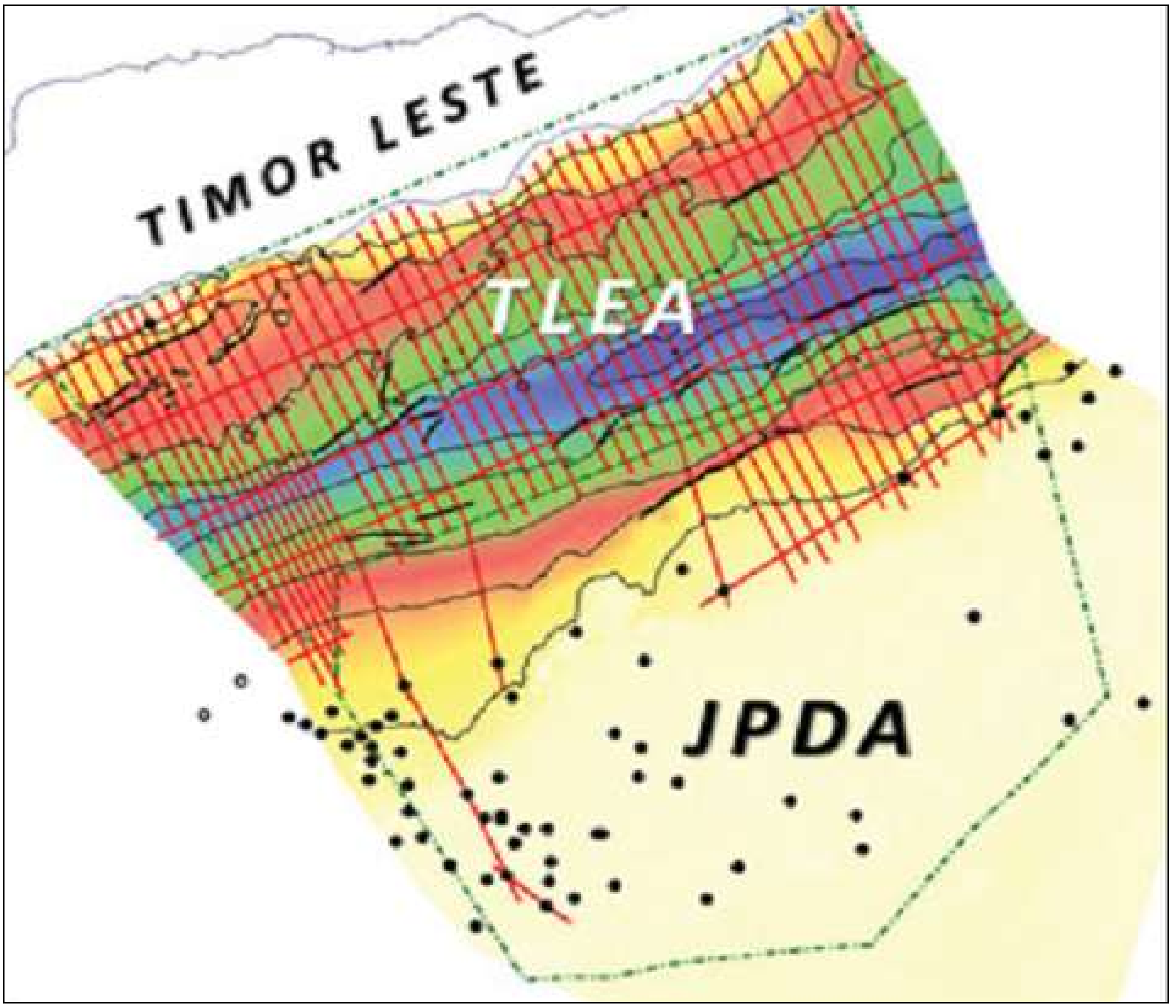

Figure 2.2. The narrow continental shelf of East Timor, the Timor Trough and JPDA overlapping with the Australian shallow continental shelf. Adapted from Robinson (2012).

The narrow shallow continental shelf of East Timor appears to be the subject to a substantial input of river-borne sediments and nutrients (see Figure 2.2), stimulating pelagic and benthic productivity in areas bordering the Timor Trough. The area is influenced by heavy seasonal rainfall, with numerous rivers transporting sediments from the South Coast uplands to the Timor Sea (Heyward, 1997a, Milliman, 1999) (see Figure 2.3).

Figure 2.3. An aerial photograph demonstrates the input of sediment into the coastal zone, particularly in Suai, at river mouths on the South Coast of East Timor. (Source: Google Earth).

The shallow narrow continental shelf of East Timor receives relatively high contributions of terrigenous material, which demonstrates the strong influence of terrestrial-based run-off on the coastal marine environment (Wyatt, 2004). Such run-off may affect primary production and eutrophication in estuarine waters. Typically eutrophication results from high nutrient inputs, leading to enhanced rates of primary production (Bonsdorff, 1997). The run-off also potentially causes high sedimentation and increased water turbidity on the continental shelf (Milliman, 1999). However, the main effects may be localised because the open high energy marine environment will tend to disperse the river discharges. The depositing of terrigenous materials is likely to be limited to the shallow continental shelf within East Timor territory and probably does not extend to the Timor Trough and Australian shallow continental shelf (see Figure 2.5).

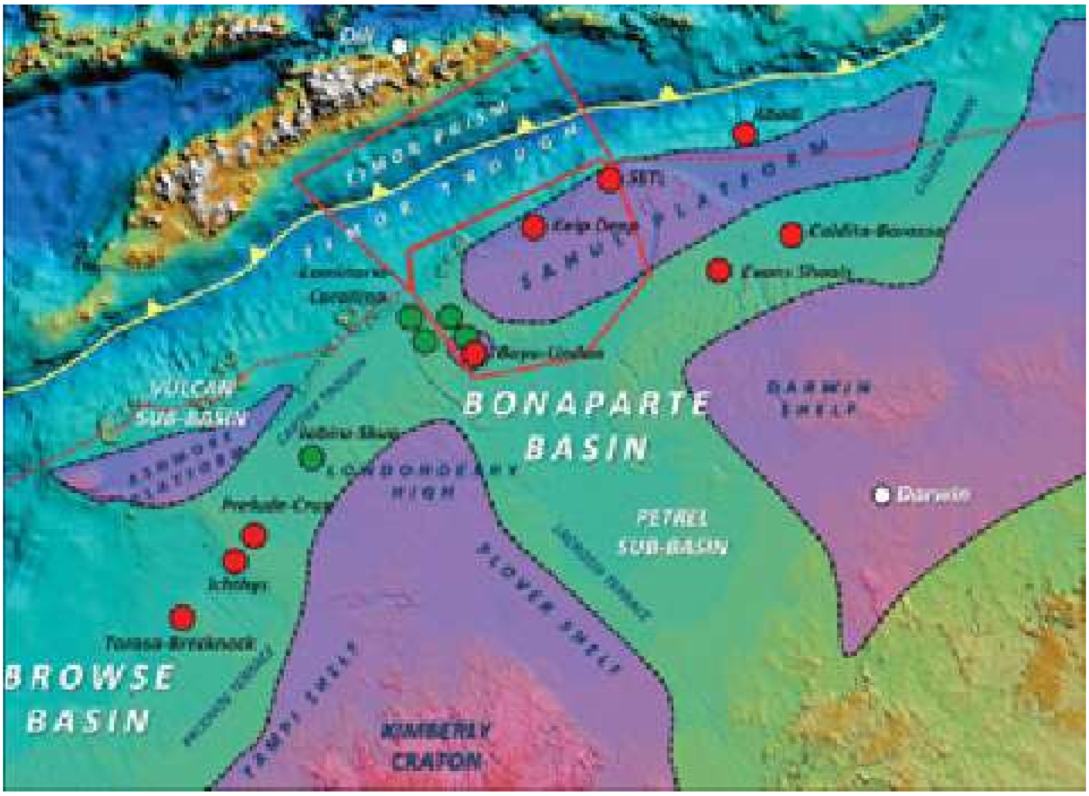

Figure 2.4. A bathymetric map of the Timor Sea showing the Timor Trough and carbonate banks. Adapted from Robinson (2012).

In contrast to the Timor shelf, the Australian continental shelf is broad and carbonate in nature (Heyward, 1997a). Australia is a low-lying, low-rainfall continental mass, and its rivers have slight channel gradient and intermittent flow. Consequently they carry only small quantities of terrigenous sediments into the sea. For this reason, shelf sediments tend to be dominated by biogenic reefs (AIMS, 2008).

The continental shelves of Australia and East Timor are separated by the Timor Trough, a tectonic plate boundary (subduction zone) running approximately west-south-west to east-north-east. The trough is approximately 200m wide and reaches depths of over 3,000m (see Figures 2.4 and 2.5).

2.2.2 Substrate and Geological Characteristics

The shallow continental shelf of Australia has scattered carbonate banks in the outer northern part, which coincides with the proposed oil development area (see Figure 2.4). This bank system stretches for approximately 60km in a north-east/south-west direction along the outer edge of the Australian continental shelf. It comprises 11 major shoals, ranging in size from $0.05km^2$ to $40km^2$, with an average size of $4.6km^2$ (Heyward, 1997b). The carbonate shelf supports hard-bottom communities of varying levels of complexity. Big Banks is the most well-known and ecologically well-developed area. In these areas the ocean is relatively shallow, gently sloping down to a depth of 200m, where there is an abrupt drop-off to the continental slope. The continental slope then descends gradually to depths of about 3km. At such depths the bottom becomes a flat, extensive, sediment-covered abyssal plain.

The continental shelf of East Timor is considerably narrower than the Australian shelf and is likely to be dominated by terrigenously derived sediments in contrast to the carbonates of the Australian shelf.

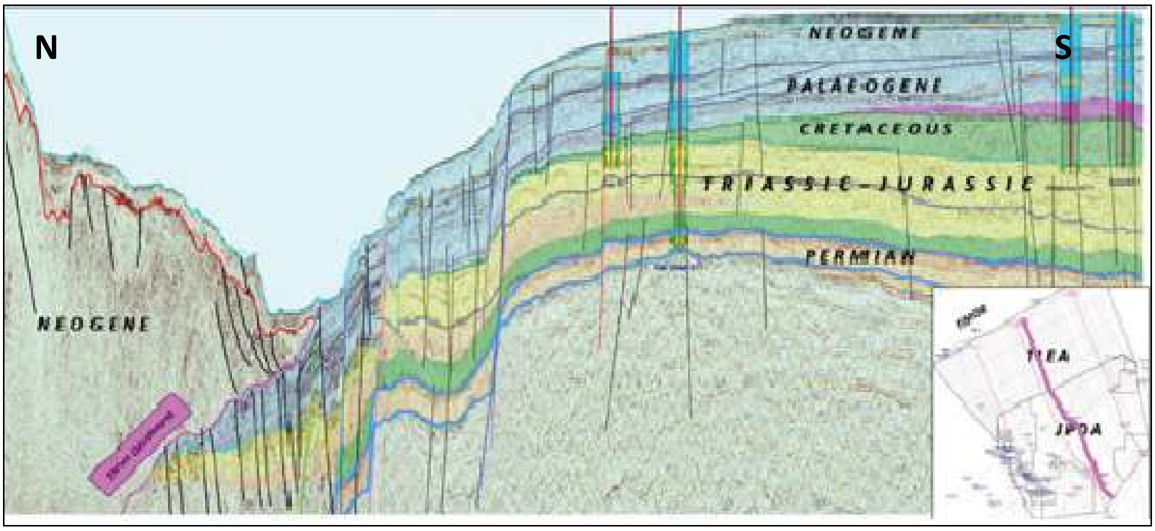

Figure 2.5. The Timor Trough showing the East Timor and Australia land masses. Adapted from Robinson (2012).

Proposed oil industry development in this area coincides with the southern edge of the Timor Trough (see Figure 2.5). The trough is a technologically active margin (Petkovic, 2000) and forms part of the Banda Arc system that runs south of Timor (Hamilton, 1979). The trough is the source of most earthquakes that have been recorded at the Sunrise field (Figure 2.1) in the Timor Sea. Records of earthquakes in the region date back 1900 and of the 131 earthquakes that occurred within 600km of the proposed oil development area five reached an intensity of 5 (AUSGEO, 2003) on the Richter scale (see Table 2.1).

Table 2.1 The strongest earthquakes recorded within 600km of the Sunrise gas field. Source: adapted from (AUSGEO, 2003).

Year	Origin (epicentre)	Location		Recorded around Greater Sunrise	Intensity (Richter scale)
		Latitude	Longitude		
1917	Banda Sea	7.5 S	128.00 E	231	5
1918	Banda Sea	8.0 S	127.50 E	190	5
1952	East Timor	8.0 S	126.60 E	245	5
1962	Banda Sea	7.0 S	128.30 E	237	5
1963	Banda Sea	6.9 S	129.53 E	328	5

In summary, the sediments of the Australian shelf are likely to be dominated by biologically derived carbonates in contrast to the narrower Timor shelf, which is likely to have a higher proportion of terrigenous deposits. The Timor Trough is likely to be dominated by fine biogenic sediments and is tectonically active, being formed by the subduction zone between the adjacent tectonic plates.

2.2.3 Climate

Wind and monsoon pattern

Timor Sea has a tropical climate and is characterised by two distinct seasons associated with monsoonal activity (Webster, 1998). The area is influenced by two monsoon seasons referred to as the northwest monsoon and the southwest monsoon. The northwest monsoon occurs from October to May and is characterised by dry weather and winds blowing from the southeast towards the northwest.

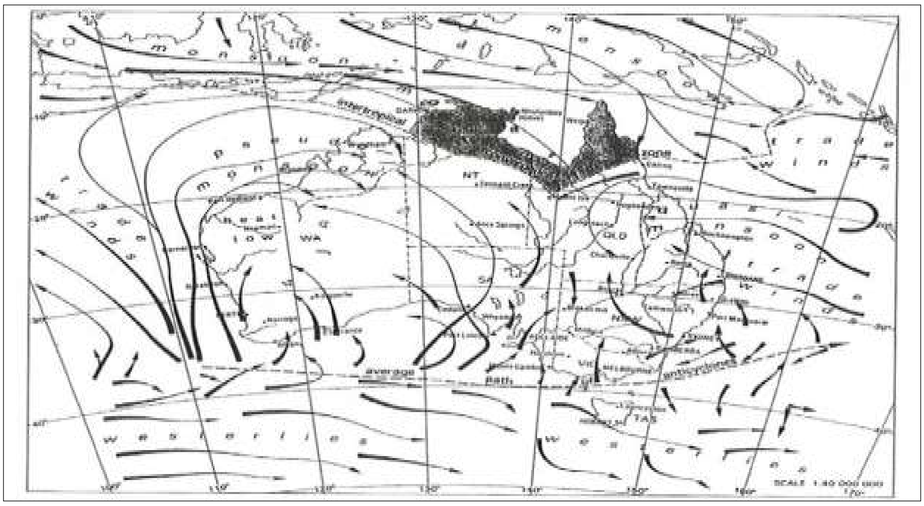

Figure 2.6. Generalised atmospheric circulation over the Timor Sea and Australia during the wet season. Source: (Swan, 1994).

The south-west monsoon occurs from June to September and is characterised by wet weather and winds blowing from the north-west towards the south-east. The season is characterised by steady easterly winds of 5 to 13ms-[1] which produces a gentle to strong breeze (see Figure 2.6). This season is predominantly influenced by the Australian continental air masses, coinciding with the north-west monsoons. The wet season, which continues from November to March (see Figure 2.6), is predominantly influenced by the south-west monsoon.

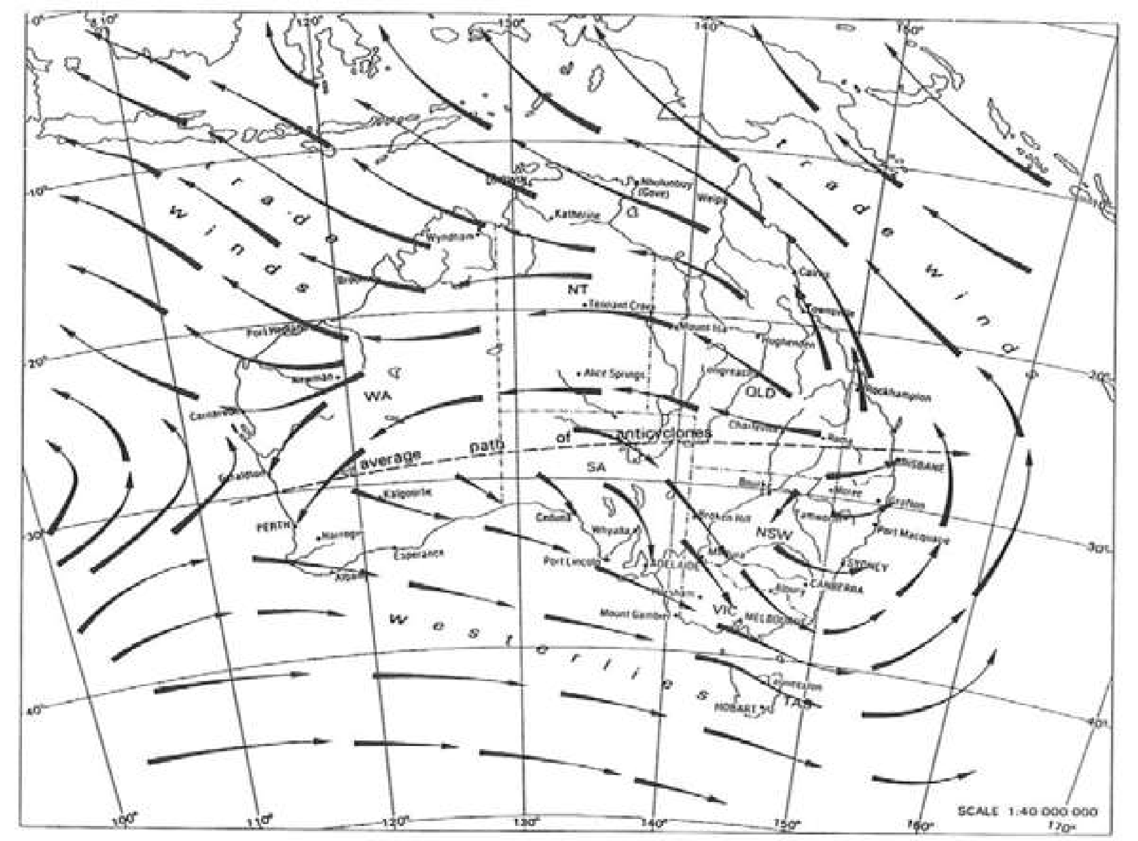

Figure 2.7. Generalised atmospheric circulation over the Timor Sea and Australia during the dry season. Source:(Swan, 1994).

The Figure 2.7 shows the wind being driven by a steady from south to east airflow originating over the Australian mainland towards a south-east direction (Webster, 1998). This period is characterised by steady westerly (driven towards the west) winds of 5ms^{-1} (the sea condition gentle breeze) for a period of 5 to 10 days, with surges in the airflow of 10ms^{-1} to 18ms^{-1} (the sea conditions when there is large breezes to strong gales) for a period of one to three days.

Cyclones

The majority of storms in the Timor Sea are tropical lows or tropical cyclones, most of which are the early stages of development and passing to the south of the JPDA. The majority (75%) of these cyclones have not fully matured and have wind speeds of less than 80km/h (severe gale force). Severe cyclones, with wind speeds exceeding 100km/h (storm force) occur on average once every 2.6 years (Heyward, 1997a).

Sea conditions consist of very high waves, with long overhanging crest and affected visibility. For details on cyclonic environmental conditions in the Timor Sea region, see Table 2.2.

Table 2.2 Cyclonic and non-cyclonic environmental conditions. Source: (OCEAN 407 Design of Ocean Engineering Facilities Ocean Program Texas A & M University).

Return period (yr)	**Wind (km/h)**	
	Cyclonic	**Non- cyclonic**
1	13	10.3
10	16.03	13.8
100	33.3	16.7

Cyclones are known to be one of the major natural disturbances to coral reefs, affecting reef structure and functioning at different spatial and temporal scales (Mireille, 1994). Cyclones can cause damage through mechanical destruction, changes in sedimentation, increased turbidity and reduced salinity (Guillemot, 2010).

Lambo and Ormond (2006) state that the salinity of nearshore may decline considerably once cyclones or storms make landfall and following intense rainfall flooding. This event may subsequently cause coral bleaching (the expulsion of endo-symbiotic zooxanthellae) and potentially lead to extensive mortality of the shallow-reef corals (Lambo and Ormond, 2006, Lugo-Fernandez and Gravois, 2010). Coral damage may also result from sediment brought into suspension by storm currents, causing sandblasting and burial of organisms (Alongi and McKinnon, 2005). The increased sediment load may also have effects through altered turbidity, decreasing available light and increasing the energy animals used to remove sediment particles (Glynn, 1964, Schaffelke *et al.,* 2005).

2.2.4 Oceanography

Currents and Tides

The Timor Sea is subject to water movements due to oceanic circulation, tidal oscillation and superficial surface water flows driven by wind (Gordon *et al.,* 2010). The main oceanic current runs in a north-east to south-west direction through the Timor Sea. It runs throughout the year, with surface current speeds averaging 0.5-1 miles (0.8-1.6km) per hour (WNI, 2001). The flow is driven by the Indonesian Through flow currents (ITF), which carry water masses from the western Pacific through the Banda Sea and into the region (Gordon *et al.,* 2010, Wyrtki, 1987). The water flows as a warm mass of saline water that travels south between the Indonesian Archipelago and Australia (CSIRO, 1999). The volume of water travelling through the Timor Trough is estimated to be ~4.3 x 10^6 m^3 s^{-1} and floods the Timor Sea region with relatively warm water that is low in salinity (Gordon, 2005).

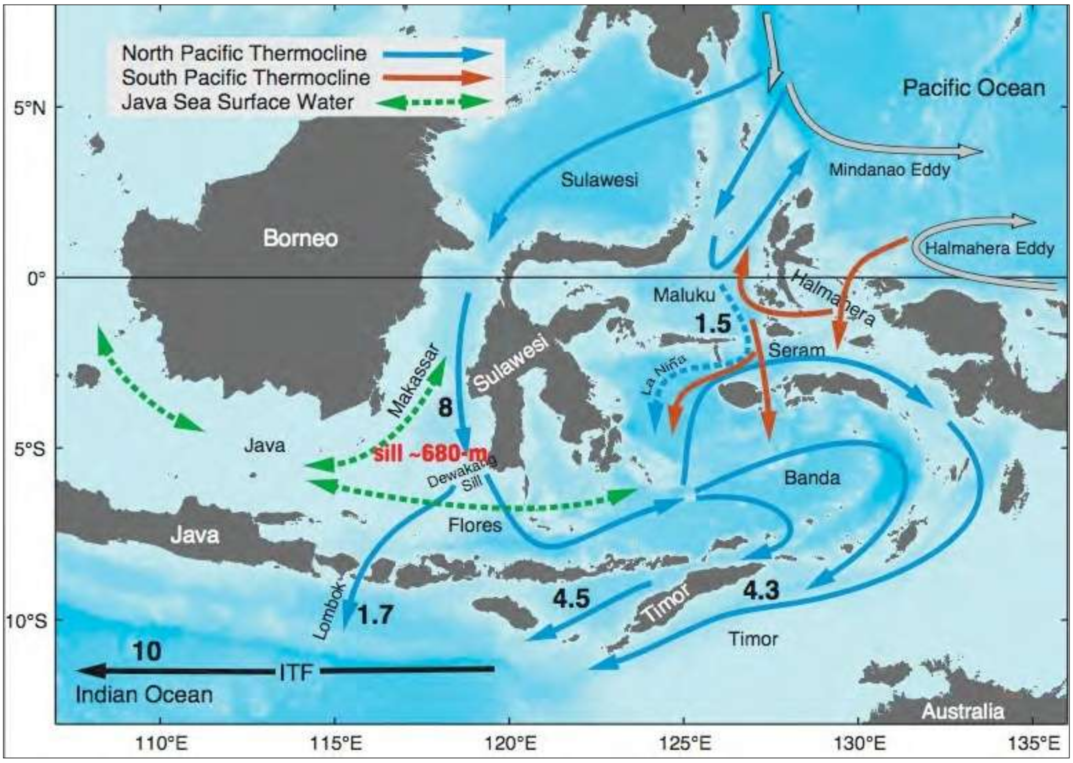

Figure 2.8. Major Ocean current that influence the Timor Sea. (CSIRO, 1999)

Tidal currents are generated by gravitational interactions between the sun, moon and earth and normally exhibit regular periodic oscillations in current direction. Tidal current flows in the Timor Sea typically run south to south-east during flood tides and in a north to north-west direction during ebb tide (Heyward,1997a). Current speeds range from approximately 0.02m/s on neap tides to 0.6m/s on spring tides (Ray, 2005). Tidal currents can attain a flow rate of up to 15.5 miles (25km) per hour when flowing in or out of narrow harbours or bays (Skinner, 2011).

The direction of superficial wind-driven currents in the Timor sea is determined by the seasonal wind regimes which are described in section 2.2.3.1 (Gordon et al., 2010). While the wind-driven surface currents attain maximum speeds of 0.7m/s during extreme monsoonal or Trade Wind surges, typically the current speeds are lower, ranging from 0.2m/s to 0.4m/s (Swan, 1994, WNI, 2001).

Oceanic current flows in the Timor Sea play an important role in marine life (Merino, 2009). Effects include impacts on nutrient circulation and the productivity of the ocean. This occurs mainly through the transportation of nutrients back to the euphotic layer from deeper waters (Alexandre, 2002, Merino, 2009). This enhances primary productivity and influences plankton distribution, larvae transport and recruitment (Merino, 2009).

El Nino-Southern Oscillation (ENSO)

The El Nino-Southern Oscillation (ENSO) influences the wet season in the Timor Sea (Gordon *et al.,* 2010). Throughout La Nina the wet season is extended, with an increase in rainfall and floods. This event can cause pronounced variations in transport of water mass, temperature and salinity (Gordon, 2005). An example of this was seen in mid-1997 to early 1998, when both El Nino and Dipole events occurred. This affected the upper part of the water column in the area (Timor Sea, Arafura Sea and Banda Sea), creating warmer and saltier conditions than normal (Sprintall, 2003).

Temperature

The monthly mean air temperature in the Timor Sea region peaks at about 33.4^{0}C in December and around 24.9^{0}C at its lowest in July. The monthly mean air temperatures recorded in the Timor Sea East Timor territory, around 180km from the South Coast, range from 24.9^{0}C in July to 29.6^{0}C in December (URS, 2002). Mean air temperature in the Timor Trough area average around 28.7^{0}C (Sprintall, 2003). While there is little variation in the temperatures between the shallow continental shelves of East Timor and Australia, mean air temperature along Australian continental shelf ranges from 31.1^{0}C in July to 33.4^{0}C in December (BHPP, 1998, BOM, 2010).

Surface water temperature recorded around the South Coast of East Timor ranges from 25 to 31^{0}C. At a depth of 150m, the water temperature ranges from 22 to 25^{0}C (OMV, 2003). Surface seawater temperature on the Australia continental shelf ranges from 27 to 30^{0}C (BOM, 2010), with the average surface temperature above the Timor Trough approximately 28.7^{0}C. Temperatures increase during the north-west monsoon from January to March, reaching a peak of 31^{0}C and falling to a low of 25^{0}C during the south-east monsoon season (Sprintall, 2003).

Salinity

Surface seawater salinities in the Timor Sea appear to be similar to conditions in the tropics and generally range from 34 to 35 ppt, with little seasonal variation (WNI, 2001). Salinity measured around the development area ranged from 33.61 to 34.71 ppt, although slightly lower salinity levels were recorded in deeper waters. There is some seasonal variability in salinity, with a distinct freshening occurring from March to May related to the enhanced rainfall during the north-west monsoon and resulting in voluminous river run-off (Sprintall, 2003).

In summary, the climate in the Timor Sea climate can be described as tropical and is characterised by two distinct seasons: the wet season from November to March and the dry season running from June to September. The region is also influenced by the north-west monsoon, which is characterised by steady, moist, west to north-west winds associated with enhanced rainfall, tropical cyclones and thunderstorm activity. These conditions in turn affect the ocean and can lead to a strong seasonal variability in the strength and direction of currents, as well as temperature and salinity patterns.

2.3 Biological Characteristics

Scientific information on marine biodiversity and habitats of the northern part of the Timor Sea is limited compared with other neighbouring regions. Consequently, this study also assesses biological data from Australia and other neighbouring regions. The Timor Sea region is part of the Indo-west biogeographical province (see Figure 2.9) and it is assumed that the majority of species within this region are widely distributed and are included in the tropical waters to the north of the Australian continent (Wilson, 1987).

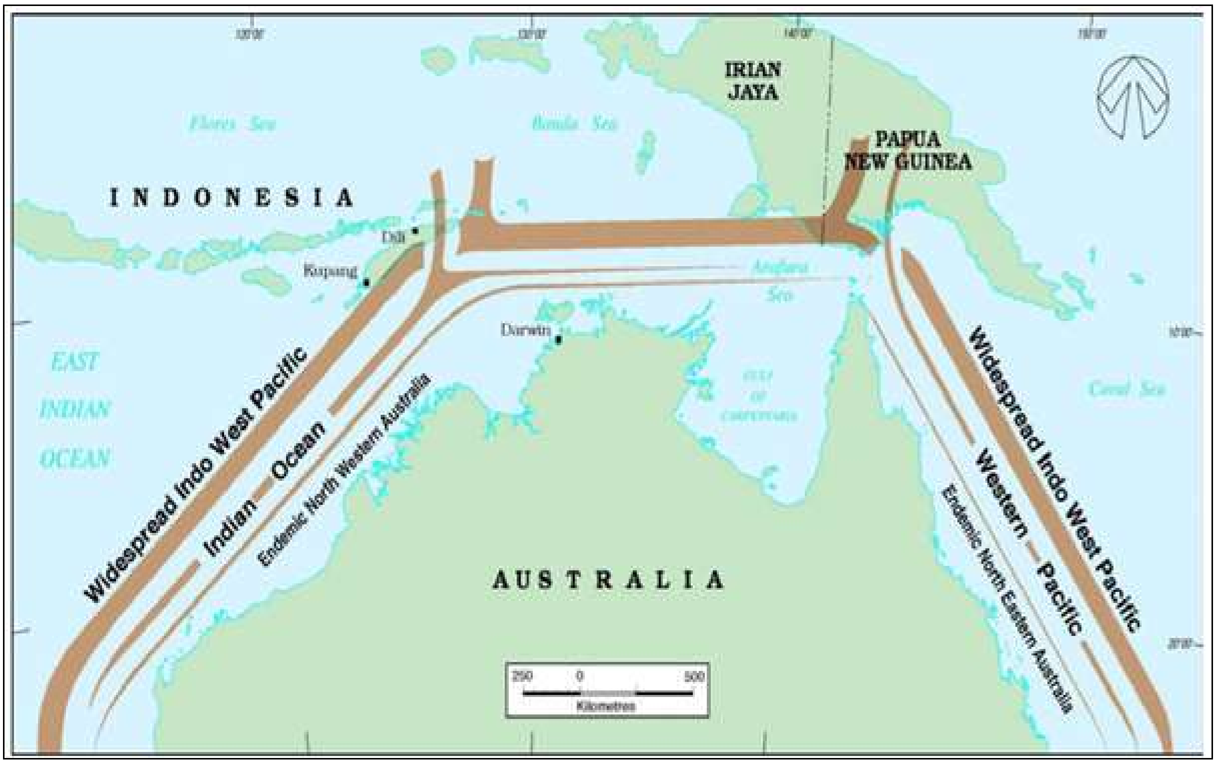

Figure 2.9. Indo-West Pacific bioregeographical province. Source: (Wilson, 1987).

To systematically assess the natural features of the study area the sections are arranged under four main sub-headings: East Timor intertidal habitats, East Timor shelf habitats, continental slope habitats (all deep-sea beyond 200m) and marine vertebrates. Where direct information on the geographical area is lacking (e.g. deep-sea habitat and the East Timor continental shelf) a prediction of the habitat and biota are made on the basis of data from bio-geographically or environmentally similar regions. Various eastern Indonesian islands and the south coast of Papua New Guinea (PNG) are considered in this study. These locations were selected because of their similarity in terms of bio-geography, adjacent mountainous land, large river mouths on the coastlines and narrow continental shelves.

2.3.1 Intertidal habitats

Intertidal

The intertidal zone of the South Coast of East Timor includes rocky intertidal shelves, sandy or muddy tidal flats and mangrove forests (Sandlund, 2001). The coast is dominated by steep, wave-exposed sandy beaches. Although most areas are sedimentary shores, these are sometimes interspersed with rock autocrops. Large river mouths are frequent along the coast and are predominantly associated with sedimentary shores and extensive sand banks *(Personal observation)*. The slopes of these adjacent coastal plains typically range from 3% to 6% (GERTIL, 2002) and river deltas and swamps are common. Long stretches of sandy beach with heavy waves and surf are also common along the South Coast and this generally results in high turbidity of coastal waters (Sandlund, 2001).

Figure 2.10. Sandy beach environments on the South Coast of East Timor, showing steep wave-exposed conditions (a & b) on Betano, (c) Beaco and Suai Loro Beaches *(Photo: Jose Lucas)*.

There is a general lack of data on the sedimentary shore biota of the South Coast. However, it is reasonable to assume the infaunal community is probably impoverished due to the mobile nature of the sediments on the steep, wave-exposed shores (see figure 2.10). As river mouths are likely to be subject to variable salinity and mobile sediments, the diversity of species is likely to be relatively limited at such locations.

The biota of rocky shorelines on the South Coast of East Timor is largely unknown, although it is presumably comparable to that of rocky shores found on the south coast of PNG. These shores are typically high energy environments with high wave exposure, turbulent waters and strong water currents, factors that often result in considerable erosive potential (Heijs, 1986). Other features include high dissolved oxygen saturation, moderately high levels of suspended material and little, if any, sediments, except in sheltered pools and backwaters in the lee of the rocks. Such habitats have their own characteristic biological communities and add an important dimension to the country's habitats and the diversity of species they contain (CTI-PNG, 2012).

Mangroves

The total area covered by mangroves in East Timor has been reduced by approximately 80% from 1,940 hectares, as recorded in 2008 (Boggs et al. 2009). Trees are harvested for timber and to use as firewood in East Timor and The illegal harvest of mangroves and the loss of this vital habitat remains a critical coastal management issue.

Typicall*y* mangrove forms a marshy or swampy terrain in mid-high tidal flats along areas of the South Coast. Mangrove areas in this region are sparse and limited in extent and tend to form small patches at the mouths of streams (Alongi, 2009). Mangroves are common in areas such as Suai Loro and are also present in Beaco *(Personal observation)*.

Mangrove forest is a vital habitat, supporting South Coast communities ecologically and economically (Alongi, 2009 and Sandlund, 2001). Mangroves provide coastal protection, as well as important spawning and breeding areas for fish and birds. They are also a source of firewood, building materials and traditional medicines. The only information available on mangroves for the region is derived from Boggs (2009) and FAO (2007).

Table 2.3. Aggregation of true mangrove species on the South Coast of East Timor. Modified from (Boggs, 2009 and FAO, 2007).

Species	Family
Avicennia marina	ACANTHACEAE
Aegiceras corniculatum	MYRSINACEAE
Bruguiera gymnorrhiza	RHIZOPHORACEAE
Ceriops decandra	RHIZOPHORACEAE
Lumnitzera racemosa	COMBRETACEAE
Excoecaria agallocha	EUPHORBIACEAE
Sonneratia alba	LYTHRACEAE
Xylocarpus mekongensis	MYRSINACEAE
Bruguiera parviflora	RHIZOPHORACEAE
Rhizophora apiculata	RHIZOPHORACEAE
Rhizophora stylosa	RHIZOPHORACEAE
Sonneratia caseolaris	LYTHRACEAE
Noumbe of species 12	Number of families 6

Twelve component mangrove species have been recorded on the South Coast of East Timor (see Table 2.3). All of these species are widespread throughout South East Asia and the Pacific in general. The literature indicates a higher richness of mangrove species in both PNG – home to 33 species (Ellison, 2000, Gilman, 2008) –and on Indonesia's Seram Island where 26 species can be found (Susetiono, 1995).

Seagrass

There remains a lack of information on the extent and density of seagrass habitats on the South Coast. Seagrass habitats in PNG and Seram Island are assessed in this sub-section on the assumption that similar habitats will occur in East Timor. Seagrass communities in PNG occur on fringing reefs, protected bays, protected barrier reefs and islands. They are most commonly found on reef flats, as well as in coastal lagoons (Brouns, 1985 and Johnstone, 1978a). They are often associated with areas close to big river estuaries that maintain a steady, but low level supply of fine silt and mud sediments to the lagoon floor (Heijs, 1986). However, if the concentration of suspended sediments is too high, seagrass growth is likely to be limited by the turbidity of the water in the lagoon (CTI, 2012, Johnstone, 1979). Seagrass communities tend to be absent on steep slopes exposed to oceanic swell, as well as areas with high silt loads and those influenced by large volumes of freshwater run-off from rivers (Johnstone, 1979). There are 13 species of seagrass present in the PNG coastal region (Johnstone, 1979). These are most dominant of these are *Thalassia hemprichii* and *Enhalus acoroides*, with another 10 species present to varying degrees (Johnstone, 1978a). Seagrass communities on Seram Island are frequently found in shallow-water back reefs (e.g. reef flats and moats) and lagoons (Tomascik *et al.,* 1997), reaching their highest abundance in such environments (Kuriandewa, 2003). However, in some locations they dominate the reef crest of barrier reefs and atolls (Neinhuis, 1989). The seagrass *Thalassadendron cialliatum*, for example, is often found attached to hard rock and coral limestone at the seaward margins of reefs (i.e. fringing reefs and atolls) (Tomascik *et al.,* 1997).

Seagrass communities are an important coastal habitat (CTI, 2012, Kuriandewa, 2003) and play an important role in stabilising coastal sediments, as well as providing habitats and feeding grounds for marine organisms. They also provide nursery grounds for fish and help support human commercial activities (Brouns, 1985). Seagrass also provides food for the endangered green turtle *(Chelonian mydas)* and the dugong *(Dugong dugong)* (Lanyon, 1989). Seagrass contributes to the productivity of ecosystems via the detrital food pathway, binding sediments and helping to prevent erosion, slow-water flow. It also helps to increase water clarity and remove harmful pollutants from coastal water (Brouns, 1985, CTI-PNG, 2012).

Seagrass communities are potentially threatened by both natural and human impacts (CTI, 2012). Seagrass losses can sometimes be linked to natural events such as storms (Brouns 1985), as well as grazing (Tomascik *et al.,* 1997) and climate change (CTI, 2012, Kiswara, 1996). However, in most cases it is linked to human activities (Brouns, 1985). This may occur through pollution (i.e. sewage, oil spills and coastal run-off), as well as physical disturbances (i.e. dredging, boat propellers and anchoring) or coastal development (CTI, 2012).

2.3.2 Shelf habitats

Shelf sediment

Information on continental shelf sediments in East Timor is extremely limited. However, the environment is assumed to be similar to that of the continental shelves of Papua New Guinea (PNG) and the islands of eastern Indonesia. The shelf sediments north of PNG are composed mainly of riverine sediments. The literature indicates that distribution of sediments in this area can be categorised into three distinct groups: 1) within 200m of organic rich mud on the shoreline, 2) between 200m and 500m poorly sorted sandy muds on the shore, 3) between 500m and 1000m of sands and fine gravel on the shore (Kineke, 2000). On the continental shelf of Seram Island the sediment is predominantly sandy in shallower areas (<200m), with silt and clay deposited in quieter deeper water (>200m) (Tomascik et al., 1997).

The Australian continental shelf in the Timor Sea is relatively extensive and slopes gently from the shore to a depth of about 200m where there is an abrupt drop-off to the continental slope (Smith, 1997). Most of the shelf is composed of soft sediment with little topographic relief. This has resulted in vast expanses of monotonous benthic communities, with only slight distinctions in different areas due to variations in sediment grain size (Heyward, 1997a, Smith, 1997). Due to the lack topographic relief, the shelf has only a limited range of habitats or niches for animals to occupy.

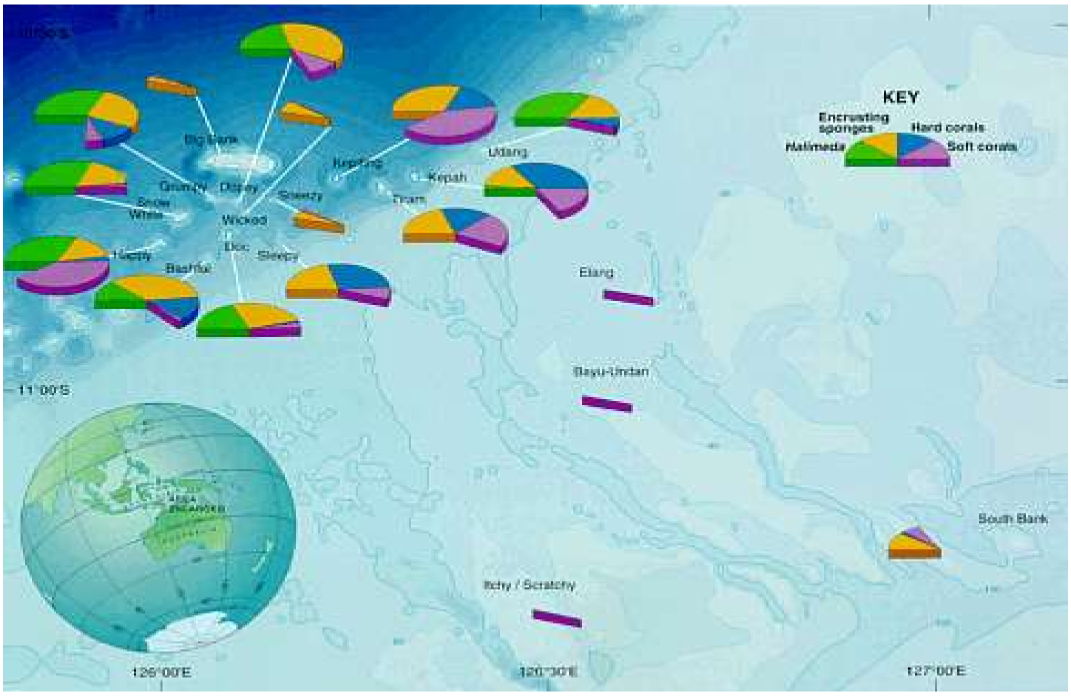

Figure 2.11. Map of the Big Bank Shoals showing the distribution of Halimeda algae, encrusting sponges, hard corals and soft corals. Source: (Heyward, 1997a).

Such habitats are dominated by filter-feeding heterotrophs such as sponges, soft corals, gorgonians, detritus-feeding crustaceans and echinoderms. A recent survey documented epibenthic communities on the Shelf, including Elang, Bayu-Undang and Itchy (see Figure 2.11). All sites recorded were of similar character, with soft, easily re-suspended sediments predominantly making up about 97% of the benthos (Smith, 1997). Shelf sediment samples taken at the three sites demonstrated that polychaetes and crustaceans were the two major taxes, making up over % of the total species at individual site (Heyward, 1997a, Smith, 1997).

Shelf biogenic reefs

Unprotected intertidal reefs and islands occur along the South Coast of East Timor, with seas usually characterised by strong waves. This is in contrast to the north coast which tends to be more placid (silent) and possesses more reefs. Maps generated by the Defence Mapping Agency Topographic Centre in 1976 highlight areas on the South Coast where coral reefs are known to occur (CTI-TLS, 2012). An aerial observation of coral reefs undertaken on the South Coast indicated that fringing reefs do not extend further than 100km from the shore (Eni, 2008). The reefs found in East Timor are comparable to those in eastern Indonesia, which have a relatively narrow reef flat of 20 to 100m in width and a drop-off at a depth of 40 to 60m (CTI-TLS, 2012). Some fringing reef systems in East Timor have a rubble zone located immediately below the reef crest (Tomascik *et al.,* 1997). Tomascik *et al.,* (1997) suggested that the rubble area may be the result of high bio-erosion rates in fast-growing branching corals (*Porites cylindrical, P. nigrescens, Acropora aspera and A. Nobilis)*, which generate fragments that are deposited at the base of the reefs. Another interesting characteristic of some fringing reef systems found on East Timor's shallow shelf is the existence of a rubble zone located immediately below the reef crest, ranging from about 2 to 3m in depth (Tomascik *et al.,* 1997). Coral reefs in East Timor appear to have a high cover of sponges, hydroids, algae groups, ascidians and *Montipora* corals. These have been recorded along the South Coast, as well as some partially damaged coral colonies by *Drupella* grazing (Ayling, 2009). East Timor's reefs are classified as oceanic fringing reefs similar to the fringing reefs in Sulawesi and Flores in eastern Indonesia (Tomascik *et al.,* 1997).

Shallow banks dominated by reefs formed by the algae *Halimeda* (Marshall, 1994) can be found in some areas on the outer part of the Australian continental shelf. *Halimeda* is a genus of macroscopic, calcareous, green algae, belonging to the Cauleprales (Chlorophyta) order and which are easily identified by their plate-like, calcified segments (Smith, 1997). *Halimeda* has generally been considered a plant of sand substrata, growing most commonly in shallow lagoon environments.

Halimeda is abundant on the outer Australian continental shelf and is of importance in terms of sediment production and reef formation. These can also form geological structures such as bioherms and banks (Marshall, 1994, Maxwell, 1968). *Halimeda* reefs commonly support encrusting sponges and a diverse range of other organisms, including bryozoans, foraminifera, tunicates and fish (Maxwell, 1968, Smith, 1997). Soft corals and outcrops of hard coral also provide structure to *Halimeda* reefs (Smith 1997). The most abundant soft corals include *Xenia spp, Sarcophyton spp and Nephthea spp.* A total of 19 different genera of scleractinian coral have been recorded on the *Halimeda* banks in the region, with *Sepriatopora* and Fungiidae the most consistently encountered including species (Heyward, 1997a, Smith, 1997). Gorgonian sea fans were also found, but were only a very small component of the fauna. *Halimeda* communities are susceptible to physical damage and disturbances due to storms or cyclones generated by seasonal monsoonal weather (Heyward, 1997a). The recovery period for *Halimeda incrassate* following severe storms has been reported as six to eight months, within which time it was able to recover pre-disturbance biomass and abundance (William, 1988). The rapid recovery has been attributed to the ability of *Halimeda* to obtain nutrients directly from the sediment (William, 1988).

The outer Australian continental shelf includes areas of shallow water at depths of 15 to 50m (Marshall 1994) such as Sahul and Big Bank Shoals (AUSGEO., 2003). Several genera of corals are found in the region, including *Goniastrea, Pocillopora, Seriatopora, Porotes, Gonjopora* and *Fungia* (Smith, 1997). Recent ROV surveys recorded 16 genera of scleratinian coral (reef-building coral) in these areas, with the most abundant hard corals being *Porites*, *Acropora, Pachyseris* and *Montipora* (Heyward, 1997a, Marshall, 1994, Smith, 1997). Soft coral found in the area were dominated by species of the families Xeniidae, Nepththeiidae and Alcyoniidae (Smith, 1997).

2.3.3 Continental slope habitats

Information on continental slope habitat in the Timor Sea is also lacking. The continental slopes of similar bio-geographical regions are reviewed in this sub-section and include the continental slopes of Papua New Guinea (PNG) and eastern Indonesian islands. The literature indicates that many pelagic community dwellers provide important feeding, reproduction or nursery habitats. The zone also provides similar opportunities in oceanic (bathyal and abyssal) depths (CTI-PNG, 2012).

2.3.4 Deep-sea habitats

Hydrothermal vents

Because the Timor Trough is on the boundary of a tectonically active plate (Hessler, 1991) it is suspected that hydrothermal vents may occur, even though there is no direct evidence of vents or vent communities. Hydrothermal vents represent discharges of magmatic fluids directly into the water column and ocean floor (Embley *et al.,* 2006, Nakagawa *et al.,* 2006). Minerals are precipitated out as the vent fluid meets the cold sea water, and the resulting mineral deposits can form massive chimney structures rising from the seabed (Gold, 1992) and (Perkins, 2001).

Vents tend to be confined to mid-ocean ridges (Tunnicliffe, 1991), but also have a wide distribution at the sea floor (Tufar, 1990, Tunnicliffe *et al.,* 1998). Vents are typically formed gradually over time on the sea floor (Tunnicliffe *et al.,* 1998). Hydrothermal vents have a wide distribution in the western Pacific (Tunnicliffe, 1991), including numerous locations that are bio-geographically similar to the Timor Sea. Such locations include Lihir Island in PNG (1450m), the Java Trench (1500m) (Southward *et al.,* 2002) and the Manus Basin (Hashimoto, 1999).

Although the fauna of hydrothermal vents varies from location to location, it is generally characterised by a relatively high biomass, high endemism and an energy supply based on chemoautotrophic bacteria. Numerically dominant species typically have a symbiotic association with the energy-generating chemoautotrophic bacteria and may include vestimentiferan tubeworms and bathymodiolid mussels. Vestimentiferan species recorded in the region include species of *Escarpia* and *Arcovestia ivanovi* (Southward *et al.,* 2002).

Cold seeps

Cold seeps potentially occur in the Timor Trough (O'Brien, 1999). Evidence from geophysical and geochemical studies indicates that methane seeps are widespread within the Timor Sea (O'Brien, 2000). Studies have also documented numerous active seeps on the shallow carbonate-rich Yampi Shelf area on the Australian continental shelf (Rollet *et al.,* 2006). The presence of these was indicated by numerous plumes of methane gas associated with hydrocarbons detected in the water column (Rollet et al., 2006). There are many similarities between cold seep and hydrothermal vent communities, including the role of chemoautotrophic bacteria as primary producers. In the case of cold seeps, the bacteria generate energy primarily from methane (Levin 2005; Hsing, 2010). However, cold seep communities in shallower areas (e.g. continental shelf) are typically less dependent on chemoautotrophic bacteria as an energy source compared to communities at greater depths (e.g. continental shelf and abyssal plain) (MacDonald, 1996). Cold seep studies in the Timor Sea have mostly focused on geochemistry, with minimal attention to biological aspects. Cold seep communities are ecologically similar to hydrothermal vent communities and are thought to show a high degree of endemism. Component fauna may include bivalves (mytilids, vesicomyids, lucinids and thyasirids), vestimentiferan tube worms, gastropods and shrimp (Levin, 2005).

2.3.5 Marine vertebrates

Fish

The composition and distribution of fish species in the Timor Sea is likely to be similar to neighbouring regions (Sandlund, 2001). In 1999, the CSIRO reported that fish densities offshore in the Timor Sea are likely to be low in comparison to coastal waters, although densities may be higher in the vicinity of shallow reefs and shoals near the edge of the continental shelf. Although a number of specific studies have been conducted in the region, there is still a lack of direct information on fish distribution and density in the Timor Sea. Boggs (2009) found that big eye tuna *(Thunnus obesus)* and whale shark (*Richncodon typus*) were present and these have been listed as threatened species. The studies of Wilson (1987) and Wudianto (2007) noted a number of species of economic importance in the Timor Sea, including tuna, mackerel, yellow fin and snappers. The most dominant of these were reported to be skipjack tuna and yellow fin. Wilson (1987) also reported that golden snappers could be found offshore in the Timor Sea, with the most dominant species being *Pristimoides multidenas* (Lloyd, 1994). The available literature indicates that both PNG and Seram Island have a higher proportion of fish species (CTI-PNG, 2012), with 3,500 and 3,215 respectively (Tomascik *et al.,* 1997).

Marine reptiles

Marine reptiles are also likely to be present in the Timor Sea development area, among these are saltwater crocodiles and species of marine turtles and sea snakes (Ross, 1998 and Storr, 1986). Turtle nesting sites have been identified on the shores of Jaco island and Tutuala beach (Figure 2.1 south of Beaco) (CTI-TLS, 2012 and Nunes, 2001). It is highly likely that there are other nesting areas which are as yet unreported.

Turtle numbers peak in November, with a high abundances occurring on the far north-east tip of Timor around Jaco Island (Edyvane, 2009).

Table 2.4 Details of six turtle species occurring in the Timor Sea development area. Source: Modified from (Sandlund, 2001) and (Edyvane, 2009).

Common name	**Species**	**Genus**	**Family**	**Conservation status**
				Global (IUCN ver. 3.1)
Oliver Ridley	*Lepidochelys olivacea*	LEPIDOCHELYS	CHELONIIDAE	Vulnerable
Loggerhead	*Caretta caretta*	CARETTA	CHELONIIDAE	Endangered
Hawksbill	*Eretmochelys imbricata*	ERETMOCHELYS	CHELONIIDAE	Critically endangered
Green	*Chelonia mydas*	CHELONIA	CHELONIIDAE	Endangered
Leatherback	*Dermocheyls coriacea*	DERMOCHELYS	DERMOCHELYYIDAE	Critically endangered
	Number of species: 5	Number of genus: 5	Number of families: 2	

Five species of turtle exist in the region, similar number to neighbouring regions such as PNG and Seram Island, which both have six species (Tomascik *et al.,* 1997). Of the five Timor Sea species two (*Erectmochelys imbricate* and *Dermochelys coriacea)* are listed as critically endangered, according to the International Union Conservation of Nature (IUCN) red list system of categorisation. A further two species (*Caretta caretta* and *Chelonia mydas)* are categorised as endangered, with another (*Lepidochelys olivacea*) listed as vulnerable.

The saltwater crocodile *(Crocodilylus porosus)* is the largest reptile to be recorded in the region. This species is also found in other neighbouring countries, including northern Australia, PNG, Indonesia and other parts of Southeast Asia (Tomascik *et al.,* 1997). The species has a tendency to travel very long distances, sometimes thousands of kilometres from their native territory (OngJia, 2011). Saltwater crocodiles can swim 24 to 28km/h (6.7 to 8.0m/s) in short bursts and 3 to 5km (0.9 to 1.3m/s) when cruising. Their distribution across the Timor Sea region is concentrated on islands and coasts. During the wet season they generally inhabit freshwater swamps and rivers systems, moving downstream into estuaries during the dry season (Ross, 1998). They also frequently occur in marine coastal areas, as well as in freshwater bodies (Ross, 1998). The species is listed as low risk in the IUCN red List.

Sea snakes are known to occur in a wide range of water depths around the shores of East Timor's South Coast, as well as reefs and banks in offshore areas. Storr (1986) recorded approximately 15 species of sea snakes, occurring in northern Australian waters and the Timor Sea.

Seabirds

There is limited information on seabirds in the Timor Sea area. Although there are migratory species that cross the region or forage within coastal waters, their status and distribution is poorly documented (Trainor, 2005). While recent studies conducted by Trainor (2007) revealed that there are waterbirds and coastal species of birds that are endemic to Timor, the study did not specify the distribution of seabirds. A study by Dunlop (1995) found that seabird distribution on the Australian continental shelf in the Timor Sea was generally very irregular. However, islands provide shelter and feeding grounds and therefore may support higher populations of birds. The region is also reported to be a significant staging point for birds migrating between Australia and the northern hemisphere. This discovery also affirmed in the work of the CSIRO (1999) that reported over 10,000 seabirds belonging to nine different species potentially utilise Ashmore Reefs as a breeding site. The literature indicates that both PNG and Seram Island have a higher diversity of species, with 21 and 26 species respectively (Tomascik *et al.,* 1997). Among the species fund in the Timor Sea area two are listed as critically endangered (Trainor, 2005). Additionally, the streaked shearwater (*Calonectris leucomelas* – also known as *Puffinus leucomelas)*, a migratory species of seabird listed under the EPBC Act, may occur within the same region (DEWHA, 2007a).

Marine mammals

Numerous species of marine mammal are likely to be present in the Timor Sea, with the Timor Trough thought to provide an important migratory corridor connecting the Pacific and Indian oceans (Dethmers *et al.,* 2009, Khan, 2003, Khan, 2005 and Mustika, 2005). There is relatively limited data available on marine mammals in the Timor Sea, although information on distribution is provided by recent observations by Eni (Eni 2007; Eni 2008; Eni 2010). These studies were commonly conducted around deep-water areas at depths of between 500 and 2,500m during September, with survey periods an average of 22 to 30 days in duration. The studies recorded 96 individual species, including Pygmy blue whales *(Balaenoptera musculus brevicauda)* and unidentified species of dolphins. The observations of pygmy blue whales is evidence they do move along a migration route, although it has also been argued that the migration of many other cetaceans usually takes place for reproduction and feeding events (Boyd, 2004 and Stevick, 2002). This statement is supported by the findings of Burton's 2008 study on the occurrence and distribution of cetacean species south of East Timor. The survey ran for 73 days and covered a track of 5500km, with a total of 670 hours devoted to the study between the months of July and September. Blue whales were recorded in deep water at depths between 500 and 2500m over the Timor Trough and were thought to be using the area for feeding and possibly also for breeding.

Humpback whales *(Megaptera novaeangliae)* are known to occur near the coast of the Australian mainland throughout their migratory cycle, with calving grounds identified in the Camden Sound, near the Kimberley coast (Jenner, 2001). The humpback migration route runs along the west coast of Australia and terminates at their breeding area in the coastal waters of Bonaparte Archipelago and in bays of the Kimberley coast over 250km from the development area. However, during their northern migration, throughout late July to early August, humpback whales may migrate through the development area in the Timor Sea (Jenner, 2001).

Dugongs *(Dugong dugong)* are likely to occur on the South Coast in areas with seagrass beds in shallow water at depths of less than 10m (Eni, 2007; Marsh 2006: Lanyon 1989).

Table 2.5. The occurrence of marine mammals in the Timor Sea. Source: modified from (Dethmers et al., 2009). A total of seven surveys were conducted to assess marine megafauna in Timor waters. These include aerial surveys and field ground-truthing.

Common name	Species	Status Global (IUCN ver. 3.1)
Blue whale	*Blaenoptera musculus*	Endangered
Bryde's whale	*Balaenoptera brydei*	Data Deficient
Killer whale	*Orcanus orca*	Data deficient
Humpbak whale	*Megaptera novaeangliae*	Least concern
Sperm whale	*Physeter macrocephalus*	Vulnerable
Short-finned pilot whale	*Globicephala macrorhyncus*	Data deficient
False killer whale	*Pseudorca crassidens*	Data deficient
Melon-headed whale	*Pephonocephala electra*	Least concern
Cuvier's beaked whale	*Ziphius cavirostris*	Least concern
Rough-toothed dolphin	*Steno bredanensis*	Least concern
Dugongs	*Dugong dugong*	Vulnerable
Spinner dolphin	*Stenella longirostris*	Data deficient
Spotted dolphin	*Stenella attenuate*	Least concern
Rissos's dolphin	*Grampus griseus*	Least concern

The list of marine mammals above shows that *Blaenoptera musculus* is categorised under the IUCN red list as endangered. Another two species (*Physester macrocephalus* and *Dugong dugong*) are categorised as vulnerable species. *Megaptera novaeangliae* is locally categorised under the EPBC Act as a vulnerable and migratory species. Table 2.1 indicates that there are only 14 species of cetaceans in the oil development area. The literature also indicates a higher diversity of mammal species in both PNG and Seram Island (CTI-PNG 2012), with a total of 32 and 30 respectively (Tomascik *et al.,* 1997).

Sperm whales *(Physester macrocephalus)* are known to feed on cephalopods in the waters of the continental slope waters (Edyvane, 2009), with similar evidence also reported in the work of Davis (1998) in the continental slopes of central and western Mexico.

2.4 Existing human pressures on the natural marine environment on the South Coast, Timor Sea.

This section assesses existing human pressures on the natural environment in the Timor Sea, as well as potential future activities that may impact on the natural environment. The overview of existing human pressures on the natural marine environment describes the context within which any potential impacts as a result of future development will occur. Such human pressures include commercial and traditional fishing, shipping, tourism and recreational and agricultural activities, as well as aquaculture and coastal development. These pressures are described and discussed in the sub-sections below.

2.4.1 Traditional and subsistence fisheries

Traditional and subsistence fishing activities conducted along both the Australian north-west coastline and South Coast of East Timor are generally limited to the shorelines, creeks and nearshore reefs (Moore, 1997). Fishing activities are normally conducted from April to December. Other activities are conducted nearshore, including free diving for the collection of trochus shells *(throchus niloticus)* and trepan (sea cucumbers) (Heyward, 1997a). Certain species of sea cucumber are targeted or preferred and these include *Actinoyga spp*. *Holothuria nobilis* and *Thelenota ananas* (Caddy, 1995). Traditional fishing methods on the South Coast of East Timor uses both hand-hauled gill nets and handlines, and do not typically do not extend more than 2NM (<4km) from the coast (Eni, 2008). Fishing is primarily undertaken from canoes or small boats with outboard motors, which restrict activities to areas close to shore. Fishing on the South Coast also appears to be a seasonal activity and is frequently undertaken at night or early in the morning *(Personal observation)*. As the proposed development area is offshore, it is highly unlikely to coincide with areas used for traditional fishing activities *(Personal observation).*

2.4.2 Commercial fishing

The oil development area is located in a zone of overlapping jurisdiction between Australia and East Timor. The development area lies outside Australian fishing zones and hence there are no Australian commercial fishing activities in the area. Other commercial fishing activities in the area include operations by long-line fishermen from Indonesia. These operations focus on fishing for shark fins (*Charedon spp.*) and for tuna mackerel (*Euthynnus affinis)* which is the most commercially valuable fishery. The shark fishing grounds are extensive and it is likely that fishing vessels will pass through the area throughout April to December.

The operation of trawl fishing in the Timor Sea is commonly undertaken in the shallow offshore areas. The most targeted species in the area are scarlet and sadletail perch *(Lutjanus erythropterus)*, snapper *(Lutjanidae)* and Emperor fish *(Lethrinidae).* Most of the trawl fishing conducted is concentrated in the proximity of Sahul bank and Echo Shoals, hence fishing vessels are likely to pass through the proposed development area. A recent survey conducted by the Australian Fisheries Management Authority (AFMA) indicated that only one vessel had been observed fishing in the vicinity of the Sunrise gas field in the past few year (Woodside, 2001). The nearest Australian commercial fishery to the proposed development area is about 75km south-east, which is included within the north-west boundary of the northern Australian Prawn Fishery in the Northern Territory.

2.4.3 Shipping activities

There are commercial shipping routes that pass through west of the development area. Vessels include navy ships, tankers and bauxite carriers servicing terminals at Gove in the Northern Territory and Weipa on Cape York Peninsula. Other vessels passing though the route include coal carriers and container vessels departing Queensland ports for destinations in the Middle East, Europe and South Africa (Moore, 1997). Figure 2.12 gives some indication of the frequency of shipping routes in the Timor Sea. Vessel traffic in the oil development area appears relatively low.

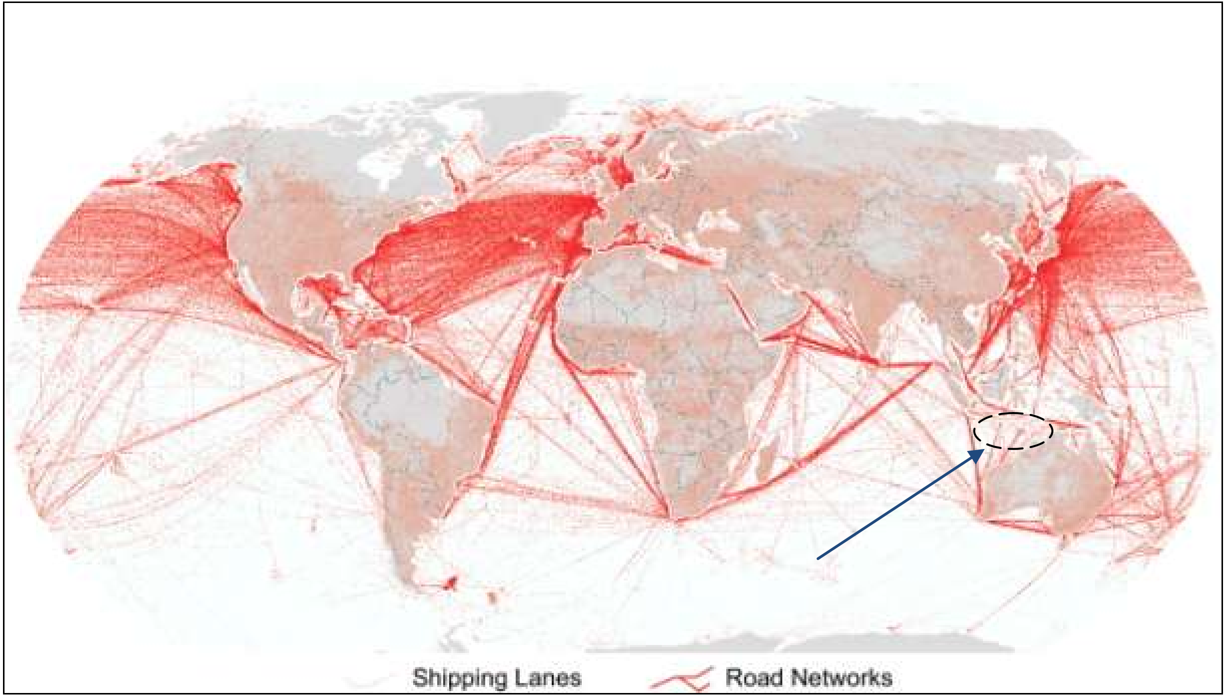

Figure: 2.12. The complex network of global cargo ship movements. Adapted from Pablo Kaluza et al., 2010. http://arxiv.org/aabs/1001.2172.

2.4.4 Traditional and Subsistence Fisheries

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2.4.5 Commercial Fishing

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2.4.6 Agricultural activities

East Timor is an agricultural-based economy with the majority (90%) of the population relying on subsistence agriculture (CIA, 2009). Slash and burn agriculture may be associated with increased soil erosion, larger sediment load in the rivers and hence increased turbidity and sedimentation at river mouths. In South Coast areas agrochemical use such as fertiliser and pesticides is localised and minimal, although it is more widely used in rice-growing areas on the north coast of the island *(Personal observation).*

2.4.7 Coastal development

The South Coast of East Timor is undeveloped compared to the north coast which accommodates the capital city, Dili. Traditional coastal populations live scattered in small groups and villages along the coast. No major city or industry exists in the region *(personal observation)*. However, as a new economically developing country East Timor could potentially develop the South Coast region to boost the country's economy through the development of oil refineries or other coastal industries. Urban expansion and industrialisation has resulted in coastal pollution from domestic, agricultural and industrial waste in the area. Any development on the coast also has the potential to alter the natural ecosystem, possibly influencing biodiversity. Detrimental changes could occur through direct habitat destruction and/or increased pollution. In summary, existing human pressures on natural resources in Timor Sea and the South Coast region are currently negligible in nature.

2.4.8 Existing human pressures on coastal and marine environments in other regions.

This sub-section provides additional evidence of human pressures on natural resources in other geographical regions to serve as a reference to assess potential future impacts in the Timor Sea. It has been well documented around the world that environmental degradation in coastal areas is closely related to human activities such as agriculture, fishing, land clearing and coastal urbanisation (Somerfield *et al.,* 2006, Schaffelke *et al.,* 2005, Ramade and Roche, 2006). Such human activities include global increases in annual nitrogen fertilizer, which is now used worldwide at more than six times the level of 1960 (Matson *et al.,* 2006). Land clearing continues at a rate of 1 percent of the earth's surface per year (Davis, 1993), rapid coastal urbanisation also occurring in many areas. Coastal and marine ecosystems are increasingly exposed to growing loads of nutrients, sediments and pollutants discharged from the land. Hence terrestrial run-off is of growing concern for those nations endowed with coral reefs with diverse fish communities (Burke, 2002). The subsections below provide an overview of the literature on the selected issues outlined, as well as the potential impacts on East Timor's South Coast.

Commercial fishing and potential effects

Table 2.6 provides an overview of the conclusions made in several selected studies on commercial fishing conducted in different geographical regions. These studies were selected on the basis that they include review papers, and note recovery time and effects on seabed habitat.

Table 2.6. Summary of main conclusions from a review of studies on human pressures on the marine environment.

Conclusions	Stressors/community	Recovery time	Reference
The most severe impacts occurred in biogenic habitats in response to scallop-dredging. Analysis of the response of different feeding guilds to disturbances from fishing revealed that both deposit and suspension feeders were consistently vulnerable to scallop-dredging across gravel, sand and mud habitats, while the response of these groups to beam-trawling was highly dependent upon habitats, particularly muddy sands, which were surprisingly vulnerable.	Scallop-dredging and beam-trawling	The biota of soft sediment habitat predicted recovery time to be within a few years. Slow-growing, large-biomass biota such as sponges and soft coral took much longer to recover (up to 8 yrs) than biota, with shorter life-spans such as polychaetes (<1yr).	Kaiser et al., (2006)
Recurrent trawling can be expected to have an accumulative impact on benthos. The effects of single trawls were not large and prawn trawls appeared to have a smaller effect than fish trawls, beam-trawls and scallop dredges.	Prawn and fish trawling	Recovery within 6 yrs.	Pitcher et al., (2009)
Although there is evidence to suggest that bottom-trawling has an impact on the environment, the extent and duration of those affects varies depending on local conditions.	Bottom-trawling gears	In deep water (>1000m) recovery time is probably measured in decades.	Jones (1992)
Long-lived, slow-growing species are most negatively affected. Shifts occur in the composition of benthic species and changes to ecosystems take place through alteration of production levels, food or population structures. In terms of loss of benthic biodiversity, sandy areas are less impacted than muddy areas or areas with coarse gravel.	Beam-trawling	In many areas recovery times take longer than between-trawling intervals.	Bouma and Lengkeek (2010)
Fishing had an impact on habitat components, community structure and ecosystem processes. This was the case for a wide range of habitats and fishing gear types. All studies indicated commonalities, with immediate effects on species composition, as well as diversity and reduction in habitat complexity.	Various fishing gear	Recovery after fishing was more variable depending on habitat type, life history, strategy of component species and the natural disturbance regime.	Auster et al., (1999)

Studies in table 2.6 indicate that commercial fishing practices using trawling and dredging have a demonstrated impact on benthic habitats and communities, with similar evidence also documented in the review by Gordon (2006). The extent of that impact varies and depends on numerous factors, including the type of gear used, physical habitats and locations (Jones, 1992). Sandy areas, for example, appear to be less sensitive to damage compared to muddy or gravelly sediments (Auster *et al.,* 1999). Although sandy areas are easy to disturb, they are much faster to recover than gravel and muddy habitats (Gordon, 2006). Many studies indicate that effects occur on production levels, population structure, species composition and diversity (Auster *et al.,* 1999, Bouma, 2010). Recovery time is also highly variable depending on the type of fishing gear and the nature of the benthic habitat. For example, the recovery period may vary from one to eight years to more than 10 years (Gordon, 2006, Kaiser *et al.,* 2006).

Artisanal fishing and potential effects

Compared to commercial fishing, artisanal fisheries (those pursued by small-scale fishers utilising traditional methods) in developing countries are less often assessed for environmental impact (Hawkins, 2004). The main reason for this is that degradation in stocks and benthic communities caused by commercial methods such as trawling and dredging are widely regarded as considerably more harmful than any effects from small-scale, traditional techniques. The work of Dalzell (1998) on archaeological records from numerous coral reef localities around the Pacific detected little or no impact from artisanal fishing over the past 1000 years. Similarly in Hawaii, reef fisheries appear to have supported a much larger human population in the past (pre-European times) than they do today, and there is no evidence that those activities have caused adverse effects to the marine environment (Birkeland, 2001). However, evidence from the past two decades demonstrates significant effects from artisanal fishing (Adam, 1997, Hawkins, 2004), presumably this is due to the increased use of modern materials and equipment such as motorised boats. Although many artisanal practices have changed little over the years (Johannes, 1997), fishing is now conducted with greater intensity and many fisheries now support larger populations (Polunin, 1996).

Concerns have been raised that recent increases in artisanal fishing could alter the structure of coral reef communities as predator species continue to be targeted and depleted (Jennings, 1998). In some cases, vulnerable species may be threatened with global or local extinction (Hawkins, 2004). The giant clam *(Tridacna gigas)*, for example, appears to have disappeared from large areas of the Pacific due to the activities of artisanal fishers (Wells and Jernakoff, 2006). Artisanal fishing can also indirectly effect coral reef habitats (Hawkins, 2004). In one case, fishing activity depleted fish populations to such an extent that their sea urchin prey increased in abundance (McClanahan, 1990). The increased numbers of these herbivorous urchins resulted in less algae and more bio-erosion, which subsequently led to decreased coral cover (McClanahan, 1996). According to Edyvane et al. (2009), illegal turtle harvesting remains a major issue in East Timor, especially in the recently declared Nino Konis Santana National Park and Marine Park.

Marine aquaculture and potential effects

Marine aquaculture is another human activity which has the potential to effect the marine environment (Russ, 2002). Fish farming is among the factors assessed in this section. Studies were selected to include review papers and studies of effects on marine habitats.

Table 2.7. Summary of main conclusions from a review of studies on the effects of marine aquaculture on the marine environment.

Conclusion	Stressor	Reference
Significant loss of benthic biodiversity and localised changes in phsico-chemical properties of sediments. Presence of these farms significantly increases in pulses the density of dinoflagellates.	Salmonid farming	Buschamann *et al.,* (2006)
Habitats considered highly sensitive include maerl, seagrass, *Sabellaria* and oyster reefs, with *serpulid* reefs, muds in deep water and sheltered muddy gravels being considered moderately sensitive. Habitats considered at greater risk were maerl, deep-water mud, sheltered muddy gravels and beds of *Modiolus modiulus*.	Salmon farms	Wilding, (2010)
Contributes to coastal nutrient pollution, atmospheric deposition and the release of toxic compounds in the area around fish farming.	Salmon aquaculture	Milewski *et al.,* (1999)
Effects observed primarily correlated with ammonium and the other nitrogen forms in the vicinity of farms.	Various fish farming	Sara (2006)
Environmental effects of seaweed cultivation can have an impact on sedimentation processes, increased invertebrate assemblage and algal epiphytic abundance. Mollusc farming causes bio-deposition, faunal changes and introduces new species. Salmon cultivation potentially effects organic sedimentation and can cause changes to fauna and phytoplankton blooms.	Seaweed, salmon and mussel faming	Buschamann *et al.*(1996)

Studies in Table 2.7 demonstrated that marine aquaculture practices such as salmon, seaweed and mussel farming have localised effects in the vicinity of fish farms (Buschamann *et al.,* 1996, Sara, 2006). The nature of the impacts appears to vary considerably depending on the habitats and species involved (Buschmann *et al.,* 2006, Wilding, 2010), as well as the local sedimentation process (Buschamann *et al.,* 1996). Aquaculture has been implicated in the introduction of new species (Buschamann *et al.,*1996) and is known to contribute to coastal nutrient pollution (Milewski, 1999). Examples of habitats considered at greater risk include maerl, mud, deep-water gravels and beds of *Modiolus modiolus* (Wilding, 2010).

Overall summary

- The Timor Sea region includes the shallow and extensive continental shelf off northern Australia, the deep sea environment of the Timor Trough (up to 3300m) and the narrow continental shelf off the South Coast of East Timor.
- The area is tectonically active with the Timor Trough forming an active subduction zone.
- There are two main seasons: Dry from April to September and wet from October to March, with the area also subject to periodic storms and cyclones.
- Water movements are driven by oceanic circulation, tidal oscillation and superficial surface water driven by wind.
- There is no evidence that the diversity of the Timor Sea fauna is particularly high.
- The shores of the South Coast of East Timor are predominantly exposed sandy beaches assumed to support relatively low faunal diversity.
- Mangroves are present at a few shore locations but are sparse overall.
- Seagrass beds and shallow-water coral reefs are likely to be present, but are not known to be extensive.
- Coastal waters and shores are subject to the influence of large rivers at a number of locations, presumably leading to local variations in salinity and increased input of sediments and detritus, resulting in increased turbidity.
- While very little is known of the benthos of the continental shelf south of East Timor, the sediments are likely to be terrigenous
- Sediments found on the Australian continental shelf are thought to be largely carbonate in composition and benthic infaunal communities are thought to show little spatial variation. Shallow banks formed by Halimeda reefs are present on the outer part of the shelf and support some coral communities.
- Virtually nothing is known of the biota of the continental slopes and the deep sea of the Timor Trough. It is assumed the benthic fauna is diverse, if sparsely distributed, and dominated by deposit feeders. Hydrothermal vent and cold seep communities are likely to exist in the area.
- Fish densities in the continental shelf are likely to be relatively low in open waters and greater in nearshore areas and around shallow reefs and shoals.
- The area is on a migratory pathway for some birds and marine mammals.

- Endangered species of turtles and marine mammals are known to occur in the area.
- Current human activities such as agriculture, fishing, shipping, and coastal development are thought to have only a negligible impact on the biota of the Timor Sea.

Chapter 3 A REVIEW OF THE POTENTIAL IMPACTS ON THE MARINE ENVIRONMENT ASSOCIATED WITH OFFSHORE OIL AND GAS EXPLORATION.

3.1 Introduction

The development of installations such as oil platforms and drilling has become a typical feature of many shelf areas in recent decades. It is anticipated that such developments will take place in the Timor Sea in the near future. The shelf zone of the region was previously used mainly for shipping and fishing. However, in the future it will become a ground for relative new, dynamic and large-scale economic activity consisting of offshore oil and gas production.

The expansion of economic activities on the continental shelf has the potential to generate a wide range of environmental impacts. Such impacts are likely to occur in both pelagic and benthic environments. This section provides a review of the potential impacts of oil development on the Timor Sea. This study therefore considers the potential impacts of seismic surveys, oil exploration (drilling muds and cuttings), oil production (produced water), decommissioning of oil installations and oil spills.

3.1.1 Objective of the study

The objective of this chapter is to assess the potential impacts of oil exploration, with a focus on the magnitude and extent of these effects. It includes an assessment of the impacts of seismic survey, drilling muds, produced water and decommissioning on the marine biota and the surrounding environment.

3.1.2 Methodology of the study

This study will achieve its objectives through:

1. An assessment of literature associated with oil exploration activities and possible impacts on the marine environment.
2. Secondary data from various reports are assessed to estimate the magnitude and extent of individual effects during the oil exploration process.

3.2 Geological and geophysical survey

3.2.1 Seismic survey

Seismic surveys are an essential component of exploration activities for offshore oil and gas. These are typically required to locate appropriate sites for exploratory drilling. The method involves generating high intensity sound pulses and recording their reflection from the seafloor and underlying rock strata. This is usually carried out by a seismic survey vessel equipped with a number of energy sources which generate a short impulse of noise every 30 to 60 seconds. The reflected signals are detected by receiver (*hydrophones)* cables of 3 to 8km in length. The vessel steams down preselected tracks about 1 to 2km apart, firing air or water guns every 30 to 60 seconds (typically at 25m intervals as the vessel moves). Energy sources and receivers are normally attached to a towed cable that is several kilometres in length. The survey array may be towed for distances of 500 to 1000km at a depth of between 6 to 8 metres (1994a, Richardson, 1995). The vessel typically travels at a speed of 4.5 to 5.5 knots (approximately 10km/h) following parallel survey tracks. A typical survey on an average geophysical exploration usually lasts two to three weeks.

Most seismic surveys operate both two dimensional (2D) and three dimensional (3D) techniques. The 2D is the simplest and the most inexpensive method when compared with 3D and 4D. Utilising a single air gun array and one seismic cable, it is possible to map 2D slices of the seabed with a distance of several kilometres between each survey line. The 3D method requires the vessel to travel along more closely spaced tracks at 100 to 500m) and normally utilises two air gun arrays and 4 to 10 hydrophone cables. Selection of 2D or 3D techniques depends on the resolution of data required. Typically 2D surveys are operated to rapidly collect information covering a broad area, while 3D surveys focus on a smaller, more specific area of interest in a tight grid pattern. In most cases, 2D is used in the initial survey, with 3D then used to gain higher resolution data from areas of interest. In some cases repeated 3D surveys – often called 4D surveys – are used to map the production of hydrocarbons in a field, and these techniques that have contributed significantly to increasing production from reservoirs.

Seismic airgun arrays typically consist of three to six subarrays, with each one having a linear alignment of four to eight individual air guns. Thus, each array usually involves

12 to 48 guns. The seismic industry typically employs arrays with an operating pressure of 2000 psi. Generally, air guns vary from 0.16 litres to 8.21 litres in volume of air discharged, although large-volume airguns specially designed for seismic refraction work can be up to 60 litres of discharge (Marine Technology, Directorate, 1996). The dominant frequencies of airgun pulses fall within the range 0 to 120 Hz, although there are significant levels of high-frequency sound up to 20KHz also produced by the pulses (Goold, 1998). Given that the utilisation of air guns is currently the most significant method of seismic prospecting (Wardle, 2001a, Gausland, 2003a), it is necessary to assess studies that have investigated the environmental effects of using this technique.

3.2.2 Potential impacts on the marine environment

The following sub-sections summarise the main conclusions in terms of environmental impacts from airgun operation in the marine environment, as reported in the literature. Studies have been undertaken in various parts of the world to assess both potential physical damage and behavioural disruptions associated with acoustic disturbance during seismic survey work. Such studies encompassed an assessment of the effects on fish – including adult fish, larvae and fishing catch – as well as mammals and certain invertebrates. There have been numerous studies on the impact of seismic surveys and the effects on mammals, a topic reviewed by Gordon *et. al,* (1998). As reviews of the impacts on fish are unavailable a selection of the primary literature has been consulted to gauge potential impacts.

Potential impacts on adult fish

The effect of seismic surveys on adult fish have been assessed based on the literature presented in Table 3.1. To determine the effects of air gun impulses on adult fish, a total of 11 studies – including experimental and field-based studies – were reviewed and summarised. The selection criteria for these studies was that they must have been conducted in the marine environment and made attempts to estimate the affected zone.

Table 3.1. Summary of conclusions on the potential impacts of seismic surveys on adult fish.

Conclusion	Source levels (dB@1m)	Distance from source (m)	Received level (dB)	Reference
There was significant damage to the sensory epithelia (ablated ear cells) in pink snapper examined 58 days after exposure. No mortality observed.	222.6	50	< 212	McCauley *et al.,* (2003)
No Sandeel mortality could be linked to airgun exposure. Where mortalities occurred, they were attributed to handling procedures.	256	>54	<221	Hassel (2004)
No physical damage and no mortality of rainbow trout or Atlantic salmon.	229	150-4000	142-186	Bjarti (2002)
No physical damage observed in European sea bass	256	180	210	Santulli *et al.,* (1999.)
Change in vertical position. Blue whiting and mesopelagics descended in the water column to depths of 20 and 50m respectively.	226.6	20-50	197.189	Slotte *et al.*, (2004)
Observed mortality. Some cod and plaice died within 48 hours. Internal injuries reported. No control to test for significance.	226	2	220	Matislov (1992)
Damage to blood cells. 50 % of exposed fish suffered damage to blood cells or internal bleeding. Eye injuries also reported.	220-240	0.5	226-246	Kosheleva (1992)
Increased swimming speed of sea bass bunched in the centre of the enclosure with random orientation. Recovery was usually within 11 hours of exposure.	256	180	240	Santulli *et al.,* (1996)
Change in vertical position. Decrease in average rockfish aggregation height	223	82-183	183-191	Skalski *et al.,* (1992)
Change in vertical position. Sandeel tended to remain higher in enclosure.	256	>54	<221	Hassel *et al.,* (2003)
Startle response. Startle (C-start) reaction of pollock to all airgun shots		5.3-195	195-218	Wardle *et al.,* (2001b)

The main conclusions from Table 3.1 indicated that physical injury and mortality were recorded in the immediate proximity of guns (<2m) and behavioural responses were noted as far as ~200m from the source. However, the difficulty is that none of these studies clearly define the boundaries of these effects on the behavioural responses.

Potential impact on fish eggs and larvae

The effect of seismic surveys on fish and larvae are assessed based on the literature presented in Table 3.2. In order to determine the effects of air gun impulses on fish larvae and eggs, a total of nine studies – including experimental, field-based and review papers – were reviewed and summarised. The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate the affected zone.

Table 3.2. Summary of potential effects of seismic surveys on fish eggs and larvae.

Species	**Life stage**	**Metre from source (m)**	**Estimated exposure level (dB re 1 µ pA)**	**Observed response**	**Reference**
Fish (various species)	Eggs and larvae	1-10	140	Observed sub-lethal to zooplankton, fish eggs and larvae	Patin *et al.,* (1999)
Pollock *(Pollachus virens)*	Egg	0.75	242	Immediate mortality	Booman *et al* ,(1996)
Cod *(Gadus morhua)*	Eggs	1-10	202-220	No sign of injury	Dalen *et al.,* (2007)
Cod *(Gadus morhua)*	Fry	1	234	Immediate mortality	Booman *et al.,* (1996)
Plaice *(Pleuronectes platessa)*	Larvae	2	214	No effect	Kosheleva (1992)
Cod *(Gadus morhua)*	Five-day-old larvae	1	250	Delimitation of retina	Matishov (1992)
Anchovy *(Engraulis mordax)*	Two-day-old larvae	3	238	Swim bladder rupture	Trunpenny *et al.,* (1994)
Red Mulet *(Mullus Surmuletus)*	Eggs	10	210	No injuries	JWL (2007)
Fish (various species)	Eggs	0.5	236	17% dead in 24 hours	Kostyuchenko in LGL, (2007)

The studies demonstrate that lethal effects are likely to occur in the immediate proximity (<1 m) of the source, while serious physical injury is likely to be at least ~3m. However, it is difficult to see where the limits of the effects are and results seem to be highly variable between studies, species and the development stage. Fry also appear more vulnerable than eggs.

Potential impact on fisheries

The impact of seismic surveys on fishing catch are summarised from the literature reviewed in Table 3.3. A total of 11 studies on the impacts of air gun impulses on fisheries were reviewed and summarised. The selection critera for these studies was that they must have been conducted in the marine environment, quantify catch reduction and make attempts to estimate the affected zone.

Table 3. 3 Summary of conclusions on the potential impacts of seismic surveys on fisheries.

Species and catch reduction	**Gear type**	**Source levels (dB@1m)**	**Distance from source (m)**	**Received level (dB)**	**Reference**
A 53% reduction in rock fish (*Sebastes spp.*) was seen. The duration of the impacts was not determined.	Longline	223	<165m	186-191	Skalski and Pearson, (1992).
Demersal fish – 36% catch reduction. Fish presumably forced to seabed	Longline	249	100-300m	200-210	Dalen and Knutsen in Worcester (2006).
Cod and haddock – reductions in both trawl (69%) and longline (68%) catch of cod and haddock.	Longline & bottom trawl	249	<33		Engas *et al.,* (1996).
No change in catch rates attributable to seismic operations.	Longline	229	<7	150	Bjarti (2002).
European Sea bass – no significant changes in trawl and gillnet catch.	Trawl and gillnet	250	1-23		Pickett *et al.,* (1994).
Lesser Sandeel (*Ammodytes marinus)* – no changes in catch rates attributable to seismic operations.	trawl	256	<55		Hassel *et al.,* (2004).
Cod and Shrimp trawl –Reductions in shrimp trawl by catch of cod by 79 and 83 %. Increased of cod by catch in saithe trawl of 300% and return to pre-exposure catches within 12-24 hrs.	trawl	239-250	<9	160-171	Løkkeborg *et al.*,(1993).
Catch rate reduced by 7%	trawl	256	5-20	250	Labella *et al.,* (1996)
Catches of cod reduced by 55-83%.	Longline	239	<9.3	161	Løkkeborg *et al.,* (1991)
Various fish (species). – 70% catch reduction in some cases.	Longline & bottom trawl		32.19	250	Alaska Marine Conservation Council, (2007)
Haddock *(Melanogrammus)* – 70-72% catch reduction lasting at least 5 days.	Trawl	250	>33	160	Engas *et al.,* (1993)

Studies demonstrated evidence of airgun impacts on catch reduction at distance within 33 m from the airgun source. No evidence found attributable to airgun impacts on catch rates at distance 55 m from the airgun source.

Potential impacts on marine mammals

There have been intensive studies on the effects of seismic surveys on marine mammals. A total of 11 studies on the impacts of air gun impulses on marine mammals were reviewed and summarised (Table 3.4). The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate the affected zone.

Table 3. 4. Summary of conclusions on the potential impacts of seismic surveys on marine mammals.

Species	Source levels (dB@1)	Distance from source (m)	Received level (dB)	Conclusion	Reference
Humpback whales (*Megaptera novaeangliacea)*	227	2000	159	Course alteration	McCauley *et al.,* (2000)
Common dolphin (*Delphinus delphis)*	120	>1000		Reduced vocalisation rate	Goold (1998)
Bowhead whales (*Balaena mysticetus)*	236	8000	142-157	Behavioural change. Change in blow rates and dive patterns	Richardson *et al.,* (1995)
Bottlenose dolphin captivity	1 sec 20 khz	1000	178	Behavioural avoidance response	Ridgway (1997)
Gray whales (*Halichoerus grypus)*		2500	173	50 percent avoidance	Malme *et al*., in (Gausland, 2003b).
Sperm whales*(Physeter catodon)*	263 dB	112	>300	Cessation of vocalisation in response to some instances of air gun activity	Bowles (1994b)
Gray Whales (*Halichoerus grypus)*		<4000	169	Short-term affects to some typical whale behaviour and their distribution on feeding grounds	Nelson (2009)
Bowhead whales (*Balaena mysticetus)*		19,000	250	Began to show avoidance behaviour	Alaska Marine Conservation Council (2007)
Humpback whales (*Megaptera novaeangliacea)*		10,000	160	Remain close to approach active air gun arrays	McCauley *et al.,* (1998)
Bowhead whales (*Balaena mysticetus)*		2000-3000	120-130	Behavioural avoidance response	Richardson *et al.,* (1999)
Humpback whales (Megaptera novaeangliacea)[1]and blue whales (Balaenoptera musculus)[2].		8000-10,000	162[1], 143[2]	Shift in hearing thresholds and auditory damage	Gordon *et al.,* (2004)

Studies demonstrated that seismic airguns resulted in reduced vocalization rates, behavioural avoidance and alternations to migration routes. Short-term impacts recorded included changes to behaviour and their distribution of feeding grounds. Studies showed that marine mammals were impacted at distances ranging from 5000 to 10,000m from the airgun source.

Potential impact on invertebrate species

The effects of seismic survey on invertebrates have been assessed based on the literature presented in Table 3.5. A total of 10 studies on the impacts of air gun impulses on marine invertebrates were reviewed and summarised. The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate the affected zone.

