CFG ENERGY PTE. LTD.

M15 Block Seismic Survey

MYANMAR

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

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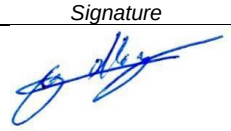
Checked by	**Maud DELLONG**	**02/07/2015**	
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ABBREVIATIONS

0-P	Zero-to-peak
AET	Apparent Effect Threshold
AIS	Automatic Identification System
APFIC	Asia-Pacific Fisheries Commission
ASEAN	Association of Southeast Asian Nations
BANCA	Biodiversity and Nature Conservation Association
BOEMRE	Bureau of Ocean Energy Management regulation and Enforcement
BOBLME	Bay of Bengal Large Marine Ecosystem Program
BSEE	Bureau of Safety and Environmental Enforcement
CNPC	China National Petroleum Corporation
CNUOC	China National United Oil Corporation
dB	Decibel
DGPS	Differential Global Positioning Systems
DMA	Department Marine Administration
DOF	Department of Fisheries
EEZ	Exclusive Economic Zones
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization
FESR	Framework on Economic and Social Reform
FRHS	Fertility and Reproductive Health Survey
GAD	General Administration Department
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIS	Geographic Information System
HSE	Health, Safety and Environment
Hz	Hertz
IAGC	International Association of Geophysical Contractors
ICPC	International Cable Protection Committee
IDP	Internally Displaced People
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labour Office
IMO	International Maritime Organisation
IMD	India Meteorological Department
IPIECA	International Petroleum Industry Environmental Conservation Association
IRC	International Rescue Committee
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JNCC	Joint Nature Conservation Committee
KOGAS	Korean Gas Corporation
LC	Least Concern
LIFT	Myanmar Livelihoods and Security Trust Fund
MARPOL	International Convention for Prevention of Pollution from Ships
Mlf, Mmf, Mhf	Frequency weightings for cetaceans sensitive to low, middle and high frequencies
MEDEVAC	Medical Evacuation
MFA	Ministry of Foreign Affairs
MFF	Myanmar Fisheries Federation
MFPPEA	Myanmar Fishery Products Processors and Exporters Association
MIMU	Myanmar Information Management System
MGO	Marine Gas Oil
MMO	Marine Mammal Observer
MOE	Ministry of Energy
MOGE	Myanmar Oil and Gas Enterprise
MOECAF	Ministry of Environmental Conservation and Forestry
MSAM	Marine Science Association Myanmar

NATS	Narrow Azimuth Towed Streamer
NCEA	National Commission for Environmental Affairs
NEP	National Environmental Policy
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Services
OCHA	United Nations Office for Coordination of Humanitarian Affairs
OCS	Outer Continental Shelf
OGP	International Association of Oil and Gas Producers
ONGC	Oil and Natural Gas Corporation
Pa	Pascal
PAM	Passive Acoustic Monitoring
PSC	Production Sharing Contract
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SEAFDEC	South East Asia Fisheries Development Centre
SEL	Sound Exposure Level
SELmp	Sound Exposure Levels – multiple pulse
SELop	Sound Exposure Levels – single pulse
SEZ	Special Economic Zone
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
TL	Transmission Loss
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift (refers to noise exposure limits of marine mammals)
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNCLOS	United Nation Convention on the Law of the Sea
UNDP	United Nations Development Program
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
VU	Vulnerable
WHO	World Health Organisation
WMP	Waste Management Plan
WWF	World Wildlife Fund for Nature

0. EXECUTIVE SUMMARY

0.1. INTRODUCTION

CFG Energy Pte. Ltd. ("CFG") is the designated operator for Block M15 offshore of Myanmar. CFG has two M15 Block partners: Century Bright Gold Pte. Ltd. ("CBG") and TRG M15 Pte. Ltd ("TRG"); in March 2014, CFG, TRG and CBG were awarded Shallow Offshore Block M-15. Under the terms of joint bid CFG propose to undertake a 3D seismic acquisition survey of part of the Block. On March 30th 2015, CFG signed a Production Sharing Contract with Myanmar Oil and Gas Enterprise (MOGE).

The M15 Block is approximately 13,479 km^2 in area, and is located off the coast of the Tanintharyi Region, in the Andaman Sea. CFG proposes a 3D seismic acquisition survey in the western part of the M15 Block totalling an area of 5,000 km² (see Figure 0-1 below).

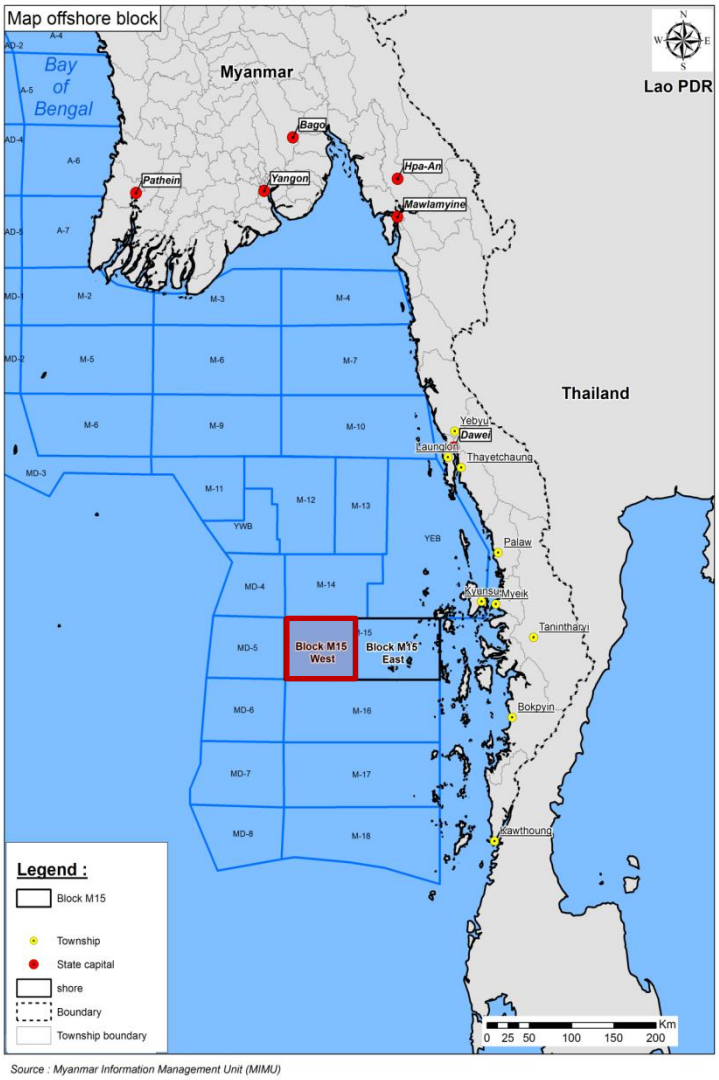


Figure 0-1: Location of M15 Block

This Initial Environmental Examination (IEE) has been developed in accordance with the current national legal and guidance framework. The study was performed by Artelia's Risk, Society & Environment (RSE) team which has operated a branch office in Yangon since 2012 and performed similar projects in Myanmar for over a decade. The project team included environmental engineers with international experience in offshore environmental impact assessment studies (including in Myanmar); an expert in marine bioacoustics; a marine research scientist; a geologist; a social specialist experienced in the management of offshore seismic campaign in Asia; and an environmental engineer and project co-ordinator based in Yangon.

0.2. PROJECT DESCRIPTION

The M15 Block 3D seismic acquisition survey is planned to commence in December 2015 with the arrival of a survey and support vessels. It is estimated that the duration of the proposed survey will be three months, including mobilisation and demobilisation phases. The survey will be performed using the Narrow Azimuth Towed Streamer (NATS) technique, using airgun arrays as seismic sources and surveying will operate continuously both day and night (24h/7d). Surveying will only cease in severe bad weather or if technical problems are encountered.

The project will require a specialised survey vessel plus two support vessels for supply, at-sea bunkering, crew change and protecting the seismic streamer equipment. Two additional vessels for managing interactions with fishing vessels and shipping may also be required. Estimated numbers of crew aboard the vessels are around 60 for the main survey vessel and around 12 for each support vessel.

Seismic surveying operations tow an array of airguns (the seismic sound source) and a streamer (signal receiver cable) behind the vessel, 5–10 m below the sea surface. The airgun array produces a burst of underwater sound by releasing compressed air into the water column that creates an acoustic energy pulse. The release of compressed air every several seconds creates a regular series of strong acoustic impulses separated by silent periods lasting 7–16 seconds, depending on survey type and depth to the target formations. Acoustic signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced within the streamer cables. In the present survey, there will be 27 guns in each array (24 active and 3 spare). The individual gun volumes range from 330 to 70 cubic inches (cui).

Seismic receiver cables or streamers comprise an array of marine receivers that are towed by the survey vessel. Streamers are long plastic cables with marine receivers evenly spaced along their lengths, which detect seismic echoes caused by the firing of the airguns. The marine receivers are composed of piezoelectric hydrophones, which respond to changes in water pressure and measure the acceleration of the medium as a seismic wave passes through it. The echoes recorded by the hydrophones are collected into an analogue signal, which is then converted to digital format and relayed to the computers on the vessel. In this case, twelve 6km-length solid streamers will be towed in order to record reflected acoustic signals. The source pressure level (SPL) is anticipated to be 257 dB re 1 µPa-m.

In summary of the project activities likely to affect the natural and human environment, these include:

- Continuous presence of a survey and support vessels and associated streamer equipment over an area of 5,000 km² operating in a 'racetrack' pattern for a three months 24h/7d operation over both day and night;
- Activities associated with maintaining a survey vessel and support vessels in a relatively small area over a long time period with a crew of 60, including fuel use, emissions to air, lighting, noise, waste, wastewater, spillages and accidents/emergencies;
- Ballast operations;
- Collision or entanglement with marine fauna;
- The continuous firing of airguns to produce powerful seismic waves into the marine environment.

0.3. POLICY AND REGULATORY CONTEXT

This section of the IEE sets out:

- the main international agreements and conventions that Myanmar is signatory to and that are relevant to the project;
- current and emerging environmental legislation that is relevant to the project, especially environmental and social impact assessment legislation; and
- the international guidelines and standards relevant to the project.

0.4. DESCRIPTION OF THE NATURAL AND HUMAN ENVIRONMENT

An Environmental Baseline Survey has not been performed in the M15 Block; this part of the study was compiled from desk-based research and from previous similar studies.

0.4.1. Physical environment

The project is located in the offshore area of the Tanintharyi Region, in the Andaman Sea. The Thanintharyi Coastal Area is the longest coastal region of Myanmar, covering an area south of the Gulf of Mottama to the mouth of Pakchan River, and includes the Myeik Archipelago. This archipelago extends from Mali Island to Similand Island and contains in total about 800 islands over an area of 34,340 km^2. The Block M15 (West) survey area is situated some 200 km west of the coast, though parts of the archipelago are situated within Block M15 (East).

The survey area is located on the continental shelf with sea depths of around 200 m falling away to around 2000 m further offshore. Adjacent to the Block on the seabed is the Sagaing Fault System; the Martaban Canyon and the Alcock Rise Seamount. The seabed geology of the Block area is characterized by silts and clays for upper layers due to river sediment deposition. In general, the seabed geology contains no major structural features such as faulting or anticline/syncline systems and seems to show no apparent specific anomalies.

The Gulf of Martaban and the inner continental shelf are covered with thick silty clays whilst relict sands fill the outer shelf. The sediments within the Ayeyarwady Canyon contain low carbonate sands and patches of silty clay. The sediments delivered by the rivers are thoroughly mixed in the high tidal regime of the Gulf of Martaban and there is not much variation in clay mineral composition over the shelf. Tidal currents play a major role in bringing in sediment from the Ayeyarwady River and retaining them in the Gulf of Martaban and the project area.

During the proposed project schedule (December to March), the Northeast Monsoon season will prevail, likely to bring fine cool weather and little rainfall. Tropical storm events occur in the M15 Block area though the highest risk is between May and November, with the risk receding during the proposed project period.

A study of the bathymetry including salinity of the Block shows a well-marked SOFAR channel at 1000-1200 m depth which, potentially could be used for whale communications and increases noise reverberation within the basin. Compared to other parts of the Andaman Sea, the Block's seawater is affected by two main influences; freshwater input from the rivers, particularly during the end of the SW monsoon; and during the hot season, M15 lies at the edge of a patch of particularly warm water that develops off Mergui, due to poor mixing of the waters in the archipelago with the rest of the Andaman sea. These two factors contribute to large seasonal variations in salinity and nutrient availability, local turbidity and chlorophyll-a concentrations.

0.4.2. Biological environment

Abundance and diversity of phytoplankton and zooplankton (mainly composed of oceanic and inshore reef fish larvae) in the study area is important during the Northeast Monsoon.

The pelagic system of the Andaman Sea is related to the considerable seasonal variations imposed by the monsoon systems. This seasonal variability, combined with reduced salinity (compared to oceanic water) due to riverine inputs, gives a distinctive character to the pelagic fish community. Strong correlations are observed between temperature, phosphate concentration, primary production, copepod density and fish larvae density during both monsoons in the pelagic fish community which include species of jack, tuna, barracuda, flying fish, ray and shark.

A total of 37 pelagic fish species identified by the IUCN as threatened potentially could be found in the M15 Block area.

- 3 species are critically endangered (CR), facing an extremely high risk of extinction in the wild.
- 5 species are endangered (EN), facing very high risk of extinction in the wild;
- 29 are classified as vulnerable (VU), facing high risk of extinction in the wild.

The Tanintharyi Region is one of the two largest commercial marine fisheries in Myanmar, and M15 Block contains important fishery stocks and sites, including tuna fishing grounds. Also present are swordfish, marlin, mackerel and sardine species.

There is presently not much information on the distribution of marine mammal species in the Andaman Sea in general, and the M15 Block in particular; but it is likely from a review of the information sources available that 21 species are likely to be present in the survey area during the project schedule including dolphin and whale species including one IUCN Vulnerable Species (sperm whale), and two IUCN Endangered Species (blue whale and fin whale).

Six threatened seabird species have been identified as possibly occurring in the M15 Block, of which four are listed as Least Concern, and two as Near Threatened on the IUCN Red List.

According to recent survey information, the benthic community of the sea bed at M15 Block is not expected to be abundant or diversified, or to contain rare or threatened species.

Most marine turtles in Myanmar waters occur in shallow, inshore waters. However, all of the five species of marine turtles recorded in Myanmar are found in open water as adults, and therefore may be encountered in the offshore waters of the M15 Block during the project schedule.

There are no marine protected areas in the vicinity of the M15 Block or surrounding waters; the nearest are Lampi Island Marine National Park (140km to the south) and the Ross Island Shark Protected Area (100km to the east).

Despite its distance from the project Block, an assessment was made of the coastal environment from Ayeyarwady to Tanintharyi and the Mergui Archipelago (situated around 60 km west of the project area), to include an assessment of coastal habitats including mangrove, seagrass, and coral habitats; and coastal mammals, birds and reptiles.

0.4.3. Socio-economic environment

The Tanintharyi Region has around 1.4 million inhabitants, representing 2.7% of the total population of Myanmar, and is the least populous Region, being sparsely populated at around 32 persons per km². The population is predominantly rural (24% urban). Most people live either near the coast or along rivers and tributaries. Myeik District is the closest to the Project area, containing around 700 000 inhabitants.

The people of Tanintharyi Region are believed to be mainly Bamars, although some self-identify as members of sub-groups such as the Dawei people, also known as “Tavoyans”. The Mergui Archipelago is also the home of the Moken (locally known as “Salone”), a group of nomadic seafarers of Austronesian origin thought to

number between 2000 and 3000. Buddhism is the dominant religion in Tanintharyi, with some of the Moken practising animism.

Owing to its long coastline of about 1200km and its 52 designated fishing grounds, the Taninthary Region is one of the two largest fish producing areas in Myanmar and there are presently over 50 000 fishermen using over 10,000 fishing boats licensed to fish in the inshore zone, and 1600 licensed vessels operating in the offshore zone.

Exploration for oil and gas resources offshore of the Tanintharyi Region represent an important and recent socio-economic change; in addition to the subject of the present study, the M15 Block, there are a further 8 Blocks awarded and three producing gas projects (Yadana, Yetagun and Zawtika).

Port infrastructures in the Tanintharyi Region are presently limited to Dawei, Myeik and Kawthaung, the latter developing as an international port, handling border trade with Thailand, though at present all three are small-scale. Shipping and marine traffic off the Tanintharyi coast is presently generally limited to regional traffic, though a busier shipping route linking Yangon to the Malacca Strait occurs some 100 km offshore of Myeik archipelago and traverses the M15 Block.

A list of Stakeholder Organisations was compiled for the Project, including the appropriate Public Authorities; Ministries; Universities and Research Institutes; Public Enterprises; Regional Authorities Business Associations; International Non-Governmental Organizations (INGOs) and Media.

Formal stakeholder consultations for the project were conducted on April 6th 2015 in Pearl Hall, Myeik and on May 21st 2015 in Kyunsu Island.

0.4.4. Summary of Environmental and Social Sensitivities

Following a sensitivity assessment of the receiving environment, it was determined that the following issues were of High Sensitivity:

- Marine Mammals
- Migratory Turtles

And the following issues were of Medium Sensitivity:

- Pelagic Fish
- Coastal or Island Habitats/Species
- Offshore Fishing
- Marine Traffic

0.5. ENVIRONMENTAL IMPACTS

Especially considering the Sensitive Receptors identified for Project Activities, an Environmental and Social Risk Assessment (ESRA) was conducted to assess and manage the environmental and social risks associated with project activity. This risk assessment was undertaken in order to identify the sources of risk (aspects) and potential environmental and social impacts associated with the activity and to assign a level of significance or risk to each impact. This subsequently assists in designing and prioritising mitigation measures to ensure that the environmental and social impacts and risks are managed to levels As Low As Reasonably Practicable (ALARP). Mitigation measures (if applied appropriately and correctly) are able to reduce the level of risk to 'residual' risk.

The ESRA for the Project determined that the Project Activities carried **Low** or **Medium** risk levels; no risks were assessed as **High**. In order to make an assessment of each risk, recent studies and international/national requirements were consulted and discussed with subject experts.

0.5.1. Impacts of Underwater Seismic Pulses on Marine Fauna

This topic is the subject of much contemporary research and an expert working group was formed by Artelia to consider recent evidence and international guidance. Studies have largely focused on the potential effects on pelagic fish stocks and marine mammals, but there are also studies on marine reptiles such as turtles and fish larvae and zooplankton.

Known potential impacts include:

- acute and chronic pathological effects (lethal and sub-lethal injuries);
- behavioural changes;
- Impacts on population abundance;
- Impacts on the abundance and behaviour of prey species for marine mammals, seabirds and fish; and
- Changed behaviour of fish stocks such that commercial or recreational fishing may be affected.

0.5.1.1. Disturbance to benthic invertebrates

Taking into account the water depth of the project area and the predicted low abundance/richness of benthic communities, the impact of seismic pulses on the benthic community on the project seabed is expected to be **negligible.**

0.5.1.2. Disturbance to planktonic organisms

Research studies indicate that some species of phytoplankton and zooplankton can be susceptible to seismic pressure at close range and that at less than 5 m from sources, lethal impacts on populations can occur in some species.

Since much of the planktonic community in the Andaman Sea occurs at sea depths greater than 5 m, and even if some localised lethality is caused near to the air guns, the zooplankton and phytoplankton communities are so extensive that the overall impact on the zooplankton and phytoplankton communities is expected to be **negligible.**

0.5.1.3. Disturbance to fish populations

There is no doubt that sound and seismic pressure can affect fish species and based on existing information, significant impacts on fish populations resulting from seismic survey noise are likely to be restricted to the following:

- short ranges and high sound intensities (less than 200 m range from the airgun source);
- populations that will not move away from operating arrays (e.g. reef-based species);
- surveys that take place over protracted periods close to feeding, spawning or breeding grounds; and
- surveys that take place over protracted periods close to migratory paths.

In addition, a number of studies have demonstrated that exposure to seismic surveys can have an impact on commercial fishing, as a result of changes in fish behaviour and distribution.

Most species of pelagic fish in the study area are likely to react to the noise from seismic pulses by avoidance behaviour, though it is also possible that there may be limited kills to individuals or schools within short distance of the airguns. Therefore, the overall impact on fish is **medium and requires appropriate mitigation.**

Eggs and larvae of many fish species occur in the upper sea layers and research suggests that tissue damage and mortality can occur close to air guns; nevertheless the overall mortality rate caused by airguns is so low overall, compared to natural mortality rates, that the impact from seismic surveys on the larvae and eggs of fish and other marine animals is expected to be **negligible**.

0.5.1.4. Disturbance to marine turtles

The study is programmed to take place from December to February which coincides with the nesting season for marine turtles which will therefore be ashore; however, it is possible that some individuals may be encountered at sea. In addition to possible entanglement with the streamers and buoys, seismic impacts may also occur; there is a reasonable research literature on the topic. Marine turtles may be exposed to noise levels sufficient to cause physical damage if airgun arrays start suddenly with turtles nearby (less than 30 m). In circumstances where arrays are already operating, (i.e. as a vessel moves along an acquisition line), individuals could be expected to swim away before entering ranges at which physical damage might take place. However, the possible impact on marine turtles is expected to be **medium and requires appropriate mitigation.**

0.5.1.5. Disturbance to marine mammals

Information is scant on the likely presence of marine mammal species in the M15 Block during the proposed survey period but several dolphin and whale species are very likely to be present.

The Joint Nature Conservation Committee (JNCC) is a UK public body that advises the UK Government on UK and international nature conservation, and is active in the field of marine mammal research. A recent JNCC (2015) review of research on the responses of marine mammals to airgun activity concluded that responses are complex and are variable according to species, conditions, and individual. Whilst it is not likely that animals would be exposed to levels likely to cause pathological damage during the present survey, chronic effects such as temporary threshold shift (TTS) and permanent threshold shift (PTS) could occur. Cetaceans are the group of greatest concern in this respect and especially baleen whales as their hearing range is optimised for exploiting low frequencies for long-distance communication, and they are likely to be present in the M15 block.

Therefore, the possible impact on marine mammals, especially cetaceans, is **medium and requires appropriate mitigation.**

0.5.2. Impacts from artificial lighting

Lighting on support and chase vessels has the potential to create light pollution and affect some marine species, including seabirds and turtles. Though the overall impact is predicted to be **slight, appropriate mitigation is recommended.**

0.5.3. Collisions and entanglements with marine fauna

Survey vessels may collide with, or cause behavioural alterations in marine mammals, and there is an especial risk of turtles becoming trapped in the buoys attached to the end of each seismic streamer. The overall impact **is minor, but requires appropriate mitigation to reduce Residual Risk to Low.**

0.5.4. Other possible environmental impacts

A number of other possible environmental impacts were identified by the study, including disturbance to benthic habitats by vessel anchoring or losing equipment to sea; atmospheric emissions from vessels; spread of invasive marine species; marine pollution and waste from routine discharges; and marine pollution from accidents or emergencies. The assessment of each is summarised in Table 0 - 1 below; these represent **Low to Medium Residual Risk Levels providing that recommended mitigation is adopted**.

0.6. SOCIO-ECONOMIC IMPACTS

0.6.1. Disturbance to fishing activities

There is likely to be a moderate to high level of activity in the offshore industrial fishery sector within or adjacent to the M-15 Block, most of which will probably be tuna long-lining conducted by Burmese vessels. Whilst the impacts of seismic airguns may disturb schools of fish in the short term, it is the physical presence of the vessels and seismic array over the survey area for a continuous period that is more potentially disruptive to fishing activity.