Table 3.5. Summary of potential impacts of seismic surveys on other species.

Species	Distance from source (m)	Estimated exposure level (dB re 1 µ pA)	Observed responses	Reference
Snow crab *(Chionoecetes)*	0.5-2	220	No sub-lethal or lethal effects were observed on snow crabs	Dalen *et al.,* (2007)
Snow crab *(Chionoecetes)*	51-85	197-225	No physical effects recorded	Christian *et al.,* (2003)
Dunganess crab *(Metacarcinus magister)*	19	225	No change in larval mortality or growth rates	Pearson *et al.,* (1994)
Scallop *(Pecten fumata)*	1	234	No increase in mortality over 17 days	Parry et al., (2006)
Lobster *(homarus americanus)*	23	202-227	No delayed mortality or physical damage	Payne *et al.,* (2007)
Iceland scallop *(Acequipecten irradians)*	2	217	Shell split in three	Mastilov (1992)
Sea urchin (Stronglyocentotus droebachiensis)	2	217	15% of the spines fell off	
Mussels *(Mytilus edulis) and* Periwinkles *(Littorina spp.)*	0.5	229	No detectable effects over 30 days	Kosheleva (1992)
Brown shrimp *(Cragnon cragnon)*	1	190	No evidence of mortality	Webb and Kempf in JWL (2007)
Snow crab *(Chionoecetes)*	2	221	Demonstrated possible signs of retarded development	Christian *et al.*, (2004)

Studies indicated that even at 2m or less from the source, seismic airguns usually don't result in any significant impacts on invertebrate species. The only effects noted were tenuous evidence of retarded development in snow crabs *(Chionoecetes)* (Christian et al., 2004) and signs of stress (i.e., shedding of spines) on sea urchins (*Stronglyocentotus droebachiensis*) (Mastilov, 1992) at 2m from the source. It can be concluded that since air guns are unlikely to be discharged in the immediate vicinity of benthic invertebrates, it is highly unlikely that seismic surveys will have a significant impact on this group.

3.3 Oil exploration

3.3.1 Drilling cuttings and muds

Once a particular location has been identified as potentially containing hydrocarbons, the next step is the implementation of a series of drilling activities. These include exploratory and appraisal drilling to determine whether the area contains commercial quantities of natural gas and oil. Drilling activities typically generate substantial quantities of waste, including drilling mud which is known to cause environmental damage (Neff *et al.,* 1989).

The principle functions of drilling muds are as follows:

- Lubricating the string and cooling working drill and drill pipe,
- To transport cuttings to the surface,
- To balance subsurface and formation pressures, preventing a blowout,

- To control and regulate hydrostatics pressures in the rock layers,
- To stabilise and seal the side of the well when abnormally high pressures in the rock layers are encountered (Neff, 1987).

Drilling muds are used in large quantities by the oil and gas industry to optimise both onshore and offshore drilling operations (Neff, 2005). The muds are continuously pumped into the pipe of the bore hole and returned via the outer hole together with the rock cuttings produced by the drill bit. Where drilling is performed from offshore platforms, the drill muds are usually treated to enable reuse and eventually disposed of either on land, re-injection into the seabed or discharged onto the seabed.

Drilling muds are composed of high-density minerals, including barite and various additives suspended in water. There are three major types of drilling mud: water-based mud (WBM) where the mud is suspended in water, oil-based mud (OBM) where the mud is suspended in oil, and synthetic-based (SBM) where the mud is suspended in a synthetic base compound such as an ester (Burke, 1995). Due to the toxicity associated with OBM their use has been banned in the oil and gas industry. There are also regulations on the discharge of SBM (Anon, 2000) and for this reason most offshore wells are currently drilled with water-based muds (WBM) (Neff, 1987).

3.3.2 Modes of effect on the environment

The discharge of drilling muds and cuttings in the marine environment has raised concerns regarding the environmental impact (Patin, 1999, Neff *et al.,* 1989) and consequences of such practices.

Suspended matter (turbidity)

The dispersed solid phase of drilling muds mainly consist of particles of clay mineral, barite and crushed rock. When drilling wastes are discharged into the marine environment this solid phase separates out and large heavy particles are rapidly deposited. However, smaller fractions gradually spread over large distances and particles of less than 0.01mm in size can remain suspended in the water column for weeks or months (GESAMP, 1993). As a result, large zones of increased turbidity are created around drilling platforms. Similar effects on an even larger scale can occur during the laying of underwater pipelines, construction of artificial islands and dredging, as well as various other activities that accompany offshore oil production operations.

Smothering effects (burial)

When drilling wastes are discharged onto the seabed during drilling operations the larger particles and flocculated solids (representing around 90% of the total mass of mud solids) quickly settle onto the seabed. The remaining 10% of the mass consists of fine-grained, unflocculated clay-size particles, as well as smaller fragments of subsurface rock, which may disperse more widely (Jonathan Wills, 2000). Although the cuttings tend to accumulate in close proximity to the discharge point, they may also disperse outwards to about 2500m from the point (Neff, 2005). The thickness and shape of the cuttings pile is dependent on the amount of drill cuttings and rate of discharge, as well as the depth of water and prevailing oceanographic conditions such as current speed and direction. Typically the suspended fractions of the drilling muds are diluted by 100 times within 10m of discharge and 1000 times after a transport time of about 10 minutes, at a distance around 100m from the platform. The discharge can adversely affect the marine environment by changing the pH of seawater, smothering benthic organisms, reducing light for plankton growth and releasing toxic chemicals. Benthic biota immediately below the point of cuttings discharge can be physically smothered regardless of the toxicity levels of the cuttings. The recovery period is dependent on the type of community affected, the physical structure and persistence of the cuttings pile itself, the presence and nature of any toxic components within the pile and the availability of colonising organisms.

Physical smothering and chronic pollution of the benthos are two adverse effects of drilling cutting discharges. If the concentration is higher than this level, a variety of effects becomes visible. Effects can include a reduction in the abundance of sensitive species, an increase in abundance of some opportunistic species, increased mortality and overall reduction in macrobenthos abundance, as well as reduced diversity of the entire macrobenthos community. The adverse effects are described in table 3.6.

Table 3.6. Adverse effects. (GESAMP, 1993)

Concentration	Level of Effects
100 mg/kg dry sediment	All types of effects from moderate to severe.
100mg/kg dry sediment	At least some moderate to severe effects.
<100 and >10mg/kg dry sediment	Some moderate effects may occur
Ca. 10mg/kg dry sediment	Sensitive species are absent or present in reduced densities, but opportunistic species increase in abundance (subtle effects).

Toxic effects

Oil-based muds (OBM) tend to show the greatest toxicity with low LC_{50} values and are also persistent in the environment. The work of Ostgaard, (1985) showed that OBM biodegraded by less than 5% within the same time that SBM biodegraded by 99% (Bakke *et al.,* 1990). Ideally, synthetic-based mud (SBM) should have LC_{50} <10,000ppm, be readily biodegradable and not accumulate in any biota (CEMP (1), 1996). The use of SBM is encouraged in drilling operations and consequently, spent OBM and SBM are normally returned to shore for disposal.

Although drilling muds contain fewer toxic compounds, this still doesn't ensure complete and rapid degradation of the oil associated with these muds. For example, when less toxic, paraffin-based drilling muds were mixed with bottom sediments, the level of the oil fraction in the upper 1cm layer of sediments declined by only 50% (from 200mg/kg to 100mg/kg) after 70 days of exposure. In the lower layers of sediments, the concentration of oil hydrocarbons remained the same and even slightly increased (Petersen, 1991).

Organic enrichment (anoxia)

Accumulation of drilling wastes on the seabed buries some of the immobile benthic fauna. Changes in sediment grain size and texture can reduce the suitability of the sediment for settlement and growth of some species, while at the same time rendering the substrate more suitable for other species. When the waste contains biodegradable organic additives it may also stimulate growth of microbial communities in sediments. Anaerobic, sulphate-reducing bacteria may further degrade the organic matter, producing hydrogen sulfide. This process, known as organic enrichment, causes changes in the abundance, species composition and diversity of the benthic community.

This process results in the depletion of oxygen due to microbial breakdown of organic matter associated with the discharged drilling muds, which may cause anoxic conditions within or adjacent to the cutting pile. Anoxic conditions may also arise due to the burial of organic material by sediment redistribution and may retard the recovery of certain marine species.

3.3.3 Potential environmental impacts

Environmental impacts of drilling muds

The impact of drilling muds and cuttings on the marine environment during oil exploration has been assessed by many studies. A total of 11 studies were selected for review and are summarised in Table 3.7. The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate the affected zone.

Table 3.7. Summary of conclusions on the impact of drilling muds on marine the environment.

Conclusion	Distance of area affected (m)	Type of oil	Recovery time (months/yrs)	Reference
- Reduction in abundance of a few very sensitive species.	1000	WBM/OBM	Benthos still affected eight years after cessation of drilling.	Daan and Mulder (1996)
- Diversity indices at background (>5000m) stations show little or no change	<5000	WBM/OBM	Recovery rates,differ and depend on many factors, but communities often remain altered for over 10 years after drilling.	UKOOA (2001)
- Changes in structure of benthic communities.	>1000	WBM	Recovery time differs and depends on many factors, but often takes several years.	Patin (1999)
- Reduction in organisms that are key components of the benthic communities and also food for bottom-living fish, and are thus ecological important.	200-5000	OBM/WBM	Within six to nine years of the cessation of drilling.	Olsgard and Gray (1995)
- Change in the abundance of species (organic enrichment) and diversity in the vicinity of oil platforms (smothering or toxic effect).	>5000	WBM	Full recovery usually after one year, but may take longer.	Kingston (1992)
- Reductions to benthic abundance and diversity.	<250	SBM	One year after cessation of drilling.	Neff (2005)
- Reduced diversity in immediate vicinity of the installation in most cases.	200	WBM	Full recovery usually after one year, but may take longer.	Davies (1992)
- Decline in abundance of species.	100-200	WBM	>11 months after cessation of drilling.	Currie and Isaacs (2005)

Conclusion	Distance of area affected (m)	Type of oil	Recovery time (months/yrs)	Reference
- Changes in structure to meiofauna communities.	200	SBM	22 months after cessation of drilling.	Netto (2010)
- Changes in the diversity and abundance of benthic organisms were detected.	1000	WBM	12 months after cessation of drilling.	RAC (2004)
- Reduction in the diversity of species and abundance of benthic communities.	100-200	WBM	One year after cessation of drilling.	Neff (2010)
- Changes in the abundance of species in benthic communities.	50-250	WBM	One year after cessation of drilling.	Pulgati et al., (2009)

In general, the studies demonstrate that modifications to benthic communities by drilling muds tends to be localised and restricted to the immediate vicinity of oil platforms. Although impacts have been detected beyond 5000m from drilling platforms or production rigs (Kingston, 1992, Olsgard and Gray, 1995, UKOOA, 2001), severe impacts tend to be restricted to within a 1000m radius of the installation (Daan and Mulder, 1996, Patin, 1999, RAC, 2004). The impacts on benthic communities are typically characterised by alterations in structure, reduction in species diversity and changes in the abundance of species. Studies indicated that recovery time is related to the type of drilling mud, with lengthy recovery periods of more than eight years required where OBM has been used (Daan and Mulder, 1996, Olsgard and Gray, 1995).

3.4 Oil production

3.4.1 Produce water and source

Produced water is a complex of waste generated from oil and gas production wells (Neff, 1987). This water may be derived from fluids within the rock or from fluids and additives deliberately injected into the well. The water is contained within the extracted oil and gas. The separation of the produced water from the oil and gas may take place on the platform or the mixture may be sent through a pipeline to an onshore facility where it is then separated from the oil and gas. If not re-injected into another well, the produced water is treated to meet regulatory limits prior to discharge into the ocean from the platform or an ocean outfall from a shore-based treatment facility.

3.4.2 Volume of produced water

The volumes of produced waters are enormous. In the UK sector of the North Sea alone, for example, it is estimated that 234 million tonnes of produced water were discharged in 1997 (Henderson, 1999). Another estimate (Black 1994b) suggests that between 7500 and 11,500 tonnes of petroleum hydrocarbons enter the environment each year from produced water discharges globally. The oil content in these discharges varies and is typically within the range of 23 to 37 mg/l (Law and Kelly, 2004). As oil fields age, the volume of produced water can exceed by 10 times the volume of petroleum produced over the economic life of a producing field (Stephenson, 1992, Henderson, 1999).

3.4.3 Composition of produced water

Hydrocarbons are the constituents of produced water that are of most concern in both offshore and onshore operations. Produced water is usually more saline than seawater (Cline 1998). Produced water contains organic and inorganic compounds. Due to high toxicity, those of the greatest concern are poly-aromatic hydrocarbons (PAH), BXT (Benzene, Xylene and Toulene), phenols, alkyl phenols and carboxylic acids (Neff, 2002). The environmental effects of this are related to the specific chemical composition of the produced water, which varies greatly between platforms. The most common heavy metals contained in the water include Arsenic (As), lead (Pb), cadmium (cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni) and zinc (Zn). These compounds vary greatly from location to location and even over time from the same well. The sources of these metals probably include the impurities in barite, chemical additives utilised in drilling and production operations, as well as in the oil/water separation process.

Chemicals added during the drilling process are complex mixtures of various molecular compounds. Such mixtures can include: 1) Corrosion inhibitors and oxygen scavengers to reduce equipment corrosion, 2) Scale inhibitors to limit mineral-scale deposits, 3) Emulsion breakers and clarifiers to break water-in-oil emulsions and reverse breakers to break oil in water emulsions, 4) Coagulants, flocculants and clarifiers to remove solids and 5) solvents to reduce paraffin deposits (Cline 1998). Produced waters can also mix with the extracted oil and gas, as well as injection waters water pumped into the reservoir to maintain pressure and oil production. Consequently, the composition of discharged produced water tends to be very complex and variable, as are toxicity levels.

3.4.4 Potential environmental impacts

Produced water may have different impacts on the marine environment depending on the hydrological conditions in different areas. Although it is normally it is discharged into the open ocean, it is unlikely to result in any measurable environmental impacts due to the higher dilution factor. A total of six toxicity test studies were selected for review and are summarised in Table 3.8. The selection critera for these studies was that they must relate to the marine environment and attempt to estimate the effects at different dosages.

Table 3.8. Summary of results of toxicology studies of produced water.

LC/EC50/Effects	Concentration, test duration, test organism	Reference
- Reduced ability of zoospores to settle on the bottom.	1-10% Chronic tests Macrophytes *Macrocystis pyrifera.*	Lewis, Reed (1994)
- 50% mortality	0.1-1.0% 96 hours Marine organisms of different groups	GESAMP (1993) (summarised data)
- 50% mortality	10-20% 7 days *Menidia beryllina* "(embryos) teratogenic effects"	Midaugh *et al.,* (1991)
- 50% mortality	10-30% Toxicity effects vary based on most toxic substances in their compositions.	Patin (1999)
- 50% mortality	5-50%. Relatively low acute toxicity to various marine organisms. Depends on the mixed aliphatic aromatic and polar compounds in produced water.	Holdway (2002)

Studies demonstrated that acute toxicity is relatively low, with acute LC/EC50's (various marine organisms) ranging from roughly 1 to 50% of produced water (Holdway, 2002, Patin, 1999). The chemical composition of produced waters is complex and variable so it is unsurprising that the toxicity is also highly variable (Holdway, 2002). Certain produced waters may have unusually high toxicity, presumably due to the presence of highly toxic components such as heavy metals and biocides.

A total of eight field-based studies on the impacts of produced waters discharged from offshore platforms were selected for review and are summarised in Table 3.9. The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate the affected zone.

Table 3.9. Summary of conclusions of field studies on produced water and the impacts on marine environments.

Main conclusions	Distance from oil platform (m)	Reference
- Increased susceptibility to disease from suppressed immune function, reduced growth and delayed sexual maturity in fish.	100-1000	Holdway (2002)
- Detected concentrations of hydrocarbons and alkylphenols above levels expected to give rise biological effects.	100-500	OGP (2005)
- Increased oil hydrocarbon concentrations. Presence of other toxicants in produced waters justified concerns about the ecological safety of their discharges, especially in shallow coastal areas with slow water circulation.	100-1000	Patin (1999)
- Monitoring of water column showed that although mussels and fish are exposed to hydrocarbons from produced water, the levels are decreasing.	1000	OSPAR (2008)
- Detected warning signs that there is potential effects for biological effects on fish population.	500	King et al., (2005)
- A 6.26% decrease in symbiotic dinoflagelates from the coral *Heliofungia actiniformist* at.	500	Jones et al., (2003)
- Benthic communities affected.	500	Ray et al., (1992)
- Effects on phytoplankton assemblages.	1000	Pinceratto (1992)
- Changes to the abundance of benthic species.	800	Rabalais et al., (1992)

Studies demonstrate that the possible biological effects of produced waters can often extend up to 500m from the discharge point (King et al., 2005, OGP, 2005), although this depends on the level of dilution and circulation of the sea water (Holdway, 2002).

For example, produced waters discharged in shallow water or in water with limited circulation can spread 500 to 1000m from the discharge point (Holdway, 2002, Patin, 1999). In addition to the variations seen between different areas, hydrological conditions can also vary over time at a single location. As a result the zone affected may vary over time, as well as between locations (Holdway, 2002).

3.5 Oil spills

3.5.1 Introduction

Marine oil spills can occur as a result of ruptured pipelines (e.g. Deepwater Horizon in the Gulf of Mexico), as well as shipping accidents. Such accidents continue to occur every year, particularly in coastal regions (GESAMP, 1993). Some major examples of disastrous spills in the past include the Torrey Canyon in the English Channel in 1967, the Amoco Cadiz off Brittany, France in 1978, the grounding of the Braer off the Shetland Islands in 1993 and the grounding of the Exxon Valdez in Prince William Sound, Alaska in 1989. Every such event raises significant challenges in terms of controlling marine pollution and damage, as well as conducting the impact assessment.

3.5.2 Physical and chemical behaviours of oil spills

When oil enters the marine environment it goes through a variety of physical, chemical and biological transformations. Spreading, evaporation, emulsification, dissolution, photo oxidation and sedimentation begin immediately after the introduction of oil into the sea and are responsible for its movement and distribution, as shown in Figures 3.2 and 3.3. Such processes disperse the oil and accelerate "weathering" (ITOPF, 2004).

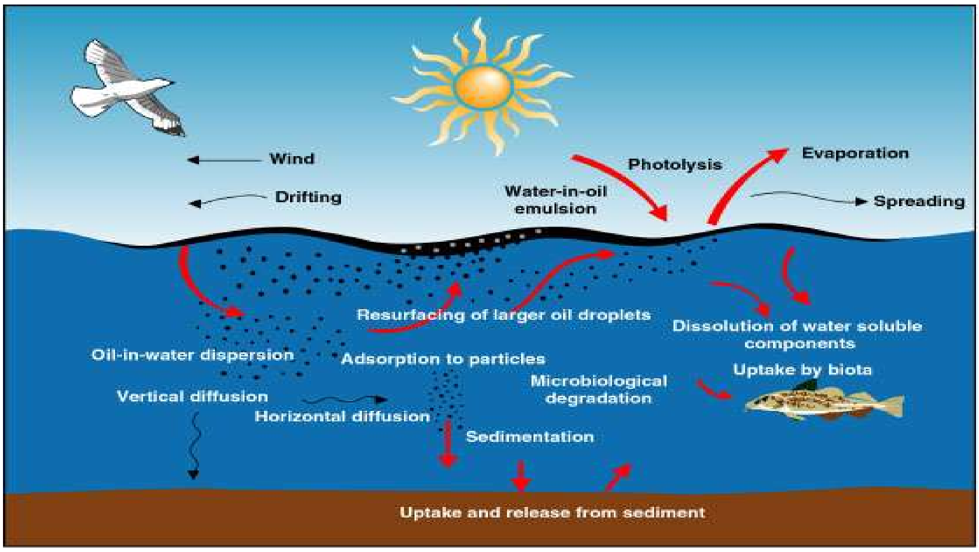


Figure 3.2. Diagram of oil spilled at sea showing the main weathering process. Modified from (ITOPF, 2004).

As soon as oil is spilled it immediately begins to spread over the sea surface. The speed of spreading depends on the volume spilled and the viscosity of the oil. Low viscosity oils spread much faster than those with high viscosity. The rate the oil spreads and fragmentation of the slick is also affected by waves, turbulence, tidal streams and currents (ITOPF, 2005).

During the initial stages of a spill evaporation is the dominant process affecting the slick and may be responsible for the loss of 40 to 50% of the slick volume within the first few days, depending on factors such as wind speed and temperature. The more volatile components of oil will be the first to evaporate into the atmosphere (ITOPF, 2005). Spills of refined products such as kerosene and gasoline may evaporate completely within a few hours, while light crudes such as Cossack can lose more than 50% of their volume during the first day (ITOPF, 2004).

Rates of physical dispersal of oil slicks largely depend on the the nature of the oil, as well as factors like turbulence and waves. The process of dispersal can often result in the natural removal of oil from the sea-water surface (ITOPF, 2004). Waves on the surface disperse the oil into droplets of varying sizes. Smaller droplets may become suspended in the water column, while larger droplets tend to remain on the sea surface forming oil slicks (ITOPF, 2005).

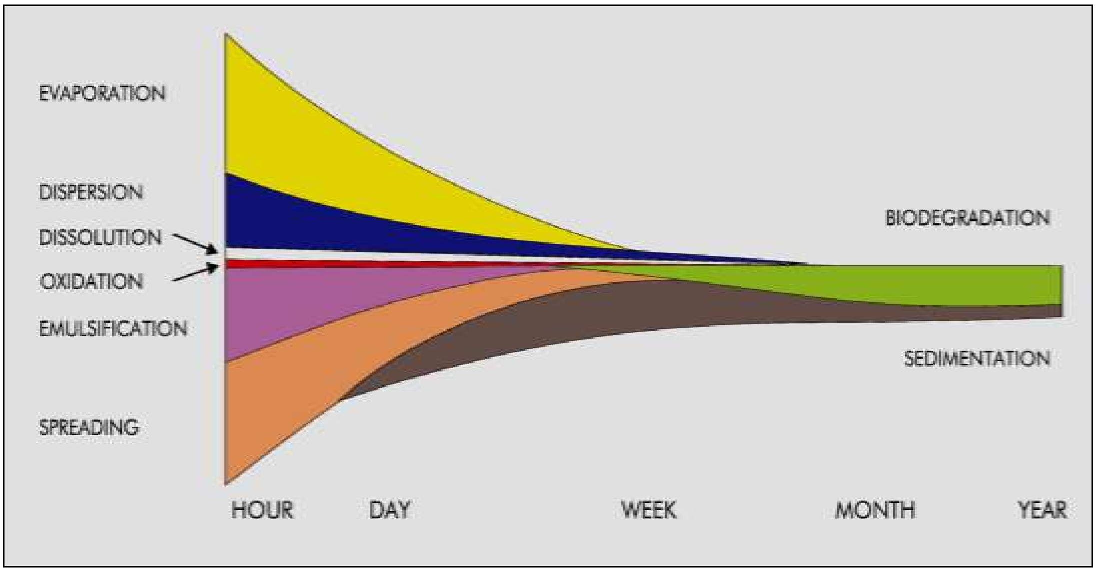


Figure 3.3. Time periods for the different stages of oil spills. Adapted from: (ITOPF, 2004).

Oil on the water surface may incorporate droplets to form ‘water-in-oil’ emulsions. Oil emulsions may contain 20 to 80% water and are frequently referred to as “mousse”. Emulsification can increase the volume of a slick by up to five times (ITOPF, 2004). The formation of emulsion depends on both oil composition and sea conditions (ITOPF, 2005). Emulsions form most readily for oils which have a combined Nickel/Vanadium concentration. Viscous oils like heavy fuel oils tend to take up water more slowly than lighter more fluid oils and therefore emulsify less readily (ITOPF, 2005). Emulsification is more prevalent in rough sea conditions (e.g. wind speeds of >7 to 10 knots) (ITOPF, 2004). Some emulsions are stable and may contain as much as 70 to 80% water, these are often semi-solid and have a distinct red/brown, orange or yellow colour (Figure 3.3). Less stable emulsions may separate into oil and water if heated by sunlight under calm conditions or when stranded on shorelines (ITOPF, 2005).

During an oil spill water soluble compounds in the oil can dissolve into the surrounding water (ITOPF, 2010). Dissolution rates depend on the composition and state of the oil, occurring most quickly when the oil is finely dispersed in the water column. The components which are most soluble in sea water are the light aromatic hydrocarbon compounds like benzene and toluene (ITOPF, 2005). However, such compounds are also among the first to be lost through evaporation, which occurs 10 to 100 times faster than dissolution (ITOPF, 2004).

Photo-oxidation occurs where sunlight promotes the reaction of oil, with oxygen forming either soluble products or persistent compounds known as tars (ITOPF, 2010).

The extent of photo-oxidation depends on the type of oil and the form in which it is exposed to sunlight. However, the process is very slow and even in strong sunlight thin films of oil break down at no more than 0.1% per day (ITOPF, 2005). The formation of tars is caused by the oxidation of thick layers of high viscosity oils or emulsions. Tar balls are a typical example of this process and are often found on shorelines. They have a solid outer crust surrounding a softer, less weathered interior, (ITOPF, 2010).

Sedimentation/sinking of oil droplets into the water column will occur if the droplet contains heavy refined products resulting in a higher density than water. This may occur in fresh or brackish water (density 1). Sea water has a density of approximately 1025 and very few crudes are dense enough or weather sufficiently to sink in the marine environment (ITOPF, 2010).

Sedimentation is most likely to occur due to the adhesion of particles of sediment or dense organic matter to the oil droplets (ITOPF, 2005). Shallow waters often contain a high proportion of suspended solids, providing favourable conditions for sedimentation. Similarly, oil stranded on sedimentary shorelines often becomes mixed with sediment particles. If this mixture is subsequently washed off into the sea it may then sink to the seabed. Sedimentation may also be enhanced if oil slicks catch fire. In this case, combustion may form residues sufficiently dense to sink.

The nature and severity of the possible consequences of oil spills are influenced by the degradation rate of the oil and its movement on the sea surface. Oil spills may stay in the open sea or move into coastal waters and contact the shoreline. If the oil remains in the open sea it is normally dispersed, emulsified and ultimately degraded by the processes outlined above.

Table 3.10. Types of shorelines given in ascending order of their ecological vulnerability to oil spills. Adapted from: (GESAMP, 1993).

Index of vulnerability	Type of shoreline	Notes
1	Open, rocky shoreline	Wave action limits the impacts. No need to manually clean the coast.
2	Flat, rocky shoreline	Oil is removed in several weeks due to wave action and other natural processes.
3	Fine sandy beaches	Oil doesn't usually penetrate deep into sand and can be removed by mechanical means. Oil pollution remains for several months.
4	Coarse sand beaches	Oil is quickly accumulated in sediments and this complicates the cleaning process. With favourable weather conditions, oil pollution disappears in several months.

Index of vulnerability	Type of shoreline	Notes
5	Open shallow tidal areas and packed sand bars	The main part of oil is removed by wave action and other natural factors, so there is usually no need to manually clean the shore.
6	Sand, pebble and gravel beaches	Oil rapidly penetrates into deep layers and pollution can persist for years.
7	Gravel beaches	Oil rapidly penetrates into gravel and pollution can persist for years. In some cases oil forms an asphalt crust.
8	Sheltered rocky shores and bays	Oil can stay for years due to weak wave action. Cleaning is not recommended except in cases of heavy pollution.

These processes can decrease oil concentrations and bioavailability relatively rapidly and biological effects will be limited to local, quickly reversible disturbances in the water column and on the sea surface. However, where oil contacts the shoreline the consequences are more diverse, severe, and persistent (Patin, 1999). A summary of the likely persistence of oil contamination on different shorelines is presented in Table 10. Oil persistence will depend on the energy levels of the shore and is more likely to be dispersed on wave-exposed shores and penetration into the substrate. If the oil is adsorbed or mixed with sediments is is far more likely to persist.

3.5.3 Biological behaviour of oil spills

In addition to the physical mechanisms and chemical processes – as described in sub-section 5.2 – biological processes also act on specific fractions of the oil. Such biological processes include the degradation of hydrocarbons by micro-organisms, as well as uptake by larger organisms followed by subsequent metabolism, storage and discharge. Micro-organisms such as bacteria, yeast and fungi are essential components in the degradation of oil in surface films, slicks, the water column and sediments (NRC, 1985). Other organisms also potentially contribute to the overall degradation. Zooplankton,for example, is known to aid in sedimentation of oil droplets that are integrated in their faeces (Payne *et al.,* 2008), with benthic invertebrates such as polychaetes also playing a significant role in the degradation of sediment-bound oil (Gordon *et al.,* 1978). Fish, marine mammals and birds can become contaminated through the uptake of oil in the water column, from oiled food and, in the case of marine mammals and seabirds, from the preening of oiled fur or plumage (ITOPF, 2010). It is through these processes they could be said to be contributing to the overall degradation of hydrocarbons in the marine environment (NRC, 1985).

Clean-up responses to oil spills often encounter considerable difficulties due to the tendency of the oil to spread and fragment rapidly, particularly if the event takes place in rough sea conditions (ITOPF, 2005). Assessing the likely movement and dispersal rates of slicks can determine whether any response beyond monitoring of the events is necessary. Where active responses to spills are implemented the natural dispersal processes should be monitored to assess the suitability of selected clean-up techniques as the response progresses and conditions change. For example, the use of dispersants at sea becomes less efficient as the oil spreads and viscosity increases. Many dispersants become significantly less effective as the viscosity approaches 10.000 cST and most cease to work at all when the viscosity rises much above this value (ITOPF, 2005). Oil viscosity can increase very quickly which means the time available for using dispersants can be very short, therefore dispersant application should be regularly monitored and spraying operations terminated if they prove ineffective (ITOPF, 2010). Similarly, the techniques used for mechanical removal such as skimmers and pumps may also need to be changed as the oil weathers, its viscosity rises and emulsions form (ITOPF, 2004).

3.5.4 Potential environmental impacts

Potential impacts on Benthic habitats

Intertidal impacts of oil spills vary depending on environmental characteristics. A total of six review papers and gray literature studies on intertidal impacts are summarised in Table 3.11. The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate recovery time.

Table 3.11. Summary of studies on the effects of oil spills on intertidal zones.

Shore type	Type of oil	Recovery time (months/years)	Reference
Exposed rocky headlands and wave-cut platform Coarse-grained sandy and gravel beaches Sheltered environments: rocky coastlines and salt marshes	Light Arabian, Iranian crude oil, Bunker C fuel oil, North Sea crude oil and N.6 fuel oil.	1 year 4 to 7 years 8 to 10 years	Gundlach (1992)
Exposed rocky shore Sheltered sediments Sand and gravel	North Sea crude oil and Bunker C fuel oil.	< 2 years >10 years >6 to 7 years	Baker *et al.,* (1990)

Shore type	Type of oil	Recovery time (months/years)	Reference
Exposed rocky shore	Bunker C fuel oil and Light Arabian	1 to 2 years after spill	Kim Moonkoo (2012)
Rocky shore	Bunker C fuel oil	>5 months	Stevens (2010)
Exposed tidal flats Exposed rocky shores Exposed medium to coarse-grained sandy beaches Wave cut platforms Mixed sand and gravel beaches Sheltered rocky shores	Light Arabian, Bunker C fuel oil and N.6 fuel oil	3 years 4 years 2 years 1 year 6 years 8 years	Nansingh (1999)
Rocky shores and sandy beaches.	Bunker C fuel oil and N.6 fuel oil.	1 year	Shriada (1998)

Intertidal recovery periods range from 1 to 10 years (Baker *et al.,* 1990, Gundlach, 1992). The timescale is influenced by shoreline characteristics, in particular energy levels and substrate grain size. Other factors include oil composition and biological characteristics of the shore (Baker *et al., 1990)*. Exposed rocky environments typically show the most rapid recovery rates, with communities returning to normal within two years (Baker *et al.,* 1990, Kim, 2012, Nansingh, 1999). Sedimentary shores such as mixed sandy and gravel beaches tend to retain oil to a much greater extent and recovery periods may range from four to seven years (Baker *et al.,* 1990, Gundlach, 1992, Nansingh, 1999). This is most pronounced for sheltered sediments where recovery can take 8 to 10 years (Baker *et al.,* 1990, Gundlach, 1992).

Potential impacts on coral reefs

Oil can come into contact with corals in numerous ways. Because oil is less dense than water it will usually float above the reefs. However, some reef areas are regularly exposed to the air during low tides and are therefore more vulnerable to direct contact with floating oil. Contact with oil may also occur due to dispersal of the oil by waves breaking on the reefs creating oil droplets in the water column that may contact the corals. A total of eight review studies on the impact of oil spills on corals were reviewed and are summarised in Table 3.12. The selection critera for these studies was that they must have been conducted in the marine environment and attempted to estimate recovery time.

Table 3.12. Summary of studies on the effects of oil spills on coral reefs.

Observed effects	Recovery time (months/years)	Reference
Reductions in coral growth and species diversity	9 years	Nansingh (1999)
Declines in coral cover and reproductive potential	>8 years	Gundlach (1992)
Changes in the structure of coral communities	8-9 years	Baker *et al.,* (1990)
The community structure of the coral was drastically altered and did not return to its pre-pollution structure within the study period.	10-12 years	Loya (1980)
Corals were negatively impacted leading to decreases in coral cover, growth, reproductive output and species diversity.	>10 years	Haapkayla *et al.,* (2007)

Studies demonstrated that oil spills can have impacts on coral reefs. These include changes in community structure and a reduction in diversity, coral abundance (Baker et al., 1990, Haapkyla, 2007, Gundlach, 1992, Loya, 1980) and coral growth (Haapkyla, 2007, Nansingh, 1999). The recovery time for coral reefs was estimated to range from 8 to 12 years.

Potential impacts on mammals and turtles

Marine mammals and sea turtles can obviously be impacted by an oil spill if they come in direct contact with oil when breathing at the surface (JWL, 2007). However, many marine mammals have been observed avoiding or attempting to avoid oil spill areas (Suderman and Thistle, 2004). Relatively few studies have assessed the impact of oil spills on marine turtles (JWL, 2007).

A total of six review papers and gray literature studies on the impacts of oil spills on mammals and turtles are summarised in Table 3.13. The selection critera for these studies was that they must have been conducted in the marine environment, documented the nature of effects and attempted to estimate the affected zone.

Table 3.13. Summary of studies on the effects of oil spills on marine mammals and turtles.

Observed effects	Species	Reference
Decrease in whale populations following The occurrence of oil spills.	Baleen whale	Matkin (2008)
Sub-lethal effects possible through oiling of mucous membranes or eyes, although this does not usually cause permanent damage.	Baleen whale	Geraci (1990)
Sub-lethal and lethal effects occurred as a result of the inhalation of volatile gases, ingestion of oil or consumption of contaminated prey.	Toothed whales and dolphins	Dahlheim (1993)
Cetaceans that feed either at the surface or at the bottom are more likely to come into contact with oil than those that feed in the water column. Dolphins that habitually force schools of prey to the surface may also be at risk.	Various cetaceans (dolphins, minke whales, grey whales and bowhead whales)	Bowles (1994b)

Observed effects	Species	Reference
Hatchlings are vulnerable and at risk of ingesting tar. Marine turtles show no avoidance behaviour when they encounter an oil slick and the recovery period is usually more than 21 days.	Loggerheads	Lutcavage *et al.,* (1995)
Direct contact with oil spills can potentially lead to sub-lethal effects. Risks include ingesting toxins through contaminated prey and a reduction in food supply such as seagrass and invertebrates.	Green turtles, hawksbill sea turtle, loggerhead sea turtle and Kemp's ridley sea turtle	NOAA (2010)

Studies demonstrate oil spills can impact on marine mammals and sea turtles, leading to reduced populations (Matkin, 2008) as a result of physical damage through direct contact with oil (Bowles, 1994a, Dahlheim, 1993, Geraci, 1990) or by ingesting contaminated food (Bowles, 1994a, Dahlheim, 1993). Oil spills may impact on sea turtles by direct contact because they show no avoidance behaviour (Lutcavage *et al.,* 1995). They may also be impacted by ingesting contaminated food such as seagrass, certain crustaceans and invertebrates (NOAA, 2010).

Potential impacts on seabirds

The effect of oil spills on seabirds is well known. A total of five review papers and gray literature studies on the impacts of oil spills on seabirds are summarised in Table 3.14. The selection critera for these studies was that they must have been conducted in the marine environment, documented the nature of effects and attempt to estimate the affected zone.

Table 3.14. Summary of studies on the effects of oil spills on seabirds.

Observed effects	Recovery time	Reference
- The immediate effects of oil spills are physical. When the plumage of birdscomes into contact with oil, this causes a reduction in buoyancy and thermal insulation.	Long-term and sub-lethal toxic effects of crude oils on seabirds appear to be very unlikely.	Hartung (1995)
- Consistent declines were detected in various localities within the Prince William Sound, Alaska.	2.5 to 3 years. Sub-lethal or long-term effects detected 14 years after oil spills.	Wells *et al*., (1992)
- Effects included immediate mortality of seabirds in the area of spills.	Recovery is 2 to 2.5 years, but persistence of the long-term effects remains uncertain due to a lack of understanding about the dynamics of seabird populations.	Mosbech (2000)
- Oil persisted for over decade in surprising quantities and in toxic forms. It was sufficiently bioavailable to induce chronic biological exposure and had long-term impacts on the population.	Effects detected 2.5 years after spills. Long-term effects up to 10 years were still detected, with ongoing suffering as a result of oil spills.	Peterson *et al*., (2003)
- Caused direct mortality and reduced reproductive performance of eagles with nesting habitats severely damaged or lost, with food resources effected and continuous mortality reported.	There was no clear, demonstrable impact on eagle abundance or reproduction, although in some cases effects could still be detected 2 years after the spill occurring.	White *et al.,* (1995)

In most cases, impacts appear to be transitory, with recovery time usually within three years. While longer-term impacts remain uncertain, studies on the Exxon Valdez spill recorded that effects remained detectable even after 14 years (Wells *et al.,* 1992). Similar findings reviewed (Peterson, 2003) also showed that oil spills can continue to have an impact even after 10 years. The immediate effects include physical damage (Hartung, 1995), direct mortality and reduced reproductive performance (White, 1995).

Potential impacts on fish

Oil spills cane impact fish and fisheries in possible several ways. Fish gills may be contaminated by direct contact with oil, while toxic components contained in oil in the water column may be absorbed by fish eggs or larvae. Juvenile and adult fish may be also impacted through the consumption of contaminated food. A total of four papers and gray literature studies on the impacts of oil spills on fish are reviewed and summarised in Table 3.15. The selection critera for these studies was that they must have been conducted in the marine environment, documented the nature of effects and attempted to estimate the affected zone.

Table 3.15. Summary of studies on effects of oil spills on fish.

Observed effects	**Reference**
- No specific oil-related effects were detected on wild pink salmon populations.	Maki et al., (1995)
- Minor effects were observed, but did not translate into decreases in the herring population.	Pearson Walter (1995b)
- Observations indicated that schools of bonito, anchovy and jack mackerel were within range ofnormal geographical areas and their behaviour appeared normal. No evidence of short-term debility from spills.	Squire (1992)
- There were no substantial effects on the critical early life stages of pink salmon in spill areas.	Brannon (1995)

The evidence suggests that the impacts of oil spills on fish population levels is limited (Brannon, 1995, Maki, 1995, Pearson, 1995a) and studies on the behavioural effects on schools of bonito, anchovy and jack mackerel did not indicate any abnormalities (Squire, 1992).

Potential impacts on mangroves

Mangroves can be impacted by oil spills in several ways. Heavy or viscous oil can block the pores and deprivetrees of oxygen. Mangroves may also be affected by the toxicity of substances in the oil such as lower molecular weight aromatic compounds. A total of seven review papers and gray literature studies on the impacts of oil spills on fish are summarised in Table 3.16. The selection critera for these studies was that they must have been conducted in the marine environment, documented the nature of effects and attempted to estimate recovery time.

Table 3.16. Summary of studies on the impacts of oil spills on mangroves and recovery timeframe.

Observed effects	Oil type and recovery period	Reference
Newly recruited trees recorded a 100% mortality rate and oil was retained in sediments.	Bunker Fuel, recovery occurs 6 years after spill.	Lamparelli et al., (1998)
Canopy reduction in oil spill areas showed 6-20% defoliation.	Bunker Fuel, recovery 4 years after spill event.	Wardrop et al., (1996)
Mangrove trees die-off and deforestation occurred in a spill area of approximately 43 hectares.	Recovery 23 years for the fringe and more than 23 years for sheltered sites.	(Duke, 1999a)
Significant alterations to supralittoral and intertidal zones during the spill event. The use of dispersant inshore could potentially lead to decade-long impacts to mangroves and near-shore coral.	Recovery process takes 6-25 years.	Getter et al., (1995)
Results indicated that the oil would weather to non-toxic concentrations in 4 years.	Bunker Fuel, recovery occurs after 4 years.	Burns and Codi (1998)
Mangrove trees die-off and lead to a loss of mangrove populations due to oil toxicity and highly volatile fraction.	Bunker Fuel, complete recovery process about 36 years after spill event.	Duke (1999b)
Exposed fringing forests recovered in terms ofstructure in stem densities, heights and biomass, but sheltered sites did not fully recover.	Recovery after 23 years of spill event.	Pizon and Duke (1997)

Most studies indicated that mangroves are highly sensitive to oil spills. The yypical recovery period for mangroves following a spill is in the order of four years, although it can also take up to 36 years (Burns, 1998, Duke, 1999b, Wardrup, 1996). The timeframe for recovery generally depends on the specific site within the mangrove ecosystem.

3.6 Decommissioning

3.6.1 Decommissioning and potential options

The typical life span of a platform isinthe order of 20 years, although it is not uncommon for platforms to be in operation for 30 to 40 years. At the end of this period the decommissioning and removal of the platform has to be addressed (Kaiser, 2006). Long-established platforms act as a substrate and habitat for a wide variety of marine organisms, including fish, corals and other invertebrates (Sayer and Baine, 2002). Very little is known about the composition or ecology of these communities.

Decommissioning of oil and gas production facilities in broad terms involves both offshore and onshore structures, and has a wide range of possible consequences. These can include ecological, economic, cultural, political, social and aesthetic aspects (Schroeder, 2001). The scope of this study will be largely limited to the marine environment. Five potential decommissioning options for oil platforms are outlined in the subsequent sections below, with potential ecological consequences also assessed.

Leaving the platform structure in place

In this option, the whole subsurface structure is left intact. Since this does not involve moving or altering the structure there would be no additional ecological impacts at the time of decommissioning. However, any ongoing impacts (positive or negative) due to the presence of the structure would continue to occur. While corrosion rates vary in seawater, depending on water temperature, fouling and other factors, it is estimated that the lifespan of a catalytically unprotected platform will range from a minimum of 100 years and up to more than 300 years (Quigel, 1989, Voskanian, 1997).

Complete removal

This option involves the removal of the entire structure by severing structures below the seabed and removing all structure and debris. This particular procedure has been performed for many steel platforms, including those in the Gulf of Mexico. (Schroeder, 2001). In the short term there may be numerous local impacts due to the removal of the platform structure from the ocean. The removal procedure itself could result in significant effects. For example, if explosives are utilised this may result in mortality of fish and other biota in the vicinity. Further disturbances might also be caused by the anchors of support vessels or barges with anchor scars altering the substrate and benthic habitat. All sessile organisms on the removed structure are likely to be killed and mobile species such as fish and invertebrates will only survive if they are successfully relocated to suitable habitats elsewhere. Recovery from the disturbances caused by the removal process may be slow and the community that develops following removal is likely to differ from that which existed when the platform was in place.

The removal of the top portion of platforms to 20 to 30 metres subsurface, with remaining lower platforms left standing in place

This option involves removal of the upper 20 or 30 metres of the platform to reduce navigational hazards (Schroeder, 2001). The removed portion may be deposited on the seabed or removed to the land. The rest of the platform is left intact on the seabed. Disturbances will occur if explosives are used in the process, as outlined in section

6.1.2. Similarly, there will be impacts on the sessile organisms attached to the top level of the platform that is being removed. If the removed part of the platform is deposited into deeper water then the attached organisms would most likely not survive. This is because the light and nutrients required by most organisms living on the top section are likely to be limited in deeper water. There may also be related impacts on the biota located on the lower section of the structure. For example, the downwards vertical transport of organic matter (especially from mussels) from the highly productive top level of the platform would stop when this portion is removed. The organic materials that provided a food supply to many species lower on the structure and on the seabed would therefore be greatly reduced. Removal of the upper structure is also likely to produce hydrodynamic changes, altering current eddies with the potential to entrain larvae, particulate matter and zooplankton. This has consequences for the communities remaining on the lower part of the structure. This alternative would therefore produce fewer disturbances than total removal of the structure, but would be less likely to to return the environment to a 'natural' state.

Structure toppled over in the same location

This option involves depositing the intact or partially cut up platform on the seabed at the existing location. The impacts of this option appear to be similar to some of those described for total or partial removal (options 2 and 3 described earlier). Impacts may include disturbances to benthic habitats due to the deposition of the structure, as well as the loss of hard substrate and associated biota high up in the water column. Similarly, changes may occur in the community associated with the structure due to deposition in deeper water. This will impact biota located underneath the platform due to the cessation of organic input from the near surface, which may also result in hydrodynamic changes.

Structure removed to a new location and toppled.

This option involves moving the platform to a new location and depositing it on the seabed. Some of the impacts of this option have already been discussed previously.

When a platform is decommissioned and removed, there is a waste-management problem concerning the way in which the structure is treated (Schroeder, 2001). Options for disposing of offshore platforms include the following: 1) Deep-sea disposal where the structure is removed and then transported to a deep ocean site and scuttled on to the seafloor, 2) Shallow disposal where the structure is dismantled and deposited on the seafloor near the original site of operation, 3) Recovery, which involves dismantling transportingthe structural components and transporting these to shore for salvage. Some components may also be disposed of in landfill, and 4) Artificial reef provision, in which a toppled platform is utilised to create artificial reefs. Alternatively, the platform may be towed from its original site to a more appropriate location. For example, rigs to reefs initiatives can now be found in places like the Gulf of Mexico, Japan and Brunei (Kaiser, 2006).

Following the completion of the decommissioning process the composition of local species will shift towards a soft-sediment community if the corse shelly material is removed. However, if the shell mound is left in place the trend will be community similar to ones inhabiting areas with low-relief cobble if the shell mound left in place). For soft-sediment communities, recovery will depend on factors such as natural and man-made disturbance rates (e.g. severe storms or trawling), the migration rates of species at both larval and benthic stages and the degree of sediment contamination. Recovery is defined at the point at which the community of organisms at the site of impact is indistinguishable from communities in similar substrates that are distant from the impact site. Some studies have documented that soft-sediment communities at platforms may require 10 years or more to recover (Schroeder, 2001).

3.6.2 Cost and benefits of decommissioning

Costs

Decommissioning is a costly operation and the relative costs of each option are an important factor in the decision-making process. While the development of decommissioning policies for oil platforms is ongoing, there have been a few attempts to quantify the costs of each alternative. Table 3.17 provides reliable information on cost estimates for two alternative options (partial or complete removal) at different water depths. This does not include detailed costing analysis, but rather focuses on the relative costs of both options.

Table 3.17. Summary of the costs of offshore platforms and decommissioning options. Adapted from different sources.

Reference	Costs/days	Water depth (m)	Options
Fernandez *et al.,* (2001)	$5,879,400 /15d	48	Complete removal
Mcginnis *et al.,* (2001)	$8,500,000 / 17d	54	Partial removal
Griffin, (1996)	$3,960,000 / 20d	60	Complete removal
Byrd, (2008)	$5,621,000 / 28d	121	Partial removal
MMS, (1999)	$15,26,.000 / 37d	122	Complete removal
Gebauer *et al.,* (2004)	$21,450,000 / 52d	313	Complete removal
Culwell, (1998)	$48,675,000 / 118d	366	Complete removal
Fields, (1998)	$5,621,000 / 28d	122	Partial removal
Green *et al.,* (1996)	$8,632,00 / 43d	266	Partial removal
Richards, (1998)	$6,432,000/23d	152	Partial removal
Lakhal *et al.,* (2009)	$69,000,000/128d	316	Complete removal

It is clear that the costs of individual decommissioning options will vary depending on water depth and the characteristics of the particular structure. However, in general complete removal is generally more expensive than partial removal. In most cases, decommissioning costs are also likely to be higher in deeper water (Culwell, 1998, Gebauer, 2004, Griffin, 1996, Lakhal et al., 2009).

Benefits

Commercial fishing value: The use of rig structures as artificial reefs may be beneficial through the enhancement of commercial fishing yields (McGinnis, 2001). This can be attributed to the substantial build-up of sea life on the underwater structures. Species harvested around rig structures include rock fish, mussels, oysters and scallops.

Recreational value: Compared with commercial fishing value, recreational values are associated with access to platforms for fishing and diving. Such recreational activities are already in operation on oil rigs in California and the Gulf of Mexico, and have yielded benefits of more than $10,000 annually (McGinnis, 2001, MMS, 1999).

Habitat conservation value: Rig structures can enhance biodiversity by creating habitat complexity and enhancing protection of benthic habitats from demersal trawling. From a conservation point of view it could be argued that leaving oil platforms partially or completely standing brings considerable local benefits.

In summary, the disturbances generated by complete removal of structures will be greater than for partial removal. While leaving all or part of the structure in place may bring considerable benefits, it will also greatly prolong the time it takes for the environment to return to its pre-development condition.

Conclusions

Seismic survey: the review demonstrates that the effects of seismic airguns on marine organisms appears to be transitory and localised.

- Marine mammals are potentially susceptible to impacts occurring at close range, generally 1 to 4km from the airgun source.

- Other species that may be affected by the operation of seismic airguns include sea turtles within a 2km range.

- Effects on fish eggs and larvae may occur in the immediate vicinity (5m) of airguns.

- The effects on adult fish and fish catch appear to be negligible.

- *Drilling mud:* Drilling muds and cuttings are major contributors to changes in benthic community structure. The most severe impacts of drilling mud and cuttings may occur up to 2000m from the oil platform. Recovery time for the benthos of the cuttings piles is undetermined but may take decades.

- The impacts of *produced water* are difficult to establish as dilution ensures these are diffused. Detectable effects are likely to be limited to within 500m of the discharge point.

- The most severe impacts from *oil spills* are likely to occur in low-energy, intertidal environments such as mangrove forests, although all intertidal environments and some shallow-water subtidal environments, including coral reefs, are also vulnerable.

- The impacts of oil spills in the open sea are difficult to detect and persistence of the oil is limited by natural dispersal and breakdown processes. Certain fauna like seabirds and marine mammals may be impacted in certain circumstances.

- *Decommissioning:* Complete or partial removal options are likely to cause disturbances and pollution. However, the removal of structures will accelerate the return of the natural environment to a pre-development state. Although leaving structures in situ will create less environmental damage through disturbance and likely result in enhanced diversity, the return of the environment to a pre-development state will be greatly prolonged.

3.7 An assessment of the natural environment and the potential impacts of the oil industry in the Timor Sea area.

This sub-section will summarise and discuss novel conclusions based on the previous review (Chapter 2 on the natural environment of the Timor Sea and Chapter 3 on the potential threats posed by the oil industry). This section will also assess the possible threats to the biological features of the Timor Sea, with the aim of contributing to improvements in offshore environmental regulatory frameworks and transboundary management in the Timor Sea and the South Coast of East Timor.

The content of this sub-section relates to the chapter on natural environment and is structured as follows:

- Discussion on the natural environment of the Timor Sea, covering diversity trends, relative conservation importance of habitats, conservation value, vulnerability, sensitivity and resilience of habitats.
- Discussion on the potential impacts of the oil industry on the Timor Sea region, including effects of seismic surveys, drilling mud, produced water and decommissioning processes.
- Discussion on the potential impacts of oil spills in the Timor Sea region.
- Discussion of existing pressures on the marine environment in the Timor Sea region.
- Conclusions are provided and contributed for the future development of the Timor Sea.

3.7.1 Potential natural environment in the Timor Sea

Apparent diversity trends

The literature, as referred to in Chapter 2, seems to indicate an impoverished biota for the marine environment, including mangroves, seagrass, marine mammals, seabirds and fish, all of which are in lower numbers in East Timor compared to the neighbouring regions of PNG and Seram Island in eastern Indonesia. It could be argued that increased turbidity and freshwater influence as a result of large rivers entering the sea has reduced marine diversity along the South Coast of East Timor. However, it is also possible that this trend is artificial and may be explained due to the following reasons:

- Limited area of shallow continental shelf off the coast of East Timor, therefore fewer habitats and fewer species,
- Fewer studies have been conducted in the East Timor jurisdiction and therefore fewer species have been recorded,
- Records for East Timor are only available post-independence from Indonesia and are therefore limited.

Relative conservation importance of habitats

The relative conservation importance of habitats may be influenced by rarity, biodiversity and existing human pressures. The level of information on the South Coast of East Timor/JPDA) is insufficient for reliable assessment of relative conservation importance.

Table 3.18. Relative conservation importance of habitats in the Timor Sea, JPDA and South Coast.

Habitat type	Rarity value	Biodiversity value	Existing pressures
Intertidal sediment			
Exposed coarse sandy beaches	The broadly defined habitat is thought to be very common, but there is little information available on sub-habitats or component species.	Unknown, but probably relatively low due to environmental stress caused by high-wave exposure. Freshwater input from rivers may also contribute stress at some locations.	Shellfish harvesting for local consumption. Probably negligible in scale.

Habitat type	Rarity value	Biodiversity value	Existing pressures
Sheltered fine sandy beaches and mudflats	The broadly defined habitat probably occurs at many locations, but there is no information available on sub-habitats or component species.	Unknown, but probably relatively low due to environmental stress associated with freshwater input from rivers at many locations.	Shellfish harvesting for local consumption. Probably negligible in scale.
Mangrove forests	The habitat type appears to be rare in the region and since most component species will be mangrove specialists, it is therefore reasonable to assume that they too will be regionally rare.	Unknown, possibly moderately high. Likely to be highly productive and composed of specialist species.	Used for construction materials, firewood and livestock feed.
Intertidal rock			
Exposed intertidal rock	The broadly defined habitat probably occurs at many locations, but there is no information available on sub-habitats or component species.	Unknown, but probably relatively low due to environmental stress caused by high-wave exposure and desiccation from tropical sun when habitat immersed.	Shellfish harvesting for local consumption. Probably negligible in scale.
Sheltered intertidal rock	The broadly defined habitat probably occurs at some locations, but there is no information available on sub-habitats or component species.	Unknown, but probably relatively low due to environmental stress caused by desiccation from tropical sun when habitat is immersed.	Shellfish harvesting for local consumption. Probably negligible in scale.
Subtidal sediment			
Shallow continental shelf sediments	The broadly defined habitat is thought to be very common, but there is no information available on sub-habitats or component species.	Likely to be highly variable, ranging from low diversity coarse mobile sediments in wave-exposed shallow areas to high-diversity, mixed stable sediments in low-energy or moderately tide swept environments.	Unknown
Deep continental slope and trough sediments	The broadly defined habitat is thought to be very common, but there is no information available on sub-habitats or component species.	Likely to be very diverse, but with low biomass.	Unknown
Seagrass	The habitat type is likely rare in the region and since most component species will be seagrass specialists, it is thus reasonable to assume that they too will be regionally rare.	Unknown, but possibly relatively high. Likely to be highly productive and composed of specialist species.	Harvesting of seagrass for local and regional market consumption.

Habitat type	Rarity value	Biodiversity value	Existing pressures
Subtidal rock			
Shallow continental shelf rock	The broadly defined habitat probably occurs at many locations, but there is no information available on sub-habitats or component species.	Probably relatively high, but variable depending on the environment. There was higher than anticipated diversity on stable rock at high energy sites.	Unknown
Deep continental slope and trough rock	The broadly defined habitat probably occurs at a few locations but there is no information available on sub-habitats or component species.	Unknown, but probably relatively low compared to shallow rock. The composition of species is likely to be highly unusual due to the rarity of rock habitats in deeper water.	None known
HTV (Hydrothermal Vents)	Unknown, but information from neighbouring areas of the Timor Trough indicates that the existence of vents is highly likely.	Diversity and abundance of biota relatively high when compared to other deep-water habitats. Species composition can be expected to be a highly unusual assemblage of vent specialists	None currently known
Biogenic reefs			
Shallow coral reefs	The habitat type is likely to be rare in the region and since some component species will be coral reef specialists, it is therefore reasonable to assume that they too will be regionally rare.	Diversity is likely to be high, but may be lower than seen in more extensive reef habitats. This is due to habitat rarity and environmental stress caused by turbid water.	Distressed by constant run-off from mountainous areas.
Deep-water coral reefs	The habitat type is unusual in most regions and since certain component species are deep-water coral reef specialists, it is reasonable to assume that they too will be regionally rare.	Diversity is likely to be relatively high in comparison with other deep-water environments.	None currently known
Halimeda reefs	The habitat type is uncommon in the region. Some component species may be Halimeda reef specialists and therefore may be regarded as regionally rare.	Diversity expected to be moderately high due to the structural complexity provided by the reef.	None currently known

General conclusions might include the following: 1) In most cases there is insufficient information to make a robust assessment of conservation importance, 2) The extent of the habitats generally limited and regionally widespread, 3) Habitats such as mangroves, seagrass, shallow-water coral reefs, deep-water coral reefs and Halimeda reefs are rare and possibly absent in some cases in the region. As most component species of such habitats will be habitat specialists, it is therefore reasonable to assume that they too will be regionally rare and 4) there is limited knowledge about the extent and intensity of existing pressures such as traditional fishing.

Mangrove habitats are unique ecosystems occurring along the sheltered intertidal coastline, mudflats and riverbanks. These are formed in association with the brackish water margin between land and sea in tropical and sub-tropical areas (Cannicci et al., 2008). Mangroves play an important role in providing essential ecological services and livelihoods for neighbouring human communities (IUCN, 2006). Mangrove wetlands offer refuge and nursery grounds for juvenile fish, shrimps, crabs and molluscs. The habitats are also prime nesting and migratory sites for hundreds of bird species, sea turtles and mud-skipper fish (Alongi, 2004). They also provide protection from coastal storms (Mazda et al., 1997), help stabilise sediments (Carlton 2009) and absorb pollutants (Tam, 1995), as well as reduce shoreline (Thampanya et al., 2006) and riverbank erosion (James 2000).

Coral reefs habitats form some of the most diverse ecosystems known and for this reason are considered to be of significant conservation importance. These complex and varied marine habitats also support a wide range of organisms (Barnes, 1991) and benefit the ecosystem through tourism, fisheries and shoreline protection (Briggs, 2005). In addition, coral reefs play a vital roles in protecting shorelines by absorbing wave energy, particularly for many small islands, which would not exist without the protection of reefs (Cooper, 2008).

Intertidal sediments and rocks are formed due to wave exposure and freshwater influence. Freshwater run-off derived from the South Coast highlands is an influential factor during the raining season, resulting in increased coastal turbidity.

Vulnerability and resilience of habitats

The relative importance of habitats for conservation management is influenced by vulnerability and resilience. It is therefore appropriate to define the meaning of these terms. *Vulnerability* is a measure of the degree to which a receptor is exposed to pressures it is sensitive too, while *resilience* is the ability of a receptor to recover from disturbance or stress. The available information is currently insufficient to form a reliable basis for assessing such variables in the Timor Sea.

Table 3.19. Outline of assessment of the vulnerability of habitats in the Timor Sea, JPDA and South Coast.

Habitat type	Vulnerability	Resilience
Intertidal Sediment		
Exposed coarse sandy beaches	High vulnerability to impacts from oil spills and localised shoreline developments.	Expected to be relatively high due to the dynamic and mobile nature of the substrate.
Sheltered fine sandy beaches and mudflats	High vulnerability to impacts from oil spill and localised shoreline developments.	Likely to be low at some locations due to low-wave energy, but mobile sandbanks in estuaries may show a more rapid recovery.
Mangrove forests	High vulnerability to impacts from oil spill and localised shoreline developments.	Documented cases indicate a slow recovery period, with regrowth of trees requiring years or decades.
Intertidal rock		
Exposed intertidal rock	High vulnerability to impacts from oil spills and localised shoreline developments.	Expected to be relatively high due to the high-energy environment and frequent wave action.
Sheltered intertidal rock	High vulnerability to impacts from oil spills and localised shoreline developments.	May be lower than at more exposed sites, although still expected to be relatively rapid.
Subtidal sediment		
Shallow continental shelf sediments	High vulnerability to localised impacts from cuttings piles or construction of subsea structures.	Likely to be highly variable, ranging from rapid recovery in coarse mobile sediments in wave-exposed shallow areas to slow recovery in mixed stable sediments in low-energy or moderately tide swept environments.
Deep continental slope and trough sediments	As it is considered unlikely that developments will occur in depths of >200m, there is low vulnerability to localised impacts from cuttings piles or construction of subsea structures.	Disturbance studies in low-energy, deep-water environments indicate a very slow recovery rate.
Seagrass	Considered to be highly vulnerable to impacts associated with shoreline developments, with a moderate vulnerability to impacts associated with oil spills.	Uncertain, although the limited extent of beds will likely reduce recovery potential due to the lack of potential colonists in the immediate area.
Subtidal rock		
Shallow continental shelf rock	High vulnerability to localised impacts from construction of subsea structures, as well as impacts associated with shoreline development in the case of shallow inshore reefs. As it is considered unlikely that drilling will be conducted on exposed benthic bedrock, vulnerability to impacts from cuttings piles is thought to be quite low.	Variable. Recolonisation is likely to be moderately rapid, although community structure may remain modified for longer periods.
Deep continental slope and trough rock	As it is unlikely that developments will occur in depths of >200m, vulnerability to localised impacts from cuttings piles or construction of sub-sea structures is considered low.	Likely to be very low due to the low-energy environment and rarity of habitat limiting potential sources of colonists.

Habitat type	Vulnerability	Resilience
HTV	As it is unlikely that developments will occur in depths of >200m, vulnerability to localised impacts from cuttings piles or construction of sub-sea structures is considered low.	Unknown, although vents are transient structures on a scale of decades so it can be assumed that associated communities will adapted and recolonise areas on a similar timescale.
Biogenic reefs		
Shallow-coral reefs	High vulnerability to impacts associated with shoreline development in the case of inshore reefs, as well as localised impacts from construction of subsea structures. Moderate vulnerability to impacts associated with oil spills. As it is highly unlikely that drilling will be conducted in inshore areas, vulnerability to impacts from cuttings piles is thought to be quite low.	Documented recovery rates of coral reefs are low and this is particularly likely to be the case in the study area due to habitat rarity limiting potential sources of colonists.
Deep-water coral	High vulnerability to localised impacts from cuttings piles or construction of sub-sea structures.	Recovery rates are not documented, but likely to be very slow due to the low-energy environment and slow coral growth rates.
Halimeda	Moderate vulnerability to impacts associated with oil spills due to shallow depths. As it is highly unlikely that drilling will be conducted in the shallow reef areas, vulnerability to impacts from cuttings piles and sub-sea structures is thought to be low.	Documented recovery rates are relatively rapid.
Species		
Turtles	Nesting beaches highly vulnerable to impacts associated with oil spills or shoreline development. The species is highly vulnerable to contamination from oil slicks and disturbances from seismic surveys.	Limited due to species rarity.
Cetaceans	Species highly vulnerable to contamination from oil slicks and disturbances from seismic surveys.	Limited due to species rarity.
Dugongs	Species highly vulnerable to contamination from oil slicks and possibly to habitat damage associated with shoreline developments. As it is unlikely that seismic surveys will be conducted in shallow inshore areas, vulnerability to disturbances from these is assumed to be low.	Limited due to species rarity.

While many habitats and component species may be vulnerable to oil spills, their vulnerability to other oil and gas development activities such as seismic surveys, installation of subsea structures, drilling cuttings and produced water will vary depending on the characteristics of the habitat or species under consideration. In the case of deep-water habitats such as continental slopes and trough environments, vulnerability is considered to be low as it is unlikely that developments will occur in depths of >200m.

The resilience of habitats and component species is likely to be highly variable. High-energy, shallow areas are likely to have a relatively rapid recovery rate, while low-energy or deep-sea environments are likely to be much slower. Slow recovery habitats can be characterised as extremely sheltered beaches, intertidal rock, mangrove forest, seagrass, shallow-water coral reefs and deep-water habitats, including deep-water coral reefs. On the other hand, intertidal habitats and shallow sites such as *Halimeda* reefs are likely to have relatively high recovery rates due to the high-energy conditions.

3.7.2 Potential impacts of the oil industry

Seismic survey

The literature referred to in Chapter 3 appears to indicate that seismic airguns only cause localised and transitory impacts on marine biota, including adult fish, fish eggs and larvae, marine mammals and invertebrates.

Table 3.20 Summary of findings of seismic impacts on marine biota extrapolated for the JPDA in the Timor Sea.

Biota	Zone of effects (Z)	Towed length (L)	Anticipated Area of effect = (Lx(Zx2))
Fish eggs and larvae	<1m	1,000,000	Surface area affected = (1,000,000 x (1 x 2)) = 1,000,000 x 2 = 2,000,000m^2 = 2km^2 impacted within 61,000km^2 area = 2km^2/61.000km^2 = 0.003%
Adult fish	< 5m	1,000,000m	Surface area affected = (1,000,000m x (5 x 2)) = 1,000,000m x 10 = 10,000,000m^2 = 10km^2 impacted within 61,000km^2 area = 10km^2 / 61,000km^2 = 0.016 %
Fisheries	<20m	1,000,000m	Surface area affected = (1,000,000m x (20 x 2)) = 1,000,000m x 40 = 40,000,000m^2 = 40km^2 impacted within 61,000km^2 area = 40km^2 / 61,000km^2 = 0.066%
Marine mammals	<30m	1,000,000m	Surface area affected = (1,000,000m x (30 x2)) = 1,000,000m x 60 = 60,000,000m^2 = 60km^2 = 60km^2 / 61,000km^2 = 0.098%
Invertebrates	<2m	1,000,000m	Surface area affected = (1,000,000m x (2x2)) = 1,000,000m x 4 = 4,000,000m^2 = 4km^2 = 4km^2 / 61,000km^2 = 0.007%

Based on the estimates above, it seems likely that the impacts of seismic surveys will only affect a very small proportion (< 0.1%) of the overall area. However, if this were to coincide with a particularly sensitive area (e.g. breeding grounds) the consequences would be greater than implied by this calculation.

Drilling muds

The literature indicates that the impacts of drilling muds are localised and generally occur through physical smothering. Recovery rates depend on the type of community affected, composition of toxic components in the pile, availability of colonising organisms and water depth. Although estimates of the extent of these impacts vary, a maximum distance of 2000m from the platform covers most situations. Therefore the potentially impacted area is within a circle of radius of 2000m centred on the oil well. The formula for this area of circle is = Pi x r^2. Using this formula, the area impacted from a single well can be calculated at 12,566,371m^2. Assuming there are 10 wells in the JPDA, a total of up to 125,663,710m^2 of seabed would be impacted. There are 1,000,000m^2 in 1km^2 so the impacted area would therefore be ~126km^2. If an estimated area of 126km^2 is impacted within 61,000km^2 of the JPDA, this indicates that ~0.2% of the JPDA seabed would likely be affected.

A detailed study and assessment should be considered before drilling activities take place in southern part of the JPDA bordering the Timor Trough, where depths can extend from 300 to 3000m. This is particularly important given the potential impacts on deep-water coral and hydrothermal communities in the area, as indicated in sub-sections 2.3.3 and 2.3.4 of Chapter 2. As oil platforms in the Timor Sea are likely to be located in deep water of more than 30m, drilling muds are not considered a big risk factor to nearshore habitats.

Produced water

The available literature suggests that the effect of produced water on marine environments tends to be localised and transitory in nature. For example, the extent of the effect of produced water in well mixed conditions might reach only 200m from the discharge point and extend between 500 to 1000m from the discharge point in shallow water or water with limited circulation. If the maximum extent of impact from the well is 1000m, then the maximum area impacted from a single well would be 3,141,593m^2. Assuming there are 10 wells in the JPDA, the impacted area would be 31,415,930m^2 or ~31km^2. This means that a maximum of ~0.05% of the JPDA area would likely be affected.

Produced water is unlikely to have a significant impact on near-shore habitats as oil platforms in the Timor Sea are typically located in deep water of more than 30m.

Oil spills

Causes

There are numerous physical features that may lead to an increased risk of oil spills in the Timor Sea. The Timor Trough is a geologically active area that is susceptible to earthquakes, which have the potential to cause subsea pipeline rupture or damage to other offshore structures. In association with the heavy sediment loads deposited by the coastal rivers, earthquakes also have the potential to generate turbidity currents on the continental slopes south of East Timor, thereby increasing the risk of damage to subsea structures in the region.

Cyclones are another factor which could potentially increase the risks to shipping and structures and thus increases the risk of oil spills in the region. This is particularly the case in the southern section of the JPDA during the cyclone period from December to April.

Wind direction is likely to have a bigger influence on the direction of drift of oil slicks rather than currents. Wind direction is seasonally variable, with prevailing easterly winds during the dry season (October to May), while the wet season throughout November to March brings prevailing westerly winds.

Fate

The most likely sources of oil spills in the Timor Sea are platforms, pipelines, tankers and refineries. Causes may include: 1) oil platforms and pipeline installed or located in an area around Timor Trough vulnerable to earthquakes and continental slope instability, 2) broken or damaged oil platforms and pipeline installed or located in the shallow continental shelf of the JPDA, which may cause spills due to sediment erosion, and 3) tankers could potentially be damaged by cyclones, resulting in oil spills.

If an oil spill occurs in the JPDA, the oil is likely to go in one of two directions depending on what season it is at the time. If the spill event occurs in the dry season from June to September then oil slicks will drift from south-east to north-west towards the South Coast of East Timor (as indicated in Figure 2.7 and described in sub-section

2.2.3). However, if the spill event occurs in the wet season from November to March then oil slicks drift from north-west to south-east, with the slicks moving towards Arafura Sea (as indicated in Figure 2.6 and described in sub-section 2.2.3). Oil is eventually assimilated by the marine environment and the time it takes to reach the land or near-shore areas depends on the factors described earlier in sub-section 3.2 of Chapter 3. During the wet season, for example, the wind is likely to take the oil away from the East Timor coast and cyclones may disperse the oil. However, if it occurs during dry season, it is far more likely to make landfall, although the probability of this depends on the size and location, as well as wind speed. Of course, if the source of the spill is from tankers or pipelines outside of the JPDA and closer to the coast then the likelihood of spills reaching the South Coast is much higher.

Decommissioning

Removal of structures will cause considerable localised disturbance and damage, but eventually the site may return to a 'natural' state. Leaving structures in place will cause less damage and the (possibly diverse) communities which have developed on the structures will remain. But it will take much longer to return to a 'natural' state. Toppling will create considerable disturbance but a diverse community may develop on the sunken structure. Again, it will take a very long time to return to a 'natural' state. The advantage of leaving structures in place is in avoiding the coastal damage associated with taking the structures to land and potentially in stimulating the development of diverse communities on the abandoned structures.

The preferred decommissioning options outlined in this study may be influenced by *conservation philosophy.* If diverse ecosystems are viewed as important it may be better to leave structures in place. For example, if in a particular place fish populations are limited by the amount of available habitat, then addition of suitable artificial habitat increases the environmental carrying capacity, resulting in a sustained increased in populations. The option of leaving structures in-situ could be viewed as a tool for habitat conservation and rehabilitation, including their use as physical barriers to discourage illegal trawling. The structures may also act as artificial reefs and provide a source of colonists for rejuvenating adjacent reef communities. But if the preference is for *'natural'* ecosystems it may be better to remove structures, although there are environmental costs associated with the removal process. Such costs include physical disturbance of neighbouring natural communities, possible release of contaminants, and facilitating the establishment and spread of invasive species due to transport of the structures and their associated fouling communities. There is also the potential for localised adverse changes in established food-web dynamics and community structures. Conclusions regarding decommissioning impacts in Timor Sea are similar to the conclusions reached elsewhere in the world. Decommissioning rigs left in-situ in deep water can enhance biological productivity, improve ecological connectivity and help facilitate conservation or restoration of benthos (i.e. cold-water corals) by restricting access to fishing trawlers. Conversely, potential negative impacts include physical damage to existing benthic habitats within the “drop zone”, undesired alteration in marine food webs and release of contaminants as reefs corrode.

If removing the structure to shore for dismantling and disposal, this will involve engaging the relevant Timorese institutions. These would include the National Petroleum Authority (NPA), the Ministry of Natural Resources and the Ministry of Commerce and Environment. Although this option might seem to have negligible impacts on the marine environment, if the process fails to comply with guidelines it could cause physical disturbances and contamination of sensitive coastal environments such as coral reefs. Thus, there is a need to develop specific environmental policies to regulate oil and gas decommissioning and disposal. These should specify that all actions be licensed and decided on a case-by-case basis. Guidelines should include provisions such as: 1) No permit shall be issued if the decommissioning option might release substances which are likely to result in a hazard to human health, harm to living resources and marine ecosystems or raise conflict among other sea users, 2) Other contracting parties, including relevant authorities and sea users, should be consulted, 3) navigational safety aspects should be considered and 4) for deeper/heavier installations, partial removal is permitted or it can be left intact at existing sites. Hence, potential effects on the marine environment should be evaluated, including effects on water quality; the potential for pollution or contamination of the site by residual products or deterioration of the installation and interference with other users of the sea include fishing, shipping, and subsea cable laying.

3.7.3 Existing human pressures

The literature in sub-section 2.4.6 indicates that the existing human pressures on the Timor Sea are on the whole negligible. However, it is possible that additional pressures from the oil industry may interact with existing pressures to amplify the impact on the marine environment. This might occur through secondary consequences of the development such as, increased coastal urbanisation, associated habitat destruction and increased effluent discharge. Development might result in increased shipping, improved transport and ports, leading to increased financial viability of commercial fishing and hence increased fishing pressure. Development might also result in changes in agricultural practices due to economic development. For example, more intensive agriculture may be necessary due to population increases and the higher demand for supply. At the same time, less intensive agriculture may become less viable as alternative job opportunities arise).

Conclusion

- Preliminary assessment on species and habitat diversity of natural environment in the Timor Sea indicates an impoverished biota. This may be due to environmental characteristics and/or a lack of comparable datasets. Rarity and biodiversity assessment indicates that shallow coral, mangroves and deep-water coral reefs are considered as relatively high conservation importance. Assessment of vulnerability and resilience of habitats indicates that coral reefs, mangroves and deep-water coral reefs are high conservation concern.

- Impacts associated with drilling muds are considered to pose localised but long-term threats on marine organisms in the Timor Sea, seismic surveys are judged likely not to impact on fisheries and marine mammals but only limited localised and transitory effects on invertebrates and fish eggs and larvae. Produced water is judged to pose only localised and transitory threats to marine biota.

- The physical environment of the area has the potential to cause oil spills and consequently pose threats to the marine environment. Relevant factors include tectonic activity in the Timor Trough and the associated risk of turbidity currents on the continental slope, as well as the possibility of cyclones.

- Oil spills originating in the Timor Sea development area are very unlikely to reach the South Coast of East Timor due to high dispersion rates. Other factors include the long distance between the point of origin and the coastline, as well as the high temperatures, which in turn cause high oil evaporation rates.

- Oil spills have potential impacts on human heath due to the possibility of contamination of fish and shellfish. If oil spills were to occur in near-shore areas on the South Coast of Timor Sea then this is likely to affect subsistence fisheries.

- The preferred option for decommissioning rigs in deep water is to leave the structures in-situ. The reason for this is because of the potential for enhancing biological productivity, improving ecological connectivity and facilitation of conservation.

- Current existing human pressures on the natural environment of the Timor Sea region are regarded as negligible. However, future increases in business hubs on the South Coast may introduce secondary environmental and socio-economic pressures.

Chapter 4. AN EVALUATION OF STAKEHOLDERS VIEWS REGARDING THE POTENTIALDEVELOPMENT OF THE OIL INDUSTRY IN EAST TIMOR: A CASE STUDY.

4.1 Introduction

There has been substantial growth in the oil industry over the years. The sector has been important in generating economic activity in many countries and in supporting the world economy. (Shadbegian and Gray, 2006, Kotchen and Burger, 2007, Committee, 2008, Festic and Repina, 2009, Kumar and Managi, 2009, Lutz and Meyer, 2009, Yang et al., 2009, Goetz, 2008, Noguera and Pecchecnino, 2007, Zou and Chau, 2006, Krywitsky and Freeman, 2006). Many developing countries face the dual challenges of providing sufficient oil and gas supplies to support their rapidly growing populations and the need to find an economic engine to drive growth and development. However, environmental problems may arise if decision makers fail to pay appropriate attention to the interests of stakeholders (Grimble and Wellard, 1997, Grossman et al., 2008) can result in higher social and environmental costs (Mwalyosi, 1998).

Recently, efforts to tackle environmental problems through stakeholder consultation and involvement initiatives have been embedded into the environmental decision-making process, from local to international level (Mushove P. and Vogel, 2005), (Stilma et al., 2007, Stringer, 2006, Thomas et al., 2007, Sutton and Bushnell, 2007, Hovardas and Poirazidis, 2007, Kellett et al., 2007, Simonovic and Akter, 2006, Bienabe and Hearne, 2006, Rouse, 2006, Hunt, 2006). In fact, it could be argued that placing importance on stakeholder involvement in the environmental management process can yield improved information and not only produce responsive decisions, but also resolve conflict, build trust, educate the public and confer legitimacy. Stakeholder consultation has also been practiced in other fields, including in the health sector (Haddow et al., 2007, Miles et al., 2006, Armstrong et al., 2007, Morrow et al., 2007, Madi et al., 2007, Lu et al., 2007), and in the area of water resource framework management (Manez et al., 2007, Lautze and Kirshen, 2009, Smyth et al., 2009, Woods, 2008, Chubarenko, 2008, Deber and Gamble, 2007, Dandrea and Combes, 2006, Kujinga and Jonker, 2006).

Environmental issues normally require a diverse approach which considers both ecological and societal issues (Groom, 2006, Carpenter, 2009). Thus, recognising social aspects of environmental management such as the willingness of different resource stakeholders to participate in environmental management programmes is vital, particularly for a resource with high social and economic importance.

Consequently, the planning process for modern environmental management, listens to the perceptions of stakeholders via formal participatory processes or public hearings. A quantitative social scientific approach can be useful in unravelling the preferences and attitudes of diffusely organised stakeholder groups and in providing decision-makers with an objective overview of stakeholders' attitudes towards environmental management programs (Arlinghaus and Mehner, 2005, Cooke et al., 2009, Myatt-Bell et al., 2002, Myatt et al., 2003). The avoidance of centrist approaches can add credibility when establishing environmental policies and generally improve environmental management planning.

As environmental management issues can become socially and biologically complex (e.g., migration of species, or where coral reefs are affected by multiple development factors), assessing stakeholder preferences for particular environmental protection measures may benefit from multivariate modelling approaches (Cooke et al., 2009) in which large numbers of stakeholders can be asked their views on the relative merits of multiple alternative management tools.

4.1.1 Objective of the pilot Study

The objective of this pilot study is to evaluate the views of stakeholders regarding the relative importance of both negative and positive potential outcomes of oil industry development. The results are intended to inform the development of appropriate management strategies aligned to the value systems of the stakeholders. The study was primarily based on the views of local residents who are relevant stakeholders and have direct knowledge of the areas under consideration for development. The novel results provided by this study could serve as a starting point for the development of a socially responsible environmental policy for East Timor.

The survey questionnaire was designed with five main specific objectives:

1) to assess the views of respondents on the importance of various components of the existing natural environment, the importance of various livelihood sectors and levels of satisfaction with provision of various basic infrastructure services,

2) to determine respondents expectations of the probable outcomes of oil industry development,

3) to assess the views of respondents on the relative importance of selected potential positive outcomes in relation to potential negative outcomes,

4) to assess the overall views of respondents on the desirability of oil industry development in East Timor,

5) To assess if the views of respondents differ according to geographic location, occupation, education level, age or gender.

4.1.2 Methods

4.1.2.1 Selection of stakeholders

Primary stakeholders in this study, according to a broadly adopted definition from Freeman (1984), are generally identified as any group or individual who can affect, or be affected by the achievement of a project. The large geographic and social footprint of the study area results in a large number of potential stakeholders.

Stakeholders for this study are classified in two distinct groups, 'individual' and 'corporate'. The 'individual'group includes those persons with local environmental management interests such as residents of the South Coast villages of Suai Loro, Betano and Beaco as well as representatives of the general Timorese public resident in the capital, Dili. To collect individual views questionnaires were distributed (see in sub-section 4.1). and the results compiled and analysed utilising a multivariate (nonparametric Multidimensional Scaling) method, as described in sub-section 2.3.6. The 'corporate'group included representatives of organisations, corporate entities or other groups. These might include government bodies at national or local level, other social service entities, environmental groups, service providers, NGOs and oil companies (see Table 4.1). The corporate representatives were not consulted by questionnaire but were invited to put forward their priorities regarding oil-related environmental issues. The views were evaluated by tabulated summaries of concerns expressed on environmental presented in results section 3.2.4 and discussion section 4.4.

Table 4.1. List of selected groups and individual stakeholders.

Category	**Group**	**Consultation**
Government	• Ministry of Agriculture, • Fisheries & Forestry (MAFF), • National Directorate of Environmental Services (DNSMA), National Directorate of Tourism, • National Petroleum Authority (NPA), • Ministry of Public Transportation, • Ministry of Public Works, • National Directorate of Land & Property, • National Directorate of Water & Sanitation Local Level; • District administrators and District Planning Officers.	Consulted/ descriptive
Services providers;	Non- governmental organisations • Fokupers *(Forum of EastTimorese Women)* • Luta hamutuk *(Monitoring gov expenses)* • Lao Hamutuk *(Monitoring natural resources dev prog.)* • FONGTIL *(National NGOs umbrella)* • Rede Feto *(Women's network)* • Hasatil *(Sustainable development)* • Haburas (*Environmental advocacy & monitoring)* Research groups; • Arafura and Timor Sea Expert Forum (ATSEF), • Coral reefs Triangle (CTI), • East Timor National University (UNTL), • Dili Institute of Technology (DIT) and; • Timor Institute for Development (TID).	Consulted/ descriptive
	Individual	
Local residents	• Residents of Suai Loro village, • Residents of Betano village, • Residents of Beaco village.	Consulted/ questionnaire based
General Public	Residents of the capital in 'Dili'.	Consulted/ questionnaire based

4.1.2.2 Study area

General characteristics

This thesis is mostly concern with the offshore oil industry however this particular chapter specifically focus on selected areas located on the South Coast of East Timor. This region is geographically suited for development in support of the oil industry and is potentially vulnerable to environmental impacts arising from this development. This region is e Joint Petroleum Development Area (JPDA) is approximately 120 km offshore from the south coast (Figure 4.1).

The south coast is relatively undeveloped in the region extending from the Suai district *(west)* to the Viqueque district *(east).* The three villages of Suai Loro, Betano and Beaco include areas of land owned either by the state or by private owners. The local communities rely primarily on subsistence agriculture and fishing. However, a recent government plan has announced the allocation of all three areas for possible development of the oil industry. This could potentially lead to the loss of important ecological value in the region.

Ecological values

The South Coast of East Timor has approximately 348 km of coastline encompassing a variety of intertidal habitats, including mangrove forests. Chapter 2 provides a full account of the biological characteristics of this coast. In terms of ecological characteristics Suai Loro has distinct differences from the other two proposed project sites. Suai is the most highly vegetated with coastal forest dominated by *Avicenna marina* (mangrove) by *Corypha umbraculifera* (talipot palm). Betano also has some mixed forest dominated by *Corypha umbraculifera* (Personal observation).

Socio-cultural characteristics

The socio-cultural features and values of the areas are summarised in Table 4.2.

Table 4.2. Summary descriptions of socio-cultural features in the proposed project sites.

Locations	Level of traditional beliefs	Significance attached to certain flora, fauna & landscape features	Recent demography & history of the areas
Beaco	Relatively moderate	Crocodiles, large trees, large rocks and rivers.	A small population prior to 1975, which expanded after 1975.
Betano	Relatively moderate	Crocodiles and rivers	The area became populated in the 1980's.
Suai Loro	Relatively strong belief system and a traditional community	Crocodiles, large trees, whales and large rocks.	The area has been populated since their ancestral period and is associated with strong traditional values.

In terms of socio-cultural features, Suai Loro is a more conservative community, compared to the other two communities. Although the objects of traditional beliefs do not appear to differ too much between the areas there are differences in the strength of these beliefs related to the demography and history of each area.

Figure 4.1. Map of the South Coast of East Timor (Adapted from SRN, 2010).

4.1.3 Research Methods

4.1.3.1 Methodology outline

This study was conducted using an inductive research approach, which aims to establish knowledge by objective, theory-free observation. This entailed collecting objective and unbiased data and subsequently trying to generate an analysis from the findings (Bryman, 2004). The observations of stakeholder views were acquired by questionnaire-based surveys and associated interviews.

4.1.3.2 Questionnaires

To gather the views of stakeholders a questionnaire-based survey was carried out. Such questionnaires are a commonly utilised method for research where a relatively large number of respondents are needed (Goodwin, 2004). For this study, the questionnaire technique enabled the researcher to gain information from a large number of subjects and thus gain a more representative sample of the views of the population (Marshall, 1999, Silverman, 2005, May, 2002, Maxwell, 2005). Care needs to be taken when devising a questionnaire in order to maximise the response rate. For example, closed questions with a range of pre-given answers gives the impression that the questionnaire is simple and may encourage the respondent to complete the survey (Denscombe, 1998) while a questionnaire which is long and contains many survey questions might potentially limit the response rate.

In utilising this technique the primary factor to consider is who needs to be surveyed in order for the aims of the research to be achieved. In this case, local residents in the project sites, who live on the South Coast, were questioned.

Another fundamental aspect is the content of the questionnaire. It was necessary for the content to explore the views of respondents regarding a range of potential outcomes and issues that might arise due to oil industry development. In order to establish the nature of such outcomes a range of possible development scenarios were considered (Table 4.3) and the possible outcomes of these scenarios were included in the questionnaire content. Although the scenarios themselves were a tool for developing the questionnaires they were not directly included in the questionnaires.

Table 4.3. Four imaginary scenarios apply for the pilot study.

Scenario A	Scenario B	Scenario C	Scenario D
Development of oil refineries on South Coast of East Timor. - Significant economic benefits to coastal community in East Timor - Significant localised coastal environmental consequences through habitat modification / loss and possible pollution - Potential broadscale environmental consequences due to increased pollution / oil spills. - Potential direct economic consequences due to interference with subsistence fisheries and agriculture - Potential future economic consequences due to reduced tourism potential - Potential social effects from increased immigration leading to demographic change - Potential conflict due to damage of cultural sites. -	Construction of supply base port on South Coast of East Timor. - Some economic benefits to coastal community in East Timor - Some localised coastal environmental consequences through habitat modification / loss and possible pollution - Potential broadscale environmental consequences due to increased pollution / oil spills. - Potential direct economic consequences due to interference with subsistence fisheries and agriculture - Potential future economic consequences due to reduced tourism potential - Potential social effects from increased immigration leading to demographic change - Potential conflict due damage of cultural sites. -	Construction of floating oil refinery in the JPDA. - No direct economic benefits to coastal community in East Timor - No obvious localised coastal environmental consequences through habitat modification / loss and possible pollution - Potential broadscale environmental consequences due to increased pollution / oil spills. - No obvious direct economic consequences due to interference with subsistence fisheries and agriculture - No obvious future economic consequences due to reduced tourism potential - No obvious social effects from increased immigration leading to demographic change - No obvious conflict due damage of cultural sites.	No development in Timor Sea and development of oil industry takes place in Australia. - No direct economic benefits to coastal community in East Timor; - No obvious localised coastal environmental consequences through habitat modification / loss and possible pollution - Potential broadscale environmental consequences due to increased pollution / oil spills. - No obvious direct economic consequences due to interference with subsistence fisheries and agriculture - No obvious future economic consequences due to reduced tourism potential - No obvious social effects from increased immigration leading to demographic change - No obvious conflict due damage of cultural sites. -

It should be stressed that these scenarios are not intended as representations, but rather are imaginary tools for visualising of the necessary conditions for the implementation of possible management strategies and the possible positive and negative consequences (Lorenzoni, 2000a). It is also essential to stress that the imaginary scenarios were not included in the questionnaires presented to the respondents during the interview sessions.

The questionnaires consist of structured and semi structured questions with additional space for comments. A summary of the questionnaire structure is presented in Table 4.4.

Table 4.4. Summary questions of the primary stakeholders.