The predicted impact is **medium and requires appropriate mitigation.** Assuming recommended mitigation is applied, the residual impact should be reduced to negligible.

0.6.2. Disturbance to shipping activities

The M-15 Block is located on a main shipping route between Myanmar and the Malacca Strait, and there may be a moderate to high volume of shipping activity in the survey area and surrounding waters during the survey period, bringing the risk of collisions, entanglement of streamers, and interference with the survey and/or navigational routes.

The predicted impact is **medium and requires appropriate mitigation.** Assuming recommended mitigation is applied, the residual impact should be reduced to negligible.

Table 0-1: Summary of Environmental and Social Risk Assessment

Hazard	Environmental / social aspect	Potential environmental / social impacts	Risk			
			Consequence of impact	Likelihood of the identified consequence	Residual risk level	Assessment section
Disturbance to marine fauna	Discharge of underwater seismic pulses	Behavioural and physiological effects on cetaceans, whale sharks, turtles and fish	Moderate	Routine	**Medium**	**7.1.1**
		Physiological effects on benthic invertebrates and plankton	Slight	Routine	**Low**	**7.1.1**
	Light generation from vessels	Behavioural effects on turtles, fish and seabirds	Slight	Possible	**Low**	**7.1.2**
	Vessel and towed equipment interactions	Behavioural and physical effects on cetaceans, whale sharks and turtles	Minor	Possible	**Low**	**7.1.3**
Disturbance to benthic habitats	Equipment loss	Localised physical damage to benthic habitats	Slight	Possible	**Low**	**7.2.2**
Atmospheric emissions	Operation of machinery and vessels powered by internal combustion engines	Localised reduction air quality Greenhouse gas emissions	Slight	Routine	**Low**	**7.3**
Invasive marine species	Discharge of ballast water from vessels	Introduction and establishment of IMS and displacement of native marine species	Minor	Possible	**Low**	**7.4.1**
	Biofouling of vessel hulls, other niches and immersible equipment		Minor	Possible	**Low**	**7.4.2**
Marine pollution from routine discharges	Discharge of sewage, grey water and putrescible wastes	Localised reduction in water quality due to nutrient enrichment	Slight	Routine	**Low**	**7.5.1**
	Discharge of bilge water	Acute toxicity effects on marine fauna and flora Localised reduction in water quality	Minor	Possible	**Low**	**7.5.2**

Hazard	Environmental / social aspect	Potential environmental / social impacts	Risk			
			Consequence of impact	Likelihood of the identified consequence	Residual risk level	Assessment section
	Discharge of other wastes i.e. garbage	Localised reduction in water quality Physical impacts on marine fauna i.e. from plastics	Minor	Possible	**Low**	**7.5.3**
Marine pollution from accidental discharges	Hazardous materials	Toxic effects on marine fauna and flora Localised reduction in water quality Indirect effects on offshore fisheries	Minor	Possible	**Low**	**7.6.1**
	Fuel and oil spills		MInor	Possible	**Low**	**7.6.2**
	Vessel collisions		Moderate	Unlikely	**Low**	**7.6.3**
Disturbance to social and community values	Interaction with offshore fisheries	Disruption to fishing vessels Potential direct and indirect noise impacts on target species Restriction of access to fishing grounds, loss/damage to gear Recreational take of finfish species	Moderate	Possible	**Low**	**7.7.1**
	Interaction with shipping	Disruption to shipping activities	Moderate	Possible	**Low**	**7.7.2**

0.7. RECOMMENDED MITIGATION MEASURES

In order to achieve the Residual Risk Levels 'As Low As Reasonably Practicable (ALARP)' levels in the table above, the following series of recommended mitigations would need to be implemented.

0.7.1. Impacts of underwater seismic pulses on marine fauna

In recent years, a number of systems of guidance have been compiled to mitigate the impacts of seismic survey on marine fauna. Having considered the conditions of the M15 seismic survey carefully and having made our impact assessment, Artelia's recommendation to CFG is to adopt JNCC (2010) guidance. This system is sufficiently precautionary in recognising that there is not a clear picture of the cetacean species likely to be present during the survey, and the JNCC guidance allows for a surveillance study during both day and night in order to minimise either collision or seismic damage to marine mammals. In summary, the methodology involves:

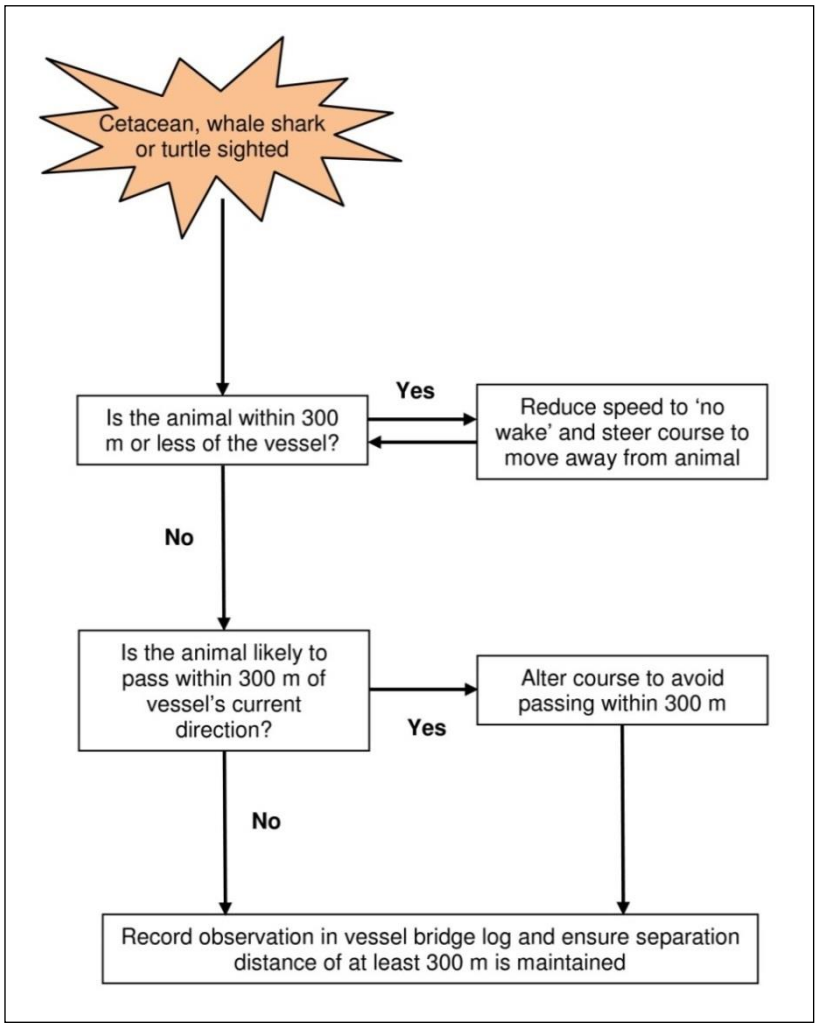
- **Marine mammal observation (MMO)** to be conducted commencing 30 minutes before survey start until end of activities during daylight hours. Two observers (qualified to JNCC standard) to be on-board the survey vessel and each monitor 180 degrees of the field of view. **Passive acoustic monitoring (PAM)** to be conducted during night operations and during low visibility during daylight hours.
- **Soft-start procedure**. At the commencement of survey, a gradual increase of power and frequency to be employed over a 30 minute period. If a cetacean is sighted within or is about to enter the low power zone, the acoustic source should be powered down to minimum. If a cetacean is sighted within, or enters the shutdown zone, the acoustic source should be shut down completely.
- **A shut down zone of 500m** if any marine mammal is observed or detected within a 500m radius from the centre of the airgun array, airgun shooting to be immediately halted. Resuming with soft start procedures only after the animal(s) has been observed to move outside the low power zone, or when 30 minutes have lapsed since the last sighting.
- **Power-down procedures** to be implemented:
    - if a marine mammal is sighted within a 3 km observation zone the operator of the acoustic source will be placed on stand-by to power down the acoustic source;
    - if a marine mammal is sighted within a 2 km observation zone the acoustic source should be powered down to the lowest possible setting.
- The same procedures to be applied should whale sharks and turtles be observed.
- All will be recorded by the MMOs and a report made following completion of the survey.

0.7.2. Impacts of lighting on vessels on marine fauna

External lighting of vessels and use of vessels to be minimised to that required for safe navigation and safety of deck operations (except in emergency)

0.7.3. Collisions and entanglements with marine fauna

To minimise this risk for cetaceans, whale sharks and turtles, the following procedure to be followed:



- Use of streamer tail buoys to be fitted with appropriate turtle guards;
- Any incident to be logged in the MMO Report.

0.7.4. Disturbance to benthic habitats

- No anchoring of vessels required
- Crew trained to minimise the risk of equipment loss and where possible lost equipment lost to be recovered.
- Equipment lost overboard to be logged and where necessary reported to the relevant Myanmar authorities.

0.7.5. Atmospheric emissions from vessels

Although the vessels will be operating for a continuous three month period, they will be at sea, with no especial sensitive receptors for local air quality impacts. Nevertheless, emissions to air from shipping are a growing environmental concern, and survey vessels as a minimum should comply to MARPOL 73/78 Annex VI requirements (International Convention for the Prevention of Pollution from Ships):

- optimisation of fuel use to increase efficiency and minimise emissions
- record and monitor fuel resources in order to prevent excessive consumption

- perform regular maintenance of engines and power generation
- use of low sulphur fuel
- emissions to be managed by the implementation of a planned maintenance system (PMS)
- implement a Ship Energy Efficiency Management Plan (SEEMP)

0.7.6. Invasive marine species

The risk of introducing or spreading alien species can be minimised by:

- the survey and support vessels shall not routinely discharge ballast water into the survey area
- recording any non-routine ballast water discharges
- survey and support vessels to have dry dock hull and other niche cleaning, anti-foulant application to prevent biofouling.

0.7.7. Marine pollution from routine discharges

- All sewage and putrescible wastes to be handled and disposed of in accordance with MARPOL 73/78 Annex IV
- Sewage and putrescible wastes to be passed through a grinder/comminuter and a disinfection system. Discharge to sea at a minimum of 3nm from the nearest landfall.
- Discharge of sewage to sea which is not comminuted/disinfected at a minimum of than 12nm from the nearest land.
- If vessels are unable to treat/store grey water only biodegradable soaps and detergents to be used.
- Bilge water to be treated and disposed of in accordance with MARPOL 73/78 Annex I.
- Bilge and deck waters to be collected through an on-board oil separator;
- Garbage to be disposed of in accordance with MARPOL 73/78 Annex V.
- No discharge of plastics or plastic products of any kind from vessels in accordance with MARPOL requirements.
- Incinerators used aboard the survey and support vessel will be compliant with MARPOL and IMO requirements.
- Harmful Packaged Substances will be handled and disposed of in accordance with MARPOL 73/78 Annex III.

0.7.8. Marine pollution from accidents and emergencies

- Adherence to the requirements of the International Regulations for Preventing Collisions at Sea 1972 (COLREGS).
- Hydrocarbons located above deck will be stored with secondary containment to contain leaks or spills
- Shipboard Oil Pollution Emergency Plan (SOPEP) as required by MARPOL

0.7.9. Disturbance to fishing activities

- Adherence to the requirements of the COLREGS.
- Notification of survey details to the Department of Fisheries (DoF) and other key fisheries stakeholders such as the local branch of MFF in Tanintharyi State, to inform them about the location of the survey area and timing of operations.

- Preparation of simple leaflets on the seismic study in Burmese and Thai languages for distribution to fishermen encountered at sea.
- Recruitment of a Fisheries Liaison Officer (where possible an existing crew member) able to speak Burmese (and if possible Thai).
- Conduct a preliminary pre-commencement survey of the study area to visually assess any on-going fishing activities
- Any significant event involving fishing vessels to be recorded, and reported to the the appropriate authorities in Myanmar.

0.7.10. Disturbance to shipping activities

- Adherence to the requirements of the COLREGS.
- Use of chase vessels to warn other vessels/shipping of the navigation hazard posed by the survey vessel and towed streamer array.
- Any significant event involving shipping to be recorded and reported to the appropriate authorities in Myanmar.

0.8. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

A draft outline Environmental and Social Management Plan (ESMP) for the study is presented, being a delivery mechanism for the identified environmental and social management and mitigation measures.

The ESMP includes the following items:

- Roles and Responsibilities;
- Training and Competences;
- Monitoring and Record Keeping;
- Auditing Systems;
- Emergency Response; and
- Socio-economic Programs

0.9. CONCLUSIONS AND RECOMMENDATIONS

Oceanic 3D seismic acquisition surveys are attracting increased attention for their environmental (and to a lesser extent, socio-economic) impacts especially in areas where marine life could be affected by the powerful sound pressure waves created by airgun arrays which are used to obtain data from below the seabed. The possible impacts of seismic pressure waves on marine life, especially mammals, are the subject of considerable contemporary research and media attention.

This Initial Environmental Examination (IEE) for the M15 Block has identified a number of environmental and social impacts and risks, all of which can be mitigated to varying extents by the measures recommended. In the case of socio-economic impacts, the exploration and possible development of the gas reserves thought to be present in the Block represents a ‘big picture’ socio-economic gain for Myanmar and the Tanintharyi Region, though during the three months of continuous seismic survey there is likely to be disturbance to the commercial fishing activities known to take place in the study area, and there may also be disturbance to marine traffic routes traversing the Block. With the adoption of sensitive operational maritime procedures and the implementation of an effective communications strategy, both of these issues can be managed to reduce both operational risks and economic impacts.

In the case of environmental impacts, many of the minor impacts and risks can be avoided or mitigated through the adoption of sensitive operational maritime procedures including compliance with COLREGS and MARPOL, and the adoption of on-board practices governed by the design and implementation of an Environmental and Social Management Plan (ESMP). However, in the case of the possible impacts of seismic pressure waves on marine life and also the possibility of collisions between vessels and cetaceans and/or entanglement of turtles in seismic arrays, a precautionary approach to mitigation is strongly recommended, especially as marine life in the Andaman Sea has to date not been especially well characterized. Our assessment is that it is highly probable that 21 species of marine mammal including IUCN Vulnerable and Endangered Species could be present during the survey period, in addition to adult turtles. With respect to possible serious impacts from seismic waves on cetaceans (in the worst case, irreversible hearing damage likely to result in fatality), we recommend the adoption of JNCC (2010) guidance, which entails the implementation of Marine Mammal Observation (MMO); Passive Acoustic Monitoring (PAM**)**; soft-start procedures; and concentric shut down and power-down zones; this in our recommendation represents best practice with respect to managing reduced impacts on and risks to, marine life. The correct implementation of a JNCC programme for the M15 survey will very significantly reduce the risk of injury to marine mammals likely to be present. Most (though not all) countries implementing national guidance on this subject have adopted JNCC guidance and our recommendation is that the relevant authorities in Myanmar should consider its adoption.

Similarly, the risk of vessel collisions and equipment entanglements with cetaceans, whale sharks and turtles can be minimised by implementing the recommended mitigation plan based on MMO and sensitive navigation procedures, coupled with preventing and checking for entanglement on streamer tail buoys.

Overall, the environmental and socio-economic impacts and risks identified for this Project can, with responsible implementation and management of the mitigation recommendations set out in this IEE, be reduced to minimal or acceptable levels.

1. INTRODUCTION

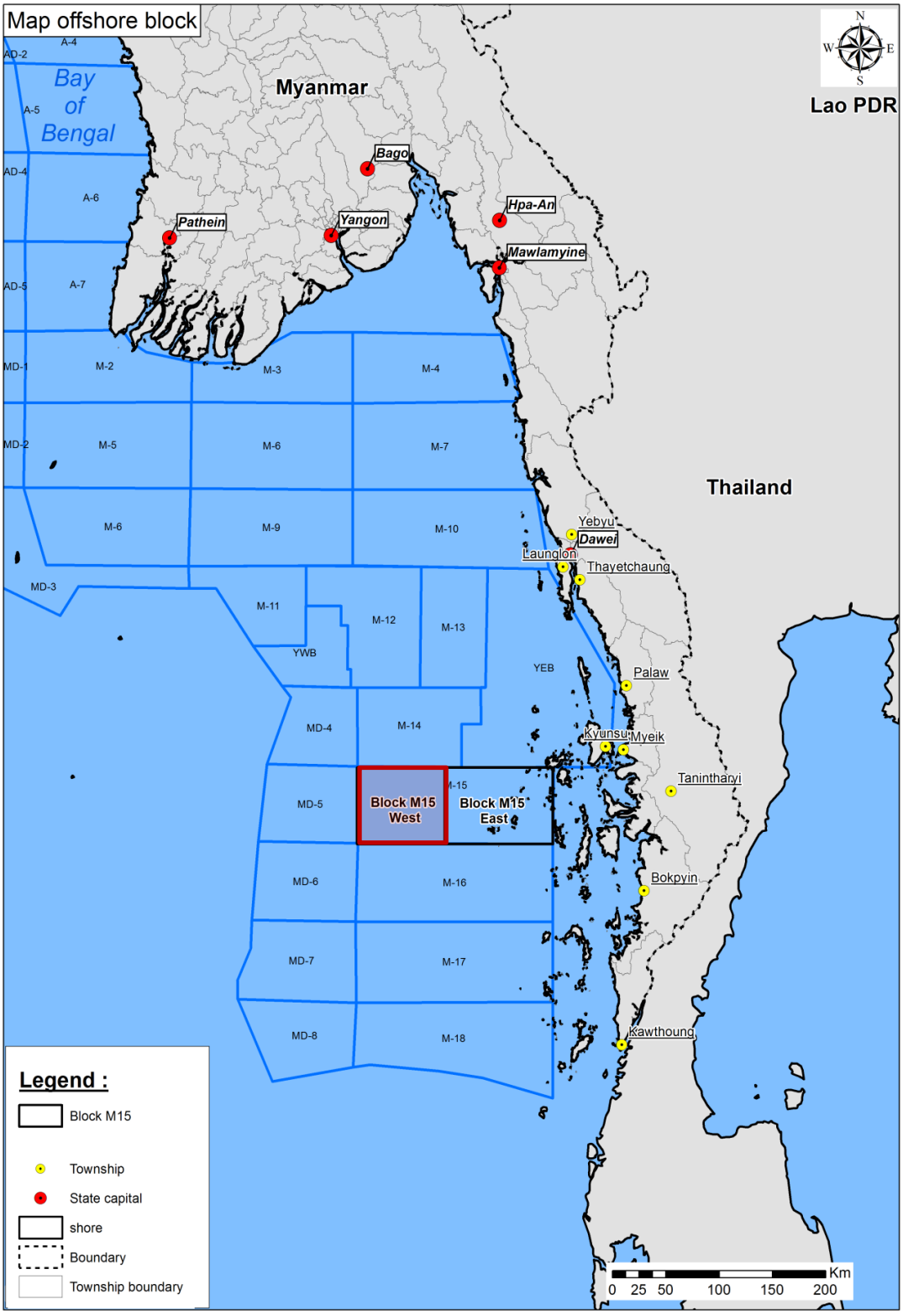
1.1. COMMERCIAL AND REGULATORY CONTEXT

CFG Energy Pte. Ltd. ("CFG") is the designated operator for Block M15 offshore of Myanmar. CFG has two M15 Block partners: Century Bright Gold Pte. Ltd. ("CBG") and TRG M15 Pte. Ltd ("TRG"); in March 2014, CFG, TRG and CBG were awarded Shallow Offshore Block M-15. Under the terms of joint bid CFG propose to undertake a 3D seismic acquisition survey of part of the Block. On March 30th 2015, CFG signed a Production Sharing Contract with Myanmar Oil and Gas Enterprise (MOGE).

The M15 Block is approximately 13,479 km^2 in area, and is located off the coast of the Tanintharyi Region, in the Andaman Sea. CFG proposes a 3D seismic acquisition survey in the western part of the M15 Block totalling an area of 5,000 km^2.

1.2. PROJECT LOCATION

The proposed 3D seismic survey is to be conducted within the M15 Block ~160 km west of Myanmar's South-western coast (~40 km from Great Western Torres Island - Tanintharyi region coastal area), in the Andaman Sea; see Figure 1.1 below. The Block is divided into Block M15 West and Block M15 East, the former being the location for the present study.



Source : Myanmar Information Management Unit (MIMU)

Figure 1-1: Location of the Project

2. PROJECT DESCRIPTION

2.1. LOCATION OF SEISMIC SURVEY

The survey is to be undertaken in area of ~ 5,000 km² in the western section of M15 Block (see Figure 1-1 above). The technique to be used is the Narrow Azimuth Towed Streamer (NATS), using airgun arrays as seismic sources.

Water depths across the M15 Block (West), range from ~200 m to deeper than 2,000 m in the western part of the Block.

2.2. SURVEY SCHEDULE

The survey is planned to commence in December 2015 with the arrival of the survey vessels in the M15 Block. It is estimated that the duration of the proposed survey will be three months, including mobilisation and demobilisation phases. Surveying will operate continuously both day and night (24h/7d), and will only cease in severe bad weather or if technical problems are encountered.

2.3. DESCRIPTION OF MARINE SEISMIC DATA ACQUISITION

Marine seismic surveys are undertaken to allow the mapping of subsurface geological formations and the identification of potential hydrocarbon deposits. Marine seismic surveys use a combination of airguns towed astern a survey vessel to produce seismic pulses below the water surface. These pulses generate acoustic energy waves which are propagated towards the ocean floor. These waves are reflected back to the water surface by the different geological formations in the earth's crust and are detected and recorded over a predetermined time period by underwater microphones (hydrophones). The data recorded is stored for later analysis and the generation of seismic data profiles, which can be interpreted to determine the presence of potential hydrocarbon reserves. The principles and practice of marine seismic data acquisition is illustrated in Figure 2-1 below.

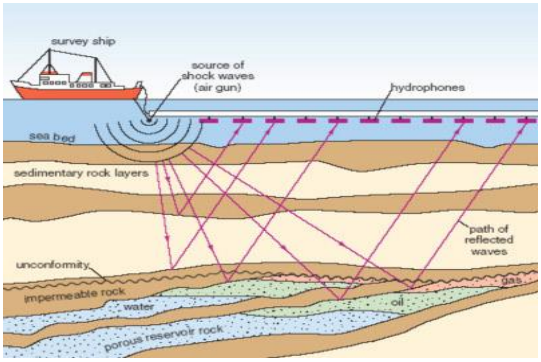


Figure 2-1: The principles and practice of data acquisition in marine 3D seismic surveys

Source: http://www.open.edu/openlearn/science-maths-technology/science/environmental-science/earths-physical-resources-petroleum/content-section-3.2.1

Usually, several hydrophone streamers are towed behind the survey vessel, together with dual seismic sources, and it is this technique that is proposed currently. Multi-streamer, multi-source surveys allow a range of different angles (azimuth) and distances (offset) to be sampled resulting in a volume, or cube, of seismic data; this allows a more detailed and accurate delineation of the boundaries and extent of sub-surface geological structures. Potential oil and gas reservoirs can be imaged in three dimensions allowing interpreters to view the data in cross-sections along 360° of azimuth, in depth slices parallel to the ground surface, and along planes that cut arbitrarily through the data volume. Information such as faulting and fracturing, bedding plane direction, the presence of pore fluids, complex geologic structure, and detailed stratigraphy are now commonly interpreted from 3D seismic data sets.

Data acquisition during a 3D survey normally takes place as shown below in Figure 2-2, with a 'racetrack' pattern being employed to reduce the time necessary to turn the vessel while allowing adjacent lines to be recorded with the data in the same direction. This minimises processing artefacts, which could adversely affect the interpretation of the data. In general, the survey area is broken into areas in which swathes of lines are completed in phases.

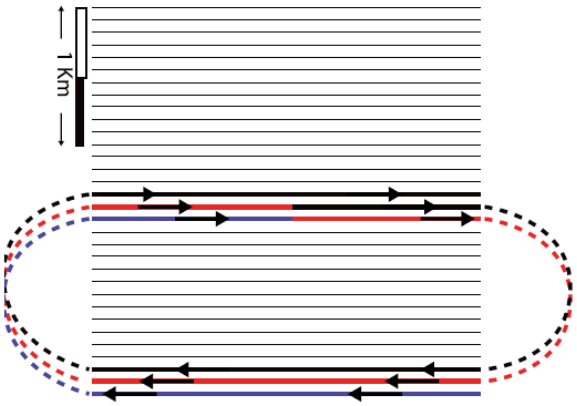


Figure 2-2: Racetrack pattern usually followed in 3D seismic surveys

Source: IAGC, 2011, an overview of

2.4. SEISMIC ACQUISITION EQUIPMENT

A marine seismic survey system is composed essentially of:

- survey vessel and support/chase vessels;
- seismic sources (airgun arrays); and
- seismic receiver cables (streamers).

Surveys are usually completed in three steps: (i) deployment of the streamers; (ii) initialization of the airgun firing sequence and acquisition of seismic data; and (iii) recovery of the streamers.

2.4.1. Survey and Support Vessels

For the M15 Block 3D seismic survey there will be one (1) survey vessel, two (2) support vessels for supply, at-sea bunkering (refuelling), crew change and protecting the seismic spread (towed equipment), and possibly up to two (2) additional chase vessels for managing interactions with fishing vessels and shipping. Estimated numbers of personnel aboard the vessels are ~60 for the survey vessel and ~12 for each support vessel (from previous studies and specifications of potential vessels that will be utilised).

The vessels are equipped with accommodation quarters and areas for storage of supplies. The survey vessel is equipped with a helipad that is used for crew change and in case of medical evacuation (MEDEVAC). Survey and support vessels are equipped with modern navigation and maritime communications equipment.

The survey vessel has an instrument room where the main seismic instrumentation is housed, including navigation and seismic source control equipment.

The back decks of the survey vessel serve the purpose of storing, retrieving and deploying the towed seismic equipment. The seismic source equipment (airgun arrays) is located on the gun deck, along with the air feed from the survey vessel compressors. The streamer deck houses the drums for storage of the hydrophone cables (streamers), along with additional equipment that allows accurate positioning of the streamer spread behind the vessel under various operating conditions.

The compressor room on the survey vessel contains compressor engines and compressors that supply high pressure air to the seismic sources (airguns). The compressor system allows the continuous firing of the airguns, typically every ten seconds during data acquisition.

The specific survey vessel that will be utilised for the M15 Block 3D survey is not yet defined. However, the survey will be acquired using a large and modern purpose-built 3D vessel, such as the R/V *Polar Duchess*, which is owned and managed by GC Rieber Shipping. Characteristics for the *Polar Duchess* are provided in Table 2-1.

Figure 2-3 provides a photograph of the *Polar Duchess*.

The support vessels and the chase vessels for this survey are also not defined yet. Characteristics are provided in Table 2-1 for the M/V *Rig Andromeda (*Figure 2-4), which is the support vessel usually used by the *Polar Duchess*.

Figure 2-3: Seismic survey vessel R/V *Polar Duchess*

Table 2-1: Generic characteristics of survey and support vessels for the 3D seismic survey

General information of the seismic vessel R/V *Polar Duchess*	
Length	106.8 m
Fuel consumption	40m^3/day (production); 80m^3/day (Transit, 4 ME's at 85%)
Crew	60 (estimated)
Survey speed	4.5 knot
Normal turn radius on operation	Max 5km
Water ballast	1,230m^3
Fresh water production	2x13.5 m^3/day
Sewage	Biological Treatment Plant
General information of the support vessel M/V *Rig Andromeda*	
Fuel consumption	Maximum 10 m^3/day per vessel (estimated)
Crew	12 persons
Transit speed	12.5 knots (11MT) – 11.0 knots (7MT)
Chase speed	4.5 knots (3MT)

Figure 2-4: Support vessel M/V *Rig Andromeda*

2.4.2. Seismic Source for 3D survey

The seismic source for this project will be airguns that emit pressurised bubbles to create powerful sound waves. Airguns are composed typically of two high pressure air chambers; an upper control chamber and a discharge chamber (Figure 2-5). A compressor situated on the survey vessel supplies high pressure air (source pressure: 2,000 psi) to the upper control chamber via an air hose that feeds into the lower firing chamber via an orifice in the shank of the shuttle. The airgun is actuated by sending an electrical pulse to the solenoid valve which opens and allows high pressure air to flow to the underside of the piston. The high pressure air is then discharged into the surrounding water through the airgun ports. The air from these ports forms a bubble which oscillates according the operating pressure, water depth and the temperature and volume of air vented into the water. The shuttle is forced back into its original position by the high pressure air in the control chamber so that once the discharge chamber is recharged the airgun is ready for firing. This process is very rapid, taking only a few seconds to recharge.

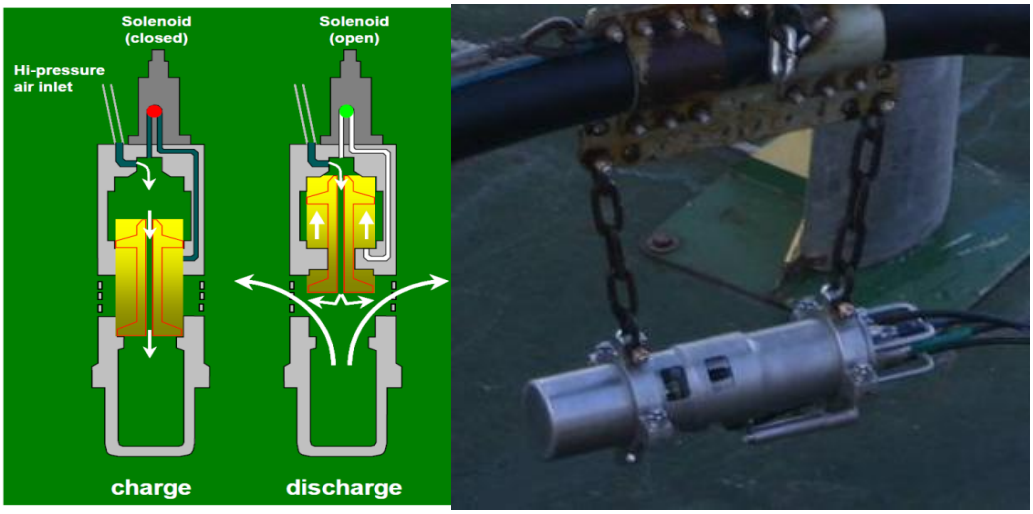


Figure 2-5: Typical air gun mechanics and example of airgun sub-array

Airguns are operated in groups (or sub-arrays), which are suspended from flotation devices to maintain the specified operating depths behind the survey vessel. The effect of having several airguns operating simultaneously as a series of sub-arrays (gun array) is to attenuate the emitted sound level by the oscillation of the bubbles to obtain the shortest acoustic signal possible.

Airguns are capable of providing information about geological structures up to 10km below the sea floor.

For the proposed 3D seismic survey, two seismic sources will operate in “flip-flop” mode (i.e. alternatively). Each source will be composed of three sub-arrays in each airgun array with an operating air pressure of 2,000psi. The total volume of each of the source arrays is 4,600 cubic inches (cui). During acquisition, the arrays are discharged at a shotpoint interval of 25m (i.e. approximately every 10sec).

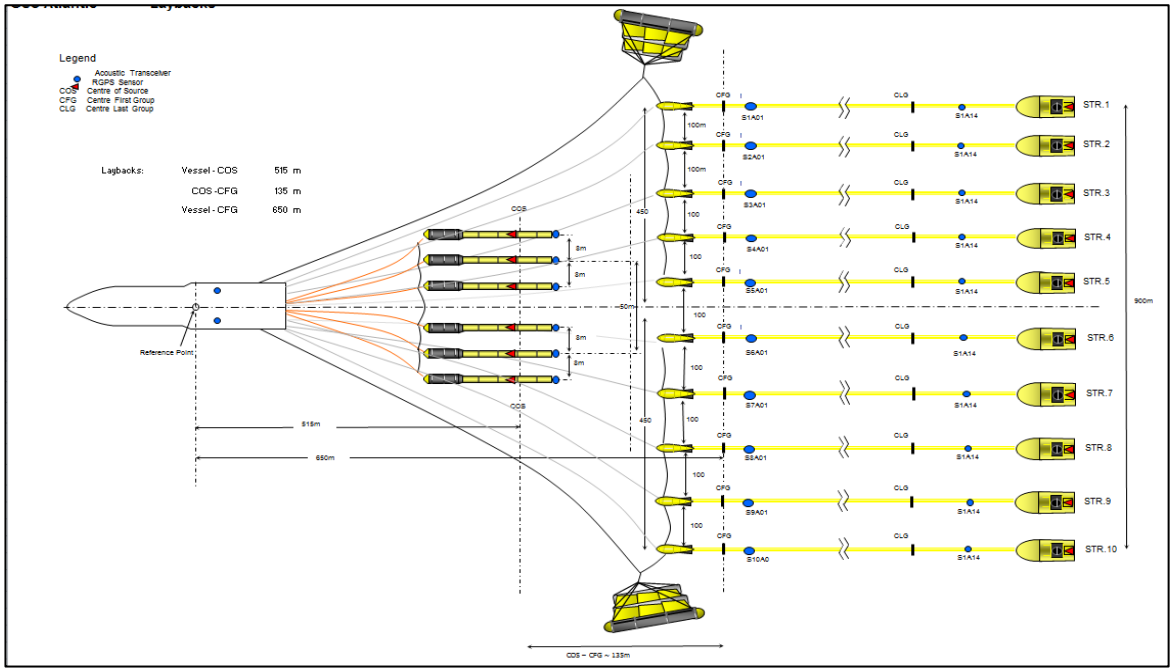


Figure 2-6: Schematic of seismic array proposed for the M15 Block 3D seismic survey

The sources will have up to 27 guns in each airgun array (24 active and 3 spare). The individual gun volumes range from 330 to 70 cubic inches (cui).

The characteristics of the seismic sources are summarized in Table 2-2.

Table 2-2: Characteristics of the seismic sources

Parameter	Value
Number of sources	2 arrays
Source centre separation	50 m
Shot interval per source	25m flip-flop
Operating air pressure	2,000 psi
Source volume	4,600 cui
Cross-line separation between sub-arrays	8 m
Source depth	6 m
Vessel speed during seismic acquisition	4.5 knots

2.4.2.1. Principles of underwater acoustics

Sound in the ocean travels as vibrations of water particles that exert push-pull pressure on objects in their path. The properties of these vibrations are important in determining the impact on receivers:

- the frequency or rate of oscillation is measured in cycles per second or hertz (Hz). Ultrasonic frequencies are too high to be heard by humans (>20,000 Hz) but may be heard by some animals such as dolphins and bats. Infrasound is too low to be heard (<20 Hz) but can be heard by baleen whales (Richardson *et al.*, 1995); and

- the wavelength is the length of the sound oscillation.

Sound pressure is expressed in pressure units - microPascal (µPa) is the parameter measured by most instruments.

Acoustic intensity is the acoustic power per unit area in the direction of propagation (units: watts/m^2). The intensity, power and energy of an acoustic wave are proportional to the average of the pressure squared (mean square pressure).

The human ear responds in a logarithmic fashion to an increase in sound intensity, therefore this scale has been adopted to reflect this response. The decibel scale is a logarithmic scale used to measure the intensity (power) of sound. It is defined as:

- **$dB = 10 \log10(I/I_0)$**, where I_0 is a reference intensity.

However, sound measuring devices usually respond to sound pressure (P) and the intensity of sound varies as the square of the pressure. Consequently, the level of sound intensity can be rewritten as:

- **$dB = 20 \log10(P/P_0)$**, where P_0 is a reference pressure.

The reference pressure (P_0) is chosen to indicate the limit of human hearing and is:

- 20 µPa in air; and
- 1 µPa in water.

The logarithmic decibel scale allows a large range of values to be represented by smaller numbers. For example, a doubling of the pressure represents approximately 3dB.

In water, the acoustic signals emitted by airguns generally have a sinusoidal form constituted by a peak and dip in pressure. The intensity is usually expressed in dB re 1 µPa-m, which represents the sound energy at 1 m of the source.

The Figure 2-7 illustrates the waveform of an airgun array, which is typically a pulsed output. The sound can be characterized by the following parameters of the Sound Pressure Level (SPL):

- Peak-to-peak (P-P) or Zero-to-peak pressure (0-P) (dB re 1 µPa-m): this considers the change in amplitude (pressure) of a sound wave, being respectively the maximum pressure of the rising part of the wave and the sum of the pressure of first peak plus the absolute value of the first trough.
- RMS (Root Mean Square) (dB re 1 µPa-rms): measures the total sound intensity, and then, divides it by the length of the signal. In other words, it expresses the average peak pressure over the duration of the sound pulse. Acoustic power, intensity and energy are proportional to the mean squared pressure.
- SEL (Sound Exposure Level): the time-integrated squared sound pressure and is expressed as dB re 1 μPa^2-s. It involves a correction of the mean square calculation to account for the difficulty in determining signal duration. Behavioural response may be correlated with SEL, in particular for single pulse (SELop) and multi pulse (SELmp) sources. In the case of multiple pulse sources, like seismic sources (one pulse per 8-10 seconds), SELmp is the sum of the energy during the supposed contact between the sources and the receiver.
- The noise level at a given frequency: usually the frequency at which the transmitted sound power is a maximum. In this case, the unit is "maximum amplitude" at µPa in dB/Hz.

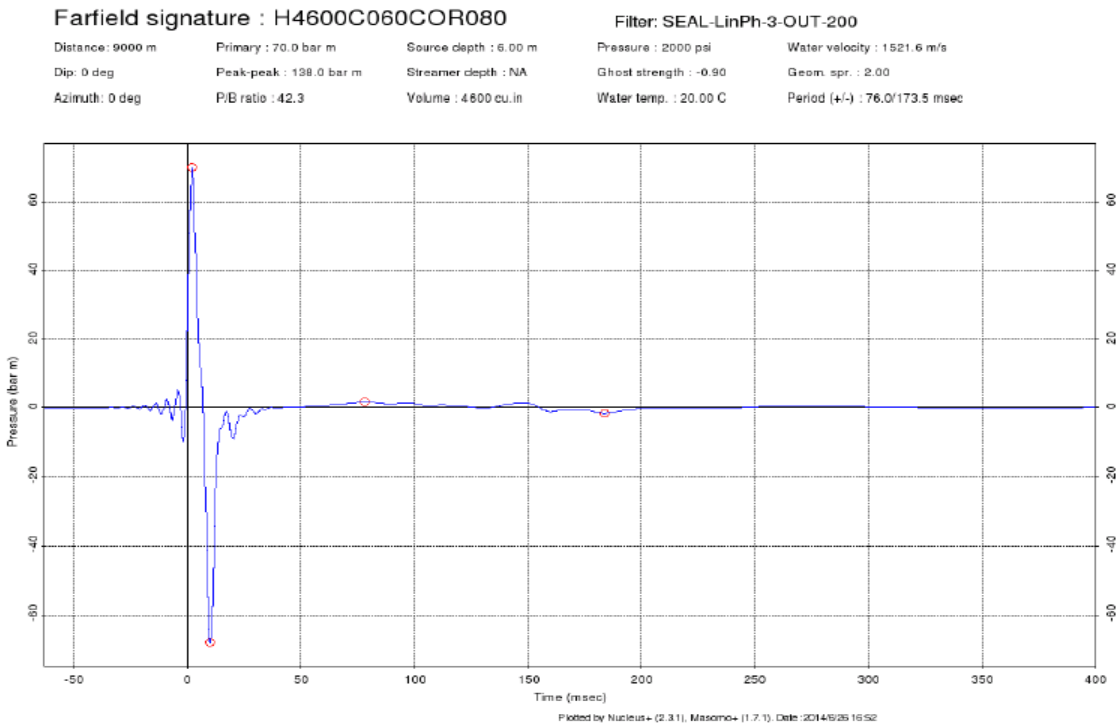


Figure 2-7: Source Farfield signature

The parameter dB-RMS, generally used by biologists, will be the primary sound parameter used in this report. Furthermore, these measurements will be applied for the protection of aquatic species during this study.

2.4.2.2. Acoustics of the seismic source

The characteristics of the 4,600 cui source that will be used for the 3D seismic survey in the M15 Block are as follows:

- **Intensity**: characteristics are summarized in Table 2-3.

Table 2-3: Characteristics of source signature intensity

Parameter	Value
Nominal initial positive peak (0-P)	69 bar-m
Nominal Primary peak to peak (P-P)	138 bar-m
Nominal SPL (0-P)	257 dB re 1 µPa-m
Nominal SPL (P-P)	263 dB re 1 µPa-m
Nominal SPL RMS (20 ms)	254 dB re 1 µPa-m
Real SPL (0-P) (1)	240 dB re 1 µPa-m
Real SPL (P-P) (1)	243 dB re 1 µPa-m
SPL (P-P) far field (300 m)	210-215 dB re 1 µPa @300m
SELop (one pulse)	231 dB re 1 μPa^2-s
SELmp (4,320 pulses over 6 hours)	265 dB re 1 μPa^2-s

Note: (1) This assumes a partial destructive interference between the signals of the individual guns. The real source level (i.e. 1 m from centre of the array) is in reality 10 times (20 dB) lower than the nominal level.

Frequency: Spectrum bandwidth at - 6dB is [7Hz - 100Hz]. The figure below presents the source bands present in the airgun source spectrum.

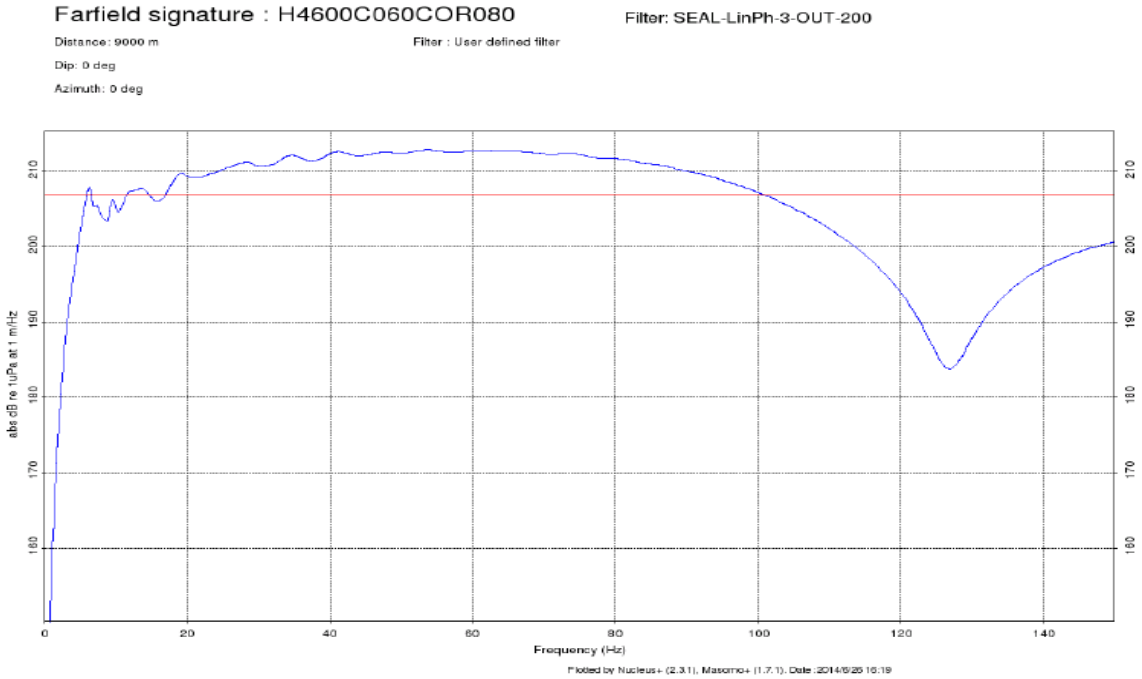


Figure 2-8: Source absolute spectrum in water

2.4.2.3. Acoustics attenuation in water and sound spreading

When sound propagates in seawater, the sound intensity reduces with the distance R from the source. This is due to: (i) the absorption of sound energy by water and (ii) energy loss from sound spreading with increasing distance from the source.

- Sound energy absorption in water: has been quantified by numerous studies as approximately 0.005 dB/km, for low frequency sounds such as those of the seismic source. This attenuation is thus considered to be negligible.
- Sound spreading losses: result from the diminution of intensity with distance from the source, as the total amount of acoustic energy remains the same as it spreads out. This sound attenuation or transmission loss (TL) is defined as

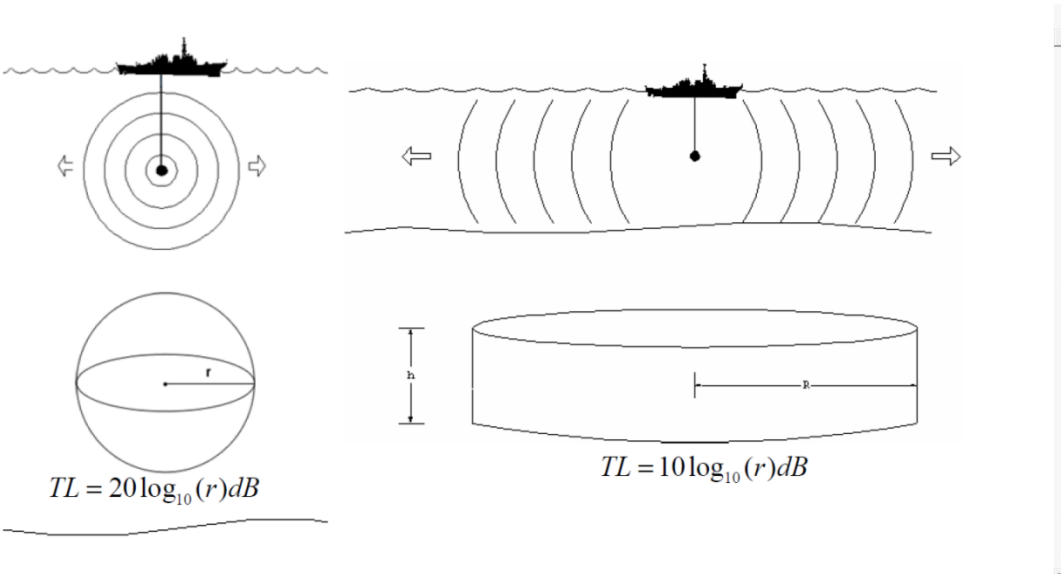
TL=n Log R in dB re 1 µPa.

The value n is a specific variable to denote the characteristics of the attenuation depending on the type of spreading and the site specific conditions.

Cylindrical and spherical spreading are two simple approximations used to describe how sound level decreases as a sound wave propagates away from a source. Spherical spreading describes the reduction in level when a sound wave propagates away from a source uniformly in all directions, such as for a sound source at mid-depth in the ocean.