Section	Purpose	Question Number & Remarks	Sub-section questions
II. Evaluates views on the importance of various aspects of the existing social and environmental situation.	To gauge views on the importance of existing natural resources on the South Coast.	**3** *(importance of the existing natural environment)*	Evaluates views on importance of - mangrove forests, - intertidal habitats, - fringing reefs, - breeding habitats, - coastal erosion, - coastal pollution, - coral reefs, - seabed conditions - protection of migratory species.
	To gauge views on the importance of livelihood sectors.	**4** *(economic sectors in the community)*	Evaluates views on importance of - fishing - agriculture, - handicrafts, - building & construction, - port & maritime transportation tourism.
	To gauge levels of satisfaction with the provision of basic socio-economic and infrastructure services in community.	**5** *(satisfaction with provision of basic socio-economic & infrastructure services)*	Evaluates satisfaction with - water sanitation services, - energy supply, - transportation links, - basic education services, - access to employment opportunities, available business opportunities.
III. Evaluates expectation of social and environmental changes that may occur due to development of the oil industry.	To measure expectations of the desirable benefits generated by development of oil industry.	**6** *(expectations of desirable benefits)*	Evaluates expectations of the desirable benefits; - improve employment opportunities, - create new business opportunities, - improve water sanitation, - provide additional energy, - improve health services, - improve basic education services, - improve transportations links - have positive economic impacts
	To measure expectations of the undesirable consequences generated by development of oil industry.	**7** *(expectations of undesirable consequences)*	Evaluates expectations of undesirable consequences - mangrove deforestation, - alteration of intertidal zone, - destruction of fringing reefs, - breeding & spawning habitats, - increased pollution in coastal areas, & coastal erosion, - destruction of coral reefs altered of seabed conditions and - disturbance to migratory species. - reductions in fish stock, - reduction in agriculture productivity, - loss of potential tourism industry, - increased health risks due to pollution & damage to cultural sites, - damage to land for future generations, - increased population of migrant workers and - increased job losses.
III. Evaluates views on the relative importance of possible positive and negative consequences of oil industry development.	To gauge views on the relative importance of **increased employment** is more important than environmental consequences.	**8** *(assuming the development of the oil industry* ***increased employment opportunities*** *to the community, how much do you agree that this is more important than the following possible negative consequences)*	Evaluates views of relative importance of - damage to the seabed in general, - damage to the intertidal zone in general, - damage to coral reefs, - damage to mangroves, - increased pollution, - reduction of fishing industry, - damage to agriculture land, - loss of potential for developing tourist industry, - increased heath risk due to pollution, - damage to cultural sites and increased population of migrant workers

Section	Purpose	Question Number & Remarks	Sub-section questions
	To gauge views on whether the relative importance of **improved healthcare** is more important than environmental consequences.	**9***(assuming the development of the oil industry brings* ***improved healthcare services*** *to the community, how much do you agree that this is more important than the following possible negative consequences)*	Evaluates views of relative importance of - damage to the seabed in general, - damage to the intertidal zone in general, - damage to coral reefs, - damage to mangroves, - increased pollution, - reduction of fishing industry, - damage to agriculture land, - loss of potential for developing tourist industry, - increased jobs losses damage to cultural sites .
	To gauge views on whether the relative importance of **improved transportation links** is more important than environmental consequences.	**10** *(assuming the development of the oil industry brings* ***improved transportation links*** *to the community, how much do you agree that this is more important than the following possible negative consequences)*	Evaluates views of relative importance of - damage to the seabed in general, - damage to the intertidal zone in general, - damage to coral reefs, - damage to mangroves, - increased pollution, - reduction of fishing industry, - damage to agriculture land, - loss of potential for developing tourist industry, - increased heath risk due to pollution, - damage to cultural sites and - increased population of migrant workers.
IV. Evaluates overall views on the desirability of oil industry development in East Timor.	To gauge locals overall views on the development of oil industry on the South Coast.	**11** *(Overall, to what extent do you agree with oil development in East Timor)*	Evaluates overall views - very important that development proceeds and environmental issues are minimal and should be disregarded, - very important that development proceeds but reasonable steps should be taken to protect the environment, - development should only take place if all environmental issues can be avoided and development should not proceed if will result in environmental harm.

4.1.3.3 Sample design

This survey design was influenced by a previous perception survey (Jones 1997) and the questionnaire design is based on attitude rating scales and tick boxes. It uses a five category scale devised to indicate how much the respondent agrees or disagrees with the statement (Myatt et al., 2003). The code for the respondent was one to five (*e.g.* 1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree). The phrasing of the questions is outlined in Table 4.5.

Table 4.5. The phrasing of the questionnaire

Phrasing of question	Code for the respondent
Agreement on the importance of natural environmental sectors (question 3)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Agreement on the importance of local economic sectors (question 4)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Dissatisfaction with socio-economic services (question 5)	1= excellent, 2=good, 3=adequate, 4=poor, 5=totally inadequate
Expectation of socio-economic benefits (question 6)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Expectation of negative socio-economic consequences (question 7)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Expectation of negative consequences on natural resources(question 7)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Agreement that increased employment is more important than possible negative consequences. (question 8)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Agreement that improved healthcare is more important than possible negative consequences. (question 9)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Agreement that improved transportation links are more important than possible negative consequences. (question 10)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree
Agreement with the alternative statements on overall views (question 11)	1=strongly disagree, 2=disagree, 3=don't know, 4=agree and 5=strongly agree

4.1.3.4 Interview (questionnaire based)

The interview was conducted for the primary stakeholders. The questionnaire approach was used for the primary stakeholders consisting mainly of local fishermen and farmers on the South Coast as well as for the general public in the capital of the country.

4.1.3.5 Corporate bodies (face to face)

Face- to -face interviews were conducted with corporate and institutional stakeholders. This approach took into account that gathering the views of an organization is more appropriate through descriptive method interviews. This is because it is recognised that being asked questions by a neutral listener is generally rewarding for respondents, since it gives them more opportunity to explain situations and attitudes in their own words rather than in a pre-determined format (Seale, 1998). The results of interviews with corporate bodies' interview are consolidated in Table 4.17 prior to the analysis of individual cooporate views respectively.

4.1.3.6 Sample size

The samples of respondents were collected from three selected south coast locations (Suai Loro, Betano and Beaco) and also from the nation's capital Dili. South Coast respondents were residents of the villages (or neighbouring land) and members of the local community of subsistence farmers and fishermen. Information was gathered to allow the respondents to be grouped into categories according to location, occupation, education and age so that trends in the patterns of responses could be investigated. The sample size of respondents from each location is shown in Table 4.6.

Table 4.6. Summary of total respondents by location

Category of Stakeholder	Number of Respondents
Locations :	
Suai Loro	47
Betano	58
Beaco	31
Dili	27
Total	169

4.1.3.7 Data analysis

Questionnaire responses were converted to numeric values as outlined in Table 4.5. Both multivariate and univariate techniques were used to investigate differences in response patterns between groups of respondents based on location, occupation, education and age. Multivariate techniques were applied using PRIMER software (version 5.2.6 PRIMER-E Ltd.). Non-metric multidimensional scaling plots (nMDS) were generated based on Bray-Curtis dissimilarities (Clarke et al., 1994). The significance of differences between overall responses of groups was tested using analysis of similarities (ANOSIM). To assess the significance of differences in responses then univariate statistical tests were then employed. This assessed both differences in response to various questions and differences between the responses of respondent groups to a given question. Non-parametric tests were utilised using the software SPSS. In order a situation where there were more than two distinct groups of respondents (e.g. for comparing areas such as Suai Loro, Beaco, Betano and Dili) a Kruskall-Wallis test was employed to establish if there was a significant difference ($P \leq 0.05$) in the responses of the respondent groups to a specific question.

If a significant difference was identified ($P<0.05$) pairwise Mann Whitney tests were used to detect which of the respondent groups were significantly different. In order to minimise

Type I errors the Bonferroni correction was applied when interpreting the results of the pairwise tests. The new significant difference level was then calculated using the formula: P<0.05/number of comparisons.

Data presented in Figure 4.2 to 4.11 shows the overall response pattern for all respondents on all questions. These are presented in median responses and the error bars denote the standard of the mean. The data is derived from the number of respondents positioned on the column and against number of questions in the row.

Meanwhile data indicated in Figure 4.13 to 4.34 and the tables derived from Mann Whitney (MW) results of the individual question categorise by locations and occupations which are presented questions in median response and the error bars denote standard of the mean.

Ethical Considerations

For any study that involves human participation, it is vital to consider ethical values. In this study, it was important to recognise that the questionnaire respondents and interviewees were affiliated to different stakeholders and thus it was essential to consider how the research might affect their activities. Hence, the individual respondents are not named or made identifiable in the final report. Prior to the interview, the questionnaire was commented on by the Heriot Watt University Ethics Committee. It was also established that participation in the study was entirely voluntary and participants had the right to withdraw at any stage of the process. It was agreed that the completed questionnaires would be kept with the researcher at the university until the completion of the project and then destroyed.

4.2 Results

4.2.1 Characteristics of respondents

4.2.1.1 Interview (questionnaire based)

Stakeholders were categorised according to gender, age, education level, occupation and location. Details of the composition of the respondent group in terms of these categories are summarised in Table 4.7.

Table 4.7. Result of respondents in percentage (%) by categories

Gender	Male (M)	61%
	Female (F)	39%
Age	18 – 30 y.o	40%
	31 – 65 y.o	60%
Education	Never attended school (NE)	34%
	Primary education (PE)	45%
	Middle education (ME)	14%
	Higher education (HE)	6%
Occupation	Farmer & fishermen (FF)	47%
	Farmer (F)	21%
	Educators & white collar workers (EWCW)	17%
	Trade & service industries (TSI)	15%
Locations	Suai Loro (SL)	34%
	Betano (BT)	30%
	Beaco (BC)	19%
	Dili (DL)	17%

Table shows that males comprised 61% of respondents. Most of the respondents were between 31 – 65 years old (60%). In terms of educational level, those having received only primary education made up 45% while 34% had no education. Only 14% had attended high school with 6% attending higher school or tertiary education. Fishermen and farmers made up the majority of respondents (68%), followed by educators and white collars workers (17%) and those in the trade and service industries (15%). The highest numbers of respondents were from Suai Loro (34%) and Betano (30%) with fewer from Beaco (19%) and Dili (17%).

4.2.1.2 Corporate bodies (face to face)

These groups of stakeholders included corporate organizations, companies, NGOs, INGOs, universities, research groups and government entities at national and local level. In this study, a total of 26 corporate organisations were visited and contacted for an interview, as shown in Table 4.8.

Table 4.8. List of corporate and institutions in number

Corporate stakeholders	**Category**	**Number**
Government	National level	8
	Local level	3
Service Providers	Universities	3
	Non-governmental organisations (NGOs)	7
	International organisations	3
Oil Companies	Oil companies	2
Total		**26**

Government entities made up the largest group in the corporate organisations, followed by Non-governmental organisations (NGOs) while oil companies were the smallest number in this group. Other corporate organizations, including universities and international environmental organisations were minor participants in this study as there is only limited number of these organisations in the country.

4.2.2 Analysis of primary stakeholders' responses

This sub-section presents overall response patterns based on all respondents. Subsequent subsections will examine the differences between the responses of distinct categories of respondents. The graphs presented are based on groups of questions on distinct topics. These topics include the importance of natural resources, the importance of livelihoods, the degree of satisfaction with basic infrastructure, expectations of social or environmental consequences and the relative importance placed on the benefits compared to undesirable consequences of development of the oil industry. The graphs show the percentage of respondents giving each particular response ('strongly disagree', 'disagree', 'and don't know', 'agree' and 'strongly disagree' for each question posed. Non-parametric statistical tests (see section 4.1.3.7) were employed to detect differences between the median responses given for different questions. Results presented in the following section are generated based on the raw dataset.

4.2.2.1 Overall views on the importance of existing natural resources

The overall responses in Figure 4.2 show that the majority of respondents regarded most of the listed natural resources as important. The exceptions were coastal erosion and pollution of which a significant number of respondents disagreed that these were important issues.

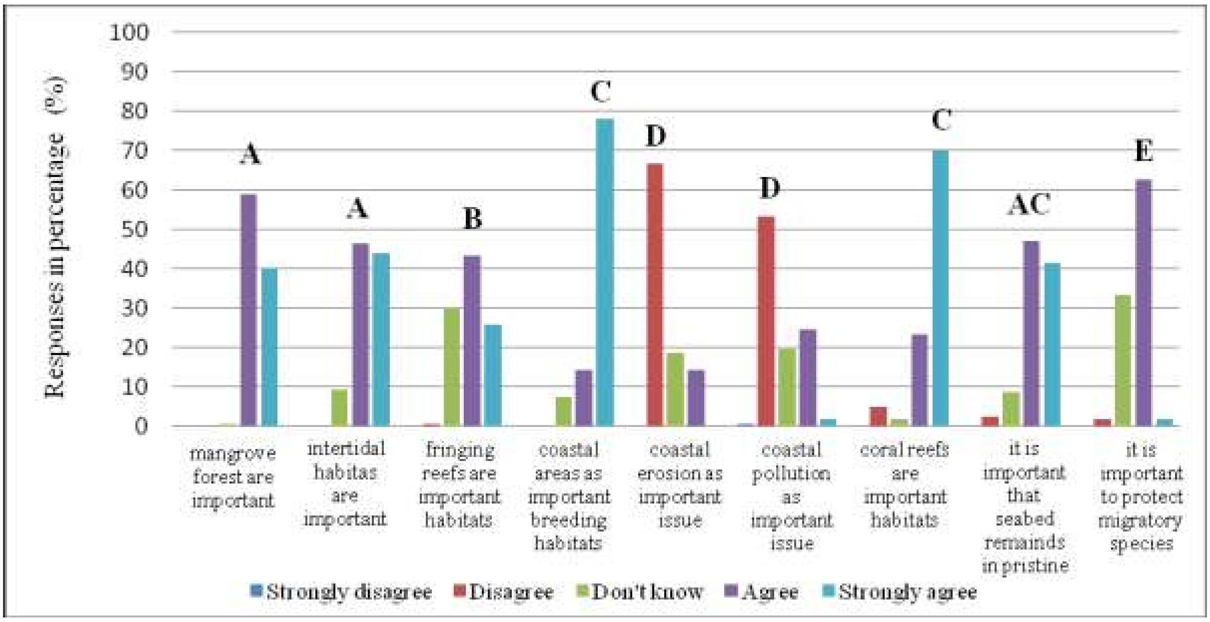


Figure 4.2. Overall response pattern for all respondents on importance of natural resources (Letter coding denotes statistically significant (P≤0.05) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

The majority of respondents strongly agreed that coastal breeding areas and coral reefs are important habitats. The majority agreed or strongly agree that it is important that the seabed remains in pristine condition and that mangrove forest, intertidal habitats, fringing reefs and migratory species were important. However moderate proportions (30% and 33%) of respondents were uncertain if fringing reefs and migratory species are important. The majority of respondent also disagreed that coastal erosion (67%) and coastal pollution (53%) were important.

4.2.2.2 Overall responses pattern on the importance livelihoods sectors

The overall responses in Figure 4.3 demonstrate that all of the listed livelihood sectors were regarded as important by the majority of respondents. This was particularly the case for port and maritime transportation as potential important future activities.

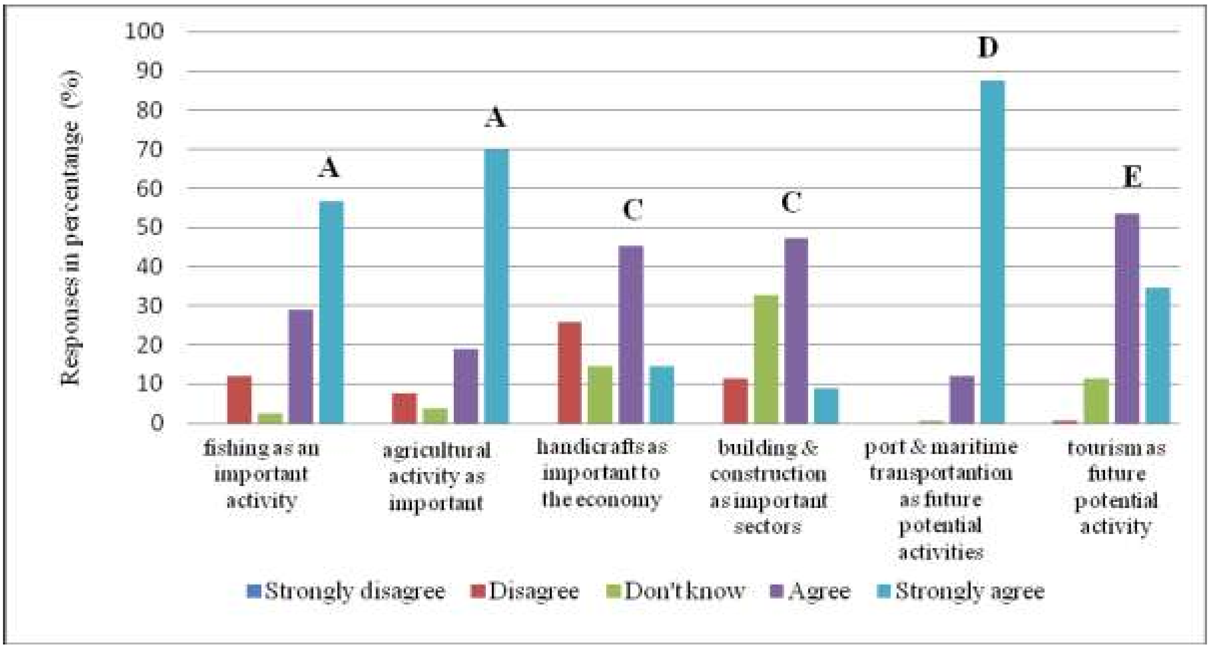


Figure 4-3. Overall response pattern for all respondents on importance of livelihoods sectors (Letter coding denotes statistically significant (P≤0.05) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

While the majority of respondents agreed or strongly agreed that agricultural, fishing and tourism activities were important, there was a small proportion (12% and 8%) of respondents who disagreed that fishing and agriculture activities were important, with only a small proportion (11%) uncertain about the importance of tourism. There was moderate agreement on the importance of handicrafts and the building and construction sector, although a significant proportion (26%) disagreed that handicrafts were important and one-third didn't know whether the building and construction sector was important.

4.2.2.3 Overall responses pattern on satisfactions with infrastructure.

The majority of respondents regarded the basic infrastructure as 'totally inadequate' or 'poor', particularly access to employment opportunities, available business opportunities, energy supply and water sanitation services.

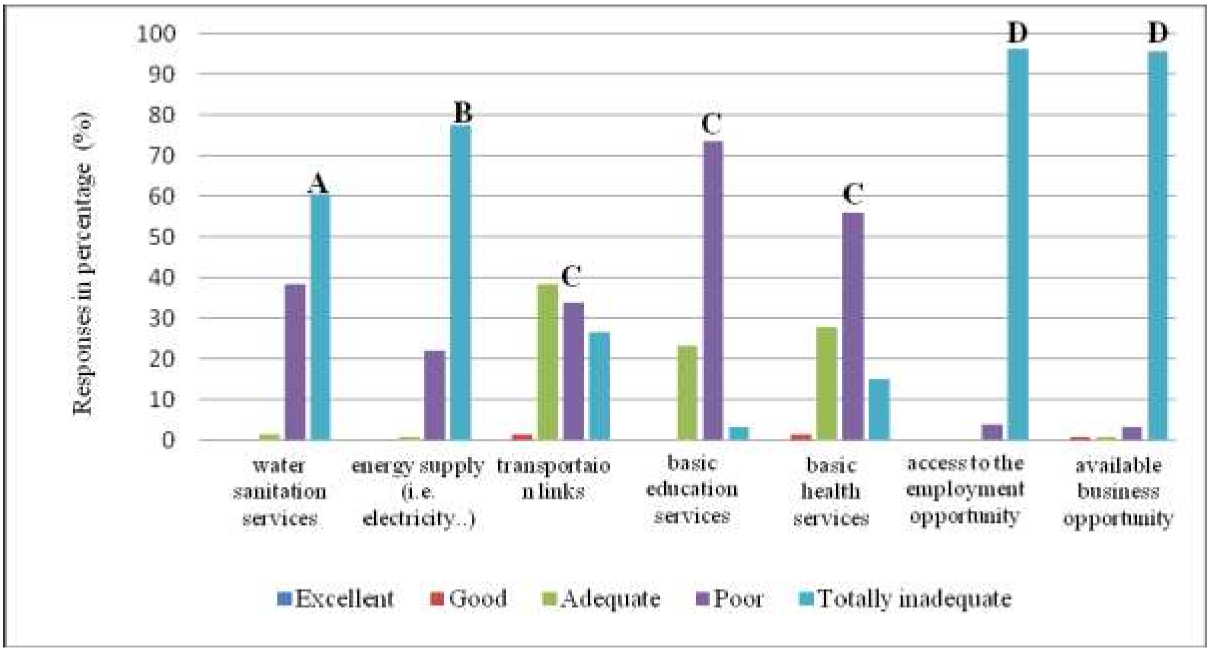


Figure 4.4. Overall response pattern for all respondents on degree of satisfaction with infrastructure (Letter coding denotes statistically significant (P≤0.05) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

However, there were a moderate proportion of respondents who regarded transportation links, basic education services and basic health services as adequate (38%, 23% and 28% respectively).

4.2.2.4 Overall responses on expectation of positive social consequences of development

The majority of respondents expected positive social consequences from the development of the oil industry albeit, with some uncertainty on the likely benefit to basic educational services (Figure 4.5).

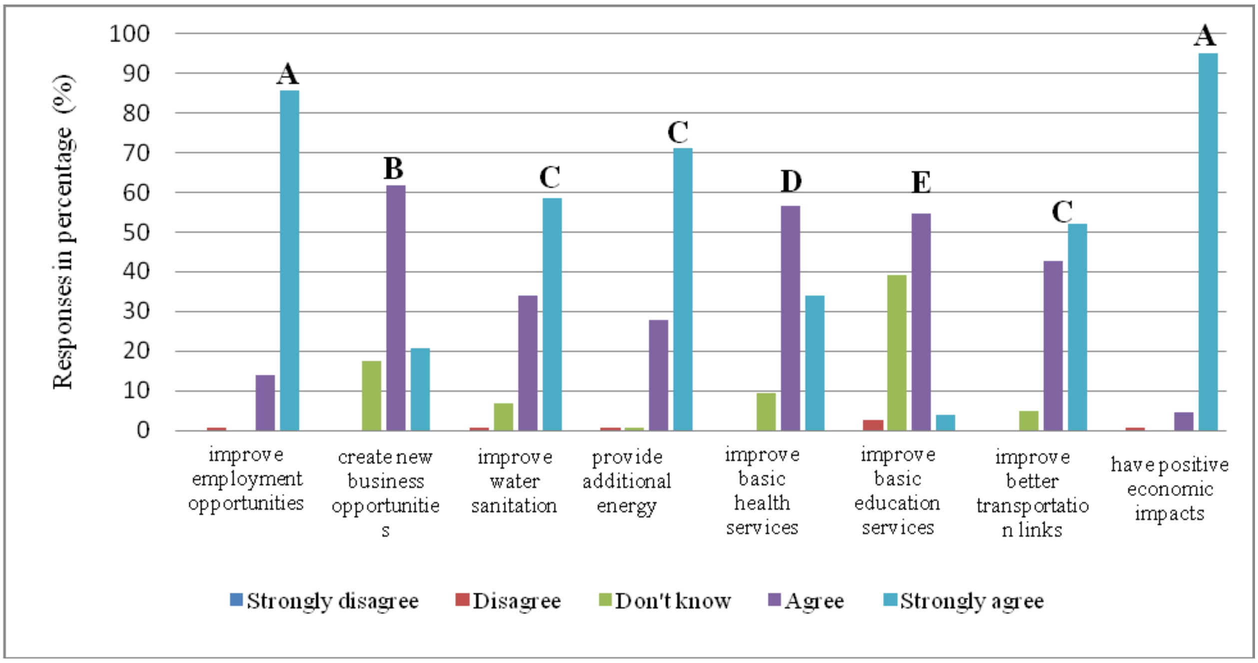


Figure 4.5. Overall response pattern for all respondents on expectation of positive social consequences of development (Letter coding denotes statistically significant (P≤0.05) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

The vast majority strongly agreed that development was likely to improve employment opportunities, have positive economic impacts and provide additional energy. The majority of also believed it would have a beneficial effect on basic education, health services, create new business opportunities, lead to better transportation links and improve water sanitation, although a small proportion were uncertain if this would happen and a significant proportion (39% and 18%) were not sure of the effect on education services or the creation of new business opportunities.

4.2.2.5 Overall response patterns on expectations of negative environmental consequences of development.

The majority of respondents expected undesirable environmental consequences from the development of the oil industry with over 80% strongly believing it would lead to the destruction of breeding and spawning habitats of fish (Figure 4.6).

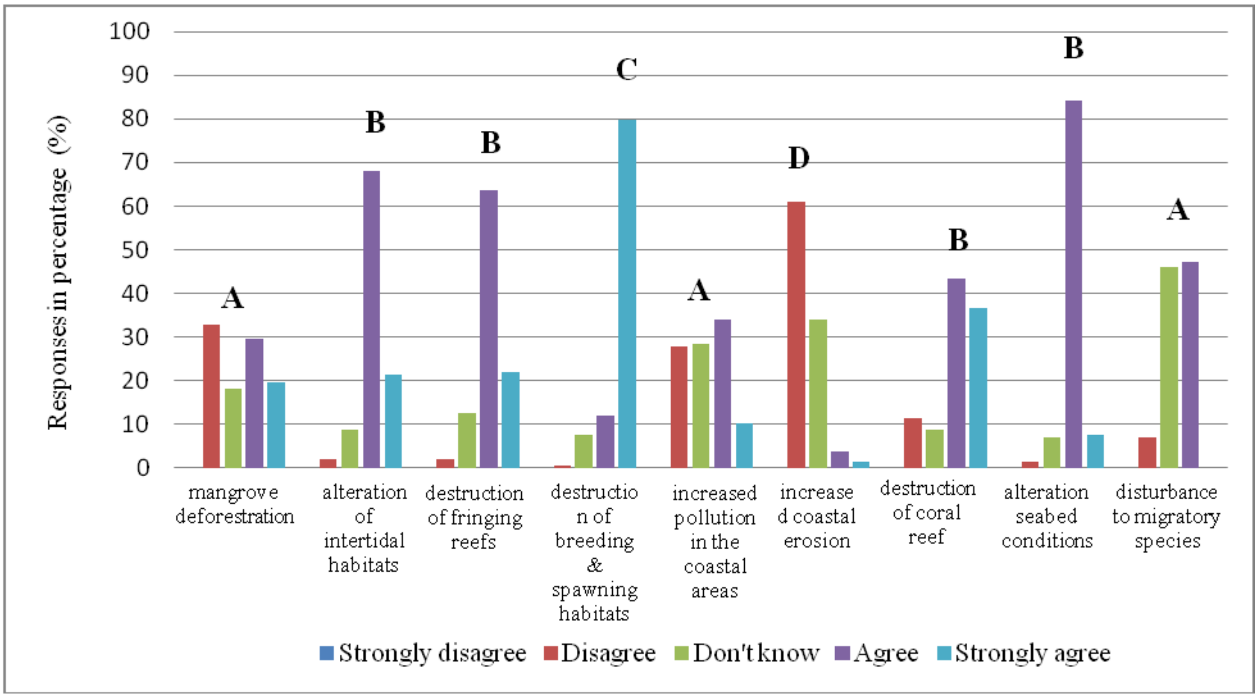


Figure 4.6. Overall response patterns for all respondents on expectations of environmental consequences of development (Letter coding denotes statistically significant ($P \leq 0.05$) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

The vast majority of respondents strongly agreed that destruction of breeding and spawning habitats was likely. The majority also agreed or strongly agreed that destruction of coral reefs, destruction of fringing reefs, alteration of intertidal habitats and alteration of seabed conditions was likely. Most respondents also agreed or strongly agreed that mangrove deforestation, increased pollution in coastal areas and disturbances to migratory species were likely. However, a moderate proportion of respondents disagreed that mangrove deforestation was likely (33%) and that increased pollution was likely (28%). While a high proportion (46%) of respondents were uncertain about the likelihood of disturbances to migratory species, most though that coastal erosion was unlikely to occur.

4.2.2.6 Overall response patterns on expectations of negative social consequences of development

Most respondents either agreed or strongly agreed that there was likely to be a reduction in fish stocks, and an increase in health risks due to pollution as well as an increase in the population of migrant workers (Figure 4.7).

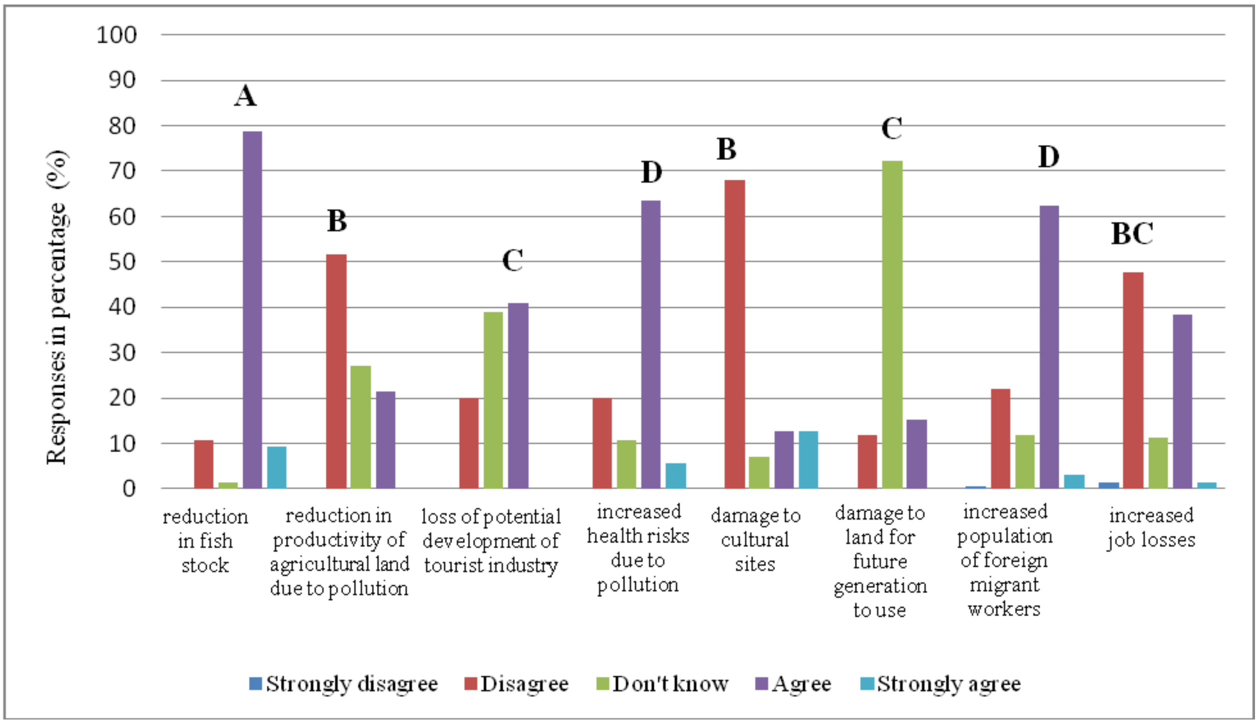


Figure 4.7. Overall response patterns for all respondents on expectations of negative social consequences of development (Letter coding denotes statistically significant ($P \leq 0.05$) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

The vast majority of respondents agreed or strongly agreed that reduction in fish stocks, increased population of migrant workers and increased health risks due to pollution were likely. Response patterns were less clear regarding views on the likelihood of loss of potential developing tourists industry, damage the land for future generation to use, reduction in productivity of agricultural land due to pollution, damage to cultural sites and increased job losses. A moderate proportion of respondents were uncertain of the impact on tourist industry development (39%) and what damage it may cause to the land for future generations (72%), while a high proportion of respondents disagreed that reduction in productivity of agricultural land due to pollution (52%), damage to cultural sites (68%) and increased job losses (48%) was likely.

4.2.2.7 Overall responses on the relative importance of employment opportunities compared with listed negative consequences.

Figure 4.8 shows that the majority of respondents believed that increased employment opportunities were more important than most of the listed negative consequences. The issues of increased pollution and associated health risks were an exception and respondents disagreed that increased employment was more important than these negative consequences.

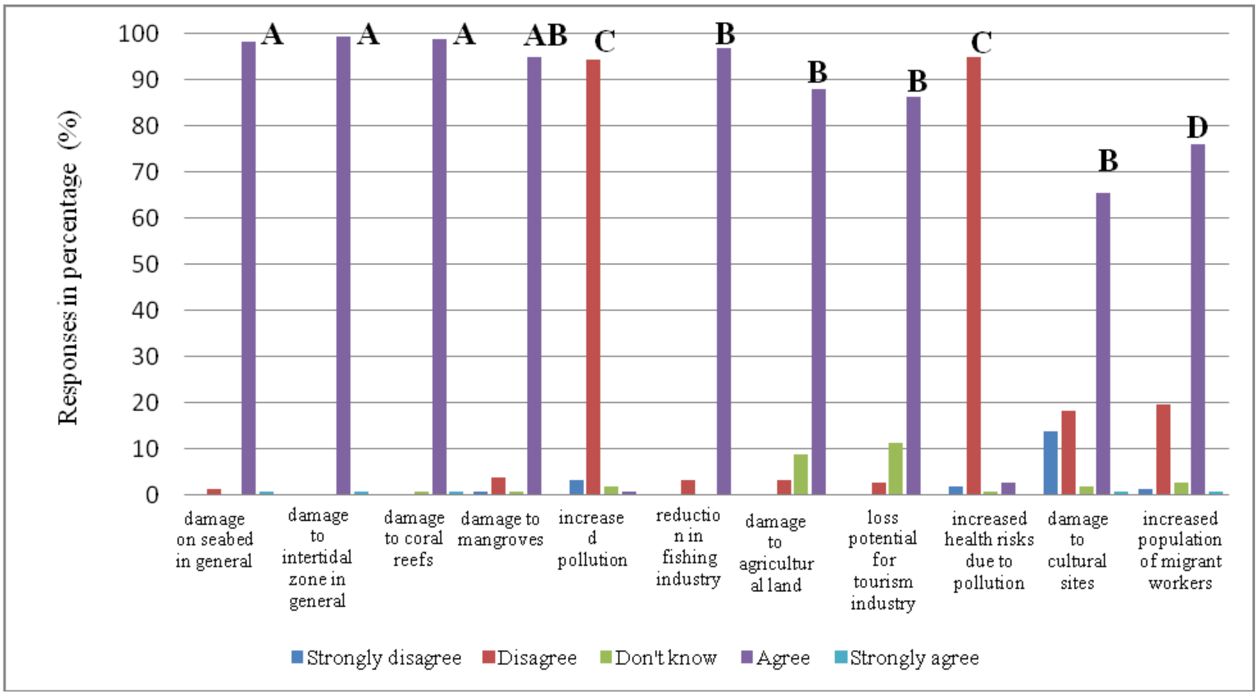


Figure 4.8. Overall response patterns for all respondents on whether the benefit of increased employment outweighs the listed negative consequences (Letter coding denotes statistically significant ($P \leq 0.05$) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

Vast majority of respondents agree or strongly agree that an increase of employment opportunities is more important than damage to seabed in general, damage to intertidal habitats in general, damage to coral reefs, damage to mangroves, reduction in fish stocks, damage to agricultural land and loss of potential for developing tourist industry. Although the majority of respondents also agree that an increase of employment opportunities is more important than increased population migrant workers and damage to cultural sites a small proportion of respondents have different views and disagree on these points (migrant workers 19% and cultural sites 18%). The majority of respondents disagree that an increase of employment opportunities is more important than increased coastal pollution and increased health risk due to pollution.

4.2.2.8 Overall responses on the relative importance of healthcare compared to listed negative consequences.

Figure 4.9 demonstrates that the majority of respondents agreed that improvements in healthcare are more important than most negative consequences. However, a large proportion (85%) disagreed that improved health care would outweigh possible increased coastal pollution and increased job losses.

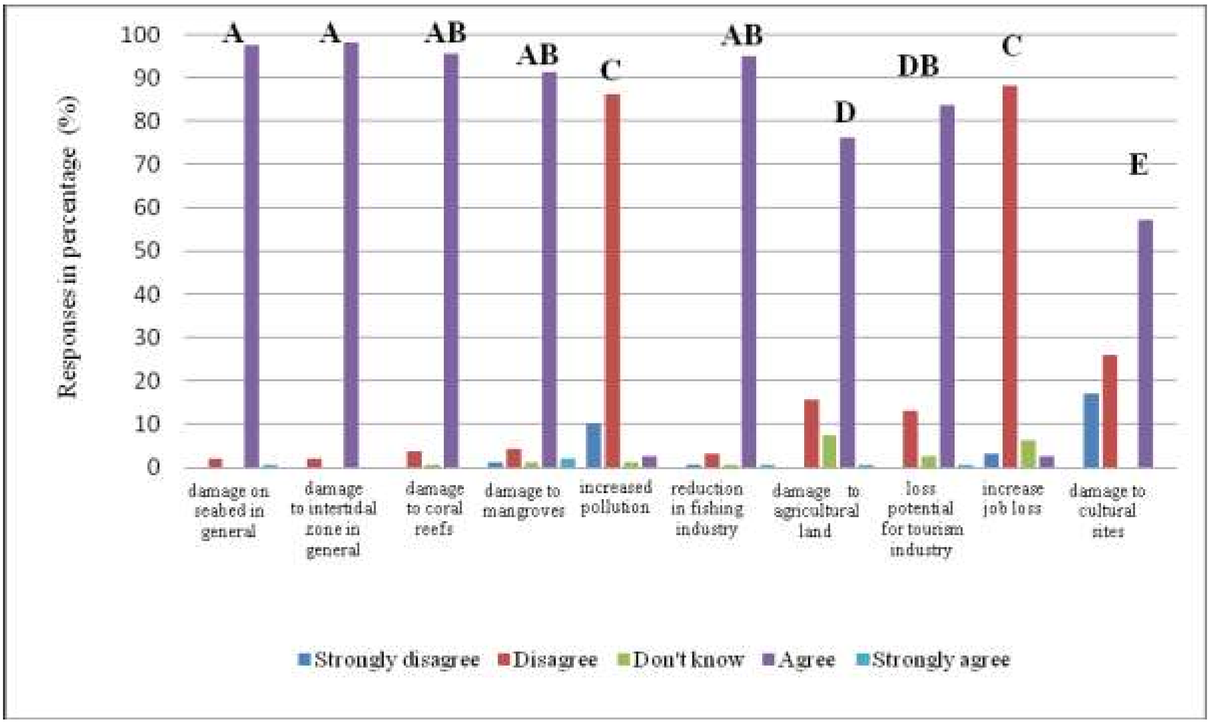


Figure 4.9. Overall response patterns for all respondents on whether the benefit of improved healthcare outweighs the listed negative consequences (Letter coding denotes statistically significant ($P \leq 0.05$) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

The vast majority of respondents strongly agreed that improved healthcare was more important than damage to the seabed, intertidal habitats, coral reefs and mangroves or decline in the fishing industry. The majority of respondents also strongly agreed that improved healthcare is more important than damage to agricultural land, loss of potential for tourist industry development and damage to cultural sites. However, a small proportion held differing views, disagreeing that improved healthcare was more important than damage to agricultural land (16%), loss of potential for tourist industry development (13%) and damage to cultural sites (26%). The majority of respondents

(>85%) disagreed that improved basic healthcare services was more important than increased pollution and job losses.

4.2.2.9 Overall responses on the relative importance of improvements to transportation links compared tolisted negative consequences.

Figure 4.10 shows improved transportation links were considered more important than most of the possible negative environmental consequences for the majority of respondents. However, 93 % of respondents did not agree that it would compensate for the risk of increased coastal pollution and pollution related health risks.

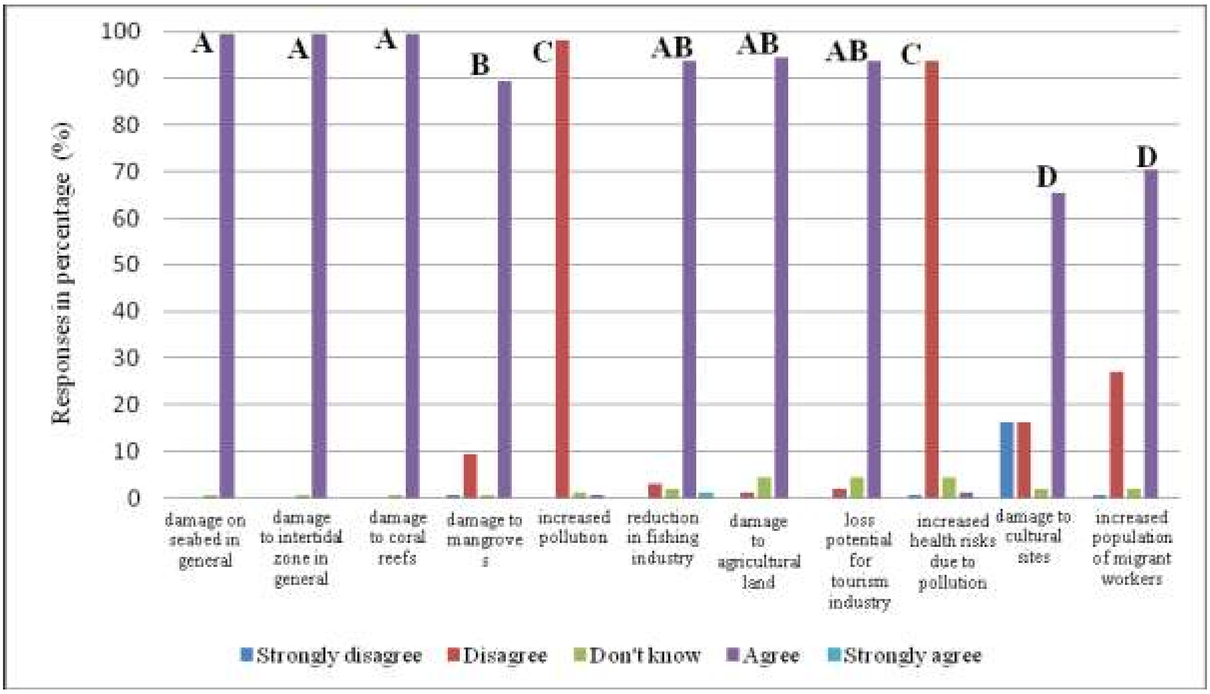


Figure 4.10. Overall response patterns for all respondents on agreement that the benefit of improved transportation links outweighs the listed negative consequences (Letter coding denotes statistically significant ($P \leq 0.05$) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

The vast majority of respondents strongly agreed that improved transportation links were more important than damage to the seabed, intertidal habitats, coral reefs, mangroves, and agricultural land. This also outweighed a decline in the fishing industry and loss of potential for tourist industry development. The majority of respondents also strongly agreed that improved transportation links were more important than damage to cultural sites and increased population of migrant workers. However, a small proportion disagreed that improved transportation links was more important than damage to cultural sites (16%) and an increased population of migrant workers (27%). The majority of respondents (>93%) disagreed that improved transportation links were more important than increased coastal pollution and pollution-related health risks.

4.2.2.10 Overall response patterns of views on the likelihoods of oil refinery development

Figure 4.11 clearly shows respondents desire for development to proceed, provided that reasonable steps are taken to protect the environment. A very high proportion (almost 100%) disagreed with the suggestion that the development should be avoided altogether due to potential environmental harm.

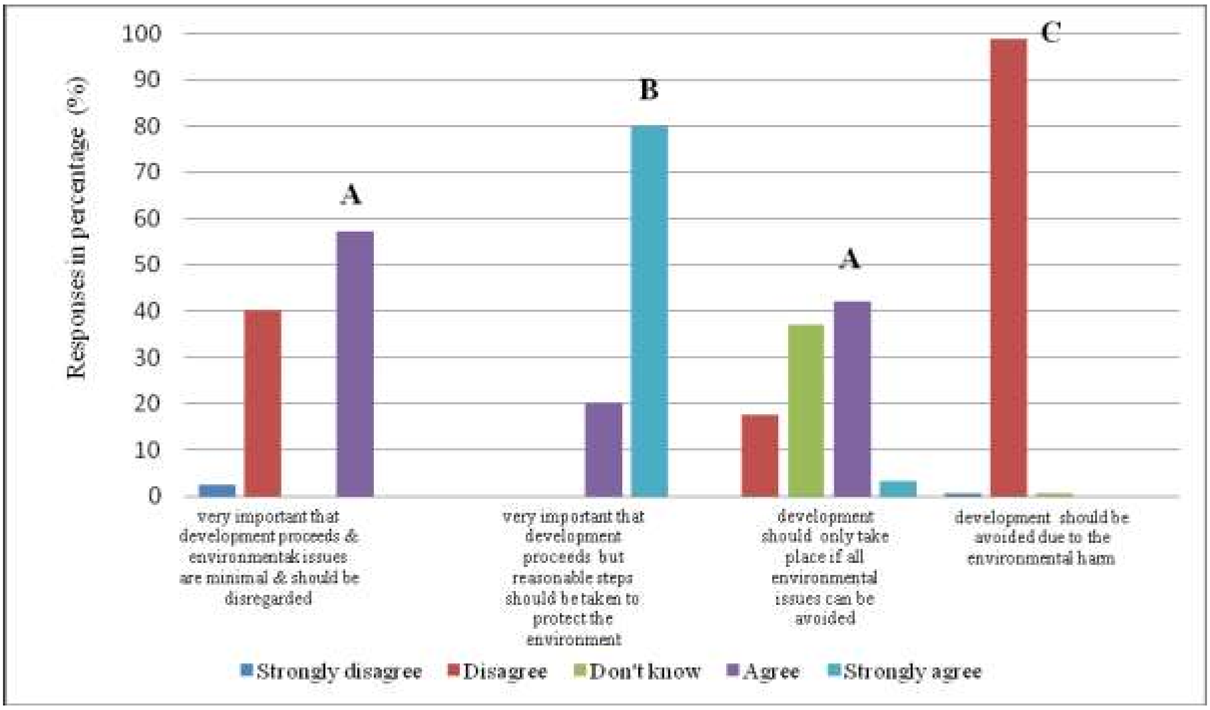


Figure 4.11. Overall response patterns on the likelihoods of oil refinery development on the South Coast of East Timor. (Letter coding denotes statistically significant ($P \leq 0.05$) difference between questions in median response. Those which share at least one letter are not significantly different). Error bars denote standard error of the mean.

A significant proportion (over 40%) of respondents disagreed with the proposition that it is very important that development proceeds and that environmental issues are minimal and should be disregarded.

In summary, the general view is that the environment is important; particularly the components that have economic value (e.g. fish breeding grounds). Unsurprisingly,while the main existing livelihood sectors of fishing and farming were regarded as important so too are the potential future sectors of ports and maritime activities. There is general dissatisfaction with the existing provision of socio-economic services, particularly regarding employment and business opportunities. There is a trend of expectation that oil development will yield a range of positive socio-economic outcomes and a range of negative outcomes that are mostly environmental in nature. The overall picture is that the majority of respondents believe that in general the positive outcomes of oil development outweigh the risks of environmental harm. However, the issues of increased pollution and human health risk due to pollution are an exception and most respondents indicated that they would not be prepared to accept these negative consequences despite the socio-economic benefits of oil development. The respondents are unanimous in agreeing that oil development should go ahead with 'reasonable' steps taken to protect the environment.

4.2.3 Comparison of response pattern of different categories of respondents.

In this section the views of respondents in different categories (location, occupation, education and age) are compared. Differences in the pattern of responses to groups of questions (these groups consist of the subsets of related questions, although the analysis is also run on the entire dataset of responses) are explored using multivariate techniques (MDS, see section 4.1.3.7 methods). Differences in responses to individual questions are assessed using non-parametric statistical tests (see section 4.1.3.7).

4.2.3.1 Comparisons of patterns of response based on all questions

A comparison of locations based on responses given to all questions revealed some evidence of differences in the pattern of responses received from the different locations (Figure 4.12). This was most pronounced in the responses from Suai Loro which were reasonably distinct from the other regions. Responses from the other locations showed some degree of overlap, but these remained in moderately discrete groups. ANOSIM results (table 4.9) supported this interpretation, with moderately high (>0.7) R values distinguishing Suai Loro respondents from both Betano and Dili.

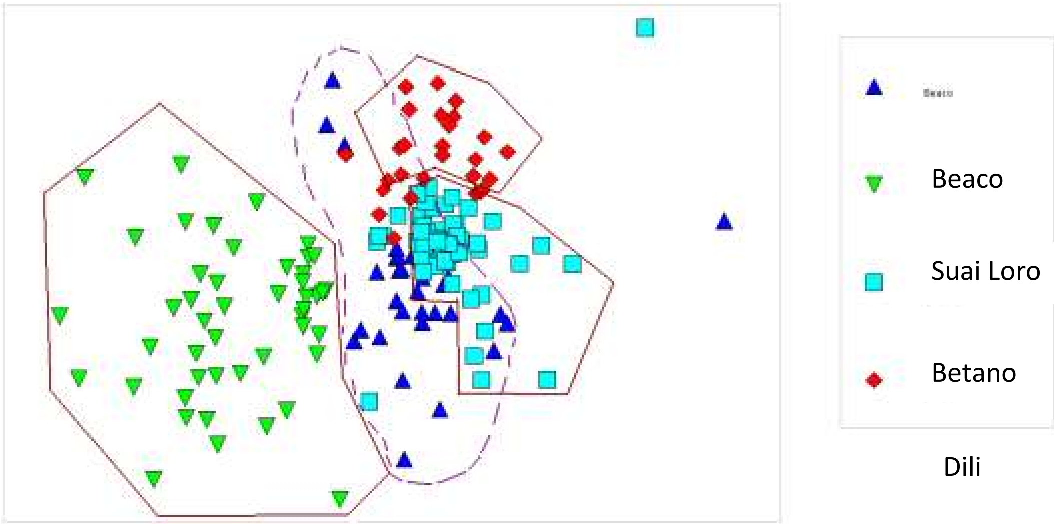


Figure 4.12 MDS plots on the overall views of stakeholders from different locations based on all questions.

Table 4.9 ANOSIM results summary for comparison between locations. The table shows R- statistics for the ANOSIM comparison significance level is <5% in all cases.

Locations	**Beaco**	**Betano**	**Suai Loro**	**Dili**
Beaco	-			
Betano	0.39	-		
Suai Loro	0.45	0.71	-	
Dili	0.51	0.47	0.76	-
Occupation	Farmer	Fishermen-farmer	Educational and white collar workers (EWCW)	Trade and services industry (TSI)
Farmer	-			
Fishermen-farmer	0.04	-		
Educational and white collar workers (EWCW)	0.02	0.09	-	
Trade and service industry (TSI)	0.31	0.19	0.34	-
Education	Never attended school	Primary education	Middle education	Higher education
Never attended school	-			
Primary education	-0.01	-		

Locations	Beaco	Betano	Suai Loro	Dili
Middle education	0.09	0.04	-	
Higher education	0.09	-0.02	-0.02	-
Age & Gender	Male>30	Male<30	Female>30	Female<30
Male>30	-			
Male<30	-0.00	-		
Female>30	-0.07	-0.01	-	
Female<30	0.01	0.02	-0.01	-

The results of ANOSIM comparisons in Table 4.9 show no convincing evidence of a difference in response patterns based on occupation, education, age or gender.

4.2.3.2 The existing natural and social environment

a. Responses relating to the importance of natural resources.

The MDS and ANOSIM analysis demonstrated no evidence of differences in overall responses to this set of questions between categories of location, occupation, education and gender. No significant differences were detected between the responses from education and age/gender categories. The MDS and ANOSIM analysis also demonstrated no evidence of differences in overall responses to this set of questions between categories of location, occupation, education and age/gender. However, univariate tests indicated some differences between location and occupation categories. No significant differences were detected between the responses from education, age and gender categories (Figure 4.9).

The statistical tests indicated that some regional differences in responses existed for every question posed. Main general trends included a relatively high proportion of 'don't know' responses from Dili whereas respondents from the other regions tended to have more firmly established views on the questions. Respondents from Suai Loro appeared to have more firmly established views (i.e. strongly agree) on the importance of certain resources than is the case in other regions.

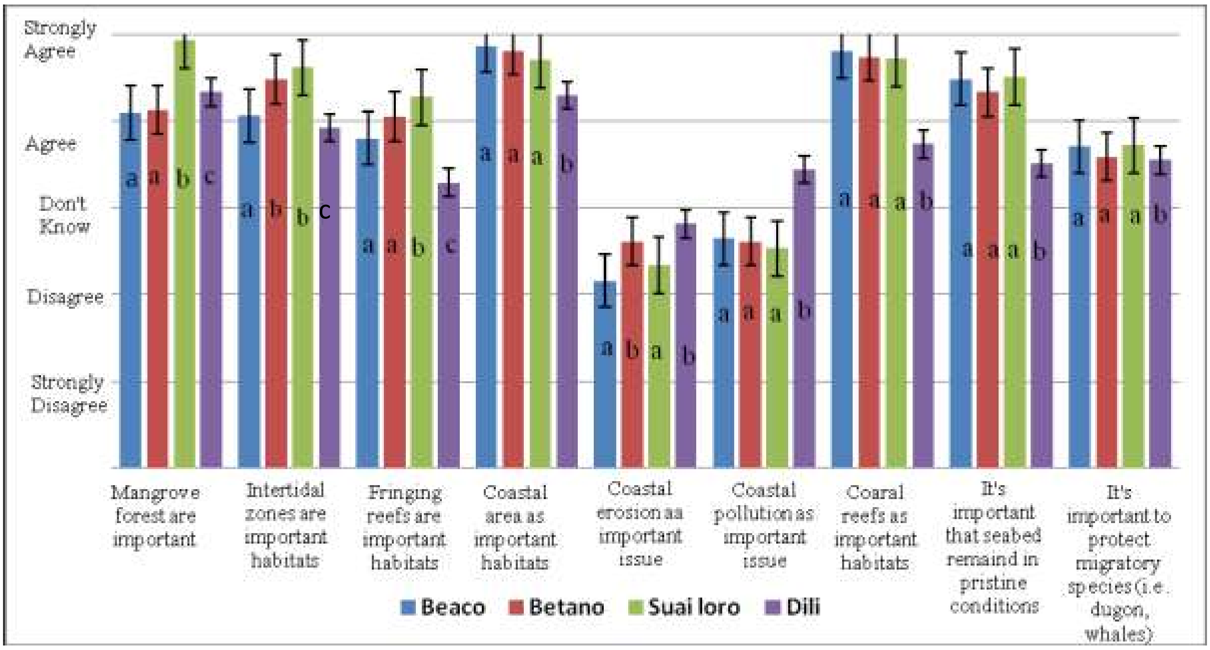


Figure 4.13 MW results on the importance of existing natural resources on the South Coast by location (Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Beaco, Suai Loro and Betano were broadly similar in terms of their responses on the importance of most natural resources (i.e. ‘agree’ or ‘strongly agree’). The exception was coastal erosion and coastal pollution where ‘disagree’ responses were given in all three locations that these issues were important. Respondents from Suai Loro tended to give ‘strongly agree’ responses to more of the questions than those in Beaco and Betano. Dili respondents provided a ‘don’t know’ response to more of the questions than was the case in Suai Loro and Beaco. They also tended to give fewer ‘agree’ or ‘strongly agree’ question responses than those in Suai Loro, Beaco and Betano.

Table 4.9.1 Mangrove forests are important habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	90	10
Suai Loro	0	0	0	6	94
Betano	0	0	2	83	15
Dili	0	0	0	67	33

Responses from Suai Loro differ due to a very high proportion of ‘strongly agree’responses compared to the other three categories Dili responses differ due to an intermediate proportion of ‘strongly agree’ responses whereas Betano and Beaco gave similar responses with a relatively low level of ‘strongly agree’ responses.

Table 4.9.2 Intertidal zones are important habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	6	81	13
Suai Loro	0	0	0	38	62
Betano	0	0	6	41	54
Dili	0	0	37	33	30

Responses from Suai Loro and Betano are similar and are characterised by a relatively high proportion of ‘strongly agree’ responses. Beaco differs because the majority of responses fall in the ‘agree’ category while Dili responses differ due to a relatively high proportion of ‘don’t know’ responses.

Table 4.9.3 Fringing reefs are important habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	19	71	6
Suai Loro	0	0	11	51	38
Betano	0	0	33	28	39
Dili	0	0	70	30	0

Responses from Suai Loro differ due to a relatively high proportion of ‘strongly agree’ responses and a relatively low proportion of ‘don’t know’ responses. Betano and Beaco responses are not significantly different despite the apparent difference in the response data. This is because, although there is a higher proportion of ‘strongly agree’ responses in Betano this is balanced by a high proportion of ‘don’t know’ responses. Dili responses differ from the other locations because the majority provided of responses fall into ‘don’t know’ responses.

Table 4.9.4 Coastal areas are important habitats for fish breeding and spawning

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	13	87
Suai Loro	0	0	11	9	81
Betano	0	0	6	7	87
Dili	0	0	15	41	44

There is no significant difference in responses from Suai Loro, Betano or Beacho with all three showing a very high proportion of responses in the ‘strongly agree’ category.

Responses from Dili differ in that they show a lower proportion of responses in the 'strongly agree' category.

Table 4.9.5 Coastal erosion is an important issue

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	87	10	3	0
Suai Loro	0	77	13	11	0
Betano	0	63	13	24	0
Dili	0	33	52	15	0

Responses from Beaco and Suai Loro are not significantly different from each other and are characterised by a high proportion of 'disagree' responses . Betano and Dili responses differ from the other regions, but are not significantly different from each other despite the apparent difference in the response data. This is because although there is a higher proportion of 'disagree' responses in Betano this is also balanced by a moderately high proportion of 'agree' responses. Dili responses are characterised by a high proportion of 'don't know' responses.

Table 4.9.6 Coastal pollution is important issue

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	55	26	19	0
Suai Loro	2	66	11	19	2
Betano	0	59	20	20	0
Dili	0	19	26	48	7

There is no significant difference in responses from Suai Loro, Betano or Beaco with all three showing a high proportion of responses in the 'disagree' category although this is counterbalanced by significant numbers of responses in the 'don't know' and 'agree' categories. Responses from Dili differ in that they show a higher proportion of responses in the 'agree' category.

Table 4.9.7 Coral reefs are an important issue

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	19	81
Suai Loro	0	0	6	15	79
Betano	0	4	0	15	81
Dili	0	22	0	59	19

There is no significant difference in responses from Suai Loro, Betano or Beaco, with all, three showing a very high proportion of responses in the ‘strongly agree’ category. Responses from Dili differ in that they show a lower proportion of responses in the ‘strongly agree’ category and a signify cant proportion of responses in the ‘disagree’ category .

Table 4.9.8 it is important that the seabed conditions remain in pristine condition.

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	0	42	55
Suai Loro	0	0	0	49	51
Betano	0	0	4	59	37
Dili	0	11	44	26	19

There is no significant difference in responses from Suai Loro, Betano or Beaco with all three showing responses falling in almost equal proportions in either the ‘agree’ or ‘strongly agree’ categories. Responses from Dili differ in that they show a lower proportion of ‘agree’ and a relatively high proportion of responses in the ‘don’t know’ categories.

Table 4.9.9 Protection of migratory species is important

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	6	19	71	3
Suai Loro	0	0	28	72	0
Betano	0	2	37	61	0
Dili	0	0	52	41	7

There is no significant difference in responses from Suai Loro, Betano or Beaco with all three showing a high proportion of responses in the ‘agree’ category although this is balanced by a significant proportion in the ‘don’t know’ category. Responses from Dili differ in that they show a higher proportion of responses in the ‘don’t know’ category.

b.Responses relating to the importance of natural resources by occupations.

The MDS and ANOSIM analysis demonstrated no evidence of differences in overall responses to this set of questions between categories of occupation. However, univariate tests indicated some differences between occupation categories in responses to individual questions.

Respondents in most occupations agreed or strongly agreed on the importance of the natural environment, although a relatively high proportion disagreed that attached coastal erosion and increased coastal pollution were important issues (as demonstrated in Figure 4.14).

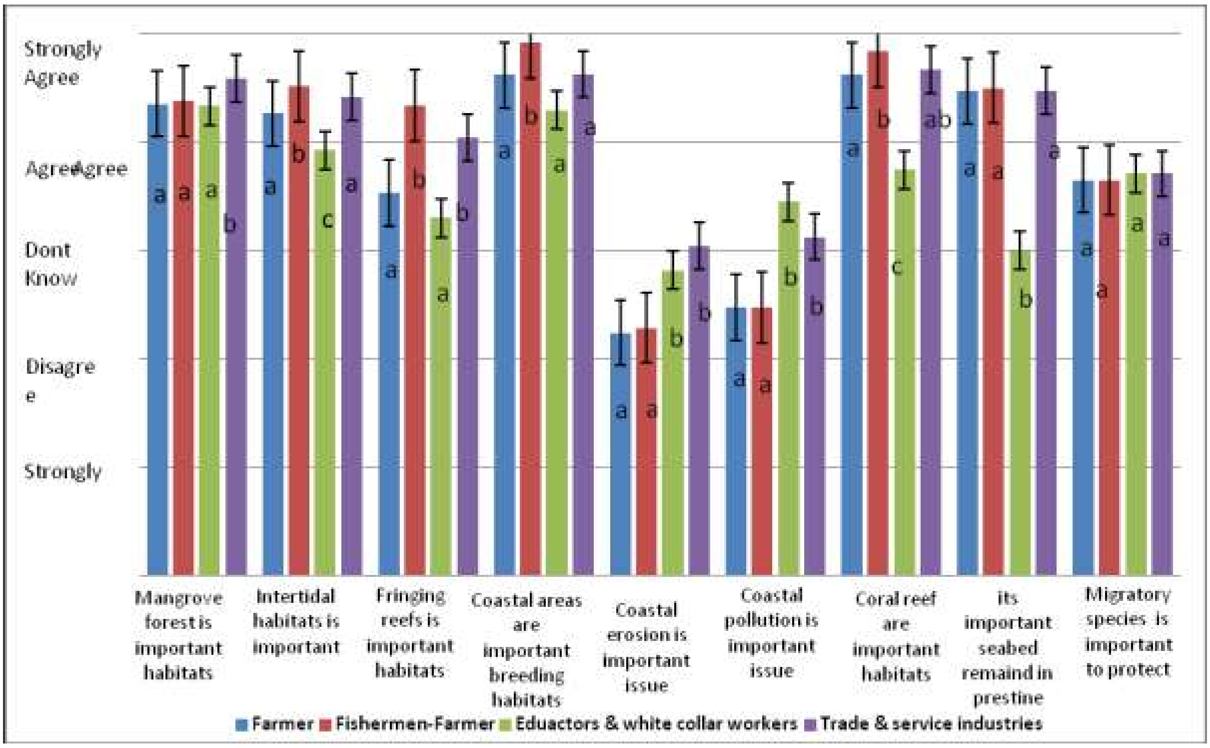


Figure 4.14 MW results on the importance of existing natural resources on the South Coast by occupation. (Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Farmers and fishermen-farmers were broadly similar in terms of their responses and tended to 'agree' or 'strongly agree' on the importance of most natural resources. The exceptions were coastal erosion and coastal pollution where both groups tended to 'disagree' that these were important. The fisherman-farmer group tended to give 'strongly agree' responses to more of the questions than those in the farmer group. The EWCW and TSI groups gave a 'don't know' response to more of the questions than was the case for the farmer and fishermen-farmer groups. They also tended to give fewer 'agree' or 'strongly agree' question responses than the farmer and fishermen-farmer groups; this is particularly the case for TSI.

Table 4.9.10 Mangrove forests are important habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	3	59	38
Fishermen -Farmer	0	0	0	62	38
EWCW	0	0	0	67	33
TSI	0	0	0	42	58

There is no significant difference in responses from farmers (F),fishermen-farmer (FF), educators and white collar workers (EWCW) and trade and service industries (TSI), with all four giving a moderate proportion of responses in the " strongly agree" category.

Table 4.9.11 Intertidal habitats are important

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	6	62	32
Fishermen - Farmers	0	0	4	41	55
EWCW	0	0	20	44	36
TSI	0	0	0	58	42

Responses from fisherman-farmers and EWCW are similar and are characterised by a relatively high proportion of responses in the 'strongly agree' category. Responses from farmers differ in that they show a higher proportion of 'agree' responses. TSI differ in that they show a relatively low proportion of responses in the 'don't know' category.

Table 4.9.12 Fringing reefs are important habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	3	47	44	6
Fishermen-Farmers	0	0	12	42	46
EWCW	0	0	70	30	0
TSI	0	0	17	63	21

Responses from fishermen-farmers differ from other categories due to a relatively high proportion of 'strongly agree' responses and a low proportion of 'don't know' responses (relative to EWCW and TSI). EWCW and farmer responses are not significantly different despite the apparent differences in the response data. This is because although farmers give a higher proportion of ‘agree’ and ‘strongly agree’ responses, this is balanced by a higher proportion of ‘don’t know’ responses among EWCW. TSI responses differ from EWCW and farmers due to a very high proportion of ‘don’t know’ responses.

Table 4.9.13 Coastal areas are important habitats for breeding and spawning habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	6	26	68
Fishermen – Farmers	0	0	3	3	95
EWCW	0	0	15	41	44
TSI	0	0	17	4	79

Responses from fishermen-farmers differ from the other categories due to a higher proportion of ‘strongly agree’ responses. Farmers, EWCW and TSI are not significantly different despite apparent differences in the response data, with farmers and TSI having the most responses in the ‘strongly agree’ category of the three groups whereas EWCW responses are equally split between ‘agree’ and ‘strongly agree’.

Table 4.9.14 Coastal erosions an important issue

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmer	0	76	24	0	0
Fishermen – Farmer	0	82	7	11	0
EWCW	0	33	52	15	0
TSI	0	42	13	46	0

Similar responses are seen in the fishermen-farmers and farmer categories which are distinct from those of the other groups in that they show a higher proportion of responses in the ‘disagree’ category. The responses from EWCW and TSI are not significantly different to each other despite some apparent differences in the response data. TSI give an almost equal number of responses in the ‘agree’ and ‘disagree’ categories whereas EWCW give the majority of responses in the ‘don’t know’ category.

Table 4.9.15 Coastal pollution is an important issue

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	68	21	9	3
Fishermen - Farmers	0	66	16	16	0
EWCW	0	19	26	48	7
TSI	0	33	21	46	0

There is no significant difference in the responses from farmers and fishermen-farmers which are distinct from those of the other groups in that they show a high proportion of responses in the 'disagree' category. The responses from EWCW and TSI are not significantly different to each other and in both cases most of the responses are in the 'agree' category although there are also a large number of 'disagree' and 'don't know' responses.

Table 4.9.16 Coral reefs are important habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmer	0	0	6	26	68
Fishermen - Farmer	0	3	0	8	89
EWCW	0	12	2	42	44
TSI	0	0	4	25	71

Responses from EWCW differ from the other groups due to a relatively low proportion of 'strongly agree' responses as well as a relatively high proportion of 'disagree' responses. Responses from farmers and fishermen-farmers are significantly different from each other due to a higher proportion of 'strongly agree' responses in the fishermen-farmer group. TSI is not significantly different from either of these groups and shows a very similar response pattern to the farmer group.

Table 4.9.17 Seabed should remains in pristine condition

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	3	47	50
Fishermen - Farmers	0	1	1	54	44
EWCW	0	14	44	26	19
TSI	0	0	0	54	46

There is no significant difference in responses from farmers, fishermen-farmers and TSI with all three that they gave a high proportion of responses in the 'strongly agree' and ‘agree’ categories. EWCW are distinct in having a high proportion of 'don’t know’ responses.

Table 4.9.18 it is important to protect migratory species

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	50	50	0
Fishermen – Farmers	0	3	22	74	1
EWCW	0	0	52	41	7
TSI	0	4	25	71	0

There is no significant difference in responses from any of the groups and the majority of responses fall in the ‘agree’ and ‘don’t know’ categories.

Responses relating to the importance of livelihood sectors by locations.

The MDS and ANOSIM analysis demonstrated no evidence of differences in overall responses to this set of questions between categories of location. However, univariate tests indicated some differences between location categories.

Respondent’s views on the importance of livelihood sectors to the local economy in the community are presented in the MDS plot in figure 4.15.

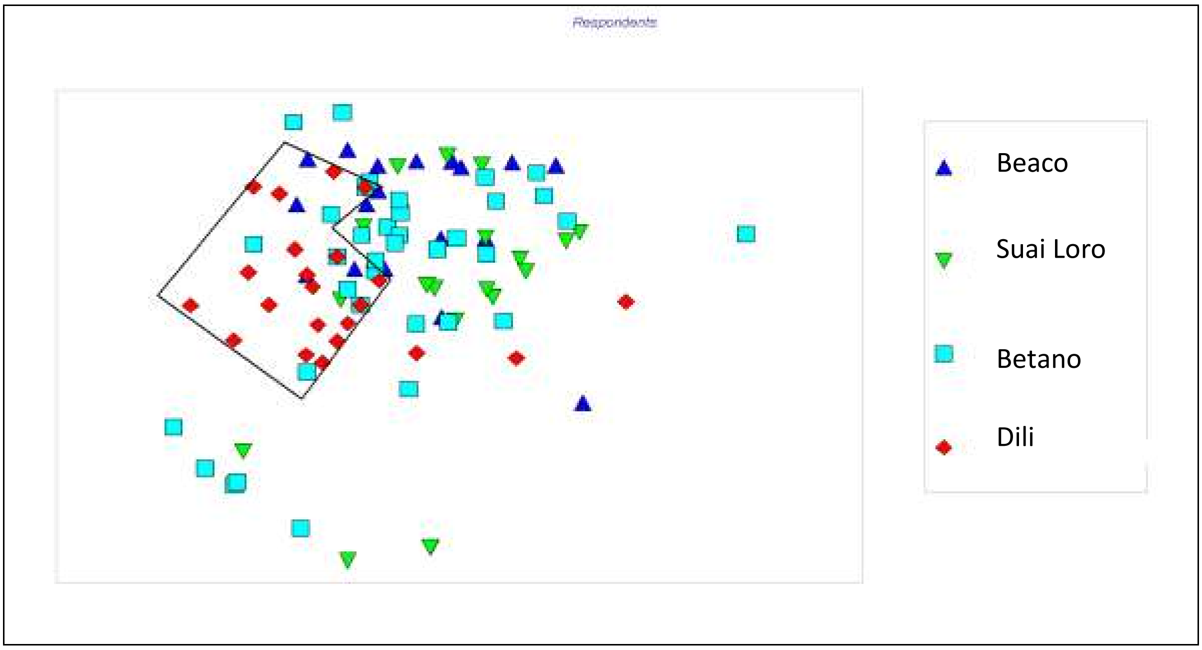


Figure 4.15 MDS results on the future importance of socio-economic sectors to the economy in the community based on location.

MDS ordination, shown in Figure 4.15, indicates some degree of grouping of responses from Dili residents. Respondent views from other areas are scattered and there appears to be no clear pattern.

ANOSIM TESTS *(Pairwise Tests)*

Table 4.10 ANOSIM Suai Loro test on locations

Groups Number Observed	R Statistics	Significance Level %
Beaco, Suai Loro	0.088	1.3
Beaco, Betano	-0.026	71.8
Beaco, Dili	0.458	0.1
Suai Loro, Betano	0.065	0.1
Suai Loro, Dili	0.308	0.1
Betano, Dili	0.218	0.1

While the pairwise test results shown in Table 4.10 indicate some differences between the responses of Dili residents and those of other areas, the R statistics values are low, so the differences are not pronounced.

At all locations the respondents tended to 'agree' or 'strongly agree' that the livelihood sectors were important although in Dili there is a lower proportion of 'strongly agree responses than in the other locations. The only exception to the general trend of agreement was at Suai Loro where a significant proportion of respondents 'disagree' that handicrafts are important.

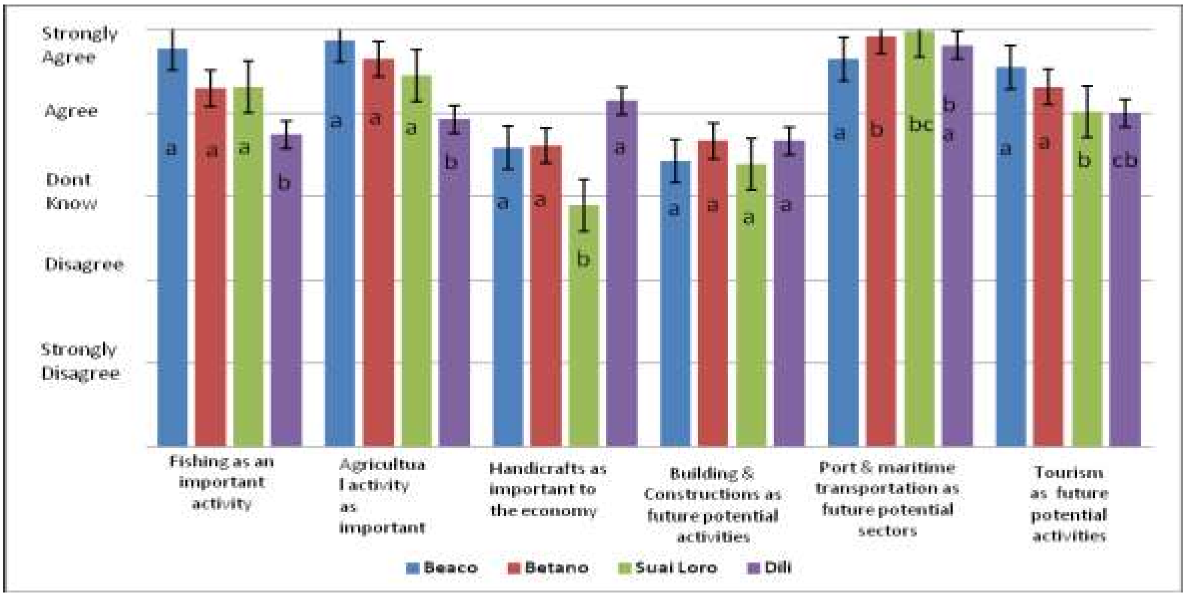


Figure 4.16 MW results on the livelihood sectors by locations. (Note: for each question, columns sharing a letter code are not significantly ($P<0.05$) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Suai Loro, Beaco and Betano were largely alike in terms of their responses and tended to 'agree' and 'strongly agree' on the importance of most of the livelihood sectors. For the handicrafts and building and construction where both groups 'don't know' and 'disagree' that these are important. Responses from the Suai Loro and Beaco tend to give 'strongly agree' responses to more of the questions than is the case for the Betano group. The Dili group tended to give 'strongly agree' and 'agree' responses to questions than Suai Loro and Beaco respectively.

Table 4.10.1 Fishing is as an important activity

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	0	13	84
Suai Loro	0	15	0	23	62
Betano	0	15	0	26	59
Dili	0	11	15	63	11

There is no significant difference in responses from Suai Loro, Betano or Beaco with all three providing a high proportion of responses in the 'strongly agree' category. Responses from Dili differ in that they show a lower level of agreement and a relatively high proportion of responses in the 'don't know' category.

Table 4.10.2 Agricultural activity is important

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	13	87
Suai Loro	0	15	0	11	74
Betano	0	9	0	7	83
Dili	0	0	22	63	15

There is no significant difference in responses from Suai Loro, Betano or Beaco with all three showing a very high proportion of responses in the 'strongly agree' category. Responses from Dili differ in that they show a lower level of agreement and a relatively high level of responses in the 'don't know' category.

Table 4.10.3 Handicrafts are important to the economy

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	19	16	52	13
Suai Loro	0	47	19	32	2
Betano	0	20	13	52	15
Dili	0	7	7	48	37

There is no significant difference in responses from Beaco, Betano or Dili. Opinions are split at all three locations with responses ranging from 'disagree' to 'strongly agree'. On balance, the majority 'agree' and Dili residents give a relatively high proportion of 'strongly agree' responses. Responses from Suai Loro differ in that there was a lower level of 'strongly agree' responses and a relatively high proportion of responses in the 'disagree' category.

Table 4.10.4 Building and constructions are important sectors

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	52	45	0
Suai Loro	0	23	19	53	4
Betano	0	9	31	43	17
Dili	0	4	37	48	11

There is no significant difference in responses from Beaco, Betano, Suai Loro and Dili. Opinions are split at all four locations with responses mainly falling in the 'don't know' or 'agree' categories. Suai Loro has a relatively high proportion of 'disagree' responses.

Table 4.10.5 Port and maritime transportation are potential future potential activities

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	35	65
Suai Loro	0	0	0	2	98
Betano	0	0	2	4	94
Dili	0	0	0	19	81

The majority of responses from all locations fall in the ‘strongly agree’ category. However Beaco differs from Suai Loro and Betano due to a slightly lower proportion of ‘strongly agree’ responses.

Table 4.10.6 Tourism is potential future potential activity

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	10	26	65
Suai Loro	0	0	15	68	17
Betano	0	2	9	44	44
Dili	0	0	11	78	11

Responses from Beaco and Betano are similar and are characterised by a relatively high proportion of ‘strongly agree’ responses which distinguishes these locations from other three areas where the majority of responses fall in the ‘agree’ category.

Responses relating to the livelihood sectors by occupation

The MDS and ANOSIM analysis demonstrated no evidence of differences in overall responses to this set of questions between categories of occupation. However, univariate tests indicated some differences between occupation categories in the responses to individual questions.

Although respondents in most occupations agreed or strongly agreed on the importance of the livelihood sectors there were differences in the relative importance attached to those in each occupation (see Figure 4.17).

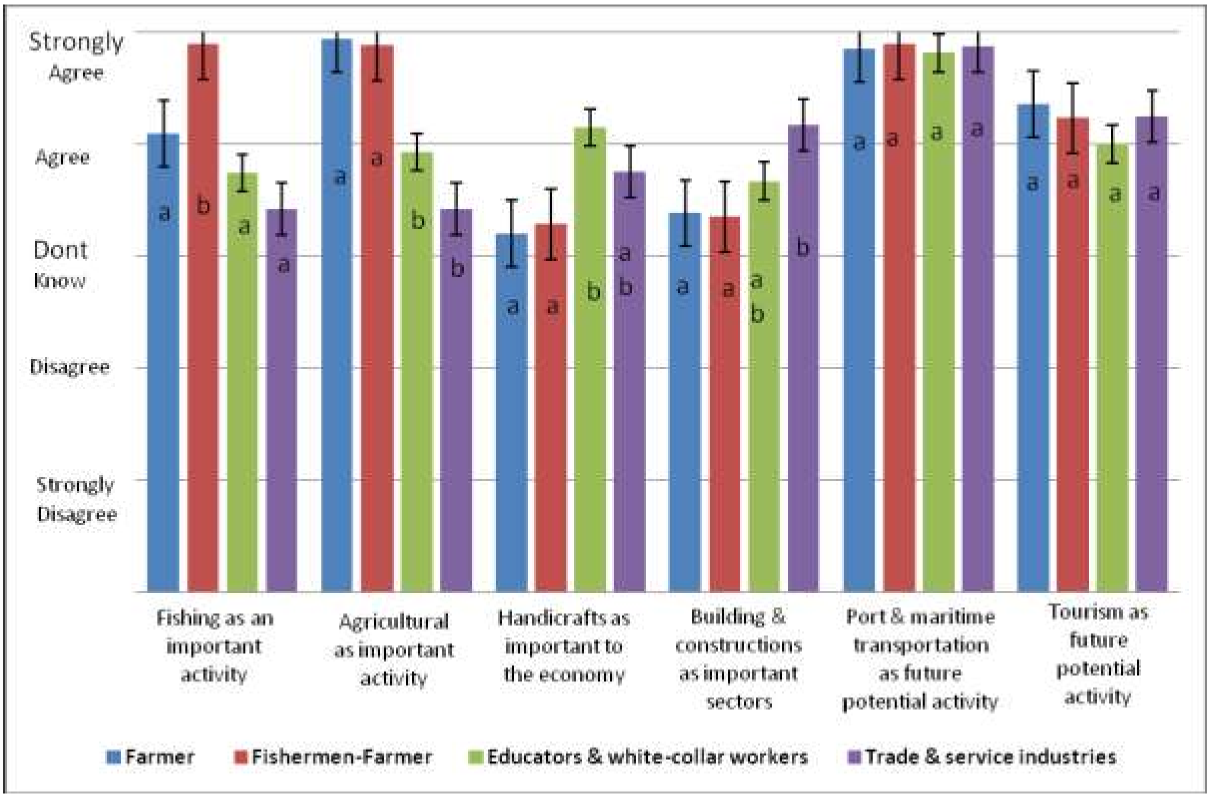


Figure 4.17 Livelihood sectors by occupations. Note: for each question, columns sharing a letter code are not significantly ($P<0.05$) different. If the columns do not share one letter in common, they are significantly different). Error bars denote standard error of the mean.

Farmers and fishermen-farmers groups provided similar response and tended to 'agree' or 'strongly agree' on the importance of most of the livelihood sectors. The exceptions were handicrafts and building and construction for which both groups split their responses between the two 'disagree' and don't know' categories. The fishermen-farmers group tended to give 'strongly agree' responses to more of the questions than those in the case for the farmer group. The EWCW and TSI groups gave 'disagree' responses to more of the questions than was the case for farmers and fishermen-farmers.

Table 4.10. 7 Fishing is an important activity

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	12	0	56	32
Fishermen - Farmers	0	0	0	11	89
EWCW	0	11	15	63	11
TSI	0	50	0	8	42

Responses from fishermen-farmers differ from other groups due to a relatively high proportion of 'strongly agree' responses. The other groups are not significantly different from each other despite the apparent differences in the response data. In the case of farmers and EWCW, the majority of responses are in the ‘agree’ category whereas most of the TSI responses are split between ‘disagree’ and ‘strongly agree’ categories.

Table 4.10.8 Agricultural activity is important

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	0	6	94
Fishermen – Farmers	0	0	0	11	89
EWCW	0	11	15	63	11
TSI	0	50	0	8	42

There is no significant difference in the responses from the fishermen-farmers and farmergroups with both showing a high proportion of responses in the ‘strongly agree’ category. Responses from EWCW and TSI are distinct from the other two groups, but not from each other despite apparent differences in the response data. EWCW has a high proportion of responses in the ’agree’ category, whereas most of the TSI responses are split between the ‘disagree’ and ‘strongly agree’ categories.

Table 4.10.9 Handicrafts are important to the economy

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	38	12	41	9
Fishermen - Farmers	0	31	19	41	9
EWCW	0	7	7	48	37
TSI	0	13	13	63	13

EWCW differ from the fishermen-farmers and farmers groups, with the majority of responses falling in the ‘agree’ or ‘strongly agree’ categories. The remaining groups are not significantly different from each other and none show a clear consensus of views on this question. In all cases, the majority of responses are in the ‘agree’ category but there are also a significant proportion of responses in the ‘disagree’ category.

Table 4.10.10 Building and construction are important sectors

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	21	29	41	9
Fishermen – farmers	0	14	39	46	1
EWCW	0	4	37	48	11
TSI	0	0	13	58	29

TSI differ from the fishermen-farmer and farmer groups due to a higher proportion of 'strongly agree' responses and a lower proportion of responses in the 'disagree' and 'don't know' categories. The remaining groups are not significantly different from each other and show a general trend of agreement on this question. However fishermen-farmer and farmer groups have a higher proportion of responses in the 'disagree' category.

Table 4.10.11 Port and Maritime transportation is a potential future activity

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	0	15	85
Fishermen – farmers	0	0	1	8	91
EWCW	0	0	0	19	81
TSI	0	0	0	13	88

There is no significant difference in the response between any of the occupation groups, with the majority of responses from all locations falling in the 'strongly agree' category.

Table 4.10.12 Tourisms as potential future activity

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	9	47	44
Fishermen – farmers	0	1	14	46	39
EWCW	0	0	11	78	11
TSI	0	0	8	58	33

There is no significant difference in the responses between any of the occupation groups, with the majority of responses from all locations falling in the 'agree' or 'strongly agree' categories.

Responses on the degree of satisfaction with the provision of infrastructure services.

The analysis with MDS and ANOSIM showed no evidence of differences in overall views between categories of area, occupation, education, gender and age. However, the Mann-Whitney (MW) test indicated differences in responses to individual sub-questions.

Respondents in most locations indicated that the provision of infrastructure services were totally inadequate or poor although there were differences in the relative importance attached to them in each location (Figure 4.18).

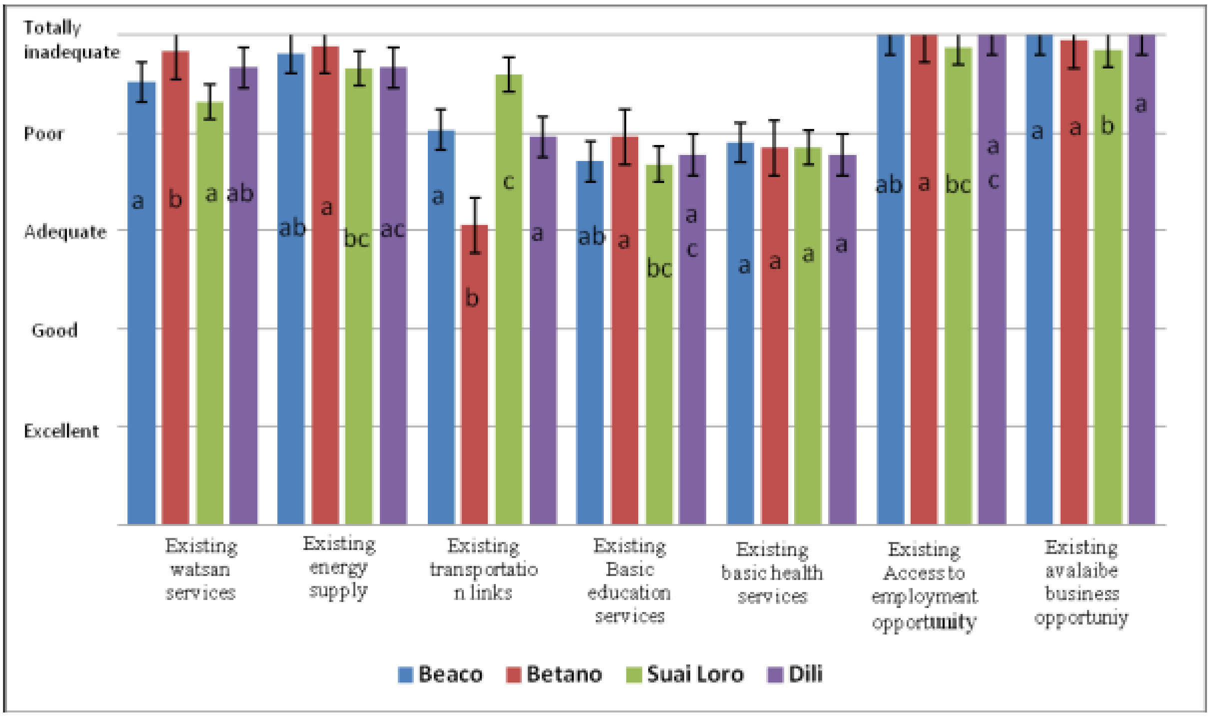


Figure 4.18. MW results on degree of satisfactions on the provision of infrastructure services by locations. Note: for each question, columns sharing a letter code are not significantly ($P<0.05$) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Betano seemed to have greater levels of dissatisfaction with many services with exception of transportation links than was the case in Suai Loro, the exception being transportation links.

Table 4.10.13 Existing water sanitation

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	0	48	52
Suai Loro	0	0	4	60	36
Betano	0	0	0	17	83
Dili	0	0	0	33	67

Responses from Betano differ from those from Beaco and Suai Loro due to a higher proportion of ‘totally inadequate’ responses. There are no other significant differences between the responses of the groups and the vast majority give responses of ‘poor’ or ‘totally inadequate’ regardless of location.

Table 4.10.14 Energy supply (e.g. Electricity)

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	3	13	84
Suai Loro	0	0	0	34	66
Betano	0	0	0	11	89
Dili	0	0	0	33	67

Responses from Betano differ from those from Suai Loro due to a higher proportion of ‘totally inadequate’ responses. There are no other significant differences between the responses of the groups and the vast majority give responses of ‘poor’ or ‘totally inadequate’ regardless of location.

Table 4.10.15 Transportation links

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	16	65	19
Suai Loro	0	0	2	36	62
Betano	0	4	87	9	0
Dili	0	0	30	44	26

Responses from Betano are distinct from those of the other areas due to a higher proportion of ‘adequate’ responses. Responses from Suai Loro are distinct from those of the other areas due to a higher proportion of ‘totally inadequate’ responses. There are no significant differences between Beaco and Dili, with each showing a range of responses from ‘adequate’ to ‘totally inadequate’. In both cases the majority of respondents also regard transportation links as ‘poor’.

Table 4.10.16. Basic education services

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	35	58	6
Suai Loro	0	0	32	68	0
Betano	0	0	9	85	6
Dili	0	0	22	78	0

Responses from Betano differ from those from Suai Loro due to a lower proportion of ‘adequate’ responses and a higher proportion of ‘poor’ responses at Betano. There are no other significant differences between the responses of the groups and the majority respondents give responses of ‘poor’ regardless of location.

4.10.17. Basic health services

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	35	39	26
Suai Loro	0	2	43	23	32
Betano	0	2	11	87	0
Dili	0	0	26	70	4

There is no significant difference in responses between any of the areas despite apparent differences in the response data. In Betano and Dili the majority of respondents regard health services as ‘poor’ whereas in Beaco and Suai Loro opinion is split more evenly between ‘adequate’, ‘poor’ and ‘totally inadequate’.

4.10.18 Access to employment opportunities

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	0	0	100
Suai Loro	0	0	0	13	87
Betano	0	0	0	0	100
Dili	0	0	0	0	100

Responses from Betano differ from those from Suai Loro due to a higher proportion of ‘totally inadequate’ responses and a lower proportion of ‘poor’ responses. There are no other significant differences between the responses of the groups and the vast majority of respondents give responses of ‘totally inadequate’ regardless of location.

4.10.19 Available business opportunities

	Excellent	Good	Adequate	Poor	Totally inadequate
Beaco	0	0	0	0	100
Suai Loro	0	0	2	11	87
Betano	0	2	0	0	98
Dili	0	0	0	0	100

Responses from Suai Loro differ from those of the other three locations in that there is a higher proportion of 'poor' responses. However, in all cases the vast majority of responses are in the 'totally inadequate' category.

4.2.3.3 Responses regarding possible outcomes of oil industry development

The MDS and ANOSIM analysis, based on the categories of area, location, education, gender and age, provided no evidence of differences. However, MW analysis of locations indicated evidence of different views.

a. Views on the expectation of positive consequences arising from oil development by location

The majority of respondents in most locations strongly agreed or agreed on the likelihood of positive effects and believed that development of an expect the oil refinery in the region would bring desirable benefits (Figure 4.19).