Beyond some range, the sound will hit the sea surface or bottom. This can be represented by cylindrical spreading in a zone with upper and lower boundaries. The assumption is adopted that sound is distributed uniformly over the surface of a cylinder having a radius equal to the range r and a height H equal to the depth of the ocean.

The concepts of spherical and cylindrical spreading are shown in



Source : IFREMER

Figure 2-9: Concept of spherical and cylindrical spreading

The theoretical value of n is 20 for spherical attenuation and 10 for cylindrical attenuation. In field, n values are demonstrated to be superior to theoretical values, in particular for cylindrical attenuation. These differences depend mainly (i) of sound absorption by sea water for medium frequencies (spherical/cylindrical attenuation) and (ii) by the absorption of the sound by the bottom of the sea and the water/air mirror at sea surface. For the calculation of the exclusion zone (please refer to Table 8-2), n has been taken as constant (i.e. calculations have been made with n=20)

The sound pulses for the scenario with n=20 usually decrease to levels in the order of 190 re 1 µPa-m within 1km of the source and approximately 185dB re 1 µPa-m within 2km (Acoustic Ecology Institute, 2005).

The sound power emitted from the two airgun sub-arrays is spread over an area of ~260m^2. Within a radius of 50m from the airguns, the SPL is significantly lower than that predicted by a point source representing the total power emitted by the airgun array. Thus, model noise predictions are only valid at distances exceeding 100m from the centre of the airgun array.

The sound waves produced by a typical seismic source, such as airguns, usually have a moderately strong directivity component (Figure 2-10). Thus, perceived SPL can fluctuate significantly at locations situated at a fixed radius from the source with different vertical angles.

Airguns are designed to transmit the maximum power towards the seafloor using low frequencies of between ~0 to 100Hz with the result that source signals are much lower near the water surface than on the vertical axis. For frequencies exceeding 100 Hz, the directional component of directivity varies, but is particularly focused.

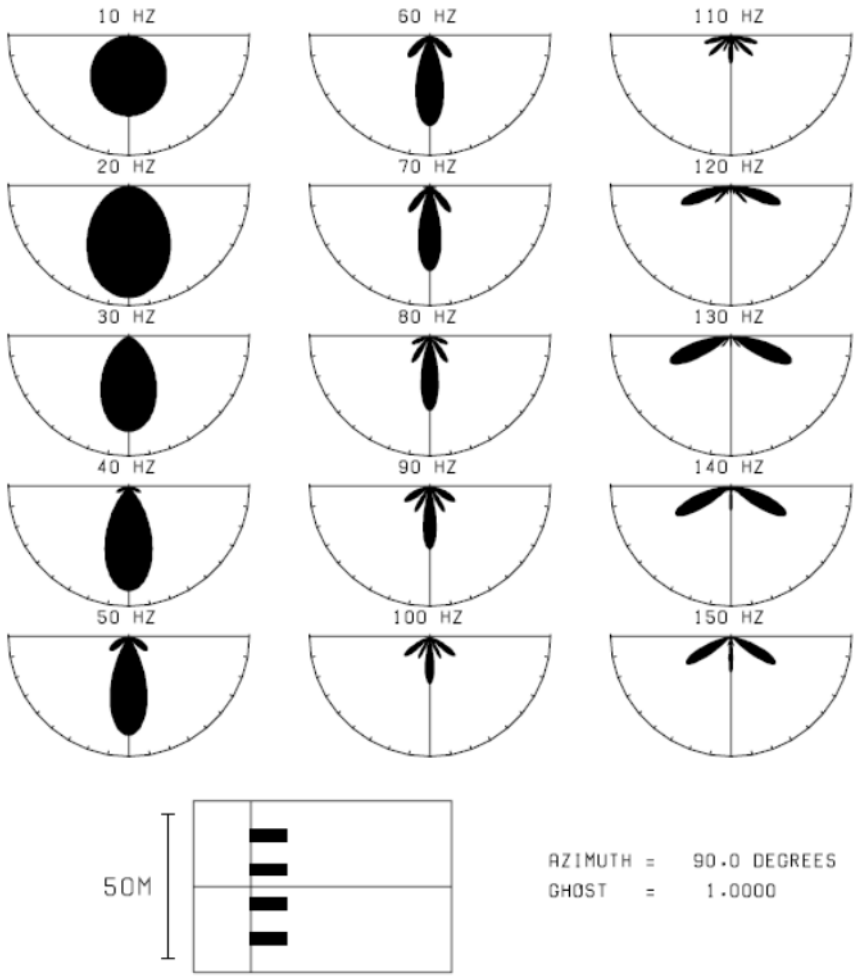


Figure 2-10: Graphical representation of a typical airgun array acoustical spectrum in water

2.4.3. Streamers

The seismic receiver cables or streamers comprise an array of marine receivers that are towed by the survey vessel. Streamers are long plastic cables with marine receivers evenly spaced along their lengths, which listen for seismic echoes caused by the firing of the airguns. The marine receivers are composed of piezoelectric hydrophones, which respond to changes in water pressure and measure the acceleration of the medium as a seismic wave passes through it. The echoes recorded by the hydrophones are collected into an analogue signal, which is then converted to digital format and relayed to the computers on the vessel.

Table 2-4: Characteristics of the streamers

Parameter	Value
Streamer length	~6,000m
Number of streamers	10+2=12
Streamer separation	100-150m
Streamer depth	8m (head) to 25m (tail)
Tow width	~1.75 to 2km (15% fan at tail)

Figure 2-11: Typical seismic streamers

The latest generation of streamers are solid section streamers, constructed of extruded foam to remove the requirement for streamer fluid. These materials are more robust and resistant to damage and do not leak streamer fluid when damaged. Another recent variation of this equipment is gel-filled cables.

The 3D seismic survey in the M15 Block will use solid section streamers.

2.4.3.1. Vessel Steering and Positioning

The configuration of the streamer array for optimal surface coverage has been determined and constitutes fan shooting mode. This will be tested during the mobilisation phase of operations.

An example of the fan shooting geometry for the streamers is shown in Figure 2-14 below.

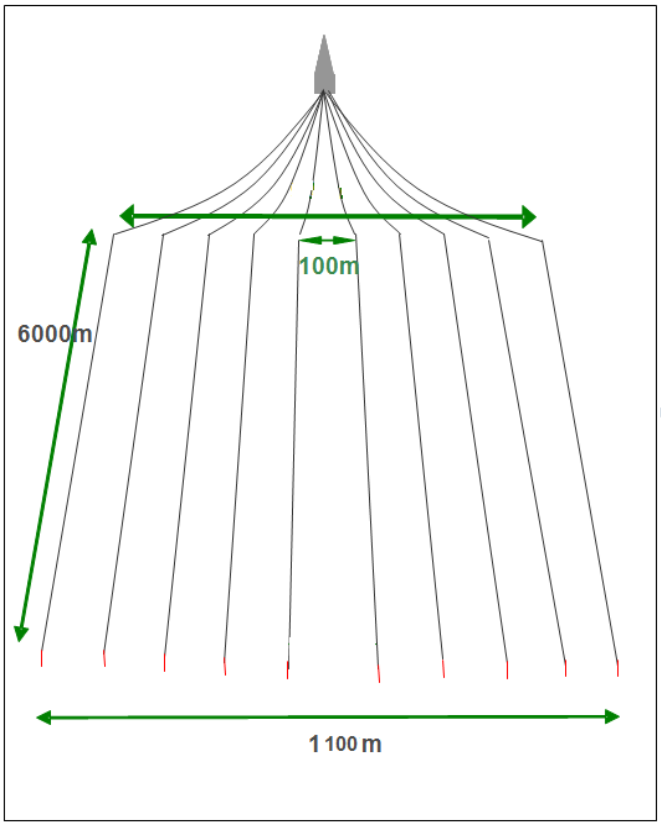


Figure 2-12: Fan mode geometry

Steering equipment (“birds”) attached to the streamers are of two types: depth control birds and lateral control birds. The positional accuracy of these systems is typically +/- 1m. The wings of the bird are electronically controlled to pivot in response to the hydrostatic pressure measured by a pressure transducer. As the streamer is neutrally buoyant, the birds are used to counteract depth variation in the streamers introduced by vessel pitching moments in heavy weather or when different currents are experienced, with corresponding fluctuation in water density and/or temperatures. These units are normally spaced approximately 300m apart along each streamer.

Source : OGP, 2011

Figure 2-13: Example of birds

2.4.3.2. Ancillary Equipment and Onshore Support

Support vessels for this project will include two support vessels and up to two additional chase vessels, which will accompany the survey vessel to monitor the survey zone and to provide any emergency assistance required.

Crew changes will be most likely carried out by helicopter from an airport such Sittwe or Myeik. Crew changes could be undertaken by the support vessels as a backup.

It is likely that the survey vessel will be bunkered (refuelled) at sea within or immediately adjacent to the survey area, using the main support vessel.

2.4.3.3. Positioning systems

Tail buoys at the end of each streamer will be used to position the streamer using two independent dual frequency Differential Global Positioning (DGPS) systems. Calibration and validation of the positioning systems will be undertaken as part of the mobilization phase. The DGPS systems will record pitch, roll and heave at around 1 minute intervals; the height will be corrected from these data and these results will be GPS time stamped.

2.4.3.4. Additional equipment

It is critically important for the success of a 3D survey to know very precisely the location of sources and receivers. To achieve this, compasses, which measure the deviation of the streamer relative to the magnetic North, are usually placed every 300m along each streamer.

Acoustic ranging units are used to provide additional positional information. These are attached to the hull of the survey vessel, to the source floats, to the streamers themselves and the tail buoys. The acoustic units operate to high acoustic frequencies, 10 to 100 kHz, with a maximum output SPL of ~195dB re 1µPa at 1m. They provide range information up to approximately 1km, after which distance the received SPL of these signals are attenuated to background levels.

Seawater temperature and salinity measurements will be performed on regular basis throughout the survey.

2.5. Policy and Regulatory Context

2.5.1. International agreements and conventions

The main international agreements and conventions that Myanmar is signatory to and that are relevant to the project activities are provided in the table below.

Table 2-5: International agreements and conventions in line with the Project

International conventions and protocols	Adherence of Myanmar in
Stockholm Convention on Persistent Organic Pollutants (POPs)	2011 International environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs)
Memorandum of Understanding on the Conservation and Management of Dugongs (*dugong dugon*) and their Habitats throughout their Range	2007 Aims to promote internationally coordinated actions to ensure the long-term survival of dugongs and their seagrass habitats throughout their extensive range
International Plant Protection Convention (1952)	2006 Multilateral treaty overseen by the Food and Agriculture organization that aims to secure coordinated and effective actions to prevent and to control the introduction and spread of pests of plants and plant products
RAMSAR Convention	2005 International treaty for the conservation and sustainable utilization of wetlands recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific

International conventions and protocols	Adherence of Myanmar in
	and recreational value
Agreement on the Establishment of the ASEAN Centre for Biodiversity	2005 An ASEAN Centre for Biodiversity (ACB) is established. The Centre shall have its seat in the Republic of the Philippines. The centre purpose is to "facilitate cooperation and coordination among the members of ASEAN, and with relevant national governments, regional and international organisations, on the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits arising from the use of such biodiversity in the ASEAN region"
Memorandum of Understanding concerning Conservation and Management of marine turtles and their habitats of the Indian Ocean and South East Asia	2001 Intergovernmental agreement that aims to protect, conserve, replenish and recover sea turtles and their habitats in the Indian Ocean and South-East Asian region, working in partnership with other relevant actors and organizations
Cartagena Protocol on Biosafety, Cartagena	2000 Is an international agreement on biosafety, as a supplement to the Convention on Biological Diversity. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology
Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS)	1998 A project developed by the Asian Development Bank which drew up a least-cost greenhouse gas abatement strategy for Asia. 12 countries participated including Myanmar. Its objectives included the development of national/regional capacities for the preparation of GHG inventories, the identification of GHG abatement options, and the preparation of a portfolio of abatement projects for each country
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1997 Multilateral treaty to protect endangered plants and animals ensuring that the international trade in specimens of wild animals and plants does not threatens the survival of the species in the wild and it accords varying degrees of protection to more than 35000 species
International Tropical Timber Agreement (ITTA), Geneva	1994 Multilateral agreement to provide an effective framework for consultation, international cooperation and the development of timber economy policies, to contribute to the process of sustainable development, to promote the expansion and diversification of international trade in tropical timber from sustainable sources, to improve forest management and the efficiency of wood utilisation, to provide members with new financial resources and to encourage information-sharing on the international timber market
Convention for the Protection of the World Cultural and Natural Heritage	1994 Each state party of the convention recognized that the duty of "ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage situated on its territory, belongs primarily to that State. It will dall it can to this end, to the utmost of its own resources and, where appropriate, with any international assistance and co-operation, in particular, financial, artistic, scientific and technical, which it may be able to obtain"

International conventions and protocols	Adherence of Myanmar in
Convention on Biological Diversity, Rio de Janeiro	1992 Multilateral treaty aiming to develop national strategies for the conservation and sustainable use of biological diversity. It is seen as the key document regarding sustainable development
United Nations Framework Convention on Climate Change (UNFCCC)	1992 International environmental treaty negotiated at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro, 1992. The objective of the treaty is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Myanmar ratified in 1994
London Amendment to the Montreal Protocol, London 1990	1990 To reinforce the measures laid down in the 1987 Montreal Protocol by extending its scope to new substances and establishing financial mechanisms
Montreal Protocol on Substances that Deplete the Ozone Layer	1989 International treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for the ozone depletion. The treaty is structured around several groups of halogenated hydrocarbons that have been shown to play a role in ozone depletion. All of these ozone depleting substances contain either chlorine or bromine. For each group, the treaty provides a timetable on which the production of those substances must be phased out and eventually eliminated.
Vienna Convention for the Protection of the Ozone Layer	1988 Multilateral Environmental Agreement agreed upon the Vienna Conference in 1985 which acts as a framework for the international efforts to protect the ozone layer
International Convention on the Prevention of Pollution from Ships, 1973 as modified by the protocol of 1978 (MARPOL 73/78)	1988 International convention designed to minimize sea pollution and to preserve the marine environment from the contamination by oil and other harmful substances and accidental discharges of such substances. Myanmar has only ratified annex I/II. Nevertheless, recommendation of annex IV and V were also considered
International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW)	1988 This convention concerns the project particularly by its 2010 amendment which asks for new requirements for marine environment awareness training and training in leadership and teamwork; and new training guidance for personnel operating Dynamic Positioning Systems.
RIPAM or COLREG Convention 72 “collision regulation 72”	1987 The International Regulations for Preventing Collisions at Sea 1972 (Colregs) are published by the International Maritime Organization (IMO) and set out, among other things, the "rules of the road" or navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels
SOLAS convention (Safety Of Life At Sea)	1987 International maritime safety treaty. It ensures that ships flagged by signatory States comply with minimum safety

International conventions and protocols	Adherence of Myanmar in
	standards in construction, equipment and operation.
United Nations Convention on Law of the Sea (UNCLOS)	1986 International agreement which defines the rights and responsibilities of nations with respect to their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources.
ASEAN Agreement on the Conservation of Nature and Natural Resources, Kuala Lumpur	1985 "(1) The Contracting Parties, within the framework of their respective national laws, undertake to adopt singly, or where necessary and appropriate through concerted action, the measures necessary to maintain essential ecological process and life-support systems, to preserve genetic diversity, and to ensure the sustainable utilization of harvested natural resources under their jurisdiction in accordance with scientific principles and with a view to attaining the goal of sustainable development. (2) To this end they shall develop national conservation strategies, and shall co-ordinate such strategies within the framework of a conservation strategy for the Region"
Convention on Wetlands of International Importance (RAMSAR), Iran	1971 International treaty for the conservation and sustainable utilization of wetlands. In Myanmar this treaty entered into force in 2005
Plant Protection Agreement for the Southeast Asia and the Pacific Region, Rome	1956 The Contracting Governments established a regional committee, to be known as the Plant Protection Committee for the South East Asia and Pacific Region to: a) the determination of procedures and arrangements necessary for the implementation of this Agreement and the making of recommendations to the Contracting Governments accordingly; b) the review of reports submitted by the Contracting Governments of progress in the implementation of this Agreement; c) the consideration of problems requiring co-operation on a regional basis and of measures for mutual assistance
Convention on the International Maritime Organization	1948 Establishment of the International Maritime Organization (IMO) by the State Parties. Myanmar acceptance in 1951

2.5.2. National environmental legislation

Whilst environmental legislation in Myanmar is under active development, some legislation has been passed; the table below summarises the national environmental legislation that is relevant to the project.

Table 2-6: Myanmar environmental legislation applicable to the Project

Legislation	Description
Myanmar Environmental Conservation Rules (5th June 2014)	These place responsibility on the Government to establish and adopt the necessary programmes for the conservation and enhancement of environment, protection, control and reduction of pollution in environment, and conservation. An environment management fund has been created. Apart from state budget and

Legislation	Description
	other donations, polluters and people which obtain benefit from the natural environment service system will have to compensate their action through the fund. The Ministry may determine conditions for hazardous waste treatment, treatment of effluent, storage and transport of hazardous products, constraint of production to protect the environment. The Rules reinforce the obligation for project developers to submit an EIA or an IEE. The ministry will publish a list of the categories of plan, business or activity which shall carry out EIA or IEE. EIA shall be conducted by a qualified third person or organization accepted by the Ministry. Sets out the process to obtain prior permission for certain categories of project.
Myanmar Investment Rules (2013)	The Myanmar foreign investment rules contain several elements dealing with environmental protection, including: Art. 33. Proposals for economic activities that are considered capital intensive by the Commission, and that are prescribed to undergo environmental impact assessment by the Ministry of Environmental Protection and Forestry have to be submitted along with Environmental and Social Impact Assessment. Art. 54. The promoter or investor shall: (a) comply with Environmental Protection Law in dealing with environmental protection matters related to the business; Art. 123. If it is scrutinized and found out that the investor has carried out business that causes environmental pollution or has not taken action to minimize environmental pollution at the land for which he is entitled to lease or use, or if it is scrutinized and found that the work carries out causes nuisance to the persons who reside around such place due to noise or by culture and if relevant persons officially object, the Commission may terminate the lease or tendering right to use after making necessary inquiry. Art. 125. The investor, for operating any business, does not have the right to lease and develop the following lands: (a) religious lands; (b) cultural heritage and natural heritage regions designated by relevant Ministries; (c) lands restricted for Union defence and security; (d) lands under litigation; (e) lands restricted by the State from time to time; (f) lands where exists place or building which may cause situations such as impact on public environment noise, pollution, impact on culture within urban residential area due to the business of the investor
National Biodiversity Strategy and Action Plan (2012)	Established under Article 6 of the United Nations Convention on Biological Diversity in which each member country needs to develop its own National Biodiversity Strategy and Action Plan (NBSAP) to integrate conservation and the sustainable use of biodiversity. In order to fulfil this commitment to the Convention, Myanmar conducted a project entitled National Biodiversity Strategy and Action Plan in Myanmar (NBSAP Myanmar). The NBSAP acts as the major guiding document for planning biodiversity conservation in the country, following its goal to provide a strategic planning framework for the effective and efficient conservation and management of biodiversity and natural resources based on greater transparency, accountability and equity On 3rd May of 2012, the Government of the Republic of the Union

Legislation	Description
	of Myanmar adopted the Myanmar NBSAP by its Government Meeting No. 16/2012. The NBSAP is intended to provide a comprehensive framework for planning biodiversity conservation, management and utilization in a sustainable manner, as well as to ensure the long term survival of Myanmar's rich biodiversity.
The Environmental Conservation Law (30th March, 2012)	The objective of this Law is to implement Myanmar's National Environmental Policy, enabling the basic principles and to give guidance for systematic integration of environmental conservation matters in the sustainable development process.
Conservation of Water Resources and Rivers Rules (2012)	Chapter 3 on Prevention of water pollution and Environmental Conservation in its Para (7C) mentions the wastewater produced from any factories and industries nearby the rivers, channels and ports should be treated before discharge. Monitoring is required. Para (8E) states that everyone must take preventive measures in accordance with international standards in order to prevent the leakage/discharge of waste water and sewage into the rivers. Para (9) states that cost for pollution abatement is supported by the polluter
Myanmar Investment Law (2012)	This Law provides elements on foreign investments in Myanmar. Art. 17: The duties of the investor are as follows: (f) making no alteration of topography or elevation of the land obviously on which he is entitled to lease or use without the approval of the Commission; (h) not to cause environmental pollution or damage in accord with existing laws in respect of investment business.
The State Supplementary Appropriation Law (2009)	This Law is concerned with sanctioned allotment and administration of supplementary expenditures and taking of loans for the respective persons mentioned in this law.
The Law Amending the Protection and Preservation of Cultural Heritage Regions Law (2009)	This Amendment is concerned with revising fines for failure to abide by this law. To implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years; to protect and preserve the cultural heritage regions and the cultural heritage.
National Sustainable Development Strategy (2009)	This strategy concerns the sustainable management of natural resources, integrated economic development, and sustainable social development.
Constitution of the Republic of the Union of Myanmar (2008)	The national constitution states that: Art. 45: The Union shall protect and conserve natural environment. Art 390: Every citizen has the duty to assist the Union in carrying out the following matters: (a) preservation and safeguarding of cultural heritage; (b) environmental conservation; (c) striving for development of human resources; (d) protection and preservation of public property.
Law Amending the Ports Act (2008)	11. Sub-section 2 of section 21 of the Ports Act shall be substituted as follows: "(2) Any person who by himself or another so casts or throws any ballast or rubbish or any such other thing or so discharges any oil or water mixed with oil, or the master of any vessel from which the same is so cast, thrown or discharged, shall be punishable with fine not exceeding fifty thousand kyats, and shall pay any reasonable expenses which may be incurred in removing the same".
Law Amending the Territorial Sea and Maritime	After Clause 3 of the Annex to the Territorial Sea and Maritime Zone Law, Clause 4 and Clause 5 have been inserted with new

Legislation	Description
Zone Law (2008)	Coordinates which have no impact on the offshore M6 Block (and mostly confined to areas adjacent to Bangladesh).
Conservation of Water Resources and Rivers Law (2006)	Section 6 outlines prohibitions for the following activities: "No person shall anchor the vessels where vessels are prohibited from anchoring in the rivers and creeks. No person shall dispose of engine oil, chemical, poisonous material and other materials which may cause environmental damage, or dispose of explosives from the bank or from a vessel which is plying, vessel which has berthed, anchored, stranded or sunk. No one shall dispose of any substance into the river-creek that may cause damage to waterway or change of watercourse from the bank or vessel." The aims of this Law are as follows: to conserve and protect the water resources and river systems for beneficial utilization by the public; to smooth and enhance safety of waterways navigation along rivers and creeks; to contribute to the development of State economy through improving water resources and river systems; to protect environmental impact. The empowerment of this Law is provided to the Ministry of Transport for controlling navigation of vessels in the rivers and creeks as well as communicating with local and foreign government and organizations for conservation of water resources, rivers and creeks. Also, to carry out conservation works for water resources, rivers and creeks, in accordance with the relevant international conventions, regional agreements and bilateral agreements for environmental conservation.
Rules on protection of wildlife and protected area conservation law (2003)	Rules created to establish a procedural framework for the 1994 Protection of Flora and Fauna, and Protected Area Conservation Law. It includes rules for licence to Hunt Animals; for Fishing in Reserved Forests Wild Life Sanctuaries; for Restricting Imports and Exports of Animals; rules as to Rewards, Appointment of Game Wardens and General Powers and Penalties.
Kyoto Protocol to the Convention on Climate Change, Kyoto (1997)	13/8/2003 (Accession) The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.
Myanmar Agenda 21 (1997)	The Myanmar Agenda 21 makes recommendations for the drafting and promulgation of a framework law which can further promote the integration of environmental and developmental concerns in the decision-making processes of the country. The Myanmar Agenda 21 contains guidelines to address the following issues: • increasing energy and material efficiency in production processes; • reducing wastes from production and promoting recycling; • promoting use of new and renewable sources of energy; • using environmentally sound technologies for sustainable production; • reducing wasteful consumption; • increasing awareness for sustainable consumption.