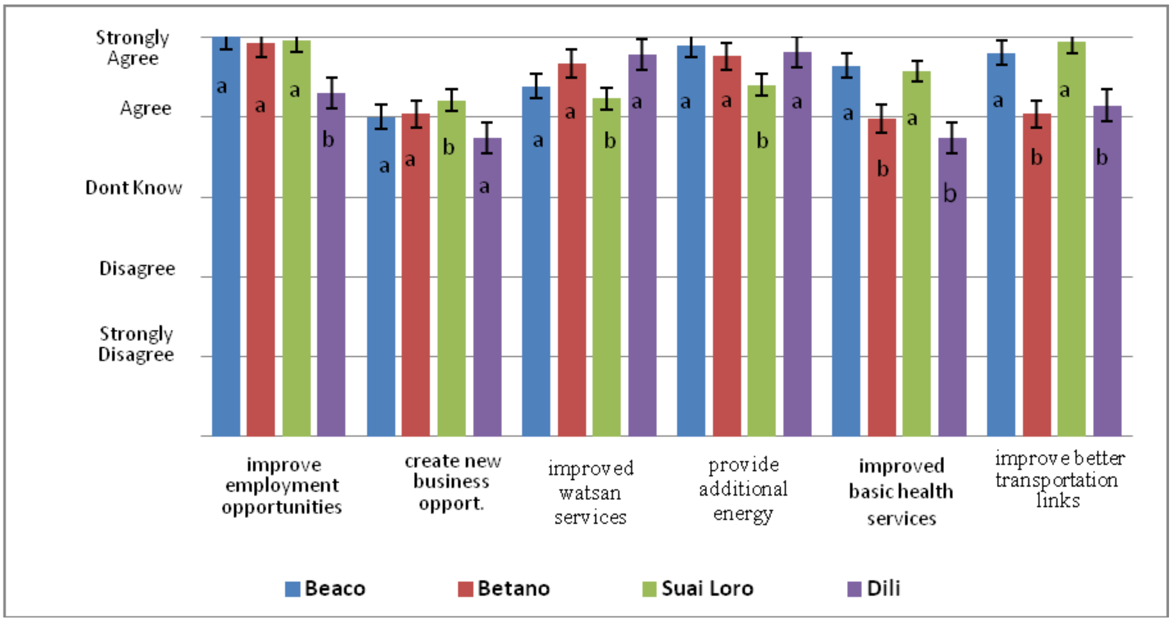


Figure 4.19. MW results on the desirable benefits expected from the oil refinery by location. Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Betano, Beaco and Suai Loro all gave similar responses to the desirable benefits expected from the oil refinery development, with most falling in the 'agree' or strongly agree' categories. In regards to basic education services, groups split their responses between the 'agree' and 'don't know' categories. Respondents in Suai Loro gave 'strongly agree' responses to more of the questions than those in Betano and Beaco, while Dili respondents gave a 'don't know' response to more of the questions compared to the other three locations.

Table 4.10.20 Improve employment opportunities

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	0	100
Suai Loro	0	0	0	4	96
Betano	0	2	0	2	96
Dili	0	0	0	70	30

There is no significant difference in responses from Suai Loro, Betano or Beaco, with all three showing a very high proportion of responses in the 'strongly agree' category. Responses from Dili differ in that there is a lower proportion of responses in the 'strongly agree' category, with the majority falling in the 'agree' category instead.

Table 4.10.21 Create new business opportunities

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	6	87	6
Suai Loro	0	0	9	62	30
Betano	0	0	24	48	28
Dili	0	0	33	59	7

Responses from Suai Loro and Dili differ from from each other due to a relatively high proportion of ‘strongly agree’ responses and a low proportion of ‘don’t know’ responses from Suai Loro. Despite some apparent differences in response patterns there are no significant differences between the other locations with the highest number of responses in the ‘agree’ category in each location. Suai Loro and Betano both have a moderately high proportion of ‘strongly agree’ responses, while Betano and Dili have a moderately high proportion of ‘don’t know’ responses.

4.10.22 Improve water sanitation

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	6	39	52
Suai Loro	0	0	9	60	32
Betano	0	0	9	15	76
Dili	0	0	0	22	78

Responses from Suai Loro differ from the other three locations due to a lower proportion of ‘strongly agree’ responses. There are no significant differences between the other locations with the majority of responses in the ‘agree’ or ‘strongly agree’ categories at every location.

Table 4.10.23 Provide additional energy

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	10	90
Suai Loro	0	0	2	55	43
Betano	0	2	0	19	80
Dili	0	0	0	19	81

There is no significant difference in responses from Beaco, Betano or Dili with all three showing a very high proportion of responses in the ‘strongly agree’ category. Responses from Suai Loro differ in that there is a lower proportion of responses in the 'strongly agree' category.

Table 4.10.24 Improve basic health services

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	35	65
Suai Loro	0	0	9	26	66
Betano	0	0	6	91	4
Dili	0	0	30	67	4

Responses from Beaco and Suai Loro are similar to each other and distinct from the other groups due to a relatively high proportion of 'strongly agree' responses. Responses from Dili and Betano are not significantly different from each other, with the majority of responses in the 'agree' category, although there are also a large number of 'don't know' responses from Dili.

Table 4.10.25 Improve basic education services

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	52	39	6
Suai Loro	0	2	49	40	9
Betano	0	2	26	72	0
Dili	0	4	33	63	0

Responses from Beaco and Sual Loro are similar to each other and distinct from the other groups due to a relatively high proportion of 'strongly agree' responses. Responses from Dili and Betano are not significantly different from each other with the majority of responses in the 'agree' category although there are also a large number of 'don't know' responses from Dili.

Table 4.10.26 Improve transportation links

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	19	81
Suai Loro	0	0	0	6	94
Betano	0	0	4	89	7
Dili	0	0	22	41	37

Responses from Beaco and Sual Loro are similar to each other and distinct from the other groups due to a relatively high proportion of 'strongly agree' responses.

Responses from Dili and Betano are not significantly different from each other, with the majority of responses in the ‘agree’ category, although there are also a large number of ‘don’t know’ and ‘strongly agree’ responses from Dili.

Table 4.10.27 Have a positive economic impact

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	3	97
Suai Loro	0	0	0	0	100
Betano	0	2	0	7	91
Dili	0	0	0	7	93

There is no significant difference in responses from Beaco, Betano, Suai Loro or Dili with all four showing very high proportion of responses in the 'strongly agree' category.

b. Responses on the expectation of negative consequences by location

The MDS and ANOSIM analysis demonstrated no evidence of differences in overall responses to this set of questions between categories of location. However, univariate tests indicated some differences between location categories in responses to individual questions.

The views on the likelihood of undesirable environmental consequences of the oil refinery development on the South Coast by area are presented in the MDS plot below.

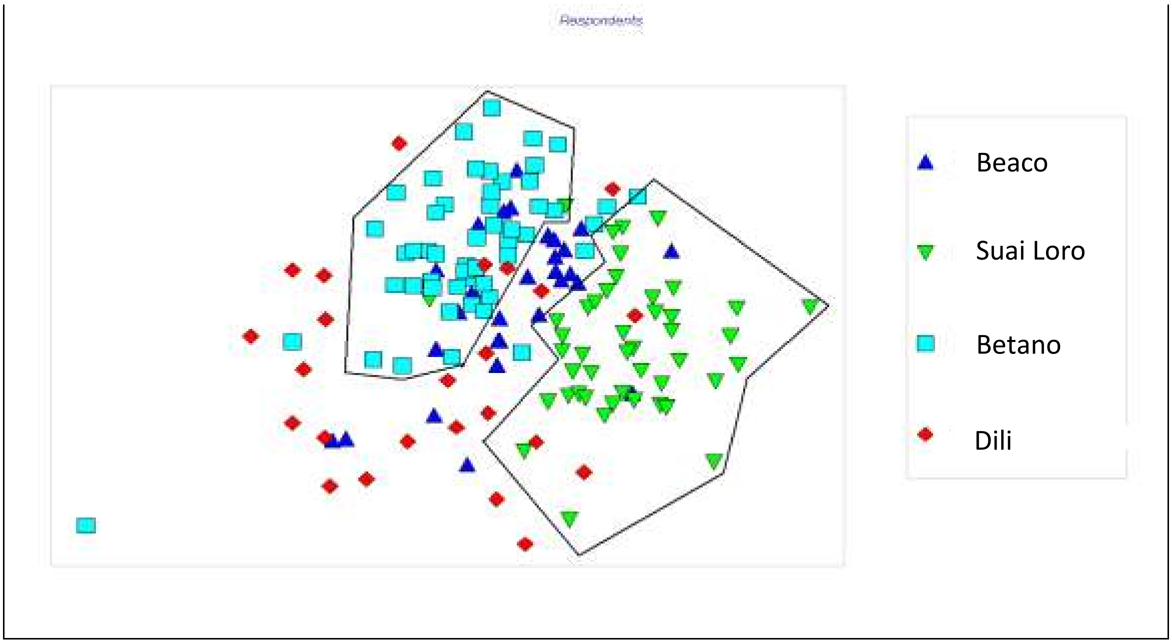


Figure 4.20. MDS results on the undesirable impacts based on location

MDS ordination indicates that the respondents views in Suai Loro are a distinct group. The views of respondents in Betano appear to be moderately grouped. For Beaco and Dili, views seem to be scattered and show no clear pattern.

Table 4.11 ANOSIM test on the undesirable impacts based on location.

Groups Number Observed	R Statistics	Significance Level %
Beaco, Suai Loro	0.411	0.1
Beaco, Betano	0.269	0.1
Beaco, Dili	0.381	0.1
Suai Loro, Betano	0.519	0.1
Suai Loro, Dili area	0.574	0.1
Betano, Dili	0.493	0.1

The ANOSIM results, presented in Table 4.10, demonstrate significant differences between Suai Loro, compared to Dili, as well as between Suai Loro compared to Betano. Comparison between Betano and Dili indicates that there tends to be significant differences. Comparisons between other groups appear to show no clear pattern.

MW analysis by location indicates differences in responses to individual questions on possible negative consequences, represented in MDS plot in Figure 4.21 and 4.22. Athough respondents in most locations 'agree' or 'strongly agree' on the likelihood of the undesirable consequences on the environment and other social sectors as a result of the oil refinery development there were differences in the relative likelihood attached to them in each region (Figure 4.21 and 4.22).

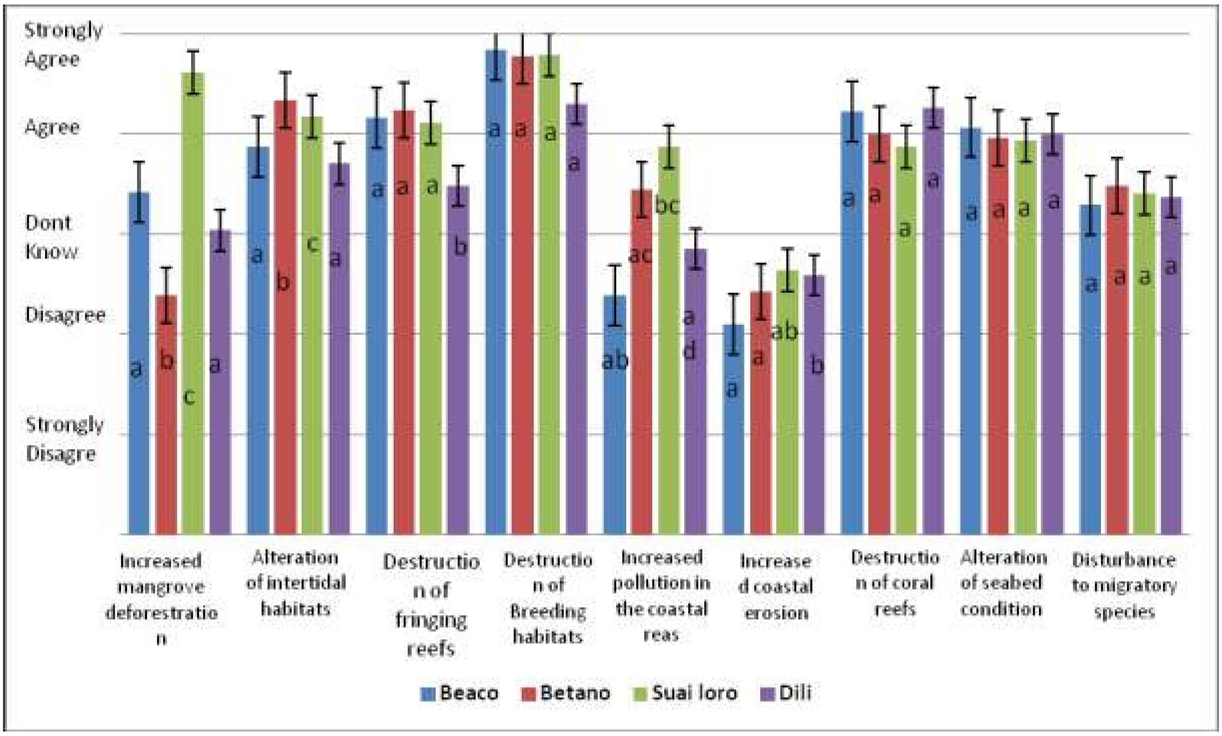


Figure 4.21 Expectation of un-desirable consequences of the oil refinery to the environment, based on location. Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Suai Loro and Betano were broadly similar, giving 'strongly agree' responses to more of the questions than was the case in Beaco and Dili. Dili and Suai Loro gave 'don't know' responses to more of the questions than was the case in Beaco and Betano. The exceptions were increased coastal pollution, coastal erosion, disturbances to migratory species, reduction of agriculture production and damage to land for future generations to use where all groups indicated they were unsure whether this might occur.

Table 4.11.1 Increased mangrove deforestation

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	16	26	58	0
Betano	0	72	17	11	0
Suai Loro	0	0	2	34	64
Dili	0	30	41	26	4

Responses from Suai Loro differ from other locations due to a high proportion of responses in the 'strongly agree' category and a low proportion in the 'disagree' and 'don't know' categories. Betano also differs from other locations and this is due to a high proportion of responses in the 'disagree' category. Responses from Beaco and

Dili are not significantly different from each other and are spread over the categories of 'disagree', 'don't know' and 'agree'.

Table 4.11.2 Alteration of intertidal habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	6	10	74	10
Betano	0	2	0	61	37
Suai Loro	0	0	0	83	17
Dili	0	0	41	48	11

Suai Loro and Betano were broadly similar, giving 'strongly agree' responses to more of the questions than was the case in Beaco and Dili. Dili and Suai Loro gave 'don't know' responses to more of the questions than was the case in Beaco and Betano. The exceptions were increased coastal pollution, coastal erosion, disturbances to migratory species, reduction of agriculture production and damage to land for future generations to use where all groups indicated they were unsure whether this might occur.

Table 4.11.3 Destruction of fringing reefs

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	13	58	29
Betano	0	2	4	63	31
Suai Loro	0	0	9	72	19
Dili	0	7	37	56	0

There is no significant difference in responses from Suai Loro, Betano or Beaco, with all three showing a high proportion of responses in the 'agree' and 'strongly agree' categories. Responses from Dili is differ due to a relatively high proportion of responses in the 'don't know' category and no responses in the 'strongly agree' category.

Table 4.11.4 Destruction of breeding & spawning habitats of fish

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	16	84
Betano	0	2	4	9	85
Suai Loro	0	0	2	17	81
Dili	0	0	33	4	63

There is no significant difference in responses from Suai Loro, Betano or Beaco, with all three showing a high proportion of responses in the 'strongly agree' categories.

Responses from Dili also have a high proportion of responses in the ‘strongly agree’ category as well as a relatively high proportion of 'don't know' responses.

Table 4.11.5 Increased pollution in the coastal areas

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	71	19	10	0
Suai Loro	0	17	24	57	2
Betano	0	11	21	38	30
Dili	0	30	59	7	4

There is a significant difference in the responses from Suai Loro and Dili but not between any other pair of locations. The majority of Suai Loro responses fall in the ‘agree’ and ‘strongly agree’ categories, whereas the majority of the Dili responses fall in the ‘disagree’ and ‘don’t know’ categories. Although other differences are not significant, there are a high proportion of ‘disagree’ responses from Beaco and a high proportion of ‘agree’ responses from Betano.

Table 4.11.6 Increased coastal erosion

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	90	10	0	0
Betano	0	63	31	6	0
Suai Loro	0	40	55	4	0
Dili	0	59	30	4	7

Responses from both Beaco and Betano are significantly different from those of Dili. This appears to be due to a slightly higher number of ‘agree’ and ‘strongly agree’ responses from Dili. However, the vast majority of responses from every location fall in the ‘disagree’ and ‘don’t know’ categories with a particularly high proportion of ‘disagree’ responses from Beaco.

Table 4.11.7 Increased destruction of coral reefs

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	10	58	32
Betano	0	24	2	24	50
Suai Loro	0	6	17	60	17
Dili	0	7	7	37	48

There is no significant difference in responses from Beaco, Betano, Suai Loro or Dili. In all cases the majority of responses fall in the ‘agree’ and ‘strongly agree’ categories.

Table 4.11.8 Alteration of seabed conditions

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	94	6
Betano	0	0	9	85	6
Suai Loro	0	4	13	68	15
Dili	0	0	0	100	0

There is no significant difference in responses from Beaco, Betano, Suai Loro or Dili. In all cases the majority of responses fall in the ‘agree’ category.

Table 4.11.9 Disturbance to migratory species

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	6	58	35	0
Betano	0	11	30	59	0
Suai Loro	0	6	47	47	0
Dili	0	0	63	37	0

There is no significant difference in responses from Beaco, Betano, Suai Loro or Dili. In all cases the majority of responses fall in the ‘don’t know’ and ‘agree’ categories.

Table 4.11.10 Reduction in fish stocks

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	0	87	10
Betano	0	4	0	89	7
Suai Loro	0	2	4	77	17
Dili	0	48	0	52	0

There is no significant difference in responses from Suai Loro, Betano or Beaco, with all three showing a high proportion of responses in the ‘agree’ categories. Responses from Dili differ in that there are a significant proportion of responses in the ‘disagree’ and ‘agree’ categories.

Table 4.11.11 Reduction in productivity of agricultural land due to pollution

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	13	65	23	0
Betano	0	78	22	0	0
Suai Loro	0	32	15	53	0
Dili	0	78	15	7	0

Responses from Beaco and Suai Loro are similar and are spread across the ‘disagree’, ‘don’t know’ and ‘agree’ categories with no clear consensus. Responses from Betano and Dili differ from this pattern in that they show a high proportion of responses in the ‘disagree' category.

Table 4.11.12 Loss of potential for tourist industry development

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	19	32	48	0
Betano	0	17	37	46	0
Suai Loro	0	9	53	38	0
Dili	0	48	26	26	0

There is no significant difference in responses from Suai Loro, Betano or Beaco with responses of all three concentrated in the ‘agree’ and ‘don’t know’ categories. Responses from Dili differ due to a high proportion of responses in the ‘disagree' category.

Table 4.11.13 Increased health risks due to pollution

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	45	6	48	0
Betano	0	17	17	63	4
Suai Loro	0	4	2	79	15
Dili	0	26	19	56	0

Suai Loro differs from other locations due to a relatively higher proportion of ‘agree’ and ‘strongly agree’ responses. At the other locations the majority of responses fall in the ‘agree’ category although this is counterbalanced by an appreciable number of ‘disagree’ or ‘don’t know’ responses.

Table 4.11.14 Damage to cultural sites

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	97	3	0	0
Betano	0	98	0	2	0
Suai Loro	0	30	2	26	43
Dili	0	41	33	26	0

Beaco and Betano are similar and are characterised by a high proportion of ‘disagree’ responses. Responses from Suai Loro differ from all other locations as the majority of responses fall in the ‘agree’ and ‘strongly agree' categories. Dili differs from all other locations due to a high proportion of ‘don’t know’ responses.

Table 4.11.15 Damage to land for future generations to use

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	6	87	6	0
Betano	0	17	72	11	0
Suai Loro	0	13	64	21	2
Dili	0	7	70	22	0

There is no significant difference in responses from Beaco, Betano, Suai Loro or Dili. In all cases the majority of responses fall in the ‘don't know’ category.

Table 4.11.16 Increased population of foreign migrant workers.

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	19	3	74	3
Betano	0	19	2	76	4
Suai Loro	2	6	30	57	4
Dili	0	59	11	30	0

There is no significant difference in responses from Suai Loro, Betano or Beaco with all three showing a high proportion of responses in the ‘agree’ category. Responses from Dili differ due to a relatively high proportion of responses in the ‘disagree' category.

Table 4.11.17 Increased jobs loss

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	48	0	52	0
Betano	4	44	7	43	2
Suai Loro	0	43	19	36	2
Dili	0	63	19	19	0

There is no significant difference in responses from Beaco, Betano, Suai Loro or Dili. In all cases the opinions of the respondents are split between the ‘disagree’ and ‘agree’ categories.

c. Responses on the expectation of negative consequences by occupation

Respondents in most occupations expected undesirable and wide-reaching environmental consequences. However, one exception was that overall they tended to be uncertain about increased coastal erosion (Figure 4.24).

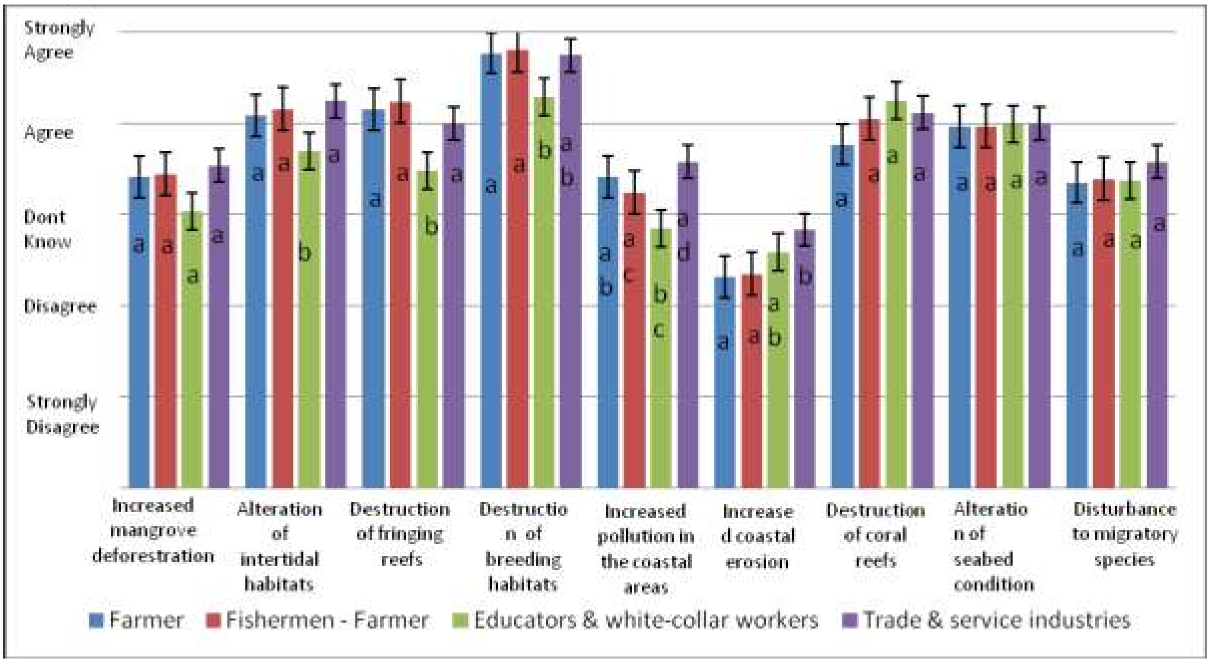


Figure 4.23 Expectations of un-desirable environmental consequences based on occupation. Note: for each question sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Fishermen-farmers and TSI were broadly similar in terms of their responses and tended to ‘agree’ or ‘strongly agree’ on the potential undesirable consequences of the oil refinery to the environment. The exceptions were increased coastal pollution and coastal erosion where both groups indicated that they didn’t know or disagreed that these might occur. Farmer and EWCW tended to give fewer ‘agree’ and ‘strongly agree’ responses to questions than TSI and fishermen-farmers.

Table 4.11.18 Increased mangrove deforestation

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	38	15	26	21
Fishermen-farmers	0	33	14	30	23
EWCW	0	25	23	23	28
TSI	0	29	13	33	25

There is no significant difference in responses from farmers, fishermen-farmers, EWCW or TSI. There is no obvious consensus of opinion on this question and for each employment category responses are spread over the ‘disagree’, ‘don’t know’, ‘agree’ and ‘strongly agree’ categories.

Table 4.11. 19 Alteration of intertidal habitats

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	3	3	74	21
Fishermen-farmers	0	1	1	79	18
EWCW	0	2	24	50	24
TSI	0	4	4	54	38

There is no significant difference in responses from farmers, farmers -fishermen or TSI, with all three showing a high proportion of responses in the 'agree' category. Responses from EWCW are significantly different because of a higher proportion of responses in the 'don't know' category.

Table 4.11.20 Destruction of fringing reefs

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	6	74	21
Fishermen-farmers	0	0	8	59	33
EWCW	0	7	37	56	0
TSI	0	4	8	71	17

There is no significant difference in responses from farmers, farmers -fishermen or TSI, with all three showing a high proportion of responses in the 'agree' category. Responses from EWCW are significantly different due to a higher proportion of responses in the 'don't know' category.

Table 4.11.21 Destruction of breeding and spawning habitats of fish

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	0	3	15	82
Fishermen - Farmers	0	0	3	14	84
EWCW	0	0	33	4	63
TSI	0	4	0	14	83

There is no significant difference in responses from the farmers, fishermen-farmers or TSI groups, with all three showing a high proportion of responses in the 'strongly agree' category. Responses from EWCW are significantly different from farmers and fishermen-farmers due to a higher proportion of EWCW responses in the ‘don’t know' category.

Table 4.11.22 Increased pollution in coastal areas

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	26	18	44	12
Fishermen - Farmers	0	32	22	35	11
EWCW	0	30	59	7	4
TSI	0	13	29	46	13

There is no obvious consensus of opinion on this question and for each employment category responses are spread over the ‘disagree’, ‘don’t know’, ‘agree’ and ‘strongly agree’ categories. There is no significant difference in responses from farmers, farmers & fishermen or TSI. Responses from EWCW are significantly different from those of TSI due to a higher proportion of EWCW responses in the ‘don’t know' category.

Table 4.11.23 Increased coastal erosion

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	71	29	0	0
Fishermen - Farmers	0	51	46	3	0
EWCW	0	56	38	2	4
TSI	0	38	42	21	0

In all cases the majority of responses fall in the ‘disagree’ or ‘don’t know’ categories. Responses from farmers, fishermen - farmers or EWCW are not significantly different and are characterised by a relatively a high proportion of ‘disagree’ responses. Responses from TSI are significantly different from those of farmers and fishermen-farmers due to a higher proportion of TSI responses in the ‘agree’ category.

Table 4.11.24 Destruction of coral reefs

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	18	12	41	29
Fishermen - Farmers	0	9	8	50	32
EWCW	0	7	7	37	48
TSI	0	13	8	33	46

There is no significant difference in responses between any of the employment categories. In all cases the majority of responses fall in the ‘agree’ or ‘strongly agree’ categories.

Table 4.11.25 Alteration to seabed conditions

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	3	6	82	9
Fishermen - Farmers	0	1	7	85	7
EWCW	0	0	0	100	0
TSI	0	0	17	67	17

There is no significant difference in responses between any of the employment categories. In all cases the majority of responses fall in the ‘agree’ category.

Table 4.11.26 Disturbance to migratory species

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	6	56	38	0
Fishermen - Farmers	0	8	45	47	0
EWCW	0	0	63	37	0
TSI	0	13	17	71	0

There is no significant difference in responses between any of the employment categories. In all cases the majority of responses fall in the ‘agree’ or ‘don’t know’ categories.

d. Responses on the expectation of negative socio-economic consequences by Occupation.

Respondents in most occupations believed there would be undesirable social and economic consequences although overall they tended to be uncertain about the likelihood of reduction in agricultural productivity and damage to cultural sites (Figure 4.24).

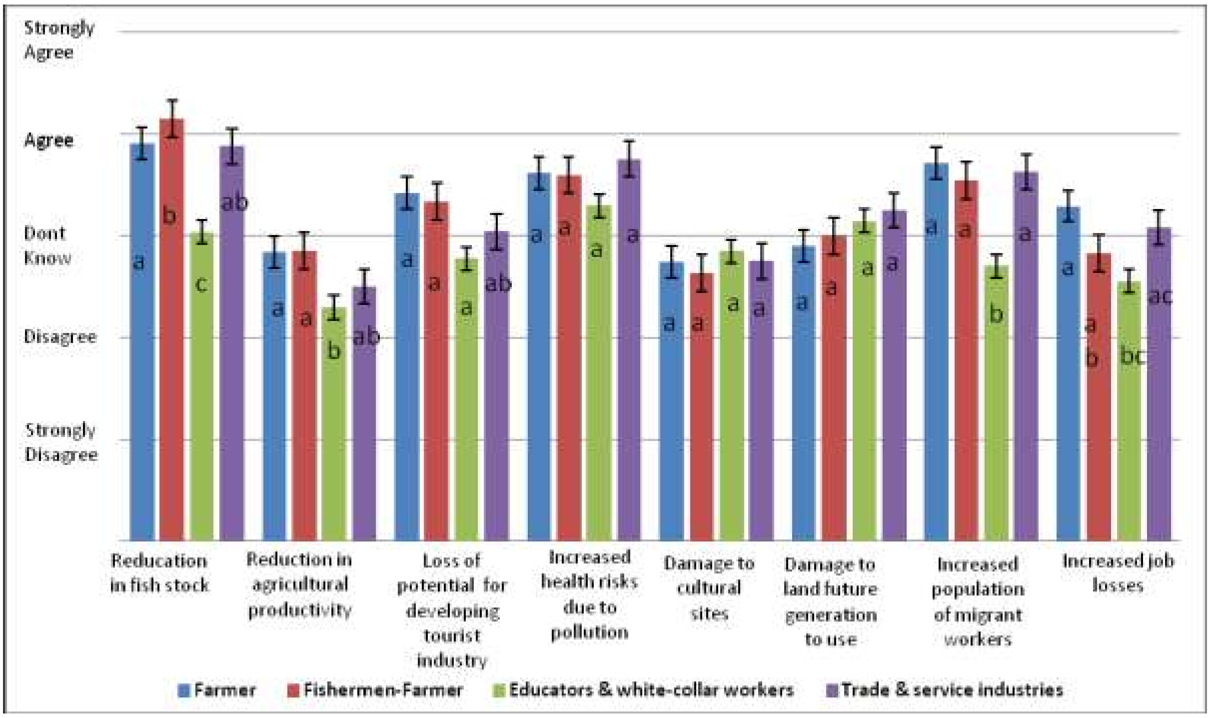


Figure 4.24 Expectation of undesirable socio-economic consequences, based on occupations. Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

The fishermen-farmers and TSI groups were broadly similar in terms of their responses and tended to give more 'strongly agree' responses to perceived undesirable socio-economic consequences than EWCW and farmers. The latter also tended to give more 'don't know' responses than EWCW and fishermen-farmers. EWCW appeared to give more 'disagree' responses than other groups.

Table 4.11.27 Reduction in fish stocks

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmer	0	3	3	94	0
Fishermen - Farmer	0	0	1	82	16
EWCW	0	48	0	52	0
TSI	0	13	0	75	13

Responses from TSI are not significantly different from those of farmers and fishermen-farmers with all three occupations giving a high proportion of responses in the 'agree' category. However, the responses of farmers is significantly different from those of fishermen-farmers, although this appears to be due only to a slightly higher proportion of ‘strongly agree’ responses from the latter. Responses of EWCW are significantly different from all other occupations and are almost equally distributed between ‘agree’ and ‘disagree’.

Table 4.11.28 Reduction in productivity of agricultural land due to pollution

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	41	35	24	0
Fishermen - Farmers	0	41	34	26	0
EWCW	0	78	15	7	0
TSI	0	71	8	21	0

Overall the majority of respondents disagree that agricultural land will be damaged by pollution. There is no significant difference in responses from farmers, fishermen-farmers or TSI. In all three cases the responses are spread over ‘disagree’, ‘don’t know’ and ‘agree’ with a higher proportion of responses of ‘disagree’ responses particularly in the case of TSI. Responses from EWCW are significantly different from farmers and fishermen-farmers due to a higher proportion of ‘disagree’ and lower proportion of ‘agree’ responses.

Table 4.11.29 Loss of potential for tourist industry development

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	6	50	44	0
Fishermen & Farmers	0	12	42	39	0
EWCW	0	48	26	26	0
TSI	0	33	29	38	0

There is no significant difference in responses between any of the employment categories. Responses are variously spread over ‘disagree’, ‘don’t know’ or ‘agree’. Farmers and fishermen-farmers give a lower proportion of ‘disagree’ responses than EWCW and TSI.

Table 4.11.30 Increased health risks due to pollution

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	24	9	62	6
Fishermen-Farmers	0	21	8	63	8
EWCW	0	26	19	70	0
TSI	0	8	13	75	4

There is no significant difference in responses between any of the employment categories. In all cases the majority of responses fall in the ‘agree’ category. However, there are also a significant number of ‘disagree’ responses from farmers, fishermen-farmers and EWCW.

Table 4.11.31 Damage to cultural sites

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	71	3	15	12
Fishermen-Farmers	0	76	1	7	16
EWCW	0	41	33	26	0
TSI	0	71	0	13	17

There is no significant difference in responses between any of the employment categories. In all cases the majority of responses fall in the ‘disagree’ category. However, EWCW show a lower proportion of ‘disagree’ responses and higher proportion of ‘don’t know’ and ‘agree’ responses than seen for the other occupations.

Table 4.11.32 Damage to land for future generations to use

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	9	91	0	0
Fishermen-Farmers	0	15	72	12	1
EWCW	0	7	70	22	0
TSI	0	13	50	38	0

There is no significant difference in responses between any of the employment categories. In all cases the majority of responses fall in the ‘don’t know’ category. However EWCW and TSI do show a higher proportion of ‘agree’ responses than seen for the other occupations.

Table 4.11.33 Increased population of foreign migrant workers

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	12	9	74	6
Fishermen-Farmers	1	16	14	65	4
EWCW	0	34	13	53	0
TSI	0	15	13	75	0

There is no significant difference in responses from farmers, fishermen-farmers or TSI groups, with all three, showing high proportion of responses in the 'agree' category. Responses from EWCW are significantly different due to a higher proportion of 'disagree' and lower proportion of 'agree' responses.

Table 4.11.34 Increased jobs losses

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Farmers	0	32	12	56	0
Fishermen - Farmers	3	50	9	38	0
EWCW	0	63	19	19	0
TSI	0	46	8	38	8

There is no obvious consensus of opinion on this question and for each employment category responses are variously spread over the 'disagree', 'don't know' and 'agree' categories. A significant difference occurs between the responses of farmers and EWCW, with the latter showing a higher proportion of 'disagree' and lower proportion of 'agree' responses.

4.2.3.4 Responses regarding the relative importance of potential oil development outcomes *(positive & negative).*

a. Views regarding relative importance of employment opportunities and environmental consequences.

Respondents' views on whether the increased employment opportunities were more important than specified possible environmental consequences are presented in the MDS plot, in (Figure 4.25), which shows that the views in Suai Loro slightly differed from the other locations. The views of respondents from other locations appear to be scattered and overlapping.

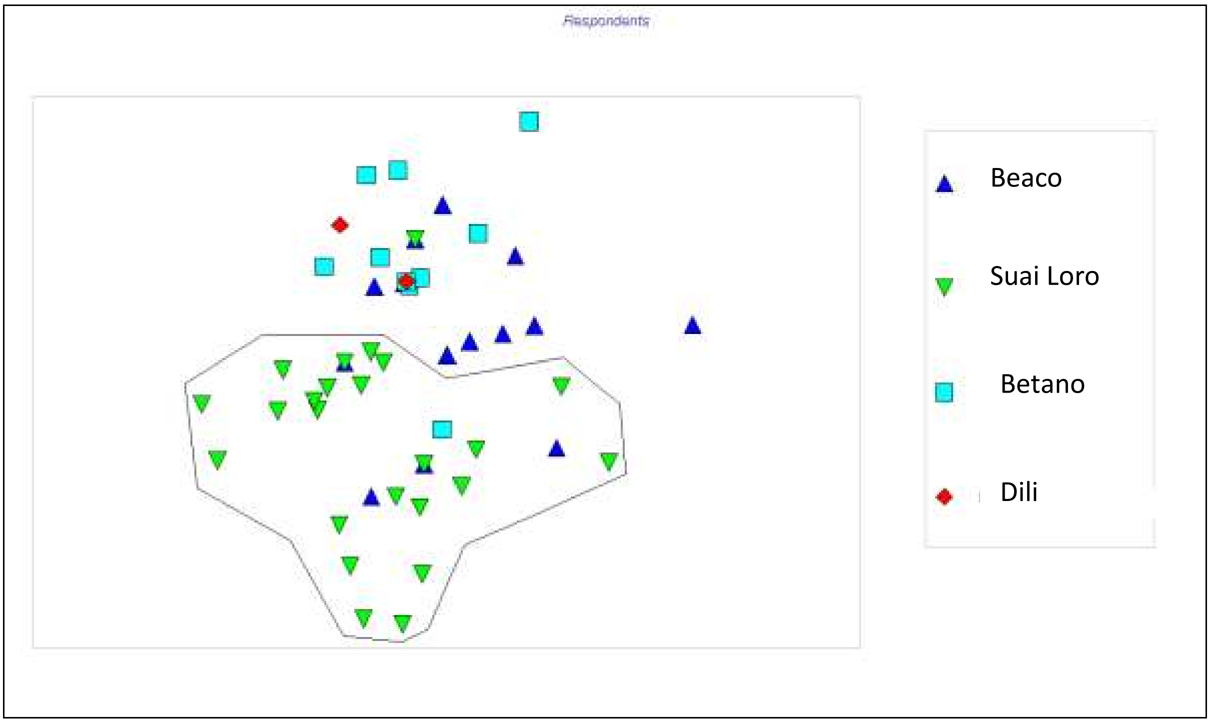


Figure 4.25 MDS results on whether the relative impacts of increased employment opportunities are more important than environmental consequences.

Table 4.12 ANOSIM on relative importance of the increased employment and environmental issues.

Groups Number Observed	R Statistics	Significance Level %
Beaco, Suai Loro	0.331	0.1
Beaco, Betano	0.225	0.1
Beaco, Dili	0.046	4.1
Suai Loro, Betano	0.566	0.1
Suai Loro, Dili	0.347	0.1
Betano, Dili	-0.073	94.9

According to the ANOSIM results shown in Table 4.13, the responses from Beaco, Betano and Dili tended to be similar (R value <0.25), whereas there is some evidence of slight differences between Suai Loro and the other locations (R value >0.25).

Respondents in most locations attached more importance to increased employment opportunities than to the listed environmental consequences, apart from increased pollution and associated health risks (Figures 4.26 and 4.27). Responses from Betano and Dili seemed highest in the ‘strongly agree’ and ‘agree’ categories. Betano tended to give more ‘strongly agree’ responses than Dili. Beaco provide more ‘don’t know’ than other locations, while Suai Loro appeared to give more ‘disagree’ responses than the other three locations.

For a number of the questions posed there were no significant differences in responses between the locations. Respondents from all locations were virtually unanimous in agreeing that increased employment opportunities were of greater importance than any possible damage to the seabed, intertidal zone and coral reefs or reduction in fishing productivity.

Conversely, respondents from all locations were virtually unanimous in disagreeing that increased employment opportunities were of greater importance than increased pollution or increased health risks due to pollution.

Questions where responses differed between locations are discussed below.

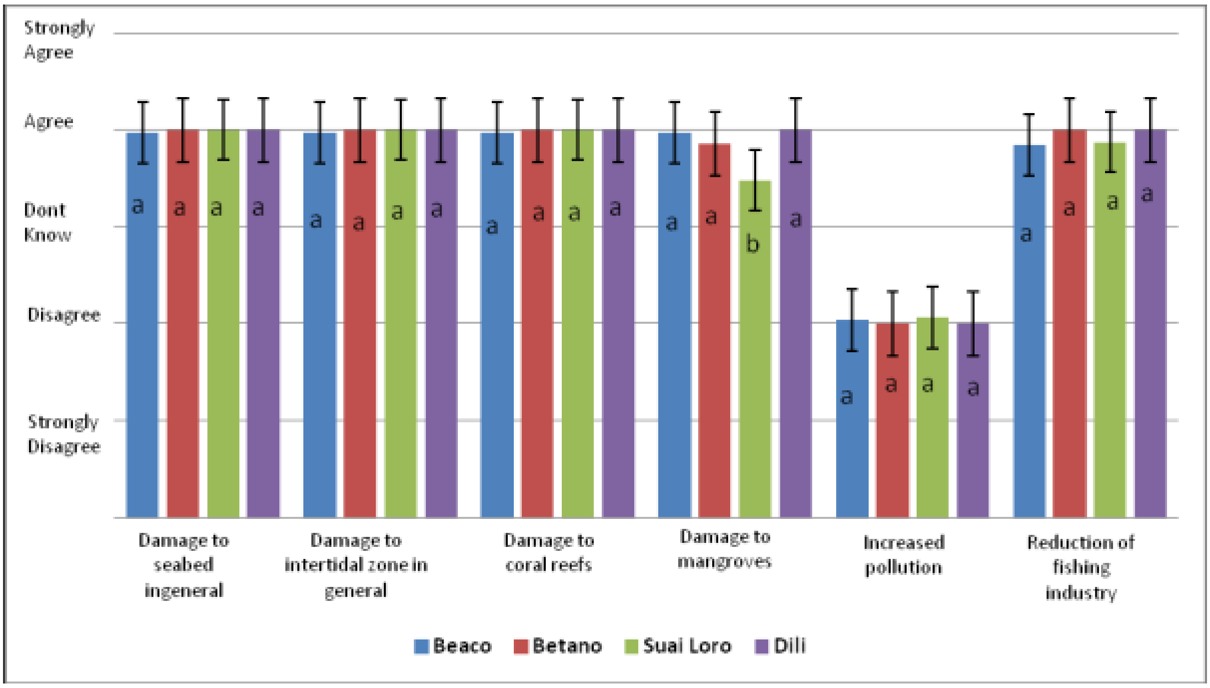


Figure 4.26 MW results on the relative importance of increased employment opportunities and environmental consequences by locations. Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

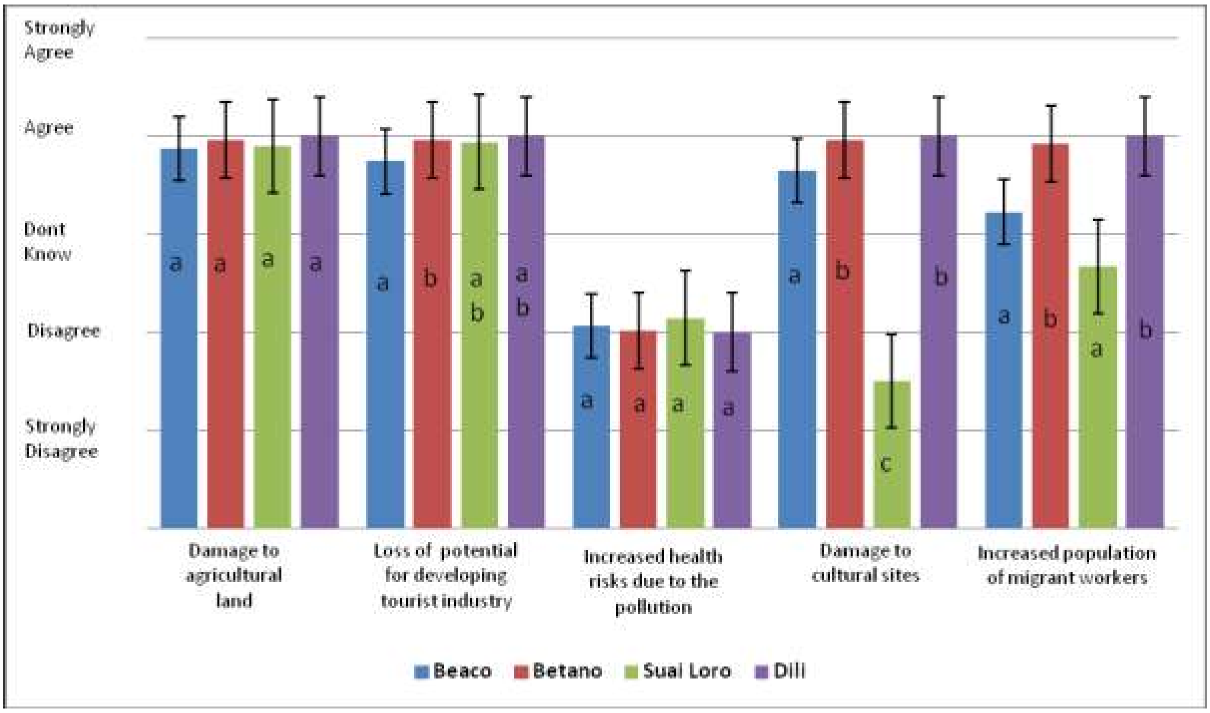


Figure 4.27 MW result on the relative importance of increased employment opportunity and environmental consequences, by location. Note: for each question, columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Suai Loro response were distinct from the other locations in that they appearend to attach greater importance to mangroves, cultural sites and possible problems related to an increased population of migrant workers (i.e. more people tend to ‘disagree’ that the advantages of increased employment outweigh these possible negative consequences). Responses from Beaco showed a similar but less pronounced trend in regard to cultural sites and possible problems related to an increased population of migrant workers. Responses from Dili show some marginal differences from the other locations in that they showed greater unanimity in regards to agriculture and tourism which were considered as of less importance than increased employment.

Table 4.12.1 Damage to mangroves

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	3	97	0
Suai Loro	2	13	0	85	0
Betano	0	0	0	100	0
Dili	0	0	0	100	0

Responses from Beaco, Betano and Dili are not significantly different and are characterised by a very high proportion of ‘agree’ responses. Responses from Suai Loro are significantly different due to a number of ‘disagree’ and ‘strongly disagree’ responses.

Table 4.12.2 Damage to agricultural land

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	3	19	77	0
Suai Loro	0	4	13	83	0
Betano	0	4	4	93	0
Dili	0	0	0	100	0

There is no significant difference in responses from Betano, Beacho or Suai loro. In all three cases the majority of responses are in the ‘agree’ category with a smaller number of responses in the ‘don’t know’ and ‘disagree’ categories. Responses from Dili are significantly different, with all respondents falling into the ‘agree’ category.

Table 4.12.3 Loss of potential for tourist industry development

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	10	23	68	0
Suai Loro	0	0	13	87	0
Betano	0	2	9	89	0
Dili	0	0	0	100	0

There is no significant difference in responses from Betano, Beacho or Suai Loro. In all three cases the majority of responses are in the ‘agree’ category, with a smaller number of responses in the ‘don’t know’ and ‘disagree’ categories. Responses from Dili are significantly different, with all respondents falling into the ‘agree’ category.

Table 4.12.4 Damage to cultural sites

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	10	10	81	0
Suai Loro	47	53	0	0	0
Betano	0	2	0	96	2
Dili	0	0	0	100	0

There is no significant difference in responses from Betano and Dili, with both showing a very high proportion of responses in the 'agree' category. Responses from Beaco also fall mainly in the 'agree' category, but are significantly different due to a number of 'don't know' and 'disagree' responses. Suai Loro is significantly different from other locations as the majority are in the'disagree' and 'strongly disagree' categories.

Table 4.12.5 Increased population of migrant workers

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	23	10	68	0
Suai Loro	4	49	2	45	0
Betano	0	2	0	96	2
Dili	0	0	0	100	0

Responses from Beaco and Suai Loro are significantly different from those of Betano and Dili. Almost all Betano and Dili residents agree, whereas responses from Beaco and Suai Loro are split between the 'disagree' and 'agree' categories.

b. Views regarding the relative importance of improved healthcare services and environmental consequences.

Respondents views on whether they regarded improved healthcare as more important than negative environmental consequences are present in the MDS plot in figure 4.28.

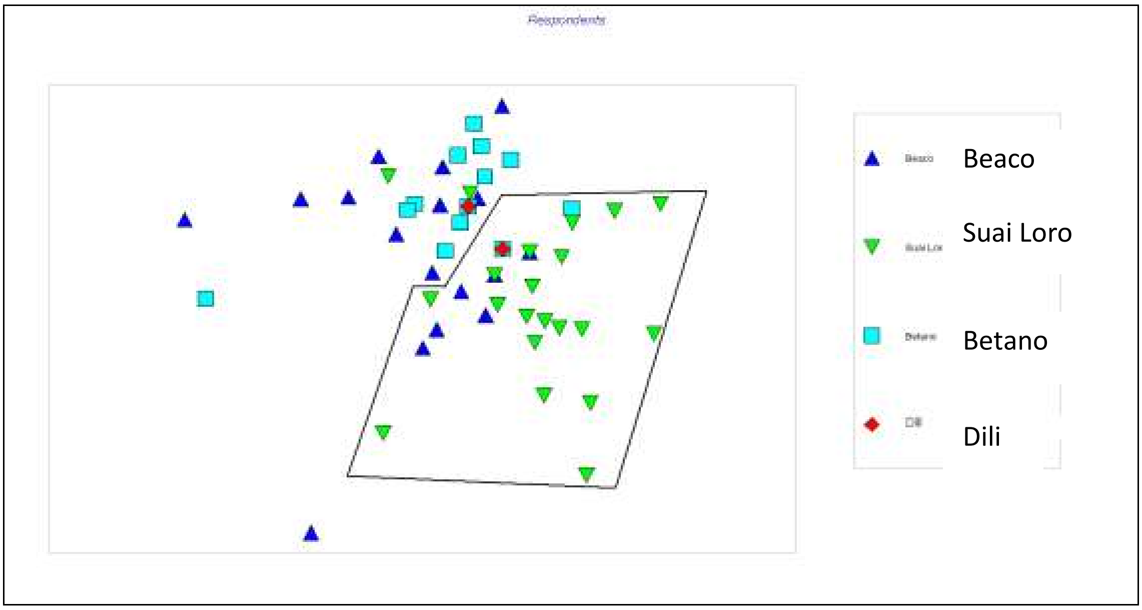


Figure 4.28 MDS results on the relative importance of improved healthcare in relation to the environmental consequences.

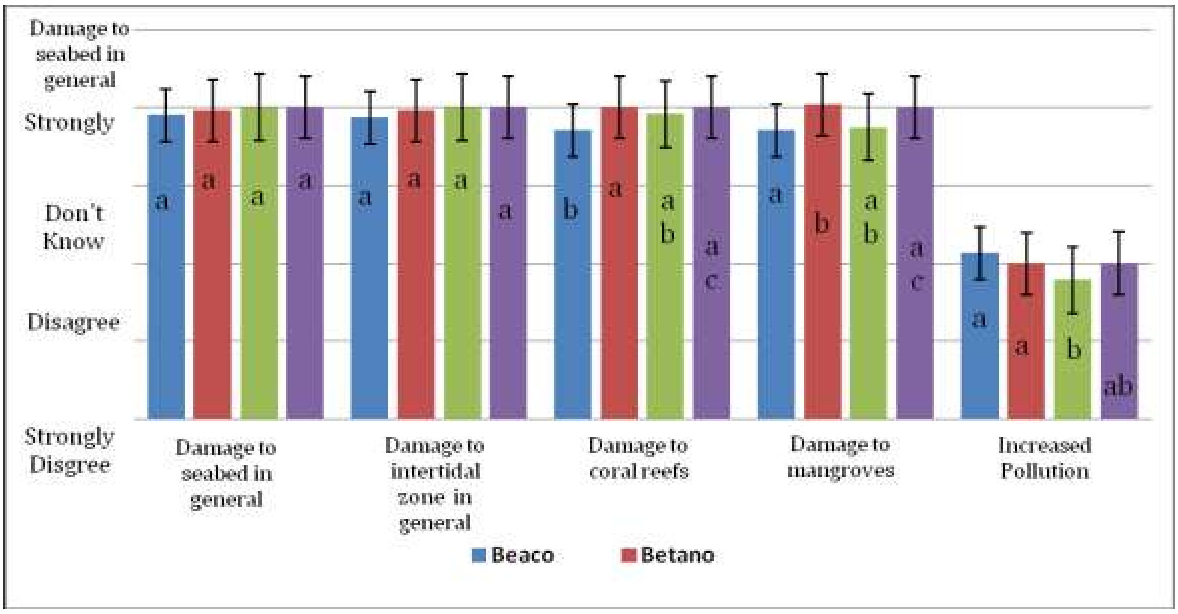
The MDS ordination in Figure 4.28 showed that the views of respondents from Suai Loro appeared to differ slightly from the other locations. The views of respondents from other locations appeared to be scattered and overlapping.

Table 4.13 ANOSIM Results of the improved health more than health care.

Groups Number Observed	R Statistics	Significance Level %
Beaco, Suai Loro	0.201	0.1
Beaco, Betano	0.376	0.1
Beaco,Dili	0.132	0.2
Suai Loro, Betano	0.459	0.1
Suai Loro,Dili	0.185	0.1
Betano, Dili	-0.082	95.7

ANOSIM results in Table 4.13 show evidence of slight differences between Betano and both Suai Loro and Beaco (R value >0.25). However, evidence of any differences between the other locations is limited (R value <0.25).

Respondents in most locations attached more importance to improved health care than the listed environmental consequences, apart from increased pollution and increased job losses (Figures 4.29 and 4.30).



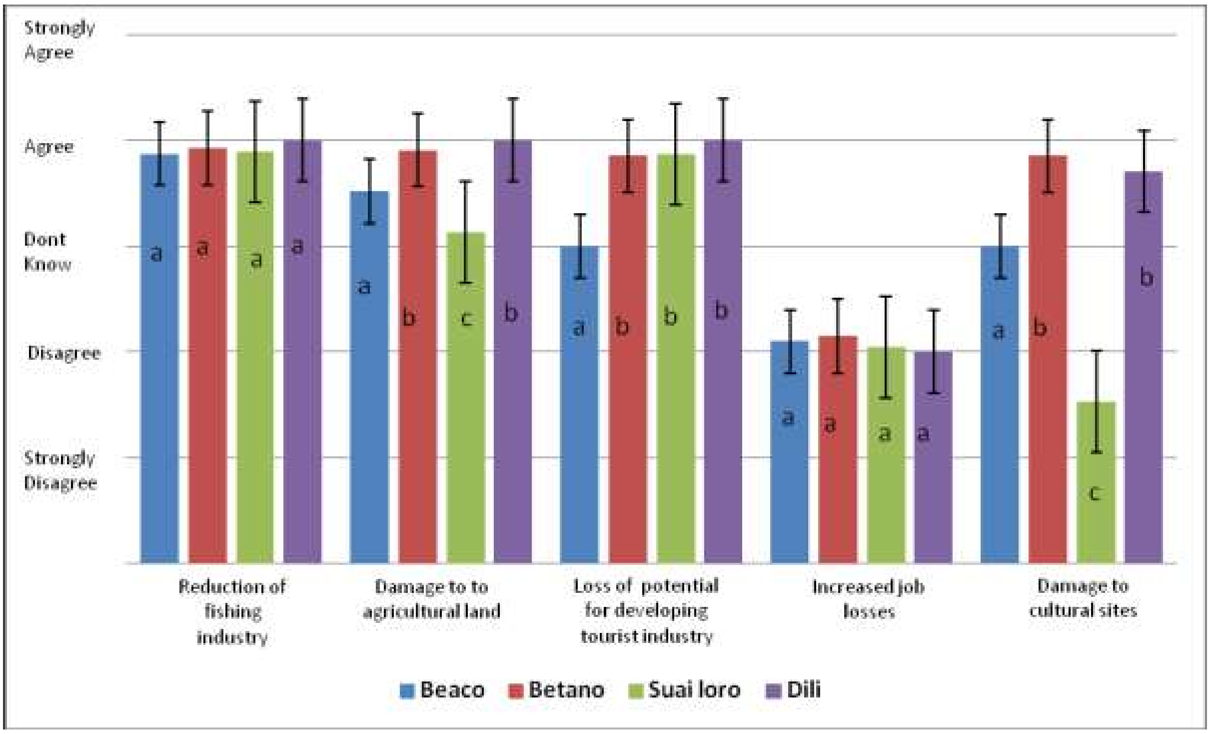


Figure 4.29 MW results on the relative importance of improved healthcare more important than environmental consequences based on locations. Note: for each question, columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Responses indicated there was broad agreement that improved healthcare was more important than the specified possible negative effects of the development. The exceptions were increased pollution and increased job losses – and here the converse view was taken. There were some differences between the views of Suai Loro and Beaco and the views of Betano and Dili. In summary, more respondents from Suai Loro and Beaco attached greater importance to corals, mangroves, agriculture and cultural sites than was the case for Betano and Dili. Additionally, Beaco residents tended to regard tourism as potentially more important, while Suai Loro residents were more strongly opposed to pollution compared to other locations.

For a number of the questions posed there were no significant differences in responses between the locations. Respondents from all locations were virtually unanimous in agreeing that improved healthcare was of greater importance than any possible damage to the seabed and intertidal zone or reduction in fishing productivity. Conversely, respondents from all locations were virtually unanimous in disagreeing that improved healthcare was of greater importance than increased job losses.

Questions where responses differed between locations are discussed below.

Table 4.13.1 Damage to coral reefs

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	13	3	84	0
Suai Loro	0	4	0	96	0
Betano	0	0	0	100	0
Dili	0	0	0	100	0

All respondents from Betano and Dili gave 'agree'responses. Responses from Beaco differ because of a small but significant proportion of 'disagree' responses.

Table 4.13.2 Damage to mangrove

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	2	93	6
Suai Loro	4	6	0	89	0
Betano	0	13	3	84	0
Dili	0	0	0	100	0

All respondents from Beaco and Dili gave a response of 'agree'. Betano differs due to a small but significant proportion of 'disagree' responses.

Table 4.13.3 Increased pollution

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	90	6	3	0
Suai Loro	30	66	0	4	0
Betano	4	94	0	2	0
Dili	0	100	0	0	0

The majority of respondents from all locations tend to disagree that improved healthcare is of greater importance than the risk of increased pollution. The responses from Suai Loro are significantly different from those of Beaco and Betano due to a higher proportion of 'strongly disagree' responses from Suai Loro.

Table 4.13.4 Damage to agricultural land

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	16	16	68	0
Suai Loro	0	40	6	53	0
Betano	0	2	7	89	2
Dili	0	0	0	100	0

Responses from Betano and Dili are not significantly different and are characterised by a very high proportion of 'agree' responses. Responses from Beaco and Suai Loro also show a majority of 'agree' responses. However, Beaco responses are significantly different from all other locations due to a number of 'disagree' responses and Suai Loro responses are also significantly different from other locations due to an even higher number of 'disagree' responses.

Table 4.13.5 Loss of potential for tourist industry development

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	45	10	45	0
Suai Loro	0	6	0	94	0
Betano	0	7	2	89	2
Dili	0	0	0	100	0

There is no significant difference between responses from Betano, Suai Loro or Dili with all three showing a very high proportion of responses in the 'agree' category. Responses from Beaco are significantly different and show an equal split between 'disagree' and 'agree' responses.

Table 4.13.6 Damage to cultural sites

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	3	45	0	52	0
Suai Loro	55	40	0	4	0
Betano	0	7	0	93	0
Dili	0	15	0	85	0

There is no significant difference between responses from Betano and Dili with both showing a very high proportion of responses in the 'agree' category. Responses from Beaco are significantly different from all other locations and show an almost equal split between 'disagree' and 'agree'. Responses from Suai Loro are also significantly different from all other locations with the majority of responses in the 'disagree' or 'strongly disagree' categories.

c. Views regarding the relative importance of improved transportation links and environmental consequences.

Respondents views on whether improved transportation links as more important than environmental negative consequences presented in the MDS plot in Figure 4.30.

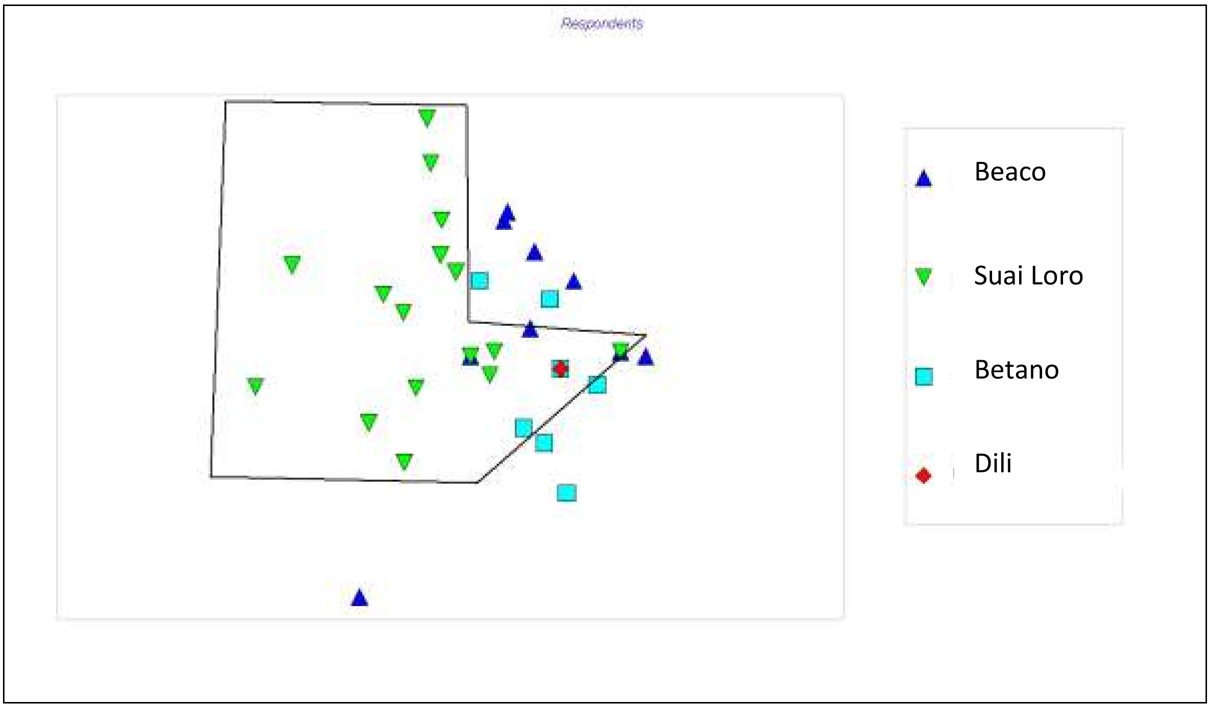


Figure 4.30 MDS results on the relative importance of improved healthcare more important than environmental consequences. Note: the minimum bars seem demonstrates that respondent's views are overlapping.

The MDS ordination in Figure 4.30 shows that the views of respondents from Suai Loro were slightly different to the other locations where the views of respondents appeared to be scattered and overlapping.

Table 4.14 The result of ANOSIMbetween Locations.

Groups Number Observed	R Statistics	Significance Level %
Beaco, Suai Loro	0.388	0.1
Beaco, Betano	0.212	0.1
Beaco, Dili	0.040	4.9
Suai Loro,Betano	0.630	0.1
Suai Loro, Dili	0.428	0.1
Betano, Dili	-0.070	100.

The results of ANOSIM in Table 4.14 shows the responses from Beaco, Betano and Dili tended to be similar (R value <0.25) whereas there was some evidence of slight differences between Suai Loro and the other locations (R value >0.25).

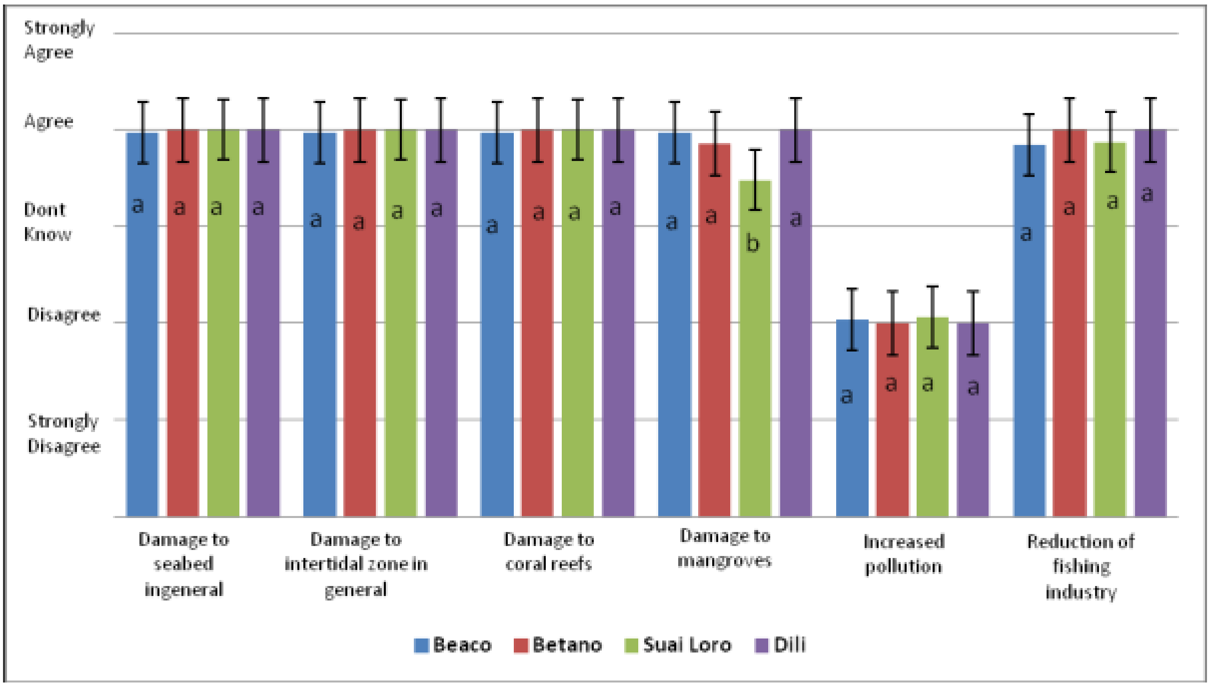


Figure 4.31 MW results on the relative importance of improved transportation links and environmental consequences, by location. Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different).

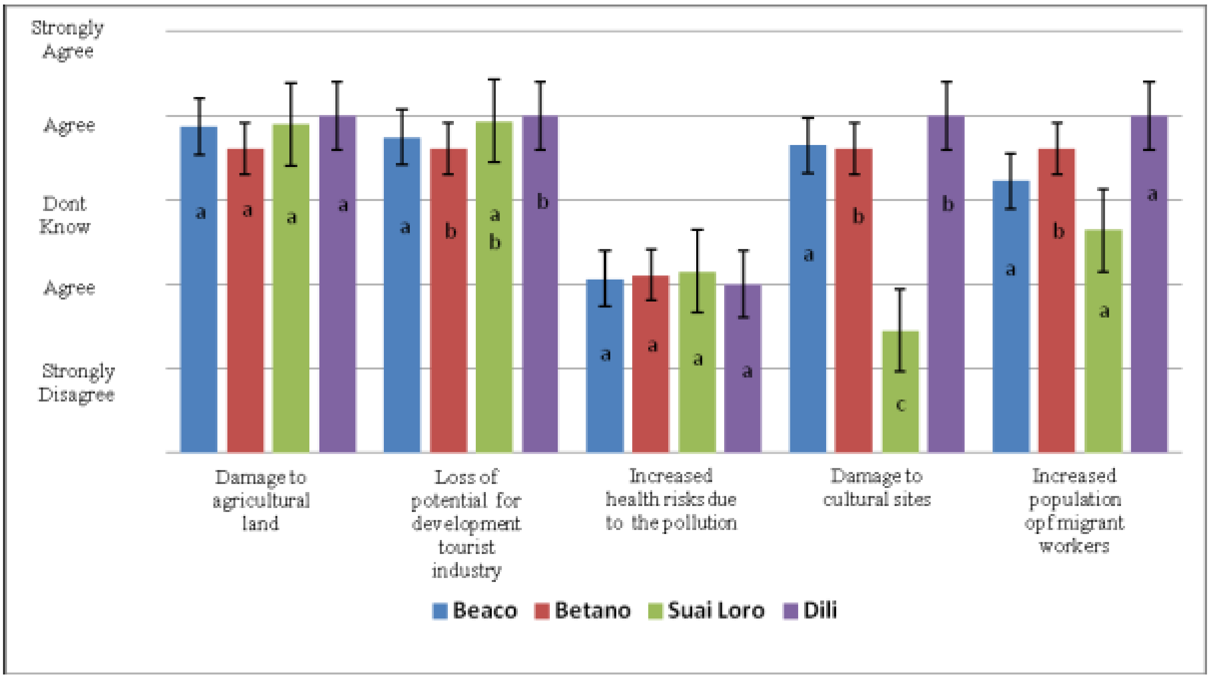


Figure 4.32 MW results on relative importance of improved transportation links and environmental consequences, by locations. Note: for each question columns sharing a letter code are not significantly (P<0.05) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

Beaco, Betano and Dili were broadly similar in terms of their responses, which largely fell in to the ‘agree’ category on the question of whether improved transportation links was more important that environmental consequences. Suai Loro tended to give fewer ‘agree’ responses than the other locations, but had a similar number of ‘disagree’ responses.

Responses indicated there was broad agreement that improved transport links were more important than the specified possible negative effects of the development. The exceptions were increased pollution and health risks due to pollution – and here the converse view was taken. There were some differences between the views of Suai Loro and Beaco and those in Betano and Dili. Respondents from Suai Loro attached a much higher importance to cultural sites and possible consequences of an increased population of migrant workers than seen in the other locations. These same trends were also observed in the Beaco responses, although they are less pronounced than Suai Loro. Additionally, a significant minority of Suai Loro residents attached a high importance to mangroves and a few Beaco residents regarded tourism as potentially important.

For a number of the questions posed there were no significant differences in responses between the locations. Respondents from all locations were virtually unanimous in agreeing that improved transport links were of greater importance than any possible damage to the seabed, intertidal zone, coral reefs and agricultural land or reduction in fishing productivity. Conversely, respondents from all locations were virtually unanimous in disagreeing that improved transport links were of greater importance than increased pollution or increased health risks due to pollution.

Questions where responses differed between locations are discussed below.

Table 4.14.1 Damage to mangroves

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	3	97	0
Suai Loro	2	23	0	74	0
Betano	0	7	0	93	0
Dili	0	0	0	100	0

There is no significant difference in responses between Beaco, Betano or Dili with all three showing a very high proportion of responses in the ‘agree’ category. Responses from Suai Loro also have a high proportion of 'agree' responses but are significantly different from the other locations as they also include a relatively high proportion of 'disagree responses.

Table 4.14.2 Loss of potential for developing tourist industry

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	6	13	81	0
Suai Loro	0	0	6	94	0
Betano	0	2	0	98	0
Dili	0	0	0	100	0

In all locations the majority of respondents agree that improved transportation is more important than the potential for tourism. There is a significant difference between Beaco and Betano which is attributable to a number of 'don't know' and 'disagree' responses in Beaco.

Table 4.14.3 Damage to cultural sites

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	13	10	77	0
Suai Loro	55	45	0	0	0
Betano	0	2	0	98	0
Dili	0	0	0	100	0

Betano and Dili show no significantly differences and are characterised by a very high proportion of 'agree' responses. Although majority respondents in Beaco 'agree' differs from all other locations due to the number of 'disagree' responses. Suai Loro responses are also significantly different from other locations due to all respondents giving 'disagree' or 'strongly disagree' responses.

Table 4.14.4 Increased population of migrant workers

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	35	6	58	0
Suai Loro	2	64	2	32	0
Betano	0	4	0	96	0
Dili	0	0	0	100	0

There is no significant difference between responses from Betano and Dili with both showing a very high proportion of responses in the 'agree' category. Responses from Beaco also show a majority of 'agree' responses but are significantly different from all other locations as over one-third of respondents 'disagree'. Responses from Suai Loro are also significantly different from all other locations with the majority of responses in the 'disagree' category.

4.2.3.5 Response regarding overall views on the desirability of developing the oil industry.

Respondents overall views on the desirability of the development oil industry on the South Coast, of East Timor are presented in the MDS plot below.

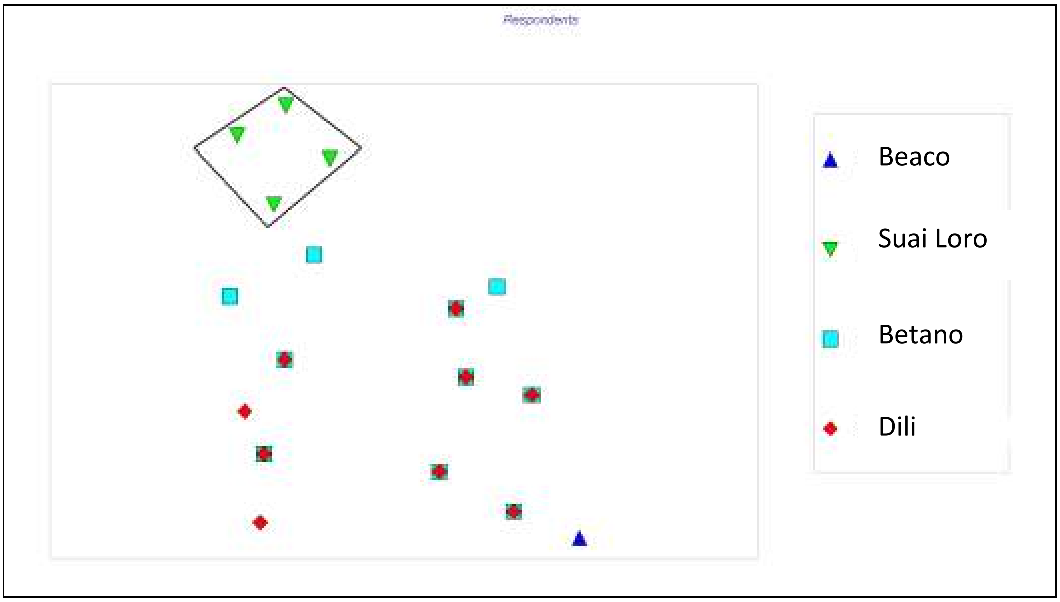


Figure 4.33 MDS results on overall views on developing the oil industry on the south coast of East Timor. Note: the minimum bars demonstrated where respondent's views were overlapping.

MDS ordination in Figure 4.33 indicates that respondents from Suai Loro had distinct views while those from other locations appear to be scattered and overlapping.

Table 4.15 ANOSIM results on overall views on developing the oil industry on the South Coast.

Groups Number Observed	R Statistics	Significance Level %
Beaco, Suai Loro	0.212	0.1
Beaco, Betano	0.064	4.5
Beaco, Dili	0.005	31.3
Suai Loro, Betano	0.081	0.4
Suai Loro, Dili	0.260	0.1
Betano, Dili	0.093	2.8

ANOSIM results in Table 4.15 demonstrate that there was no clear significant difference between groups. The highest R values (0.08 to 0.26) were associated with the comparison of Suai Loro responses with the other locations. Respondents in most locations agreed with the overall statement that it was important to go ahead with the oil refinery development on the South Coast on the condition that reasonable steps were taken to protect the environment. Most also disagreed that the development should be avoided altogether due to the potential for environmental harm (Figure 4.34).

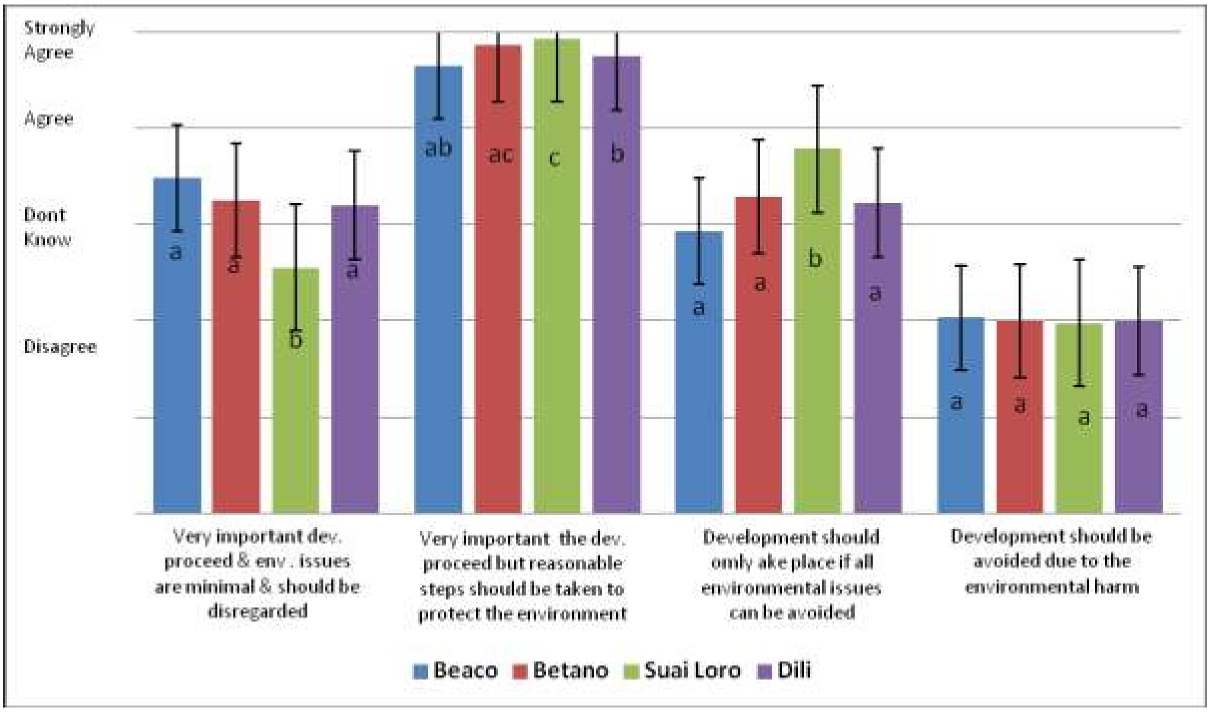


Figure 4.34 MW results on overall views on oil industry development on the south coast of East Timor. Note: for each question columns sharing a letter code are not significantly ($P<0.05$) different. If the columns do not share one letter in common they are significantly different). Error bars denote standard error of the mean.

There were consistent differences between the responses from Suai Loro and those of other locations. Respondents from Suai Loro were more likely to disagree with the statement that ‘environmental effects are minimal and should be disregarded. They were also likely to agree that ‘development should only take place if all environmental issues can be avoided’ and more likely to strongly agree that ‘reasonable steps should be taken to protect the environment’.

Table 4.15.1 Very important that development proceeds and environmental issues are minimal and should be disregarded.

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	26	0	74	0
Suai Loro	9	60	0	32	0
Betano	0	37	0	63	0
Dili	0	30	0	70	0

There is no significant difference in responses from Beaco, Betano or Dili with all three showing a high proportion of responses in the 'agree' category but with a significant minority (about one third) of responses in the 'disagree' category. Responses from Suai Loro show the reverse of this pattern and are significantly different from the other locations. The majority of Suai Loro respondents 'disagree' with the statement, while the remainder (about one third) of responses 'agree'.

Table 4.15.2 Very important that development proceeds but reasonable steps should be taken to protect the environment.

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	0	0	35	65
Suai Loro	0	0	0	6	94
Betano	0	0	0	13	87
Dili	0	0	0	41	59

Respondents from all locations are unanimous in giving 'agree' or 'strongly agree' responses to this statement. Responses from Suai Loro are significantly different from those of Beaco and Dili. This is due to a higher proportion of 'strongly agree' responses from Suai Loro.

Table 4.15.3 Development should only take place if all environmental issues can be avoided.

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	35	35	29	0
Suai Loro	0	4	23	62	11
Betano	0	15	41	44	0
Dili	0	26	56	19	0

There is no significant difference in responses from Beaco, Betano or Dili with all three showing a lack of consensus and responses spread variously over the 'disagree', 'don't know' and 'agree' categories. Responses from Suai Loro are significantly different from those of the other locations with a clear majority of responses in the 'agree' category.

Table 4.15.4 Development should be avoided due to the environmental harm.

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Beaco	0	97	3	0	0
Suai Loro	2	98	0	0	0
Betano	0	100	0	0	0
Dili	0	100	0	0	0

There is no significant difference between any of the locations and virtually all responses fall in the 'disagree' category.

4.2.4 Results of secondary stakeholders views

4.2.4.1 Summary results of the views of corporate organisations

The corporate bodies and organizations were interviewed and the summary is presented descriptively in Table 4.17. The views were divided into five sub-headings:1) overall views on the desirability of oil refinery development, 2) environmental aspects which need to be considered, 3) social aspects which need to be considered, 4) aspects of infrastructure provision which need to be improved and 5) likelihood of undesirable environmental and socio-economic outcomes resulting from the oil refinery development.

Table 4.16 Summary of Corporate views on the research questions obtained through an interview session.

Names	Summary of Corporate Organization Views development of oil refinery and possible consequences				
	Overall views on desirability of oil refinery development	Views on Environmental aspects needing consideration	Views on Social aspects needing consideration	Views on infrastructure provision needing improvement.	Views on likelihood of development having negative consequences on environment & socio-economic sectors
Government					
National Directorate Fisheries & Aquaculture	Very important for development to go ahead, but policy & regulations should be in place to protect breeding habitats	Breeding, spawning habitats & coral reefs	Fishing & agriculture	Electricity & transportation links	Breeding, spawning habitats & fishing
Department of Agriculture & Forestry	Very important for development to go ahead but policy & regulations should be in place to protect mangroves & coral reefs	Mangroves & coral reefs	Agriculture & fishing	Electricity & transportation links	Mangroves, coral reefs, agriculture & fishing
Department of Tourism	Very important for development to go ahead but policy & regulations should be in place to protect coral reefs & migratory species	Coral reefs & migratory species	Sacred sites ,fishing & tourism	Transportation links, electricity & water sanitation	Coral reefs, coastal habitats & fishing
National Department of Environment (DSNMA)	Very important for development to go ahead, but policy & regulations should be in place to protect breeding habitats, mangrove & coral reefs	Coral reefs, breeding, spawning site & mangroves forests	Fishing, sacred sites & agriculture	Transportation links	Breeding & spawning habitats, fishing and agriculture

Names	Summary of Corporate Organization Views development of oil refinery and possible consequences				
	Overall views on desirability of oil refinery development	Views on Environmental aspects needing consideration	Views on Social aspects needing consideration	Views on infrastructure provision needing improvement.	Views on likelihood of development having negative consequences on environment & socio-economic sectors
National Petroleum Authority (NPA)	Very important for development to go ahead, but policy & regulations should be in place to protect breeding habitats, mangroves & coral reefs	Coral reefs, mangroves & breeding habitats	Fishing, sacred sites & agriculture	Transportation links & electricity	Breeding & spawning habitats ,coastal habitats, fishing & agriculture
National Directorate of Water & Sanitation	Very important development to go ahead but policy & regulations should be in place to protect mangroves & coral reefs	Coral reefs & mangroves	Fishing& agriculture	Waters sanitation & electricity	Coral reefs, mangroves fishing & agriculture
Department of Public Works & Transportations	Very important for development to go ahead, but policy & regulations should be in place to protect breeding habitats & mangroves	Mangroves & breeding habitats	Fishing, sacred sites & agriculture	Transportation links & electricity	Mangroves, breeding habitats & fishing agriculture
National Directorate of Land & Property	Very important for development to go ahead, but policy & regulations should be in place to protect coastal habitats	Coastal habitats	Fishing, sacred sites & agriculture	Transportation links ,electricity & water sanitation	Coastal habitats, fishing & agriculture
Suai District Development Officer	Development can only take place if avoid sacred places, mangroves, coral reefs	Mangroves & coral reefs	Fishing & sacred sites	Transportation links & electricity	Mangroves, coral reefs, fishing & sacred sites
Same District Development Officer	Very important for development to go ahead, but policy & regulations should be in place to protect coastal habitats	Coral reefs & spawning habitats	Fishing, sacred sites & agriculture	Water sanitation, basic education services & electricity	Coral reefs, spawning habitats, fishing, sacred sites & agriculture
Viqueque District Development Officer	Very important for development to go ahead, but policy & regulations should be in place to protect coral reefs & spawning habitats	Coral reefs & spawning habitats	Fishing & agriculture	Basic health services, basic education services and transportation links	Coral reefs, spawning habitats & Fishing & agriculture
NGO's:					
HABURAS Foundation *(environmental lobby group)*	Development can only take place if it avoids damage to mangrove forest, coral reefs & seabed conditions	Mangrove forest, coral reefs & seabed conditions	Increased local job losses	Water sanitation, electricity & transportation	Mangrove forest, coral reefs & and Increased local job losses
Lao Hamutuk *(natural resources monitoring group)*	Development can only take place if it avoids fringing reefs & mangrove deforestation	Fringing refs & mangrove deforestation	Increased local job losses & ground water contamination	Water sanitation, electricity & basic health services	Mangrove deforestation & increased local job losses
Luta Hamutuk *(monitoring government expenditures)*	very important development to go ahead but policy and regulations should be in place to protect seabed conditions	Seabed in pristine condition	Increased job losses, spiritual values and land disputes	Electricity, water sanitation & transportation links	Coral reefs, increased job losses and spiritual values
NGO Forum *(national umbrella for NGOs)*	Development should only take place with proper environmental study	Seabed in pristine conditions & mangroves deforestations	Fishing, agriculture & sacred sites	Electricity, water sanitations & basic health services	Mangrove deforestations, Fishing, agriculture & sacred sites
HASATIL *(sustainability agriculture group)*	Development should only take place with proper environmental study	Seabed in pristine conditions	Agriculture, fishing & tourism	Electricity, water sanitation & basic health services	Coral reefs & agriculture, fishing
FOKUPERS *(women's communication forum)*	Development should only take place with proper environmental study	Coastal habitats & coral reefs	Agriculture, fishing & tourism	Electricity, water sanitation, transportation links & basic health services	Coastal habitats & coral reefs & agriculture, fishing
Service providers:					
National University of East Timor (UNTL)	Development should only take place with proper environmental study	Coral reefs, seabed conditions, coastal pollution & mangroves forests	Fishing & agriculture	Transportation, basic educations services, water sanitation, & electricity	Coral reefs, mangrove forests, fishing & agriculture

Names	Summary of Corporate Organization Views development of oil refinery and possible consequences				
	Overall views on desirability of oil refinery development	Views on Environmental aspects needing consideration	Views on Social aspects needing consideration	Views on infrastructure provision needing improvement.	Views on likelihood of development having negative consequences on environment & socio-economic sectors
Timor Institute for Development (DIT)	very important development to go ahead but reasonable steps should be taken to protect the environment	Coral reefs, fish, seabed & coastal pollution	Fishing, sacred sites, agriculture & tourism	Basic education services, water sanitation & electricity	Coral reefs, Fishing, sacred sites, agriculture
Timor Institute for Development (TIDS)	Development should only take place with proper environmental study	Mangrove forest, coral reefs, breeding habitats & coastal pollution	Sacred sites, fishing & agriculture	Water sanitation, electricity, basic education services & transportation	Mangrove forest, coral reefs, breeding habitats & Sacred sites, fishing & agriculture
Oil Companies:					
Eni Timor Leste SpA.	Development can proceed with an approved EIA study.	Coral reefs & coastal habitats	Fishing & agriculture	Transportation links & electricity	Coral reefs, coastal habitats, fishing & agriculture
Oilex Timor Leste	Development can proceed with an approved EIA study.	Coral reefs & mangroves *(applicable for Suai only)*	Fishing & agriculture	Transportation links & electricity	Coral reefs & mangrove s *(applicable for Suai only)* & fishing & agriculture
Environmental Organizations:					
Arafura & Timor Sea Expert Forum	Development important for the country, but reasonable steps should be taken to protect the environment	Seabed conditions, coral reefs & mangrove forests	Fishing & agriculture	Transportation links, electricity & water sanitation	Coral reefs, mangrove forests, fishing & agriculture
Coral Reefs Triangle	Development important for the country, but reasonable steps should be taken to protect the environment	Fringing reefs, coral reefs, breeding & spawning habitats	Fishing & agriculture	Transportation & electricity	Coral reefs, breeding, spawning habitats & Fishing & agriculture

4.2.4.2 Comparisons of views on the importance of existing natural resources

The corporate bodies and organizations consulted generally emphasised the importance of existing natural resources, as shown in Table 4.17. A high proportion of the organisations consulted specified that coral reef (73%) and mangrove (50%) conservation should be considered when planning developments. However, issues such as coastal habitats, coastal pollution and migratory species received fewer mentions. This was particularly on the case of migratory species, although this does not necessarily mean that the respondents disregard this issue or consider it unimportant. The respondents were not directly questioned on these topics and the fact that they did not mention them specifically does not provide evidence that they view them as unimportant.

Table 4.17 Summary of corporate views on the environmental issues which need to be considered.

Corporate bodies	Existing natural resources that need to be considered.							
	Total	Coral reefs	Mangrove forests	Coastal habitats	Seabed in pristine conditions	Migratory species	Coastal pollution	Spawning & breeding habitats
Government Institutions	**11**	82	54	9	-	9	-	54
Non-Governmental Organizations consulted	**7**	43	43	14	57	-	-	-
Service providers Institutions	**3**	100	67	-	67	-	100	33
Oil companies operating in country	**2**	100	50	50	-	-	-	-
Environmental Organizations (National & Regional)	**3**	67	33	-	33	-	-	33
Total	**26**							

About a third of the respondents specified the importance of maintaining the pristine condition of the seabed, as well as coastal habitats as spawning and breeding grounds. However, a relatively low proportion of respondents mentioned issues such as coastal pollution, coastal habitats and the possibility of disturbance to migratory species.

4.2.4.3 Views on the existing local social structures and livelihood sectors

While the majority of corporate bodies and organizations consulted highlighted the importance of existing social aspects and the local livelihoods sector, there appeared to be less concern at the present time about issues such as land dispute and ground water contamination. However, as specific questions were not asked on this aspect this does not necessarily mean that the respondents regard them as unimportant. A high proportion of representatives of the organizations consulted specified fishing (80%) and agriculture (73%) as important activities which should be considered when planning developed.

Table 4.18 Majority summary of corporate views on the livelihood sector that should be to considered.

Corporate bodies	Social aspects which need to considered							
	Total	Fishing	Agriculture	Sacred sites	Tourism	Increased job losses	Land dispute	Ground water contamination
Government Institutions	**11**	100	82	64	9	-	-	-
Non-governmental Organizations	**7**	43	43	28	28	43	14	14
Service providers Institutions	**3**	100	100	67	-	-	-	-
Oil companies operating in country	**2**	100	100	-	-	-	-	-
Environmental Organizations (National & International)	**3**	66	67	-	-	-	-	-
Total	**26**							

Although significant proportion (42%) mentioned the importance of sacred sites, a relatively low proportion of respondents commented on other issues such as ground water contamination and land dispute.

4.2.4.4 Comparison of views on need for improvement of infrastructure provision

Improved provision of infrastructure was considered important by the representatives of most of the corporate bodies and organizations consulted. A high proportion of the interviewee's specified electricity (88%) and transportation links (65%) as the most important sectors which need to be considered for improvement in planning any proposed development. A moderate proportion, (54%) referred to the importance of water and sanitation.

Basic education and health services appeared to be of less concern, at the present time.

Table 4.19 Summary of corporate views on the provisions of infrastructures.

Corporate bodies	Views on provision of infrastructures					
	Total	Electricity	Transportation links	Water & sanitations	Basic education services	Basic health services
Government Institutions	**11**	91	73	36	18	9
Non-governmental Organizations	**7**	86	43	86	-	57
Service providers Institutions	**3**	100	67	100	100	-
Oil companies operating in country	**2**	100	100	-	-	-
Environmental Organizations (National & International)	**3**	67	67	33	-	-
Total	**26**					

4.2.4.5 Views on the anticipated negative environmental and socio economic impacts.

In general, the majority of interviewees indicated that they anticipate some negative impacts on the environment and social and economic sectors.

Table 4.20 Summary of corporate views on the negative impacts on the environment.

Corporate bodies	Total number	Views on the anticipated negative environmental and impacts							
		Coral reef	Mangrove	Breeding & spawning habitats	Coastal habitats	Fishing	Agriculture	Sacred sites	Increased job loss
Government Institutions	**11**	54	36	27	27	100	73	9	-
Non-governmental Organizations	**7**	57	43	-	14	43	43	28	43
Service providers Institutions	**3**	100	67	33	-	100	100	67	-
Oil companies operating in country	**2**	100	50	-	50	100	100	-	-
Environmental Organizations (National & International)	**3**	67	33	33	-	67	67	-	-
Total	**26**								

A high proportion of the respondents cited the negative impacts on fishing (81%) agriculture (69%) and coral reefs (65%) as the main concerns which would need to be considered in development planning. A moderate proportion also mentioned anticipated negative impacts on mangrove forests (42%) and a relatively small number mentioned other anticipated negative impacts, including damage to coastal habitats, spawning and breeding habitats and increased job losses.

4.2.4.6 Views on the desirability of oil industry development

The majority of representatives of corporate bodies and organizations consulted took the view that it was very important that oil development takes place on the south coast. At the time of interview, few took the view that development should only take place if specified environmental issues could be avoided altogether.

Table 4.21 Summary of corporate views on the oil development.

Corporate bodies	Views on the oil development			
	Total	Very important for development to proceed but reasonable steps should be taken to protect natural environment	Development should only take place with proper environmental study	Development can only take place if environmental issues are avoided
Government Institutions	**11**	10	-	1
Non-governmental Organizations	**7**	6	2	1
Service providers institutions	**3**	67	33	-
Oil companies operating in country	**2**	-	100	-
Environmental Organizations (National & International)	**3**	66	-	33
Total	**26**			

The highest proportion of respondents consulted stated that it was very important for development to proceed but that reasonable steps should be taken to protect the natural environment. A moderate proportion stated development should only take place with proper environmental study and relatively low proportion stated that development should only proceed if specified environmental issues are avoided altogether.

In summary, the overall responses indicated that mangrove and coral reefs were considered as the most important existing natural resources with fishing and agriculture regarded the most important sectors. It is also anticipated that all of these are highly likely to be affected by the development. Electricity and transportation links appear to be regarded as the most essential infrastructures needing improvement. As for the desirability of oil industry development overall responses indicated a belief that it was very important for this proceed, although reasonable steps should be taken to protect the natural environment.

4.3 Discussion

4.3.1 Overall response patterns

Summary trends of overall response patterns for all questionnaire respondents are presented in Table 4.22 – 4.33.

4.3.1.1 The importance of natural resources and livelihoods and levels of satisfaction with the provision of basic infrastructure.

The response pattern for all respondents on the issue of natural resources shown in Table 4.22 (also refer to graph in Figure 4.2) demonstrates that the majority of respondents regarded coral reefs as an important resource, with a high proportion (70%) 'Strongly agreeing' on this issue and also on the importance of coastal areas as spawning & breeding habitats (where 78% strongly agreed). Respondents' strong views on coral reefs were probably due to popular perceptions that these are highly diverse environments with aesthetic value and beauty. In the case of awareness of breeding habitats, the underlying reasons were perhaps because of the fishing communities and their economic interest. The majority of responses (over 90%) indicated that they agreed on the importance of mangrove forests, intertidal habitats and maintaining pristine seabed conditions, presumably for the underlying reason that they were familiar with these habitats and also the fact they are important within the local traditional beliefs system. This high level of agreement indicates a general environmental awareness and shows that the natural environment rates highly in the respondents' value system.

Table 4.22 Summary of response patterns on natural resources

Group	Questions	Response pattern
1	Coral reefs Breeding & spawning habitats	Majority of respondents 'strongly agree' these are important habitats.
2	Mangroves Intertidal habitats Pristine seabed	Majority of respondents either 'agree' or ' strongly agree' these are important
3	Fringing reefs Migratory species	About one- third of respondents 'don't know; if these are important habitats while remaining respondents either ' agree' or 'strongly agree'.
4	Coastal erosion Coastal pollution	Over half of respondents 'disagree' that these are important. Remaining respondents either 'don't know' or 'agree'.

However, they were mixed responses (one-third 'don't know' and two -thirds 'agree') in terms of the importance of fringing reefs and migratory species. This lack of certainty may be due to that fact that some respondents were unclear of the distinction between fringing reefs and coral reefs and were perhaps unfamiliar with which species could be regarded as migratory. Over half of the respondents did not regard coastal erosion and coastal pollution as important issues. Possible reasons behind this may be because these impacts have not yet occurred or do not exist locally. For example, believing these are not important issues because they are not current issues is different from saying they are intrinsically unimportant. When asked later if they would be prepared to tolerate higher pollution levels in order to gain benefits like improved transportation most people said 'no'.

In summary, coral reefs, breeding habitats and mangrove forests were all identified in the overall set of responses as important natural resources or features, and thus should be considered as primary priority habitats for protection by general policy for the entire South Coast region. Other natural resources and features such as migratory species, fringing reefs, coastal erosion and pollution may require an increase in environmental awareness in the future.

Table 4.23 Summary of response pattern on the importance of livelihoods

Group	Questions	Response pattern
1	Port & maritime transportation	Majority of respondents 'strongly agree' these are important.
2	Fishing activities Agricultural activities	Majority of respondents either 'agree' or 'strongly agree' these are important
3	Tourism activities	About one-third 'strongly agree' these are important activity. But some don't know or are unsure.
4	Handicrafts Building & construction	These generated mixed views, with about one-quarter of respondents indicating they 'disagree' and one-third saying they 'don't know whether these are important. Remaining respondents either 'agree' or 'strongly agree'.

The response pattern for all respondents on the importance of livelihoods is shown in table 4.23 (also refer to graph in Figure 4.3). This demonstrates that the vast majority viewed port and maritime transportation as important future potential activities ('strongly agree'). Presumably, respondents viewed this as a plausible outcome of development that would yield benefits for the local community. Additionally, a majority of respondents strongly agreed that fishing (57%) and agricultural (70%) were important activities. This likely reflects the fact that these activities are a major current income source for the South Coast, and hence are regarded as important (see section 2.2.1). The majority of respondents agreed or strongly agreed (53% and 35% respectively) that tourism was an important potential future activity, although a small proportion (11%) were uncertain. This indicates that locals generally agreed that tourism was a plausible potential source of revenue in the near future, whereas the majority of respondents expressed mixed views on handicrafts and building and construction, probably because these sectors were not currently associated with their economic interests.

In summary, port and maritime transportation, fishing and agriculture were identified by the overall set of respondents as the most important potential sectors. This suggests that such sectors should be considered a priority for protection by general development and environmental policies for the South Coast.

Table 4.24 Summary of response pattern on degree of satisfaction with infrastructure

Group	Questions	Response pattern
1	Employment opportunities Business opportunities	Vast majority of responses indicate 'totally inadequate'
2	Water sanitation services Energy supply	Majority of responses indicate 'totally inadequate' and most of remainder indicate 'poor'.
3	Basic health services Basic education service	Majority of responses indicate 'poor' with remaining responses indicating 'adequate' or 'totally inadequate'
4	Transportation links	Mixed responses, split between 'adequate', 'poor' and 'totally inadequate'.

The response pattern for all respondents on degree of satisfaction with infrastructure is shown in Table 4.24 (also refer to graph in Figure 4.4). The results demonstrate that the strongest views were on access to employment and business opportunities. The vast majority (over 90%) of respondents regarded these as 'totally inadequate'. This view also reflects the lack of access and opportunity for businesses on the national scale. On the importance of energy supply and water sanitation services more than half of the respondents indicated these were 'totally inadequate' and the remainder indicated 'poor'. Electricity supply was also regarded as unsatisfactory. This is probably due to the fact local residents required it to operate small businesses such as conserving foods and carpentry among others and electricity services are still far from adequate. In addition, the high proportion of respondents dissatisfied with water sanitation reflects the lack of clean water services in south coastal areas, particularly drinking water facilities, installations and regularity of supply. In the case of basic education and health services over 50% regard these services as 'poor'. However, a substantial minority (>20%) regard provision as adequate. Almost 40% of respondents regarded transportation links as 'adequate', while most of the remainder regarded transportation provision as 'poor' or 'totally inadequate'. The mixed views on transportation links is presumably because this sector is not currently considered of great concern to respondents, whereas in the case of basic education and health services a substantial majority regarded these services as 'inadequate', with only a small proportion indicating they were 'adequate'.

To sum-up, the overall response patterns identified employment and business opportunities as the most unsatisfactory aspects for respondents, suggesting that these should be addressed as serious priority policy issues.

4.3.1.2 Expectations of the respondents of possible consequences of oil development.

The overall response patterns presented in Table 4.25 also refers to the corresponding graph 4.5 (See the results section) demonstrate that the vast majority (over 85%) of respondents have strong expectations of positive economic impacts and improved employment opportunities. This is probably due to the lack of present employment opportunities and consequent limited economic development on the south coast.

Table 4.25 Summary table of expectations of positive consequences.

Group	Questions	Response pattern
1	Positive economic impacts Improved employment opportunities	Majority (>85%) of respondents 'strongly agree' these are likely positive impacts.
2	Provide additional energy, Improve transportation links, Improve basic health services Improve water sanitations	A lower proportion of 'strongly agree' responses than for group 1 but majority of respondents either 'agree' or 'strongly agree' that these are likely results of the development
3	Improve basic education services Create business opportunities	A significant minority of respondents 'don't know' if these are likely positive impacts. Remainder of respondents either 'strongly agree' or 'agree'.

The majority of overall respondents agreed that the development is likely to result in the provision of additional energy and improved transportation links, basic health services and water sanitation. Presumably these views were reflective of the lack of social development in South Coast areas, which in turn generated respondents desire for or expectation of immediate material benefits from the oil development. In terms of basic education services and the creation of business opportunities, responds generally agreed, although a small proportion (18% and 39%, respectively) indicated that they 'didn't know. This may be because these particular respondents were uncertain about how basic education services and new business opportunities would be created.

These overall response patterns suggest that promoting positive economic impacts and improved employment opportunities should be noted as priorities for policy making.

Table 4.26 Summary of expectations of negative environmental consequences .

Group	Questions	Response pattern
1	Destruction of breeding and spawning habitats of fish	Majority of respondents 'strongly agree' these are likely negative environmental impacts.
2	Alteration of seabed conditions, Disturbance to coral reefs, Disturbances of fringing reefs, Alteration of intertidal habitats	A lower proportion of 'strongly agree' responses than for group 1 but majority of respondents either 'agree' or 'strongly agree' that these are likely
3	Disturbance to migratory species	Responses almost equally split between 'agree' and 'don't know'
4	Increased pollution, Mangrove deforestation	Mixed responses, majority of respondents either 'agree' or 'strongly agree' but also a high proportion of 'don't know' and 'disagree' responses.
5	Increased coastal erosion	More than half of the respondents 'disagree' and most of the remainder 'don't know'.

The overall response patterns presented in Table 4.26 refer to the corresponding graph 4.6 in the results section. As demonstrated, a high proportion (80%) of respondents indicated a strong expectation that destruction of breeding and spawning habitats of fish was most likely to occur. This reflected the concerns of fishing communities and was probably associated with the respondents' economic interests. The majority of respondents also expected negative environment consequences in terms of alteration to seabed conditions, disturbances to coral and fringing reefs and alterations to intertidal habitats. These respondents were clearly familiar with certain habitats and the patterns observed also reflect their general environmental awareness and the importance given to the environment. There were mixed responses regarding possible increased pollution and disturbances to migratory species, with half indicating they didn't know and the other half agreeing that these were likely to occur. This divide may be because the respondents didn't know about or hadn't experienced oil pollution. They may also be unfamiliar with which species are considered migratory. More than half of the respondents didn't agree that there would be increased coastal erosion, presumably because these impacts are not currently occurring. Respondents may also have had limited knowledge regarding the effects of the oil industry in relation to coastal erosion.

Furthermore, their perceptions were probably influenced by the current pristine environment.

In summary, the destruction of breeding and spawning habitats of fish was identified as the most likely potential negative consequence by the overall set of respondents, and thus should be regarded as priority concern for protection policies for development on the South Coast.

Table 4.27 Summary of responses on expectation of negative social consequences of development.

Group	Questions	Response pattern
1	Reduction in fish stock Increased health risks due to pollution Increased population of foreign migrant workers	Majority (>60%) of respondents 'agree' these are likely negative impacts.
2	Loss of potential for tourist industry development	Most responses are 'agree' and 'don't know' (almost equal numbers in each category)
3	Damage to the land future for generations to use	Majority (>70%) 'don't know'
4	Damage to cultural sites, Reduction in productivity of agricultural land due to pollution Increased job losses	Majority (>45%) 'disagree' these impacts are likely to occur

The overall response patterns presented in Table 4.27 refer to the corresponding graph 4.7 in the results section. As demonstrated, the majority of respondents (over 60%) indicated that they had a strong expectation of a reduction in fish stocks, increased health risks due to pollution and an increased population of foreign migrant workers. These patterns of concern probably reflected fishermen's concern that development could potentially affect their current major source of income. The responses also indicated a level of serious concern regarding heath and pollution, as well as a sense of insecurity among locals that jobs may be taken by outsiders. Respondents were unsure whether the potential for tourist industry development would be lost, although some did indicate that they agreed, suggesting that some locals also see tourism as a promising potential source of revenue. Apart from these issues, the majority of respondents were uncertain whether there would be damage to the land for future generations to use. This perhaps shows that respondents were uncertain about how development might damage the land or that they had limited knowledge on the subject. More than half of respondents disagreed that damage to cultural sites, reduction in productivity of agricultural land due to pollution and increased job losses were likely. It appears that these were not seen as important as they are not current issues. It could also be the case that respondents don't consider it likely that farm land would be negatively impacted.

To summarise, a reduction in fish stocks, increased health risks due to pollution and an increased population of foreign migrant workers were identified by the overall set of responses as the most likely negative consequences to occur in the social and economic sectors, and therefore should be taken in to account as primary issues when making policy decisions.

4.3.1.3 Overall views on the relative importance of employment opportunities

Summarised response patterns associated with the difference in percentages are presented in the results section in the Tables 4.28 – 4.31 and are corresponding to the graphs in the results section (see also Figures 4.8 – 4.11).

Table 4.28 Summary of responses on statement that the benefit of increased employment outweighs the listed negative consequences.

Group	Questions	Response pattern
1	Damage to the seabed in general Damage to intertidal zone in general, Damage to coral reefs, Damage to mangroves, Reduction in fishing industry, Damage to agricultural land, Loss of potential for tourism industry	Majority of respondents 'agree' these are not more important than increased employment opportunities.
2	Damage to cultural sites Increased population of migrant workers	Over two third of respondents 'agree' but one fifth 'disagree' that increased employment opportunities are more important than these.
3	Increased pollution, Increased health risks due to pollution.	Majority of respondents 'disagree' that increased employment opportunities are more important than these.

A high proportion of respondents agreed (over 85%) that the benefit of increased employment was more important than possible damage to the marine and coastal environment or impacts on fishing agriculture or tourism. Presumably these strong views reflected overall economic interests and lack of employment opportunities in the South Coast areas. Perhaps respondents hold these views because they desire or expect immediate access to jobs and therefore accept some sacrifice must be made to the natural environment in order for development to proceed. However, a small proportion of respondents disagreed with this view, which is likely the cause of the reduced proportion of affirmative responses regarding cultural sites and migratory workers. Another reason presumably is the more traditional belief systems and conservative attitudes of respondents in Suai, as recorded in section 2.2.3. Conversely, a large majority of respondents (over 85%) disagreed that the benefit of more employment outweighs increased pollution and associated health risks. These strong views suggest that oil pollution and its environmental effects and health risks should be regarded as a priority for development controls or protection policies.

Table 4.29 Summary of responses on whether the benefits of improved healthcare outweighs the listed negative consequences.

Group	Questions	Response pattern
1	Damage to seabed in general, Damage to intertidal zone in general, Damage to coral reefs, Damage to mangroves, Reduction in fishing industry	Majority of respondents 'agree' that improved healthcare is more important than these.
2	Damage to cultural sites, Loss of potential for tourist industry development Damage to agricultural land	Over two thirds of respondents 'agree' but one fifth 'disagree 'that improved healthcare is more important than these.
3	Increased pollution Increased job losses	Majority of respondents 'disagree' that improved healthcare is more important than these.

For 90% of respondents, improved healthcare would outweigh environmental damage or reduction in the fishing industry. Presumably these views stem from the fact that, in general, there is limited access to healthcare facilities and services on the South Coast. More fundamentally, these views presumably arise due to the fact respondents value their health and would not sacrifice this to limit environmental damage. However, one-fifth of respondents did not consider improved healthcare more important than damage to cultural sites, loss of potential for tourist industry development and damage to agricultural land. Perhaps such respondents are uncertain of the meaning of the term, as well as the needs for healthcare services. Conversely a large proportion of respondents (over 85%) strongly disagreed that the benefits of healthcare outweighed the risk of increased pollution and job losses. This reflects a high level of concern about avoiding unemployment and a polluted environment.

Table 4.30 Summary of responses on whether improving transportation links is more important than the listed negative consequences.

Group	Questions	Response pattern
1	Damage to seabed in general, Damage to intertidal zone in general, Damage to coral reefs, Damage to mangroves Reduction in fishing industry, Damage to agricultural land, Loss of potential for tourist industry development	Majority of respondents 'agree' that these are less important than improved transportation links.
2	Damage to cultural sites Increased population of migrant workers	Over two- third of respondents 'agree 'that improving transportation links is more important than these, but one fifth disagree.
3	Increased pollution Increased health risks due to pollution	Majority of respondents think that these are more important than improving transport links.

The vast majority of respondents (over 93%) agreed that improving transportation links is more important than effects on the coastal environment, fishing, agriculture and tourism. Presumably for these respondents transportation links were considered more important as, in general, transportation on the South Coast is still of a poor standard.

However, on the question of whether improved transportation links was more important than damage to cultural sites and an increased population of migrant workers opinions were more divided. Conversely, the vast majority of respondents (over 92%) disagreed that the benefits of improved transportation links would be more important than increased pollution levels and the associated health risks. Hence it is worth having an environmental policy in place to balance the provision of transportation links with any negative environmental consequences that may arise.

To summarise, the strong views on oil pollution issues and health risks were identified by the overall set of responses as priority issues, thus should be subject to control or protection by general policies.

4.3.1.4 Patterns on the overall views on the development of the oil refinery.

Summary trends of overall responses pattern for all respondents are presented in Table 4.31. These are the summarised response patterns for all respondents associated with differences in percentages already presented in the graph in the results section (Figure 4.31).

Table 4.31 Summary of responses on overall views on the oil refinery development.

Group	Questions	Response pattern
1	It is important for development to take place, but reasonable steps should be taken to protect environment	Majority of respondents ‘agree’ or ‘strongly agree’ on this statement.
2	Very important that development proceeds & environmental issues are minimal & should be disregarded. Development should only take place if all environmental issues can be avoided	Over half of respondents ‘agree’ and the remainder ‘don’t know’ or ‘disagree’.
3	Development should be avoided due to the environmental harm	Majority of respondents ‘disagree’ with this statement.

According to Table 4.31, the prevailing view is that it is important for development to take place provided reasonable steps are taken to protect the environment (20% agreed and 80% strongly agreed). Conversely, most respondents (99%) disagreed that development should be avoided altogether in order to avoid possible environmental harm. This response pattern indicates that most respondents are in favour of development proceeding so this should be regarded as a priority and policies to protect or control the environment should be designed so as not to conflict with development in general.

4.3.2 Differences in responses between different locations

The respondents’ overall responses patterns in each location on questions associated with natural resources are summarised in Table 4.32.

4.3.2.1 Importance of the natural environment

Suai Loro was distinctive in that respondents had more strongly held views on the importance of mangroves and fringing reefs than was the case in other regions. Presumably this was because mangrove forests are more common in Suai Loro compared to other regions. Perhaps it is also because Suai residents have stronger traditional practices and belief systems that have a close association to natural resources, as documented in sub-section 4.1.2.2.

Table 4.32 Summary trends of differences in views between locations on existing natural resources. (Note: majority in agreement = strongly agree + agree which less than 50%).

Questions	Suai Loro	Beaco	Betano	Dili
Perception of importance natural features				
Mangrove	most (94%) strongly agree	most (90%) agree	most (83%) agree	most (67%) agree
Intertidal habitats	most (62%) strongly agree	most (81%) agree	most (54%) strongly agree	most (37%) don't know
Fringing reefs	most (51%) agree	most (71%) agree	majority in agreement (67%)	most (70%) don't know
Breeding habitats	most (81%) strongly agree	most (74%) strongly agree	most (87%) strongly agree	majority in agreement (85%)
Coastal erosion	most (77%) disagree	most (87%) disagree	most (63%) disagree	most (52%) don't know
Coastal pollution	most (66%) disagree	most (55%) disagree	most (59%) disagree	most (48%) agree
Coral reefs	most (79%) strongly agree	most (81%) strongly agree	most (81%) strongly agree	most (59%) agree
Seabed in pristine condition	most (51%) strongly agree	most (55%) strongly agree	most (59%) agree	most (44%) don't know
Migratory species	most (72%) agree	most (71%) agree	most (61%) agree	most (52%) don't know

Dili was distinctive in that there were a relatively high proportion of 'don't know' answers to many of the questions (e.g. intertidal habitats, fringing reefs, coastal erosion, seabed condition and migratory species). It is also distinctive in that there was a greater level of agreement that pollution was an important issue. This is possibly because Dili residents are remote from the South Coast and are therefore unfamiliar with the natural environment there. Dili respondent also seemed uncertain of the definition of fringing reefs and had difficulties distinguishing between these and coral reefs. As Dili is the capital city rather than a fishing village perhaps it is not surprising that more respondents were uncertain when asked about specific features of the marine environment.

To summarise, assessment on the responses patterns identified evidence of regional differences which have policy implications with regard to the importance of natural resources and features. Particular attention should be paid to coral reefs, seabed condition, breeding habitats and mangroves as priority habitats for protection. This should be addressed through policies that have an inbuilt flexibility to allow more stringent measures to be employed if development occurs in Suai Loro as opposed to the other regions. Other essential features that should be considered in policy development include raising greater awareness of the importance of intertidal habitats, fringing reefs and migratory species, as well as issues of coastal erosion and pollution.

4.3.2.2 Importance of livelihood sector

Suai Loro is distinctive in giving a relatively high proportion of respondents disagreed that handicrafts were an important activity. Presumably this is because handicrafts are not currently well developed and also they are more interested in traditional values. Suai Loro also gave fewer 'strongly agree' responses on the question of tourism. Perhaps as a traditional society they feel less enthusiasm about an influx of tourists.

Table 4.33 Summary trends of differences in views on livelihoods based on location. (Note: majority in agreement = strongly agree + agree).

Questions	Suai Loro	Beaco	Betano	Dili
Perception of importance of livelihood sectors				
Fishing activites	most (62%) strongly agree	most (84%) strongly agree	most (59%) strongly agree	most (63%) agree
Agricultural activities	most (74%) strongly agree	most (87%) strongly agree	most (83%) strongly agree	most (63%) agree
Handicrafts	most (47%) disagree	most (52%) agree	majority in agreement (67%)	majority in agreement (85%)
Building & construction	most (53%) agree	most (52%) don't know	majority in agreement (60%)	majority in agreement (59%)
Port & maritime	most (98%) strongly agree	most (65%) strongly agree	most (94%) strongly agree	most (81%) strongly agree
Tourism	most (68%) agree	most (65%) strongly agree	majority in agreement (88%)	most (78%) agree

Dili is distinctive in that the majority of respondents agreed that all livelihood sectors were important. Dili residents also gave more 'don't know' and fewer 'strongly agree' responses, presumably because they are less likely to be directly reliant on fishing and farming. It was also distinctive in that there was a relatively high level of agreement on the importance of building and construction. This is not surprising considering Dili is a mostly an urban area and not as directly associated with activities such as farming and fishing in comparison to other villages on the South Coast.

To summarise, the response patterns demonstrated evidence of regional differences in the importance of livelihood sectors. In terms of policy implications, more flexibility with respect to fishing and agricultural activities, as well as the development of port and maritime transportation, should be taken into account. It's also important that policy not conflict with the development process should it occur in Suai Loro, Betano and Beaco, where it was identified as a priority sector, as compared to Dili. The tourism sector was also identified as a priority sector and any policies for protection or control should have sufficient inbuilt flexibility to allow more stringent measures to be employed if development occurs in Beaco compared to other villages.

4.3.2.3 Level of satisfaction with basic infrastructures

Suai Loro was distinctive in that there were more ‘totally inadequate’ held views on the questions of transportation links than was the case in the other regions. Certainly, their views reflecting existing road conditions and the public transport services available at present time in Suai Loro, which remain far from standard.

Table 4.34 Summary of trends in difference of views on degree of satisfaction with infrastructure based on location. Note: majority in agreement = strongly agree + agree).

Questions	Suai Loro	Beaco	Betano	Dili
Degree of satisfaction with infrastructure				
Water and sanitation services	most (60%) poor	most (52 %) totally inadequate	most (83%) totally inadequate	most (67%) totally inadequate
Energy supply	most (66%) totally inadequate	most (84%) totally inadequate	most (89%) totally inadequate	most (67%) totally inadequate
Transportation links	most (62%) totally inadequate	most (65%) poor	most (87%) Adequate	majority inadequate (60%)
Basic education services	most (68%) poor	most (58) poor	most (85%) poor	most (78%) poor
Basic health services	most poor (43%)	most poor (39%)	most (87%) poor	most (70%) poor
Access to employment opportunities	most totally inadequate (87%)	all totally inadequate (100%)	all totally inadequate (100%)	all totally inadequate (100%)

Betano was distinctive in that there were a relatively high proportion of ‘adequate’ responses on the question of transportation links than was the case in the other regions. This certainly reflects the superior existing road conditions in Betano in comparison to the other regions. Respondents from Betano also demonstrated other differences on the question of water sanitation services where more considered these ‘total inadequate’ compared to Suai Loro and Beaco. A further difference could be seen on the question of energy supply, with more Betano respondents indicating this was ‘total inadequate’ compared to Suai Loro. In terms of education there were fewer ‘inadequate’ and more ‘poor’ responses compared to Suai Loro. Overall, although Betano respondents were relatively satisfied with transportation links, they were less satisfied about other aspects, particularly when compared with Suai Loro.

To summarise, an assessment of the response patterns identified regional differences in satisfaction with basic infrastructure and this has policy implications. Transportation links, in particular, were identified as highly unsatisfactory in Suai Loro so policy should therefore have enough flexibility and not conflict with the development process.

4.3.2.4 Positive social consequences

Suai Loro respondents gave a lower proportion of 'strongly agree' responses regarding expectations of improvements in water and sanitation as compared to Betano and Dili. They also had lower expectations of improvements in energy as compared to the others regions. Conversely, Suai Loro respondents gave a higher proportion of 'strongly agree' responses in comparison to Betano and Dili regarding expectations of improvements in health services and transportation links.

Dili respondents gave a lower proportion of 'strongly agree' responses regarding expectations of improvements in employment opportunities in comparison to the others regions. They also gave a lower proportion of 'strongly agree' responses and a higher proportion of 'don't know' responses regarding expectations of improvements in business opportunities,as compared to Suai Loro.

Table 4.35 Summary of trends on differences in expectation of positive social consequences of oil and gas industry development. Note: majority in agreement = strongly agree + agree).

Questions	Suai Loro	Beaco	Betano	Dili
Expectation of positive social consequences of development				
Improve employment opportunities	most strongly agree (96%)	all strongly agree (100%)	most strongly agree (97%)	most agree (70%)
Create new business opportunities	most (62%) agree	most (87%) agree	majority in agreement (67%)	most (59%) agree
Improve water and sanitation	most (60%) agree	most (52%) strongly agree	most (76%) strongly agree	most (78%) strongly agree
Provide additional energy	most (55%) agree	most (90%) strongly agree	most (80%) strongly agree	most (81%) strongly agree
Improve basic health services	most (66%) strongly agree	most (65%) strongly agree	most (91%) agree	most (67%) agree
Improve basic education services	most (49%) don't know	most (52%) don't know	most (72%) agree	most (63%) agree
Improve better transportation links	most (94%)strongly agree	most (81%)strongly agree	most (89%) agree	Majority in agreement (78%)
Have positive economic impacts	all strongly agree (100%)	most strongly agree (97%)	most strongly agree (91%)	most strongly agree (93%)

Similarly to Suai Loro, Beaco respondents gave a higher proportion of 'strongly agree' responses in comparison to Betano and Dili regarding expectations of improvements in health services and transportation links.

To summarise, analysis of these response patterns has identified that it is clear that there are strong expectations of positive benefits and it might be politically astute to try and ensure that the populations in these areas are not disappointed in their expectations.

4.3.2.5 Negative environmental consequences

Suai Loro respondents gave a higher proportion of 'strongly agree' responses regarding expectations of mangrove deforestation (as compared to all others). Suai Loro also differed on the question of intertidal habitats, as was indicated in the results section. Suai had higher a proportion of agreement ('agree' and 'strongly agree') than Beaco and Dili and a lower proportion of 'strongly agree' than Betano. Certainly, respondents' views reflect the fact that Suai Loro is the only region home to mangroves habitats. Another essential factor is that residents continue to practices traditional beliefs, closely associated with the mangroves in Suai Loro.

Table 4.36 Summary of trend on expectations of negative environmental consequences of development. Note: majority in agreement = strongly agree + agree).

Questions	Suai Loro	Beaco	Betano	Dili
Expectations of negative environmental consequences of development				
Mangrove deforestation	most (64%) strongly agree	most(58%) agree	most (72%) disagree	most (41%) don't know
Alteration of intertidal habitats	most (83%) agree	most(74%) agree	most(61%) agree	majority in agreement (59%)
Destruction of fringing reefs	most(72%) agree	most(58%) agree	most(63%) agree	most(56%) agree
Destruction of breeding habitats	most (81%)strongly agree	most (84%)strongly agree	most (85%)strongly agree	most (63%)strongly agree
Increased pollution	majority in agreement (68%)	most (71%) disagree	most (57%)agree	most (59%) don't know
Increased in erosion	most (55%) don't know	most (90%) disagree	most (63%) disagree	most (59%) disagree
Destruction of coral reefs	most (60%) agree	most (58%) agree	most (50%) strongly agree	majority in agreement (85%)
Alteration of seabed conditions	most (68%) agree	most (94%) agree	most (85%) agree	All (100%) agree
Disturbance to migratory species	most (47%) don't know	most (58%) don't know	most (59%) agree	most (63%) don't know

Beaco was distinctive in that a relatively high proportion disagreed that increased coastal pollution was a potential impact of oil industry development compared to other regions.

Betano respondents gave a higher proportion of 'disagree' responses regarding expectations of mangrove deforestation and a higher proportion of 'strongly agree' responses regarding expectations of intertidal alteration (as compared to all others).

Dili was distinctive in that respondents indicated a relatively high proportion of 'don't know' responses to a numbers of questions (e.g. destruction of fringing reefs and fish habitats and increased pollution) on the potential negative consequences of development.

To summarise, the differing of response patterns on the expectation of negative environmental consequences of development highlights the potential policy implications between the regions. Mangrove deforestation and increased coastal erosion were noted as priority concerns so policy should therefore allow more stringent measures to be employed for mangrove protection if development occurs in Suai Loro. It should also contain specific provisions, such as development sites be an appropriate distance from mangrove forest. It is important to conduct awareness-raising programs in order to increase respondents' knowledge on issues of coastal erosion in Suai Loro, increased pollution in Beaco and the importance of the marine environment, particularly among Dili respondents.

4.3.2.6 Negative social consequences

Suai Loro was distinctive in that a relatively high proportion gave 'strongly agree' responses to the questions on increased health risks due to pollution and damage to cultural sites as potential negative social consequences of development. These views seem to suggest that Suai residents are perhaps more resistant to external interventions or anything that could cause change to their traditional way of life.

Table 4.37 Summary of trends on expectations of negative social consequences as a result of development by location. (Note: majority in agreement = strongly agree + agree).

Questions	Suai Loro	Beaco	Betano	Dili
Expectation of negative social consequences of development				
Reduction in fish stock	most (77%) agree	most (87%) agree	most (89%) agree	most (52%) agree
Reduction of agricultural land due to pollution	most (53%) agree	most (65%) don't know	most (78%) disagree	most (78%) disagree
Loss of potential for developing tourist industry	most (53%) don't know	most (48%) agree	most (46%) agree	most (48%) disagree
Increased health risks due to pollution	(15%) strongly agree	most (48%) agree	most (63%) agree	most (56%) agree
Damage to cultural sites	Strongly agree (43%)	most (97%) disagree	most (98%) ddisagree	most (41%) disagree
Damage the land for future generation to use	most (64%) don't know	most (87%) don't know	most (72%) don't know	most (70%) don't know
Increased population migrant workers	most (57%) agree	most (74%) agree	most (76%) agree	most (59%) disagree
Increased job losses	most (43%) disagree	most (52%) agree	most (44%) disagree	most (63%) disagree

Dili was distinctive in that there were a relatively high proportion of 'disagree' answers to questions. For example, the majority correspondents did not consider loss of potential for tourism industry, reduction of agricultural land due to pollution and an increased population of migrant workers to be among the potential negative social consequences of development. This perhaps indicates that Dili respondents have less interest in fishing, farming and tourism than the coastal villages which are more reliant on these for their livelihoods. Dili respondents may also not have regarded increased migrant workers as a significant issue as they live in a big city as opposed to a small community.

To conclude, overall responses from Suai Loro mainly focused on cultural sites, although the view that oil development would cause damage to those sites is not necessarily correct. In the case of health effects due to oil pollution and in consideration of public expectations, a wider public information campaign might be appropriate in order to reassure concerns and reduce resistance to development based on misconceptions.

4.3.2.7 Importance of increased employment compared with listed negative consequences.

Suai Loro respondents gave a higher proportion of ‘disagree’ and ‘strongly disagree’ responses to the assertion that increased employment was more important than damage to mangroves and cultural sites. They also gave a higher proportion of ‘disagree’ responses to the assertion that increased employment was more important than an increased population of migrant workers in comparison to Betano and Dili.

The responses to other questions show evidence that Suai respondents regarded lack of employment opportunities as a significant issue. This data also illustrates that they are a far more traditional and conservative society and attach greater importance to mangroves and other features of cultural relevance than is the case in other locations. They also appear to have more concerns regarding migrant workers. This is perhaps because they fear that an influx of migrants would be detrimental to their culture. The results are presented in the median responses and the error bars denote standard of the mean.

Table 4.38 Summary of trends on importance of increased employment when compared with the listed negative consequences. (Note: majority in agreement = strongly agree + agree).

Questions	Suai Loro	Beaco	Betano	Dili
Level of agreement on whether the benefit of increased employment outweighs the listed negative consequences				
Damage to the seabed in general	all agree (100%)	all agree (100%)	most agree (98%)	most agree (93%)
Damage to intertidal zone in general	all agree (100%)	all agree (100%)	most agree (98%)	all agree (100%)
Damage to coral reefs	all agree (100%)	most agree (97%)	most agree (98%)	all agree (100%)
Damage to mangroves	most agree (85%)	most agree (97%)	all agree (100%)	all agree (100%)
Increased pollution	most disagree (87%)	most disagree (94%)	most disagree (98%)	all disagree (100%)
Questions				
Reduction to fishing industry	most agree (98%)	most (97%) agree	most agree (98%)	all agree (100%)
Damage to agricultural land	most agree (83%)	most agree (77%)	most agree (93%)	all agree (100%)
Loss of potential for tourist industry development	most agree (87%)	most agree (68%)	most agree (89%)	all agree (100%)
Increased health risks due to pollution	most disagree (91%)	most disagree (94%)	most disagree(96%)	all disagree (100%)
Damage to cultural sites	most disagree (53%)	most agree (81%)	most agree (96%)	all agree (100%)
Increased population of migrant workers	most disagree (49%)	most agree (68%)	most agree (96%)	all agree (100%)

The responses from Beaco show some similarities to those of Suai Loro. Like Suai Loro, they gave a higher proportion of ‘disagree’ responses to the assertion that increased employment was more important than an increased population of migrant workers, as compared to Betano and Dili. They also gave a higher proportion of ‘don’t know’ and ‘disagree’ responses to the assertion that increased employment was more important than damage to cultural sites. Presumably this is because Beaco shares some of the same cultural attributes as those subscribed for Suai Loro.

Dili respondents gave a higher proportion of ‘agree’ responses to the assertion that increased employment was more important than damage to agricultural land and the loss of potential for tourism. This corresponds to the response patterns apparent in earlier questions that suggested farming and tourism had limited direct relevance to many Dili residents.

The findings of this section of the study suggest that although employment opportunities were clearly important to the majority of respondents in all areas, policies should take into account the differing opinions in Suai Loro. It would also be prudent, for example, to only allow entry to skilled foreign workers in order to prevent potential conflicts and build trust within communities.

4.3.2.8 Importance of improved health care compared with listed negative consequences

Suai Loro respondents gave a higher proportion of ‘disagree’ and ‘strongly disagree’ responses to the assertion that improved healthcare was more important than damage to cultural sites. They also gave a higher proportion of ‘strongly disagree’ responses to the assertion that improved healthcare was more important than increased pollution in comparison to Betano and Beaco. A higher proportion of ‘disagree’ responses than any other location was also given on the question of whether improved healthcare was more important than damage to agricultural land. This presumably reflects their high interest in cultural values and general resistance to any potential change to their way of life. This view differed to the other regions on the South Coast, for which the majority agreed that healthcare was a key priority.

Table 4.39 Summary of trend s on importance of improved healthcare when compared to listed negative consequences.

Questions	Suai Loro	Beaco	Betano	Dili
List of agreement whether the benefit of improved healthcare outweighs the listed negative consequences				
Damage to the seabed in general	all agree (100%)	most agree (90%)	most agree (98%)	all agree (100%)
Damage to intertidal zone in general	all agree (100%)	most agree (94%)	most agree (98%)	all agree (100%)
Damage to coral reefs	most agree (96%)	most agree (84%)	all agree (100%)	all agree (100%)
Damage to mangroves,	most agree (89%)	most agree (84%)	most agree (93%)	all agree (100%)
Increased pollution	most disagree (66%)	most disagree (90%)	most disagree (94%)	all disagree (100%)
Reduction fishing industry	most agree (96%)	most agree (94%)	most agree (93%)	all agree (100%)
Damage to agricultural land	most agree (53%)	most agree (68%)	most agree (89%)	all agree (100%)
Loss of potential for tourist industry development	most agree (94%)	equal proportions (45%) disagree and agree	most agree (89%)	all agree (100%)
Increased job losses	most disagree (77%)	most disagree (94%)	most disagree(89%)	all disagree (100%)
Damage to cultural sites	most strongly disagree (55%)	most agree (52%)	most agree(93%)	most agree(85%)

The responses from Beaco show some similarities to those of Suai Loro. Like Suai Loro, the respondents gave a higher proportion of ‘disagree’ responses to the assertion that improved healthcare was more important than damage to cultural sites in comparison to Betano and Dili. They also gave a higher proportion of ‘don’t know’ and ‘disagree’ responses to the assertion that improved health care was more important than damage to agricultural land when compared to Betano and Dili. Beaco also differed from the other regions in that there was a higher proportion of 'disagree' responses to the assertions that improved healthcare was more important than damage to coral reefs and the loss of potential for tourist industry development. Presumably this is because Beaco shares some of the cultural same attributes as Suai Loro and perhaps envisage a greater potential for tourism than is the case for other locations.

The findings of this section of the survey suggest that although improved healthcare was clearly important to the majority of respondents in all areas, policies should also take into account the opinions in places such as Suai Loro and Beaco. It would also be prudent when planning oil industry development to consider possible protection of cultural sites and agricultural land, as well as to formally assess possible loss of tourism potential.

4.3.2.9 Importance of improved transportation links compared to listed negative consequences

Suai Loro respondents gave a higher proportion of 'disagree' and 'strongly disagree' responses to the assertion that improved transportation links were more important than damage to cultural sites. They also gave a higher proportion of 'disagree' responses to the assertions that improved transportation links were more important than damage to mangroves and an increased population of migrant workers. This presumably reflects their strong interest in cultural values and general resistance to any change in their way of life compared to other regions on the South Coast, for which the majority agreed that transportation links was higher priority.

Table 4.40 Summary of trends on importance of improved transportation links compared to the listed negative consequences.

Questions	Suai Loro	Beaco	Betano	Dili
Level of agreement on whether the benefit of improved transportation links outweighs the listed negative consequences				
Damage to the seabed in general	all agree (100%)	most agree (97%)	all agree (100%)	all agree (100%)
Intertidal zone in general	all agree (100%)	most agree (93%)	all agree (100%)	all agree (100%)
Coral reefs	all agree (100%)	most agree (97%)	all agree (100%)	all agree (100%)
Damage to mangroves	most agree (74%)	most agree (97%)	most agree (93%)	all agree (100%)
Increased pollution	most disagree (96%)	most disagree (97%)	all disagree (100%)	all disagree (100%)
Reduction to fishing industry	most agree (91%)	most agree (90%)	most agree (94%)	all agree (100%)

Questions	Suai Loro	Beaco	Betano	Dili
Damage to agricultural land	most agree (91%)	most agree (87%)	most agree (98%)	all agree (100%)
Loss of potential for tourist industry development	most agree (94%)	most agree (81%)	most agree (98%)	all agree (100%)
increased health risks due to pollution	most disagree (85%)	most disagree (94%)	most disagree (98%)	all disagree (100%)
Damage to cultural sites	most (55%) strongly disagree	most (77%) agree	most (98%) agree	all agree (100%)
Increased population of migrant workers	most disagree (64%)	most agree (58%)	most agree (96%)	all agree (100%)

There were some smiliarities in responses between Beaco and those in Suai Loro. Like Suai Loro, they gave a higher proportion of 'disagree' responses in comparison to Betano and Dili to the assertion that improved transportation links was more important than damage to cultural sites and avoiding an increased population of migrant workers. They also gave a higher proportion of 'don't know' and 'disagree' responses to the assertion that improved transportation links was more important than loss of potential for tourism.

As with the previous findings, these highlight the importance of establishing and protecting specific cultural sites and limiting immigration to specialised migrant workers only.

4.3.2.10 Overall views on the development of the oil refinery

Suai Loro is distinctive in showing a greater level of concern for environmental protection than demonstrated in the responses in the other areas. Suai Loro respondents showed a greater tendency to 'disagree' that environmental concerns can be disregarded, a greater tendency to 'strongly agree' that reasonable steps should be taken to protect the environment and a greater tendency to 'agree' that development should only proceed if all environmental issues can be avoided.

Table 4.41 Summary trends of overall views by location

Questions	Suai Loro	Beaco	Betano	Dili
Overall views				
Very important that development proceeds and environmental issues are minimal and should be disregarded	most (60%) disagree	most (74%) agree	most (63%) agree	most (70%) agree
Very important the development proceeds but reasonable steps should be taken to protect the environment	most strongly agree (94%)	most strongly agree (65%)	most strongly agree (87%)	most strongly agree (59%)
Development should only take place if all environmental issues can be avoided.	most agree (62%)	disagree (35%)	most agree (44%)	Don't know (56%)
Development should be avoided due to the environmental harm.	most disagree (98%)	most disagree (97%)	all disagree (100%)	all disagree (100%)

4.3.2.11 Summary of differences between regions

This sub-section is intended to provide a summary of the differences between regions, including the main conclusions, underlying causes of trends and the main policy implications for each question in turn.

Importance of natural environment: It was clear that there were distinct regional differences in views on the importance of different components of the natural environment. Such differences may have arisen due to cultural differences between the communities, different levels of economic links (e.g. fishing) to the marine environment or merely different levels of familiarity with the marine environment. This finding underlines the importance of local stakeholder consultation in developing environmental policy as general or national views are not necessarily well-aligned with local views. It may also be desirable to maintain sufficient flexibility in the detail of environmental policy so that it can be adapted to accommodate the strongly held views of a particular community of local stakeholders.

Importance of livelihood sectors: There was evident disparity between the regions on the perceived importance of different components of livelihood sectors. This was likely due to differences in local employment patterns and variations in the relative importance of the livelihood sectors.

It is obviously important to consider the potential consequences for local employment opportunities before proceeding with a development and that the existing patterns of employment are likely to vary depending on location.

Levels of satisfaction with basic infrastructure: It was apparent that there were clear differences among regions on the level of satisfaction with basic infrastructure. Such differences potentially arose due to the different levels of access to transportation links (e.g. road access, public transport services etc.) in communities, as well as the varying distances from public services such as schools and health centres. Although it was Suai that was most dissatisfied with transportation, they were also most opposed to possible changes due to development. The overall picture is quite complex and even though a high level of dissatisfaction with infrastructure exists; this does not necessarily mean that development is more strongly welcomed.

Expectations of positive consequences: The survey indicated regional dissimilarities in expectations of positive consequences of development. Such dissimilarities likely arose from social interests (e.g. access to schools, clinics or hospitals) and other differences between the communities such as economic interests (e.g. employment opportunities and creation of new business opportunities) and attitudes towards lifestyle changes. Re-organising this is vital to emphasise the essentiality of local stakeholder consultation in developing environmental policy.

Negative consequences on environment and social sector: It was equally apparent that there were distinct regional differences in views on the development's potential negative consequences on the environment. This stemmed from the different levels of economic association (e.g. fishing), cultural differences between communities and varying levels of environmental knowledge and familiarity with the marine environment. The research also found similar regional differences in views on negative social consequences of development, arising from a similar mix of causes. By clearly identifying such differences, this study has confirmed the importance of inbuilt local stakeholder consultations on environmental policy.

Agreement on importance of employment benefits, improved healthcare and transportation weighed against negative environmental consequences: It was evident that there were regional differences in views on each of these questions, possibly resulting from similar factors to those already identified above. These novel findings underline the importance of seeking the opinions of relevant local stakeholders. It is thus desirable to employ inbuilt stakeholder consultation as part of the EIA to identify the strongly held views in different locations and examine these for their policy implications.

4.3.3 Differences in responses based on occupations

The summary of trends in the overall response patterns for respondents is presented in Table 4.32. The summary of response patterns of the MW results for all respondents associated with the questions on the importance of natural resources and livelihoods sectors, as well as expectations of positive and negative consequences, show significant differences according to categories of occupations.

4.3.3.1 Overall responses on the importance of natural features

The fishermen/farmer and farmer groups showed some similarities in that they gave a higher proportion of 'disagree' responses regarding the importance of coastal erosion and coastal pollution (relative to the other groups). The fishermen/farmer group was further distinguished by the higher proportion of 'strongly agree' responses regarding the importance of intertidal habitats, fringing reefs, breeding and spawning habitats (relative to other groups) and coral reefs (relative to farmers). This seemed to reflect the fact that fishermen and/or farmers had a greater vested interest in the marine environment. It also indicated a greater familiarity with the marine environment in that they showed greater certainty that coastal pollution and erosion was not currently an important issue.

Table 4.42 Summary of trends on overall perceptions of importance

	Farmer	Fisherman & Farmer	Educators & white – collar workers (EWCW)	Trade & Service Industry (TSI)
Perceptions on importance natural features				
Mangroves	most agree (59%)	most agree (62%)	most agree (67%)	most strongly agree (58%)
Intertidal habitats	most agree (62%)	most strongly agree (55%)	most agree (44%)	most agree (58%)
Fringing reefs	most don't know (47%)	most strongly agree (46 %)	most don't know (70%)	most agree (63%)
Breeding habitats	most strongly agree (68%)	most strongly agree (95%)	most strongly agree (44%)	most strongly agree (79%)
Coastal erosion	most disagree (76%)	most disagree (82%)	most don't know (52%)	most agree (46%)
Coastal pollution	most disagree (68%)	most disagree (66%)	most agree (48%)	Most agree (46%)
Coral reefs	most strongly agree (68%)	most strongly agree (89%)	most strongly agree (44%)	most strongly agree (71%)
Seabed in pristine conditions	most strongly agree (50%)	most agree (54%)	most don't know (44%)	most agree (54%)
Migratory species	agree (50%) & don't know (50%)	most agree (74%)	most don't know (52%)	Most agree (71%)

Limited familiarity with the marine environment was also indicated in the response pattern of EWCW where a higher proportion of 'don't know' responses were given on the questions of the importance of intertidal habitats and a pristine seabed. Similarly, EWCW gave a lower proportion of 'strongly agree' responses regarding the importance of coral reefs.

Conversely, TSI gave a higher proportion of 'strongly agree' responses to questions regarding the importance of coral reefs and fringing reefs.

Differences relating to respondents' occupation appear to partially reflect the degree of economic dependence on the marine environment of each employment sector. Development policy should therefore recognise economic importance and seek to avoid any adverse impacts on the livelihoods of the relevant sectors.

Livelihood sectors

The fishermen / farmer and farmer groups show some similarities in that they gave a higher proportion of 'strongly agree' responses regarding the importance of agriculture. The fishermen / farmer group also gave a higher proportion of 'strongly agree' responses regarding the importance of fishing (relative to the other groups). EWCW gave a higher proportion of 'strongly agree' responses regarding the importance of handicrafts and TSI gave a higher proportion of 'strongly agree' responses regarding the importance of building and construction (relative to the other groups).

Table 4.43 Summary of trends on importance of livelihoods sectors

	Farmer	Fisherman & Farmer	Educators & white – collar workers (EWCW)	Trade & Service Industry (TSI)
Perceptions on the importance of livelihood sectors				
Fishing activities	most agree (56%)	most strongly agree (89%)	most agree (63%)	most disagree(50%)
Agricultural activities	most strongly agree (94%)	most strongly agree (89%)	most agree (63%)	Most disagree (50%)
Handicrafts	most agree (41%)	Most agree (41%)	most agree (48%)	most agree (63%)
Building & construction	most agree (41%)	most agree (46%)	most agree (48%)	most agree (58%)
Port & maritime	most strongly agree (85%)	most strongly agree (91%)	most strongly agree (81%)	most strongly agree (88%)
Tourism	Most agree (47%)	Most agree (46%)	Most agree (78%)	Most agree (58%)

Differences relating to respondent occupation appear to closely reflect the degree of economic dependence on each employment sector. Development policy should recognise economic importance and seek to avoid adverse impacts on the livelihoods of the relevant sectors.

Possible environmental negative consequences

Table 4.44 Summary of trends on expectations of negative environmental consequences of development.

	Farmers	Fishermen & Farmers	Educators & white – collar workers (EWCW)	Trades & service industry (TSI)
Expectations of negative environmental consequences of development				
Mangrove deforestation	most disagree (38%)	most disagree (33%)	most strongly agree (28%	most agree (33%)
Alteration of intertidal habitats	most agree (74%)	most agree (79%)	most agree (50%)	most agree (54%)
Destruction of fringing reefs	most agree (74%)	most agree (59%)	most agree (56%)	most agree (71%)
Destruction of breeding & spawning habitats of fish	most strongly agree (82%)	most strongly agree (84%)	most strongly agree (63%)	most strongly agree (83%)
Increased pollution in coastal areas	most agree (44%)	most agree (35%)	most don't know (59%)	most agree (46%)
Increased erosion in coastal areas	most disagree (71%)	most disagree (51%)	most disagree (56%)	most don't know (42%)
Destruction of coral reefs	most agree (41%)	most agree (50%)	most strongly agree (48%)	most strongly agree (46%)
Alteration to seabed conditions	most agree (82%)	most agree (85%)	all agree (100%)	most agree (67%)
Disturbance to migratory species				

EWCW were distinct in that they gave a higher proportion of 'don't know' responses to various questions (i.e. alteration of intertidal habitats, destruction of fringing reefs, destruction of breeding and spawning habitats of fish and increased pollution in the coastal areas) than was given by the other employment sectors. This response pattern is similar to that shown for previous questions and seems to indicate a general lack of familiarity with the marine environment within the EWCW sector.

Possible Social negative consequences

Table 4.45. Summary tof rends on expectations of negative social consequences of development.

	Farmer	Fisherman & Farmer	Educators & white –collar workers (EWCW)	Trade & Service Industry (TSI)
Expectations of negative social consequences of development				
Reduction in fish stocks	most agree (94%)	most agree (82%)	most agree (52%)	most agree (75%)
Reduction in productivity of agricultural land due to pollution	most disagree (41%)	most disagree (41%)	most disagree (78%)	most disagree (71%)
Loss of potential for tourist industry development	most don't know (50%)	most don't know (42%)	most disagree (48%)	most agree (38%)
Increased health risks due to pollution	most agree (62%)	most agree (63%)	most agree (70%)	most agree (75%)
Damage to cultural sites	most disagree (71%)	most disagree (76%)	most disagree (41%)	most disagree (71%)
Damage the the land for future generations to use	most don't know (91%)	most don't know (72%)	most don't know (70%)	most don't know (50%)
Increased population of foreign migrant workers	most agree (74%)	most agree (65%)	most agree (53%)	most agree (75%)
.....				

EWCW were distinct in that they gave a higher proportion of 'disagree' responses to various questions (i.e. reduction in fish stocks, reduction in productivity of agricultural land due to pollution, increased population of foreign migrant workers and increased jobs loss) than was given by the other employment sectors. The sector also appeared to be more optimistic regarding the potential consequences of development. This was possibly due to a lower degree of direct economic dependence on activities such as fishing and agriculture.

4.3.2 Summary of policy implications based on occupation

This section provides a summary of differences in opinion between the different categories of occupations and the main policy implications for each question.

Importance of natural environment and livelihood sectors: It was evident that there were distinct occupational differences in views on the importance of different components of the natural environment. Such differences may have arisen due to varying levels of knowledge on environmental issues among the communities with different occupations, as well as different levels of economic links to the marine environment. Another factor may have been the different levels of familiarity with the marine environment. Likewise, there were evident differences in the views on the importance of livelihood sectors based on different interests (e.g. fishing, farming) and the level of social sector development (e.g. tourism, handicrafts). These novel findings again highlight the vital role of local stakeholder consultation in identifying issues of interest and concern, as well as the importance of setting flexible environmental policies to accommodate the fact that general or national views are not necessarily well aligned with the views of particular occupations.

Negative consequences on the environment or social sectors: It was apparent that there were distinct occupational differences in views on the possible negative consequences of development on both the environment and social sectors. This was based on factors such as economic interest, level of knowledge and familiarity with the environment, particularly with the marine environment. This degree of divergence further emphasises that local stakeholder consultation is an essential part of the EIA process. It is important that this consultation explore the differences in views according to individual occupations and incorporate strongly held views when formulating the details of environmental policy.

This section provides summary of differences in opinion between categories of occupations and the main policy implications for each question.

Importance of natural environment and livelihood sectors: It evident that there are distinct occupational differences in views on the importance of different components of natural environment. Such differences might arise from different levels of knowledge on environmental issues between the communities with different occupations, different levels of economic links to the marine environment or merely to different levels of familiarity with the marine environment. Likewise, here are evident differences in the views on the importance of livelihood sectors based on different interests (e.g. fishing, farming) and different levels of social sector development (e.g. tourism, handicrafts). The identification of these issues of interest and concern these novel findings again highlight the vital role of local stakeholder consultation in setting flexible environmental policies to accommodate the fact that general or national views are not necessarily well aligned with the views of particular occupations.

Negative consequences on the environment or social sectors: It is apparent that there are distinct different occupational differences in views on the possible negative consequences of development on both the environment, and social sectors, based on such factors as economic interests and levels of knowledge on or familiarity the environment particularly with the marine environment. This degree of divergence also emphasizes essential local stakeholder consultation as part EIA process, which should explore differences views in individual occupations, and incorporate strongly held views, into the details of environmental policy.

4.3.3.2 Differences in responses based on education gender and age

Responses based on educational categories did not appear to demonstrate differences either by ANOSIM analysis or MW pairwise comparisons, although it might be expected that in education categories, for example, better educated people would be more likely to better understand the importance of environment. Consequently, as better education is likely to result in better understanding those who are less educated would benefit from a public information campaign that explained potential development consequences. These novel findings also suggest that this lack of difference may be due to the fact that there is a very limited number of people with higher education in the villages, which may have disproportionately influenced the results. The sample size may also not have been large enough to reveal such differences.

Within the gender and age categories it might be expected that older people are presumably better informed and have more life experience compared to the younger generation, for whom policy development has less influence. To help keep the younger generation informed it is therefore worth having a policy which emphasises environmental information and awareness.

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On gender and age categories it might be expected that older people are presumably better informed and have more life experience compared to the younger generation, for whom policy development has less influence. To inform to the younger generation it is worth having a policy which emphasizes environmental information and awareness.

4.3.4 Views of corporate bodies and institutions between sectors

A summary of overall differences in views on different issues, for all corporate bodies, are presented in Table 4.46, These have been classified within five main categories: natural resources, social aspects, satisfaction with provision of basic infrastructure, possible negative consequences and views on the desirability of the development of the oil refinery. These issues are ranked in priority order based on the frequency with which they were mentioned by respondents. The validity of the respondents' prioritisation was then assessed and differences between the views of organisations evaluated.

Table 4.46. Summary of differences in views between sectors.

Environmental Issues	Corporate views (%)
Views on natural resources highlighted as important include : - Coral reefs - Mangroves	 75 50
Views on social aspects which needs to be considered for protection include: - fishing - agriculture	 80 73
Dissatisfaction with provision of basic infrastructure: - electricity - transportation links - water sanitation	 88 65 54
-Views on possible negative consequences which should be avoided: - fishing - agriculture - coral reefs - mangrove	81 69 65 42
Views on the likelihood of development of oil refinery: - Very important development proceeds but reasonable steps should be taken to protect the environment	77

A high proportion of all corporate respondents attached importance to coral reefs (75%) and mangroves (50%) as natural resources. This presumably arose from the generally high profile of such habitats and public perceptions on their highly diverse nature and fragility. However the high priority given to these habitats is questionable given the limited information available on the marine habitats of the region. In fact, perhaps there are other habitats which also exist in the region which should be given equally high priority but which have not yet been identified. Nevertheless, environmental policies should prioritise coral reefs for protection, as well as ensure that development sites should are located an appropriate distance from the reefs. Mangrove forests were also identified as important natural features by corporate representatives, presumably because of general perceptions that mangroves are highly diverse and fragile. Other common perceptions are that mangrove forests offer protection from flooding and this perhaps influenced respondents' views. It could further be argued that such views draw more on general perceptions than scientific evidence. Nevertheless, it would seem appropriate to prioritise the protection of mangrove areas at this stage in the development of environmental policy.

Fishing (80%) and agricultural activities (75%) were identified as important economic and/or social sectors. This was clearly based on the fact that these are two major economic sectors with significant economic interest for the local residents on the South Coast, as has been documented in section 2.2.1. Fishing and agriculture should therefore be noted as priority sectors for protection and a policy for the protection of these sectors should constrain oil refinery development. For example, developments should be tightly controlled in the vicinity of fishing grounds and agricultural land. Fishing and farming communities should be involved in stakeholder consultations to explore possible mutually acceptable solutions and appropriate decisions.

Electricity (88%) was identified in all corporate responses as the most important basic infrastructure provision in need of improvement. Perhaps these strong views are because electricity is regarded as a vital aspect in generating or supporting local economic activities in various sectors. The views also presumably reflected the fact that electricity is also important to facilitate local education and telecommunications. About two-thirds of corporate respondents identified transportation links as unsatisfactory. Perhaps these views were strong due to the importance of transportation to local economic activities and in helping promote local products such as agricultural products, fish and handicrafts. More than half of the corporate respondents identified water and sanitation services as unsatisfactory. These views are possibly associated with the lack of clean drinking water supplies and installations in the South Coast region, as well as the relatively long distances between drinking water stations and residents' homes.

Reduction in fishing activities (81%) was identified as a possible negative consequence of development and should therefore be noted as a priority for protection policies in order to prevent or minimise any adverse effects. Other possible negative consequences that should be avoided included damage to agriculture (69%), destruction of coral reefs (65%) and destruction of mangroves (42%).

Corporate bodies were also were questioned on their overall views on the development of the oil industry and the majority (77%) indicated that they believed it was important that development proceed in order to boost the national economy, with the proviso that reasonable environmental regulations and standards are out in place to protect the natural environment. Presumably these strong views reflected a strong desire for economic benefits, although corporate bodies did not believe that development should impact unduly on the natural environment or constrain development in other sectors.

4.3.5 Assessment of patterns between questionNaires and interviews with corporate bodies and implications for policy.

This section assesses the results of the responses given by government institutions in comparison to those of NGOs. Consequently, the assessment is limited to ranking the scores recorded and assessing relative priorities given to different issues. A summary of the ranking is given in Table 4.47.

Table 4.47. Summary of the ranking the results based on the responses from government institutions and the NGO sector, *(Note: the superscript 1, 2, 3...etc. represents the ranking given to the issues in the responses from each stakeholder group.* ***The value of responses is derived from the highest score in each category and then converted into a percentage. The values in the table are presented in percentages and show the comparison between the two stakeholder groups).***

Categories	Government Institution (%)	NGO's (%)
Views on importance of natural resources:		
Mangrove forests	54^{2}	43^{2}
Coral reefs	82^{1}	43^{2}
Breeding habitats	54^{2}	-
Seabed in pristine condition	-	57^{1}
Coastal pollution	-	-
Migratory species	9^{3}	-
Coastal habitats	9^{3}	14^{3}
Views on social aspects:		
Fishing	100^{1}	43^{1}
Agriculture	82^{2}	43^{1}
Tourism	9^{4}	28^{2}
Sacred sites	64^{3}	28^{3}
Increased job losses	-	43^{1}
Land disputes	-	14^{3}
Views on provision of basic infrastructure:		
Electricity	91^{1}	86^{1}
Transportation links	73^{2}	43^{3}
Water and sanitation	36^{3}	86^{1}
Basic education	18^{4}	-
Basic health services	9^{5}	57^{2}
Views on negative consequences:		
Fishing	100^{1}	43^{2}
Coral reefs	54^{3}	57^{1}
Mangroves	36^{4}	43^{2}
Breeding habitats	27^{5}	-
Coastal habitats	27^{5}	14^{4}
Agriculture	73^{2}	43^{2}

Categories	Government Institution (%)	NGO’s (%)
Sacred sites	9^{6}	28^{3}
Increased job losses	-	43^{2}
Overall views:		
Very important development proceeds with proper safeguards	10^{1}	6^{1}

Overall, the results demonstrated that in general the two stakeholder groups had widely diverse priorities, with only minor similarities between the rankings given to the various issues.

However, rankings on existing natural resources indicated that priorities were relatively closely aligned when it came to mangrove forests, coral reefs and coastal pollution. This could be interpreted by considering that both government institutions and NGOs have more knowledge of such natural resources based on regional or general information, as biodiversity data for the region is still far from complete. However, there were significant differences in regard to the issue of pristine seabed conditions. This could indicate a higher level of concern among NGOs or perhaps the low ranking given by respondents from government institutions was due to the fact they were unfamiliar with local villages on the South Coast. In comparison, NGO respondents were all originally from local communities on the South Coast and were therefore more familiar with the existing natural resources. Thus, implementing an environmental policy would be wise in this case in order to prevent conflict among development stakeholders. It is also essential for the protection and conservation of local biodiversity.

The priority given to the provision of social aspects was less closely aligned between both stakeholders groups, particularly for fishing, agriculture and sacred sites. Possible causes for the difference in responses was because respondents from government institutions assumed that subsistence agriculture was the major and predominant occupation on the South Coast. The priority given to sectors such as tourism, increased job losses and land disputes appeared to be more pronounced in NGO responses compared to those of government respondents.

The priority of views on the provision of basic infrastructures was relatively diverse in nature. The only similarity was in the responses on the electricity sector and transportation links. In regards to the priority given to sectors such as basic health, education and water and sanitation services there was significant differences.

Responses on negative social and environmental consequences demonstrated split views. While aspects such as fishing, coastal habitats and agriculture recorded similarities in priority, other aspects, including mangroves, coral reefs, breeding habitats, sacred sites and increased job losses generated a diverse range of responses.

The priority of views on the importance of development proceeding with proper safeguards was similar in both stakeholder groups. This demonstrated that while the majority of responses showed a strong interest in development proceeding due to economy interests, there was also concern about the sustainability of natural resources.

A summary of the results above indicated that while the two stakeholders groups do differ substantially, there were minor similarities in priority. It is therefore worth proposing a policy that can provide mechanisms for sharing environmental information among relevant stakeholders.

Conclusion

1. The study has established that around the South Coast of East Timor the views of respondents on the issue of oil refinery development are not evenly distributed. Suai Loro, in particular, appears to have strong community linkages and a more traditional belief system. This should therefore be taken into account if oil refinery construction does take place in that area.

2. The study has identified that fishermen and farmers are the most influencial groups in terms of the environment on the South Coast, and thus their livelihoods need to be protected if oil refinery construction takes place in the region.

3. The study has found that the majority of respondents are prepared to accept localised environmental impacts in order to gain the perceived economic benefits of oil industry development. However, additionally steps are needed to protect the social welfare of those in areas likely to be affected.

4. The study has also found that while the majority of respondents agree that development of the oil refinery should proceed, they also believed that reasonable steps should be taken to preserve the environment from damage.

5. Multivariate statistical analysis has provided some evidence of differing views among project locations and occupations. However, there was no evidence of difference found in the age, gender or education categories.

Chapter 5. INTERNATIONAL ENVIRONMENTAL REGULATORY FRAMEWORKS ON THE OFFSHORE OIL & GAS INDUSTRY: AN ASSESSMENT OF EFFECTIVENESS

5.1 Introduction

Oil industry activities in national and international waters have been a major concern for many developing countries in recent decades. Environmental issues arising from such activities in national and international waters potentially generate further conflicts among bordering countries. Consequently, to safeguard the environment in these waters, bordering countries typically have national and international environmental regulatory frameworks as well as transboundary environmental regulations in place. The Timor Sea potentially will require similar systems in the near future.

This chapter draws on experiences from other regions in relation to their environmental regulatory framework and transboundary regulations. It is anticipated that scrutiny of these experiences will facilitate the development of enhanced planning, regulations and management in the Timor Sea in regards to management of transboundary waters that respect both political borders and ecological realities. Increased exploitation of natural resources in international waters has made it increasingly important to consider management options in these cases.

The environmental regulatory framework and transboundary environmental management of the Timor Sea is still at an early stage of development. However, similar environmental concerns occur in other parts of the world and have been addressed by appropriate regulatory frameworks. Thus, this chapter focuses on analysing the environmental regulatory framework and environmental transboundary practices regarding the upstream oil and gas industry in other regions.

5.1.1 Objective of the Chapter

This chapter is aimed at critically assessing the effectiveness of current existing international environmental regulatory frameworks and transboundary environmental regulations for the oil and gas industry.

5.1.2 Methodology of this chapter

The aim of this study will be achieved through the assessment and analysis of case studies of Transboundary (international) environmental management systems. These will consider the following aspects:

- Environment issues and conflicts, with a focus on environmental law, environmental guidelines and standards. International environmental regulatory frameworks for the offshore oil and gas industry will also be reviewed.
- EIA process elements, including issues arising from treaties and conventions Associated with EIA and TEIA. This will be conducted by reviewing international practices treaties, declarations, customary laws and international conventions.
- Evaluation of transboundary impacts. This sub-section provides comprehensive reviews on EIA, including costs, delays and benefits, as well as TEIA applicable procedures, benefits and costs.
- Challenges and benefits will be presented through TEIA case studies from Mekong River, Danube River, English Channel and Greater Tumen River. The intention is to compare environmental issues and conflicts.

5.2 International Environmental Regulatory Frameworks for the Offshore Oil and Gas Industry

5.2.1 Environmental Law

Environmental law is a set of complex, integrated bodies that exist to regulate the interaction of humanity and the natural environment. The aim is to reduce the impact of human activities. International environmental laws pertinent to oil and gas operations have become increasingly acknowledged as being important over the last 50 years. However, comparable national level legislation has developed more slowly (Gao, 1998). The first emergence of an international treaty law for offshore oil and gas activities occurred at the 1958 UN Geneva Conference (known as UNCLOS I, it mainly covered agreements and did not extend to environmental issues). This conference resulted in the development of four 1958 Conventions on the Law of the Sea. Among these was the Convention on the Continental Shelf, which granted coastal states the sovereign right to explore and exploit the mineral resources along their continental shelves. This consequently provided for the development of the offshore oil industry. Presently, with the exception of the Law of the Seas Convention of 1982 (UNCLOS III) there is no general multilateral convention dealing specifically with the environmental control of petroleum production.

Environmental agreements affecting offshore operations include the London Dumping Convention (1972), the Offshore Pollution Liability Agreement (OPOL) (1974), the Convention on Civil Liability for Oil Pollution Damage Resulting from Exploration of Seabed Mineral Resources (1977) the International Convention on the prevention of Marine Pollution by Ships (1978), the Vienna Convention on the Protection of Ozone Layer (1985), the Convention of Climate (1992) and The Convention of Biodiversity (1992).

These international environmental agreements have resulted in the development of a series of environmental treaties at regional levels on different continents. These regional agreements *(treaties or multilateral environmental agreements)* play a crucial role in facilitating identification of regional problems; and coordination of monitoring as well as compliance programmes and procedures (Bodansky, 2007). For example the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention of 1992) has replaced a suite of prior agreements including the 1972 Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (Oslo Convention) the 1974 Convention for the Prevention of Marine Pollution from Land-based sources (Paris Convention), the Environmental directives of the EU and the Regional Seas agreements (derived from the homonymous United Nations Environment Programme).

The OSPAR Commission is the responsible body for the administration of the Convention of the same name. It has two main committees: Programme and Measures Committee (PRAM) and Environmental Assessment and Monitoring Committee (ASMO). The OSPAR Convention has been in force since 1998 and encompasses a range of important relevant provisions for the offshore oil industry such as; the precautionary principle, the polluter pays principle best available techniques (BAT), best environmental practice (BEP) and clean technology. Other essential regulatory annexes include Annex III on prevention and elimination of pollution from offshore sources, and Annex IV on assessment of the quality of the marine environment (OSPAR, 2008).

In terms of chemical discharges OSPAR focuses primarily on discharges of produced water. This occurs due to the more effective measuring system and studies of impacts on biota in the water column (Dicks, 1986). The OSPAR regulations on produced water were complemented by other measures (Recommendation 2001/1 for the Management of Produced Water from Installations) (OSPAR, 2008) because water discharges and associated chemicals were more loosely regulated at the time and only later became a significant concern. Thus by 2007, the standard for dispersed oil of 30 mg/l for produced water discharged into the sea was established and the requirement of high toxicology standards on aqueous drilling fluids, this was due to the fact that toxicity impact on benthic communities proved to be always present and increased with oil content in cuttings (Delvigne, 1996).

EU environmental law is extensive and comprises more than 200 directives, regulations and decisions addressing all facets (European Environmental Law, 2008). EU regulations go beyond the setting of discharge standards. Instead, they have ecological goals with sustainable focus. One example is the European Strategic Environmental Assessment Directive (Directive 2001/EC) for major developments and programmes likely to have significant effects on the environment. The Strategic Assessment is expected to "provide protection to the environment by the integration of environmental considerations into the plans towards the promotion of a sustainable development vision".

EU directives relating to the offshore oil and gas industry are presented in Table 5.1. These pieces of legislation range from general strategies and environmental goals to specific regulatory standards for environmental compartments (air, water and soils) or discharges (emissions, effluents or solid waste), and constitute the basis for the establishment of the minimum regulatory standards for EU members.

Table 5.1. Several EU directives applicable to the offshore petroleum industry. Source: (Europa, 2008) .

Directive	Name	Scope
93/43/EEC.	Habitat Directive, (Nature 2000)	The network comprises ‘’special areas of conservation’’ designated by member states in accordance with the provisions of the Directive, and special protection areas classified pursuant to Directive 79/409/EEC on the conservation of wild birds.
Regulation 96/61	Integrated Pollution Prevention and Control (IPPC)	The IPPC bureau has agreed upon the application of the BAT-principle for certain installations. A series of 32 briefs (BAT reference documents) to help the industry comply with the directive are available.
COM (98) 49	Offshore decommissioning	Communication from the Commission to the Council and the European Parliament of 18 February 1998 on removal and disposal of disused offshore oil and gas installations.
2001/42/EC	Strategic Environmental Assessment (SEA)	The SEA Directive aims at ensuring that environmental consequences of plans and programmes are identified and assessed during their preparation and before their adoption. The public and environmental authorities can give their opinion and all results are integrated and taken into account in the course of the planning procedure.
2003/4/EC	Public access to environmental information	Secure the right of access to environmental information for the public and ensures a highly electronic availability
2004/35/CE	Environmental liability	A controversial and potentially far-reaching piece of EU legislation aimed at preventing environmental damage by forcing industrial polluters to pay.
Regulation 614/2007	Financial Instrument for the Environment (LIFE+)	This Regulation brings together features of the LIFE-Environment and LIFE-Nature Programmes, as well as Forest Focus, the Urban Programme and several other smaller funding streams from DG Environment.
COM (2008) 46	Shared Environmental Information System (SEIS)	This Communication aims to improve the quality and the availability of environmental information in Europe. It is designed to simplify the collection, exchange and use of this information in order to correctly implement environmental policies. Information will be stored in environmental databases throughout the EU. Formats and interoperability of the data system will be harmonised to allow for integrated analyses and shared use.
EIA Directive (85/33/EEC)	EIA Water Directives	These have been in force since 1985 and apply to a wide range of defined public and private project, which are defined in ANNEX I & II.
Directive 2000/60/EC	Water Framework Directives	An EU directive which commits EU member states to achieving good qualitative & quantitative status of all water bodies (including marine waters up to one nautical mile from shore) by 2015. It is a framework in the sense that it provides precise steps to reaching the common goal rather than the adoption of the more traditional limit value.

5.2.2 Environmental guidelines and standards

5.2.2.1 Guidelines and standards of international organizations

Environmental guidelines are vital to international environmental policies. These guidelines provide a way to affect the behaviour of states *(or other international* *actors).*Broadly speaking, these guidelines are advice documents which provide guidance on procedures and processes with the aim of minimizing environmental impacts. Generally the environmental values reflected by the guidance are aligned with those of industry. An example of such guidelines is the standards for oil tankers outlined in the Marine Pollution (MARPOL) Convention. A common approach is for international agreements to incorporate a requirement that participating states should develop appropriate legislation to ensure compliance with the environmental guidelines (e.g. Rio Declaration, Agenda 21, and United Nations Environment Program (UNEP) and International Maritime Organization (IMO) guidelines). Alternatively, there may be a requirement that states issue their own environmental guidelines but participating states have independence in devising strategies to ensure environmental compliance (*e.g. Kyoto Protocol).* Such international regulatory frameworks are called "soft-laws".

These soft-laws have been issued by numerous relevant international organisations. These include UNEP (initiative on 'Offshore Oil and Gas Environment Forum) and the United Nations Conference on Trade and Development (UNCTAD) (facilitate information exchange). Another example is the IMO which is primarily concerned with the safety of shipping and the prevention of marine pollution. However, the IMO has also introduced regulations covering liability and compensation for damage, such as pollution, caused by ships.

The World Bank has 10 environmental and social Safeguard Policies. One of these (Environmental assessment policy) include specific environmental guidelines relating to oil and gas production (World Bank, 1991). At the Rio Summit on the environment (1992) the International Standard Organization (ISO) presented a framework for the development of an environmental management system and supporting audit programme. It subsequently developed a series of international standards on environmental management (ISO 14000 series). There are also relevant ISO standards for the petroleum industries which are shown in Table 5.2 below.

Table 5.2. ISO Environmental Standards for the oil and gas industry. Source: (OGP, 2005).

ISO 14001	Environmental management systems (EMS)-Specification with guidance for use
ISO 14004	EMS-General guidelines on principles, system and supporting techniques
ISO 14040	Environmental management (EM-Life cycle assessment (LCA)- Principles and framework
ISO 14041	EM-LCA-Goal and scope definition and inventory analysis
ISO 14042	EM-LCA-Life cycle impact assessment
ISO14043	EM-LCA-Life cycle impact assessment

5.2.2.2 Oil and Gas industry guidelines

Private companies are the ultimate target of most regulations. Consequently the industry often plays an active role in the formulation of such regulations at a national and international level. Industry motivation for influencing regulating may arise from their own business interests, a desire to forestall government regulation or a desire to ensure an internationally uniform application of standards (Bodansky, 2007). Industry representatives are arguably in the best position for advising on appropriate regulation because of their deeper understanding and experience of the relevant procedures and processes (Wawryk, 2002).

The Oil and Gas Producers (OGP) previously known as Exploration & Production (E & P Forum) is one of the most influential E & P organizations. It is comprised of the world's leading publicly-traded, private and state-owned oil and gas companies, industry associations and major upstream service companies. The Standards Committee's main focus is on development of a new set of international standards for the oil and gas industry, under the vision of 'Global Standards used Locally Worldwide'. The International Association of Geophysical Contractors (IAGC) is an international trade association comprised of organisations which provide geophysical services to the oil and gas industry. The remit of the IAGC concerns health and safety an environmental manual for worldwide geophysical operations including specific guidelines for operations in marine environment.

The International Petroleum Environmental Conservation Association (IPEACA) serves as a forum for discussion and cooperation involving industry and international organisations. Because it is not a lobby group, the IPEACA is well placed to ensure the establishment of an effective channel of communication between relevant stakeholders, which is seen as a crucial and important factor in the effective management of global environmental issues. Following the establishment of the UNEP, the IPEACA was established in 1974 to better facilitate communication.

Regional representative bodies of the offshore oil and gas industry play crucial roles. These regional bodies were primarily formed to promote and facilitate the development and the integration of the oil and natural gas industry. Subsequently, varying representative regional bodies emerged with different purposes or based on needs, including emphasis on the relevance of high environmental standards among its members operations in terms of sustainable development and biodiversity conservation. For example, in the UK, safety and occupational health issues are promoted comprehensively as part of national regulations. These also cover environmental operational standards for all phases and aspects of the offshore petroleum industry. In Norway, the Norwegian Oil Industry Association (OLF) exists to promote the unifying, efficient and effective organisation of its members. The American Petroleum Industry (API) was established to produces standards, recommended practices, specifications, codes and technical publications, reports and studies that cover each segment of the industry, some of which help to reduce regulatory compliance costs. The Canadian Association of Petroleum Producers (CAPP) is designed to analyse environmental – as well as other issues – while working closely with governments, communities and stakeholders. It also strives to achieve consensus on industry codes of practice and operating guidelines that meet or exceed government standards. In Australia, the Australian Petroleum Production and Exploration (APPEA) was developed to ensure a high standard of industry operations within Australia's environment. The regional Association of Oil and Natural Gas Companies in Latin America and the Caribbean (ARPEL) were created to promote and facilitate the development and the integration of the oil and natural gas industry in Latin America and the Caribbean.

5.2.2.3 Guidelines of individual organizations within the oil and gas industry.

Codes of Ethics for oil companies are a fundamental component for the assurance of environmental quality and are also important for achieving an ethically responsible model for the company. These codes form a reference point for all partners who might enter into relationships or transactions with the company. The codes also reflect how the company and its employees perform their daily activities to ensure the maintenance of adequate and healthy environmental quality. However, although they are stated as equal in multinational companies these principles are actually, not accomplished at the same standard in all subsidiaries. Although companies claim standard principles in all subsidiaries, only enforcement of local statutory laws can ensure they are adhered to.

In addition, private initiatives for standards or operational guideline definitions are compulsory. For example oil companies' national associations, technical groups' guides initiatives or industries' codes of conduct, are limited in their legitimacy, as most of them have not been approved or even reviewed by government or regulatory bodies, and thus, they are not part of the legal framework of operations in any country. The compliance of a company with any sector's guidelines will not necessarily mean compliance with legal obligations, and must therefore fulfil the related national legal framework. Law enforcement is a crucial factor depending on governmental agencies effectiveness. Difficulties are found in some countries and even exclusions or omissions in their legal framework, but under any circumstance, companies should be committed to the accomplishment of relevant laws.

5.2.3 Treaties and Conventions Associated with EIA and TEIA

5.2.3.1 Treaties and Declarations

Compared with transboundary environmental impact assessment (TEIA), EIA procedures have emerged and have been well developed in international environmental agreements for decades (Bruch, 2004) as manifested in the Rio Declaration, in Principle 17 which states that: *"Environmental impact assessment 'as a national instrument 'shall be undertaken for proposed activities that are likely to have adverse impacts on the environment and are subject to a decision of a competent national authority".*

Further explanations in the Rio Declaration, Agenda 21, particularly in section II 'Conservation and Management of Resources for Development' also strongly endorse the substantial EIA characteristics in various aspects of environmental management. In the Rio Declaration and Agenda 21 and Stockholm Declaration, environmental planning themes can be found in principles 2, 4, 12, 13, 14, 15 and 17.

In addition, the World Charter for Nature (WCN) 1982 restates the "no harm principle" and considers the essential elements of the EIA concept process which should be accomplished prior to project commencement (Bruch, 2004). This statement can be found in II Function 11 (c) and states: "*Activities which may disturb nature shall be preceded by assessment of their consequences, and environmental impact studies of development projects shall be conducted sufficiently in advance, and if they are to be undertaken, such activities shall be planned and carried out as to minimize potential adverse effects".*

However, the instrument is considered "Soft Law" and, therefore, not legally binding. A prominent feature of the EIA process is the requirement for public participation, also codified in this mechanism (EVNTL, 2003). Since the 1983 WCN, the EIA concept has been regarded as a standard component in many regional as well as international agreements. Similarly, in environmental management and regulation the international community has increasingly applied the EIA concept used in the domestic context to the management of transboundary resources. At the same time a growing number of international instruments explicitly consent to the use of TEIA.

After the pioneer declarations, there later developed the Convention on Biological Diversity (CBD), the United Nations Convention on the Law of the Sea (UNCLOS), and the Protocol on Environmental Protection to the Antarctic Treaty. The UNCLOS 1997 on the Law of the Non-Navigational uses of International Watercourses also identified a number of introductory components of TEIA. For example Article 12 includes requirements for notification and information to be shared between states.

The 2002, the World Summit on Sustainable Development (WSSD), in Johannesburg promoted the integrated management of watersheds, with particular attention to international watersheds. The resulting document clearly demonstrates in its Plan of Implementation, the essence of environmental impact assessments, inter alia, national instruments, as appropriate, as an essential barometer when making decisions on projects which may cause significant adverse effects to the environment.

5.2.3.2 Customary law

As with the EIA and TEIA processes, customary law also developed promoting EIA at international level, while laying down a foundation for creating an emerging TEIA process. The enactment of the International Law Association (ILA) in 1966, known as the ‘Helsinki Rules’, served as the basis for negotiations of the 1997 UN Watercourses Convention (Beaumont Peter, 1997). The substantial rules produced included 1) *equitable utilisations*: this theory is now seen as the *“cornerstone”* of international law regarding transboundary watercourses and which has also been adopted in the principle of customary water law. The Helsinki Rules, specifically in Article IV, state that each basin state is entitled, within its territory, to a *reasonable and equitable share* in the beneficial uses of the waters of an international drainage basin. The UN Convention, in Articles 5 and 6, also addresses equitable utilisation. Specifically, Article 5.2 (1) and (2) covers the idea of participation in achieving equitable and reasonable use.

2) No significant harm; this concept appears to be well established in international law and specifically in the Stockholm Principle 21, as well as in the Rio Principle 2, which precludes States from exploiting their own resources to such a point so as to cause damage to other bordering States. Such a concept is codified in Article 7 of the UN Convention (1) and (2).

3) State’s Duty to Cooperate: this point is a notable foundation principle underlying international law. It is undeniable that without the cooperation of States, it would be impossible for them to fulfil their obligations as instructed under international law. Particularly Article 6 of the UN Convention stipulates that in any negotiations, watercourse States should enter into consultations based on a spirit of cooperation. Article 8 provides forms of cooperation whereby States may consider the establishment of joint mechanisms or commissions. For example, utilising a joint mechanism will assist when two riparian States disagree as to what activity will provide “optimal utilisation and adequate protection”. The Article further states that watercourse States shall on a regular basis exchange readily available data and information on the condition of the watercourse. Article 10 underlines that States must also work together to determine the equitable and reasonable uses of a watercourse.

4*) Dispute Avoidance and Settlement:* this point is commonly stipulated in the Helsinki Rules, the UN Convention and in the Berlin Rules. However, it should be borne in mind that the inclusion of this information is especially important to ensure that a harmed party will have a mechanism for legal enforcement. As a result, in the updated version, Chapter VIII of the 9th draft revision, on “Impact Assessment” requires States to use the TEIA process in managing transboundary watercourses. Furthermore, Article 32 (2) states that potential impacts should be assessed.

Subsequently, the updated version strongly addresses developments in customary international law, favouring public participation in the TEIA process. The document describes how EIA and TEIA collectively served as foundational principles that have formed the evolution of the TEIA process. Therefore, it is pertinent to mention the raising of customary law cases prior to 1966, including cases decided by the International Court of Justice (ICJ), although, these are not directly related to the process (Upadhye, 2000). Examples include the Gabcikovo Nagymaros damns project, which involved the construction of a system of locks on the border between Hungary and Slovakia and the Trail Smelter Arbitration, an ad hoc tribunal decision between Canada and the United States (Troell, 2006) . Moreover, there are other international law cases such as the Corfu channel and the Lake Lanoux Arbitration (Bruch, 2004).

5.2.4 International Conventions

5.2.4.1 The Basel Convention

The Basel Convention is the sole legal instrument for addressing transboundary movements and environmental management of hazardous waste. Since the early stages of its approval, the Basel Convention has become the focus of an international legal regime on the hazardous waste issue. This is reflected in its fundamental principles; which include the principles of proximity of disposal of wastes, environmentally sound management and prior informed consent to the import of potentially hazardous substances. Key features of the Basel Convention include: 1) disposal of hazardous waste in the generating country, 2) reduction in the amount of hazardous waste in terms of quantity and hazardousness, 3) establishment of serious controls and check points on the export and import of hazardous waste, 4) prohibition of the shipment of hazardous wastes into countries that lack the technical know-how to safely dispose of this waste, and 5) cooperation , exchange of information, transfer of technology and harmonizing standards and guidelines among the signatory countries dealing with hazardous waste. From the presence of all these it can be argued that the convention has contributed to the development of customary international law in the relevant field. As a result, numerous regional treaties consisting of these principles have been adopted by diverse groups of countries worldwide. These have contributed to complementing the global regime of the Basel Convention which addresses specific regional requirements. Other recent developments have included efforts to cooperate with organizations working in areas that complement and strengthen the Basel Convention in particular with the World Customs Organization and the International Maritime Organization (IMO) in the area of marine pollution and transboundary movements.

5.2.4.2 The Arhus Convention

The Arhus Convention is defined as a vehicle to promote transboundary environmental process particularly the issues of access to information and public participation underlying all Articles of this Convention. Article 4 has the heading "access *to the environmental information*" which is vital in the transboundary environmental process as part of raising environmental awareness. The point here is how to make the environmental transboundary process available to the potential stakeholders, prior to the consultation stage. Article 5 is the *collection and dissemination of environmental information.* Each State or party shall be responsible for ensuring that all relevant authorities and potential stakeholders possess updated environmental information which is in line with their function. This article also requires that mandatory systems are adequately established and hence there is an appropriate flow of updated information to relevant authorities about the process. Article 6 is *public participation in decisions on specific activities*. This is to ensure that each party should respects the decision on whether to permit proposed activities listed in Annex I and importantly, that this is in accordance with existing national law. Article 8 states that there should be: "*public participation during the preparation of executive and/or generally applicable legally binding normative instruments*".

This article aims to promote effective public participation at the appropriate stage, i.e. the time frame is sufficient for effective participation and thus the draft should be made available publicly and the public should be given enough time to comment and be represented in consultative bodies. Article 9 provides access to justice as well as the provision for each Party may request under Article 4 has been ignored or wrongfully refused either partly or in full before the court approval.

In other words, the convention is to serve as a global framework for strengthening citizen's environmental rights. The role of civil society in environmentally related issues is so important because environmental sustainability requires the involvement of all actors and more participation generally leads to better decision-making processes. For example, criticism strengthens the quality of proposals and more participation leads to better implementation of decisions in turn generating a stronger sense of ownership.

The central tenet of this international legal instrument can potentially make an enormous difference in strengthening the role of the public in tackling environmental changes in transboundary contexts. This convention may also serve as a model for development of other regional instruments or national legislations. A high level of NGO involvement serves to enrich the process and assists in ensuring more effective implementation. It is also essentially an elaboration of Principle 10 of the Rio Declaration (1992). In relation to the transboundary environmental regulation, the requirements of the Arhus Convention are also addressed in the United Nations Economic Commission for Europe (UNECE) on environmental impact assessment in transboundary contexts.

5.2.4.3 The Espoo Convention

In order to be able to analyse the applicability of the Espoo Convention for the Timor Sea projects, it is necessary to understand it in depth. This should include its objectives and mechanisms as well as the process by which they function. As of April 2014 the convention has been ratified by 44 states in the European Union. East Timor is not signatory of the convention. This sub-section will examine the convention's origin performance, scope and administrative structure.

The origin of the Espoo Convention: concern over transboundary impacts in the early 1970s served as the foundational stone of the Espoo Convention. The term 'transboundary impact' was first introduced in the Stockholm Declaration in 1972 at the point where Principle 21 declares: "States should ensure that activities within their national jurisdiction do not cause any harm to the environment of bordering states territory". However, the implementation of the EIA transboundary process itself only started nine years later by a group of United Nations Environmental Programme (UNEP) experts who further elaborated the principle of the TEIA (Connelly, 1999).