Legislation	Description
National Environment Policy (1994)	The National Environment Policy is reproduced below: "To establish sound environment policies, utilisation of water, land, forests, mineral, marine resources and other natural resources in order to conserve the environment and prevent its degradation, the Government of the Union of Myanmar hereby adopts the following policy: The wealth of the nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's environmental policy is aimed at achieving harmony and balance between these through the integration of environmental considerations into the development process to enhance the quality of the life of all its citizens. Every nation has the sovereign right to utilise its natural resources in accordance with its environmental policies; but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interests of present and future generations. Environmental protection should always be the primary objective in seeking development."
The Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law (1994)	Its objective is to implement a Government policy for wildlife protection and natural areas conservation; to "carry out in accordance to international conventions acceded by the State in respect of the protection and conservation of wildlife, ecosystems and migratory birds"; to protect endangered species and their habitats and establishing zoological and botanical gardens and "to contribute for the development of research and natural science". Of relevance the statement in Chapter 11 which outlines the penalties for whoever causes "water and air pollution, causing damage to a water-course or putting poison in the water in a natural area", and possesses or disposes of pollutants or mineral pollutants in a natural area.
Union of Myanmar Marine Fisheries Law (25 April 1990, amended 1993)	Especial relevance of this law the M6 Block project is that it places restriction on pollution: "No person shall dispose of living aquatic creatures or any material into the Myanmar Marine Fisheries Waters to cause pollution of water or to harass fishes and other marine organisms".
The Forest Law (1992)	Government policy regarding forest management and usage. Chapter IV, regarding management of forest land states that whoever, within a forest land and forest covered land at the disposal Government is desirous of carrying out any development work or economic scheme shall obtain the prior approval of the Forestry Ministry. The text has been completed by Rules and Policy in 1995.
Territorial Sea and Maritime Zones law (1977)	The Union of Myanmar has exclusive jurisdiction for the construction, maintenance or operation of offshore terminals and exclusive jurisdiction to preserve and protect the marine environment, and to prevent and control marine pollution.
Public Health Law (1972)	Section 9 of this law empowers the Government to carry out measures relating to environmental health, such as garbage disposal, use of water for drinking and other purposes, radioactivity, protection of air from pollution, sanitation works and food and drug safety. However, detailed provisions do not exist to ensure more effective and comprehensive regulation of these areas
Penal Code (1 May 1961, and extended to public health law in 1972)	The penal code is mainly concerned with public health; it is considered an offence to "voluntarily corrupt or foul the water of any public spring or reservoir so as to render it less fit for the purpose for which it is ordinarily used", or to pollute the atmosphere arising from smoke, fumes, noxious odours, dust particles, noise and radioactive substances. The only control of water pollution in the country is through

Legislation	Description
	guidelines issued in June 1994 by the Myanmar Investment Commission. These guidelines require that new projects, from both foreign and private investments, have waste water treatment plants or systems.
The Oilfields Act (1918)	This Act provides clarification on activities within the oil and gas industry and provides the Government with the power to define and alter limits of any notified oilfield. In addition, the Government can make rules for regulating all matters connected with many operations related to the extraction of oil and/or gas. The Act also provides guidance and issues such as preventing oil and gas wastes, reporting of fires, accidents and other occurrences and regulating the collection and disposal of both oil and gas.

2.5.3. Environmental and social impact assessment legislation

The 7th Article of the Environmental Conservation Law (2012) includes the requirement to:

- "Formulate systems for conducting Environmental Impact Assessments and Social Impact Assessments"

The strategic purpose is to assess if a proposed project may cause a significant impact on the environment. The Ministry may, with the approval of Government, require their prior authorization for projects which are considered potentially damaging to environmental quality.

On the basis of this Law, Environmental Conservation Rules were issued on June 5th 2014 (see Table above). Stemming from these Rules is the need to develop Environmental Impact Assessment Procedures. The establishment of the Procedures, which determine among other issues will define the need for a project to submit an Initial Environmental Examination (IEE) or EIA, are at the time of compiling this report on their 6th iterative draft and consultation, and are not yet issued or yet effective.

Item 21 will deal with Offshore Oil and Gas Development and currently cites as Guidance the IFC Offshore Oil and Gas Development Guidelines, and therefore these are referenced later in this chapter (See Section 2.5.4).

2.5.4. International Guidelines and Standards used for this study

The following table summarizes the international guidelines and standards relevant to the Project.

Table 2-7: International guidelines and standards relevant to the Project

Standards/guidelines	Aim/Goal
World Health Organization (WHO) standards and guidelines	Gives guidelines value for ambient air quality regarding emission of SO_2, NO_2, Particulate matter (PM10 and PM2.5), O_3
IFC Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (2007)	Potential environmental issues associated with offshore oil and gas development projects include the following: • Air emissions (especially from seismic operations). Recommended measures to reduce the risk: ▪ Significant (>100,000 tons CO2 equivalent per year) greenhouse gas (GHG) emissions from all facilities and offshore support activities should be quantified annually. ▪ All reasonable attempts should be made to maximize energy efficiency and operation of vessels for lowest energy use. During equipment selection, air emission specifications should be considered. ▪ Methods for controlling and reducing fugitive emissions should be considered and implemented in the design, operation, and maintenance of offshore vessels. Leak detection and repair programs should be implemented. • Noise (especially from seismic operations). Recommended measures to reduce the risk of noise impact on marine species include: ▪ Identifying areas sensitive for marine life; ▪ Planning seismic surveys to avoid sensitive times of the year; ▪ Identifying fishing areas and reducing disturbance by planning seismic surveys at less productive times of the year, where possible; ▪ Maximize the efficiency of the seismic surveys to reduce operation times; ▪ If sensitive species are anticipated in the area, monitor their presence before the onset of noise creating activities, and throughout the seismic program or construction. In areas where significant impacts to sensitive species are anticipated, experienced observers should be used; ▪ When marine mammals are observed congregating close to the area of planned activities, seismic start-up or construction should begin at least 500 meters away; ▪ If marine mammals are sighted within 500 meters of the proposed seismic array or construction area, start-up of seismic activities or construction should be postponed until they have moved away, allowing adequate time after the last sighting; ▪ Soft-start procedures, also called ramp-up or slow build up, should be used in areas of known marine mammal activity. This involves a gradual increase in sound pressure to full operational levels; ▪ The lowest practicable power levels should be used throughout the seismic surveys, and their use should be documented; ▪ Methods to reduce and/or baffle unnecessary high frequency noise produced by air guns or other

Standards/guidelines	Aim/Goal
	acoustic energy sources should be used, where possible. ● Emergency Preparedness and Response Plan: ▪ Spill prevention and control plan as part of the Emergency Preparedness and Response Plan ▪ The company must have the funds available to implement the spill control plan, including equipment, budget and insurance. This plan should include details of response procedures in case of emergencies such as spills and leaks, including: • Inspection program implementation to ensure infrastructure integrity • Preparation of standard operating procedures for appropriate containers and transfer operations • Hazardous material location • Documentation of specific PPE needs and operator training • Documentation of availability of spill response equipment and lists of external resources • Description of response activities including notification procedures (internal and external) • Decision process for severity and action assessment. The results of this plan will be reported annually and the plan updated regularly in response to the outcomes reported.
MARPOL (Annex I, IV and V) (activities carried out at sea)	Annex I: Any discharge into the sea of oil or oily mixtures from ships is prohibited except if the following conditions are satisfied for vessels ≥400 gross tons and <400 gross tons: ● Proceeding en route; and ● Oil content less than 15 parts per million; and Oil discharge monitoring and control system and oil filtering equipment to be operating Any discharge into the sea of oil or oily mixtures from ships is prohibited except if the following conditions are satisfied for vessels <400 gross tons: ● Oil and all oily mixtures retain on-board for on shore disposal OR ● Proceeding en route; and ● Has in operation equipment of a design approved by the administration that ensures oil content less than 15 parts per million Annex IV provides information concerning sewage treatment/discharge conditions. Annex V provides information concerning garbage treatment/discharge conditions, including comminute or ground food wastes
IAGC Recommended Mitigation Measures For Cetaceans during Geophysical Operations (June 2011)	Identifies and recommends mitigation measures to be used for cetaceans (whales, dolphins and porpoises) only during geophysical operations. Gives procedures such as pre-watching, soft start, etc. in order to prevent potential damages on cetaceans.

Standards/guidelines	Aim/Goal
UK Joint Nature Conservation Committee (JNCC) *Guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys (August 2010)*	Standard for the protection of marine mammals against important underwater acoustic waves, particularly due to seismic survey. Gives procedures such as pre-watching, soft start, etc. in order to prevent potential damages on cetaceans.
Joint OGP/IAGC position paper Seismic Surveys & Marine Mammals (2004);	A paper that provides a joint vision of the exploration and production (E&P) activity with regards to their impacts on the marine fauna.
International Petroleum Industry Environment and Conservation Association (IPIECA) The Oil and Gas Industry: Operating In Sensitive Environments (2003)	IPIECA is a voluntary non-profit organization whose membership includes both petroleum companies and associations at the national, regional or international levels. It addresses global environmental and social issues related to the petroleum industry: oil spill preparedness and response, global climate change, biodiversity, social responsibility, fuel quality and vehicle emissions, and human health. IPIECA also helps members identify new global issues and assesses their potential impact on the oil industry. The Association represents the views of its members in public forums and provides an interface between the petroleum industry and the United Nations Agencies. IPIECA's goals are to promote good practices and industry consensus through arranging international workshops, publishing authoritative reports, providing a channel of communication with the UN, providing a forum for open dialogue, facilitating stakeholder engagement, promoting partnerships.
International Association of Oil and Gas Producers (OGP) Environmental management in oil and gas exploration and production (1997)	The OGP is the worldwide association of Oil and Gas Companies involved in exploration and production. The members include private and state-owned oil and gas companies, national associations and petroleum institutes. OGP represent their members before international regulatory bodies, and has observer status as a non-governmental organisation, with global and regional regulatory bodies that have an interest in marine environment protection.
OGP Waste Management Guidelines (1993)	Provides an insight to the oil exploration and production processes and to waste management methods. Appendix 3 provides a waste management planning worksheet and Appendix 5 and 6 a specific waste information and waste management options.
International Cable Protection Committee (ICPC) Procedure to be Followed Whilst Offshore Seismic Survey Work Is Undertaken In The Vicinity Of Active Submarine Cable Systems (ICPC Recommendation No. 8)	This document recommends procedures to be followed whilst offshore seismic survey work is undertaken in the vicinity of active submarine cable systems where these are installed in water depths of 200 m or less.

2.6. EMISSIONS, DISCHARGE AND WASTE INVENTORY

This section of the EIA provides a brief description of the routine emissions and discharges generally associated with marine seismic surveys.

The most significant impacts of a marine seismic survey generally are associated with the underwater noise produced during the discharge of airguns. Other emissions and discharges include emissions to air and sea from the vessels, and transfer back to shore of wastes for onshore treatment and disposal.

2.6.1. Acoustic Emissions

Acoustic emissions from marine seismic surveys are usually associated with the airguns, survey and support vessel noise (e.g. engines, propeller cavitation, hull flow noise, etc.) and noise from helicopters.

This is particularly important due to the different frequencies generated and the impacts of water attenuation, the low frequencies and the susceptibilities of marine species to these bass frequencies.

The effects of the low frequency acoustic emissions of seismic survey airguns on marine life are the subject of a complex assessment process. The impacts are related to the number of exposures, level of exposure and the noise type, be it single pulse, multiple pulse or continuous noise.

Acoustic emissions are also associated with the operation of survey and support vessels and helicopters. Under normal operating conditions, the emissions of the support vessels would be confined to within a short distance of the vessel itself. McCauley (1998) measured underwater broadband noise of ~182dB re 1µPa from a rig support vessel holding station in the Timor Sea. Emissions associated with helicopters are expected to be more significant, but due to the infrequent activity of helicopters (zero for some surveys) these impacts are expected to be temporary and of short duration.

The acoustic impacts associated with vessel noise are negligible in the context of airgun noise impacts.

2.6.2. Atmospheric Emissions

Atmospheric emissions are generally associated with engines' combustion and energy generation processes. The main sources of atmospheric emissions for marine seismic surveys are usually the following:

- vessels' marine gas oil (MGO) engine combustion;
- incinerators (if present aboard); and
- helicopter engine combustion (MEDEVAC case and for crew changes).

The hypotheses assumed for this study are given in the table below and considered previous similar seismic campaigns.

Table 2-8: Hypotheses considered for the M15 Project for calculation of the atmospheric emissions

Parameters	Details	Source
Survey vessel fuel consumption (MGO)	40 m^3/day	Estimation from previous studies
Support vessel/chase vessel fuel consumption (MGO)	10 m^3/day	Estimation from previous studies
Helicopter fuel consumption (Jet A1)	0.6 m^3/h	Estimation from previous studies
Helicopter flight duration	12h/week	Estimation from previous studies
Duration of the Project	105 days	Estimation from previous studies
MGO/Jet A1 fuel density	~0.85 t/m^3	Internet data

The estimates of atmospheric emissions were done by multiplying fuel consumption and emission factors for relevant atmospheric components.

The fuel consumption was estimated for the survey vessel and support/chase vessels based on typical fuel consumption figures of 40m^3/day and 10m^3/day respectively for three months of seismic survey.

Table 2-9: Calculation of atmospheric emissions

Gas produced during the activity	OGP Emission Factor (t/t)	Total Emission (metric tonnes)
CO_2	3.2	15,187
CO	0.0021	10
NO_X	0.0094	45
N_2O	0.0002	1
SO_2	0.0080	38
CH_4	0.0001	0
VOC	0.0019	9
	TOTAL	**15,290**

(1) GHG emissions correspond to the sum of CO_2, N_2O and CH_4 emissions each multiplied by the corresponding Global Warming Potential factor.

In conclusion, the overall GHG production during the proposed 3D seismic survey will be ~15,290 mt (metric tonnes).

Emissions from incinerator usage aboard the survey vessel were considered to be negligible.

2.6.3. Water Discharges

Discharges are generally associated with wastewater and bilge water. These waste streams are usually collected in the water storage areas on the survey and support/chase vessels. The water storage areas generally incorporate domestic and sanitary wastewater; and deck and bilge water.

2.6.3.1. Domestic and Sanitary Wastewater

Domestic and sanitary waste will be generated as a result of the human presence on the survey and support/chase vessels. The calculations for the survey and support/chase vessels are summarised in Table 2-12 below.

The wastewater will be treated and monitored before discharge into the surrounding environment.

Table 2-10: Summary of domestic and sanitary wastewater

Waste stream	Quantity (m^3)	Assumption for estimation
Black water (m^3) (sewage from the toilets)	850	Based on **108** crew members (60 persons on survey vessel and 48 in total for the 4 support/chase vessels) and the flow rate determined by the US Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) for EIA in the Gulf of Mexico (**75L/person/day for black water** and **110L/person/day for grey water**). The estimated seismic survey duration is ~105 days.
Grey water (m^3) (all domestic water with the exception of the flush toilets)	1,247	

2.6.3.2. Deck and bilge water

The deck water comprises rainwater and deck washdown water of the survey vessel. The run-off water is usually collected by an open drain system.

The deck area free space comprises an area of ~106.8m by 19.2m at waterline metres (according to the *Polar Duchess* specifications– see Annex 2) and all water falling within this area will be contained in isolated drainage systems. Annual rainfall in the M15 Block area is in the order of 3,890mm/year. However, considering that the seismic survey is planned to take place in the first quarter 2016, the rainwater and deck

washdown water volumes are likely to be very small because during these months there is very low rainfall (~ 20mm/month in average for the first quarter).

Bilge tanks receive fluids from many parts of the vessel, including machinery spaces. Bilge water can contain water, oil, dispersants, detergents, solvents, chemicals, particles and other liquids, solids or chemicals. This can cause a localised reduction in water quality if not treated prior to discharge.

In order to minimise the potential impacts associated with oils in bilge and deck washdown water, no water will be discharged without prior on-board treatment. These wastewater releases will comply with relevant Myanmar regulations and MARPOL 73/78 Annex I requirements. The table below summarizes the deck and bilge water production assumptions.

Table 2-11: Summary of deck and bilge water estimations

Waste stream	Quantity (m^3)	Assumption for estimation
Deck water	147	Survey vessel = 106.8 x 19.2m and rainfall about 1mm/month in the considered period. Support vessel = 90.5 x 14.6m and rainfall about 1mm/month 4 support/chase vessels The seismic survey duration is anticipated to be ~105 days or 3.5 months
Bilge water	931	53.2m^3/month, based on previous experiences and studies 5 vessels and anticipated duration of ~105 days or 3.5 months

2.6.4. Hazardous and non-hazardous waste

A variety of non-hazardous solid wastes will be generated during the seismic survey such as glass, paper, plastic and wood. Much of this is associated with galley and food services operations and with operational supplies such as shipping pallets, containers and protective coverings.

No solid wastes will intentionally be disposed of into the marine environment. All solid wastes must be collected and shipped to shore. Comminute or ground food wastes (i.e. <25 mm diameter) can be discharged in the survey area or surrounding waters in compliance with MARPOL regulations. Hazardous wastes from lubricants, filters, chemical containers, used equipment, will be stored and consolidated for onshore disposal.

Table 2-12: Estimated wastes and emissions from the 3D seismic survey

Waste stream	Quantity (t)	Assumption for estimation
Hazardous wastes	15	Estimate based on waste records database from previous similar studies. Waste generated is based on vessels utilized during the installation phase activities which will have a similar waste production schedule as the current project: **10 tonnes of hazardous waste/vessel/year** and **434 tonnes of non-hazardous waste/vessel/year**. The survey duration is 3.5 months in total; 1 survey vessel and 4 support/chase vessels.
Non-hazardous wastes	635	
Domestic waste	42m^3	Based on the last seismic survey study of similar duration performed by Artelia in the area.

2.7. IMPACT PRODUCING FACTORS

Based on the project description, impact-producing factors identified can be divided into two different categories.

1) The first category is related to 3D seismic acquisition activities:
   - **Underwater noise** generated by the seismic sources (discharge of airguns through the survey area).
2) The second category is related to the activities of the vessels:
   - **Physical presence**: the vessels may interfere with shipping activities; and/or with commercial fishing. In addition, collision with marine mammals and other protected marine species (such as turtles and whale sharks) can occur.
   - **Atmospheric emissions**: emissions primarily from fuel combustion on the survey and support/chase vessels.
   - **Discharge to sea and solid wastes:** sewage, grey water and food waste discharge, impact to the marine environment from incorrect handling and disposal of chemicals, solid and hazardous wastes.
   - **Generation of light**: generation of artificial light aboard the vessels is necessary for safety reasons; however it can attract marine fauna close to the vessels, and have an impact on local communities if the activity is taking place close to the coast.
   - **Accidental releases:** spills of MGO during at-sea bunkering, or resulting from vessel collisions.

3. PROJECT PROPONENT DETAILS

CFG ENERGY PTE. LTD.

The operator of the project is CFG Energy Pte. Ltd.

- CFG Energy Pte. Ltd. ("CFG") was founded by a group of investors and key team members of various oil and gas companies operating in Canada and worldwide.
- CFG's experienced management team has extensive expertise in both onshore and offshore oil/gas exploration and development, particularly in Asia, with over 250 years of combined industry working experience.
- CFG was established to pursue international E&P opportunities in Asia.
- CFG has strong financing support from its existing shareholders and financial institutions based in North America and Asia
- CFG participated in Myanmar's November 2013 offshore bidding round along with TRG M15 Pte. Ltd. (TRG) and Myanmar's Century Bright Gold Pte. Ltd. (CBG).
- CFG, TRG and CBG were awarded Shallow Offshore Block M-15 on March 2014. Under the terms of joint bid, CFG, being the operator, will undertake a seismic program and drill two wells.
- CFG Signed the Production Sharing Contract with the Myanmar Oil and Gas Enterprise on March 30th, 2015

CFG Work Programme

- Continue fundraising – 2nd Q 2015
- Hire staff for local office in Yangon, Myanmar – 2nd Q 2015
- Prepare Environmental and Social Impact Studies – 2nd Q 2015 to 3rd Q 2015
- Continue reprocessing previously acquired seismic and plan for a 3-D seismic program - 2015 to 2016
- Continue performing geological and reservoir evaluation of existing data as well as review well information from previously drilled location to identify potential reservoir structures – 2015 to 2016
- Conduct seismic survey after IEE approval
- Drill Initial well – 2016

Board of Directors

Songning Shen - Mr. Shen is a professional geologist registered in Alberta, Canada. Mr. Shen is currently the CEO and director of Caiterra International Energy Corporation which is listed in the Toronto Stock Exchange – Venture Exchange. He was a Co-founder, Co-Chairman and Director of Sunshine Oilsands Ltd., a company listed on the Hong Kong Stock Exchange and the Toronto Stock Exchange. Sunshine holds over 1.0 million acres of oilsands leases and has a resource base of 4.2 billion barrels. Mr. Shen holds a M.Sc. from the Norwegian University of Science and Technology.

Kevin Flaherty - Mr. Flaherty, currently residing in Vietnam, is a managing director of Energy & Natural Resource Investments at Saigon Asset Management. He has spent his entire career working in the international energy and natural resource sector, and has been active in Southeast Asia for over 20 years. He co-founded two firms in Vietnam: Tiberon Minerals and Keeper Resources; both of which were subsequently acquired by Asian-based investment firms.

Greg Turnbull - Mr. Turnbull is currently a senior partner at the Calgary office of McCarthy Tétrault LLP. He currently serves as a director of a large number of publicly listed oil and gas E&P companies, including Sunshine Oilsands Ltd., Crescent Point Energy Corp., Storm Exploration Inc., Heritage Oil plc, Hyperion Exploration Corp. and Marquee Energy Ltd.

Raymond Fong - Mr. Fong has over 22 years of experience in the oil and gas industry. Mr. Fong was a director of China Coal Corporation from 2007 to 2012. He held previous directorships with Abenteuer Resources Ltd., Stealth Ventures Ltd., Zapata Capital Inc., director and president of Ultra Capital Inc. and a former director of United Rayore Gas Ltd. Ray is currently serving as a Director for Sunshine Oilsands Ltd.

Wei (David) Wu - Mr. Wu has over 30 years of experience as owner and operator of businesses in China. He is a Director of West Pacific Petroleum and Yunnan Tianli Trading Ltd. He has also been a Manager of Husky Energy Challenge Holdings since September 2005. Currently, Mr. Wu serves as the Chairman of the Board of Directors of Caiterra International Energy Corporation.

Management

Shan Li - Vice President of Finance. Ms. Li has been the Investment Manager of the Strategic Investment Division of the Bank of China Investment Group since 2010 and previously served as the Vice-President of BOCI Asia Limited. In both companies, she identified, developed, and maintained client relationships. She has been involved in numerous IPOs and major M&As transactions.