Initially, TEIA was a controversial idea due to the subject of sovereignty. However, at a meeting in Warsaw a recommendation was made to develop a framework agreement on EIA in waters beyond the national jurisdiction. This marked the beginning of negotiations, assisted by a favourable political environment in enhancing cooperation among eastern and western nations (Connelly, 1999). After a series of meetings in the 1990s, the United Nations Economic Commission for Europe (UNECE) negotiated the creation of the Espoo Convention. Substantial issues defined and discussed in the meetings included public participation and whether the Convention would apply solely to projects or also policies, plans and programmes. Among other issues discussed was the determination of the significance of impacts, the possibility of rejecting a project if it has significant impacts and the role of the parties and of the Espoo Secretariat (Connelly, 1999). The Convention was signed in February 1991 in Espoo, Finland and entered into force six years later in 1997, with 41 member countries. To date, the Convention has been amended twice, with two substantial proposed changes: 1) to make it accessible to other UN members and 2) the inclusion of the Strategic Environmental Assessment (SEA) protocol (UN/ECE, 1996b).

Objectives of the Espoo Convention: the general aim is to ensure environmentally sound and sustainable development through international cooperation. This may be undertaken in the form of prevention or reduction, as well as control of adverse effects on international waters. Along with that, there are also a specific set of objectives to enhance international cooperation in assessing environmental impact, particularly in a transboundary context. There are other motivations behind the existence of the Espoo Convention, including to promote development that is sustainable and optimises the use of resources (IAIA, 1999) and the application of the already working EIA framework to assess transboundary impacts and to prevent conflicts among countries.

Mechanisms of the Convention: to achieve the objectives the Convention established certain mechanisms or measures. The following section outlines Espoo mechanisms and processes in more detail based on the Convention's text (Espoo Convention 1997) and guidelines (UNECE, 2006). Figure 5.1 is an illustrated chart of the Convention process, which is fragmented into the several phases.

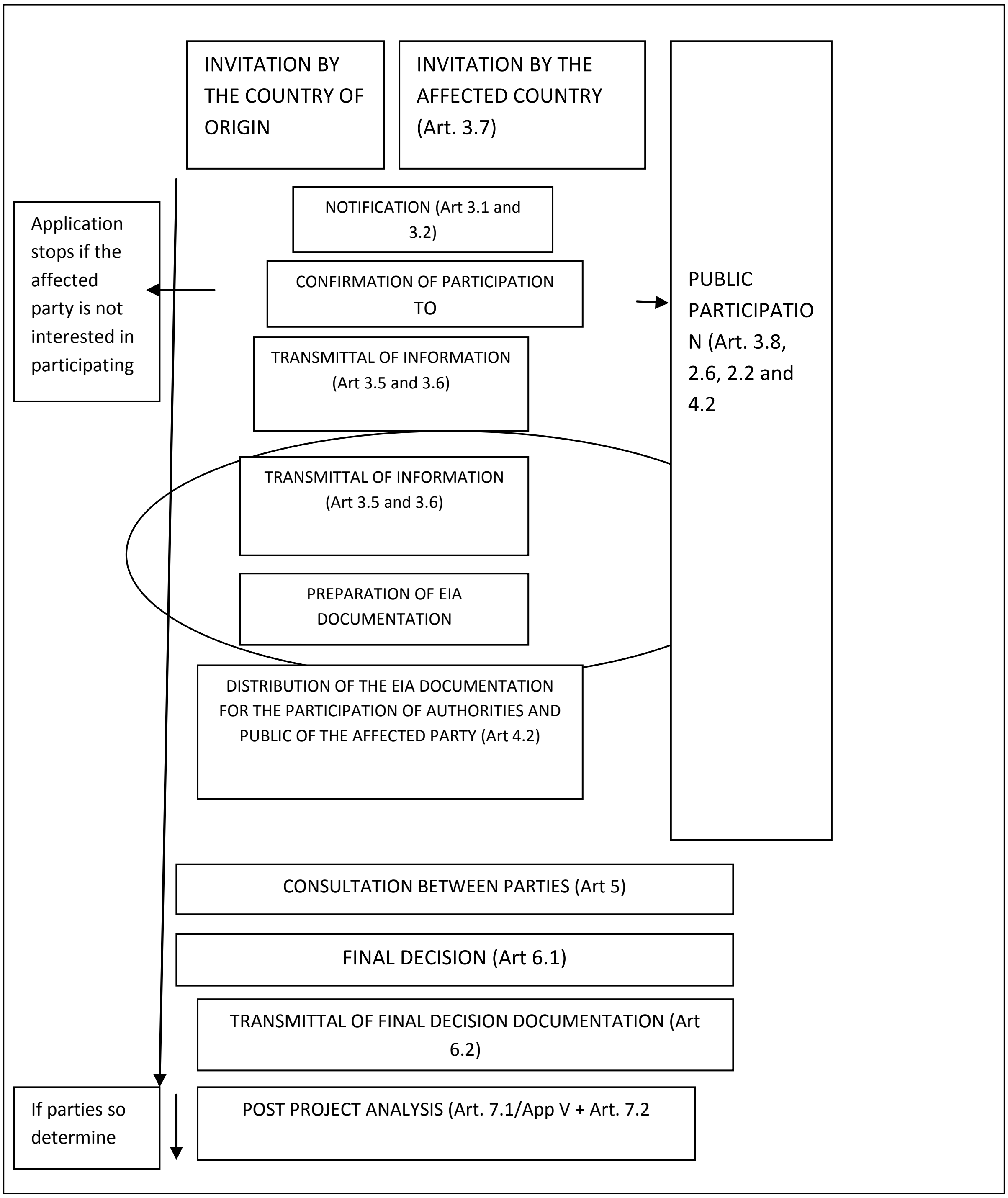

Figure 5.1. EIA in transboundary context (the Espoo Convention) . Adapted from Convention on EIA in a Transboundary Context (UN/ECE, 1996b).

Initiation of the Espoo process: The Espoo process officially starts off with a "Notification", as described in *Article 3.4.2*. However, in practice, there is a range of activities that have to be carried out earlier. Typically a general approach is undertaken to inform stakeholders (government, NGOs, general public etc.) so that they are informed about the Convention and its mechanisms with the intention that the stakeholders are capable of identifying potential Espoo cases, as well as reporting to the respective authorities. There is also another step prior to the notification and that is the screening stage, where it is determined whether a project is subject to assessment under the Espoo Convention.

The notification and transmittal of information (Article 3): these refer to activities that are likely to cause transboundary impacts where the *party of origin* (the country under whose jurisdiction a proposed activity is planned to be undertaken) should notify the affected party through the "contact point for discussion". Generally notification is the official starting point of the EIA process. If it is the case where the parties of the Convention are also the parties of origin and affected parties, then joint notifications should be sent out. Normally notification consists of information of the proposed activity and the Espoo process. In cases where the affected party does not intend to participate in the EIA process, the application is terminated. However if the affected party does intend to take part in the EIA process then the application of the Espoo Convention continues with the exchange of information. Some additional information might be supplied at a later stage if the affected party requires it. This may include relevant information about the EIA procedure, as well as potential adverse transboundary effects. In this stage the party of origin must also ensure that the potentially affected party has been informed with appropriate time given for comments or objections. Public comments, including opinions, are transmitted to the party of origin. After the transmittal of information stage is completed the preparation of EIA documents is initiated.

Preparation of the EIA documentation (Article 4): primarily comprises the description of the proposed activity, the alternatives, the environment likely to be affected and the potential environmental impacts, as well as the mitigation measures. At this stage the party of origin should send the EIA information to the affected party. This documentation is specified in Appendix II of the Convention. The concerned party must also ensure that the EIA documentation reaches the relevant authorities, as well as the general public. It is important to re-submit the comments to the party of origin prior to the final decision.

Consultation between parties (Article 5): As in the case of the domestic EIA, prior to the final decision in the Espoo EIA process the party of origin should ensure that consultations with the affected party (Article 5) on the potential transboundary impacts and safeguard measures have been completed. The concerned parties should also reach an agreement on aspects such as timing of consultation, issues to be addressed, who is participating in the consultation process, roles of different stakeholders and the methods to be used in the consultation process.

Final decision (Article 6): if approval is granted to the party of origin then this should be based on the results of the EIA process and the documentation provided. It is imperative to know that the comments submitted by the affected party (authorities and general public) were included in the final decision, together with how these were addressed.

Other issues: the Convention also provides an option under Article 7 which covers post-project analysis with its objectives (Appendix V). It depends on the parties decisions whether project analysis is required or not. Another optional article emphasises the importance of bilateral and multilateral agreements as prominent instruments in order to enhance cooperation between members of the Convention (described in Article 8 and Appendix VI). Although this article is optional, its existence is essential to improving the Convention's effectiveness. For example, under this agreement it is possible to establish and define specific issues of the Convention's application, including determining what impacts are significant. This also applies to setting up a joint body, public participation and consultation between concerned parties, as well as translations if required. Finally, for monitoring and evaluation purposes, the Espoo Convention encourages parties to carry out research programmes to improve the impact assessment and other aspects (Article 9).

The scope of the Convention: it regulates only transboundary impacts generated by specific projects and does not include transboundary impacts from other sources (i.e. air pollution, nuclear accident etc). Recent amendments have also proposed a Strategic Environmental Assessment (SEA) protocol. This protocol enables parties to establish appropriate policies and legislation and consider environmental issues in earlier phases of the decision-making process, as well as promoting wider public participation. Administration: the Convention is administered by a Secretariat under the UNECE Espoo, which involves; 1) Meetings between the parties; 2) Formation of a working group on the EIA;

In summary, it can be seen that the Espoo Convention took several years of negotiations to establish. It appears that issues of transboundary environmental impacts are becoming increasingly significant and hence the Convention is vital. The ultimate objective of the Convention is to contribute to sustainable development through international cooperation and ensure environmental aspects are considered in the decision-making process. Since it came in to force, its application has been increasing with relatively good results (Connelly, 1999). From the review above, the main mechanisms of the Convention can be summarised as follows: 1) obligatory EIA procedure, 2) consultations among countries, 3) public participation, 4) bilateral and multilateral agreements and 5) settlement of disputes.

5.3Transboundary Environmental Regulations

The idea of Transboundary Environmental Impact Assessment (TEIA) originated from the Environmental Impact Assessment (EIA) practices adopted within certain countries. It is therefore essential to first comprehend the purposes and fundamental approaches of an EIA. The term TEIA usually applies to the relationship between States, with provisions found in customary and treaty law. It may also apply within a State where there are separate jurisdictions. However this study considers only a single dimension the TEIA between States.

5.3.1 Environmental Impact Assessment (EIA)

The term EIA refers to a systematic process that aims to identify, evaluate and mitigate the environmental effects of a proposed project and inform decision-making prior to granting development consent (UNEP, 2002). Included in the report are the type and nature, magnitude, extent, timing and duration, uncertainty, reversibility and significance of the impacts. The impact assessment typically adopts a broad definition of ‘environment’, addressing the following environmental effects biophysical and resource use, socio and cultural factors, environmental health, health and safety, indigenous rights and historic areas. The EIA process, is based on three core values: 1) integrity (the EIA process will conform to agreed standards), 2) utility (the EIA process will provide balanced, credible information for decision-making and increased acceptability and 3) sustainability (the EIA process will result in environmental safeguards) (Sadler, 1996).

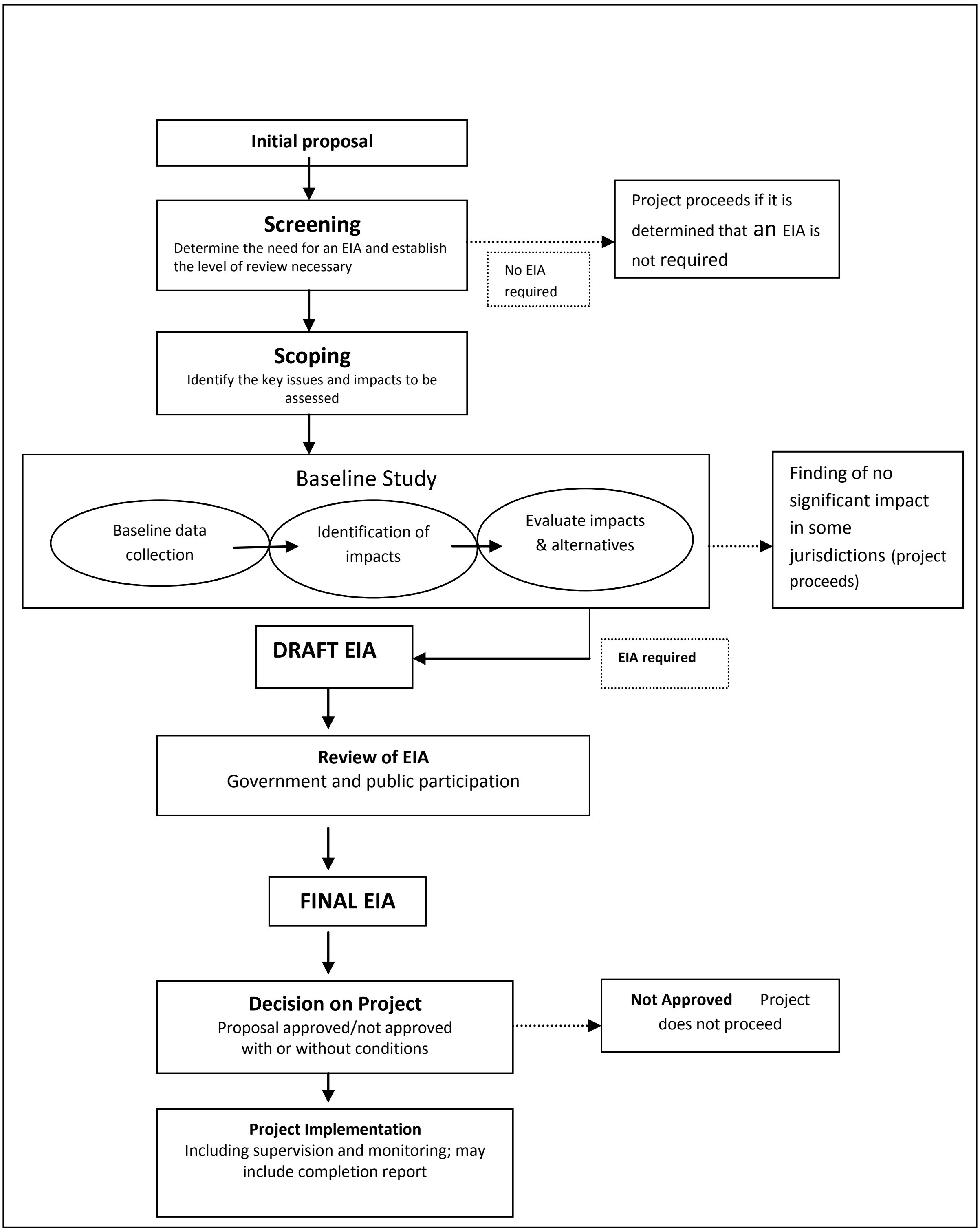

Figure 5.2. A gemeralised EIA process. Modified from the UNEP EIATraining Manual 112 (Second Edition 2001).

As shown in Figure 5.2, the EIA process is generally initiated when a proponent submits a proposal to the relevant government authority relating to an existing or new project which may lead to some environmental effects. This process usually falls into three major phases: 1) screening and scoping of the project, 2) environmental impacts assessment and 3) decision-making and EIA review.

Initially, the decision makers must agree on whether an EIA is required. Typically the *"screening"* phase is a first assessment of whether the proposed project triggers the EIA requirements and if the proposed project has potential significant environmental impacts. It is usually conducted by the responsible authority, as prescribed by domestic legislation or policy (Planning, 2004). The screening process will determine the likelihood of significant environmental effects arising from factors such as the nature, size and location of the development.

If an EIA is necessary, then the next phase is *"scoping"*. This phase is the process of determining the content and extent of matters to be covered by the EIA and in the resulting Environmental Statement (ES). Scoping also seeks to ensure that the information provided addresses the key environmental effects of the proposed development. Most importantly, the scoping process should seek to remove issues from the assessment process if significant effects are unlikely. According to Troell et al (2006), the significance of these effects is generally determined on the basis of expert judgement. The broad criteria for significance includes: 1) the value of the environmental resources, 2) the magnitude of the impact, 3) the duration of the impact, 4) the reversibility of the effect.

Once the scoping phase is completed, a baseline study is usually conducted to gather further data. This study aims to identify and evaluate the possible impacts, as well as alternatives of possible impacts. Typically, at this stage the draft EIA is reviewed by the relevant government entities and permitting agencies. Government entities also have an opportunity to submit written and/or verbal comments on the EIA either in support or criticising the EIA methodology, information, analyses or conclusions. Once input from government agencies and the stakeholders has been considered and accommodated then a final EIA is completed.

The final EIA results are incorporated into the authorisation ruling and although the practical effects can be high, Kloepfer (in Polonen, 2005) points out that there have only been a few cases where this has lead to permission being denied. The relevance of EIA is moreover to assess alternatives with respect to size or location of the development and to lay a basis for compensation orders. Furthermore, Troell et al, (2006) claims that it is imperative to emphasise that the EIA process is a planning practice in which certain aspects of a proposed project, such as economic yield, may suggest the selection of a single alternative over another, even if that alternative is not the one with the least impacts. Nevertheless, it is essential that the decision is well informed and balanced.

5.3.2 EIA Cost

In many cases the cost of the EIA is borne either by private or public institutions. Typically, this covers direct costs associated with the preparation phase and takes into account probable delays in the project's progress, as well as the costs to the competent authorities. Included in this are step-by-step activities such as processing the information, checking its quality and utilising it in decision making. There will also likely be costs arising from legal procedures, which would not have occurred if there had been no EIA procedure. Mostly EIA costs are categorised into four main categories, including overall costs, costs to public administrations, cost of procedural requirements and sometimes costs of any delays (Oosterhuis, 2007).

5.3.2.1 Overall Cost

Several papers have reviewed and discussed these categories of EIA costs in different geographical areas. In terms of overall costs, Lee (1994) found that for the majority of 50 sample UK cases any cost increases associated with the EIA process were insignificant or minor. An evaluation on the EIA costs (Naturvardsverket, 2001) found that the overall costs of EIA in Norway were reasonable in relation to their respective projects . Later, Annandale (2003) carried out a large survey of mining company executives in Australia and Canada and revealed that companies see environmental approvals regulation as an incentive rather than as an impediment to development.

5.3.2.2 Costs of performing an EIA

In most cases, the costs of performing an EIA vary depending on the location, volume of the project (Sager, 2003) and the competent authority (Obrucka, 2005), as shown in Table 5.3. In many cases, such costs are expressed as a percentage of the total (investment) costs of the project. Although it is appears that the range of estimates for EIA are likely to be broad, the guidelines indicate that the relative cost of this process (e.g. relative to the total cost) is in most cases below 1% (Wood, 1997a, Oosterhuis, 2007, UNEP, 2002).

Table 5.3. Range of the costs of performing an EIA according to various sources. Adopted from (BIO, 2006b).

Reference	% costs estimate (range)	Geographical coverage
Millard et al. (1999)	0.06	Ghana
Donnelly et al. (1998)	0.50	Tanzania
Glasson et al. (2005)	0.05	Kenya
Petts et al. (1999)	0.08	Malawi
Garner, (1982)	>0.6	UK Sector
European Commission, (1997)	>0.5	EU Sector
Zetter (1997)	0.1 to 0.5	UK
Wood (2003)	< 1	Not Specified
Coles et al. (1992)	0.000025 – 5	UK
Athanassopolou, (2001	<1	Greece
Kessel et al., (2003)	< 1	Netherlands
Harakson et al, (2003)	0.5-3	Iceland
Miloverndepartmentet (2003)	<0.1-0.5	Norway
BIO (2006a)	<2.5	Spain

Another study (BIO, 2006b) discovered that in addition to the size of the project, there are other vital factors that could influence EIA costs, namely project characteristics. For example, the costs of EIAs are relatively expensive for projects related to the marine environment or for those related to nuclear or industrial activities among others. A review of numerous EIAs (Pritchard, 1995) revealed that the preparation of the Environmental Statement (ES) cost considerable time and money. To minimise the further cost of preparing an EIA Kessel (2003) and Bell (2004) recommend applying a cost benefit assessment (CBA), as well as clearly defined procedures and criteria for screening.

5.3.2.3 The costs of delays and procedural requirements

The cost of the delays and procedural requirements for an EIA has been investigated by numerous studies. Such delays are mostly caused during the EIA process when: 1) the EIA commences too late in the project cycle, 2) the terms of reference are poorly drafted, 3) the EIA is not managed according to a schedule, 4) the EIA report is inadequate and needs to be upgraded and 5) there is a lack of technical data (Oosterhuis, 2007) .

The work of Coles (1992) in the UK found that the average approximate time it takes to complete the entire EIA process is 62 weeks, with 25 weeks dedicated to the preparation of the EIS. The EC (1996a) reported that EIAs are normally completed within two years, although this varies from project to project. Sadler (1996) confirmed that internationally, the majority EIA reports were processed in less than 18 months. The studies reviewed above suggest that EIA may potentially cause significant delays in certain cases.

However, this does not imply that reducing nor preventing delays will result in a reduction of overall net cost (net benefits). For instance trimming the process may impact on the quality of the assessment by reducing or limiting the opportunities for public consultation. Therefore, attempts to reduce the costs of delays might also cause a loss of benefits due to low-quality EIAs. It could be also argued that tight administrative deadlines for authorities may lead to a lack of in-depth analysis of issues and could result in very general or superficial terms of reference for the detailed assessment.

In summary, it has been found that the cost variation between different EIA processes are all about 0.5 to 1% of the total project investment cost. However, it depends more on project types, characteristics and locations. In order to keep costs low there are several aspects which need to be considered, including clearly defined screening criteria and applying a cost benefit analysis (CBA).

5.3.3 EIA benefits

5.3.3.1 Environmental benefits

It is undeniable that the EIA process can contribute to significant environmental benefits. Despite this, there have been very few studies that have attempted to estimate the environmental benefits (quantified or even monetized) and environmental improvement (prevention of environmental damage) as a result of EIAs. However, there is a substantial amount of literature that has recorded the quality of EIA. In fact, a good EIA procedure and EIS are basic requirements for environmental benefits to arise (BIO, 2006b, Lee et al., 2006) .

In recent decades the usefulness of EIA environmental decision making has been recognised and discussions on these can be found in numerous papers (Lee et al., 2006, DoE, 1996, Wood, 1997b). Although these papers differ in details, all of them appear to confirm that the EIA process results in benefits, in terms of a better information base for decision making (EC, 1996a). Thus, to achieve optimal benefits in terms of actual planning decisions in the EIA process Tennoi (2006) argues that more emphasis should be given to improving the communication of uncertainties in the EIA. Another significant benefit of EIAs is their influence on the design of projects and modifications and mitigation of negative environmental impacts. According to Wood et al. (2006), these are indeed primary direct EIA benefits.

5.3.3.2 Other benefits

If developed effectively the EIA process can provide an opportunity for public involvement and participation in the decision-making processes that affect environment and livelihoods (Robinson, 1993). By accommodating meaningful suggestions and input, EIA regulations and guidelines normally accentuate public access to relevant information with regard to project proposals and their potential impacts. Such a mechanism of transparency seems to enhance the level of accountability and ensures that conclusions are better reasoned. This mechanism can also serve as a way of building trust and encouraging cooperation among the public and authorities responsible for overseeing the EIA. In supporting this argument, Troell (2006) and Bruch (2004), point out that increased access to information can also improve public understanding of how decision making works, which, in turn, creates a greater sense of empowerment and social responsibility. Furthermore, Skelley (1997) argues that failure to provide quality information can contribute to public resistance to development projects, increased administrative costs, and a poorly designed and executed project. There are many other EIA benefits: 1) increased awareness and knowledge (Wood, 1995), 2) promoting better co-operation (Radnai, 2000), 3) reducing conflicts and gaining higher acceptance (BIO, 2006b).

5.3.4 TEIA applicable procedures

Basically, the procedures that apply to the domestic EIA apply likewise for the TEIA. TEIA is usually conducted only for large projects likely to have significant impact. Compared to the standard procedures of EIA, TEIA is significantly more complex particularly, the aspect of transboundary impact assessment, which requires further political, administrative and regulatory layers throughout the process, often making it more complex than most EIA processes (Bruch, 2004). Such differences can be noted in the underlying agreement between parties including numerous procedural matters which are relevant to most systems of TEIA. These include issues such as notification by the party of origin to the affected party of planned activity and likely significant effects, sharing of information, preparation of documentation and distribution to the affected party, as well as further consultation between authorities and participation of the public in both states. It also incorporates decision making taking into account documentation and comments, information shared relevant to the decision and monitoring and post- project analysis.

The TEIA is also focused on addressing international impacts. For example, Nord Stream gas pipeline in the Baltic Sea between Russia and Germany had potential impacts on the territory of another state or states. There is no precise definition agree upon for TEIA. It could be argued that a TEIA is analogous with an EIA but takes into account transboundary issues. *Include national sovereignty, impacts and notifying all potential stakeholders of possible effects, for their perspectives and to accommodate their comments as well as issues on transboundary features and common international watercourses also imposing political, economic and cultural interactions on the process, making it far more complex than the domestic requirements of EIAs* (UNEP, 2002).

The TEIA process when an EIA result suggests that there is a risk of significant environmental impact on States other than the "Source State". Thus, determination of the risks of significant harm is therefore required to trigger the procedure, known as *screening*. This process should probably be in accordance with the list of major activities (as laid out in the Espoo Convention Appendix I and III). Another method, which is rarely practiced, requires assessment of all activities undertaken. In the case where the procedure has been triggered, the terms of reference for the assessments are then decided upon during the phase known as *scoping*. The implementation of scoping frequently takes in to account the view of a broad range of stakeholders, such as the public and NGO. Further requirements for consultation and participation are possibly also included in the stages leading up to the production of an environmental impact statement (EIS). It is also common that opportunities for inputs are given in aspects of the decision-making process itself so that decisions are informed by views of stakeholders as well as by the information reported in the EIS.

5.3.4.1 Benefits of TEIA

The TEIA and EIA processes offer similar benefits as described in sections 5.3.1 and 5.3.2 of this chapter. In terms of TEIA the additional complication is that the parties involved in the process are from different countries and therefore legal or regulatory systems are may vary greatly.

5.3.4.2 Cost of TEIA

The TEIA costs are likely to be similar to those for EIA and these can therefore be taken as a baseline, as indicated in subsection 5.3. However, since those projects subject to a transboundary EIA are generally larger projects, the percentage cost may be proportionally at lower. The duration of the TEIA process is highly variable, but is normally between one to three years. Possible additional costs associated with TEIA may arise 1) in the notification process (i.e. preparing and sending notification through various media), 2) translation of documents in to the language in the affected country, 3) distribution of documents in affected country, 4) organisation of public hearings, 5) travel and accommodation and 6) fees charged by the competent authority in the affected country for the review of the EIA documentation.

5.4 Assessment of TEIA experiences from other regions

This section is dedicated to the assessment of relevant case studies on TEIA mechanisms from other geographical regions. The assessment covers the review of case studies available to the Convention secretariat, EIA process elements and bilateral cooperation in the evaluation of transboundary impacts. Further critical analysis of transboundary EIA case studies covers assessment of good practice, as well as challenges and benefits of transboundary cooperation. These case studies include the Mekong River, Danube, English Channel and Greater Tumen River Initiative (GTI). In order to proceed, an overview of these case studies is presented below:

5.4.1 Mekong committee

5.4.1.1 Mekong river environment and conflict

The Mekong River is one of the greatest river systems in the world. It has a length of 4,800km and drains a land area of 795,000km^2 spanning six countries, including China, Myanmar, Thailand, Lao PDR, Cambodia and Vietnam (Xikun, 2006, Xiaming, 2001). The river has high levels of productivity, although there are seasonal variations in the water level and in the extent to which wetland habitats are inundated. In the wet season river levels can be 8 to 10m higher than dry season levels (Guangchen, 2004). This results in the creation of a rich and extensive series of wetlands in the four countries encompassing the Lower Mekong Basin.

The biodiversity of the Mekong River Basin is of truly exceptional significance to regional and international biodiversity conservation. The habitat includes numerous tributaries, backwaters, lakes and swamps which support unique ecosystems. It also supports a wide array of globally-threatened species such as the Irrawaddy Dolphin, Siamese Crocodile, Giant Catfish Giant Ibis and Sarus Crane (Xikun, 2006). There is a human population of 55 million living around the Lower Mekong Basin and the biodiversity is vital to the viability of rural livelihoods (Guangchen, 2004). The population living in the catchment area of the river is equivalent to about one third of the combined total population of Cambodia, Lao PDR, Thailand and Vietnam.

The Mekong River region faced huge problems in terms of ecological security mainly due to the construction of cascade hydropower dams on the Chinese part of river (Xiaming, 2001). This had considerable potential to cause serious flow-on effects for countries downstream of the developments. Consequently, over recent years ecological and socio-economic issues in the Mekong River region have garnered attention at both regional and international level. Concerns have been particularly focused on the construction of the Lancang Hydropower Cascade, which is located on the mainstream of the Lancang River. This was an urgent issue requiring an analysis of the transboundary security issues in the area and the construction of a regulation system to protect and restore the ecosystem.

5.4.1.2 TEIA practices for the Lancing-Mekong River

In the initial stages of development of the TEIA there were no specific regional conventions and agreements related to TEIA systems. The committee assessed experiences of similar issues from other regions such as Europe and the USA. Almost all riparian countries on the Mekong River had their respective national environmental law based on EIA (not TEIA). In 1995, countries including Cambodia, Lao, PDR and

Vietnam signed an agreement on the Sustainable Development of the Mekong River Basin, which required riparian countries to provide timely notification and consultation prior to implementing any projects utilising the rivers. Although this agreement was not a direct regional document, it did emphasise the TEIA process and also provided regulations similar to those required for constructing TEIA systems. The specific steps and details of TEIA process for the Mekong River are presented below:

- Notification and screening process

It is obvious that due to the absence of a regional agreement on the TEIA in the Mekong River there is a huge gap in transboundary environmental management in the region. Hence, prior to initiating any proposed development, including hydroelectric projects within the Mekong River catchment, the country initiating the development should first notify all countries potentially affected and provide relevant information as early as possible. This notification should inform and explain the nature, as well as the possible impacts, of the activity and ensure adequate and effective investigation is undertaken. (Article 3 'Notification' of Espoo Convention). The next step is then similar to the EIA screening process.

- Subject party to submit to TEIA

The subject party is the body responsible for submitting the TEIA for the exploitation of hydroelectric resources. In this case, it is the national government or authorised agency assigned to the task. However, in some specific cases the TEIA might be prepared by NGOs, IGOs or other trans-state actors.

- Scoping

The scoping stage in the TEIA for Mekong river hydroelectric exploitation occurred prior to the drafting of a formal TEIA document. It was conducted when the relevant countries agreed that a TEIA was required. The decision was made based on preliminary deliberations following the notification and screening process. This step is crucial in identifying the most critical elements for further study and research and should also involve riparian nations and/or public participation to some degree (Xikun, 2006). A major task at this stage was to identify key interest groups, both governmental and non-governmental, within the potentially affected countries. Consultation and public participation were also considered essential, particularly in the case of the

Mekong River project due to the potential for significant adverse transboundary environmental impacts (Xiaming, 2001).

- Preparation of the TEIA documentation

The TEIA documentation for hydroelectric projects is similar in content to domestic EIAs. Also included were other uncertainties arising from the lack of technology, mitigation measures which can be taken to control any adverse environmental impacts and suggestions on whether the project should proceed or not (Xiaming, 2001).

- Consultation and public participation

Subsequent to the preparation of the TEIA documentation, the originating country provided relevant information to individuals and communities identified as being potentially affected by the project. Prior to the distribution of documentation the originating country needs to consider language differences in the affected countries. The countries concerned should ensure that the TEIA documentation reaches the relevant national authorities and any communities which may be affected by the proposed development. Following the distribution of the TEIA documentation, each of the countries should arrange the third round of consultation and public participation. At this stage, the affected parties in relevant countries have the right to know the possible impacts of the project, mitigation measures and associated costs (Xiaming, 2001).

5.4.1.3 Bilateral cooperation in evaluation of transboundary impacts

The cooperation among riparian countries of the Lower Mekong River Basin began in 1995 through the institutional arrangement of the Mekong River Commission (MRC). An agreement was produced on cooperation for the sustainable development of the Mekong River Basin. MRC consists of three permanent entities: the Council, Joint Committee and Secretariat. Each individual permanent entity is mandated with specific responsibilities as follows:

1. Responsible for policy and decision-making tasks and comprising one member from each participating riparian State at the ministerial and cabinet level (MRC, 1995, particularly in Article 15).

2. Responsible for implementing Council policies and decisions (MRC, 1995, Article 23).

3. Responsible for providing technical and administrative services in support of Council policies and decisions (MRC, 1995 Article 28).

The focus of Mekong cooperation is to manage the delicate balance between socio-economic development and the need for environmental protection and maintenance of the ecological functioning of the river basin. The role of the MRC aims to coordinate and promote cooperation in all fields of sustainable development, utilisation management and conservation of water and other related resources in the Basin. This is instituted through three types of programmes: core (long term), sector (all water and other related resources) and support programmes (crosscutting).

During the development cycle, MRC has experienced challenges and also opportunities. The internal challenges arose within the riparian countries and included difficulties in integrating management between government agencies both vertically (between national, provincial and local government levels) and horizontally (between ministries and sectors). Community participation was a particular challenge but it was carried out in a transparent and very flexible manner. The opportunities to emerge from the MRC Cooperation were through the full participation of agencies at the local and national level.

5.4.2 Danube River

5.4.2.1 Danube River environmental issues and conflicts

The Danube River is located between Bulgaria and Romania in central Europe. It extends 2,857km in length and the catchment basin spans 817,000km^{2}. The catchment supports numerous important natural habitats, including Europe's second largest wetland. It also supports the livelihoods of millions of people through fishing, tourism, recreation, power generation, transport, water supply, agriculture and disposal of waste waters. The intensive uses of the basin have created environmental problems and reduced biodiversity in the basin in general (UNEP, 2002).

Transboundary environmental conflicts in the area arose in 2005 with the construction of the Vidin-Calafat Bridge over the river. The construction aimed to provide an essential link to transport infrastructure in both Bulgaria and Romania. The bridge also served as part of the southern branch of the pan-European corridor number IV which provided for both road and rail links. The project proponent was the Bulgarian Ministry of Transport and Communications, although in the execution stage both countries jointly operated and maintained the bridge.

5.4.2.2 TEIA practices for the Danube River

To facilitate the process of the environmental impact assessment for the construction of the Danube Bridge, an agreement was reached and signed between the governments of Bulgaria and Romania in 2000. The agreement included a requirement to conduct an "EIA and this was based on Article 3 of the Agreement which stated that this be done at the stage of the preliminary design in accordance with the existing legislation in Bulgaria and Romania as well as international conventions and treaties".

The EIA procedures in both Bulgaria and Romania are different. The Bulgarian system has a one-stop EIA procedure at the beginning of the project design process; whereas the Romanian EIA system is based on a permitting process framework (e.g. An EIA is required prior to obtaining a construction permit). To reach a consensus for the differing systems and to provide a solid robust overall EIA, the TEIA took place in two stages. Firstly, a preliminary EIA according to Bulgarian legislation was conducted followed by a final EIA according to Romanian legislation. The TEIA team for the project was led by experts from an international consulting company and involved local consultants from both countries. As a joint EIA had been agreed and decided upon in the bilateral agreement, no formal notification and screening procedures under the Espoo Convention were exercised for this project because. The EIA documentation was prepared by a joint EIA team and provided full translations into Bulgarian, Romanian and English.

Competent authorities in both Bulgaria and Romania were notified of their respective rights in the early stages of the EIA process and following the completion of the preliminary report. As proponents of the project, the Bulgarian authorities, together with EIA experts, conducted consultations with the public throughout the preparation of the preliminary EIA and the final EIA report. The competent Romanian authorities also notified the public about the possibility to consult on the final EIA report and the project proposal. The documentation was available for a month to all interested members of the public, as well as representatives of NGOs and other interested parties. The competent Romanian environmental authority subsequently issued its opinion on the preliminary EIA report communicated this to its Bulgarian counterpart. Information relating to the EIA was then published in a Bulgarian national newspaper, with additional copies of the EIA given to the project proponent (various organisations who wanted to build the bridge), local municipality and relevant authorities. The EIA report was also translated into the English sent to the competent Romanian authority.

The completed EIA final report was prepared in English, Romanian and Bulgarian and subjected to public hearings. Although the Bulgarian legislation does not require further public participation regarding the final EIA report, it was made available to the public and proponents in Bulgaria for comment. Finally, the Bulgarian Ministry of Environment and Water had the responsibility of preparing a draft opinion on the final EIA report.

5.4.2.3 Bilateral cooperation in evaluation of transboundary impacts

Both countries (Bulgaria and Romania) initially signed a bilateral agreement on the project‘s technical, financial, legal and organisational aspects. The agreement was then ratified by the Parliaments of both countries and entered into force in 2001. The agreement particularly underlined that an EIA should be undertaken jointly and aligned with Bulgarian, Romanian and EU legislation.

As part of the agreement a Joint Committee was established to oversee the project, which was chaired by authorities at ministerial level from both countries. This included representatives of the Ministry of Transportation and the Ministry of Environment. Nine thematic working groups of experts were subsequently established. These included the Environmental Joint Working Group, which was primarily responsible for environmental matters and the coordination of environmental procedures. Project Implementation Units (PIMU) was also established in each individual country to serve as communication channels throughout the project’s life cycle.

5.4.3 English Channel

5.4.3.1 English Channel environmental issues and conflicts

The English Channel is located between Great Britain and northern France. The Channel is about 560km (35 mil) long and stretches 240km (150km) at its widest point and just 34km (2.1 m) at its most narrow. The sea is relatively shallow and covers approximately 75,000km^2 of the continental shelf of Europe. The region supports a variety of seabed habitats and numerous fish, mammals and sea birds. Aggregate dredging activity in this region potentially contributes to the disturbances of the marine environment (UNEP, 2002).

5.4.3.2 EIA process elements

In the case of the EIA process, all concerned parties are bound by the legal requirements of the EU EIA Directive (Directive 85/337/EEC as amendment by Directive 97/11/EC). In the early stages of the dredging project France proposed a bilateral agreement with the United Kingdom. The United Kingdom acted as the party of origin, with Belgium, Denmark and France the affected parties. The proponent for the project was the private company Volker Dredging Ltd and notification was conducted from the very beginning of the process. The competent authority of the party of origin was responsible for informing the EIA findings to the competent authorities of the affected parties. Final EIA documentation was translated in to Danish, French, German and Dutch, with the consultation process taking a total of 16 weeks. Return comments were received only from the competent authority and affected parties. Under UK EIA legislation, the final EIA documentation requires the affected country to publish its decision. This is undertaken to ensure the decision took the available environmental information into account.

5.4.4 Greater Tumen River

5.4.4.1 Greater Tumen River Environment issues and conflicts

The Tumen River is located in North Korea and Far East Russia and lies between North Korea and north-east China. The river is the third longest river in Korea with a length of approximately 521km. Only 17km of the river forms the border between North Korea and Russia, while the remaining 504km lies along the border between North Korea and China. The river provides water to the riparian nations for agriculture and industrial development. More importantly it also helps to preserve globally significant biodiversity in the Tumen Delta in the Pacific Ocean. The river’s water quality is poor as it has been heavily polluted, primarily from industry in China and North Korea (UNECE, 2008). The river flows through numerous countries include North Korea and South Korea and Mongolia. Because the economic potential of the river for the region it was agreed to establish an organisation to assist with the sustainable development in Greater Tumen Region

5.4.4.2 TEIA process elements

The TEIA procedures for the Great Tumen Initiative (GTI) were stipulated in a Memorandum of Understanding (MoU) on environmental principles governing the Tumen River Economic Development Area and north-east Asia. The MOU also asserts that states and concerned parties will prepare and adopt national laws and policies, as well as bilateral and multi-lateral environmental agreements if required, in order to ensure environmentally sound and sustainable development in the region. Article 1.2 of the MoU states comprehensively that contracting parties will jointly conduct a regional environmental assessment (EA), evaluating the local, national, regional and global environmental implications that may occur as a result.

Article 1.5 mentions project specific EIA requirements and are transboundary in nature. It is an obligation of the contracting party on whose territory the proposed project is located (party of origin) to prepare a project specific EIA. A screening process for the project proposal is needed to determine its environmental significance. During the GTI EIA process experts in all affected States are also required to participate.

5.4.4.3 Bilateral cooperation in evaluating transboundary impacts

In 1995 countries bordering to the Great Tumen River, including North Korea, China and Russia, reached an agreement to establish a Coordination Committee for the development of the area. To date, the GTI consists of five countries: China, South Korea, Mongolia and Russia. This agreement subsequently supported a further agreement to establish a Consultative Commission which was also open to other non-riparian States. The Consultative Commission is composed of government representatives of the five GTI member States and serves as a core decision-making institution. The Commission also conducts annual evaluation meetings which rotate around member states.

5.5 Discussion

This section aims to examine the transboundary environmental impact assessment for the Mekong River, Danube, English Channel and Greater Tumen River Initiative (GTI). It also seeks to compare the environmental issues and conflicts, the TEIA process and elements, as well as the bilateral cooperation in evaluating transboundary impacts. A comparison of these requirements is presented in the table below.

Table. 5.4. Summary of comparison between the four selected case studies.

	Mekong River	Danube River	English Channel	Greater Tumen River
1. Environmental issues and conflicts	-Wetland & threatened species. -Construction of the Lancang Hydropower Cascade which is located on the mainstream of the Lancang River	- Natural wetland and associated s fauna - Construction of Vidin-Calafat, a bridge over the Danube River	-Marine environment and associated fauna -Construction of seabed transportation channel	-Wetland and significant biodiversity -Increasing industry & agriculture development in the region
2. TEIA process and elements	- EIA law exists in all riparian countries - Adopt TEIA principles including: notification, screening, scoping, consultations and participation.	-EIA in both countries are different - To reach a consensus for the differing systems and to provide a solid robust overall EIA, the TEIA took place in two stages 1) a preliminary EIA according to Bulgarian legislation, and 2) a final EIA according to Romanian legislation. -EIA process lead by independent hire company -EIA document translated in to two national languages -No screening and notification process involved because the EIA process has been agreed on -Each country responsible for public consultations.	-In the case of EIA process all concerned parties are bound by the legal requirements of the EU EIA Directive (Directive 85/337/EEC as amendment by Directive 97/11/EC).	-EIA process stipulated in the MoU. -Concerned parties prepare to adopt national EIA laws, both regional and international. -Established consultative commission to consult non-riparian countries.

	Mekong River	Danube River	English Channel	Greater Tumen River
3. Bilateral cooperation in evaluation of transboundary impacts	- Signed an agreement on the Sustainable Development of the Mekong River Basin -Established Mekong River Commission (MRC) as secretariat and for coordination	-signed bilateral agreement & approved by their Parliaments respectively. - Established a joint committee which was chaired by authorities at ministerial level from both countries.	- Signed bilateral agreement	- Signed MoU and established Coordination Committee.

5.5.1 Environmental issues and conflicts

Wetland and marine environment and associated fauna in general are important to environmental health and require protection and conservation. In the Greater Mekong, Danube and Greater Tumen River, wetland habitats are identified as particularly important habitats. In the Mekong River in particular numerous threatened species require protection from the impacts of developments (Xikun, 2006). For the English Channel marine environment dredging has the potential to alter and affect marine habitats which riparian countries are required to protect.

5.5.2 TEIA process and elements

The existing domestic EIA in each riparian country plays an important role in transboundary environment assessment. In the case of the Greater Mekong and Greater Tumen River, the TEIA was built on the existing domestic EIA. In cases where domestic EIA systems are in different countries, solid solutions could still be decided, as is the case for the Greater Tumen River. Under the specific circumstances of the Greater Tumen River, the screening and scoping stages were not exercised due to the EIA system being based on agreement. In the case of the Mekong River, the riparian countries adopted Espoo Conventions models. This differs for the English Channel and Danube River in that as well as having domestic EIA regulations such countries also adopted EU regulations, including the adoption of Espoo Conventions. In the English Channel the EIA process is bound by the legal requirements of the EU EIA legislations.

5.5.3 Bilateral cooperation in the evaluation of transboundary impacts

Bilateral agreements and provisions of MoUs on environmental protection and sustainable development are typically a common starting point in transboundary management. In all four locations, established committees and their secretariats generally act together for coordination during project implementation. Only in the case of the Danube River was the agreement approved by the national Parliaments involved, with the committee heads were at ministerial level.

Conclusion

An assessment of other regions and the lessons learnt provide a valuable contribution to TEIA development in the Timor Sea, particularly in the points listed below:

1) Existing domestic EIA plays an essential role in the TEIA process. Countries which have different EIA systems typically build on an agreement or adopt the Espoo Convention model.

2) The establishment of a committee and secretariat as a centre for TEIA coordination during project implementation is very important.

3) Different languages and government administration systems among participatory countries are regarded as challenges which should be addressed.

Chapter 6. EAST TIMOR ENVIRONMENTAL REGULATORY FRAMEWORKS FOR THE OFFSHORE OIL & GAS INDUSTRY: CASE STUDIES.

6.1. Introduction

Development of the oil and gas industry is expected to expand in the coming decades as one of the most important economic activities worldwide. The long-term energy supply will come from more expensive mature assets and unconventional resources; hence oil prices are likely to remain high in the foreseeable future. This has been the case since the early US experiences in 1945, when the US Government promulgated what became known as the "Truman Proclamation". This asserted exclusive jurisdiction over the natural resources of its own defined "continental shelf" for conservation and exploitation purposes (2008). Since then, the oil industry's activities have consistently expanded along the continental shelf and into deep offshore waters.

The development of the offshore oil and gas industry has given rise to multiple environmental impacts, including large volumes of toxic compounds associated with diverse and complex activities. These could be dispersed in marine water and accumulated in sediments, posing a high risk to marine and coastal habitats. The source of such environmental changes includes regular operational discharges, atmospheric emissions, generation of solid wastes and other forms of pollution. The public's and governmental concerns related to general environmental impacts and the effects of the oil and gas industry's activities was first raised in the 1960s and early 1970s (Meadows, 1972) when the *Torrey Canyon* (Pollard Rock, England 1967) and *Alpha* Platform (Santa Barbara, California 1969) oil spills triggered widespread concern and thus major ecological movements in regards to the possible consequences of oil pollution on important industries such as fishing and tourism, as well as on the natural marine resources themselves (Freedman, 1994). In response to these circumstances, specific legislation emerged to regulate the oil and gas industry. The aim was to protect the marine environment and its resources from the detrimental effects of the coastal and offshore oil industry's operations and provide a framework for ensuring optimum relationships among all sea users.

These impacts could also potentially generate transboundary environmental effects or other tensions and even conflicts beyond national jurisdictions, being recognised as not only local or regional concerns, but also national and international. The increased recognition of environmental problems as transnational issues, demonstrated that national regulations were no longer sufficient. This also illuminated the weakness in various bilateral and regional agreements which traditionally emphasised economic importance, while only minimally addressing environmental issues. This was indicative of the inefficiency of national regulations to address certain environmental problems.

This chapter focuses on the Timor Sea, which is bordered by four states and where the potential for transboundary conflicts is high. This region has great economic and environmental value from activities that include fishing, offshore oil exploration and recreational purposes among many others. Potential environmental harm to the Timor Sea could result from the presence of large infrastructure projects such as oil platforms, installation of subsea pipelines and international transportation routes. Similar cases have occurred in many countries and notably came to public attention of public after concerns were raised about the impact of oil development activities. These concerns have encouraged the national and international community to consider the implications for the environment.

6.1.1 Aim of the chapter

The aim of this chapter is to critically assess the effectiveness of alternative approaches to the design environmental regulatory frameworks in other national contexts. This is achieved through a comparative assessment of regulatory frameworks that are already in place in other parts of the world.

6.1.2 Methodology of the Chapter

The case studies of other national regulatory frameworks will be considered and comparisons drawn based on the following aspects:

- Legal frameworks which cover: existing laws in place and concerns,
- Regulatory/ management frameworks consisting of existing relevant authorities, how they relate to each other and their responsibilities,

- Standards, guidelines and discharge limits: what authorities are responsible for monitoring and under what regulations?

6.2 Environmental Regulatory Framework for Offshore Oil and Gas Industry in East Timor

6.2.1 The East Timor Government organization

East Timor is a centralised State, with executive power exercised by the Prime Minister, Ministers, Vice Ministers and other officials. The central executive power lies in the hands of 15 ministers which form the government cabinet. Legislative power is exercised by the National Parliament, made up of representatives elected from different parties and district representatives. In exercising their right to vote, every citizen has the right to elect three representatives to the National Parliament.

Matters associated with the conservation, protection and improvement of the environment are dealt with by the Environment Commission, Natural Resources and Territorial Ordination of the National Parliament. Their aim is to promote the sustainable use of natural resources and economic development in the country.

Article 61 of East Timor's Constitution is concerned with that of the protection and conservation of the environment and the use of natural resources in a sustainable manner. This article serves as the legal base for the country to promote and produce regulations for the protection of the environment. The legislative process involves the submission of legislation pieces (proposals) for public consultation prior to final discussion and approval by the National Parliament. Once approved, the legislation is then signed off by the President and published in the *Journal da República*. The laws (decree laws) thus produced are valid for the whole territory (land and aquatic). Any amendments to the decree laws can only be made by substitution, whereby a new decree law must be created to replace an existing law.

6.2.2 Offshore Oil and Gas activities in East Timor

The first oil exploration in East Timor was conducted in 1959 on the south coast of Viqueque (Charlton, 2002). After this a number of shallow wells were drilled (see figure 6.1). However, the most significant deep wells were drilled between 1957 to 1975 under Department of Geologia e Petrolifero da Portuguesa (Crostella, 1975).

Following the discovery of offshore petroleum in the Timor Gap region of the Timor Sea in the 1970s, there have been ongoing disputes concerning the rights to ownership and exploitation of the oil resources *(Note: the boundary dispute will not be discussed in this thesis).*

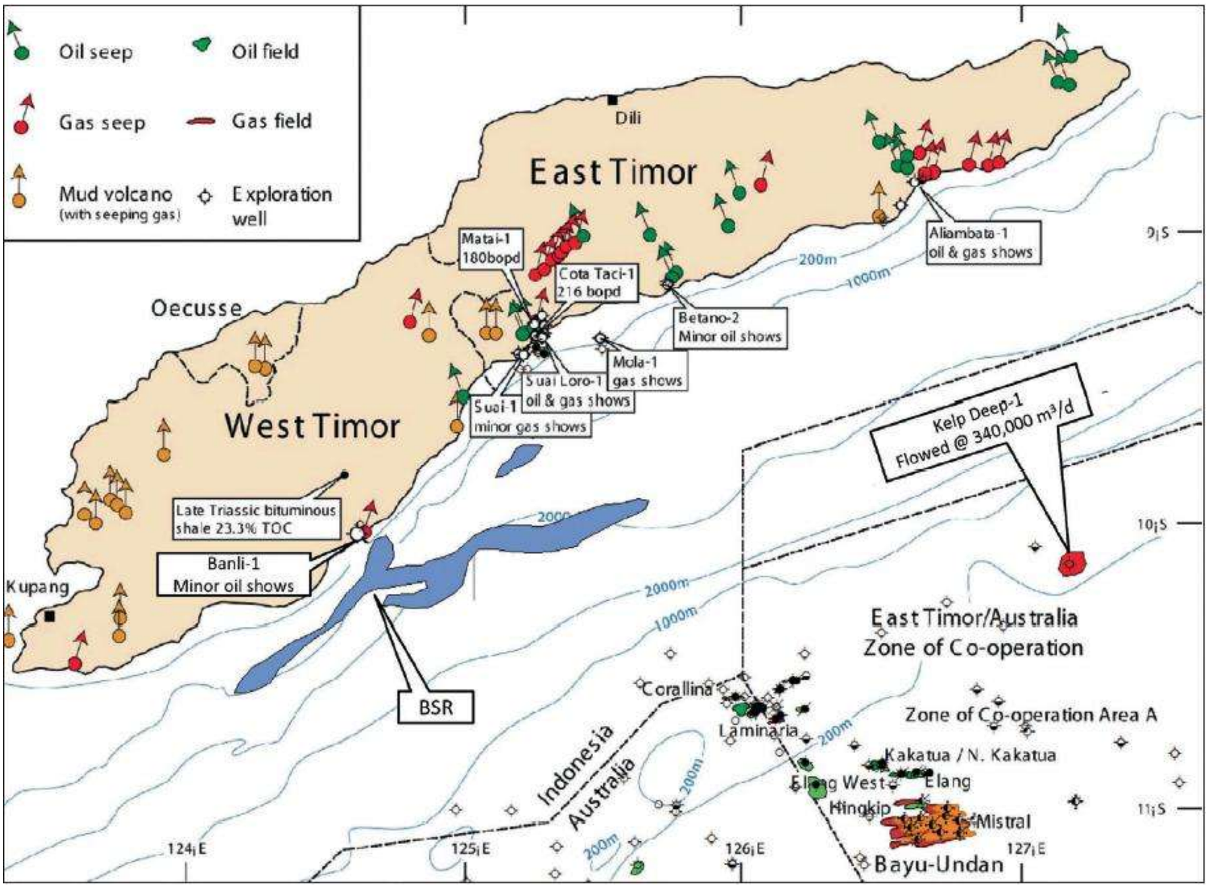

Figure 6.1. Oil and gas locations in East Timor. Source (Charlton, 2002).

The Bayu-Undan gas/condensate field was discovered in 1995. It is a giant field of condensate and liquid petroleum gases (LPGs) (Kyranis, 2003). Another two small oil fields were also later discovered in Jahal in 1966 and Kuda Tasi in 2001. Both fields are relatively small and are located in the former "JPDA 03-01 Production Sharing Contract Area" (now the JPDA 06-105 Area). The contract operator is ENI JPDA 06-105 Pty Ltd. In 1998, Shell discovered the Chuditch field with significant quantities of carbon dioxide contamination. This field is included in a contract area covered by PSC 06-101(A), signed by Minza Oil & Gas on 30 October 2006.

Table 6.1. The history of E & P activities in East Timor.

Year	Highlights
1893	Petroleum exploration began
1915-1975	Some 20 wells drilled, several gas/oil
1975	Mola-1 well TD 3077m, gas shows
1991	One well drilled (under Timor Gap Agreement)
2003	46 wells drilled (under Timor Sea Treaty)
2003	One exploration well drilled after TST came in to force in April
2004	Elang Kakatua and kakatua North oilfields
2004	Development of Jahal and Kuda Tasi oil fields
2004	Discovery of Kitan oil Field
2008	Greater Sunrise Gas Fields are in the process for Development

6.2.3 East Timor Environmental Regulations and Regulatory bodies

Environmental regulations relating to oil industry matters in the territory of East Timor are the concern of the Ministry of Petroleum and Ministry of Environment. Most environmental regulation development and law enforcement involves organisations within both of these ministries. There are different arrangements for the Joint Petroleum Development Area (JPDA) in the Timor Sea, which is regulated by the National Petroleum Authority (NPA) (see Figure 6.1). East Timor is a relatively new county and is still in the early stages of development and is experiencing rapid economic growth. Environmental movements have not yet developed and concerns regarding serious environmental issues are not being voiced like most countries in the region. East Timor also still lacks strong environmental institutions capable of formulating and implementing policy. The situation is made worse by jurisdictional complexity, insufficient information, lack of analytical frameworks for this information, inadequate enforcement and low level of participation and awareness among the private sector, general public and other interest groups managing fishing and aquaculture resources.

Limitations such as institutional capabilities and scientific knowledge often tend to be overlooked by regulations, standards and guidelines. Only basic laws exist for air and water quality and hazardous waste management. The regulatory provisions are as yet neither complex nor extensive.

6.2.4 Ministry of Petroleum and Mineral Resources

The responsibilities of the Ministry of Petroleum and Natural Resources include the development and management of natural resources for East Timor such as minerals and energy sources. The ministry is also responsible for efficiently administering legislation relating to minerals, energy and extractive industries in a consistent way and provide leadership in achieving environmental regulatory reform..

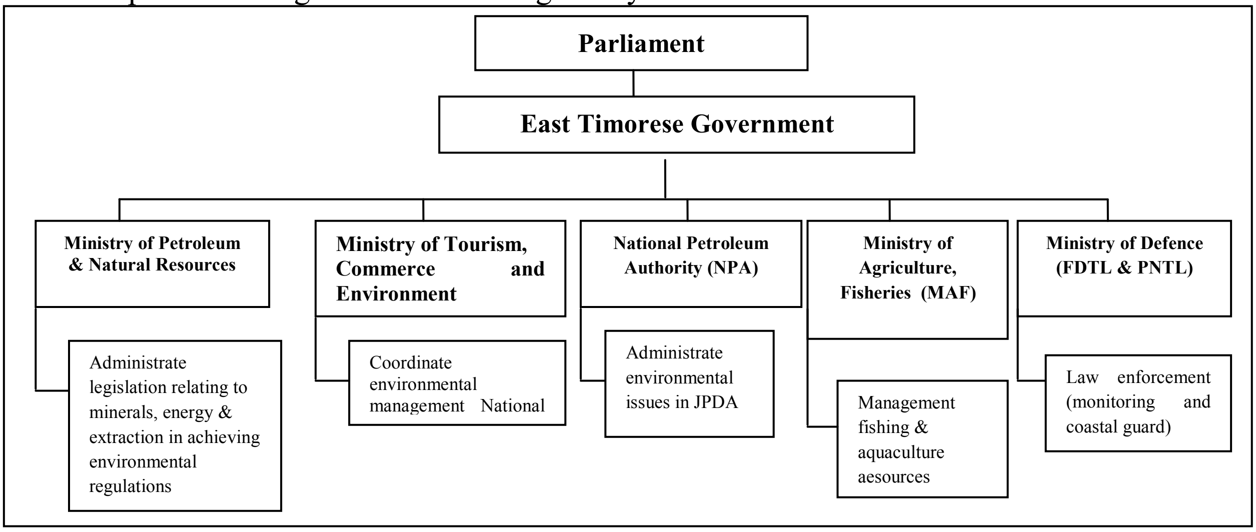

Figure 6.2. Environmental regulatory bodies and responsability in East Timor

6.2.5 National Petroleum Authority (NPA)

The National Petroleum Authority (NPA) is the entity responsible for managing and regulating petroleum activities in East Timor's exclusive jurisdictional areas (covering an area of some 28,776 square kilometres), as well as the Joint Petroleum Development Area (JPDA) (see Figure 1). The establishment of the NPA is in accordance with the Decree Law No. 20/2008, the Timor-Leste Petroleum Activities Law and the Timor Sea Treaty. The NPA works in conjunction with other governmental bodies to define general environmental policies and standards and ensure compliance with the regulations relating to hydrocarbon exploration and production processes. These processes include exploration, development, production, transportation and distribution of petroleum and natural gas resources. The NPA deliver the environmental licences (or permits) that define the scope of environmental inspections and monitoring, establish environmental performance standards for projects and define responsibilities in the case of operational incidents.

6.2.6 Ministry of Agriculture and Fisheries (MAF)

MAF has responsibility for managing fishing and aquaculture resources in line with legal frameworks in order to achieve the responsible and sustainable utilisation of these resources (see Figure 6.2). MAF participates in the evaluation of Environmental Impact Studies relating to activities that may pose a threat to the resources for which they have responsibility for. These might include activities with potential to affect traditional and potential fishing zones.

6.2.7 The Timorese Defence Force (FFDTL) and National Police (PNTL)

Coastal Watch (an organisation dependent on the National Guard of Timorese) and the Coast Guard (an organisation dependent on the East Timorese Navy) share responsibility for the enforcement of environmental law in the aquatic territory, together with the National Directorate of Environmental Services (DNSMA) (see figure 6.2).

6.2.8 East Timor regulatory framework for offshore oil and gas operations

Article 61 of the East Timor Constitution concerns the sustainable use of natural resources and the protection and conservation of the environment. Hence, this article has been used as a legal foundation for the country to participate in international agreements on the environment. East Timor subsequently signed up to numerous international agreements, as demonstrated in Table 6.2 below.

Table 6.2. International conventions adopted by East Timor

Convention/Protocol	Description
Three Rio conventions in 2006	United Nations Framework Convention on Climate Change (UNFCCC)
	United Nations Convention on Biodiversity (UNCBD)
	United Nations Convention to Combat Desertification (UNCCD).
Kyoto Protocol adopted in 2008 put in force in 2009	An international agreement linked to the UNFCCC, which commits each party by setting internationally binding emission reduction targets.

6.2.9 Offshore planning, licensing and environmental permits

The discovery of the Elang field in Timor Sea in the 1970s began a remarkable series of successes for East Timor's petroleum sector. Production sharing contracts were subsequently awarded to 11 consortia, representing more than 20 companies and initiating a highly competitive search for oil and gas. Following the declaration of East Timor's independence in 1999, the terms of the Timor Gap Treaty were abandoned and negotiations initiated between East Timorese and Australian governments, culminating in the Timor Sea Treaty. Under the Timor Sea Treaty, the Timor Sea Designated Authority (TSDA) was established to oversee JPDA exploration, as well as technical and management-related matters on behalf of both governments.

The first Indigenous licensing rounds (for local companies) took place in the 1990s. Operators in the oil and gas industry are required to obtain the necessary environmental permits from the DNSMA, which also regulates environmental issues. The DNSMA sets out a list of activities in the oil and gas sector that require environmental assessment and approval. They include all seismic operations, hydrocarbon processing facilities, construction of waste treatment and/or disposal facilities, as well as oil and gas field developments onshore, near shore, offshore and in deep water. The Director of DNSMA is responsible for issuing permits for all aspects of oil-related effluent discharges from point sources (gaseous, liquid and solid) and oil-related project development. The DNSMA also provides that environmental permits shall be issued for existing and new sources of effluent emissions. This is in contrast to the Environmental Impact Assessment for Timor-Leste, particularly for the JPDA, where the process is prepared by operators (companies) and then submitted for review by NPA (more details on the EIA process in the JPDA are discussed in Chapter 5).

The Petroleum Act is the principal law governing concessionary agreements. The Act pertains to the conduct of petroleum operations undertaken anywhere within East Timor and its 200-mile territorial sea areas. This Act distinguishes between petroleum from other mineral resources for legislative purposes. It defines 'petroleum' as crude oil, natural gas and other petroleum by-products occurring naturally (Chapter 1, Article 2). The Act resulted from the adoption of a concessions royalty system by the East Timorese government. The main concept of this system (under Chapter 1, Article 5) is that petroleum belongs to the state, and therefore any person and/or entity wishing to explore for or produce petroleum can only do so after receiving a concession issued by the government. When producing petroleum, under Chapter IV Article the concessionaries must make a payment to a royalty and tax according to the regulations or rules issued by the government. The Minister of Natural Resources is empowered to enforce the Act. The minister can exercise his power in consultation with the Petroleum

Committee in regards to any concession, including the awarding, expiration, extension and invalidation of a contract.

The Petroleum Act aims to regulate petroleum operations, including exploration, production, storage, transport, sale or disposal. The Act is comprised of nine chapters: general provisions, authorising petroleum activities, participation by the state, development of petroleum activities, information and research, public information, regulations and directives, penalising provisions and other provisions and final provisions. Because of the relatively young age of the petroleum industry in East Timor, provisions in the Petroleum Act and possible future amendments issued provide an umbrella for a wide spectrum of environmental issues.

Table 6.3 Environmental Regulations apply in offshore operations in East Timor.

Types of guidelines	Scope
Legislation and Regulations in East Timor	
Maritime Zones Act 2002 (MZA)	The act claims East Timor's Exclusive Economic Zone (EEZ) and seabed (continental shelf) entitlement extending 200 nautical miles (nm) from East Timor's coast, pending an agreement on boundaries with Australia and Indonesia. The MZA is based on international law, 1982 United Nations Conservation on the Law of the Sea (UNCLOS).
Timor –Leste Petroleum Act 2005	To regulate petroleum operations, including exploration, production, storage, transport, sale or disposal
DNSMA Guideline 5 on Public Engagement	This guideline is aimed at regulating community engagement and participation in the public consultation process.
DNSMA Guideline 6 on Environmental Screening	This guideline is provided as guidance for the environmental screening process.
DNSMA Guideline 7 on Preparation of an Environmental Management Plan	This guideline is aimed at regulating the preparation process for development an environmental management plan.
Indonesian legislation and regulations effective as of 25 October 1999	
Law 23/1997 on Environmental Management	Concerned with regulating efforts to preserve environmental functions, covering planning policy, exploitation, development, maintenance, reparations, supervision and environmental controls.
Reg. 20/1990 on Control of Water Pollution	This regulation refers to the prevention or control or waste pollution, water quality standards pollution loads, capacity to assimilate pollution loads and effluent quality standards.
Reg. 51/1993 on Environmental Impact Assessment (EIA)	An integrated effort for the purpose of utilisation, regulation, maintenance, supervision, control, rehabilitation and development of the environment. EIA is the process of studying the significant potential impacts of a proposed business or activity on the environment, as is required as part of the decision-making process.
International conventions	
United Nations Convention on the Law of the Sea 1982 (UNCLOS).	The Law of the Sea is the most comprehensive attempt at creating a unified regime for governance of the rights of nations with respect to the world's oceans. The treaty addresses a number of topics, including navigational rights, economic rights, pollution of the seas, conservation of marine life, scientific exploration and, piracy among others.

Types of guidelines	Scope
Convention on the Conservation of Migratory Species of Wild Animals 1979 (commonly known as the Bonn Convention).	The Convention is to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty under the aegis of the UNEP and which is concerned with the conservation of wildlife habitats on a global scale.
International Convention on Civil Liability for Oil Pollution Damage 1969	The purposes of the Fund are to provide compensation for pollution damage to the extent that protection afforded by the 1969 Civil Liability Convention is inadequate. To provide ship owners, in respect of the additional financial burden imposed on them by the 1969 Convention, some relief, being subject to the conditions designed to ensure compliance with safety at sea and other conventions. To give effect to the related purposes set out in the Convention.
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971.	The purposes of the Fund Convention are: to provide compensation for pollution damage to extent that the protection afforded by the 1969 Civil Liability Convention is in-adequate. To give ship-owners in respect of the additional financial burden imposed on them by the 1969 Convention, such relief being subject to conditions designed to ensure compliance with safety at sea and other conventions. To give effect to the related purposes set out in the Convention.
International Convention on Oil Pollution Preparedness, Response and Co-operation 1990.	An International maritime convention establishing measures for dealing with marine oil pollution incidents nationally and in cooperation with other countries.
International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (commonly known as MARPOL 73/78).	The main international convention covering prevention of pollution of the marine environment by ships due to operational causes or accidents.
Based Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal.	The treaty is designed to reduce the movements of hazardous waste between nations, and specifically to prevent the transfer of hazardous waste from developed to less developed countries (LCDs). It is also intended to minimise the amount and toxicity of waste generated, and ensure environmentally sound management as closely as possible to the source of waste generation. It is also designed to assist LCDs in environmentally sound management of hazardous and other wastes generated.
Protocol to International Convention for the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 (commonly known as the 1996 Protocol)	The protocol is one of the first international conventions for the protection of the marine environment from human activities. The Convention contributes to international controls and prevention of marine pollution by prohibiting the dumping of certain hazardous materials. In addition, a special permit is required prior to dumping of a number of other identified materials, with a general permit required for other waste or matter.
The Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar, Iran, 1971 (Known referred to as the Ramsar Convention).	An international treaty for the conservation and sustainable utilisation of wetlands, which recognises their fundamental ecological functions, as well as their economic, cultural, scientific and recreational value.

6.2.10 Transboundary Environmental Management in East Timor

The Timor Sea Environmental Management Systems

Prior to examining transboundary water resources management systems in Timor Sea (see Figure 6.1); it is useful to briefly review the domestic management frameworks that exist both in East Timor and Australia. On the East Timor side, responsibility for the management of water resources can be seen as a partnership between numerous ministries, including the Ministry of Natural Resources, Ministry of Agriculture, Forestry and Fisheries (MAFF) and Ministry of Public Transportation. The Clean Water Act states management of water quality is considered a national interest and responsibility. This Act establishes a framework for regulation and best practice by which pollution is controlled and water quality is protected. The central government also has responsibility for the development and management of large water resource development projects and navigable stream management through the Ministry of Development.

Environmental management in Australia is jointly undertaken through a partnership between the Department of Sustainability and the Department of Agriculture. The central government also has responsibility for the development and management of large water resource development projects and navigable stream management through the Ministry of Development and the National Defence Force. Individual Australian states have their own EIA processes in place, in addition to the central government EIA system. Because the JPDA is considered to be in international waters, the central government EIA system has the most influence in this respect.

The EIA System in East Timor

In the absence of a national environmental law, the Constitution allows East Timor in this instance to adopt Indonesia government Regulation 51/1993 (Bapedal, 1993). Thus, the implementation of EIA in East Timor adopts the Indonesian EIA system, which is defined in Article 1 (2) of Regulation 51/1993.

The EIA process in East Timor is administered under the Secretariat of State of the Environment and implemented by the National Directorate of Environment (DNSMA). EIA in East Timor was first introduced into the environmental management system in 2004 through the provision of DNSMA guideline no. 7 on environmental impact assessment (EIA), together with other additional regulations. These included guideline no. 5 on public engagement, guideline no. 6 on environmental screening processes and pollution control and guideline no. 8 for preparation of an environmental management plan Table 6.3 the current EIA process under Indonesian Regulation 51 of 1993.

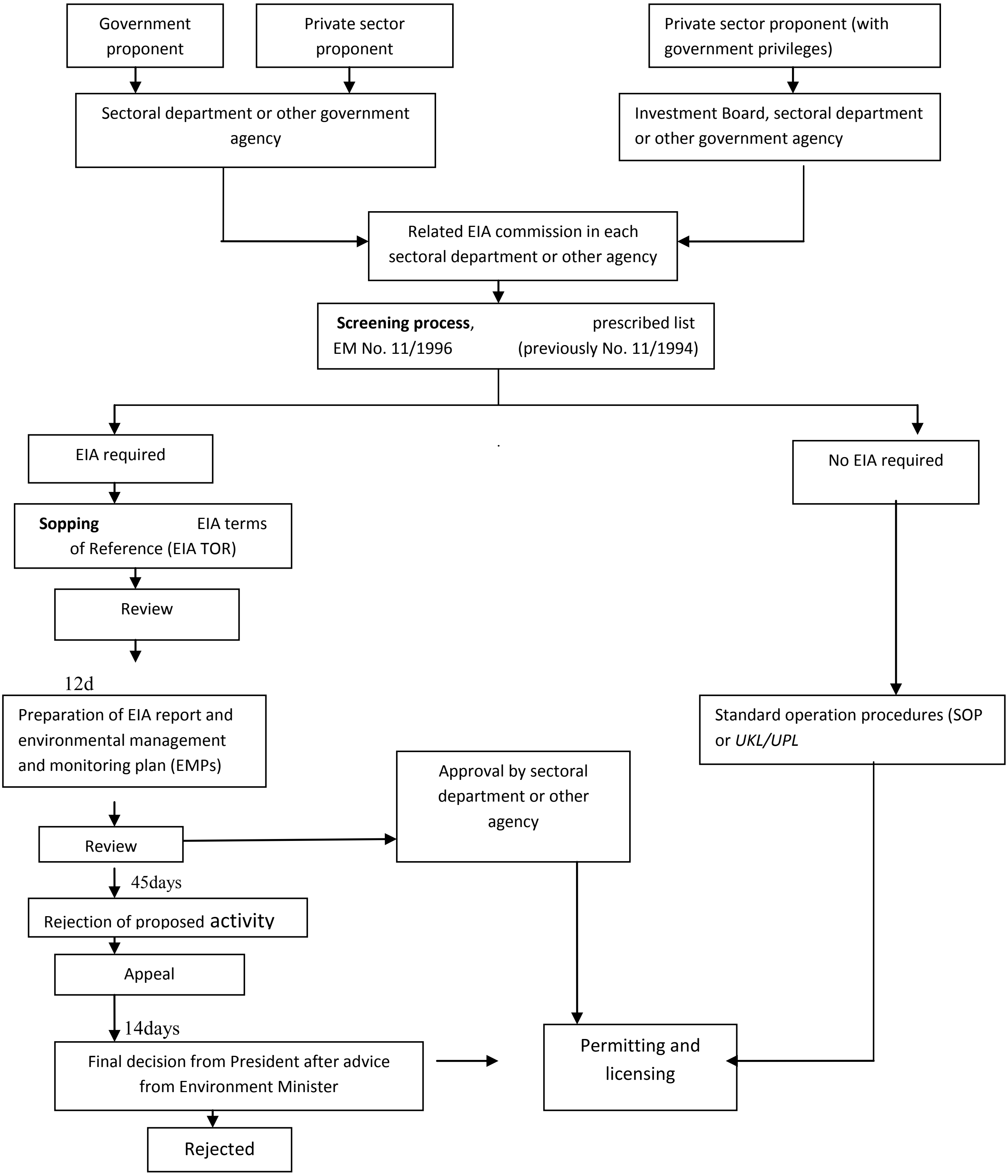

Figure 6-3. The EIA process under regulation 51 of 1993. (Adapted from the Indonesian Government 51/1993).

The *screening* process and triggering mechanism in East Timor utilises a prescribed list of activities and processes though the Environment Ministry Decree (EMD) 39/1996 and Environmental Guidelines no 6. Additionally, the minister has the call-in power to request an EIA where there are uncertain conditions, or for a specific major project that has not yet been defined on the prescribed list. *Scoping* is undertaken through the preparation of the terms of reference (TOR) for developing an environmental impact statement (EIS). The scoping process occurs when the EIS TOR are reviewed by all EIA stakeholders for further agreement on the scope of the EIA investigation. Once the TOR is agreed, the proponent starts to prepare an EIS, along with environmental management and environmental monitoring plans (EMPs) in accordance with the agreed TOR, general guidelines and sectoral technical guidelines. After the completion of the EIS and EMPs, the assessment process occurs within 45 working days. During this period, the proponent has the right of appeal, which must be lodged within 14 days of receiving the rejection.

In the case of undertaking an EIA in East Timor, public opinion is typically represented by representatives from non-government organisations (NGOs). Once approval of the EIS and EMPs has been granted, the competent authorities will pursue the execution of the EIS as well as the EMPs. These may be altered or revised where there are any changes either in the environmental setting or the actual development. Any mismatch between the forecast results and what actually occurs could potentially cause a revision of the EMPs.

The EIA system in Australia

The EIA in Australia is partly administered by the Department of the Environment (DOE) and governed under Article of 164 of the Environmental Protection Act 1974. The Commonwealth Government has its own EIA system distinct from the EIA systems in each state or territory. In the case of the Timor Sea, since the location is close to the Northern Territory, the EIA system of that territory could possibly be applied to the process. On the other hand, because any potential development would be in international waters, it is presumably more appropriate that the Australian Commonwealth EIA system be given more weight in the decision-making process. The key purpose underlined in the EIA procedures document is “to inform decision-makers of the likely impacts of a proposal prior to a final decision” (Australian EIA Network, 1996b) as shown below in Figure 6.4.

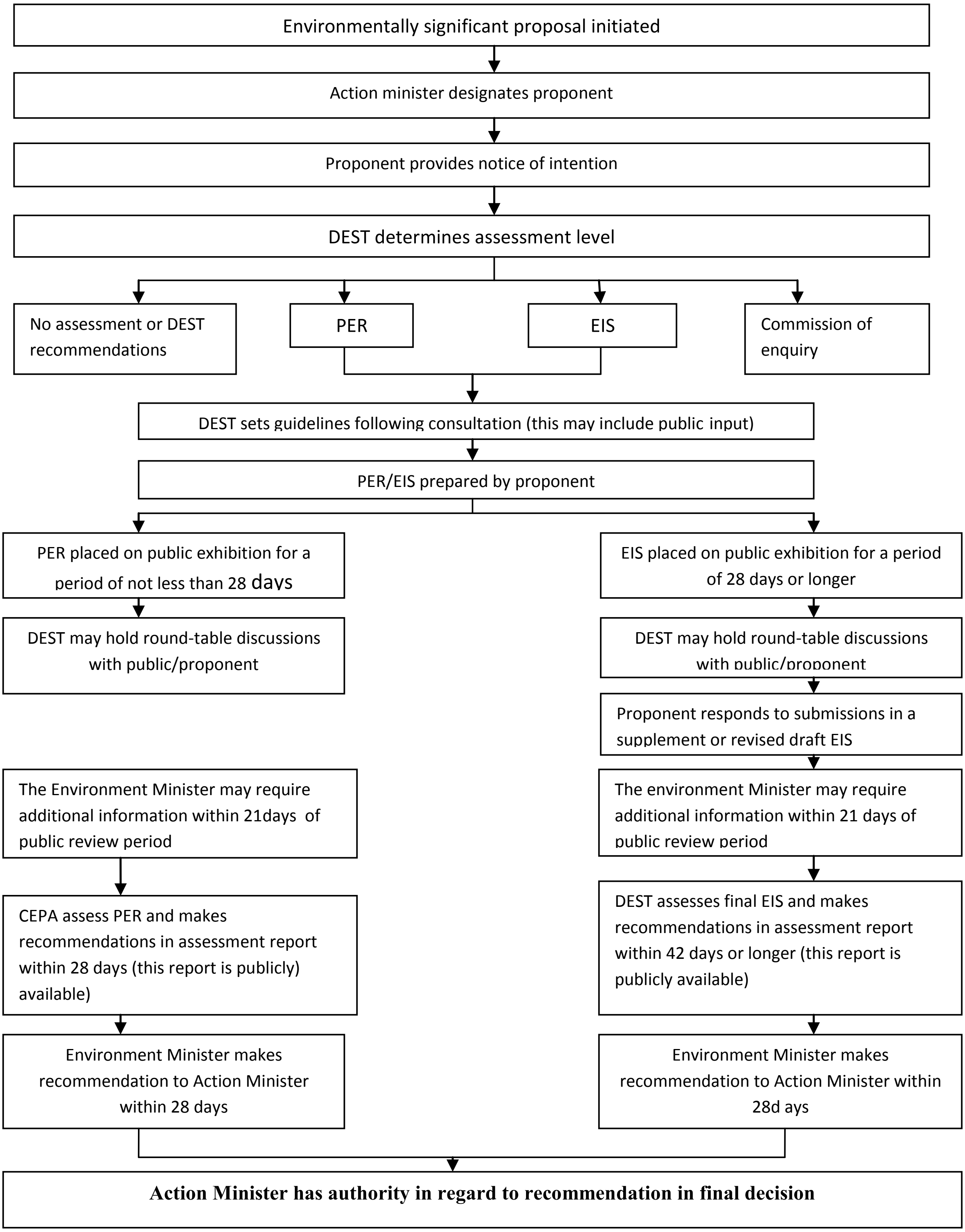

Figure 6.4. Australian Commonwealth EIA process under EP (IP) Act 1974. Adapted: Harvey (1998)

In the Commonwealth EIA process, as discussed in Harvey (1998), it is highlighted that in the triggering of an EIA, it is not necessarily the Minister of Environment who should be responsible for the proposed development. Subsequently, the screening process in this phase is fully optional. Later, the minister in charge would designate the proponent responsible for supplying information related to the proposal, commonly referred as a Notice of Intention (NOI).

The next step is taken by the Department of Environment which decides on the level of assessment, either with or without the preparation of an EIS, or whether to proceed with a public environmental report (PER). Furthermore, the scoping process is undertaken prior to the assessment level agreed by the department and specific project guidelines. In parallel with these processes, public opinion is also accommodated in accordance with the consultation process.

The proponent must continue to prepare the actual document after the content of the EIS or PER is decided. Once the first draft of the EIS or PER is completed, public participation becomes the central activity in the process and the draft should then be made accessible to the public for comment. The whole period for public participation takes at least 28 days, including a commentary period of no more than one week for the purpose of reporting feedback or concerns from the proponents. PER is carried out by the Commonwealth Environmental Protection Agency (CEPA), which takes a maximum of 28 days, while the EIS is conducted within 48 days. At the end of these processes, the Minister for the Environment recommends the outcome of an EIA to the action Minister within 28 days for PER and within 42 days for EIS prior to the Action Minister making a decision.

The EIA system in the Joint Petroleum Development Area (JPDA)

Environmental impact assessment procedures in the JPDA are shown in the flowchart in Figure 6.5 below. The initial step is the contract operator's triggering information, describing the environmental impact of the proposed petroleum activities or preliminary environmental report (PER) to the Joint Authority (JA). This preliminary report mainly contains a description of the environment in the vicinity of the structure and other baseline data. The document also states the potential impacts of the structure on the marine environment, including information on the primary, secondary, short-term and long-term, adverse and beneficial effects of the proposed structure. The preliminary report is then assessed by the Joint Authority or by an expert engaged by the JA. The JA will also refer the report to the relevant East Timorese authorities – in this case DSNMA and Australian authorities CEPA – for further comment. The next stage is determining if further environmental information and thus an environmental impact statement (EIS) is required. The JA will be responsible for determining to what extent the proposed petroleum development would affect the marine environment. If the JA determines the EIS is not required, it may still direct that changes be made to the development proposal in order to protect the marine environment. The reasons for the JA deciding that an EIS is not required an EIS will then be made available to the relevant East Timorese and Australian authorities. However, if the JA decides an EIS is necessary, the contract operator must submit a draft EIS. This document is then referred by the JA to the relevant East Timorese and Australian authorities for further comment. Each authority will assess the draft EIS according to its own procedures. At this stage the Australian environmental authorities may request the JA to require the contract operator to meet the cost of advertising the draft EIS for public comment in Australia. The JA will allow at least 60 days for comments. The JA may also direct the contract operator to revise the draft EIS where necessary, after which the JA will give the go ahead or approval for the petroleum development in accordance with the final EIS.

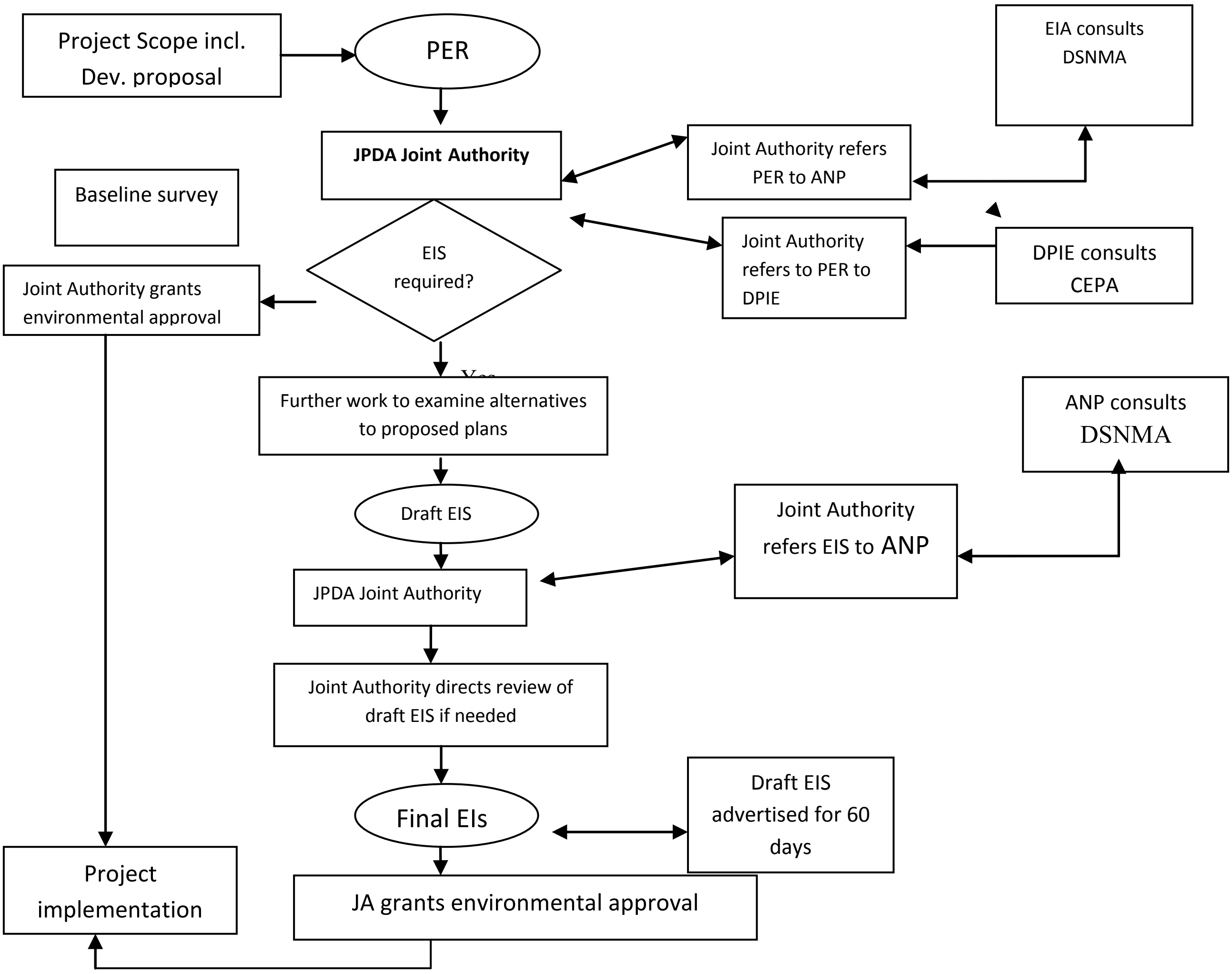

Figure 6-5. EIA process for development in the JPDA. Modified from the JPDA, report 2008.

Government and political involvement: the EIA process is generally not isolated from political interests. From the above descriptions, it can clearly be seen that three main stakeholders are commonly associated with these processes: the government, business groups and communities. In line with that, Doyle and McEachern (1998) examined the relationship between these first two groups, stating that an EIA is often considered as a form of government regulation imposed on business and resisted by business. Furthermore, Blake et al (1995) also recognised the involvement of highly political interests in the Timor Sea. Under the terms of the Timor Sea Treaty, politics takes precedence over the EIA process. It is therefore possible that the interests of the project, whether political or economic, override the principle and best practice of EIA. In this way, the EIA can be seen as a "rubber stamping" mechanism, only needed as a formality for the approval procedure.

Table 6.4. Summary of differences in EIA systems in East Timor, Australia and the Timor Sea.

	Timor Sea EIA system	Australian EIA system	East Timor EIA system
EIA legislative frameworks			
1.Regulation	The Timor Sea Treaty (2002).	The Australian Commonwealth EP (IP) Act 1974.	The Indonesian Government Regulation 51 of 1993
2. Regulatory system	EIA is part of a permit system and has very strong legal implication.	EIA is part of environmental legislation.	EIA is part of environmental legislation.
3. Guidelines for EIA process	Administrative Guideline no. 5.	Administrative procedures under EP (IP) Act 1974.	More than 14 guidelines under Environmental Ministerial decree, Head of Bapeda, Head of Sectoral Department Decree.
EIA processes			
1.Triggering mechanism and screening process	Prescribed list Administrative Guideline No. 5	At the discretion of the Action Minister based on a set of criteria.	Prescribed list and at the Environment Minister's discretion if necessary. Ministerial Decree 39 of 1996
2. Level and type of EIA	Generic project-based EIA, no EIA categorisation (except for level of assessment PER and EIS)	Generic project-based EIA, no EIA categorisation.	Four types of EIA: single project, multi-project, multi-sectoral and regional.

	Timor Sea EIA system	Australian EIA system	East Timor EIA system
3. Guidelines for EIS preparation, scoping process	General guidelines are set out by the Joint Authority without standardised format and structure, although content of the report is specified.	General guidelines and others are set out generically by Environment Australia without standardised format and structure.	General guidelines are set out by Environment Ministerial Decree with standardised format, structure and content. Specific guidelines must be prepared by proponent with direction from stakeholders.
4. Times required for EIA process	No total time limitation, but draft EIS should be advertised for a minimum of 60 days.	Public exhibition is limited to 28 days. Additional information and public review 21 days, assessment of PER 28 days, EIS 42 days, Environment Minister's recommendation: PER 28 days, EIS 42 days.	Time limitation: the EIA evaluation should be undertaken within 57 business days: 12 days for EIS TOR; 45 days for EIS review.
5. EIS assessment authority	The Joint Authority in consultation with DPIE, **Australia's CEPA** and East Timor's DSNMA	Environment Australia, DEST on behalf of Environment Minister	Three different EIA commissions: 1 integrated and regional EIA commission, 14 central EIA commissions, 27 provincial commissions
6. Monitoring or auditing and management plan	Specifically required by Administrative Guideline. Formal documentation of environmental management plan and monitoring program mandatory.	Not specifically required by Act, based on assessment report. Request/recommendation not mandatory.	As a part of EIA process, formal documentation of environmental management and monitoring plan is mandatory.
Public participation processes			
1. Public participation methods	Public comment and submission after media advertisement.	1. Public submissions 2. Media publication 3. Public exhibition 4. Public meeting 5. Lobby group	1. Mostly represented by NGOs 2. Public submissions 3. Media publication 4. Public meeting
2.Time for public participation	Minimum 60 days after media advertisement.	Minimum 28 days for public exhibition.	No time limitation and community can voluntarily participate during all stages of the EIA process.

In East Timor, the part of political involvement is recognised. For example, the EIA process is seen as a part of the JA's responsibility. Hence, DSNMA and representatives from sectoral departments are only involved throughout the consultation complementary to the EIA process carried out by the JA. It is similar in the Australian system, where administrators of the review of the Timor Sea EIA for the Australian side conducted only a consultation process. Dadang (2004) found that, based on the Environmental Assessment Branch of Environment Australia, there was no formal EIS assessment for the Timor Sea projects according to Australian legislation. In this case it is interesting to note that decisions made by the Joint Authority are not required to undergo an EIA, according to Australian law. In this regards, the role of the designated authority in terms of administration needs to be clarified further in order to avoid mismanagement of the EIA process.

An institutional framework is one of the critical points in managing the EIA process. For example, the EIA authority plays an important role in the review process. According to Gilpin (1995), other than the dominating influence of politics, the institutional structure and the strength of the environmental laws are of vital significance. Moreover, Ebisemiju (1993) claims that "institutional arrangements deal with the type and effectiveness of the agency responsible for management of the EIA system". Hence, a competent institution is imperative to managing the overall EIA process and ensuring its effectiveness. This is particularly relevant in terms of the Timor Sea EIA system, where the JA is the principal and central authority that administers the EIA process and acts as a review body. It also grants approval, as well as requesting comment from the relevant authorities of both countries. Similar guidance on authority can also be found under the Espoo Convention (UN/ECE, 1996b), in which authorities are involved at various stages of the EIA process. Regarding the institutional framework of the Timor Sea EIA system, there are two essential issues: resources of EIA expertise and an independent body to review EIA documents. It is undeniable that by utilising environmental experts from the competent authorities in both countries this could potentially overcome the issue of EIA expertise.

EIA legislative framework: EIA systems in both Australia and East Timor generally have a comprehensive regulatory system for EIA implementation. This is in contrast to the bilateral or transboundary EIA schemes (the Timor Sea and Espoo Convention), which only provide general guidelines. While the Timor Sea EIA process is part of a permit system, the Espoo Convention's provisions are more general in terms of promoting environmentally sound development and enhancing international cooperation in assessing transboundary EIAs to avoid negative environmental consequences. Unlike the former system, in the Espoo arrangement there are no permit procedures between the countries involved and the decision on the operation permit depends on the country of origin (that is, party of origin). Of course, other concerned parties can only influence the final decision through the EIA consultation process. In the case of the Timor Sea, if referring to the Timor Sea EIA system, the term party of origin doesn't exist as the system only applies in the Joint Petroleum Development Area (JPDA), which is managed by the JA and not owned by one party. However, it would be different if there was a proposed development by East Timor *(managed by East Timor)* for example. In this case, the East Timor EIA system would apply to the whole process and East Timor would be the designated the party of origin as activities would be carried out in the area and potentially affect another party's territory.

The transboundary EIA under the Timor Sea Treaty is supported by regulations, directions and guidelines that have strong legal implications for the relevant proponents. In contrast, the Espoo EIA system is directed by, and mostly relies on, guidelines for EIA implementation by the party of origin. The nature of the EIA system varies between countries based on existing procedures and statutory instruments, including external influences such as the European Community Directives.

EIA process: The triggering mechanisms and screening process are referred to in the summary in Table 6.4. The EIS systems presented adopt a prescribed list *(screening list),* with the exception of Australia, which utilises discretionary mechanisms. The Timor Sea's EIA utilises a prescribed list according to three categories of activity subject to EIA requirements. The justification for utilising a prescribed list given by the Espoo EIA system is that the utilisation of a discretionary mechanism could produce inconsistency in two similar cases, while a prescribed list is considered more consistent (Swensen, 2006). However, there is a risk of producing a long prescribed list. This is because the crucial issues for using a prescribed list are the triggering criteria and thresholds, which if inappropriately drawn up could encourage proponents to avoid the EIA process.

Level and type of EIA: The levels of assessment in the Australian EIA system cover preparation of PER, an EIS examination and a commission of enquiry. In this regards, PER differs from EIS in that several are criteria based on the significance of the impacts. In contrast, East Timor has only a single level of assessment in the prescribed list. However, the system has been divided into three different types: a single project EIA, integrated and multi projects EIA. The Timor Sea EIA system actually utilises two levels of assessment: the PER and EIS. Espoo differs in comparison as its provisions are very general in nature and the arrangement of the assessment criteria and process depends on the party of origins EIA system (Albrecht, 2008).

Scoping: The Timor Sea EIA has a simple scoping process. The content and the scope are generally provided in the guidelines 5 A and B attachments included with guideline 5. There is no further process of discussion and direction from the assessment authority in terms of scoping. This has occurred because the Timor Sea projects apply only to oil exploration and exploitation. For this reason the scope of study to some extent is obvious to all stakeholders and decided earlier in the guidelines. Furthermore, only very minor variation is likely to occur in the proposed project activities in the Timor Sea or in those concerning the environmental conditions of the region.

Timing of EIA: The timing of the EIA assessment process and time efficiency potentially affect the overall planning process. The aspects that most influence the overall time consumption are evaluation, public participation and the EIS preparation stages. In the case of the Timor Sea, Australia and East Timor set out the timeframe for their EIA stages. The Timor Sea EIA system provides a minimum required time for comment from interested parties, which is at least 60 days, as described in guideline no. 5. In this case it is analogous with the TEIA in the Espoo Convention, which does not specify the time needed to perform the overall EIA process.

EIS review process: In the Timor Sea there is a unique process as the only authority is the JA. However, it seems that there was a misunderstanding about the term 'consultation' set out by the administrative guideline in the review process. In this context consultation actually means that DSNMA and CEPA would provide opinions, comments and suggestions to the designated authority (not to the proponent). However, it did not mean that DSNMA conduct a formal EIS assessment or review. Another important issue here is that the JA simply compiled the comments from the relevant authorities of both countries and passed them on to the proponent. The JA therefore cannot be categorised as an assessment authority. If using the Espoo Convention as reference point in this matter then the EIA system is supposed to provide the opportunity for joint assessment through the joint body, which is responsible for providing environmental information regarding EIA experiences. This is particularly the case for the Timor Sea EIS, where there was an absence of direct information exchange or agreed environmental standards to deal with a specific project, in that the TEIA was carried out between East Timor and Australia. Thus, a direct joint EIA review between the relevant authorities of both countries would perhaps give more comprehensive EIS experience and expertise.

Monitoring, auditing and management plan: The Timor Sea EIA system seems to adopt a procedure that requires monitoring and auditing, as well as a management plan in addition to PER or EIS. However, the reporting of monitoring and management results is based only on self reporting by the proponent. This is in contrast to the Espoo EIA system, which requires 'post-project analysis' to be conducted. This takes place at the request of any party involved with the aim of considering any likely significant adverse transboundary effects (Article 7 (1). Included in this activity is surveillance with numerous objectives such as compliance monitoring, impact management reviews, as well as verification of past impact predictions. With regard to this system, Ebisemiju (1993) points out that the involvement of related agencies in monitoring compliance and post-project audits aims to ensure that the project development is implemented according to approved EIS standards. It appears that the monitoring methods in the Timor Sea EIA system have reduced the role of the JA to a supervisory agency, as it only requires minimal supervision of post-EIA activities. However, if considering the environmental risks of sensitive activities, the JA or the competent authorities either from East Timor or Australia should consider the possibility of establishing a cross-checking mechanism through a specific survey, investigations or inspection procedures.

Public participation: In the Timor Sea EIA system in particular little attention has been paid to public involvement. This is due to the fact that the Timor Sea project is highly political and driven by economics. The Administrative Guidelines mention very little about the role of the JA in involving the public in the EIA process. However, there is general provision for voluntary-based public participation where the competent East Timor and Australian authorities may seek comment from interested parties. This differs in comparison to the Espoo TEIA in which public participation is an essential element in communicating the process to decision-makers. In the Espoo process, public participation is encouraged from very early in the EIA process. In this context, the Convention should consider that opportunities for public participation differ from one country to another EC (1996a) and therefore the concerned parties should be informed of the chosen method of formal public participation by the party of origin.

6.2.11 Assessment of environmental regulatory frameworks in other countries

The selection of countries to analyse considered as reference cases was based on numerous criteria which are presented below. Information on legislation review and study consists not only of publications but also digital information available on the internet. The selection of reference countries as offshore producers was made based on:

1. Historical development and experience in offshore operations

   There is no doubt that many countries around the world have experience with the offshore oil and gas industry, however leadership in this respect has been taken by the US and the North Sea countries, particularly the UK and Norway.

2. Information availability.

   Unfortunately, not all countries have available information about their regulatory regimes which can be readily accessed on internet websites or at local libraries. It is also the case that regulations are available in other languages and only small parts of the whole regulatory body is translated.

3. Geographical locations.

   Taking all this information into account, the countries selected as case studies are the following: US in the Gulf of Mexico area, UK, Norway in the North Sea area and Canada, including Newfoundland in the Atlantic Ocean.

There are aspects considered for the comparison of national environmental regulatory frameworks. The legislation governing environmental controls for offshore activities in the references countries and East Timor was analysed and compared based on the following aspects:

1) Overview of the legal framework and applicable legislation: covers applicable laws that are in place and any concerns;

2) Regulatory/management framework and standards for offshore oil and gas operations: relevant authorities, how they related to each other and their responsibilities,

3) Guidelines and standards on discharge limits: guidelines and standards (i.e. which authority is responsible for monitoring and compliance activities).

a. The United States in the Gulf of Mexico

The development of offshore oil and gas in the United States is associated with inter-related legal regimes such as international, federal and state laws (Gao, 1998). International law (United Nations Conventions of the Sea) normally serves as the instrument for establishing national ownership and control of offshore areas. On the other hand, US domestic law has been aligned with such internationally recognised principles. US law also defines the jurisdiction for marine resources and ownership of offshore mineral resources, dividing regulatory authority among states (Gao, 2012).

US legal framework on offshore oil and gas

Environmental legislation concerning the oil and gas industry in the US is primarily covered under the *Outer Continental Shelf Lands Act* (OCSLA), (GAO, 2012). Other legislation of general application which governs related topics such environmental issues, responses to oil spills, emergency planning, marine and fisheries management, economic considerations and leasing moratoria on OCS Lands are presented in Table 6.5.

Table 6.5. EPA regulations that apply to the offshore and coastal oil industry in USA. Sources: (EPA, 1997, GAO, 2012).

Main topics	Regulation and legislation	Scope
The basis of offshore legislation and regulations	Outer Continental Shelf Lands Act (OSCLA) and Outer Continental Shelf Lands Act Reform of 2010	Requires federal agencies to integrate environmental values into their decision-making processes by preparing a detailed Environmental Impact Statement.
	The Federal Oil and Gas Royalty Management Act.	To ensure that all offshore federal lands have proper enforcement mechanisms.
Legislation and regulations related to environmental issues	National Environmental Policy Act (NEPA) of 1969	To promote the enhancement of the environment and the environment quality.
	Clean Air Act (CAA)	Control gas emissions and flaring.
	Coastal Zone Management Act 1972	Voluntary. Encourages states/tribes to preserve, protect, develop, and where possible, restore or enhance valuable natural coastal habitats, as well as the fish and wildlife using them.
	Endangered Species Act 1973	Conservation of ecosystems on which threatened and endangered species of fish, wildlife and plants depend.

Main topics	Regulation and legislation	Scope
	Clean Water Act (CWA) 1977 Safe Drinking Water Act	Aqueous wasters. Black, gray, oily, processing, cooling, storm and domestic waters. Discharge permits based on the best available technology (BAT) economically achievable or best conventional pollutant control technology.
Spill preparedness and planning	Oil Spills Response Act.	Community engagement in relation to chemical risks and emergency response plans.
Waste and pollution management	Solid waste management	General directives on waste management and the enforcement of reduction at source.
	Oil Pollution Prevention Act	Regulating oil discharges and contingency plan requirements for oil spills.
	Solid Waste Disposal Act	Management of waste generated during oil, gas and energy activities categorised as "special wastes" (exempt from federal hazardous waste regulations).
	Toxic Substances Control Act	Risk management of toxic substances.
	Underground Injection Control (UIC) Program.	Underground injection of waste in order to prevent contamination of drinking water resources.
	Comprehensive Environmental Response, Compensation and Liability Act (Superfund).	EPA response to releases or threatened releases of hazardous substances that may endanger public health, welfare or the environment.
Marine and fisheries management	Fishery Conservation and Management Act	Provides for management of fish and other species in the Exclusive Economic Zone (EEZ) under plans drawn up by Regional Councils
	Marine Mammal Protection Act	Federal responsibility to conserve marine mammals such as sea otter, walrus, polar bear, dugong, and manatee, cetaceans and pinnipeds.
	Marine Protection, Research and Sanctuaries Act (MPRSA or Ocean Dumping Act)	Prohibits the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. Ocean dumping cannot occur unless a permit has been issued.
	National Wildlife Refuge System Act	Provides guidelines and directives for a National Wildlife Refuge System managed as a national system of all related lands, waters and interests for the protection and conservation of national wildlife resources.
Economic considerations	Outer Continental Shelf Deepwater Royalty Relief Act of 1995	To encourage natural gas and oil development in the Gulf of Mexico in waters at least 200m deep by offering royalty relief on qualifying natural gas and oil lease sales.
	Distribution of OCS revenues	Provides for a fair and equitable share of revenue for states affected by offshore operations in adjacent federal waters.
Leasing moratoria on OCS lands	Deepwater Port Act	Licensing system for man-made structures located beyond the US territorial sea. Sets out conditions that applicants must meet, including minimising adverse impacts on the marine environment.

USA regulatory/management framework for offshore oil and gas operations

The regulatory regime related to the oil and gas industry in the US is primarily under the command of the Department of Interior (DOI) (see Figure 6.6) and the US Coast

Guard (USCG). The office of DOI established two main branches within the department: 1) Land and Mineral Management, responsible for administering of public lands and managing subsurface mineral deposits on state, federal and private lands and 2) Policy Management and Budget, a federal agency established to assist the president in the evaluation, formulation and coordination of management procedures and programs among the department's executive branch. Established under the Land and Mineral Management office are the Bureau for Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). For implementation of policy the BOEM works closely with the National Environmental Agency (NEPA), while the Policy Management and Budget office is linked to the Office for Natural Resources Revenue.

The USCG is a branch of the United States Armed Forces and is a uniform service.

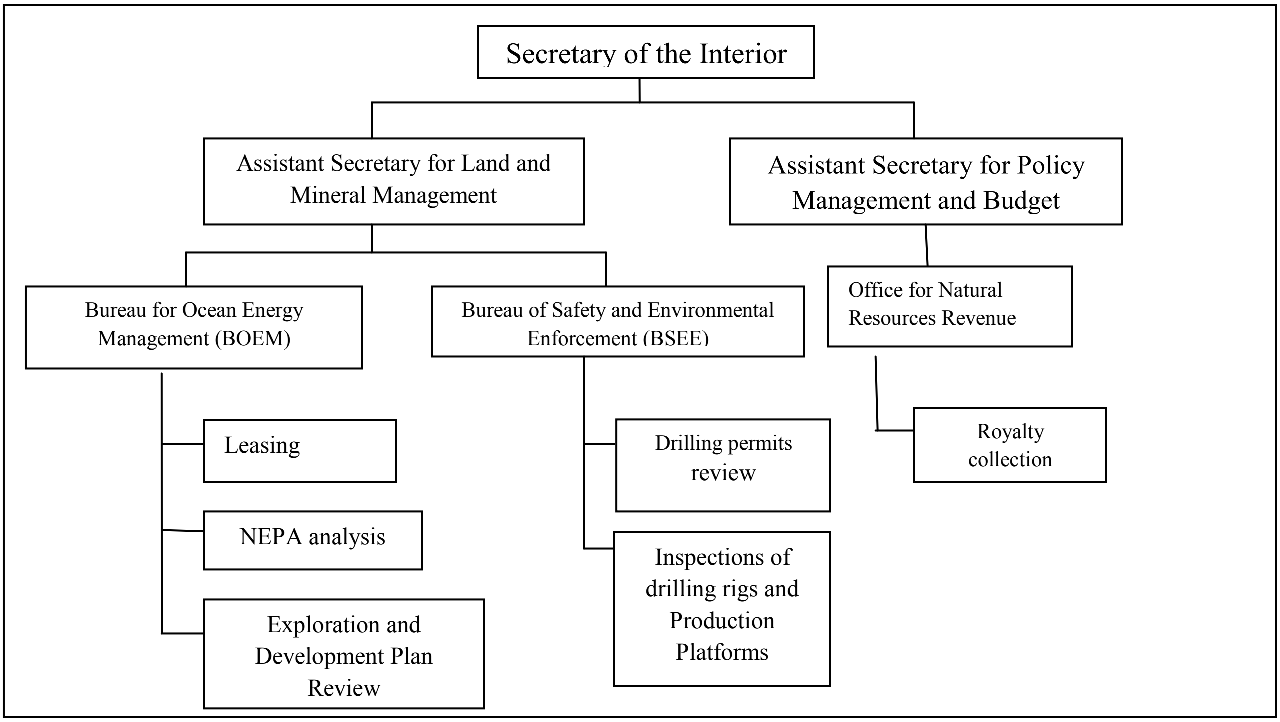

Figure 6.6 . Environmental regulatory bodies for the oil and gas in industry in the U.S. (Gao, 2012).

To execute its responsibilities the DOI delegates its regulatory authority to auxiliary regulatory bodies with specialisations in offshore energy. In doing so, DOI separates the issues associated with offshore energy into three main administrative functions: effective enforcement, energy development and revenue collection, with BOEM and BEES having primary responsibility. BOEM oversee resource management activities, including preparing the five-year Outer Continental Shelf (OCS) oil and gas licensing program, reviewing all oil and gas exploration, development plans and environmental studies, as well as conducting National Environmental Protection Agency (NEPA) analyses. The BEES' responsibilities are to oversee operations and environmental compliance, including reviewing drilling permits, inspecting offshore drilling rigs and production platforms, assessing civil penalties and developing regulations and standards for offshore drilling.

US standards and guidelines for the offshore oil and gas industry

It is mandatory for offshore oil and gas facilities in the US to acquire National Pollutant Discharge Elimination permits. These permits seek to ensure that appropriate treatment technology is applied to discharges. In the oil and gas exploration industry, NEPA has issued Effluent Limitations Guidelines, which established technology-based limits for produced water, as presented in Table 6.6.

Table 6.6. Summary of NEPA guideline for effluent limitations.

Guidelines	Scope
NEPA Effluent Limitations Guidelines	Guidelines representing the degree of effluent reduction attainable by the application of: - The best available technology (BAT) economically achievable, - New Source Performance Standards (NSPS) and, - The best practicable technology (BPT) currently available.

The guidelines on effluent discharge are placed into five sub-categories based on location: offshore, coastal, onshore, agricultural activities and wildlife. The offshore categories are in the open oceans and coastal categories include wells that are located in the estuaries and bays. The other three sub-categories refer to onshore areas so are not as relevant to this study.

In general, the standards differ between the offshore and coastal sub-categories. Effluent discharges from coastal facilities are mostly prohibited (Environmental Protection Agency (EPA), (2000). Typically, every request for permission must meet the obligations for effluent discharges. This must be obtained prior to a lease being offered by the US Department of Interior's Mineral Management Services (MMS) under the Clean Water Act. MMS is responsible for assessing the nature and extent, as well as recoverability and value of leasable mineral for energy-related or other authorised marine-related purposes across the OCS.

Permits for offshore facilities generally require the use of the best available technology economically achievable (BATEAs) or best conventional pollutant control technology (BCPCTs). Facilities defined as outer continental shelf which are conducting activities relating to petroleum productions (e.g. drilling, producing, handling, transferring, processing and transporting) are subject to a permit under the Oil Pollution Act (OPA), (Kimber, 1994).

Facilities located in offshore areas are subject to general consent under the Clean Water Act (CWA). This covers all facilities in certain geographic locations and can also apply to individual facilities in some cases offshore. Such facilities may be subject to Section 403 of the CWA which is intended to ensure that sensitive ecological communities are protected and no unreasonable degradation of the marine environment occurs due to permitted discharges. Requirements may involve ambient monitoring programmes to determine degradation of marine waters, alternative assessments designed to further evaluate the consequences of various disposal options and pollution prevention techniques designed to further reduce the quantities of pollutants requiring disposal and thereby reducing the potential for harm to the marine environment (Environmental Protection Agency (EPA), (2000). Some of the most strict quality standards for waste management are shown in Table 6.7.

Table 6. 7. Some restrictions applied to discharge from Alaskan facilities. Sources: (Henderson, 1999).

ASPECT	REGULATION	TYPE OF CONTROL
Distance to shoreline	No discharges permitted > 3 miles of the shore	Control of discharge location
Oil drilling waste	No discharge of free oil, diesel oil, or oil-based fluids and cuttings.	Control at source
Toxicity of non-oil drilling waste	Maximum toxicity 96-hr LC-50, 30,000 ppm for standard isopod	Control of waste quality
Raw materials	Barite containing <1 mg/kg mercury and ≤ 3 mg/kg cadmium	Control of water quality

Technology standards applied to effluent discharges in the US may include best available technology (BAT), new source performance standards (NSPS) and best practice technology (BPT). The BPT and best conventional technology (BCT) apply to drilling fluids, whereas BAT and NSP apply to production water (See Table 6.8).

Table 6.8. Summary of oil associated waste water and its parameters and limitations.

Waste stream	Parameter	BAT and NSPS limitations	BPT effluent limitation	BCT effluent limitation
Produce water	Oil and grease	Daily maximum of 42 mg/l and a monthly average of 29 mg/l.	72 mg/l daily maximum 48 mg/l 30-day average	Daily maximum of 42 mg/l and a monthly average of 29 mg/l.
Drilling fluids	Free oil	No discharge < 3 miles from the shore	No discharge	No discharge
Drilling cuttings	Free oil	No discharge < 3 miles from the shore	No discharge	No discharge
Well treatment fluids	Free oil	No discharge	No discharge	No discharge
Deck drainage	Free oil	No discharge	No discharge	No discharge

Restrictions are imposed to restore and maintain the chemical, physical and biological integrity in water. Under section 308 of the CWA Act, the Director of the Environmental Department can insist on the conduct of monitoring to determine compliance with effluent limitations and to facilitate in the development of effluent standards. Generally, environmental monitoring in the US is divided into three separate stages 1) the environmental assessment prior to approval, 2) during the development and 3) during the decommissioning process under the Outer Continental Shelf Lands Act (OCSLA). Therefore, under OCSLA regulations, proposed activities must comply with the National Environmental Policy Act (NEPA).

b. The United Kingdom in the North Sea

The central body of legislation governing the offshore oil and gas sector in the UK is the *Petroleum Act 1998* (GAO, 2012). The Act regulates oil development on the UK continental shelf, particularly in the North Sea which contains the bulk of the country's oil reserves. It is the responsibility of the Department of Energy and Climate Change (DECC) and the Health and Safety Executive (UK HSE) to arrange and execute key regulation regarding oil and gas exploration in cooperation with other relevant institutions.

Most UK offshore oil and gas legislation is influenced by related European Community (EC) legislation, especially the influence of OSPAR and PARCOM. Such legislation mainly exists in the form of international conventions/agreements, European directives, UK Acts of Parliament and regulations.

UK legal framework on offshore oil and gas

UK legislation regarding the oil and gas industry is primarily governed by the Petroleum Act 1998 and also heavily influenced by the European Communities Act

1972 (as shown in table 6.9). Legislation relating to environmental issues is primarily governed by the Environmental Protection Act 1990, which includes provisions for controlling pollution caused by industrial activity and other subsequent process.

Table 6.9. Major legislations concerning the offshore oil and gas industry in the U.K.

Main topics	Regulation and legislation	Scope
The basis of offshore legislation and regulations	Petroleum Act 1998 and clause	To consolidate certain enactments in regards to petroleum, offshore installations and submarine pipelines.
	European Communities Act 1972	An Act of Parliament providing for the incorporation of European Community Law into UK domestic law. This includes the Offshore Petroleum Production and Pipelines (Assessment of Environment Effects) Amendment Regulations 2007.
Legislations and regulations related to environmental issues	Environmental Protection Act 1990	To make provision for the improved control of pollution arising from certain industrial and other processes.
	Food and Environment Protection Act 1985	To authorise the making of emergency of orders specifying activities which are to be prohibited as a precaution against the consumption of food rendered unsuitable for human consumption due to contamination.
	Merchant Shipping Act 1995	To amend the law relating to the registration of ships, make provision for financial assistance in connection with the training of seamen and crew and establishment of a Merchant Navy Reserve; ensure shipping safety and liability of compensation for oil pollution.
	Pollution Prevention and Control Act 1999	To make provision for the implementation of Council Directive 96/61/EC and for otherwise preventing and controlling pollution. To make provision for the disposal of expired or soon-to-be expiring waste.
	Continental Shelf Act 1964	To make provision as to the exploration and exploration of the continental shelf. To enable effect to be given to certain provisions of the Convention on the High Seas.
	Coast Protection Act 1949	To amend the law relating to the protection of the UK coastline against erosion and encroachment by the sea. To provide for the restriction and removal of works detrimental to navigation.
Health and safety	Health and Safety at Work Act 1974	To make further provision for securing the health, safety and welfare of persons at work, for protecting others, against risks to health or safety in connection with the activities of persons at work, for controlling the keeping and use and preventing the unlawful acquisitions, possession and use of dangerous substances, and for controlling certain emissions into the atmosphere.
	Coast Guard Act 1925	An Act authorising the Coast Guard to initiate and coordinate civil maritime search and rescue operations within the UK maritime search and rescue region. Includes the mobilisation, organisation and tasking of adequate resources to respond to persons either in distress at sea or at risk or injury or death on shorelines of the UK.
Licensing	Petroleum Licensing (E & P) Regulations 2004	To issue licenses (includes delineation of blocks) and regulatory controls on E & P waste.
	Petroleum Licensing (production) (Seaward Areas) Regulations 2008	To issue licenses (production) (seawards Areas)

Other environmental legislation is also in place to control contamination of human food supplies, shipping safety (including liability for compensation in the case of oil pollution), for the prevention and control of pollution, as well as exploration of high seas and protection of the coastline.

UK regulatory/management framework for offshore oil and gas operations

Environmental law in the UK is proposed by government (see figure 6) and approved by the House of Commons and House of Lords. The current statutory instruments within the UK regulatory regime include the Bill (a proposal of law), the Act of Parliament (a bill that has passed into statute law), regulations and orders (instruments for the implementation of acts in the form of statutory instruments or Scottish statutory instruments in Scotland), guidance notes and codes of practice or circulars (Oil and Gas UK, 2008).

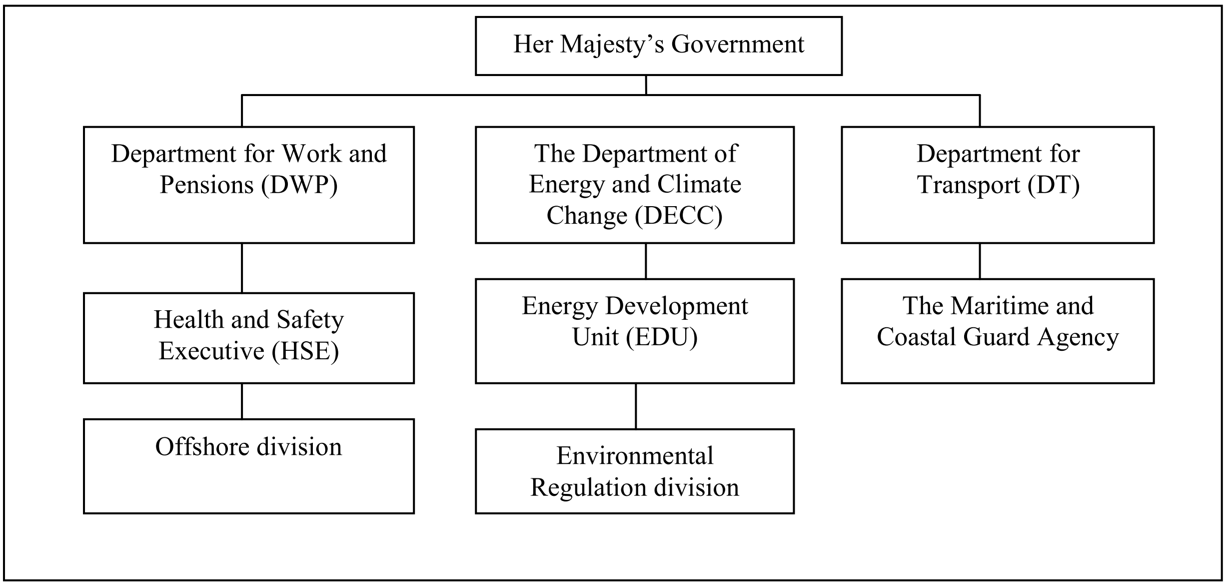

Figure 6.7. UK governmental organisations for petroleum activities. Adopted from (Trucco, 2012)

Relevant government organisations associated with offshore oil and gas industry regulation in the UK are shown in Figure 6.7. Under the Petroleum Act authorisation is also given to three government departments to prepare offshore environmental regulations. The DECC is responsible for matters such as discharge consents and Environmental Impact Assessment, as well as issuing licenses for exploration and production. However, in this regard the DT delegates this to the Maritime and Coastal Guard Agency, which is responsible for regulating the safety of ships and their crews, including construction, seaworthiness, navigation and operation and carriage of cargoes.

The DT therefore does appear to have an indirect environmental role in preventing accidents which might cause oil spills. On the other hand, the DWP is concerned with human health and safety and has no role in the management of regulatory interface.

UK standards and guidelines for offshore oil and gas operations

Performance standards for produced water discharges in the UK Sea are based on OSPAR 2001 recommendations 1, which requires that all institutions should meet the **30 mg/l average** maximum monthly concentration of produced water. Discharge of drill cuttings above 1% (10g/kg) of cuttings is also prohibited in the North Sea.

Table 6.10. Discharge standards for offshore oil and gas projects in the U.K.

Waste stream	Parameter	Standard	Reference
Produced water	Oil and grease	daily maximum of 30 mg/l monthly average	OSPAR Recommendations 2001/1
Drilling cuttings	Oil on cuttings	Discharges of < 1% (10 g/kg) are prohibited.	PARCOM 92/2; OPPC Regulations 2005 as amended.
Drilling fluids	Cuttings	allowed >12 nautical miles at depths of more than 200m.	PARCOM 92/2; OPPC Regulations 2005 as amended.
Discharge waste water	Displacement water	Average monthly concentration of 40 mg/l	OPPC Regulations 2005 as amended.
Effluent	Oil water oil mixture	15 ppm	MARPOL 73/78

Environmental monitoring for offshore oil and gas activities in the UK is conducted to meet OSPAR protocols, Joint Nature Conservation Committee (JNCC) guidelines, offshore chemical regulation 2002 and OPPC regulation 2005. Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and DECC are entities responsible for conducting offshore environmental monitoring.

c. Norway

The legislation on offshore oil and gas in Norway consists of a collection of legislation. These incorporate legislation on pollution prevention, petroleum activities, statutes associated with labour and working conditions, health and health care and fire and explosion prevention (Petroleum Safety Authority of Norway (PSA), 2008). The content of the various legislation is largely broad statutes of general application. These are mostly general in nature and are not specific to the offshore oil and gas sector. The complex string of legislation is governed under the Petroleum Act, the Product Control

Act and the Pollution Control Act. Such legislation is highly coordinated under the single authority of the Petroleum Safety Authority (PSA).

Norway legal framework on offshore oil and gas

The environmental regulations for offshore oil and gas in Norway are largely issued under the Petroleum Act and another two acts as mentioned above. These regulations typically refer to the framework, management, the information duty, the facilities and activities associated with the industry. Regulations and acts controlling the offshore industry in the Norwegian Continental Shelf are shown in Table 6.11.

Table 6.11. Norwegian legislation applicable to the offshore petroleum industry

Main topics	Name	Scope
The basis of offshore legislation and regulations	The Petroleum Act 2011	General terms of exploration and production licenses, environmental responsibilities, liabilities for pollution damage and special rules relating to compensation for Norwegian fishermen.
	The Pollution Control Act 1981	Protection of the external environment from pollution and to reduce the existing volumes of waste, as well as to promote better treatment of waste. The Act is aimed at maintaining adequate environmental standards, so that pollution and waste do not cause adverse affects to human health and wellbeing or damage nature's capacity for production and renewal.
	Product Control Act (1976)	Prevent chemical products from causing adverse impacts on health or disturbances to the environment or ecosystems such as pollution, waste, noise or similar.
Legislations and regulations related to environmental issues	Greenhouse gas emission allowance trading and the study to surrender emission allowances act (2008)	Limits the emission of greenhouse gases in a cost-effective manner through a system involving the duty to surrender CO_2 emission allowances and freely transfer emission allowances, based on restrictions deriving from international law.
	Right to know and public participation related to the environment act (2003)	Environmental information management by public authorities. This involves disseminating information and facilitating public participation in environmental decision-making processes.

Main topics	Name	Scope
	Nature Conservation Act 1970	The natural environment is a national asset that should be protected. Disturbance and intervention restrictions should be based on long-term, all-round management, taking into account the conservation of the natural environment in the future as the basis of human activity, health and wellbeing.
	Regulations on Environmental Impact Assessment (2005)	General provisions for applicability, substantive scope and competent authority, rules for administrative processing and scope and content of submitted documentation.
	Regulation related to health, safety and environment for petroleum-related activities (enforced by the PSA)	HSE framework, management, information duty, facilities and activities.
	Pollution regulations 2004	Contaminated soil and sediments, noise, local air quality, sewage, certain pollutants in water and groundwater, pollution of watercourses and marine environment from shipping and other activities, requirements for preventing pollution from certain activities or sources permission to pollute, European Eco-Management and Audit Scheme (EMAS) and fees.

Norway regulatory/management framework for offshore oil and gas operations

The regulatory regime related to the oil and gas industry in Norway is primarily authorised under the Ministry of Petroleum and Energy and Ministry of Labour and Government Administration (NPD, 2004). The Ministry of Petroleum and Energy delegates' responsibility to the Norwegian Petroleum Authority (NPD) and the Petroleum Safety Authority (PSA), as demonstrated in Figure 6.8.

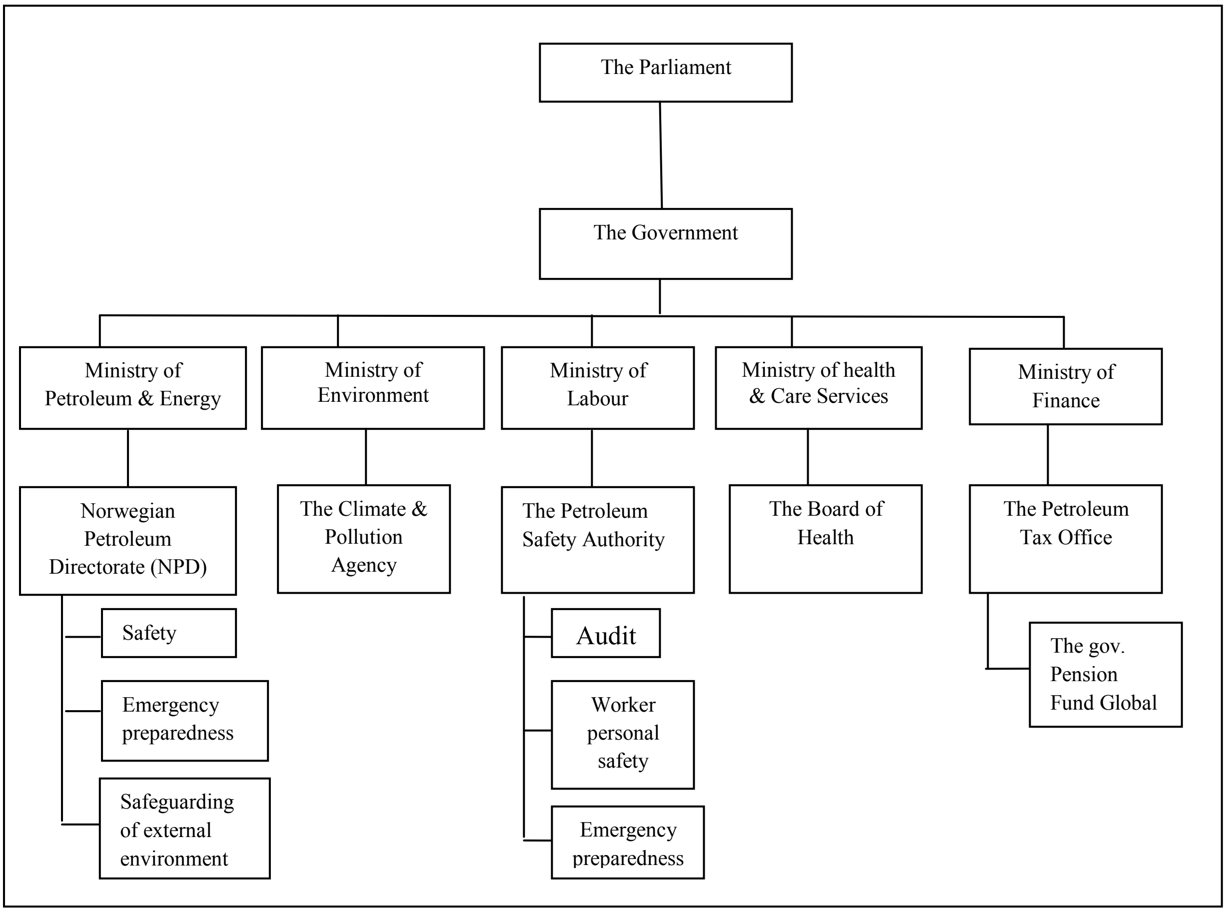

Figure 6.8. The Norwegian regulatory authorities for the oil and gas activities. Adopted from: (NPD, 2004).

The NPD was created to contribute to the creation of the greatest possible values for society from the oil and gas activities by means of practical resource management based on safety, emergency preparedness and safeguarding of external environment. The NPD is responsible for ensuring industry compliance with environmental standards based on precautionary measures incorporated in the statutory requirements (NPD, 2004).

The PSA is the regulator for technical and operational safety, including emergency preparedness and for the working environment in all phases of the petroleum activity such as planning, design, construction, use and possible later removal (NPD, 2004). Additional tasks delegated to the PSA include the issuing of detailed regulations for safety and the working environment in the industry and making specific decisions in the form of permits, consents, orders, prohibitions, enforcement fines and halting operations. The PSA also performs audits with other associated HSE entities to ensure that petroleum activities are supervised in a safe and unified manner. The PSA also cooperates with the Norwegian Pollution Control Authority and the Norwegian Social and Health Directorate on regulations relating to health, environment and safety on the Norwegian continental shelf (SFT, 2008).

Under the Ministry of Environment, the Climate and Pollution Agency issues discharge permits and lays down provisions, imposes sanctions, reports serious incidents to the police and monitors compliance through audits and inspections, as well as checking annual reports and assessing environmental monitoring.

Norway standards and guidelines for offshore oil and gas

Environmental policy in Norway is implemented according to several principles, including the precautionary principle, risk reduction, continuous improvement, the use of BAT and the polluter pays principle. The main instruments in Norwegian environmental law on oil and gas discharge permits are shown in Table 6.12.

Table 6.12 .Classification of chemicals in Norwegian environmental regulations. Modified from (OLF, 2006).

Waste Stream	Parameter	Standard	Reference
Produce water	Oil and grease	30 mg/l average 100 mg/ l maximum	OSPAR Recommendations 2000/3
Produced water	PAH	Through reinjection, cleansing technology & technology to reduce water production	OSPAR Recommendations 2000/3
Waste Stream	Parameter	Standard	Reference
Drilling cuttings	Oil on cuttings	< 1% (10 g/kg) prohibit to discharge	PARCOM
Drilling fluids	Cuttings	allowed >12 nautical miles at depth more than 200 m.	Under PARCOM
Discharge Waste water	Displacement Water	Monthly average concentration 40 mg/l	OSPAR Recommendations 2000/3

Produced water discharges are generally allowed, subject to approval of all chemicals according to OSPAR protocols. Pre-approval is required for the discharge of drilling wastes. A baseline survey is required prior to the commencement of production drilling, with monitoring required every three years in the form of sediment sampling and analysis of biological/chemical properties. Furthermore, the guidelines for characterising cuttings piles is available from the OLF (OLF, 2006).

d. Canada Arctic

The primary offshore oil and gas legislation in Canada is the *Canada Oil and Gas Operations Act* (COGOA) (RAC, 2004). The Act covers issues related to resource exploration and offshore operations. The regulatory frameworks applicable to oil and gas activities in Canada's offshore areas are broadly similar to each other in nature, as presented in Table 6.15.

Canada's legal framework for offshore oil and gas

The Canadian government has ratified numerous international marine conventions, agreements and guidelines which represent its goal of protecting and conserving the environment and living resources in the costal and offshore marine regions under its national jurisdiction (Green, 2005). These include the United Nations Law of The Sea Convention (1994), MARPOL 73/78 (the international Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978), Agenda 21 (United Nations Conference on Environment and Development 1992), the Convention on Biological Diversity (1992) and the Organizational for Economic Cooperation and Development (OECD).

The regulatory frameworks applicable to oil and gas activities for different parts of the country are typically similar as mentioned earlier. Major statutory environmental regulations of general application in Canada are shown in Table 6.13.

Table 6.13. Major statutory environmental regulations of general application in Canada. Compiled from different sources.

Main topic	Name	Scope
The basis of offshore legislation and regulations	Canada Oil and Gas Operations Act, R.S.C. 1987	To govern the regulation of petroleum operations and associated benefits and requirements.
Legislations and regulations related to environmental issues	Canadian Environmental Assessment Act (CEAA)	To provide high-quality environmental assessment that contributes to informed decision making in support of sustainable development.
	Canadian Environmental Protection Act, 1999	Pollution prevention and the protection of the environment and human health in order to contribute to sustainable development.
	Species at Risk Act	To protect endangered or threatened organisms and their habitats. The Act also manages species which are not yet threatened but whose existence or habitat is in jeopardy.
	Ocean Act	Provides a framework for modern ocean management.
	Arctic Waters Act and Regulations	To prevent pollution of Arctic waters adjacent to the mainland and islands of the Canadian Arctic.
Maritime and shipping	Canada Shipping Act 2001 and Regulations	Shipping and navigation and the amendment of the Shipping Conferences Exemption Act, 1987 and other acts.

Main topic	Name	Scope
	Marine Transportation Security Act and Regulations	To provide for the security of marine transportation.
	Marine Liability Act and Regulations	Marine liability and to validate certain by-laws and regulations.
	Transportation of Dangerous Goods Act and Regulations.	To promote public safety in the transportation of dangerous goods (substances).
Fisheries development and wildlife	Atlantic Fisheries Restructuring Act.	To authorise investment in the provision of financial assistance to the Atlantic Fisheries for the purpose of restructuring fishery enterprises.
	Fisheries Fishermen Development Act.	To regulate development of commercial fisheries
	Canada Wildlife Act	To protect Canada's wildlife.

Canada's regulatory/management framework for offshore oil and gas operations

Canada has three regulatory bodies: the National Energy Board (NEB), Canada Newfoundland Atlantic Offshore Petroleum Board (C-NFAOPB) and Canada Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB). The NEB is an independent federal agency established by the Parliament to regulate international and interprovincial aspects of offshore oil and gas exploration and development under the COGOA (GAO, 2012). The purpose of the Board is to promote safety, regulations of pipelines, energy development and trade. The Board is accountable to Parliament through the Minister of Natural Resources.

The NEB's environmental responsibility includes ensuring environmental protection throughout the planning, construction, operation and abandonment of energy projects within its jurisdiction (RAC, 2004). Under the NEB Act, the Board is required to consider matters of public interest and how they may be affected by the granting of a particular application. Additionally, the Canadian Environmental Assessment Act, 2012 (CEA Act 2012) grants mechanisms to ensure that projects receive appropriate levels of assessment prior to proceeding.

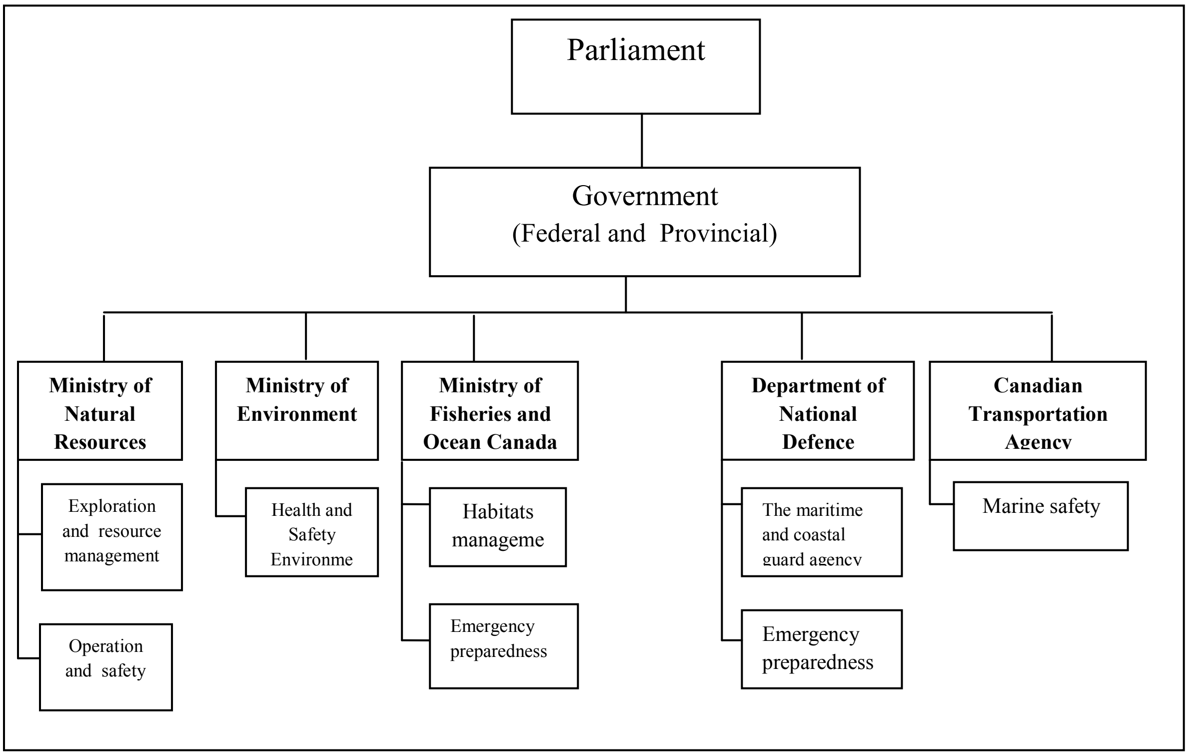

Figure 6.9. The Canadian regulatory authorities for oil and gas activities. Adopted from: (GAO, 2012).

Canada Standards and guidelines for offshore oil and gas operations

The disposal of produced water is banned in Canada's seaways unless the system is designed and maintained to ensure that average oil content of the water does not exceed a set monthly average or maximum daily volume as specified in the requirements of the production operations authorisation (see Table 6.14).

Table 6.14. Standards and limits for drilling waste discharge in Canada (NEB, 2002).

Waste	Parameter	Standard
Drilling fluids	Oily and grease	Allowed without restrictions, but operators encouraged to reduce the need for bulk disposal.
Produced water	Free oil	In 30 days average < 40 mg/l In 24 hour average < 80 mg/l
Drilling fluids	Polycyclic aromatic hydrocarbon concentration	< 10 mg/kg
Drilling fluids	Cuttings	Allowing 1%
Displacement water	Oil should be treated	< 15 mg/l
Drilling fluids	Oil on cuttings	Retention limit of 6.9% wet weight

Environmental impacts monitoring in Canada is performed according to several regulations, with approval of the regulatory bodies (NEB, C-NLPB and C-NSPB). Regulation on the environmental aspects of offshore oil and gas activities in Canadian Arctic waters is separated into two distinct stages. Environmental assessment is first conducted prior to the development, with monitoring then conducted throughout the development process. Such monitoring regulations are enshrined in the Canadian Environmental Protection Act (CEPA), Canada Oil and Gas Drilling and Production (COGDP) regulations, the Canada Oil and Gas Operations Act (COGOA) and Canadian Environmental Assessment Act (CEAA) (RAC, 2004).

6.2.12 Discussion

This section focuses on a comparative assessment of regulatory systems from case studies. Included are studies from the US, UK, Norway and Canada to provide a better understanding of the collective approaches, similarities and differences to complete the picture of the environmental protection efforts for offshore oil and gas activities and evaluate the East Timor system.

Legislation governing offshore oil and gas

In the case studies reviewed in section four, the scope of legislation governing offshore oil and gas can include environmental protection, health and safety, emergency preparedness, oil spill responses and licensing. These topics can be governing less than one primary or single comprehensive statute, as well as associated regulations or separate statutes which address individual topics. However, there is potential overlap among many of these topics and a single statute focused on the offshore production may also facilitate an integrated approach to regulation that ensures coordination and provides a single window to the regulatory system. Nevertheless, even when regulatory regimes are structured in such a way, there are still some statutes of general application (i.e. statutes not limited to one type of activity) which also apply to other offshore activity. In this case, individual offshore activities are regulated to ensure coordination and the application of these provisions and enhance the ability of regulated entities and other parties to understand the overall approach to regulation and the specific requirements

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Table 6.15. Summary of main legislation and its jurisdiction. Compiled from different sources.

Jurisdiction	Main Legislation
US Gulf of Mexico	Outer Continental Shelf Lands Act (OSCLA) and Outer Continental Shelf Lands Act Reform of 2010
	The Federal Oil and Gas Royalty Management Act.
UK	Petroleum Act 1998 and clause
	European Communities Act 1972
Norway	The Petroleum Act 2011
	The Product Control Act 1976
Canada	Canada Oil and Gas Operations Act, R.S.C. 1987
East Timor	Petroleum Act 2005
	Maritime Zone Act 2002

In East Timor offshore oil and gas production is primarily regulated under the Petroleum Act 2005 and Maritime Zone Act 2002. Other legislation on general applications governs some related topics, including environmental assessment, oil spill response, emergency planning and licensing standards. The legal basis for regulation differs according to country. In Norway, for example, many separate statutes are used to regulate different aspects of this activity, while in the US and UK, each have one principle administering offshore oil and gas production activity and various laws of general application that regulate specific aspects.

Division of authority among regulatory bodies

Typically the enforcement and administration of regulations governing offshore oil and gas production is the responsibility of the government and specialised agencies. For operational and administrative roles within the regulatory regime these can be concentrated in a single specialised entity or separated in to numerous bodies. This division may reflect the primary structure of legislation, even though a single entity may be granted authority to govern multiple statutes and regulations.

Table.6.16. Summary of main regulatory bodies. Compiled from different sources.

Jurisdiction	Main Regulatory Bodies
US	BOEM and BEES
	Environmental Protection Agency (EPA)
	US Coast Guard (USCG)
UK	Department of Energy and Climate Change (DECC)
	Health and Safety Executive Offshore Division (HSE)
Norway	Petroleum Safety Authority (PSA)
Canadian Arctic - offshore	National Energy Board (NEB)
East Timor	Ministry of Petroleum and Mineral Resources (MPMR)
	National Petroleum Authority (NPA)

In the case of the East Timor, authority to regulate offshore production lies primarily with the Ministry of Petroleum and Mineral Resources (MPRM) and the National Petroleum Authority (NPA). The MPMR administers the relevant acts and regulations for oil and gas exploration and production activities within the National jurisdiction and

NPA administers the Joint Petroleum Development Area (JPDA) in the Timor Sea. Norway's main regulator is the Petroleum Safety Authority (PSA), which oversees the application of multiple statutes in regards to offshore activity. However, there are another two separate regulators with independent authority over aspects of health, safety and environmental regulation of the industry. For the US institutional structure offshore activity is the primary responsibility of BOEM and BEES. The Environmental Protection Agency and the US Coastal Guard are also involved in specific aspects of offshore regulation and other associated issues. In the UK, the Department of Energy and Climate Change is responsible for the licensing, exploration and development of oil and gas, while for the Health and Safety Executive Offshore Division is responsible for regulating the risks to health, safety and the environment arising from work activities.

Coordination among regulatory bodies

It is apparent that in situations when there exists multiple regulatory bodies responsible over aspects of offshore oil and gas, then coordination is required to ensure the effectiveness and efficiency of the regime. Coordination plays a particularly vital role in areas such as emergency response, circumstances where timely and effective action by numerous departments or agencies to anticipate and minimise the significant risks is necessary. Coordination should also help to avoid conflicting requirements, duplication of effort and uncertainty regarding authority and accountability for regulated bodies. In the case studies observed various mechanisms have been used to coordinate the mandates, regulatory authority and operational activities of departments and agencies responsible for offshore oil and gas activity.

In the case of East Timor, MPMR and NPA have established informal cooperation and formal agreements with relevant authorities that regulates aspects of offshore activity. Similarly, as is the case in Canada, the NEB has informal cooperation and occasional formal agreements with other departments and agencies that regulate aspects of offshore activity. However, in countries where regulatory functions are divided between different authorities, a memorandum of agreement has been used to facilitate coordination. For example, in the case of USEPA and USCG, which have overlapping responsibilities with BOEM and BEES in respect to certain objectives that are specifically associated with environmental and safety regulations to protect human health and the marine environment. In cases of overlap of regulatory regimes or duplication of the agencies then agreements can be entered into that about define and demarcate jurisdiction among them. In the UK requirements for a memorandum of understanding established the framework for cooperation between the three organisations with responsibilities for aspects of health and safety enforcement and accident investigations related to offshore activities.

Standards and guidelines for offshore oil and gas

In general, standards from all case studies permitted waste discharge into the marine environment, apart from the US, which does not permit the discharge of PAHs are and displacement water. Discharges of drilling fluids or drilling mud was permitted in most cases, except the UK and US, which only allowed this a certain distance from the shoreline.

Table.6.17. Summary of parameters associated with limits in the UK, USA, Norway and Canada. Compiled from different sources.

Table 6.17. Summary of parameters associated with limits in the UK, USA, Norway and Canada. Compiled from different sources.

Parameter	UK	USA	Norway	Canada
Drilling Fluids	Allowed >12 nautical miles at depths more than 200m.	No discharge < 3 miles from the shore	30 mg/l average	Allowed without restrictions, but operators encouraged to reduce the need for bulk disposal of drilling fluids.
PAH concentration in drilling fluids	Through reinjection and cleansing technology to reduce water production.	No discharge	Through reinjection, and cleansing technology to reduce water production.	< 10 mg/kg
Drilling cuttings	Discharges of <1% (10 g/kg) prohibited.	Discharges not permitted <3 miles from the shore	Discharges of <1% (10 g/kg) prohibited.	1% permitted.
Parameter	UK	USA	Norway	Canada
Produce water	30 mg/l average 100 mg/ l maximum	Daily maximum of 42 mg/l and a monthly average of 29 mg/l.	30 mg/l average 100 mg/ l maximum	In 30 days average < 40 mg/l In 24-hour average < 80 mg/l
Displacement water	Monthly average concentration of 40 mg/l	No discharge	Monthly average concentration of 40 mg/l	< 15 mg/l

The discharge of PAH is not allowed in most countries apart from Canada. Drilling cuttings discharge and produced water are allowed in all cases. Discharge of displacement water is also permitted in most cases, with the exception of the US. Other discharges such as drilling cuttings and produced water are allowed in all case studies.

Table 6.18. Summary of jurisdictions and monitoring guidelines and entities. Compiled from different sources.

Jurisdiction	Monitoring guidelines	Monitoring entities
US	Outer Continental Shelf Act (OCSLA) OCSLA Regulations (must comply with NEPA effluent limitations guidelines)	National Environmental Protection Agency (NEPA)
UK	OSPAR protocols, Joint Nature Conservation Committee (JNCC) guidelines, offshore chemical regulation 2002, and OPPC regulation 2005.	Centre for Environment, Fisheries and Aquaculture Science (CEFAS), DECC.
Norway	Pollution Control Act, Petroleum Act	The Climate and Pollution Agency and the Petroleum Safety Authority (PSA)
Canada	Canadian Environment Protection Act (CEPA) Canadian Environmental Assessment Act (CEAA) Protection Act the Canadian Oil and Gas Drilling and Production (COGDP) Regulations.	Environment Canada
East Timor	Petroleum Act 2005 Environmental guidelines no. 5	Ministry of Petroleum and Mineral Resources (MPRM), National Petroleum Authority (NPA) and National Directorate of Environment (NDSMA).

Environmental monitoring in most jurisdictions is generally conducted based on more than single regulations and guidelines, apart from the US. As far as the environmental monitoring is concerned, the US and Canada are governed under a single entity, with Norway, East Timor and the UK having multiple environmental monitoring entities.

Conclusion

- The legislation governing offshore oil and gas production normally has one principal department administering offshore oil and gas production activity and various laws of general application that regulate specific aspects.

- The enforcement and administration authority of offshore oil and gas production is the primary responsibility of the government regulatory bodies and the operational and administrative roles of the specialised entity.

- The effectiveness of coordination among regulatory bodies under a single authority typically requires formal agreements with other relevant departments or agencies. This differs between countries, with regulatory functions sometimes separated among different authorities, requiring a memorandum of agreement among the different parties.

- Discharges of drilling fluids and produced water into the marine environment are permitted with restrictions from the shore and usually encourage operators to reduce the toxicity concentrations prior to disposal. Monitoring of environment mostly comes under more than one single regulation or guideline and is regularly conducted by the environmental agency.

6.3 An assessment of environmental regulatory frameworks in the Timor Sea

6.3.1 Introduction

This sub-chapter is provided to discuss and draw conclusions from the material provided in chapters 5 and 6. The chapter will focus on providing suitable recommendations for an offshore environmental regulatory framework for East Timor. Subsequently this sub-chapter is structured as follows: i) brief account of the development plans in the Timor Sea; ii) current regulations that apply in the Joint Development Area (JPDA); and iii) the discussion on topics relevant to the present situation in East Timor according to a Strengths, Weaknesses Opportunities and Threats (SWOT) analysis, as well as national and transboundary case studies by and analysis of strengths and weaknesses.

6.3.2 Brief account of development plans in the Timor Sea

The Timor Sea region (see Figure 2.1 in Chapter 2) contains natural oil and gas reserves and has been designated as an oil and gas industry development site by the East Timorese government (see section 1.1 in Chapters 1). The area is a possible site for drilling, including within national waters and the Joint Petroleum Development Area (JPDA). For the JPDA, three specific development options have been proposed as possible future development plans. The first option involves the creation of an oil refinery on the South Coast of East Timor. This will incorporate the installation of a subsea pipeline from oil platforms in the JPDA to the landing point in Beaco. An LNG plant would also be constructed in Betano and a supply base created in Suai Loro. The second option would see the establishment of a floating offshore refinery in the JPDA region, while the third involves the installation of a subsea pipeline from the JPDA to the Darwin coast in Australia.

6.3.3 Current regulations applicable to the Joint Development Area (JPDA).

Existing regulations regarding oil industry development in the JPDA in the Timor Sea have developed in response to a variety of concerns and at times competing priorities. This section presents a brief account of the major legislation and regulations that have affected the natural gas and oil industry in the past two decades. It includes international agreements or conventions, an existing transboundary agreement between East Timor and Australia and current domestic regulations in both East Timor and Australia.

6.3.4 International agreements/conventions

Throughout exploration, development and production in the JPDA various conventions have been engaged to regulate oil industry activities, as presented in Table 5 in Chapter 6. UNCLOS provides solid ground for States with opposite or adjacent coasts to achieve an equitable solution when drawing the median line. This includes the adoption of international rules and established national regulations to prevent or control pollution of the marine environment, as outlined in Section 5 Art. 207 – 212. The law emphasised that bordering States should cooperate to protect and preserve the marine environment (see Art 116 – 120). Section 4 of the law accentuates that bordering States should work together to establish regulations that promote monitoring and environmental assessment. Section 2 (see Art 197 – 199) along with the International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 both underlined the importance of global and regional cooperation among States, as well as contingency plans for pollution regulations in each respective country.

Numerous conventions that underpin regulations on pollution prevention in the Timor Sea have been applied. These include the International Convention for the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 (commonly known as the 1996 Protocol); International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating to and commonly known as MARPOL 73/78. Others include the International Convention on Civil Liability for Oil Pollution Damage 1969 and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971.

The Convention on the Conservation of Migratory Species 1979 (also known as the Bon Convention) underpins national regulations on migratory species in order to conserve terrestrial, aquatic and avian migratory species (including marine mammals and seabirds), their habitats (e.g. sea grass beds) and migration routes.

While East Timor is not a member of the Basel Convention, a bilateral agreement to regulate hazardous waste was reached between East Timor and Australia in 2002 based on the same convention.

6.3.5 Transboundary agreement between East Timor and Australia

The development of the oil and gas industry in the Timor Sea is primarily governed under the Timor Sea Treaty (TST). The Treaty established a bilateral agreement with a three-tiered, joint administrative structure consisting of a designated authority, a joint commission and a ministerial council. The joint body, known as the Timor Sea Designated Authority (TSDA), was set up to manage and control activities relating to exploration and exploitation of petroleum and gas resources in the cooperation zone for the period of time agreed by the Joint Commission. The designated authority is also responsible for establishing environmental regulations to protect the marine environment, if necessary under the Autoridade Naçional de Petroleo (ANP). The TSDA is also responsible for the implementation of Environment Impact Assessment (EIA) in the JPDA in the Timor Sea.

6.3.6 Domestic regulation in East Timor

The main domestic legislation relating to offshore oil and gas in East Timor is the Petroleum Act, 2005. The environmental regulations arising from this legislation are simple, but also very flexible. The management system is under one government authority which is the Ministry of Petroleum and Mineral Resources (MPRM). The Act covers a wide range of environmental issues, but has little detailed regulation. Articles 6b, 13 (3.a.ii) and 23c are the key sections relating to environmental protection. Apart from the Petroleum Act, other environmental regulations applicable for the offshore environment (see Table 6.3) include DNSMA guidelines (specifically no. 5 on public engagement, no. 6 on environmental screening and no. 7 on preparation of an environmental management plan).

6.3.7 Domestic regulation in Australia

Environmental management in Australia is undertaken by a partnership between the Ministry for Sustainability, Environment, Water Population and Communities and the Ministry of Agriculture. As the Timor Sea is located close to the Northern Territory, the EIA system used there may influence the process. On other hand, because the area is considered an international entity, it is presumably appropriate that the Australian EIA system have more power in the decision-making process regarding JPDA projects in terms of administrative procedures carried out under the Act, later amended in 1987 and 1995 (Australian EIA Network, 1996b). EIA in Australia is partly administered by the Department of the Environment (DOE) and governed under Article of 164 of the Environmental Protection Act 1974. Of course, the Commonwealth Government has its own EIA system apart from that in each state or territory. Aside from EIA, the Australian Petroleum Production and Exploration Association (APPEA) Code of Environmental Practice 1996 also provides guidance on recommended minimum standards for the petroleum industry's activities offshore and this would include the JPDA. Furthermore, the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) Policy Statement 2.1 regulates seismic vessels operating in Australian waters as well as in the Timor Sea.

6.4 Discussion and analysis

The discussion section is intended to assess the strengths, weaknesses, opportunity and threats of East Timor's present situation. This section also discusses the strengths and weaknesses of national and transboundary case studies in selected countries and geographical areas. Suitable strategies also provide for the delivery of suggested improvements or elements.

6.4.1 Assessing the present situation in East Timor using the SWOT analysis technique

The present situation of the MPRM regarding environmental compliance and enforcement of the upstream E & P industry was analysed by using the SWOT analysis technique. This technique analyses strengths, weaknesses, opportunities and threats of the whole organisation.

Strengths: The strengths are those areas of system control or performance that are positive. These are areas to build on in developing and moving forward.

Weakness: These are areas where system control or performance appears at risk: where practices, procedures or processes indicate some opportunity for failure. These are areas that the action plan will focus on.

Opportunities: These are areas where new actions or initiatives may bring benefits and will need to be followed up in the action plan.

Threats: Although not always clearly apparent, these risks may damage the short- or long-term development of the organisation. These may need policy formulation before actions are implemented.

The SWOT analysis of the MPRM's present situation regarding the environmental regulatory framework for oil and gas industry is summarised in Table 6.19.

Table 6.19. SWOT analysis of the MPRM's present situation.

FACTORS IN THE INTERNAL ENVIRONMENT
STRENGTHS (S)
1. Existing Petroleum Act, 2005. 2. East Timor has implemented international conventions and agreement in the Timor Sea. 3. Existing experiences of low-level environmental inspections work for E & P activities. 4. Existing bilateral agreement applicable in the Timor Sea. 5. There is a good and close relationship between MPRM and the industries.
WEAKNESSES (W)
1. Regulatory provisions are only very general. There are currently no formal environmental reporting mechanisms other than EIA. 2. Existing EIA in Timor Sea is only reviewed by the Joint Authority and is not accessible for public comment. 3. Existing regulations are mostly based on international best practice. 4. Limited environmental baseline data for E & P activity.

OPPORTUNITIES (O)
1. To develop an appropriate compliance and enforcement program (CEP) based on the existing system. 2. MPRM could learn from the corporate experience of the industry regarding environmental management. 3. The Petroleum Act could be revised to include further environmental regulatory elements. 4. Provision of environmental monitoring is incomplete as there are no other reporting mechanisms other than EIA.
THREATS (T)
1. The good relationship between MPRM and the industry may become strained if MPMR starts to impose firmer regulation. 2. Political inconsistency may threaten continuity and stability in the public sector. 3. The current lack of general environmental management information and research related to the E & P industry in East Timor may not improve. 4. The requirement of the current environmental provision guidelines do not cover environmental reports, such as environment assessment or baseline study surveys, monitoring or auditing for the E & P industry.

After undertaking the SWOT analysis technique to explore the MPRM's existing circumstances of environmental management for the oil and gas industry, it is suggested that the MPRM can improve its own administration in regards to environmental management by using the strategies as shown in Table 6.20.

Table 6.20. Environmental factors and strategies for the MPRM's administration.

1.STRENGTHS & OPPORTUNITIES S1: Existing Petroleum Act → To revised and identified environmental Issues. S_3: Existing MPRM experiences → Continue to develop expertise. S^4: Existing bilateral agreement applicable in the Timor Sea → Identify and include specific Environmental issues. O_1: Can develop CEP based on existing system → Prepare CEP action plan. O_2: Industry experience → Involve industry in the CEP Development.	**2. WEAKNESSES & OPPORTUNITIES** W_1: Only basic provisions → Tighten legal requirements. W_2: Lack of laws defining MPRM's work. → Amend law to support MPRM's roles. O3: Revision of Petroleum Act → Develop standards and detail regulations on environmental management. O^4: Incomplete requirements of environmental report → Develop comprehensive requirements for environmental reporting.
3.STRENGTHS & THREATS S_5: Good relationship with industry. → Maintain by working closely. S_2: Existing international conventions and agreements. → Develop and identify specific issues concerned with the environmental management of the Timor Sea. T^3: Lack of environmental management, information and research. → Develop standard information and research on environment. T^4: Lack of requirements in the current environmental provision guidelines. → Develop standard details and mechanisms.	**4. WEAKNESSES & THREATS** T_1: Industry may resist. → Reassure companies and discuss issues. T_2: Lack of political will. → Ensure politicians awareness of issues. Guidelines. W^3: Existing regulations are mostly based on international best practice. → Clarify regulatory framework and develop national regulatory framework. W^4: Limited environmental baseline data → Develop mechanisms for monitoring and evaluation in the collection of baseline data.

From the SWOT analysis outcomes presented in Table 6.20, the proposed strategies outlined could possibly be developed from an assessment of:

1. 'Strengths' and 'opportunities' – MPMR may establish a working group specifically tasked with improving inspection expertise in order to advocate for the amendment of the Petroleum Act and Timor Sea Treaty to include improved elements for environmental management.

2. 'Weaknesses' and 'opportunities' – MPMR may establish a working group to explore and promote communication with industry and enable their participation in policy development.

3. 'Strengths' and 'threats' – MPMR may establish a working group tasked with producing interpretive guidelines based on existing law to clarify requirements and

define weaknesses in existing legislation and petition government to pass additional legislation to eliminate those weaknesses.

4. ‘Weaknesses’ and ‘threats’ – MPMR may establish a working group with specific responsibility for preparing concise and clear briefing documents for politicians. The group would also be responsible for developing flexible environmental guidelines and advocate for the approval of other national regulations. The group would also promote the development of new mechanisms for environmental monitoring.

It is therefore recommended that East Timor develop a better defined environmental regulatory framework as the existing one is of limited value.

6.4.2 National case studies

Reviewing the experiences of other countries in terms of offshore oil and gas activities serves as an essential reference for the elaboration of national environmental regulations. In general, a framework of plans, processes and procedures are utilised to ensure that an offshore oil and gas facility fulfils the regulatory requirements concerning aspects such as health and safety, environmental protection and contingency planning for accidents and emergencies.

Table 6.21. Summary of strengths and weaknesses in National case studies.

	Strengths	Weaknesses
US	- **Regulatory approach in the US** - One main statute and general laws that regulate specific aspects of offshore drilling, but also has specific regulations on preparedness and planning for oil spills, licensing system, oil pollution, endangered species and marine mammals and fisheries conservation. - **Regulatory body:** Offshore drilling is regulated by the BSEE - Operators are responsible for environmental management system prior to being granted approval. - **Discharge limits** should meet NEPA discharge guidelines. - **Emergency preparedness**: emergency response plan must comply with emergency response contingency plans. - **Monitoring and compliance**: BSEE may monitor the environmental performance of the operator.	- Often incorporating industry standards.

	Strengths	Weaknesses
UK	- **Regulatory approach in the UK:** operators must continuously demonstrate that they are taking measures to minimise hazards and risks as low as practicable. - **Regulatory body:** the UK has one main statute and general laws that regulate specific aspects of offshore drilling. - **Discharge limits**: pollution quality control (concentrations) to meet OSPAR standards. - **Emergency preparedness:** emergency response plan must be approved by the UK HSE. - **Monitoring and compliance**: operators must undertake a periodic review of safety cases. - UK HSE requires regular audits **and installation's safety case.**	- No stated provisions in the management system for UK HSE to visit and inspect an installation.
Canada Artic	- **Regulatory approach in Canada**: a hybrid approach **(could be regulations based or based on performance through continuous monitoring).** - the regulations have a single main statute and other general Legislation for some aspects of offshore drilling. - **Regulatory body:** offshore drilling operations in the region are regulated by NEB. - Operators responsible for designing the management system prior to authorisation. - **Emergency preparedness**: must identify hazards and take all reasonable precautions to manage any associated risks. - **Monitoring and compliance**: operators are responsible for reviewing and submitting an annual environmental report to the NEB. - Provisions allowing the NEB to inspect an installation.	- Apart from utilising a single statute, Canada has much separate legislation to regulate different aspects of offshore drilling operations.
Norway	**Regulatory approach in Norway:** operators must continuously indicate that they are taking measures to minimise hazards and keep risks as low as practicable. - **Discharge limits:** should meet standards of Norwegian national environmental regulation. - **Emergency preparedness:** operators must have plan and analyse the risks on the environment. Must have national and regional plans. - **Monitoring and compliance**: management system for periodic audits.	- Norway utilises many separate statutes to regulate different aspects of offshore drilling operations. - There are no provisions stated allowing for the Petroleum Safety Authority (PSA) to visit and inspect an installation.

Below are summarised recommendations from the national case studies, as presented in Table 6.22. Operators must have adequate plans for their response to oil spills that details their responsibilities, as well as a general framework. Normally the requirements must meet a number of different regulations. Such regulations could be continuous measures and both are typically goal-oriented, as well as being prescriptive.

The absence of regular inspections and visits on offshore installations are a potential issue and may weaken monitoring and compliance mechanisms. Developing mechanisms that facilitate visits by environmental inspectors is therefore an essential part of an effective environmental monitoring strategy.

In general, a more tightly defined regulatory framework would be a reasonable recommendation for East Timor in order to improve environmental management of offshore oil and gas activities.

6.4.3 Transboundary case studies

The experience of other geographical transboundary case studies is an attempt to assemble transboundary regulatory elements for the interest of the Timor Sea. A framework with an agreement or MoU should generally be in place prior to the commencement of any development and it's common for a joint secretariat to be established.

Table 6.22. Summary of strengths and weaknesses of transboundary case studies.

	Strengths	Weaknesses
Mekong River	- Signed an agreement on sustainable development with emphasises on TEIA. - TEIA practices cover notification and screening, scoping, preparation of TEIA document and consultations and public participations. - The establishment of the Mekong River Commission and its secretariat which is tasked with specific mandates.	- The agreement is a non-binding document in the region. - The agreement was not ratified by the parliaments of bordering countries.
English Channel	- All concerned parties are bound by the legal requirements of the EU EIA Directive (Directive 97/11/EC). - Adequate time allocated for notification and the consultation process	- TEIA documents only translated into the languages of the respective bordering countries.
Danube River	- Signed an agreement ratified by the parliaments of the riparian countries. - Agreed that an environmental impact assessment (EIA) should be undertaken jointly and aligned with Bulgarian, Romanian and EU legislation. - Established a Joint Committee which was chaired by authorities at ministerial level from both countries. - Established Project Implementation Units (PIMU) in each individual country.	- No joint coordination secretariat - The agreement was not ratified by the parliaments of bordering countries.
Greater Tumen River	- Signed MoU on Environmental Principles Governing Tumen River Economic Development Area. - Jointly conducted a regional environmental assessment (EA) evaluating the local, national, regional and global environmental implications which may occur. - EIA participation by experts in the affected States is a requirement. - Established a Consultative Commission.	- The agreement was not ratified by the parliaments of bordering countries.

The agreement should be endorsed by the Parliament and coordinated at ministerial level. Regulatory elements should include aspects such as TEIA (joint or agreeable TEIA) and have measures to cover notification, screening, scoping and public consultation.

In summary, a tightly defined TEIA process would be a reasonable recommendation for East Timor to improve transboundary environmental management of offshore oil and gas activities.

Conclusion

- This study is an attempt to identify specific environmental laws, regulations, standards and guidelines identified as foremost obstacles for environmental regulatory management in East Timor.

- The Ministry of Petroleum and Mineral Resources (MPMR) should enhance regulatory frameworks and push for amendments to the Petroleum Act to solve these limitations.

- The study identified that a more strategic approach to TEIA mechanisms would be a valuable consideration in terms of the effectiveness of the EIA regulatory system in the JPDA.

Chapter 7. ENVIRONMENTAL MONITORING POLICY IN THE OFFSHORE OIL AND GAS INDUSTRY: AN ASSESSMENT OF EFFECTIVENESS.

7.1 Introduction

Environmental monitoring of the offshore oil and gas industry is essential to understanding the possible environmental impacts and the appropriate design of regulatory requirements. This chapter highlights the benefits gained from effective marine environmental monitoring tools and the importance of well defined monitoring requirements.

The approaches to monitoring can be placed in two main categories. Compliance monitoring involves the monitoring of potentially damaging activities to ensure the operator is compliant with regulatory requirements. This might involve monitoring the volume or toxicity of discharges to ensure it does not reach damaging levels, as well as procedures or safety standards to ensure the risk of environmentally damaging incidents are reduced. The second category of monitoring focuses on direct monitoring of biota or contaminants in the environment. Contaminants can be measured within the water column or benthic sediments or within the tissues of selected organisms to assess levels of bioaccumulation or contamination in the human food supply. Although knowledge of contaminant levels is useful, it is often difficult to gauge the likely response of marine biota to a given level of contamination. Consequently, it is also useful to assess the biota directly. This is often approached by assessing the species composition and levels of abundance within marine communities.Focus may also be given to a specific 'indicator' species in order to determine well established responses to contamination or disturbance.

Monitoring in offshore areas may be appropriate at any stage of the development process from the initial exploration through to the decommissioning of the installation. For effective monitoring it is generally necessary to establish baseline conditions of biota and contaminants for comparison when assessing subsequent changes. Such baseline data is also useful in developing an understanding of potential impacts that should be considered within the Environmental Impact assessment (EIA).

7.1.1 Objective of the study

This study aims to assess the effectiveness and cost of mechanisms of environmental monitoring policy, including compliance and biological/direct monitoring. The findings captured aim to improve environmental monitoring policy in the offshore oil industry of East Timor. Data and information employed in the specific sub-section was collected from both published and gray literature.

7.1.2 Methodology of the study

This assessment will achieve the objectives of the study through an investigation of the literature, conducted using the following methods:

Review of literatures associated with environmental monitoring policy, compliances and enforcement. The literature and other materials was mostly sourced through websites and was used to obtain information on the status of standard environmental monitoring policy in the offshore oil industry and its implementation. Published and unpublished draft materials were also collected through direct and secondary sources for review.

7.2 Environmental monitoring policy

Environmental monitoring policy refers to a public statement by a company as to how they will assess the impact on the environment. In this study, environmental monitoring is defined as a set of activities that provide chemical, physical, biological and other environmental, social or health data as required by environmental managers (Environmental Protection Agency (EPA), 2008). According to Everet (1992), data was collected for one or more of the following purposes: to establish a baseline, to assess long-term trends, to estimate inherent variations within the environment and possibly to make comparisons between situations or against a standard or target level. Hence, environmental monitoring policy in the offshore oil industry means a public statement of an organisation's intention on the procedures for gathering information for assessing its environmental impact. The targets of the monitoring program would typically include elements associated with environmental features (e.g. seabed, soil, noise and air), biological features (such as habitats, animals and plants), as well as other visual resources, social impacts and human health.

The aim of conducting a comprehensive environmental monitoring process involves the systematic collection of data to determine: 1. the actual environmental effects; 2. the compliance of the project with regulatory standards and 3. the degree of implementation of environmental protection measures and the success of these measures. When successfully integrated with the environmental management system for the project, environmental monitoring can provide valuable feedback on the effectiveness of environmental protection measures and in turn monitoring may form a component of the post-project analysis (Behrman, 2003). Additionally, environmental monitoring is also essential to check the implementation of mitigation measures, as well as provide early warning of potential environmental damage, audit mitigation measures, refine assessment methods and improve project outcomes through adaptive environmental management.

Despite its widely recognised importance, monitoring is not a well-established activity. The reasons for this are varied. As well as being time consuming, environmental monitoring data is expensive and difficult to collect. Guidance is often lacking and there may also be minimal legal pressure to stimulate monitoring. The lack of appropriate monitoring procedures therefore impedes scientific progress in impact prediction and assessment, which makes it difficult to learn from experience (Khadka, 2011).

7.2.1 Compliance monitoring

Compliance monitoring refers to the process of oversight designed to determine conformity with environmental legal mandates, regulations, lease stipulations, and conditions of approval as set up by the government. The process is one of the key components government entities and other relevant authorities undertake to ensure that the regulated community follows environmental laws and regulations. During the implementation process, various activities may be carried out, such as; on-site visits, investigation of public reports of violations and review of information submitted by the regulated industry (as part of self monitoring and through reporting programs). Information collected and analysed throughout this process is expected to improve decision making through the following processes: a) evaluating the program's progress by stabilising compliance status, b) detecting and correcting violations, c) supporting information strategies to promote compliance, d) providing evidence to support enforcement actions and deter non-compliance. Three major sources of compliance information are presented and discussed below; 1) inspections, 2) self-monitoring and 3) citizen monitoring (USEPA, 1984).

Inspections

Inspections of environmental monitoring compliance serve as the backbone of most enforcement programs (USEPA, 1989). These works are mostly conducted either by government inspectors or in some cases by independent parties contracted to provide reporting for the responsible government agency. The inspections are often performed on a regular basis to ensure that mitigation measures and commitments are properly maintained and implemented and that specific management procedures such as waste storage and disposal are being followed. In this regard, the inspector's role is to collect and analyse data, record observations and then produce a report reviewing standards set out in law.

Inspectors are mainly tasked with gathering information to establish compliance status. In some cases, inspections can be very resource-intensive, and hence need to be targeted effectively and conducted efficiently. It is therefore vital to standardise inspection procedures, as well as employ enforcement officials who can assist to ensure that all facilities are treated equally.

Audits versus Inspections

Auditing is typically conducted to assess compliance of the site activities with both regulatory and site management system requirements (e.g. waste management procedures and systems) (Wassermant et al., 1984, Commerce, 1989, ICC, 1989). While audits are usually conducted by internal staff or an external contracted consultant, inspections are generally conducted by the government or its agents. Audits are also conducted as part of a larger management system, as well as to and acquire certification (i.e. ISO certificate) and demonstrate that the company is complying with its environmental responsibilities.

If any violations are detected it is important that standard procedures are followed to ensure that evidence collected will be upheld in court.

Types of inspection

There are three levels of inspection at which an inspector can proceed (USEPA, 1989): a) the most basic level, where inspectors may making observations on procedures that are encountered around the plant, oil refinery etc, b) compliance evaluation, involving a systematic inspection of the compliance of processes and procedures by reference to check lists, but not including sampling and, c) sampling, including visual inspection and recording reviews of the other inspection levels, as well as pre-planned collection of data and analysis of physical samples. Sampling inspections are the most resource-intensive.

According to Norman (1984), inspection is typically conducted with specific objectives, which may include: a) identify specific environmental problems, b) ensure the source is aware of any problems, c) gather information to determine the compliance status of the facility, d) collect evidence for enforcement, e) ensure the quality of self-reported data, f) demonstrate government's commitment to compliance by creating a credible presence and, g) inspect whether facilities that have been ordered to comply have done so appropriately.

The inspection process

In most cases, environmental monitoring follows a standardised set of steps for the inspections process, with only minor variations. To begin with, the inspection process is explained to the facility operators (USEPA, 1984). Typical phases of an inspection process are presented below:

a) *Targeting inspections:* The rationale for selection of inspection sites may vary and can be placed into three categories: 1) random selection of sites from all of the identifiable members of a regulated community, frequently referred to as a neutral inspections scheme, 2) a selection that emphasises a specific sector of the identifiable regulated community, normally based on enforcement history, potential threat or other clearly researched criteria, and 3) a selection based on information received from the public or other external sources such as a tip-off or complaint.
b) *Preparation of an inspection plan*: This particular stage requires numerous reviews of the relevant available information, contacting relevant stakeholders, gaining administrative clearances and making the necessary arrangements for collecting samples if required.
c) *Collecting evidence in the field*: Evidence refers to anything that provides information that can be utilised to establish, certify, prove, substantiate or support an assertion. Evidence might include physical samples, photographs or copies of facility documents.
d) *Collecting evidence from the records and reports*: A record is any means of monitoring an event, individual, place or thing. In this regard, inspectors have the authority to review relevant firm records to determine compliance. Common records kept on offshore oil and gas platforms include discharge monitoring reports, waste management records, spills reports, safety reports, accident reports, waste management records and quality control reports.
e) *Report writing*: The objective for generating the inspection report is to organise and coordinate all documentation and potential evidence in a comprehensive, understandable and usable manner.
f) *Referral for follow-up/enforcement*: Activities considered under this sub-heading consist of issuing a letter to the company, informing other inspecting bodies of the findings and observations, planning a follow-up inspection and possibly starting criminal or civil action to enforcee compliance.
g) *Appearance as a witness*: Usually the inspector may be present as a witness if civil or criminal enforcement actions are taken.

7.2.2 Self monitoring, self recordkeeping and self reporting

Introduction

Monitoring methods are distinguishable from auditing where they are conducted on a mandatory basis. These measures are often employed by government to encourage the regulated community. The adoption of such methods is intended to improve iindustry compliance and environmental performance through an increased sense of ownership, as well as to raise awareness. At the same time, such monitoring methods codify particular requirements placed on the regulated community to gather and maintain identifiable information.

There are a variety of individual self-monitoring methods. In ***self-monitoring***, operators measure emissions, discharges or performance parameter which provides information on the nature of the pollutant discharge or the effectiveness of control technologies. For example, operators may periodically sample and analyse effluent for the presence and concentration of a particular pollutant, as well as monitor groundwater quality. Additionally, an operator may also be requested to monitor operating parameters on pollution control equipment to demonstrate how well the equipment is operating. Operating parameters are normally low-cost to monitor and provide reliable data that could provide additional accurate representations of emissions. Typically this kind of monitoring method appears to be a less expensive option than enforcement programs and operators usually operate it correctly. ***Self-recording*** implies that operators are responsible for maintaining their own records on certain regulated activities (e.g. shipments of hazardous waste etc), while in ***self-reporting*** operators are required to provide reports to the the enforcement authority based on their records of self monitoring, either at set intervals or upon request.

Advantages of self-monitoring, self recording and self reporting.

These methods offer some advantages over conventional inspections as self-monitoring provides a continuous record of information about activities. These are much inexpensive compared to conventional inspections and provide much more extensive information on compliance. Such methods also provide a mechanism for educating industry on compliance requirements, increasing the levels of management attention and preventing pollution. Self-monitoring is frequently required by environmental regulations. While there is potential for under-reporting, regulators can counteract this through ongoing stringent enforcement of the disclosure requirements. Information gathered through these methods is frequently used as a basis for enforcement.

7.2.3 Citizen monitoring

Citizen monitoring plays an essential role in recognising or identifying violations. The method is often applied in circumstances where government monitoring institutions have limited resources. Citizen participation can contribute to enforcement efforts in monitoring industrial environmental performance through providing independently gathered data or information. Mechanisms for citizen monitoring differ between countries. In some countries government institutions will support existing citizen monitoring activities. Formal cooperative partnerships are sometimes established among citizen organisations to provide training in practical issues such as how to identify locations of pollutant emission and observe the effects. In USA, for example, the Izaak Walton League of America trains citizens in how to monitor the environment and the findings are then reported to federal and state agencies (USEPA, 1984). In the Philippines, multi-party monitoring has enabled local community residents, NGOs and industrial project proponents to collaborate with representatives from the Department of Environment and Natural Resources to conduct environmental impact compliance monitoring (USEPA, 1989). Some countries also allow their citizens to participate in compliance inspections undertaken by government agencies. This process typically occurs prior to government inspection. An example of this can be found in Argentina's water quality legislation which allows private parties who have filed a complaint about a facility to be present throughout the inspection process.

Citizen participation may also be included in complaint processes and in administrative enforcement in several countries. The government's role in this regard is to establish an appropriate mechanism for citizens to submit complaints to the government concerning activities identified as causing environmental harm. In such cases, the complaints of citizens play an essential role in drawing government attention to enforcement issues. In some countries, governments have established independent organisations to handle citizen complaints. For example, in Poland, this role is filled by the Commissioner for Civil Rights Protection and in Mexico it is supported by the Federal Ecology Law, as well as other parallel state laws. These enable any person to file a complaint to the Federal Environmental Protection Agency regarding any activities which are thought to be causing environmental harm or ecological imbalance (USEPA, 1984).

7.2.4 Factors affecting compliance

In order to achieve environmental compliance measures need to be taken to motivate the regulated community to comply, remove barriers which prevent compliance and overcome existing factors that encourage non-compliance. Several factors that possibly affect compliance are summarised and presented in Table 7.1.

Deterrence

Responses to the requirement for compliance may range from non-compliance, voluntary compliance to compliance that has been stimulated by witnessing others receiving sanctions (any adverse consequence imposed on a violator) for non-compliant actions. This trend of bringing about change in the behaviour of people because they wish to avoid sanction is called *deterrence*. Through this means, enforcement deters possible violators from violating again and deters other violators by sending a message that they may experience adverse consequences if they do not comply with regulations (USEPA, 1984). Such consequences are a powerful enforcement tool for achieving wider compliance. There are four critical factors that contribute to effective deterrence: 1) there is a good chance that violations will be identified, 2) the response to violations will be swift and predictable, 3) the response will include an appropriate adverse consequence imposed on the violator and 4) those subject to requirements perceive that the first three factors are in place. These factors are inter-linked such that an appropriate level of deterrence requires more severe sanction for violations which are unlikely to be detected, whereas a less severe sanction may be sufficient if violations are likely to be detected and response can be relatively swift. This illustrates the importance of perception in creating or designing deterrence. Importantly, enforcement actions can have significant effects far beyond bringing a single violator into compliance if they are well placed and well publicised.

Table 7.1. Summary of factors affecting compliance (Modified from: (Wassermant et al., 1984).

Factors motivating compliance	Barriers to compliance and factors encouraging non-compliance
Economic	
- Desire to avoid a penalty - Desire to avoid future liability - Desire to save money by using more cost-efficient and environmentally sound practices.	- Lack of funds - Greed/desire to achieve competitive advantage. - Competing demands for resources
Social/moral	
- Social values for environmental quality - Societal respect for the law - Clear government will to enforce laws	- Lack of public support for environment - Lack of societal respect for the law - Lack of government will to enforce laws
Personal	
- Positive personal relationship with enforcers - Desire to avoid legal process - Desire to avoid adverse publicity / conviction	- Fear of change - Inertia - Ignorance about how to meet requirements
Management	
- Jobs and training for compliance - Financial incentives for compliance	- Lack of compliance training for personnel - Lack of accountability for compliance - Lack of management systems for compliance
Technological	
-Availability of affordable technologies	- Technological inability to meet Requirements and unreliable techniques

Economics

Change in compliance behaviour within a community may also be motivated by economic considerations. A community may be more likely to comply in cases where enforcement officials demonstrate that compliance will save money, (e.g. achieving compliance through recycling valuable materials instead of discharging them into the environment). Another alternative may be that the government provide some form of subsidy to offset the costs of compliance. An example from the Netherlands showed a relatively high degree of compliance for processing used oil from inland waterway vessels when the processing was offered free; However, compliance decreased as soon as the government levied a charge for this service (Wassermant et al., 1984).

Institutional credibility

Every country has its own social norms and ethics regarding compliance. Such norms are embedded largely through the laws and the institutions responsible for implementing these laws. Examples of such norms can be seen in the social norms of noncompliance in countries where historically compliance has not been enforced, whether because the law is unenforceable or because the institutions responsible for enforcement have lacked the political power or resources to do so (Wassermant et al., 1984). Another cause of resistance to compliance is seen in countries where previous regimes have imposed laws against the will of the citizens. In such countries it may take longer for regulations to establish credibility (IMPEL, 1992). It is clear that the necessary strategies to build credibility will vary from one country to another. For certain cultures it may be that aggressive enforcement will successfully provide credibility while in other countries it is essential to have a preliminary period for promotion or encouragement to build a spirit of cooperation followed by a well publicized shift to more aggressive forms of enforcement, to signal that there will be consequences for noncompliance. Alternatively, in some cultures a mixed approach at the outset may be the most successful to employ.

Social factors

In some cases, personal and social relationships also influence the behaviour of the regulated community. Moral and social values, may either inspire or hinder compliance. Positive behavioural changes for example could occur in situations where facilities may voluntarily comply with the requirements out of a genuine desire to improve environmental quality (IMPEL, 1992). The facility owner may also comply out of desire to be a good citizen and maintain the good will of their local community or clients. The managers may also fear a loss of prestige that can result if information about noncompliance is made public. On the other hand, motivation will likely be low in countries where there has been little or no social disapproval associated with breaking laws and / or damaging the environment.

Technological

Apart from being motivated to comply, the regulated community must also have the technical ability to comply. This means that the community must acknowledge that they are subject to requirements and understand what steps are necessary to build compliance (USEPA, 1984). Additionally, they must also have access to the necessary technology to prevent, monitor, control or clean up pollution and must possess the skills to operate the equipment. Hence, it could be argued that a lack of knowledge is therefore a significant barrier to compliance, although such barriers can be removed through access to training and outreach initiatives.

7.3 Enforcement

7.3.1 Introduction

Enforcement in this section refers to sets of actions that government or others take to achieve compliance within the regulated community and to correct or halt situations that endanger the environment or public health (IMPEL, 1992). In other words, enforcement serves as the backbone to any compliance program. Government enforcement typically covers; 1) *Inspections* to determine the compliance status of the regulated community and to detect violations, 2) *Negotiations* with individual or facility managers who are non-compliant to develop mutually agreeable schedules and approaches for achieving compliance, 3) *Legal action* where necessary in order to compel compliance and to impose some consequences for violating the law or posing a threat to public health and environmental quality and 4) *Compliance promotion* through educational programs, technical assistance and subsidies to encourage voluntary compliance.