Perla Woo - Vice President of Corporate Operations and Treasurer. Ms. Woo is the Vice-President of Caiterra International Energy Corporation. She was a Co-Founder of Sunshine Oilsands Ltd. and has been the Senior Vice President of Sunshine Oilsands from October 2007 to September 2008 and previously held the position of Vice President, Engineering. Ms. Woo has over 20 years experience working in the oil and gas industry in Canada in the fields of reservoir engineering, exploitation, and pressure transient analysis.

Kyaw Moe - Special Representative of CFG to Myanmar. Mr. Kyaw Moe is Founder and CEO of Asia Network Service Inc., a company providing business consulting service and trading with South East Asia Countries including China. Kyaw Moe has about 15 years of media and communication working experience in both corporate and radio station including Voice of America (VOA) radio.

Richard W. Pawluk - Corporate Secretary. Mr. Pawluk has been a partner of the law firm of McCarthy Tétrault LLP since 2003. He has worked for the law firms Donahue LLP and Code Hunter LLP. He has acted for a number of private and publicly traded oil and gas exploration and production companies with assets in Canada, the United States of America, Egypt, Pakistan, Albania, Portugal, Columbia and Turkey, advising on all types of domestic and international financing and acquisition.

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THE ENERGY CONSORTIUM

CFG Pte. Ltd. has two partners on the M15 Block: Century Bright Gold Pte. Ltd. and TRG M15 Pte. Ltd.

Century Bright Gold Pte. Ltd (CBG)

CBG is a local partner, subsidiary of the KMA Group, founded in 2008 to engage in the extractives sector. Its current activities include running an underground gem mining project in Mogok.

Century Bright Gold Co.,Ltd. is a subsidiary of the KMA Group, it was formed in 2008 with the principal objective of doing responsible mining operations in Myanmar for the prosperity and development of the isolated and challenging terrain.

With their wide range of contacts with the government and ministries, the technocrats at the helm of KMA Mining have identified high priority sites for mining operations and have successfully set-up gold mining activities in Sagaing, Mandalay and Bago divisions.

TRG M15 Pte. Ltd.

TRG was established by the current Chairman Anthony Trevisan 30 years ago. The current Managing Director is Simon Trevisan. TRG is a diversified business enterprise operating across the oil and gas, mineral resources, industrial and property sectors. TRG has founded and managed over 20 public companies listed in major stock exchanges, it has raised over a billion dollars in capital.

4. INFORMATION ON EXPERTS

Artelia operates a branch office in Yangon since October 2012 and has already performed several offshore studies in Myanmar. Our project team is as follows:

Table 4-1: Presentation of the team of experts

Name	Specific knowledge / skills	In charge of
Marine JEAN-RAMIS	Environmental engineer, Marine expert	Section 2, 3 Section 5: 5.1 to 5.4, 5.6 Section 6 Section 7: 7.1 to 7.6, 7.8 Section 8, 10 & 11
Sara MULLER	Social impact management specialist	Section 5: 5.5, 5.6 Section 7: 7.7, 7.8 Section 9
Charles BOUHELIER	Environmental engineer	Responsible of the data collection Meeting with the identified stakeholders
Frederica PACE	Bioacoustics expert	Section 7: 7.1
Maud DELLONG	Environmental engineer	Section 1, & 4 Section 2: 2.6 Technical control quality
Mark MCLELLAN	Projects Director	Project management Technical peer review QA/QC

5. DESCRIPTION OF THE ENVIRONMENT

5.1. PHYSICAL ENVIRONMENT

Myanmar is the largest country in mainland South-East Asia comprising a land area of 676,577km^2 located geographically between 9°32' and 28°31' N latitude and 92°10' and 101°11' E longitude stretching over 2,280 km. It shares common maritime boundaries with Bangladesh in the northeast of the Bay of Bengal and with Thailand and India in the Andaman Sea.

Myanmar slopes from an elevation of 5,881m in the extreme north at Mount Hkakabo (the country's highest peak) to the Ayeyarwady (Irrawaddy) and Sittang (Sittoung) river deltas at sea-level in the south. There are three main mountain ranges, namely the i) Rakhine Yoma (western range 400km including the Patkai, Naga, Mizo, Chin and Arakan hills/mountains), ii) Bago Yoma/Pegu Mountains (south-central range 435km), and ii) the Shan Plateau (eastern range) (Figure 5-1a).

The mountain ranges divide the country into three river systems, the: i) Ayeyarwady (Irrawaddy), which is the longest river system in Myanmar, ii) Sittoung; and ii) Salween (Thanlwin) (Figure 5-1b). The Ayeyarwady (2,170km long), with its major tributary the Chindwin (960km) has a vast drainage area (~255,081km²) (Figure 5-1c) that supports a range of socio-economic sectors and livelihoods in the country. As the Ayeyarwady enters the sea it forms a delta of ~50,400km^2 in area.

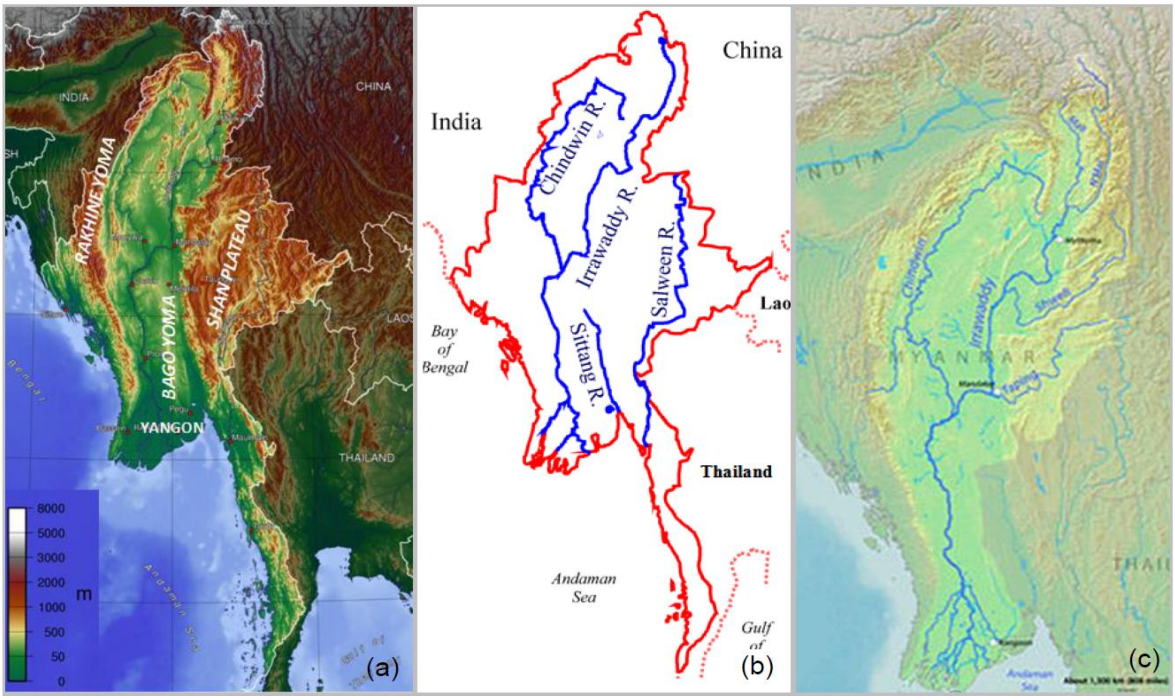


Figure 5-1[1]: Elevations and rivers in Myanmar

a) Elevation above sea-level and mountain ranges in Myanmar[2]; (b) major rivers in Myanmar and (c) the Ayeyarwaddy River Basin[3]

[1] Myanmar National Adaptation Programme of Action (Napa) to Climate Change, 2012
[2] http://en.wikipedia.org/wiki/Burma
[3] http://en.wikipedia.org/wiki/Irrawaddy_River

The country can be divided into three main agro-ecological zones: i) Central Dry; ii) Coastal; and iii) Hilly (Figure 5-2a). These zones can be further subdivided in eight physiographic regions: i) Northern Hilly; ii) Central Dry; iii) Rakhine Coastal; iv) Western Hilly; v) Eastern Hilly (Shan Plateau); vi) Ayeyarwaddy Delta; vii) Yangon Deltaic; and viii) Southern Coastal (including Tanintharyi coastal strip) (Figure 5-2b)[4].

The Myanmar continental shelf covers an area of ~230,000km^2 with a relatively wider portion in the central and southern parts. The coastal zones of Myanmar can be subdivided into three main areas, namely Rakhine Coast, Ayeyarwady Delta and Tanintharyi Coast.

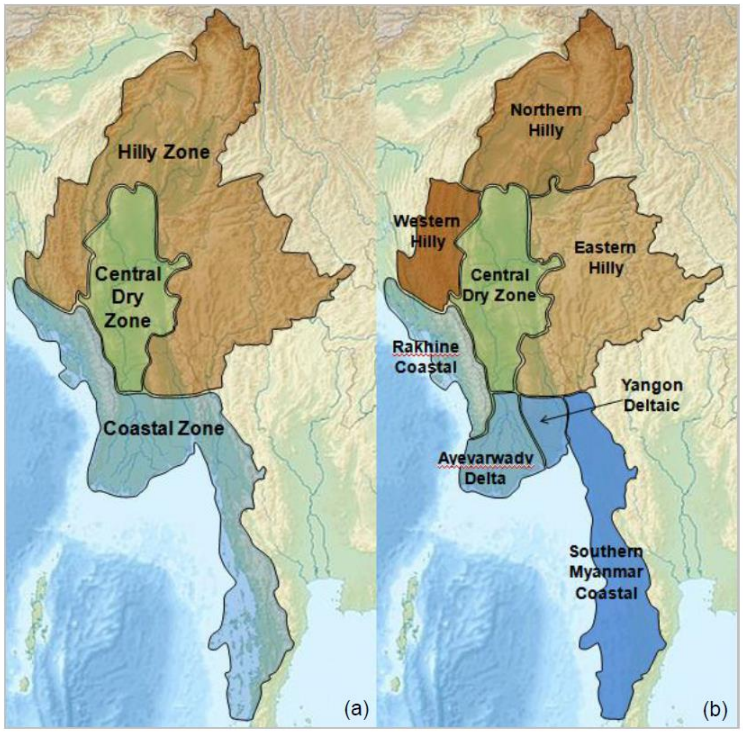


Figure 5-2[5]: Myanmar's agro-ecological zones (a); and physico-geographic regions (b)[6]

The current project is located in the offshore area of the Tanintharyi Coastal Zone (Southern Myanmar costal) in the Andaman sea.

The Thanintharyi Coastal Area is the longest coastal region of Myanmar, at around 1,200km. It covers south of the Gulf of Mottama up to the mouth of Pakchan River. It includes Myeik Archipelago. This archipelago extends from Mali Island to Similand Island and contains about 800 islands over 34,340 sqkm. The coastal plain is narrow and gradually rises towards the east to become Tanintharyi Yoma (highest peak : 2,073m). BOLME, Country report on pollution, Myanmar, 2011)

5.1.1. Geomorphology and seismology

5.1.1.1. Geomorphology

The project is located within the continental shelf (depth comprises between 200-2000m).

At the Eastern/Northern sides of the project area, specific geological structures are present, namely: the Sagaing Fault system (SFS ~230 km of the project location), the Martaban canyon (~120 km of the project location) and the Alcock rise seamount (~180 km of the project location).

[4] http://www.roadtomandalay.com/business/myanmar_burma.htm
[5] Myanmar National Adaptation Programme of Action (Napa) to Climate Change, 2012
[6] Base topographic maps: http://en.wikipedia.org/wiki/Hlawga_National_Park

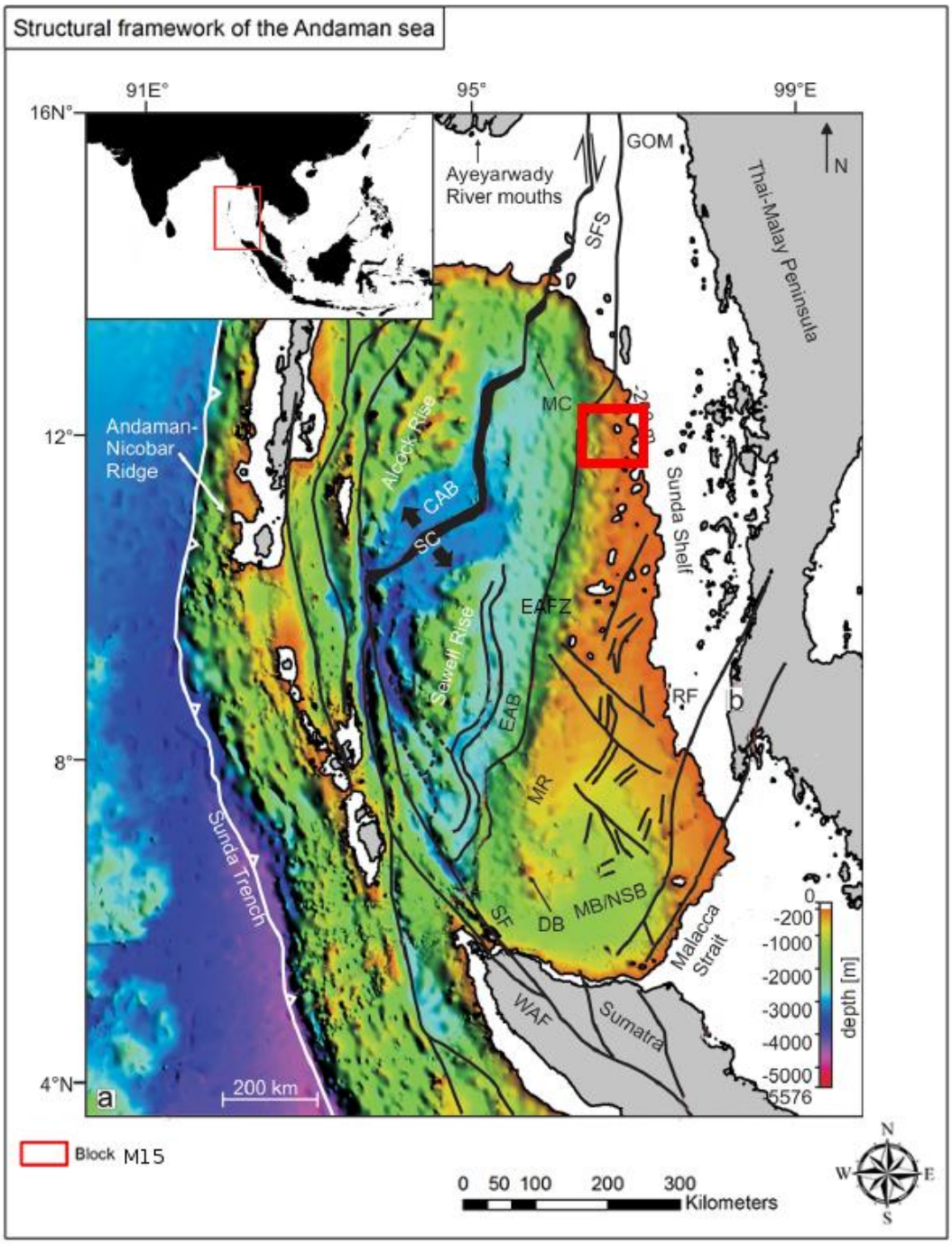


Figure 5-3: Structural Framework of the Andaman Sea

SOURCE: SUBMARINE MASS WASTING AND ASSOCIATED TSUNAMI RISK OFFSHORE WESTERN THAILAND, ANDAMAN SEA, INDIAN OCEAN, J. M. SCHWAB, S. KRASTEL, NATURAL HAZARDS AND EARTH SYSTEM SCIENCES, 2012 (SC: SPREADING CENTRE, CAB: CENTRAL ANDAMAN BASIN, EAB: EAST ANDAMAN BASIN, GOM: GULF OF MARTABAN, MR: MERGUI RIDGE, AEFZ: EAST ANDAMAND FAULT ZONE)

The vicinity of the study area is characterized by quite diversified structures, including the presence of:

- Seamounts;
- Canyons, and,
- Associated mud slides.

These geological structures may have a specific interest for some marine species.

Martaban canyon and associated mud slides

The Andaman Basin has an area of 800,000km² separated from the Bay of Bengal by the Andaman-Nicobar Ridge. The basin's principal sediment source is the Irrawaddy River's annual load of about 265.l06 metric tons of silty clay.

Mud slides are generally localised between the continental shelf or slope and abyssal depths; phenomena of gravity transport may occurs due to the existing degradation of aquatic fauna and the huge amount of sediments coming from Irrawaddy Rivers. Therefore, the slope failures lead to mud slides.

Seamounts

Seamounts are manifestations of crustal tectonics and volcanism, and are also sites of biodiversity and hydrothermal events. Unlike islands, seamounts never reach the surface of the ocean. These are special ecosystems which often contain a biomass and biodiversity higher than the surrounding water bodies. The waters are shallow and the substrate, often harder, provides habitat for marine species absent in the area.

Two seamounts have been identified in the vincinity of the project area: Alcock rise and Sewell seamounts. Table below gives the distance and main characteristics of these seamounts.

Table 5-1: seamounts within the project area

Name	Location	Characteristics
Alcock rise seamount	12°30′N 94°40′E	270 km long and 100 km wide. Maximum relief 2400 m. Slope > 3°. Massive slabs of unaltered intergranular basalt. Pre-Pleistocene age, distinct magnetic anomalies.
Sewell rise seamount	9°25′N 94°45′E	Pleistocene volcanic episode, distinct magnetic anomalies Size and relief similar to Alcock Seamount.

SOURCE: SRIDHAR D. IYER*, PRANAB DAS, NIYATI G. KALANGUTKAR AND CHINTAN M. MEHTA, 25 MAY 2012, SEAMOUNTS – WINDOWS OF OPPORTUNITIES AND THE INDIAN SCENARIO, *CURRENT SCIENCE* (VOL. 102, NO. 10)

The nearest seamount (Alcock Seamount) is situated at approx. 180km of the project area.

5.1.1.2. Seismology

Myanmar is located in the very active tectonic area which includes the Burma oblique subduction, the Sagaing strike slip fault system and the Andaman opening region (Ir. Subagyo Pramumijoyo; Kyaw Linn Zaw; Kyaw Zin Lat, 2010).

According to USGS, the Sumatra-Andaman portion of the collision zone forms a subduction zone megathrust plate boundary, the Sunda-Java trench, which accommodates convergence between the Indo-Australia and Sunda plates. This convergence is responsible for the intense seismicity and volcanism in Sumatra. The Sumatra Fault, a major transform structure that bisects Sumatra, accommodates the northwest-increasing lateral component of relative plate motion.

The project area is localized at a relative proximity of The Ridge Transform Sagaing Fault (Cf.

Figure 5-4). Main earthquakes are located in the vicinity of Coco and Andaman Islands, between the Trench parallel shear of Coco Delta and the Sagaing Fault. The most recent undersea megathrust dates of 2010. The most impressive was the 2004 earthquakes which led to Indian Ocean Tsunami. With a magnitude of Mw 9.1–9.3, it was the third largest earthquake ever recorded on a seismograph.

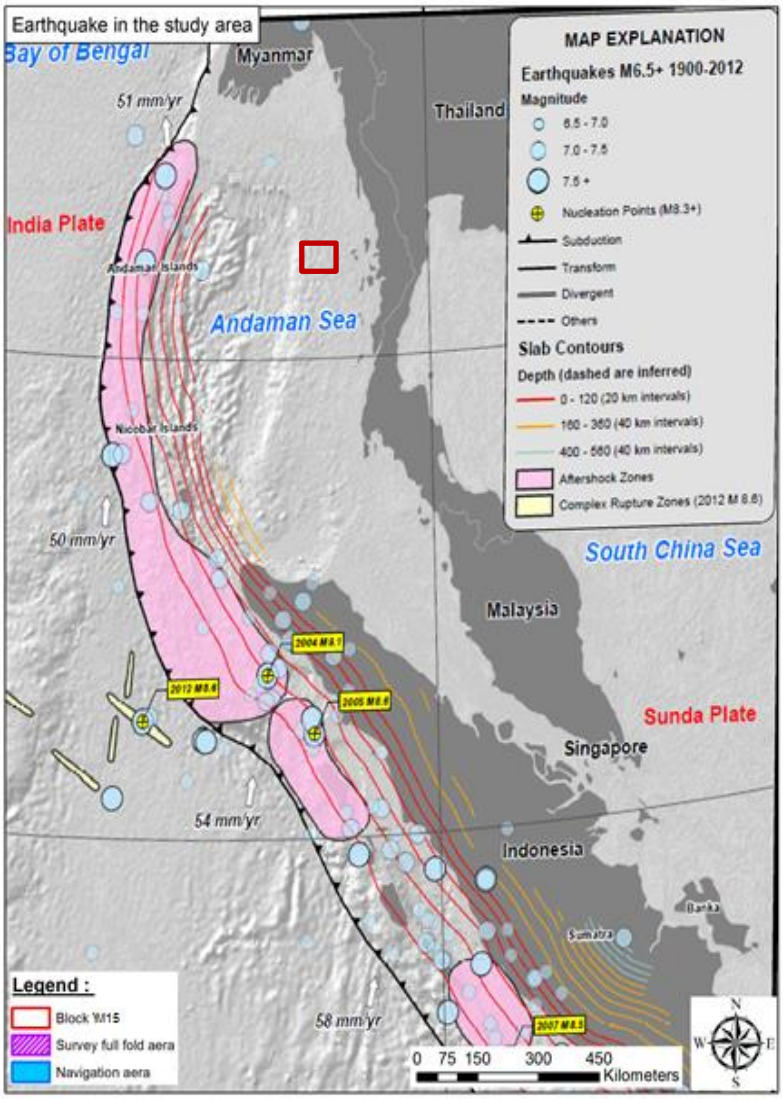


Figure 5-4: Earthquakes in the study area

SOURCE: YU WANG, EARTHQUAKE GEOLOGY OF MYANMAR, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASSADENA, 2013

5.1.1.3. Geology

The geology of the project area is characterized by silts and clays for upper layers due to the important sediment deposition coming from Irrawaddy River (e.g., annual load of about 265.10^6 metric tons of silty clay).

Contribution from the Irrawaddy River constitutes 86% of the central trough's sediment, the difference being foraminiferal carbonate. Areal patterns of sediment indicate that transport of Irrawaddy sediment into the basin is related to bottom topography.

In general, the sub-sea geology is simple and contains no major structural features, like faulting and anticline/syncline systems. The project is located on the continental shelf with no specific anomalies.

5.1.2. Meteorological Conditions

Most of the country of Myanmar lies between the tropic of Cancer and the Equator but although the country is located in the monsoon region of Asia, its climate is greatly modified by its geographic position and its topographical relief. The cold air masses of Central Asia bring snow to the northern mountains for two months of the year, but this mountain wall prevents the cold air masses from moving farther south, so that Myanmar lies primarily under the influence of the monsoon winds.

Its climate can be described as tropical monsoon characterized by strong monsoon influences, a considerable amount of sun, a high rate of rainfall (coastal regions receiving over 5,000mm of rain annually) and high humidity. Temperature in the country varies from 19°C to 38°C and humidity from 66% to 83%.