7.3.2 Importance of compliance and enforcement

Compliance, together with enforcement, is vital and helps deliver multiple benefits to society. These (USEPA, 1984) are described below in more detail:

- The most important is *to protect environmental quality and public health*. Compliance is imperative to achieving the goal of protecting public health and environmental quality as envisioned by environmental laws. Public health and environmental quality will be protected only if environmental policy regulations obtain the desired results.

- *To build and strengthen the credibility of environmental requirements*. In order to obtain the desired results the execution of environmental requirements by government agencies must be rigorous.
- *To ensure fairness:* It is undeniable that without enforcement facilities that do violate environmental requirements may enjoy more benefits compared to facilities that voluntarily choose to comply. A consistent and effective enforcement program helps ensure that all companies affected by environmental requirements are treated fairly. Operators will be more likely to comply if they perceive that they will not be economically disadvantaged relative to competitors by doing so.
- *To reduce cost and liability:* Compliance is seldom costly in the short term and it can have significant long-term economic benefits to both society and to the complying facility. In particular, the healthier environment built by compliance reduces public health and medical costs, as well as the long-term cost to society of cleaning up the environment. Compliance benefits industry by reducing its liability and long-term clean-up costs. It's possible that industry may also realise immediate economic benefits if compliance involves the recycling of valuable materials or an increase in the efficiency of its processes. Hence, it could be argued that a strong enforcement regime may also stimulate operators to comply by preventing pollution and minimising waste, rather than installing expensive pollution controls and monitoring equipment.

7.3.3 The enforcement process

The legal system, laws and culture in every nation are unique in nature. However, the process of balancing the rights of individuals with government's timely interventions on behalf of the public is a challenge common to all nations. To ensure equality and fairness in enforcement responses the following steps must be observed: 1) *Notice:* it is necessary that a notification of any violation be issued prior to pursuing a formal enforcement action. This allows the violator an opportunity to contest the findings or correct the issue within a specified timeframe. 2) *Appeals*: to contest evidence findings and, 3) *Dispute resolution*: the majority of enforcement is bound to create disputes among government officials and facility representatives (IMPEL, 1992).

Enforcements are usually supported by administrative or court proceedings (USEPA, 1984). Enforcement officials therefore have to be constantly ready to: 1) prove that violations have occurred, 2) establish whether procedures and policies were equitably implemented, 3) illustrate that a remedy for violation is available (e.g. pollution control equipment or stopping a particular activity) and 4) justify the proposed penalty (IMPEL, 1992). Additionally, there are the rights of *public comment* on enforcement agreements, orders and decrees prior to the conclusion or final document. Providing the opportunity for the public to access this process is one way to ensure that violators are treated fairly and consistently.

7.3.4 Designing enforcement response policies

Enforcement response policies are essential and serve an important role in maintaining fairness particularly when assessing monetary and criminal penalties (Wassermant et al., 1984). Key issues which need to be considered in the process of drafting an enforcement response policy include: 1) criteria for non-compliance with specific guidelines and standards to ensure enforcement is perceived as fair by all members of the regulated community. 2) setting-up or designating authorities. This offers the legal grounds for enforcement, which is vital to the power and credibility of an enforcement program (IMPEL, 1992)

7.3.5 Types of enforcement responses

Enforcement responses are usually classified as formal and informal mechanisms. An informal response usually advises the facility managers on the nature of the violation detected, what actions should be taken to avoid penalties and what time period is allowed for compliance.

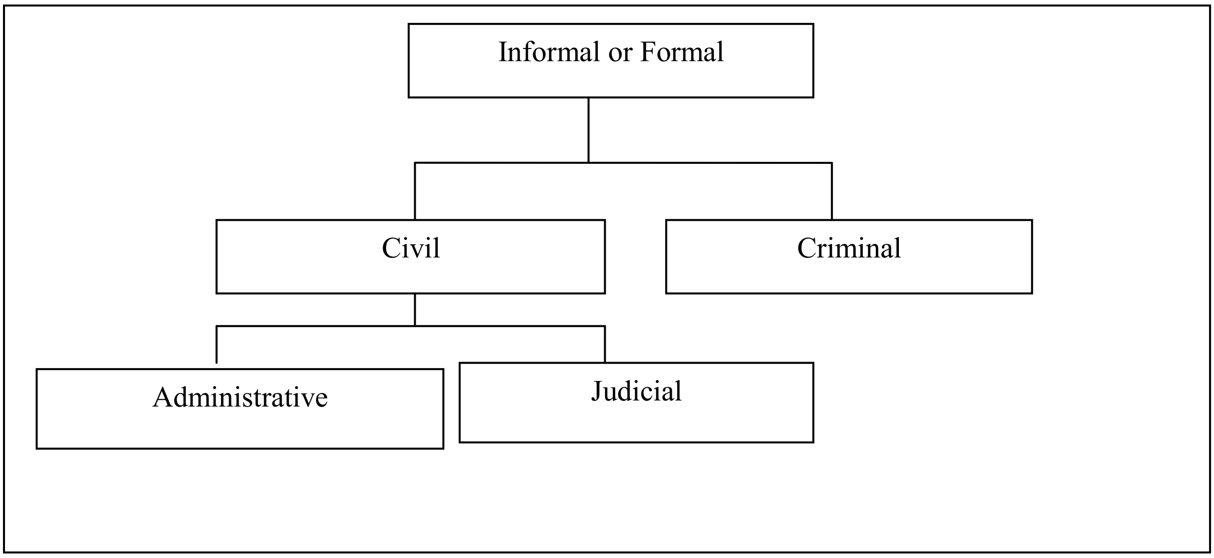

Figure 7.1 Enforcement responses informal and formal. (Source: Modify from Wassermant, 1998).

Unlike informal mechanisms, the formal mechanism is usually backed by law and supported by the procedural requirements to protect the rights of each individual in the regulated community. The types of formal mechanisms vary from country to country, with some having both civil and criminal options, while others have not only judicial sanctions imposed by a court or other judicial authority, but also administrative sanctions directly imposed by the enforcement program (Wassermant et al., 1984).

Civil administrative options generally comprise of two major categories: *Administrative orders:* legally binding, independently enforceable orders issued directly by enforcement program officials. Such an order typically defines the violation, provides evidence of the violation and requires the recipient to take corrective action within a specific timeframe. If there are additional violations by the recipients, then further legal action must be taken via the court system or through additional orders. In the second category are *field citations*: normally issued by inspectors onsite at the regulated field site or facility. This approach usually requires the violator to correct a clear-cut violation and pay a small monetary fine. This approach can be a relatively efficient means to address certain violations which are clear and do not pose a major threat to the environment.

Clearly civil judicial enforcement actions have greater significance than administrative enforcement and also have more power to deter potential violations and set legal precedents. However, this action is generally more expensive and requires more staff and time to complete compared to administrative enforcement methods.

Criminal enforcement is generally considered appropriate when an individual or facility has knowingly violated the law. Normally, in this situation, society decides to impose serious legal sanctions. To proceed with this approach requires intensive investigations and case development. Hence, as specific training is often required for criminal investigators do develop cases further, this approach is therefore regarded as difficult and expensive. Such an example can be found in Brazil, the country with the most recent modern and comprehensive Environmental Crime law, approved in March 1998 (IMPEL, 1992).

7.3.6 Negotiations and settlement of dispute

Negotiation plays an essential role in the enforcement response. The primary reason for negotiation is enabling concerned parties to consider the correctness of the facts, the circumstances of the case and the variety of alternative possible responses. Normally negotiation also provides an opportunity to obtain further information and clarify misinterpretations prior to proceedings with legal action (IMPEL, 1992). Aside from that, negotiations may also provide the opportunity to reach a solution that satisfies all involved parties. Negotiation can typically improve compliance by sending a message or signal to the the regulated community that while proceeding with the enforcement response the government is willing to work cooperatively to develop a satisfactory solution (Wassermant et al., 1984).

Negotiation processes can vary from one culture to another. In some cultures negotiations can be face-to-face between the violators and government officials, while in others they may be represented by different components in the community such as representatives from community groups, workers and non-governmental organisations (NGOs). Negotiations in the presence of an experienced third party can be used to change the dynamics, offer fresh ideas and novel perspectives for possible solutions. The outcome of any of these types of negotiation is called a settlement (a documented official resolution to the situation). Normally, this results in a legally binding agreement between the violators and enforcement officials which is then submitted to the court for consideration and approval (IMPEL, 1992).

7.4 Biological monitoring

7.4.1 Rationale for biological monitoring

Monitoring is a term widely used as shorthand for studies to detect change in the context of environmental impact assessment and management to minimise any adverse effects of human activities. The term monitoring is defined by Hellawell (in Hiscock, 1998) as "surveillance undertaken to ensure that formulated standards are being maintained". In another definition it is described as "an attempt to detect unanticipated impacts, particularly ones that may be wide ranging, subtle or that only slowly become large and obvious" (GESAMP, 1993).

Biological monitoring is undertaken not to satisfy curiosity but to be fed back to the managers of a site or development so action can be taken if deleterious effects are suspected. The purpose of monitoring can be defined in various ways such as: to detect any system disturbance greater than caused by variability in the natural environmental and to identify the causes of such disturbances (Rees, 1990); to understand and identified changes as results of the human activities (Chabanet et al., 2005, Ravera, 1999); an approached and techniques required to gather data survey, identify, protected areas (Ravera and Riccardi, 1997) and to provide means of baseline conditions, for informing decisions on ecosystem management and policy formulation (Parr, 2001).

7.4.2 Features to be monitored

Monitoring community

Benthic communities are commonly targeted for marine monitoring (McIntyre, 1984). Initially, the idea was aimed at quantifying the role of benthos as food for fish but the work led to the development of the concept of communities of marine organisms inhabiting discrete zones of the sea bed.

Since then in with heightened concern about the consequences of effluent discharges, attention has been focussed on benthic organisms as indicators of environmental changes, largely because of their relative immobility as well as ease of quantitative sampling (Rees, 1990). Such organisms conventionally are sub-divided on the basis of size as indicated in the subsequent table.

Table 7.2. A scheme for classifying benthos by size. Modified from (McIntyre, 1984).

Category	Size	Biological features	Sampling techniques
Microbenthos	Pass finest sieves	High rates of respiration and reproduction	Plating and culturing. Cores of < 2 cm diameter.
Meiobenthos	Pass 0.5 to 1 mm sieves	Medium respiration rates. Two or more generations per year	Cores of 2-10 cm diameter
Macrobenthos	Retained on 0.5 to 1 mm	Low respiration rates. Two or less generations per year. Mostly infauna	Grabs sampling at least about 0.1 m^2
Megabenthos	Handpicked from samples	As above, mostly epifauna	Towed gear, trawls and dredges.

Essential reasons why benthic communities are an appropriate target in many investigations of marine pollution are presented as below:

1) Seabed sediments represent the ultimate sink for most contaminants discharged into the sea;

2) Most benthic macrofauna species are relatively long-lived (>1 year) and sedentary, and so can provide an indication of the integrated effects of discharges over time;

3) They are relatively easy to sample quantitatively. Plankton or fish populations are typically less amenable to quantitative study on a scale appropriate to the delineation of localised effects of most discharges and, in the later case, they also have the ability to avoid contaminated areas. No such option is available for sedentary benthic species:

4) They are well studied scientifically compared to the other sediment dwelling components (e.g. meio-fauna and microfauna), and taxonomic keys are available for most groups;

5) There may be direct links to valued resources such as fish (via feeding) and edible molluscs; and

6) Macrofauna community structure has been shown to respond to pollutants in a predictable manner, therefore the results of changes can be interpreted with some degree of confidence.

Monitoring contaminants in biota

Monitoring contaminants refers to sampling and analysis of contaminants in fish, shellfish and seabird eggs. This monitoring is suitable for trace metals, Polycyclic Aromatic Hydrocarbons (PAH), chlorobiphenyls and several other chlorinate organic compounds, including DDT, metabolites, HCH, HCB and dieldrin (Bakke et al., 1990). Monitoring of contaminants in fish, shellfish or seabird eggs (OSPAR, 1995a) is typically undertaken for the following reasons:

- To assess the effectiveness of measures taken for the reduction of marine contamination (temporal trend monitoring). Changes in contaminant inputs are reflected in the concentrations of contaminant in biotas over time;
- To assess the existing level of marine contamination (spatial distribution monitoring). Monitoring contaminant concentrations in selected biotas can be used to indicate large-scale regional differences in contaminations;
- To assess harm to living resources and marine life.

It is important to select appropriate species when monitoring temporal trends in contaminants in biota. Existing information on fish stock composition and history and more importantly long-term data for one particular species must be available. Samples should be representative of the population and able to be repeated annually. Generally, fish and shellfish species currently utilised for trend and spatial distribution monitoring include: mussels *(Mytilus edulis or M.galloprovincialis)*, Pacific oysters *(Crassostrea gigas)*, dab *(Limanda limanda),* plaice *(Pleuronectes platessa),* flounder *(Platichthys flesus),*cod *(gadus morhua),*whiting *(Merlangius merlangus)* and hake *(Merluccius merluccius).* Seabirds that are commonly used in contaminant monitoring programmes include common tern (*Sterna hirundo)* oystercatcher (*Haematopus ostralegus)* and guillemot (*Uria aagle*) (Furness, 1997, OSPAR, 1995a).

Monitoring contaminants in sediments

This type of monitoring is important because many contaminants in the sea have a high affinity for particles and hence accumulate in benthic sediments. Monitoring contaminants in sediments is conducted for a broad range of reasons (OSPAR, 1995b), such as:

- To assess spatial distribution of chemical components in surface sediments. This can identify areas of enhanced concentrations of contaminants and allow interpretation in terms of relative degrees of contamination and location of sources.
- To assess temporal changes in the chemical composition and physical properties of surface sediments at specific locations through repeated sampling.
- Retrospective assessment of temporal changes in the chemical and physical properties of sediment at specific locations through examination of surface and sub-surface sediments. This would usually cover identification of background or pre-industrial conditions preserved within the sedimentary column to provide a framework within which to view current conditions.

More specialised programmes for particular purposes are also needed, for example, to support studies of the effects of contaminants (e.g. as is the case for TBT).

7.4.3 Monitoring approaches

The selection of appropriate methods of monitoring requires consideration of many factors. The purpose of monitoring is of critical importance as is the nature of the environment and the size and abundance of the target biota. It is also important to consider the level of change that needs to be detected so that data can be acquired at an appropriate level of accuracy and precision.

Does the monitoring strategy measure change accurately?

Typically, monitoring programmes aim to detect any system disturbance greater than that caused by variability in the natural environmental and identify the causes of such disturbances. Significant consideration therefore must be placed on ensuring that the sampling design can distinguish between natural and anthropogenically caused variability (Rees, 1990). Both these sources of variation need to be assessed and therefore consideration must be given to the timing and extent of sampling, as well the type of environmental and biological data to be collected (Ecoscope, 2000a). Such factors along with financial and logistical constraints influence the design of monitoring programmes.

Sample stations and locating samples

The selection of sample site locations is an important consideration at the design stage of a monitoring survey. Permanent sample stations can provide an effective approach to reducing random variability when temporal changes are to be monitored (Ecoscope, 2000a). These methods provide a very precise measure of change and are especially useful for monitoring rare sessile species in particular locations. However, there are considerable drawbacks to utilising permanent plots because they may prove to be unrepresentative of the habitat as a whole. They may also cause damage to sites if repeated monitoring is conducted and incur significant cost (Davies, 2001). According to Ecoscope (2000a), permanent plots should only be used if: a) minimising sampling variation is of prime importance (e.g. changes must be detected in areas with high heterogeneity), b) sufficient field work time is available for marking and relocating permanent sampling locations, c) sampling locations are representative of the site and sufficient samples are taken to minimise the risk of chance events reducing their representativeness, d) provision is made for the unexpected loss of sample locations and e) the feature and surrounding environment will not be considerably altered or damaged by repeated field visits. If the permanent stations are not appropriate, the method used to establish the precise location of individual sample sites does itself influence the reliability of determining change and understandably has been extensively investigated (Brown, 2000). Typically, four strategies are commonly used for selecting sample sites as described in the table below.

Table 7.3. Summary of the advantages and disadvantages of different types of sample selection. Modified from (Ecoscope, 2000a).

Sampling location	Advantages	Disadvantages
Random	- Required minimum knowledge of population in advance. - Free of possible classification errors. - Easy to analyse data and compute errors.	- Locating sample observations can be time consuming. - Often larger errors for a given sample size than with systematic sampling. May not monitor what is required.
Stratified – random	- Ensures that all the main habitat types present on a site will be sampled (if defined as strata). - Characteristics of each stratum can be measured and comparisons between them can be made. - Greater precision is obtained for each stratum and for overall mean estimates if strata are homogenous.	- If strata have not been identified prior to monitoring, preparation can be time consuming. - The most appropriate stratification for a site at any one time may have changed when repeat surveys are carried out. - Monitoring efficiency may therefore also change.
Systematic or grid	- If the population or attribute is ordered with respect to some pertinent variable, a stratification effect reduces variability compared with random sampling. - Provides an efficient means of mapping distribution and calculating abundance at the same time.	- If sampling interval is correlated with a periodic feature in the habitat, bias may be introduced. - Strictly speaking, statistical tests are not valid, although in practice conclusions are unlikely to be affected.

The selective or judgement approach is likely to be the most efficient as it is based on prior knowledge (Brown, 2000), although this approach should also be supported by expert advice. While the classic random approach is rarely suitable for targeted monitoring it may be suitable for surveillance and environmental effects monitoring.

Rees (1990) argued that the distribution of sampling stations can be influenced by the following:

1) The type of disturbance anticipated. For example, assessment of point source pollution is best done by trends analysis of data from grid or transect (s) of sampling stations. The influence of generally disseminated contaminants is better understood from comparative analyses of data from stations randomly distributed over the survey area.
2) The local topography and hydrography. For example, uniform depth and substratum type over the sampling area will allow for the establishment of a regular sampling pattern constrained only by consideration of the anticipated disturbances. Tidal and residual currents must be considered in the survey design. Irregular depths and variable substrata in the area will necessitate the imposition of some form of stratification to whatever sampling pattern has been chosen as suitable to the type of disturbance to be assessed.

How many samples do I need to take?

In general, increasing the number of replicate samples reduces the risk of inaccurate conclusions (Davies, 2001). To determine the number of replicate samples to collect in each sampling site Rees (1990) indicated that three aspects should be considered:

1) The need for statistical accuracy in assessing sample heterogeneity. At least 10 samples are usually required to obtain a fully representative array of the commonly occurring species, together with some measure of their variability.
2) Operational constraints. Such factors interact in dictating a practical compromise for any particular survey.
3) Site characteristics. Local complexities and heterogeneities will influence the number of samples necessary to establish community variability. From the outset, the design of any survey should be site specific.

Generally, for practical purposes a single sample taken at as wide a possible number of stations will be adequate to assess the general distribution of communities over a survey area. However, if quantification of the fauna is required then a minimum of three samples should be taken at each site (Rees, 1990).

Frequency of sampling

Usually the frequency of sampling will be dictated by the individual survey requirements. For example, spatial patterns may be assessed from data obtained on a single sampling occasion, but assessing temporal trends can only be done by repeated sampling. To obtain information on seasonal changes the sampling frequency might be related to the life cycles of the principal organisms present in the area (Davies, 2001). Fluctuating input levels of the agent(s) thought to be responsible for changes may therefore impose a sampling timescale (Rees, 1990).

7.4.3.1 Sample design

The requirements of sampling design for monitoring usually depend on the availability of existing information for the area of interest and the monitoring purpose. A well studied location may provide all the information necessary for selecting suitable sampling tools and designing a baseline survey. Generally, four stages may be identified in planning, initiating and undertaking a survey or initial desk study, which is then followed successively by exploratory, baseline and ongoing surveys.

Exploratory survey

An exploratory survey of the study area may be required in order to define those topographic and environmental details that may influence the survey plan. The adopted sampling design may be random, systematic, stratified or even selective (e.g. for the confirmation of the presence of features) and depends on the extent of the prior environmental data (or biotope map) of the sampling site (Ware, 2011). For the characterisation of seabed features it is usually sufficient to use single sample stations (e.g. no replication) at suitable spatial frequency to define the main habitats and their associated communities (Rees, 1990). Semi-quantitative or rapid qualitative techniques may be utilised in this type of survey rather than the fully qualitative techniques utilised in baseline and ongoing surveys. Underwater video, photography and REMOTS techniques (combines sediment profiling with photography) are appropriate for assessment of the distribution of substrate types and communities over an area and may be suitable for this type of preliminary synoptic survey (Rees, 1990). For the assessment of epifauna and fish, such sedimentary explorations should be combined with trawl samples. The extent of the survey should cover the entire area of actual or potential disturbance (Ware, 2011). The exploratory survey should then map all major habitats types within the survey area to give an overview of the distribution of the biota present in each of the habitats (Kenny, 2000).

Baseline survey

Baseline surveys are conducted to establish the distribution and abundance of target fauna throughout the area and record appropriate environmental data. Survey design is based on the results of exploratory surveys (Rees, 1990).

In the case of an area of relatively uniform habitat type within and adjacent to the predicted zone of impact, a transect or grid based design may be adopted for the positioning of baseline stations. In circumstances where the effects can be predicted to occur along well-defined gradients associated with factors such as tidal currents, then weighted transects whose orientation follows the major axis of the tidal ellipse are most suitable (Ware, 2011).

Quantitative techniques should be used where possible. Sediment samples of known volume should be obtained utilising grabs and/or cores. Different techniques like beam trawls or dredges might be required for harder substrates (Rees, 1990). The extent of the sampling area should extend beyond the outer limits of the area potentially threatened by disturbance. Reference areas must be sampled and it is imperative that these also include comparable representative habitats.

Traditionally, monitoring surveys have been carried out using grids or transects leading away from the installations and following the prevailing current direction to investigate causal links among biological, chemical and physical features of the seafloor at a range of spatial scales (Thrush et al., 1998). Typically, sediment samples were taken at stations set at varying distances (e.g. 500, 800, 1200, 2500 and 5000 metres) from the platform along the transects.

In an area with a heterogeneous seabed, a robust stratified design may be applied with the aim of achieving an adequate and balanced density of sampling within the predicted impact zone (e.g. primary impacted zone), along with an adequate density of sampling with comparable strata from adjacent reference (un-impacted) locations (Kenny, 2000, Ware, 2011). Quantification of populations is generally required of baseline surveys and therefore a minimum of three replicates should be taken at each sample station. While this may adequately quantify the common species, it won't quantify the less common or rare species. For example, in soft silt three samples might be expected to collect 60 percent of species present in an area, while five samples would habitually yield over 70 percent (Rees, 1990). Baseline surveys generally rely on data taken on a single sampling occasion and consideration should be given to the timing of the sampling period as subsequent monitoring will need to be conducted at the same time of year in order to minimise variation due to seasonal fluctuations. Ideally, baseline sampling would be repeated at intervals over at least one full seasonal cycle to establish the limits of seasonal variability within the survey area.

Ongoing survey

An ongoing survey generally emphasises the monitoring of temporal trends before, during and after the initiation of oil and gas activity and requires regular repetitive sampling (Kenny, 2000). The techniques employed in such surveys are normally identical to those utilised in the baseline survey. Sampling should be repeated at different stations at infrequent intervals. This is aimed at balancing the representativeness of regular monitoring and to ensure that no unexpected effects occur elsewhere (Rees, 1990). Such regular sampling should be continued at a selected series of stations which should represent a gradient from potentially disturbed to potentially undisturbed conditions in at least the dominant habitat type in the area. The number of samples that should be taken for the most common species at any one station is three, but if less common species are also required then at least five samples should be taken (McIntyre, 1984). Ideally, sampling frequency should allow seasonal changes to be assessed, which would require a minimum of four sampling occasions annually. Often a single annual set of samples is taken and hence sampling must be undertaken during the same season oeach year (Rees, 1990).

Techniques and equipment

The techniques for oil-related benthic surveys have changed over time and currently the focus is often on wide-scale baseline environmental monitoring at a pre-operational stage. Such a survey involves screening the development area for any potential ecologically important habitats and species. Numerous acoustic techniques – particularly side scan sonar – are used to gather information on seabed habitats (Brown et al., 2002, Boyd et al., 2004, Limpenny et al., 2002). Some examples of these techniques are discussed in the following sections. The list of techniques is not exhaustive and is focused primarily on methods suitable for assessing benthic habitats and biota.

Acoustic methods

Acoustic techniques are often used to inform and complement the survey design by providing a base map which allows efficient and thorough sampling strategies to be designed (McIntyre, 1984). The products of these techniques can provide maps of the physical and biological features of the seabed. Advantages and disadvantages of the alternative technologies are outlined in the table below.

Table 7.4. Summary of remote acoustic systems. Modified from Judd (2012)

System	Use	Resolution	Relative cost	Environmental application
Echo-sounder (single line bathymetry)	Line bathymetry	Low resolution (< 100%) – poor spatial coverage	Low	Detection of broad-scale features, map to inform direct sampling survey design.
Multi-beam echo-sounder	Line bathymetry	Along track – typically it can detect structures with a size of 0.3m. Measurement area with distance of 10 to 1000m.	High	Can generate quantitative bathymetric data open to any classification and various types of image processing.
Acoustics ground discrimination systems (AGDS)	Line bathymetry and sediment discrimination	Low spatial resolution only. Ban detect >10m, but full coverage requires interpolation between tracks	Low	Habitat mapping. This can help inform direct sampling survey design.
Sub-bottom profiling	Sediment layers and shallow geology	Vertical resolution varies with frequencies.	High	Can help to infer habitat distribution through identification of geological features.
Side scan sonar	Sediment texture features	Very high (100% coverage possible)	Low to high (depending on system)	Identification and monitoring of specific habitats, sediment and transport pathways etc. Broad-scale base map to inform direct sampling survey design.
Swath bathymetry	Bathymetry and sediment discrimination	Very high (100% coverage possible)	Moderately high (for entry-level system). High-performance system very expensive.	100% bathymetric coverage and detection of topographical features.

Echo-sounders

Echo-sounders can vary in sophistication and cost but all operate on the same principle. A transducer converts an electrical pulse into a mechanical pulse which then generates a sound wave that is directed towards the seabed. Although the suitability of echo sounders for habitat assessment is limited by poor resolution and restricted areal coverage, they are frequently used in conjunction with other acoustic systems.

Multibeam echo-sounders (MBES)

Multibeam echo-sounders are a technique designed to provide a relatively new seabed mapping technology that can be applied to an understanding of the marine habitats, aggregate resources and seabed processes. The system works through digital processing techniques, which use data to provide shaded relief topographic maps. Multibeam echo-sounders have a major advantage in comparison to sidescan sonar in that they can generate quantitative bathymetric data to any classification and various types of image processing. However, it is not applicable for a narrow beam less than one metre. (Kenny, 2000).

Acoustics Ground Discrimination Systems (AGDS)

Acoustic Ground Discrimination Systems are designed to detect various acoustic reflective properties of the seabed substrata (CEFAS, 2002). The aim is to distinguish acoustic differences associated with the particular physical or biological features of the substrate. AGDS techniques are commonly used for habitat mapping. Usually a vessel mounted with a single beam echosounder is utilised to generate a single frequency acoustic pulse, which is reflected from the seabed and subsequently received back onboard the vessel. The signals are processed by AGDS to detect differences in the roughness and hardness of the seabed. According to Kenny (2000), AGDS can be remarkably effective at showing where changes in seabed characteristics occur, although appropriate attention should be paid to ground-truth calibration. Although AGDS is relatively simple to utilise, the outputs require considerable interpolation to process and produce a broad-scale map of the seabed with 100% coverage (Boyd, 2002).

Soft-bottom profiling

These techniques are designed to obtain information on sediment layers from below the sediment water interface. Such systems use a technique that is similar to single beam echo sounders. A sound source emits an acoustic signal vertically downwards into the water and a receiver monitors the return signal which has been reflected off the seafloor

(Eleftheriou, 1984). This generates sufficient energy to penetrate the sediment and identify the different density layers (sediments) below the seabed surface (McIntyre, 1984).

Sidescan sonar (SSS)

The outcomes of sidescan sonar surveys have proved useful for identifying the footprint of disposal activity and detecting changes in topography (Limpenny et al., 2002). Kenny (2000) found that these vary in precision and accuracy depending on numerous factors. Accuracy can be ~0.1m at a range of 50m (100m swath), but fall to 0.3m at a range of 150m (Kenny, 2000). Utilising sidescan sonar is advantageous in that it can generate a photo-realistic picture of the seabed where geological and sedimentological features can be easily identifiable, offering valuable qualitative insight into the dynamics of the seabed.

Swath bathymetry

This technique is designed to collect seabed bathymetric data utilising a system that collects data from a swath oriented perpendicular to the survey vessel. The beam shapes and geometry of the system enable the collection of data with 100 % coverage (Kenny, 2000). It provides a detailed representation of the seabed environment that allows spatial patterns to be visualised, as well as providing foundation maps for survey planning, data overlay and interpretation. This technique provides the means for detecting small features and spatial patterns in sediment types that are required for habitat classification (Ware, 2011).

Grabs and cores

The selection of gear for sampling seabed substrata and the benthic macrofauna at offshore oil and gas extraction sites is primarily determined by the hardness or compactness of the substrata. Despite the availability of a variety of sampling methods (McIntyre, 1984), only just a small proportion of these have the ability to effectively collect samples from areas of relatively coarse sediments. Commonly, the downwardly-directed jaws of grabs are vulnerable to incomplete closure due to the present of stones. Grabs allow quantitative evaluation of macrobenthic infauna but because of their size and mode of action they do not effectively sample larger sparsely distributed epifauna species or those capable of rapid avoidance reactions. Where epifauna is of interest the use of towed gear such as trawls and dredges is more appropriate. Depending on the aims of the survey it may be appropriate to use more than one technique in order to sample the full range of benthic organisms present in a survey area. A range of grabs typically employed for surveys of seabed sediment is given in table 7.5.

Hamon grab

Hamon grabs are well suited for sampling the benthic macro-infauna from coarse sediments (Oele, 1987). Larger versions sample an area of about $0.25m^2$ but smaller versions are available and can sample an area of $0.1m^2$. The smaller version has the advantage of relative ease of handling allowing it to be operated on smaller vessels. In addition, $0.1m^2$ is the conventional sample unit employed in most benthic surveys of continental shelf sediments and conformity with this size allows direct comparison of results with those from a wide array of other sources using a range of other sampling devices. The $0.1m^2$ grab also has the advantage that samples are of a more manageable volume than the large Hamon grab. The $0.1m^2$ grab yields a sample volume of 15 litres as compared with up to 35 litres from a $0.25m^2$ grab. The drawback of the Hamon grab is that the sediment sample is mixed during the process of collection and retrieval thus precluding the examination of an undisturbed sediment surface.

Modified Day grab

This grab is designed for sampling soft sediments, those ranging from sands to muds. Unfortunately, it does not function well on coarse sediment, due to the tendency of larger particles to prevent closure of buckets, causing the loss of samples. The modified Day grab evolved from the spring-loaded Smith-McIntyre grab (Holmes and McInyre, 1984) and can be utilised for sampling an area of 0.1 m^2 up to a maximum sediment penetration of 14 cm.

Table 7.5. Comparison of devices used for the collection of faunal samples. Modified (McIntyre, 1984).

Sampling devices	Surface area sampled	Approximate weight without sample	Suitable for sampling coarse substrata	Easily and safely deployed from small(25m) vessel	Advantages	Disadvantages
Small Harmon grab	$0.1m^2$	300kg+up to 300kg	Yes	Yes	Easy to handle. Sample size comparable to that of other commonly used grabs.	More replicates maybe required in patchy environments, compared to its large counterpart. Sediment sample is mixed during the process of collection and retrieval thus precluding the examination of an undisturbed sediment surface.
Large Hamon grab	$0.25m^2$	350kg+weights up to 150kg	Yes	No	Large sample may be more representative of coarse or more sparely populated sediments.	Large size makes it more difficult to handle than smaller version. Large sample volumes (35 litres max) can be relatively time consuming to process. Surface area sampled not directly comparable to other sampling devices.
Day grab	$0.1m^2$	80kg+weights up to 80kg	No	Yes	Easily deployed. Standard sampler for most U.K. in faunal soft sediment surveys.	Not effective in coarse substrata
Small van Veen grab	$0.1m^2$	80 kg	No	Yes	Easily deployed. Widely used for infaunal surveys, especially in continental Europe	Not effective in coarse substrata
Large van Veen grab	$0.2m^2$	100 kg	Depending on the coarseness of substrates	Yes	Easily deployed. Widely used for infaunal surveys, especially in continental Europe	Unreliable in very coarse substrata, but may be more effective in some coarse sediments than $0.1m^2$ version.
Shipek grab	$0.04m^2$	80 kg	Yes	Yes	Can be used effectively for physical characterisation of substrata	Sample too small and variable for quantitative faunal assessment.

Shipek grab

This device employs a semi-circular bucket activated by powerful springs (Holme & McIntyre, 1984) in (Kenny, 2000). It has been proved that the device is very effective in sampling coarse substrata and it is widely utilised in marine geophysical and geochemical surveys. The strong spring mechanism also allows samples to be collected from relatively hard and consolidated sediments, although with an increased failure rate due to larger particles preventing proper closure. Due to its small size (it has the capacity of sample an area of about $0.04m^2$), this device is unsuitable for routine macrofauna investigations (Boyd, 2002). However, it may be useful in pilot surveys aimed at preliminary characterisation of variability in habitat type and associated fauna. This device can also be used where there is high percentage of soft sediment (sands or muddy sands). These are typically associated with gravelly components and have a relatively high failure rate.

Van Veen grab

Like many other grabs, this device relies on two opposing jaws for the collection of sediment samples. A a small van Veen grab is able to sample an area of $0.1m^2$, while a larger model can cover $0.2m^2$. The main difference between this and the Petersen grab (Holme and McIntyre, 1984) is that the van Veen grab has long arms attached to each bucket, giving better leverage during closure. It is not ideally suited for the collection of coarse sediments as large particles of gravel can often become caught between the jaws, resulting in loss of the sample upon retrieval of the grab. However, when used in localities with softer substrata then the success rate and cost effectiveness is high.

Trawls and dredgers

Prior to discussing sampling methods for epifauna, it is worth providing a brief description of epibenthos and their importance in environmental assessment. Epibenthos refers to the animals and plants living on the surface of the seabed, including decapods, starfish and flatfish. There are numerous reasons why this group is a suitable target for environmental assessment, some of which are listed below:

- On predominantly rocky areas or tide-swept grounds, they may be the only significant component of the benthos. These areas may support an exceptionally high diversity and biomass of species, for example those associated with subtidal mussel beds.
- Sedentary epibenthic species provide a direct route for carbon from the water column to the seabed via filter-feeding.
- Many epibenthic species are preyed upon by fish.
- Complementary surveys of the epifauna provide further information beyond that obtained from infaunal investigations, including the status of an area in terms of the range and relative abundance of species present or their mode of feeding.

Small ($0.1m^{2)}$ grab samplers are unsuitable for the quantitative assessment of epifauna due to the wide size range of the animals, as well as the motility and comparative rarity of some species. A wide range of dredges and trawls have been devised for remote epibenthic sampling with varying efficiency for different groups of organisms (Eleftheriou, 1984). Furthermore, there are alternative methods for *in situ* assessment such as remotely deployed underwater video and still photography. Such options and other imaging methods have been reviewed by Rumohr (1999). These remote methods have advantages over diving surveys in that they tend to be cheaper, less weather dependant and more able to operate in deeper areas.

Trawls

Trawls are commonly designed to sample at and just above the surface of the seabed. Because of the relatively large area that can be covered in a single deployment, they are appropriate for collecting the larger and more motile species. Small Beam and Agassiz trawls are the most commonly employed devices and are used to sample the epifauna either in a semi-quantitative or qualitative manner. Two-metre-wide beam trawls are recommended for sampling the epifauna in an offshore environment. The small size of the gear makes it relatively easy to deploy and usually results in a manageable sample size. If coarse substrates are anticipated, the use of heavy-duty 2m beam trawls is advised (Jennings et al., 1999). The standard 2m Lowestoft beam trawls with wooden beams, while thicker ground chains have proved useful for epifaunal sampling of finer substrata and have a 3mm mesh cod end liner to capture smaller organisms (Rees, 1990). A range of semi-quantitative trawls and dredges which are suitable for deployment on a range of sediments types are shown in table 7.6.

Table. 7.6. Descriptions of trawls and dredges used for collection of semi-quantitative epifaunal samples.

Sampling device	Surface area sampled	Approximate weight (no of sample)	Suitable for coarse sediments
2m beam trawl	Variable	60kg	Yes
Anchor dredge	Variable	65kg	Yes
Rock dredge	Variable	140kg	Yes

An appropriate towing distance can range from 200 to 800m. The tow should cover sufficient ground to adequately characterise the communities while at the same time avoiding the collection of unfeasibly large sample sizes. The speed at which the beam trawl is towed will depend on local circumstances and the types of vessels employed, although a maximum speed of 1.5 knots over the ground is recommended (Kenny, 2000).

The efficiency of sampling gear may be influenced by the prevailing tide and wind conditions at the time of the survey. Consequently, sample sizes and quality may vary irrespective of whether tows are conducted over fixed times or fixed distances. For that reason is imperative that the information on tidal state and weather conditions are recorded accurately as these can contribute to observed disparities between stations or sampling periods.

Dredges

Towed dredges are usually utilised for the evaluation of the epifauna community structure in the case other sampling tools cannot be effectively employed. For sampling sessile biota, dredges are normally more efficient than benthic trawls like the beam trawl. There are numerous types of dredges which could be used to obtain samples:

a. *Newhaven scallop dredge:* this commercially used device normally operates over coarse terrain, but would likely suffer damage if towed over bedrock or large boulders (Franklin et al. 1980). Typically, the mouth of the dredge is approximately 800mm wide and 110mm high throughout the deployment. The maximum diameter of particle likely to be retained within the dredge is approximately 20mm. During operation, care must be taken to ensure that the dredge is deployed the right way up. Other variables which should be considered include the duration of the tow and the length of warp paid out. This device can also be used for the collection of keystone species (e.g. horse mussels) in the area of interest.
b. *Raller-Du-Baty dredge*: this is designed to operate in a range of substrata from sands to cobbles, and has long been successfully used in the English Channel and Celtic Sea (Cabioch, 1968). The dredge consists of a robust metal ring, with aninside diameter of 550mm for the large version and 390mm for the smaller version attached to a central towing arm. The open-ended bag has a mesh size of 500µm or 1mm and is attached to the ring. The trailing end of the bag is tied to prevent loss of materials during the collection of samples. The towing speed should not be more than 1.5 knots for a pre-determined time limit, normally exceeding five minutes. The advantages of using this device is that it can continue to sample over uneven terrain and is particularly suitable for collecting both infaunal and epifaunal organisms. The disadvantage is that it can collect very large volumes of sediment (occasionally >100 litres) which may be very time consuming to process.
c. *Anchor dredge*: this is designed to operate on sandy sediments, although it can also produce acceptable samples when utilised on coarser substrata (Forster, 1953). The device consists of a rectangular metal frame, forming the mouth of the dredge, which is towed by hinged wishbone arms. The advantage of using this dredge is that it can fall either side up and will still collect a sample. Its small size makes it relatively easy to manage and deploy and it is also relatively inexpensive.
d. *Rock dredge*: this refers to an extremely robust device that was originally designed for the collection of rock samples from deep-water locations (Nalwalk et al., 1962). The device consists of a heavy gauge rectangular metal ring to which is attached a heavy-duty mesh made of interlaced metal rings. The largest particle which can pass through the mesh is approximately 20mm. This mesh size is useful over most substrata, including gravels or cobbles and could even collect surface scrapings of bedrock. Like the anchor dredge, it can fall either side up and is small and inexpensive.

Underwater video and camera

Underwater video and stills photography are valuable and non-destructive methods for the assessment of all types of seabed habitats (Gage, 2001). These methods are particularly useful when operating over hard and consolidated ground where physical sampling is difficult (Kenny, 2000). In most cases camera platforms fall into two categories: Remote operated vehicles (ROVs) and photographic sledges (Gage, 2001). The photographic sledge is the most commonly utilised method for photographing coarse environments as it is robust and simple to operate. The advantage of ROVs is the control you have over movement, allowing objects of interest to be selectively examined. Photographic and video cameras have also been attached to grabs to obtain images of the seabed from which samples are collected.

7.5 Discussion

This section builds on the findings of the literature review on compliance and biological monitoring. It also assesses the suitability of processes and techniques used in the specific environment of the Timor Sea.

7.5.1 Assessment on environmental monitoring compliance

A combined approach with regular inspection of self-monitoring practices in addition to compliance evaluation, involving systematic inspections of the facility would be an appropriate approach for the Timor Sea of East Timor. Despite the cost and resources required, inspection appears likely to be the most suitable tool for providing relevant and reliable information with regard to compliance of offshore facilities. Citizen monitoring is of limited relevance as with the exception of on-shore oil refineries, the public has limited access to offshore facilities. Other reasons to employ self-monitoring and recording are that this will help to reduce the costs of compliance monitoring.

In terms of enforcement, a two-tier system would be appropriate for the Timor Sea area. A low-cost, informal enforcement system would ideally be implemented in the first instance, with the option to initiate stronger, more formal enforcement measures should the operator fail to comply or if violations are of a particularly serious nature.

7.5.2 Evaluation of biological monitoring methods

Monitoring is typically aimed at estimating the extent and magnitude of changes in benthic communities resulting from oil and gas developments in the Timor Sea. The development sites are mostly located on the shallow continental shelf of Australia (under joint jurisdiction of East

Timor and Australia). Seabed habitats are predominantly sedimentary and range from fine muds to coarser sediments. Physical and biological characteristics of the proposed development area are assessed further in sections 2 and 3 of Chapter 2.

The initial step in monitoring a proposed development site should be the establishment of a baseline. Any existing information on the biota of the site should be assessed and a habitat mapping survey conducted using acoustic techniques to assess the heterogeneity of the seabed. Habitat mapping allows benthic sampling to be targeted appropriately to best evaluate the composition and distribution of benthic communities. Random stratified sampling should also be considered, with sampling blocks set up to represent the different types of seabed as indicated by the acoustic survey. Sampling provides ground truth data for the interpretation of the acoustic habitat map, as well as baseline data to evaluate future changes in the community. Single replicate samples from a large number of different locations are likely to be appropriate for ground truth data, whereas multiple replicates from a small number of selected locations is more appropriate for the baseline data. The best strategy would be to first conduct a habitat mapping survey with single replicate samples forming the ground truth data. The habitat map can then be used to select locations for the collection of replicated baseline samples. The quantitative techniques employed for sediment sampling would depend on the nature of the seabed. For example, remote video is preferable for rock or biogenic reefs A Hammon grab is the better option for coarse sediment, while a Day or Van veen grab should be deployed for normal sediment. The sampling area should extend beyond the anticipated impact, with the more distant stations acting as reference stations for the assessment of any future changes occurring as a result of the development.

The costs of conducting such surveys are considerable, both in terms of ship time and subsequent sample processing. For this reason, it is important to pay close attention to the efficient planning of sampling strategy. This will help ensure that the sampling intensity meets the monitoring objectives, but does not exceed them. The baseline data also needs to be sufficient to assess future post-development monitoring surveys. It is recommended that a minimum of four replicate samples are taken from each sample station to adequately assess changes in community composition. One possible strategy for reducing costs while ensuring options for future monitoring are kept open would be to collect baseline samples from numerous stations, but only process those that prove relevant for assessing the results of future monitoring surveys. This would provide a repository of information on pre-development conditions which could then be accessed if it proves necessary to do so.

When conducting monitoring activities in the Timor Sea and South Coast it is essential that consideration be given to the location and number of sample stations and the frequency of monitoring surveys. It's clear that by increasing sampling frequency and intensity this would in turn increase the resolution of monitoring data, although it would also increase costs. One approach would be to collect baseline data from several stations at varying distances from the proposed development site, but reduce the number of stations visited on subsequent monitoring surveys unless there are specific causes for concern. Regarding the frequency of monitoring surveys, it is likely to be useful to assess the initial impact of the development and therefore it would be appropriate to conduct an initial monitoring survey within a year of completion of the development. Subsequent changes are likely to occur slowly, so it might be appropriate to conduct monitoring at intervals of two or three years. In all cases, it would be important to ensure consistency in the sampling methodology and seasonal timing of monitoring surveys in order to ensure comparable reference (control) samples are collected for the assessment of changes.

Chapter 8. SUMMARY, CONCLUSIONS AND RECOMENDATIONS

8.1 Introduction

This chapter summarises and discusses the conclusions of the previous chapters (Chapter 2 to 7). The chapter consists of four main sections. The first section is concerned with the identification of habitats of conservation importance in the Timor Sea. This section is arranged in three sub-sections as follows: 1) habitat importance based on biological criteria such as diversity and rarity, 2) habitat importance based on economic value and ecosystem services, 3) habitat importance based on stakeholders views.

The second section is concerned with assessing priorities and determining appropriate levels of protection for important habitats. This addresses what level of degradation or loss can be regarded as acceptable to allow for economic benefits. It is based on 1) evaluation of vulnerability to damage, 2) evaluation of resilience and recovery potential of habitats, 3) evaluation of stakeholder views and cultural issues.

The third section is concerned with assessing mechanisms for the implementation of environmental protection or conservation measures. Attention is given to the assessment of what regulations or policies are required to limit potential habitat loss or degradation to acceptable levels. It includes 1) procedures and requirements for permit systems and 2) specific regulations concerning particular habitats or activities.

The fourth section is focused on assessing mechanisms for evaluating and monitoring the effectiveness of the environmental protection and conservation measures as outlined above.

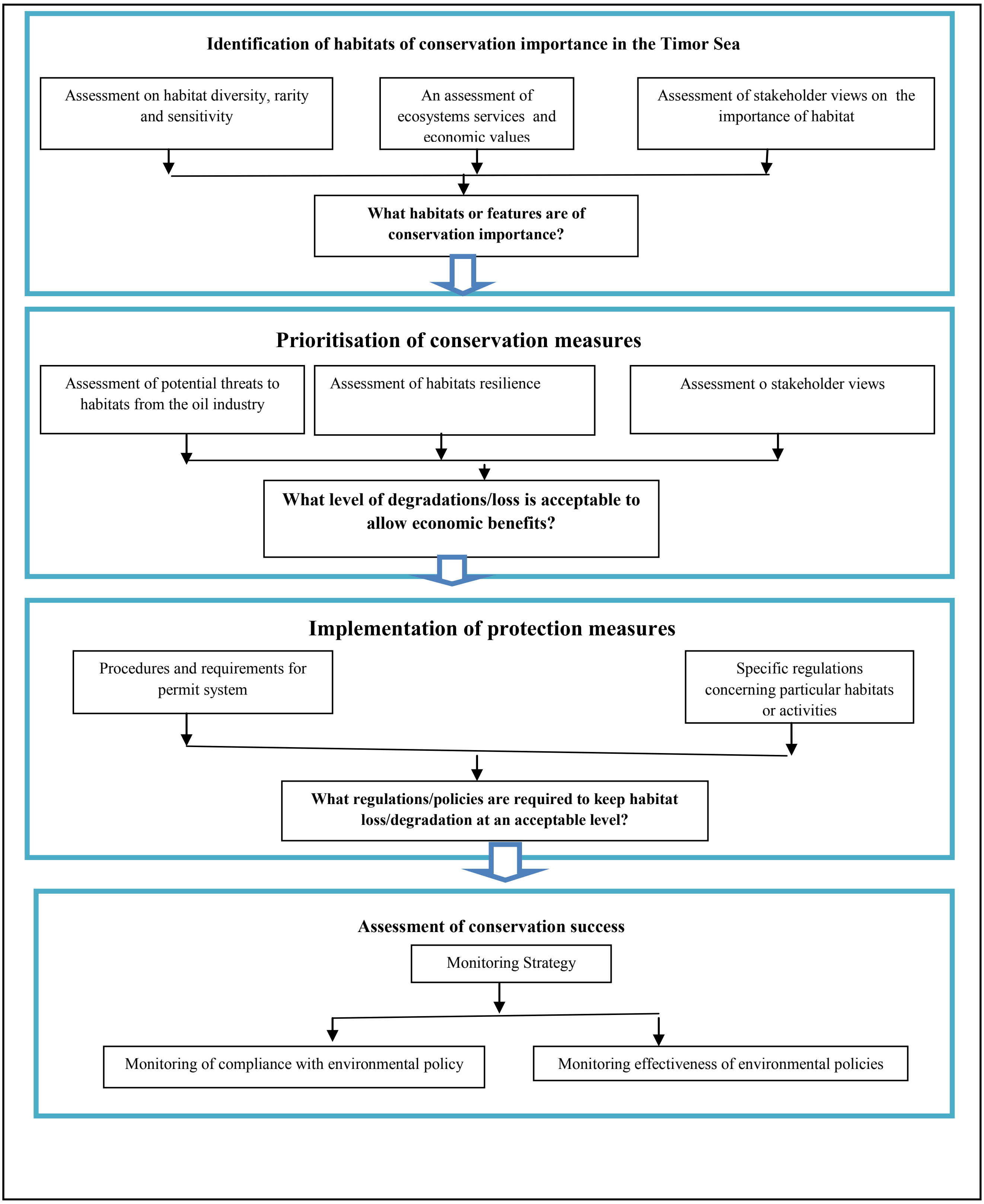

Figure 8.1. Logical structure of the summary chapter.

8.1 Habitats or features of conservation importance

Habitat conservation is vital for protecting both species and ecological processes. The evaluation of habitat conservation importance is based on information presented in the earlier chapters on the natural resources in the Timor Sea (Chapter 2), potential impacts of oil industry developments on natural resources (Chapter 3) and stakeholder consultations regarding oil industry impacts on natural resources (Chapter 4).

8.2 Assessment of habitat conservation criteria

8.2.1 Assessment on diversity patterns

Species diversity on the South Coast of East Timor and JPDA region is poorly documented. In most cases, diversity appears to be relatively low compared to the neighbouring regions of Papua New Guinea and Indonesia. This is possibly due to environmental stressors such as high wave exposure and freshwater input from rivers. However, it seems probable that there are numerous habitats which are likely to be of relatively high diversity value, due to their high productivity and the presence of specialist species. Such habitats might include mangroves, shallow and deep-water sediments and rocks, seagrass, shallow and deep-water coral reefs and *Halimeda* reefs. For an assessment of natural resources in the Timor Sea see Table 8.1.

8.2.2 Rarity of habitat and component species

Despite the general lack of reliable data, it is a reasonable assumption that many of the habitats in the Timor Sea are regionally widespread in the biographical region, both in the Timor Sea and neighbouring areas. That being said, it appears that the Timor Sea area is home to certain rare habitats, including mangroves, seagrass, shallow-water coral reefs, deep-water coral reefs and *Halimeda* reefs. Since many component species of these habitats tend to be 'specialists', it is reasonable to assume that these species will also be rare in the region. Some groups of Turtles, cetaceans and dugongs are all found in the Timor Sea and known to be globally rare. For more details see Table 8.1.

8.2.3 Economic value and ecosystem services

Certain intertidal habitats in the region have some economic value in supporting small-scale shellfish harvesting. Economic value is also provided by habitats that through ecosystem services directly or indirectly support subsistence fisheries that sustain many coastal villages. Some habitats such as mangroves may also supply services by providing coastal protection from storms.

Table 8.1. Summary of economic value and ecosystem services.

Habitat type	Economic value and ecosystem services
Intertidal Sediment	
Exposed (coarse) sandy beaches	Local shellfish harvesting. Potential future amenity / tourism value.
Sheltered (fine) sandy beaches and mudflats	Local shellfish harvesting. Feeding areas for exploitable fish species.
Mangrove forests	Local shellfish harvesting. Feeding areas for exploitable fish species. Protection from wave damage during storms.
Intertidal rock	
Exposed intertidal rock	Local shellfish harvesting.
Sheltered intertidal rock	Local shellfish harvesting.
Subtidal sediment	
Shallow (continental shelf) sediments	Fisheries. Feeding and breeding areas for exploitable fish species.
Deep (continental slope and trough) sediments	None known
Sea grass	Feeding and breeding areas for exploitable fish species
Subtidal rock	
Shallow (continental shelf) rock	Feeding areas for exploitable fish species.
Deep (continental slope and trough) rock	None known
Hydrothermal vents (HTV)	None known
Biogenic reefs	
Shallow water coral reefs	Feeding and breeding areas for exploitable fish species
Deep water coral reefs	None known
Halimeda reefs	None known
Group of animals	
Turtles	None known
Cetaceans	None known
Dugongs	None known

Ecosystem services considered in the area include feeding areas for exploitable fish species and protection from waves during storms. Economic value and ecosystem services of habitats and component species in the deep water beyond 200 m are currently unknown.

8.2.4 Assessment of stakeholder views on importance of habitats.

The majority of stakeholder views indicated that most habitats were not regarded as especially important. The exception was mangrove forests and shallow-water coral reefs, which respondents attached a high importance to.

Table 8.2. Summary of values in stakeholders views on the importance of natural environment al features and species on the South Coast and the JPDA.

Habitat type	Value attached by stakeholders
Intertidal Sediment	
Exposed (coarse) sandy beaches	Low
Sheltered (fine) sandy beaches and mudflats	Low
Mangrove forests	High in some regions for cultural reasons.
Intertidal rock	
Exposed intertidal rock	Low
Sheltered intertidal rock	Low
Subtidal sediment	
Shallow (continental shelf) sediments	This is due moderate. Due to the fact that they are a fishing resource
Deep (continental slope and trough) sediments	Low
Sea grass	Low
Subtidal rock	
Shallow (continental shelf) rock	Low
Deep (continental slope and trough) rock	Low
Hydrothermal vents (HTV)	Low
Biogenic reefs	
Shallow water coral reefs	High
Deep water coral reefs	Low
Halimeda reefs	Low

Habitat type	Value attached by stakeholders
Group of animals	
Turtles	Moderate
Cetaceans	Moderate
Dugongs	Moderate

Respondents also attached moderate importance to shallow continental shelf sediments and to certain animal groups such as; turtles, cetaceans, dugongs, fish and seabirds.

8.2.5 Summary on habitats of conservation importance

In general, habitats in the study area are poorly documented and species diversity appears relatively low. Habitats identified as having high conservation importance include mangrove forests, shallow- and deep-water coral reefs, seagrass and intertidal sheltered sediment and rock. Some of these habitats are highlighted due to their economic value and ecosystem services for the local community. Animal groups considered as having conservation importance include turtles, dugongs, cetaceans, fish and seabirds.

8.3 Prioritization of Conservation Measures

The discussion on the prioritisation of conservation measures in this section encompasses vulnerability to the impacts from the oil industry, habitat resilience and potential for recovery and stakeholder views. Among the factors influencing prioritisation of conservation measures are topography and energy (wave/tide) levels in the environment, the type of oil industry activities planned and the estimated recovery period.

8.3.1 Vulnerability to impacts arising from the oil industry

Intertidal habitats are typically very shallow shorelines and are therefore potentially vulnerable to the impacts of oil spills, as are air-breathing marine animals like cetaceans, turtles and sea birds. Almost all Subtidal environments are potentially vulnerable to disturbances from subsea structure pipelines and pollution from cuttings.

Deep-water (> 200 m) sites are arguably less vulnerable as development is unlikely to take place at these depths.

8.3.2 Assessment of habitats resilience or recovery rate

The recovery rate for South Coast habitats and component species varies considerably depending on the different habitats and available energy in the environment. Those potentially characterised as being slow to recover include sheltered beaches and intertidal rocks, mangrove forests, seagrass, shallow-water coral reefs and deep continental slope sediments and rock, as well as deep-water coral reefs. In contrast, exposed intertidal sediments and rocks, *Halimeda* reefs and HTV are considered as habitats with relatively high recovery rates due to high energy levels in the environment (see Table 2.2).

8.3.3 Stakeholder views.

While stakeholder consultations revealed that the vast majority of respondents would like development to proceed, due to economic necessity, they were not prepared to accept an increase in coastal pollution and potential health risks. Thus, reasonable steps should be taken to protect the environment. This suggests that stakeholders would regard regulatory tools that create an obstacle to economic growth as undesirable. Habitats of particular concern to stakeholders included coral reefs, mangroves and breeding habitats for fish. These specific habitats therefore require the provision of specific conservation and protection measures.

8.3.4 Summary Prioritization of Conservation Measures

The assessment identified that habitats and component species can be prioritised into four levels for environmental protection. The first group of habitats prioritised as requiring a relatively high level of protection included mangrove forests, seagrass, shallow-water coral reefs and deep-water coral reefs, as well as certain animal groups (e.g. turtles, dugongs and cetaceans).

Table 8.3. Summary of habitats and component species

Habitat type	Judgement on prioritisation for environmental protection.
Intertidal sediment	
Exposed (coarse) sandy beaches	Relatively low priority at most locations (due to broad extent of habitat, low diversity and high resilience. Exceptions may include seabird feeding areas, turtle nesting beaches and areas with high amenity value for potential future tourism development.
Sheltered (fine) sandy beaches and mudflats	Relatively low priority at many locations due to extent of habitat, low diversity & relatively high resilience. Exceptions may include seabird feeding areas and areas exploited for shellfish or fin fish.
Mangrove forests	Relatively high priority due low resilience and high cultural value as well as rarity of habitat and component species.
Intertidal rock	
Exposed intertidal rock	Relatively low priority at many locations (due to extent of habitat, low diversity and relatively high resilience). Exceptions may include areas exploited for shellfish.
Sheltered intertidal rock	Relatively low priority at many locations due to extent of habitat, low diversity and relatively high resilience. Exceptions may include areas exploited for shellfish.
Subtidal sediment	
Shallow (continental shelf) sediments	Priority should be assessed on a case by case basis with lower energy sites given higher priority (due to their higher diversity and lower resilience) than higher energy sites. Sites with economic value connected to fisheries would also warrant higher priority.
Deep (continental slope and trough) sediments	Low general priority due to low vulnerability. But if developments are likely to occur then high diversity and low resilience are of concern and the probable extent of habitat may need to be assessed when assessing need for environmental protection.
Sea grass	Relatively high priority due to rarity of habitat and component species.
Subtidal rock	
Shallow (continental shelf) rock	Priority should be assessed on a case-by-case basis with higher energy sites given higher priority (due to higher diversity) than lower energy sites. Sites with economic value connected to fisheries should also warrant higher priority.
Deep (continental slope and trough) rock	Low general priority given due to lower vulnerability. But if developments are likely to occur then low resilience is of concern and probable extent of habitat may need to be assessed when assessing need for environmental protection.

Habitat type	Judgement on prioritisation for environmental protection.
Hydrothermal vents (HTV)	Low general priority due to low vulnerability. But if developments are likely to occur then habitat rarity is of concern and probable extent of habitat may need to be determined when assessing need for environmental protection.
Biogenic reefs	
Shallow water coral reefs	Relatively high priority due to rarity of habitat and component species, high diversity low resilience and high cultural value.
Deep water coral reefs	Relatively high priority due to high diversity and low resilience.
Halimeda reefs	Moderately high priority due to habitat rarity and high diversity although resilience is high and vulnerability is low.
Animals groups	
Turtles	Relatively high priority for most species due to rarity and low resilience.
Cetaceans	Relatively high priority for most species due to rarity and low resilience.
Dugongs	Relatively high priority for most species due to rarity and low resilience.
Seabirds	Relatively high priority for some species due to rarity and low resilience.

The second group consists of habitats prioritized with moderate to high priority (*Halimeda* reefs).The third group consists of habitats and component species which are assessed and prioritized on a case by case basis (shallow water continental shelf and slope sediment and rock, deep water (continental shelf and trough) sediment and rock. Fourthly, habitats for which there is relatively low protection priority include exposed (coarse) sandy beaches sheltered (fine) sandy beaches and mudflats, exposed intertidal rock and sheltered intertidal rock).

8.4 Possible Implementation of Protection Measures

The possible implementations of protection measures are essential to protect conservation habitats. In this section comprise the procedures and regulations for permit system and specific regulation concerning particular activities are presented and discussed.

Procedures and regulations for the permit system

The procedures and regulations for the permit system should be in place to facilitate smooth environmental management. In this section, a range of environmental management tools will be discussed, including a zoning system, a system of EIA, licensing and issuing permits and contingency planning.

8.4.1 Zoning system

Zoning is a management tool for spatial control of activities where defined activities are permitted (sometimes with associated conditions) or prohibited from specified geographical areas (Gubby, 2005). It might be appropriate to establish such multiple zoning systems in the Timor Sea region. A zoning system would need to recognise the importance of natural resources in the region as a source of employment, food, recreation and for subsistence fishing.

The application of zoning in the Timor Sea potentially offers the opportunity to maximize flexibility in environmental management while allowing economic benefits. Such benefits include 1) establishment of *shipping areas* which (i) limit risks of vessels running aground with consequent environmental damage. ii) to limit shipping activities in vulnerable areas such as breeding habitats and shallow water habitats, (iii) limit deballasting in shallow water habitats; 2) establishing *Fisheries areas*: (i) to protect fishing resource from other activities, (ii) areas where fishing activity is regulated to reduced environmental impact cause by the fising, *3) Controlling or limiting Military activities:* to limit disturbances of marine mammals and turtle breeding beaches. *4) Controlling and locations of subsea structures*: to limit disturbances to fishing grounds and avoid damage or environmentally sensitive areas. *5)* Regulating the *seismic survey*, to limit or avoid seismic effects on fish and other animals breeding habitats, cetacean and dugong habitats and commercial fishing grounds. (6) during *drilling activities*, to limit disposal of cuttings piles on rock or *Halimeda* reefs, (7) Shoreline development: to limit the effects of installation of shoreline pipelines on shallow water habitats, including intertidal habitats.

8.4.2 System of Environmental Impact Assessment (EIA)

EIA is an essential tool for assessing the environmental risks and possible impacts of a specific development and then seeking ways of reducing those risks and impacts (For a detailed description, see section 6.2.1, chapter 6). Typically, based on the proposed development in the Timor Sea, tentative EIA objectives would include : 1) ensuring that the environmental effects receive careful consideration prior to responsible authorities approval; 2) encouraging responsible authorities to take action to promote sustainable development; 3) ensuring that projects that are to be carried out in the Timor Sea do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out and; 4) ensuring that there would be an opportunity for public participation in the environmental assessment process. The risk rating apply for the summary (Table 8.4) based on assessment of natural resources of the Timor sea (chapter 2) and the assessment of potential effects of oil industry on marine environment (chapter 3) and also considered stakeholders views through stakeholders consultation results. Low risk represents limited information to judge, moderate represents there is some indications and information on the habitats or species and high risks means the available information are indicated possible or very likely to occur.

Table 8.4. Summary of EIA on the Timor Sea and South Coast of East Timor.

Source of risk	Potential environmental effects	Mitigation measure (s)	Risk
Seismic air guns	Impacts on fish eggs and larvae	- Undertake consultation with relevant indigenous interest groups (local Timorese fishers) to establish fishing grounds.	Low
	Marine turtles and marine mammals	In general, the risk of ship-whale collisions can be effectively mitigated by: - Limiting the number of vessels - Controlling vessel routes - Implement system - employ sighting personnel and marine mammal observer (MMO) - Use navigational lighting on the seismic vessel to ensure visibility at night - Conduct public meetings with communities in Suai, Betano and Beaco during the public engagement period to prevent collisions with fishing boats.	Moderate
	Traditional and commercial fishing	- Notify East Timorese Government authorities, including National Directorate for Fisheries (DNPA), in order to identify local fishing grounds and avoid disturbances to traditional or subsistent fishing grounds.	Moderate
Drill cuttings	Smothering of benthic organisms	- Undertake a post-drilling ROV survey to confirm the fate of riser-less drill cuttings on seabed. - Re-injection in to the seabed - Bring waste onshore for disposal - Treat mud prior to disposal	High risk of impact, but anticipated extent will be limited
Accidental spills	Impacts on fish eggs and larvae	- Restrict the use of dispersants in and around fish breeding areas. - Restrict deployment of oil spill response vessels in and around fish breeding areas. - Restrict use of in-situ burning of oil waste.	High

Source of risk	Potential environmental effects	Mitigation measure (s)	Risk
	Marine turtles, marine mammals, fisheries	- Restrict the use of dispersants in and around marine mammal feeding areas. - Restrict deployment of oil spill response vessels in and around marine mammal feeding areas. - Restrict the use of in-situ burning of oil waste. -Use of aerial surveillance.	Moderate
	Sea birds	- Prepare or revise contingency plan for dealing with seabirds affected in an oil spill. - Monitor and collect affected sea birds and treat them prior to release back in to wild.	Moderate
	Intertidal habitats	- Consultation with relevant indigenous interest groups (local Timorese fishers) to establish sensitive areas and habitats in order to reduce the risk of oil spills.	High
	Shallow water coral reefs	- Consultation with relevant indigenous interest groups (local Timorese fishers) to establish sensitive areas and habitats so as to avoid harm from oil spills.	Moderate to High
	Deep water coral reefs	- Consultation with relevant indigenous interest groups (local Timorese fishers) to establish sensitive areas and habitats habitats so as to avoid harm from oil spills.	Low
Decommissioning	Disturbances to sub-sea structures	- Leave rigs in place the rigs so as to reduce seabed disturbances - Transport waste onshore for disposal - Dispose of waste in deep waters	Low

8.4.3 Licensing and permitting

The offshore oil and gas licensing and permit system is designed to promote environmental protection and good oil industry practice within a particular national jurisdiction. Licensing conditions are primarily concerned with good management practice throughout all stages of petroleum exploration and reflect the specific environmental concerns present.

Under block licensing conditions associated with environmental protection usuallyan environmental impact study is usually expected to be carried out in preparing a development program for ANP and MPMR. This study will subsequently be discussed with environmental entities, local authorities and other sea and coastal users prior to the consent for production being approved.

Development on the seabed: This may require the consent of ANP or MPMR, where there is work below the high-water mark in territorial waters or in a designated area. The operators will also need the consent of the Ministry of Transport and DSNMA.

Development in protected areas: A production license would not be granted if it is located in protected areas as identified by DSNMA.

Offshore block licensing conditions:

Seismic survey: Conditions attached to seismic activities may include restrictions during spawning seasons in order to reduce mortality rates in periods of greatest biological activity. The main concern of such licensing conditions is to provide consultation and/or notification to the MPMR/DSNMA or relevant regional agriculture and fisheries departments at least 28 days prior to the commencement of work. This is to help to avoid disturbances during fish spawning and breeding periods which could possibly impact on fish production.

Drilling site: No drilling is permitted during fish spawning seasons within a three-mile zone or in specific designated areas that require prior written agreement before drilling can take place.

8.4.4 Contingency planning and pollution response

Prior to any offshore oil and gas activity being undertaken every operator must have an Emergency Procedure Manual specifying actions to be taken in the vent of an emergency such as a well blow-out, leak or spillage. All spills greater than one tonne should be reported to the relevant authorities. This type of issue should be contained in the license conditions inclusive of the following instructions:

- In general, any oil spilled from an offshore installation should be tracked and the incident reported to the appropriate authorities.
- If a spill occurs at an installation operating in any block entirely or partially within 25 miles of the coast and/or if it is clear to that there is an identified threat to any vulnerable environmental interest or resource requiring protection (including fishing operations), then the operator should carry out such spraying as is necessary to allay the threat. The Timor-Leste coastguard, police service and defence force should also be advised accordingly.

- Where a spill occurs and may become extensive (e.g. a blow-out) there should be the earliest possible consultation with the Department of Transport and other interested government bodies. However, where a spill is limited in size and not ongoing there is no need to engage an urgent consultation. The use of a dispersant is considered unnecessary except for reasons of safety or to protect environmental resources.
- An event such as blow-out requires immediate action and often the mobilisation of considerable resources for regaining well control. In such circumstances there are should be arrangements in place for liaison with a government blow-out emergency team.

8.4.5 Specific regulations concerning incidents or potential environmental concerns.

To protect the marine environment it is worth establishing practical measures to safeguard it from oil pollution. Sub-headings considered under this section include shipping accidents, the oil and gas industry, pipeline ruptures and marine safety zones.

Shipping accidents

Shipping accidents are one of the major marine incidents contributing to oil spills in the marine environment. Implementation of the Merchant Shipping Act offers guidelines and regulations relevant to merchant shipping accidents and environmental protection.

Pipeline rupture

Pipeline rupture is another potential marine incident that can contribute to the occurrence of oil spills. Hence a plan for installation of subsea pipelines should be considered as part of any pertinent design criteria. These criteria are generally categorised into 1) selection of routes: this could be done by conducting geological (seismic) surveys in order to identify geological hazards (e.g. sea floor instability and landslide), as well as biological habitats such as coral reefs and benthic communities. Furthermore, the proposed route should also consider components of potential conflict such as commercial fishing and shipping areas. 2) Pipeline installation: this should be done according to high engineering standards in order to minimise the risk of rupture; and 3) pipeline testing: there must be appropriate monitoring, inspections and maintenance to minimise the risk of leaks.

Oil and gas industry

Seismic surveys can potentially generate hazards to the marine environment. Hence practical regulations should be in place, which include: 1) Regulations regarding the minimum permitted distance between related activities and known locations of marine mammals; 2) Seismic surveys are prohibited in areas at certain times of the year when endangered species are likely to be near or present their migration routes 3) The operation of air guns should be advised against in areas where fishing is taking place. A buffer zone of approximately 50km around the outer edges of fishing areas should be enforced and 4) Surveys are forbidden all year round in shallow areas that are known to be reproduction (spawning and breeding) areas for fish.

Operational stages (including drilling and produced water): Numerous generic and technical aspects require serious attention during the operational stage of the oil and gas industry. These include: 1) Limited and standardised concentrations of drilling and produced water discharges; 2) The disposal of drilling cuttings in the immediate vicinity of oil platforms, 3) For drilling mud discharge re-injection into the seabed is considered the favoured technique, and 4) no oil-based mud (OBM) is permitted during drilling operations unless it is re-injected into the seabed.

Decommissioning: Any proposed sites for the decommissioning option (disposal of the installation on the seabed) should be considered in terms of the relevant legislation and regulations considered most appropriate to any particular case. The following key factors should be taken into account: 1) Potential impact on the marine environment (assessed either by benthic sampling or ROV survey); 2) Potential impact on human health and safety (i.e. not situated on navigation and transportation routes); 3) stakeholder views and public concerns. Such criteria must be carefully balanced to ascertain the most beneficial or the least harmful course of action.

Marine safety zones

Due to increasing development activities in the region is important to regulate marine safety zones around installations the Timor Sea. The Geneva Convention on the Continental Shelf allows states to create 500m radius safety zones around fixed platforms and drilling rigs when operating on their shelves and to regulate navigation within these zones. These extend for 500m around all platforms and are areas from which ships are excluded unless directly involved with the structure.

Summary of implementation of protection measures

National environmental regulations for the oil and gas industry should be drawn up based on comprehensive environmental legislation applying to the offshore oil industry and other related activities. Appropriate regulations should be established to regulate and protect specific habitats and species in the Timor Sea region.

8.5 Assessment of success of environmental policies

8.5.1 Monitoring of compliance with environmental regulations

To ensure operators and companies have been successful in complying with environmental policies or are meeting the regulatory standards, record keeping and periodic inspections should be considered. Such monitoring compliance strategies are presented and discussed in subsequent sections.

Record keeping

Record keeping is a monitoring strategy which operators must maintain and make accessible. These include:

Seismic survey: The following records are associated with seismic surveys: 1) records on maximum frequency and duration of seismic air guns in operation, 2) records of daily communications with relevant stakeholders (i.e. subsistence fishermen and local community members) on the potential environmental effects and 3) records of how many marine mammal observers were onboard seismic boats and their findings. 4) reports of daily environmental incidents, including the number of affected marine mammals (injury and behavioural changes), number of seabirds affected and number of invertebrates encountered within affected zone.

Drilling: records associated with drilling activities such as volume of hazardous waste produced (mud and cuttings), waste management (treatment), volume, time and frequency of waste storage and disposal.

Produced water: records may include volume of hazardous waste produced, waste management (treatment), volume, time and frequency of waste disposal.

Pipeline: record of observations and findings along the pipeline by ROV, as well as records on leak accidents (frequency and volume) and vibration reports (frequency and intensity).

Decommissioning: findings of projected site surveys, including physical and biological features, as well as records of any physical or biological alterations at decommissioning sites after decommissioning took place. The volume and time of disposal should also be recorded. Keep a record communications or correspondence with relevant stakeholders on possible environmental effects.

9. Periodic inspections

Inspections are generally conducted based on the nature of activities and available budget. Such inspections include direct observations on procedures, compliance and sampling inspection if needed.

Seismic survey: This may first require an onsite or basic inspection so that inspectors can provide direct assistance or make observations on the procedures that were encountered during the seismic operation. Secondly, a compliance evaluation on the seismic process could potentially be conducted during or after the seismic operation. This inspection involves a more structured inspection of compliance with the processes and procedures of the seismic survey based on reference check lists. These include: 1) The presence of a marine mammal observer (MMO), 2) A check must be conducted for the presence of marine mammals within 5000m of the vessel at least 30 minutes prior to the commencement of operations. Hydrophones may also be used, particularly in poor visibility. 3) If marine mammals are present then the start of the survey should be delayed until they have moved on. Allow at least 20 minutes from the last sighting prior to commencing operations and 4) Ensure the survey vessel avoids manoeuvring near any concentration of marine mammals.

Drilling cuttings and produced water: An environmental statement (ES) is required for any proposed drilling activities in the Timor Sea, near the South Coast of East Timor or in sensitive areas. An environmental statement is also required for any other new development in the region. If in any circumstances it is unclear whether an ES is required then discussions should be held with the National Directorate of Environment (DNSMA). Key compliance requirements for drilling activities include: 1) Ensure any required spill prevention and oil spill response procedures are introduced to rig personnel and appropriate equipment is in place, 2) Use only the permitted chemicals and mud system, 3) If not reinjecting cuttings, ensure alternative legal disposal methods are in place, 4) Routinely monitor base fluid use and discharges, as well as sample and analyse the cuttings of oil content during drilling, 5) Use apropriate technology and other techniques to prevent or reduce discharges of all chemicals, 6) If necessary, undertake a pre-mobilisation audit of the drilling rig to ensure environmental compliance of drilling operations and other non-drilling activities and 7) Ensure the oil content of discharges meets the legal performance standard of 15 ppm (oil in water). Record books should also be maintained and kept up to date.

Direct observations or onsite inspections could also be conducted, particularly on drilling procedures encountered during operations.

Inspection of subsea pipeline

To accurately inspect a subsea pipeline beyond diver accessible depths is a complex and challenging task. Seabed inspections are traditionally conducted based on the type of locations, including external and internal inspections. Typically this challenge has been tackled through the development of automatic survey ultrasonic tools which can be deployed entirely by a remote system (ROV).

Decommissioning

In the event of decommissioning activities of an oil platform in the study area there are two types of inspections that could apply. These include: first direct observations on the procedures for the decommissioning process to ensure these meet numerous essential key compliance conditions: 1) ensure in a situation where pipelines or any part of the installation are left in place that location data and depths surveyed are submitted to the relevant office. Navigational aids must also be installed and maintained for any remains above the sea surface, 2) ensure segregation of hazardous and non-hazardous wastes (e.g. oily waste and chemicals), 3) ensure records are kept for all hazardous (special waste) and that consignment notes for transfer are completed.

Secondly, compliance inspections should also be conducted to ensure compliance with all waste disposal licenses and that waste transfer documentation requirements for scrap metal and non-hazardous waste are adhered to.

Third, a sampling inspection could also be conducted to monitor levels of hydrocarbons and ensure a post-decommissioning survey is undertaken to determine the level of heavy metals and other contaminants. In this regard, the survey design should be agreed with the relevant authorities.

9.1.1 Effective monitoring policy

Environmental requirements for monitoring

In general, benthic surveys are one of the foremost methods used to assess the health of coastal and marine waters. Typically, samples are usually collected with a grab. Commonly utilised grabs include the Smith-McIntyre and Day grab, which samples 0.1 square metres of seabed to a depth of 15 to 20cm. At each sampling site it is normal to collect replicate samples to allow for spatial variance in the densities of invertebrates. Benthic macrofauna samples are typically sieved through 1mm mesh.

The sampling strategy should take into consideration all major habitats and include a reference area. Where a range of habitats or communities may be present a stratified random sampling approach should be considered.

For post-development monitoring, temporal changes need to be measured in repetitive sampling (e.g. over a period of one to two years). The extent of survey areas and distribution of stations should be arepeated. The minimum number of samples taken at any station is ideally three to five replicates. If temporal monitoring is conducted on an annual basis, care should be taken to ensure that repeat surveys are conducted at the same time each year.

9.1.1.1 Stakeholder views

Stakeholder views are an important facet in evaluating environmental monitoring policies. Ideally, threes should be conducted be to seek the opinions of stakeholders on the state of the environment and whether any deterioration or changes have been observed. Subsequent investigations would then need to be conducted in order to verify such reports. It should also be noted that there is the potential for stakeholders to make allegations of environmental deterioration in the hopes of claiming compensation from oil operators (see Chapter 4).

CONCLUSION

- Habitats of conservation importance in the Timor Sea and South Coast include mangrove forests, shallow and deep-water coral reefs, seagrass and intertidal sheltered sediment and rock. These are largely exploited for their economic value and ecosystem services for the local community. Animal groups regarded as of conservation importance include turtles, dugongs, cetaceans and seabirds. There is limited information or data on natural resources for the purposes of this study and hence this was obtained from secondary sources. Potential threats to the marine environment have been identified should development of the oil industry proceed in the Timor Sea area, although these are likely to be contained locally and transitory in nature.

- Stakeholder views show that economic development needs to be balanced with environmental protection in order to prevent deterioration of the natural environment.

- The analysis of existing regulatory frameworks in other countries demonstrates that multiple, simple, command-control; exclusive legislation is not necessarily effective. Overly excessive, prescriptive, complex and multi-agency-based frameworks have proven to be inefficient and time consuming. Regimes with a mixture of command-control systems and regulations that encourage the application of adequate environmental technology seem to have had good results in the conservation of marine environments, especially when a participatory approach involving industry, government other interested parties is adopted.

- The proposed Integrated Environmental Regulatory Framework for East Timor combines multi-statutory and contractual approaches. The design is based on the current legislative framework and organisational approaches. The scope of guidelines also complements existing regulations and the requirements for new legal frameworks.

- Regulation is required to clarify the roles and responsibility of government authorities and relevant stakeholders in terms of managing the environment.

- The system should be based on EIA in conjunction with a flexible permitting system

- The regulatory system should compose of penalties for non-compliance, as well as an adequate monitoring and enforcement process.

- A system of environmental monitoring should be implemented in order to ensure that environmental policy is effective and penalties are imposed for any damage or deterioration.

RECOMMENDATIONS

In order to efficiently manage the natural environment in the Timor Sea and South Coast of East Timor this study recommends numerous essential components in order to effectively manage the natural environment in the region and enhance the regulatory framework for environmental compliance and enforcement for oil and gas activities in East Timor. The sub-sections below provide details of the descriptions:

1. Recommendations for effectively managing the natural environment of the Timor Sea

To better manage the Timor Sea environment it is imperative to develop:

- A *zoning policy* that incorporates a marine protected area (MPA) for environmental protection which includes social and environmental features.
- A comprehensive *study of biological features* in the Timor Sea and on the South Coast would provide a better foundation for the development of environmental policy.
- *Oceanography and geological data* is needed for depths beyond 200m in order to assess poorly documented and potentially sensitive habitats.

2. Recommendations for enhancing regulatory framework

One main weakness of MPMR is the lack of specific driving laws, regulations, standards and guidelines. In addition, there is also a lack of formal environmental reporting requirements. MPMR should push for the amendment of the Petroleum Act, as well as amend and set up new regulations, standards and guidelines for environmental compliance and enforcement. This process should consider lessons learnt from the case studies of environmental policy in the UK, USA, Norway and Canada. It should also take into account the transboundary case studies referenced, including the English Channel, Danube River, Tumeng River and Mekong River. Figure 8.2 represents the proposed enhanced regulatory framework.

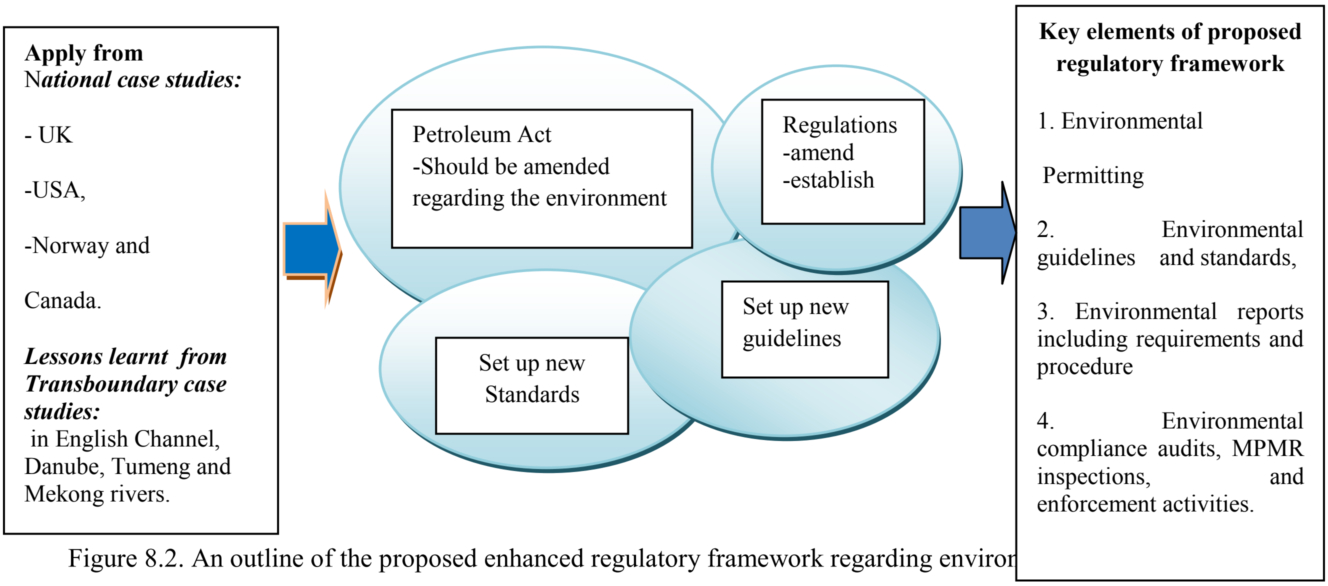

Figure 8.2. An outline of the proposed enhanced regulatory framework regarding enviror compliance and enforcement for oil and gas activities.

Key elements proposed to enhance the regulatory framework regarding environmental compliance and enforcement for oil and gas activities in East Timor are presented in Figure 6.2. In order to improve the existing regulations, the MPMR should consider: 1) regulatory priorities, 2) clarity, certainty and predictability in the application of environment requirements, 3) clearly defined agency responsibility and jurisdiction, 4) reasonable time schedules for administrative processes and for permitting duration, 5) simplify permitting system, 6) timely government decision making, 7) Flexibility in selecting technology and methods to achieve environment standards and 8) fair and consistent treatment for all companies.

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Appendix I

Questionnaire

My name is **Jose Lucas da Silva** from East Timor and currently studying for a PhD degree at Heriot-Watt University in the UK. I am carrying out research on local residents' opinions on the potential outcomes associated with the possible development of the oil industry on East Timor's south coast. I am interested in three (3) main categories of costs or risks: social, economic and environmental. It would be a great help to this research if you would be willing to take part in a short questionnaire survey. It should take no more than 15 - 25 minutes.

I would like to stress that it is your opinion that I am interested in; there are no right or wrong answers and all the views you give me will be used purely for academic research and kept strictly anonymous and confidential. If you wish to abstain from answering any of the questions within the questionnaire you are entirely free to do so.

Introduction

Q1. Are you familiar with coastline of the south coast of East Timor?

Yes ☐ No ☐

2. If yes, please indicate which area (s)

Suai Loro ☐ Betano ☐ Beacho ☐ Others (please specify)..............

Section I. Questions (Q3 – Q5) are intended to assess your views on the <u>current situation</u> in your environment and community. The questions are intended to gauge your views on the importance of certain elements of the natural environment, the importance of certain economic, sectors and your level of satisfaction with the provision of basic infrastructure services in your community.

Q3. Can you tell us what is your opinion about the importance of the existing natural environment of the south coast? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

I consider...........	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
mangrove forests are important habitats					
intertidal habitats are important					
fringing reefs are important habitats					
coastal areas are important as spawning and breeding habitats for fish					
coastal erosion is an important issue					
coastal pollution as an important issue					
coral reefs are important as habitats for various marine biota					
it is important that the seabed remains in a pristine and undamaged condition					
it is important to protect migratory species *(i.e. dugon-dugon, whales....).*					

Q4. How important do you think the following sectors are to the economy in your Community either now or in future? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with (strongly agree, agree, don't know, disagree or strongly disagree).*

I regard..................	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
fishing as an important activity					
agricultural activity as important					
handicrafts as important to the economy					
building and constructions as important sectors					
port and maritime transportation as future potential activities					
tourism as future potential activity					

Q5. The following statements are related to your level of satisfaction with the provision of basic socio-economic and infrastructure services in your community? *(Please indicate your closest reaction to each statement by marking the appropriate cell, with: excellent, good, adequate, poor and totally inadequate)*

.

I consider........	**Totally inadequate**	**Poor**	**Adequate**	**Good**	**Excellent**
water sanitation services					
energy supply (i.e. electricity)					
transportation links					
basic education services					
basic health services					
access to the employment opportunities					
available business opportunities					
Other Comments....					

Section II. Questions (Q6 – Q7) are intended to assess your views on the <u>probable outcomes</u> of the development of the oil industry in south coast of East Timor. The questions are intended to assess your opinion on the probability of certain beneficial consequences occurring as a result of oil development and also assess your opinion on the probability of the occurrence of certain undesirable consequences.

Q6. Desirable benefits. To what extent do you agree with the following statements? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

Development of the Oil industry will......	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
improve employment opportunities					
create new business opportunities					
improve water sanitation					
provide additional energy					
improve basic health services					
improve basic education services					
improve better transportation links					
have positive economic impacts					

7Qa. Undesirable consequences to the environment. To what extent do you agree with the following statements? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

Development of the oil industry will contribute to.......	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
mangrove deforestation					
alteration of intertidal habitats					
destruction of fringing reefs					
destruction of breeding & spawning habitats of fish					
increased pollution in the coastal areas					
coastal erosion					
destruction of Coral reefs					
alteration seabed conditions;					
disturbance to migratory species					

Q7b. Undesirable consequences to the other sectors**.** To what extent do you agree with the following statements? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

Development of the oil industry will contribute to.........	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
reduction in fish stocks					
reduction in productivity of agricultural land due to pollution					
loss of potential for developing tourist industry					
increased health risks due to pollution					
damage to cultural sites					
damage the land for future generations to use					
increased population of foreign migrant workers					
increase jobs loss					
Other comments..............					

Section III. Questions (Q8 – Q10) are intended to assess your views on the <u>relative importance,</u> of the potential positive and negative consequences of oil industry development. The questions ask you to assume that the oil industry will bring significant benefits to a particular sector and ask you to evaluate if these benefits would outweigh certain significant negative consequences.

Q8. Assuming the development of oil industry brings increased employment opportunities to the community, how far do you agree that this is more important than the following possible negative consequences? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

Increased Employment is more important than.......	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
damage to the seabed in general					
damage to the intertidal zone in general					
damage to coral reefs					
damage to mangroves					
increased pollution					
reduction of fishing industry					
damage to agriculture land					
loss of potential for developing tourist industry					
increased heath risk due to pollution					
damage to cultural sites					
increased population of migrant workers					

Q9. Then, assuming the development of the oil industry brings improved healthcare services to the community, how far do you agree that this is more important than the following possible negative consequences? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

Improved healthcare is more important than.......	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
damage to the seabed in general					
damage to the intertidal zone in general					
damage to coral reefs					
damage to mangroves					
increased pollution					
reduction of fishing industry					
damage to agriculture land					
loss of potential for developing tourist industry					
increased jobs loss					
damage to cultural sites					

10. And also, assuming the development of the oil industry brings improved transportation links to the community, how far do you agree that this is more important than the following possible negative consequences? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

Improved transportation links is more important than.......	**Strongly agree**	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
damage to the seabed in general					
damage to the intertidal zone in general					
damage to coral reefs					
damage to mangroves					
increased pollution					
reduction of fishing industry					
damage to agriculture land					
loss of potential for developing tourist industry					
increased heath risk due to pollution					
damage to cultural sites					
increased population of migrant workers					
Other Comments....					

Section IV. Question (Q11) is to assess your overall view on the potential development of oil industry in East Timor.

Q11. Overall, to what extent do you agree with oil development in East Timor? *(Please indicate your closest reaction to one statement by marking the appropriate cell in each line with: strongly agree, agree, don't know, disagree or strongly disagree).*

I consider	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
very important that development proceeds and environmental issues are minimal and should be disregarded.					
very important the development proceeds but reasonable steps should be taken to protect the environment					
development should only take place if all environmental issues can be avoided.					
development should be avoided due to the environmental harm.					
Other Comments....					

Personal details....

Q12. Could you please indicate your profession/occupation?

- fisherman ☐
- farmer ☐
- fisherman and farmer ☐
- local traders ☐
- local business ☐
- local contractor ☐
- travel agent ☐
- tourism ☐
- hotels & restaurants ☐
- Government ☐
- University ☐
- Research groups ☐
- NGOs ☐
- INGO's ☐

Other (please specify)............

Q13. Could you indicate your current educational level?

- Higher education enrolled at school/university ☐
- Higher education completed ☐
- Middle education enrolled at school ☐
- Middle education completed ☐
- Primary education still in school ☐
- Primary education completed ☐
- Never attended school ☐
- None of these ☐

Other (please specify)..................

14. Personal details.

Female / male

☐ ☐

Age class

Under	18		☐
18	-	30	☐
31	-	45	☐
46	-	65	☐
Over	65......		☐

Thank you very much for your help. The processed results of the survey should be available by October 2011. Would you like to receive a summary of the results of this survey?

Y ☐ N ☐

Dr/Mr/Mrs/Ms..

Address ....

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