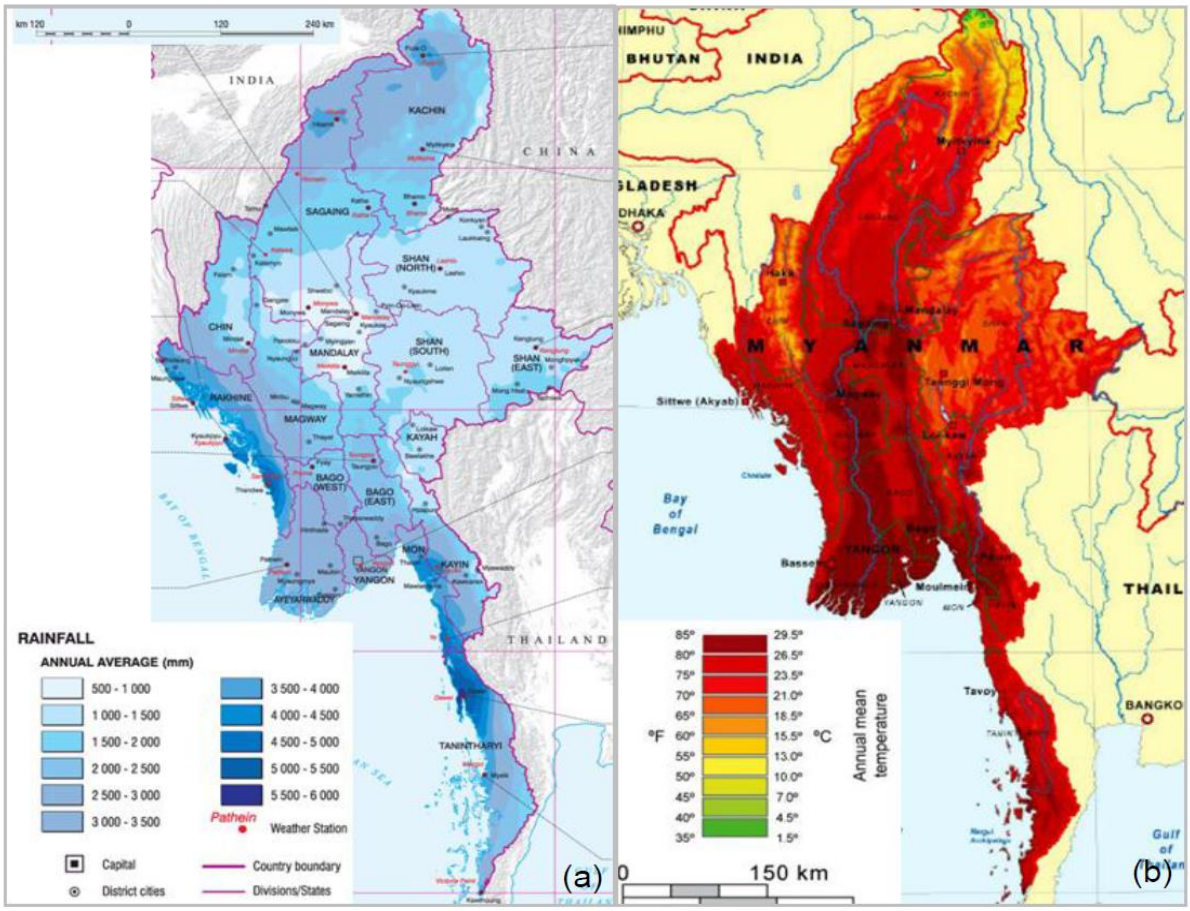


Figure 5-5[7]: Annual average rainfall (a); and annual average temperatures over Myanmar (b)

In the Andaman Sea, four seasons are distinguished:

- The Northeast Monsoon, which brings fine cool weather and very little rainfall to the area;
- The Pre-monsoon transition period, characterised by relatively weak and variable winds (prevailing land and sea breezes) and hot temperatures (37°C on the coast);
- The Southwest Monsoon, characterised by overcast skies, nearly daily drizzle, interspersed with squalls, thunderstorms and very heavy torrential rains (more than 1,200 mm) over the Tenasserim coast on the east side of the Andaman Sea;

[7] http://dwms.fao.org/atlases/myanmar/downs/atlas/p030_rainfall_table.pdf

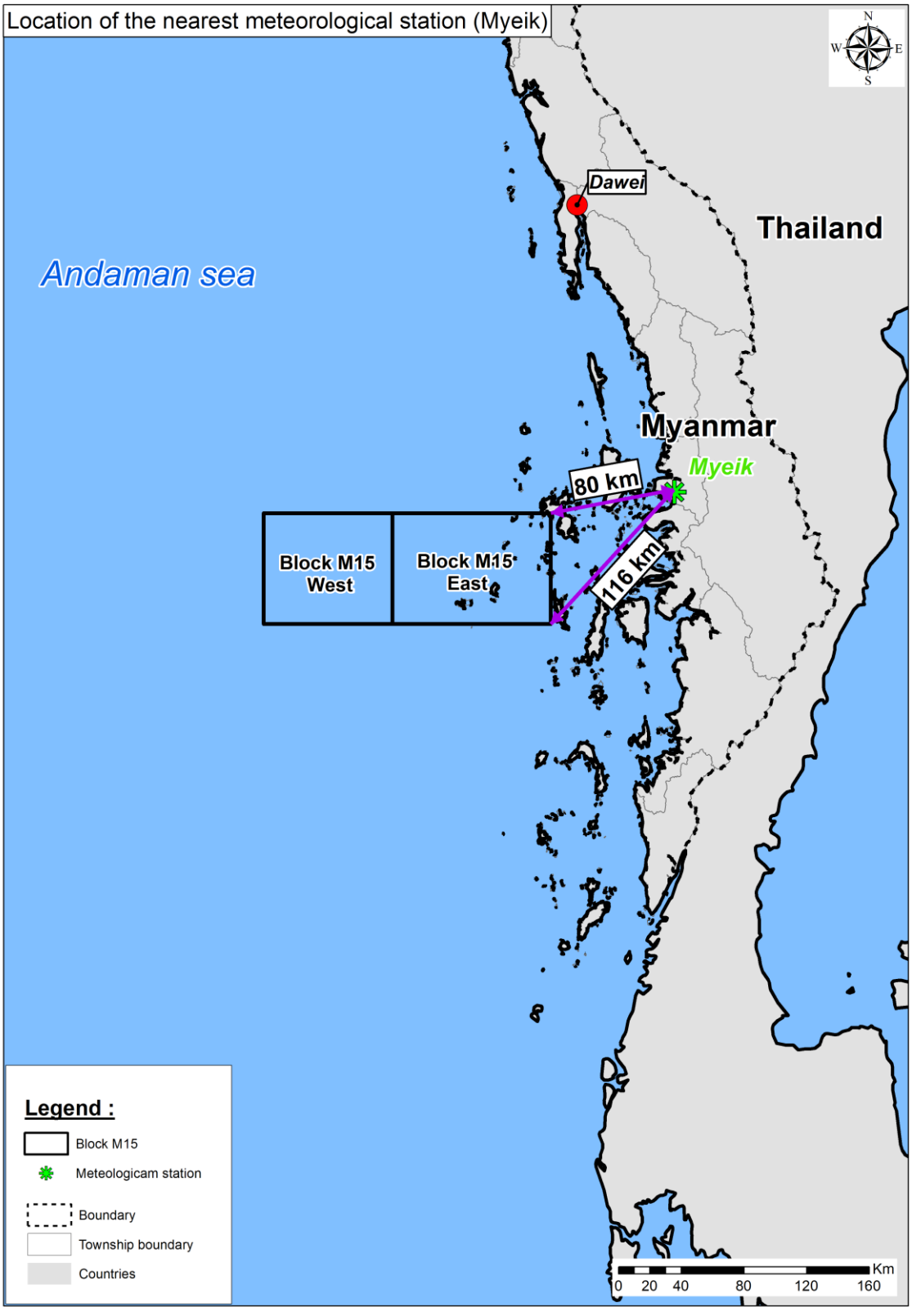
- The Post-Monsoon Transition, which is relatively similar to the Pre-monsoon transition with cooler temperatures.

The calendar of the four seasons in the Union of Myanmar is presented in Table 5-2.

Table 5-2: Calendar of the four seasons in the Union of Myanmar

	J	F	M	A	M	J	Jy	A	S	O	N	D
Northeast Monsoon												
Pre-monsoon transition												
Southwest monsoon												
Post Monsoon transition												

According to the Department of Meteorology and Hydrology of the Myanmar's Ministry of Transport the closest coastal meteorological station to the M15 Block is Myeik (~160km from the block) (Figure 5-6). Details of the Myeik meteorological station are provided in Table 5-1.



Source : Myanmar Information Management Unit (MIMU)

Figure 5-6: Location of the nearest meteorological station to the M15 Block

5.1.2.1. Temperature

In Myanmar, mean temperature ranges from 32°C in the coastal and delta areas to 21°C in the northern lowlands. Seasonal temperatures generally vary greatly throughout most of Myanmar. In the Central Dry Zone temperatures range from a maximum of 40°-43°C in the hot/dry season to 10-15°C in the cool/relatively dry season and decrease to -1ºC or 0ºC at times in the highlands. Seasonal temperatures do not change much in the southern parts of the country. Myanmar's west coast is subject to frequent tropical storms and cyclones during October to December with a secondary peak in April to May.

According to the following data, the average annual temperature at Myeik is 26.6°C (Figure 5-7). The maximum temperatures are recorded in April (28.5°C) and the minimum in January (25.6°C).

Table 5-3: Average temperatures recorded in Myeik

T (°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av.[3]
Maximum[1]	30.6	31.8	32.4	33.1	31.9	29.7	29.3	29.2	29.3	30.2	30.5	30.6	**30.7**
Minimum[2]	20.6	21.8	22.9	24.0	24.0	23.5	23.0	23.0	23.0	23.0	21.8	20.6	**20.6**
Mean	25.6	26.8	27.6	28.5	27.9	26.6	26.1	26.1	26.1	26.6	26.1	25.6	**26.6**

Note: (1) Average maximum temperatures; (2) Average minimum temperatures; (3) Average annual temperatures

Source: World Meteorological Organization/ Myanmar's Ministry of Transport/ climate-data.org

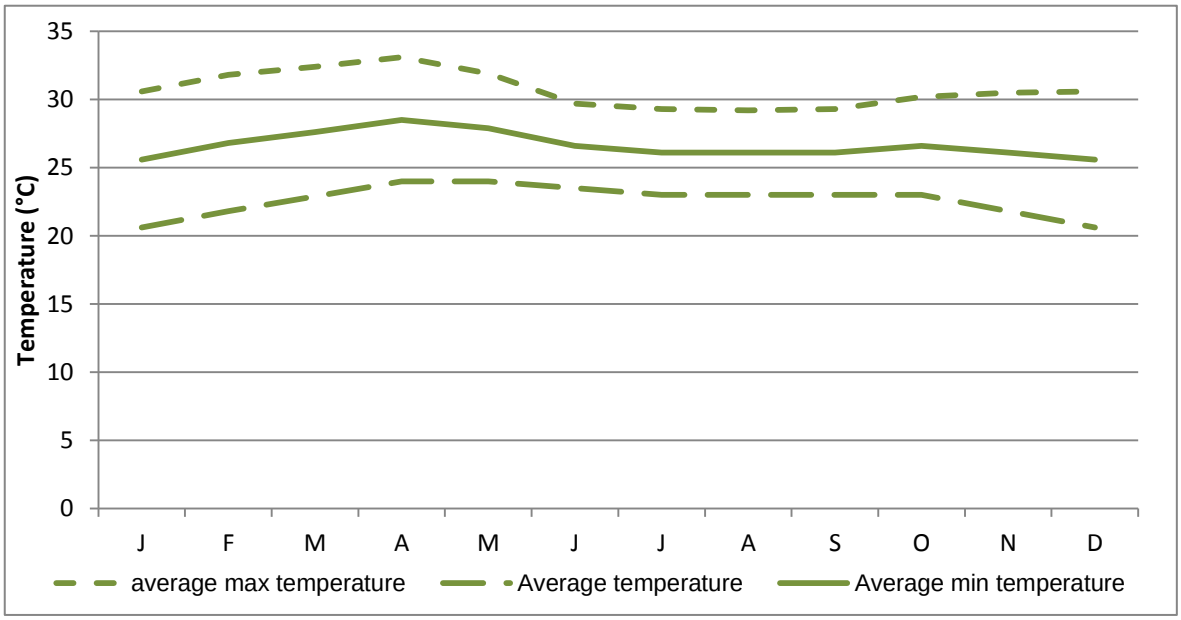


Figure 5-7: Average temperatures at Myeik

5.1.2.2. Rainfall

Rainfall is abundant in Myanmar and often very heavy during the wet season.

Mean annual rainfall is the lowest in the Central Dry Zone (500-1,000 mm per year) increases in the eastern and northern hilly regions and is the highest in the southern and Rakhine coastal regions (2,500–5,500mm)[8].

Levels are highest along the coast exposed to the moist Southwest Monsoon from Chittagong to Victoria Point, which covers the entire Myanmar coast. Intense rainfall events are quite common with up to 250mm in a day and 100mm in one hour, depending on the period.

Two monsoon systems influence the area to create four seasons in the Andaman Sea:

[8] Egashira, K. and A. T. Aye. 2006. Cropping characteristics in Myanmar with some case studies in Shan State and Mandalay Division. Journal of the Faculty of Agriculture, Kyushu University 51:373.

- Northeast monsoon: December to March, cool season (winter);
- Pre-monsoon transition: April to May, hot season (spring);
- Southwest monsoon: June to September, rainy season (summer);
- Post-monsoon transition: October and November (autumn).

Table 5-4: Average rainfall recorded in Myeik

(mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average rainfall	13	41	68	101	365	815	754	775	577	296	72	13	**3,890**

Source: World Meteorological Organization/ Myanmar's Ministry of Transport / climate-data.org

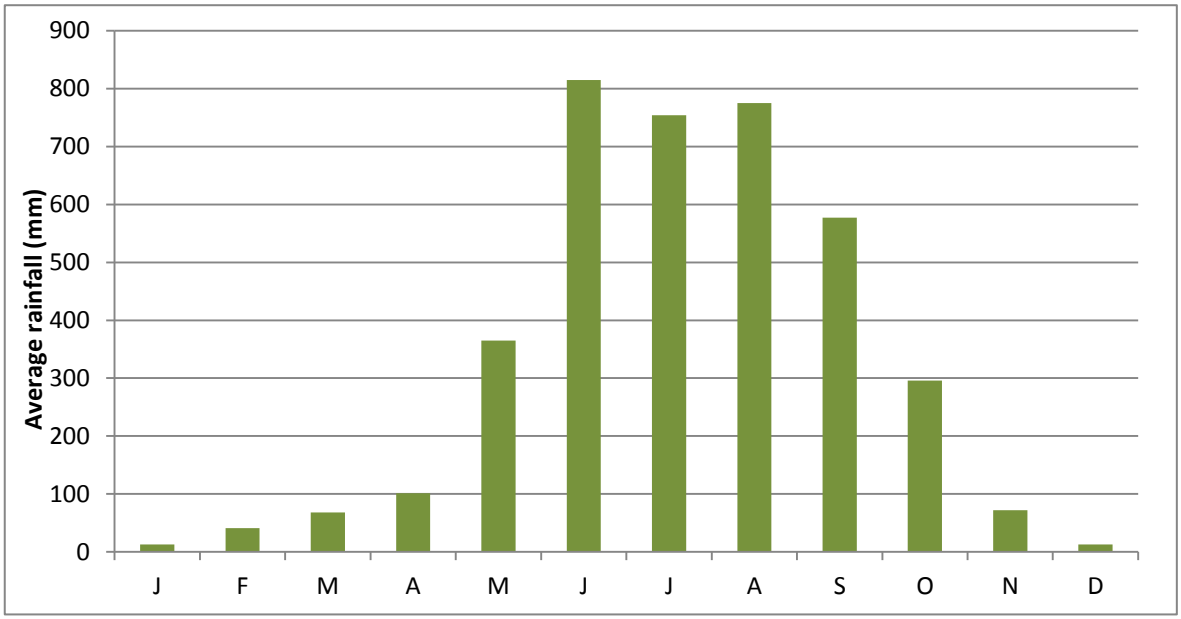


Figure 5-8: Rainfall at Thandwe

As shown in Table 5-3 and Figure 5-8, the driest months are January and December. Most rainfall occurs in June-August with an average of 781mm. The average annual in Myeik rainfall is 3,890mm.

The project area is impacted by abundant rainfall during the wet season, with frequent thunderstorms.

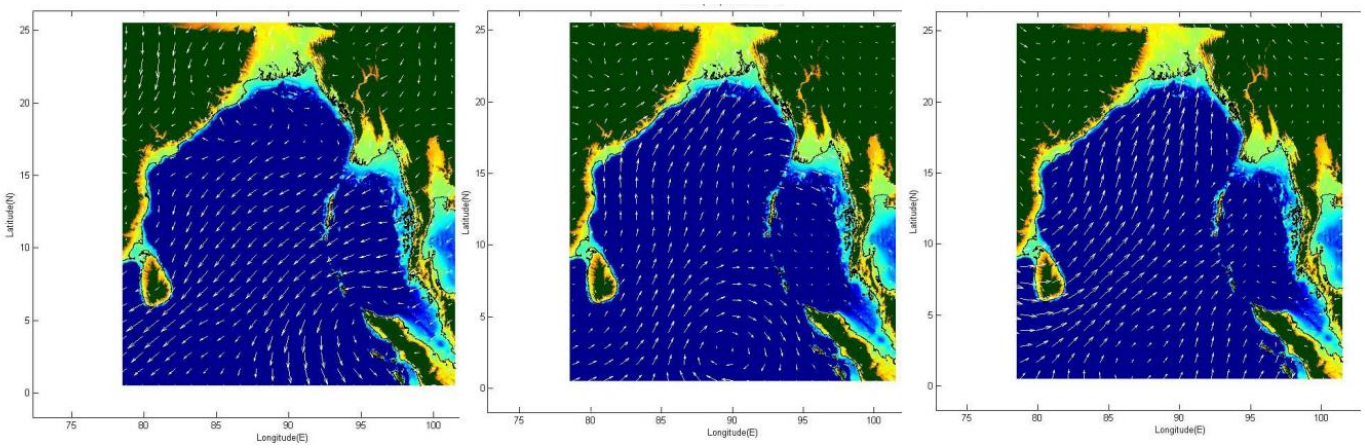
5.1.2.3. Humidity

The main differences in the humidity values occur during the seasonal changes from the moist equatorial air of the Southwest Monsoon to the dry continental winter monsoon. The Northeast Monsoon generates high moisture levels over the south and south-west. Myeik is permanently humid with an annual average relative humidity of 80%.

5.1.2.4. Wind

Winds in Northern Andaman Sea are generally gentle to moderate. The strongest winds mainly occur during the Pre-monsoon Transition (April) and the Southwest Monsoon (summer period) and are southwest orientated. The winds are then moderate changing to north-easterly during the Post-monsoon Transition (November) and north-westerly during the Northeast Monsoon (January).

Tornadoes recorded in the area are considered small scale and while very destructive, they are rare in the study area. Waterspouts are more common, and their destructive path is more limited. They occur throughout the wider region, mainly in the south.



a) Nort-East monsoonal wind (January)

b) Monsoon-transitional wind (May)

c) South-West monsoonal wind (September)

Figure 5-9: Changing patterns of wind circulation (cm/s) in the Bay of Bengal and Andaman Sea

Source: (international conference on environment Science and Engineering, Singapore, 2012)

Description of the wind directions within the project area is described more in detail in section 5.2.3.

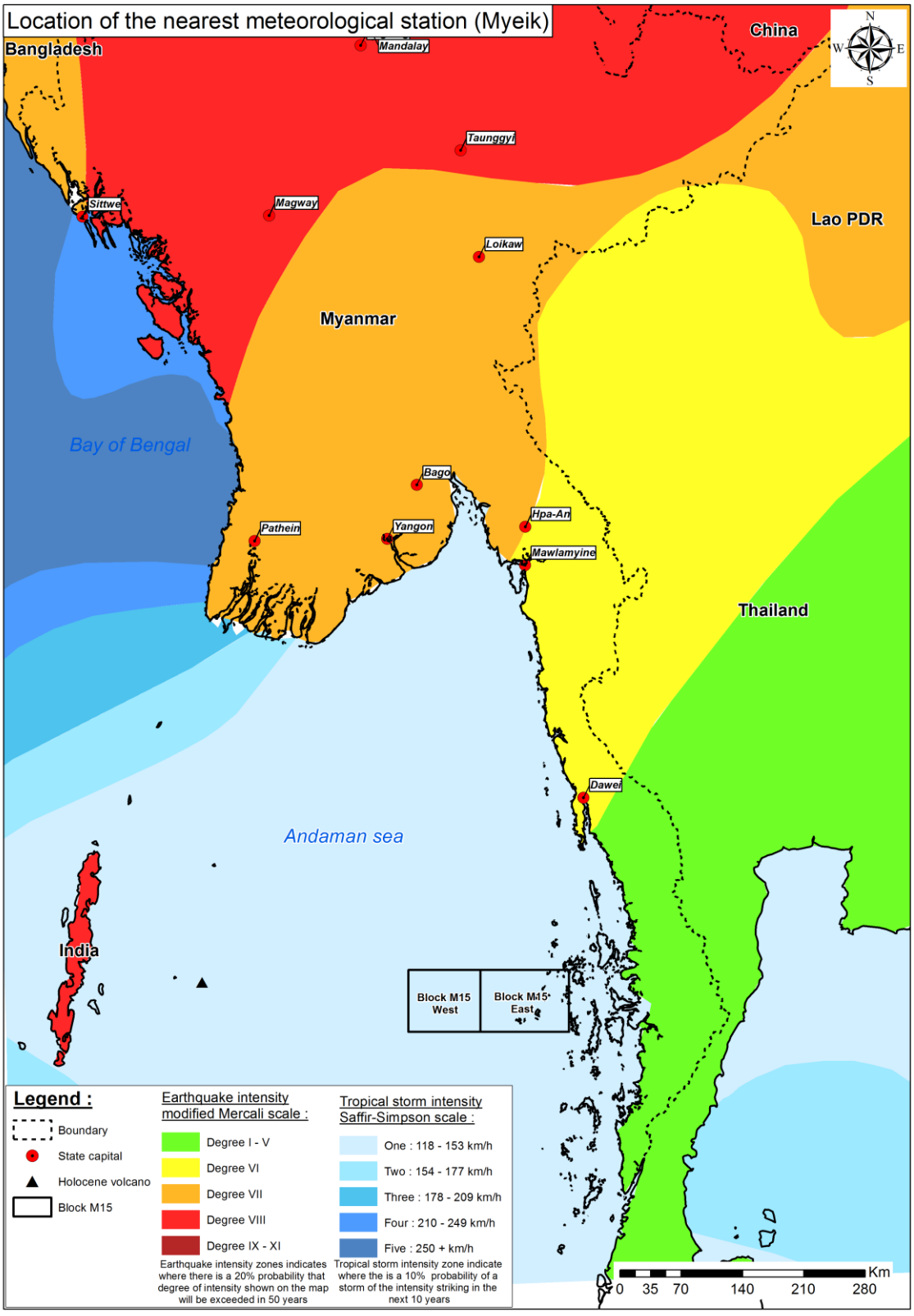
5.1.2.5. Vulnerability to natural hazards

Myanmar is exposed to multiple natural hazards including cyclones, earthquakes (Figure 5-10), floods, tsunamis and fires, and has been periodically hit by natural disasters.

According to OCHA, the tropical storm season in Myanmar occurs from May to November, with a peak of risk in October.

Taking into account the bar chart on the figure below, the major natural hazard risks in Myanmar are:

- Earthquakes;
- Tropical storms;
- Floods (onshore).



Source : Myanmar Information Management Unit (MIMU)

Figure 5-10: Natural hazard risks in Myanmar

The M15 block is potentially exposed to multiple natural hazards; including tropical storm. The highest risk of occurrence is from May to November, with maximal risk in October.

5.1.3. Regional Oceanography

5.1.3.1. Bathymetry

Water depths range from ~200m to 2,000m in the west part of the M15 Block (Figure 5-11).

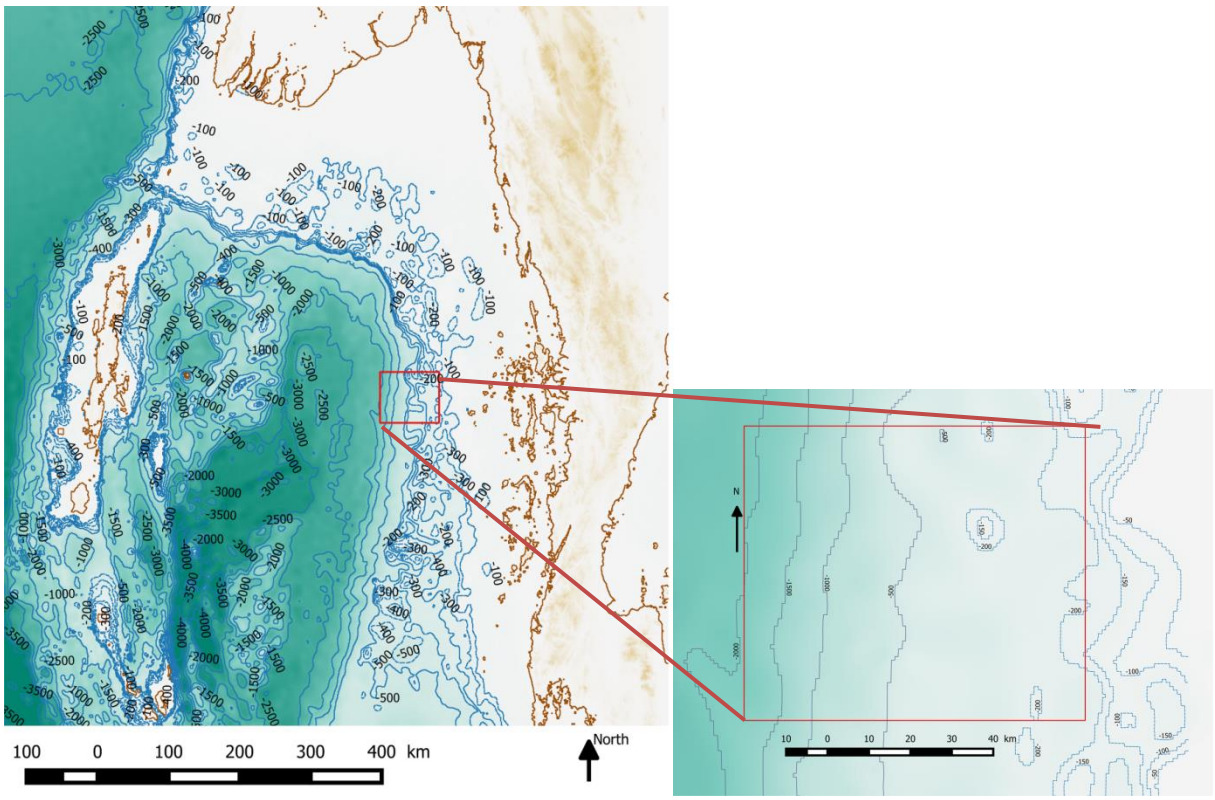


Figure 5-11: Bathymetry of the project area

5.1.3.2. Water masses and properties

Figure 5-12 shows the annual profiles for selected parameters at a station on Block 15, and compares the values to a station at the same latitude located just outside of the Andaman archipelago; note that some caution is required in the interpretation as the M15 profiles are based on small samples, particularly in the deeper layers.

Both stations feature many similarities, particularly warm low salinity waters at the surface, especially on M15. The waters deeper than 1250 m are slightly warmer at M15, presumably because the Andaman islands create a sill effect which prevents renewal of the bottom waters. The vertical temperature distribution in sea waters shows a maximum at the surface layer and then decreases with depth. The thermocline zone of the Tanintharyi coast is present at 50 meter depth to 230 meter depth (MyintPe, 2003). Oxygen depletion on M15 reaches a well-marked maximum at 250 m, but oxygen is less depleted than in the Bay of Bengal station due to the influence of the Ayeyarwady inputs. Below 1250 m oxygen saturation remains stable, again because of poor renewal of the waters. Depletion of silicate below 1250 m could also be explained by lack of renewal of the deepest waters, but the values plotted are derived from very few measurements.

Plotting the temperature salinity diagram (Figure 5-12) essentially shows three masses of water corresponding to linear sections of the plot: waters above 25°C or shallower than 100 m, which are under the influence of the Ayeyarwady, waters colder than 12°C or deeper than 500 m which have a fairly stable stability (with possibly

an inflection in the line at the 1250 m depth / temperature of 6°C, but data is insufficient to clearly show this), and finally the intermediate mixing zone between the two.

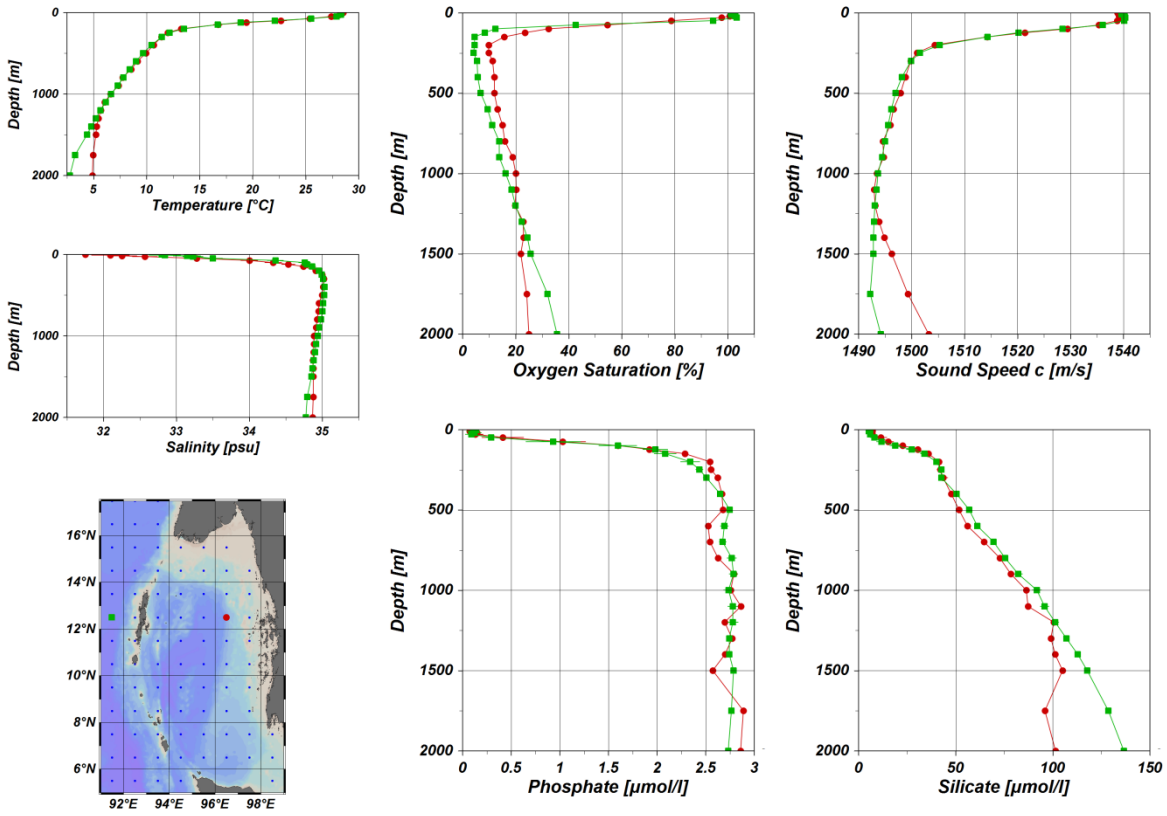


Figure 5-12: Profile of key parameters for a station on Block M15 (red), compared to a station at the same latitude in the Bay of Bengal (green)

Source: "World Ocean Atlas 2009

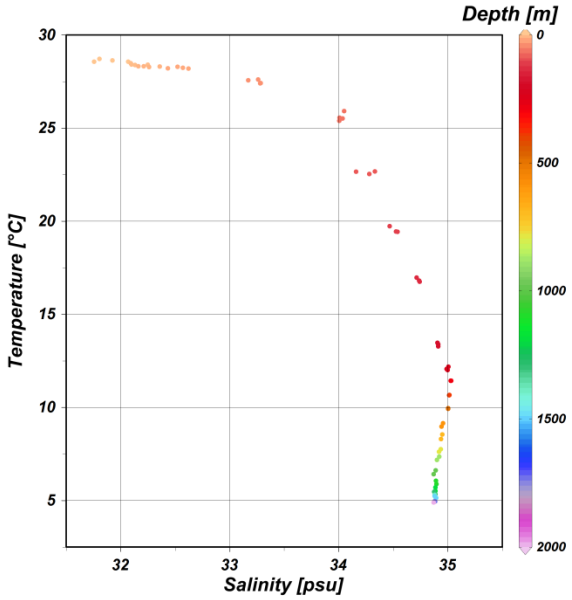


Figure 5-13: Temperature – salinity diagram of waters on Block M15

Source: "World Ocean Atlas 2009

The celerity of sound on Block 15 (Figure 5-14) shows a very well-marked minimum from 1000 to 1200 m, which is much more pronounced than the deeper one in the Bay of Bengal station. This minimum defines the SOFAR channel (Sound Fixing and Ranging channel), or deep sound channel (DSC), along which sound waves reverberate easily, and which is used by some cetaceans for long-distance communications.

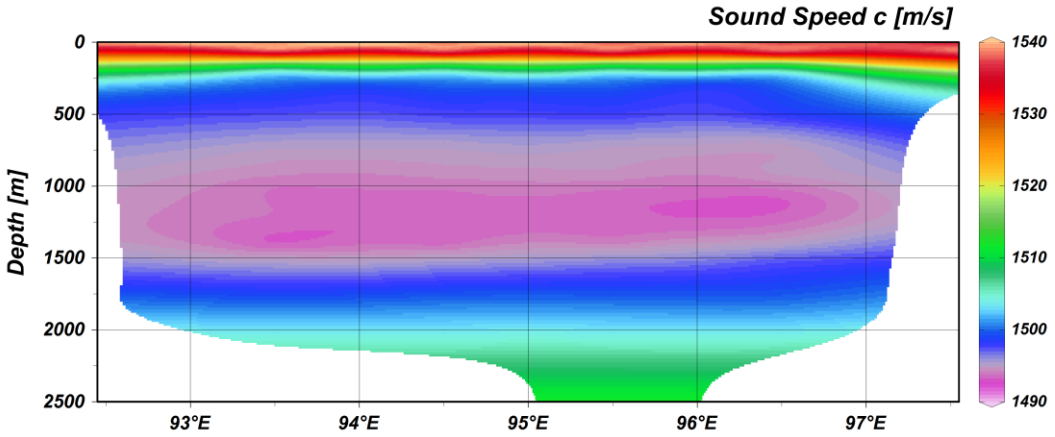


Figure 5-14: Sound velocity profile across the Andaman sea at the latitude of Block M15, showing a well-marked SOAFAR channel at 1000-1200 m, potentially used for whale communications and increasing noise reverberation within the basin

Source: "World Ocean Atlas 2009

Finally, a plot of the Brunt-Väisälä frequency across Block 15, which is a parameter indicating the stability of internal waves, shows that the interface around 75 m between surface waters from the Ayeyarwady and deeper waters is very sharp during the period April to June. This creates an additional split within the top 250 m layer surface, between waters from the river outflow of that particular year and the rest of the layer under river influence but which has already been incorporated into the main seawater. This boundary may have biological consequences on the vertical distribution of organisms.

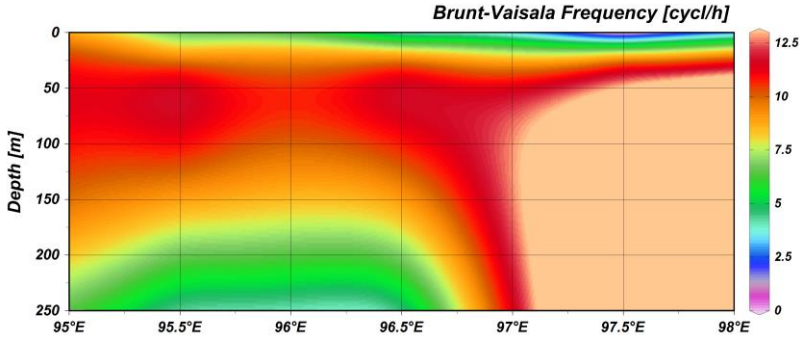


Figure 5-15: Brunt-Väisälä frequency on Block M15 during April-June, showing a sharp interface at 75 m

Source: "World Ocean Atlas 2009

5.1.3.3. Currents and Circulation Patterns

The influence of the monsoon winds changes the current patterns considerably during the course of the year. In the relatively restricted waters of the Andaman Sea, there is no simple pattern of currents associated with each monsoon (see Figure 5-16). Boundaries imposed by the coast of Myanmar and the Andaman Islands modify any general flows.

The variation along the year is as follows:

- The Northeast Monsoon produces a clockwise gyre. It is extensive and contributes to a general south-westerly flow of water in the Andaman Sea, from the Gulf of Martaban towards the Andaman Islands. This flow is of moderate constancy, at approximately ¼ knots (0.125m/s). This flow weakens during subsequent months, moving southwards.
- By May, the north-east monsoon system has broken down and water movement in the Andaman Sea is generally eastward, though relatively inconstant (less than 50%).
- By September, an anticlockwise loop forms in the Andaman Sea, with water flowing east immediately to the south of the Andaman Islands and flowing west along the Irrawaddy coast of Myanmar before turning north along the Arakan coast.
- By November, the Southwest Monsoon system no longer exerts an influence and the general flows in the Andaman Sea are North-Westward.

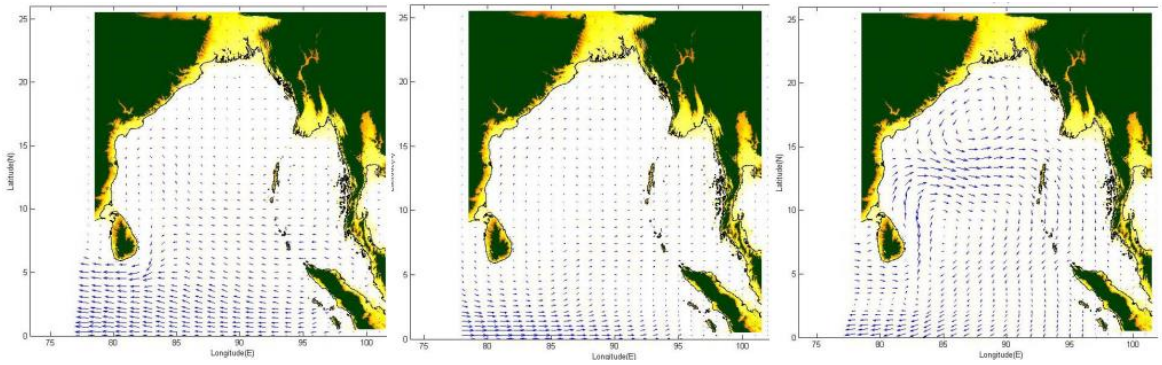


Figure 5-16: Sea currents in Bengal Bay and Andaman Sea

5.1.3.4. Winds

The winds in the Northern Andaman Sea are generally gentle to moderate, with mean monthly wind speeds ranging from 3.5 m/s to 7.5 m/s. Strong winds (>11.0 m/s) occur less than 2% of the time during the year and are generally limited to the monsoonal seasons. Mean winds are stronger during the summer Southwest Monsoon (~6.5 m/s, from the south-west to west sector) than during the winter Northeast Monsoon (~4.5 m/s). Winds in excess of 14 m/s can occur during any season but are most common during the monsoonal seasons. Strong surges of the Northeast Monsoon, squalls associated with the Southwest monsoon and the occasional tropical cyclones can occasionally cause gale force winds (> 17.5 m/s) in the Northern Andaman Sea.

The least windy season is the spring (Pre-monsoon) transition period with a mean wind speed of 4.2 m/s, when land/sea breezes (i.e. onshore – offshore wind flow) dominate. The autumn transition season is windier than the Northeast Monsoon, with a mean wind speed of 4.8 m/s. Wind speed values less than 2.0 m/s occur less than 7% of the time during the year.

Predominant wind direction within the project area blows from North-Northeast from November to April. From May to October, the predominant wind direction is Southwest (Cf. figure below).

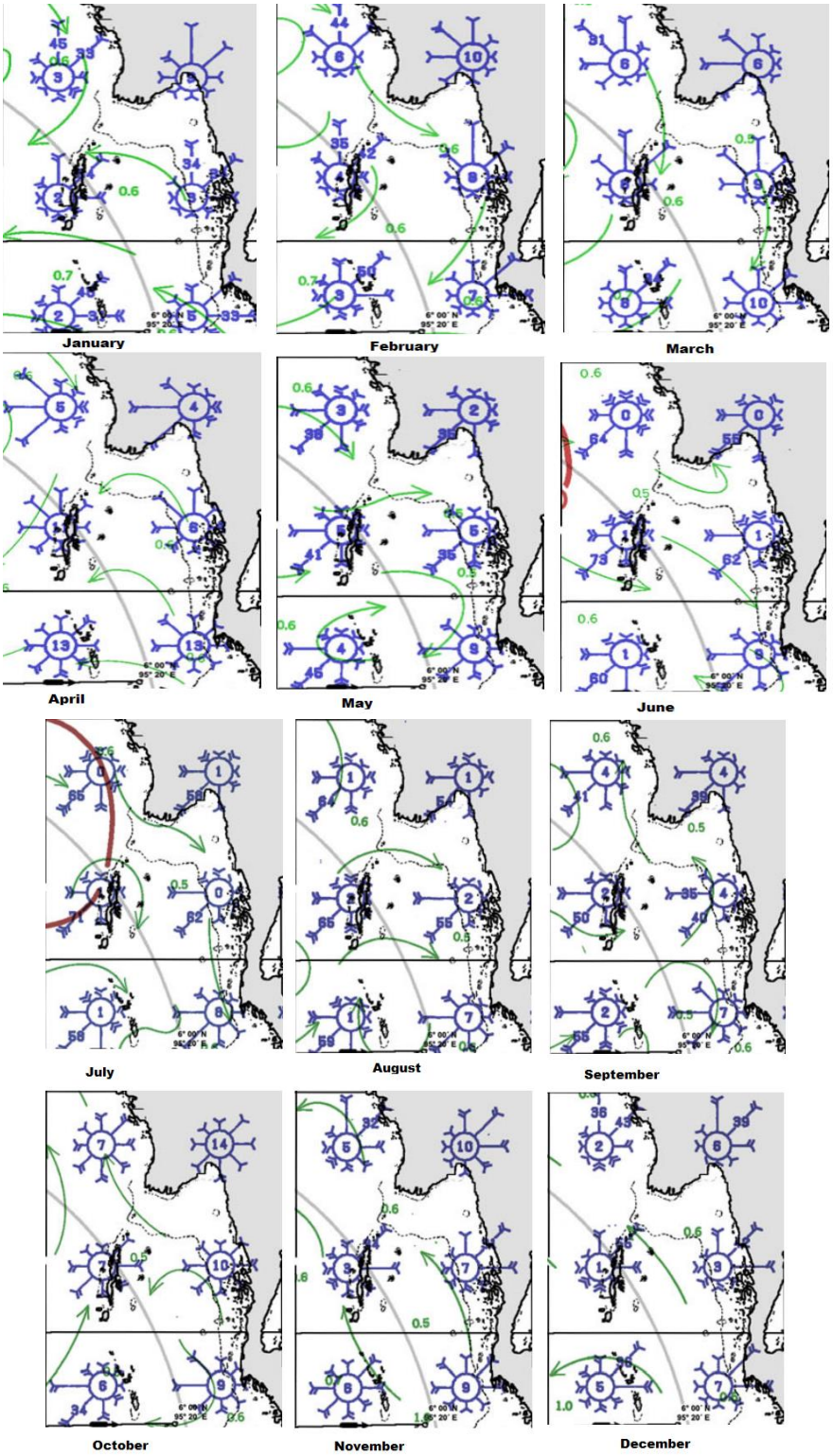


Figure 5-17[9]: Average wind and current direction around the project area
Source: "Pilot Chart of the Indian Ocean" (Pub. #109) National Imagery and Mapping Agency

[9] The wind rose in blue colour shows the distribution of winds that have prevailed in the area over a considerable period. The wind percentages are summarized for the eight points and calm. The arrows fly with the wind indicating the direction from which the wind blew. The length of the shaft, measured from the outside of the circle gives the percentage of the total number of observations in which the wind has blown from that direction. The number of feathers shows that average force of the wind on the Beaufort scale. The figure in the centre of the circle gives the percentage of calms.

5.1.3.5. Storm, cyclones and tornadoes

Cyclones characterised by winds above 32.7m/s affect different areas of the country at different times of the year although the major cyclone paths do not pass over the Andaman Sea. **They are most frequent from mid-May to early December.**

Violent storms can occur in the transition seasons but the maximum monthly frequency of severe storms is during October and November. In June the storms originate mainly to the north of the Indian coast, but do not in general affect the study area. During July and August, the storm development area is around latitude 18°N but further south in September. The subsequent movement is towards northeast.

Tornadoes recorded in the area are considered small scale and while very destructive, they are rare in the study area. Waterspouts are more common, and their destructive path is more limited. They occur throughout the wider region, mainly in the south.

Among the 10 cyclones recorded in the Bay of Bengal the last 15 years, two have reached the study area. Table below gives characteristics of these two cyclones.

Table 5-5: Cyclones recorded within the project area

Name	Category	Year	Trajectories
Cyclonic Storm Phailin	5	October 2013	
Odysha cyclone	5	October/November 1999	

5.1.4. Sediment

Few studies concerning sediment quality have been performed within the project area. However, some information is available on sediment distribution and dispersal on the Ayeyarwady continental shelf and Gulf of Martaban.

The Gulf of Martaban and the inner shelf are covered with thick silty clays while relict sands deposited during lowered sea levels fill the outer shelf. The sediments within the Ayeyarwady Canyon contain low carbonate sands and patches of silty clay. The principal clay minerals are illite, kaolinite, chlorite and smectites. The sediments delivered by the rivers are thoroughly mixed in the high tidal regime of the Gulf of Martaban and there is not much variation in clay mineral composition over the shelf. Tidal currents play a major role in bringing in sediment from the Ayeyarwady River and retaining them in the Gulf of Martaban. Tidal currents also help in flushing out sediments from rivers and estuaries and depositing them on the continental shelf.

According to V. Ramaswamy, the Ayeyarwady-Thanlwin River system discharges huge amount of suspended sediment which gets deposited in the deep Andaman Sea via Maraban canyon by different tidal currents.

Even if the project area is situated in the slope of the continental shelf, sediments' deposits coming from the Ayeyarwady River should be found within the project footprint.

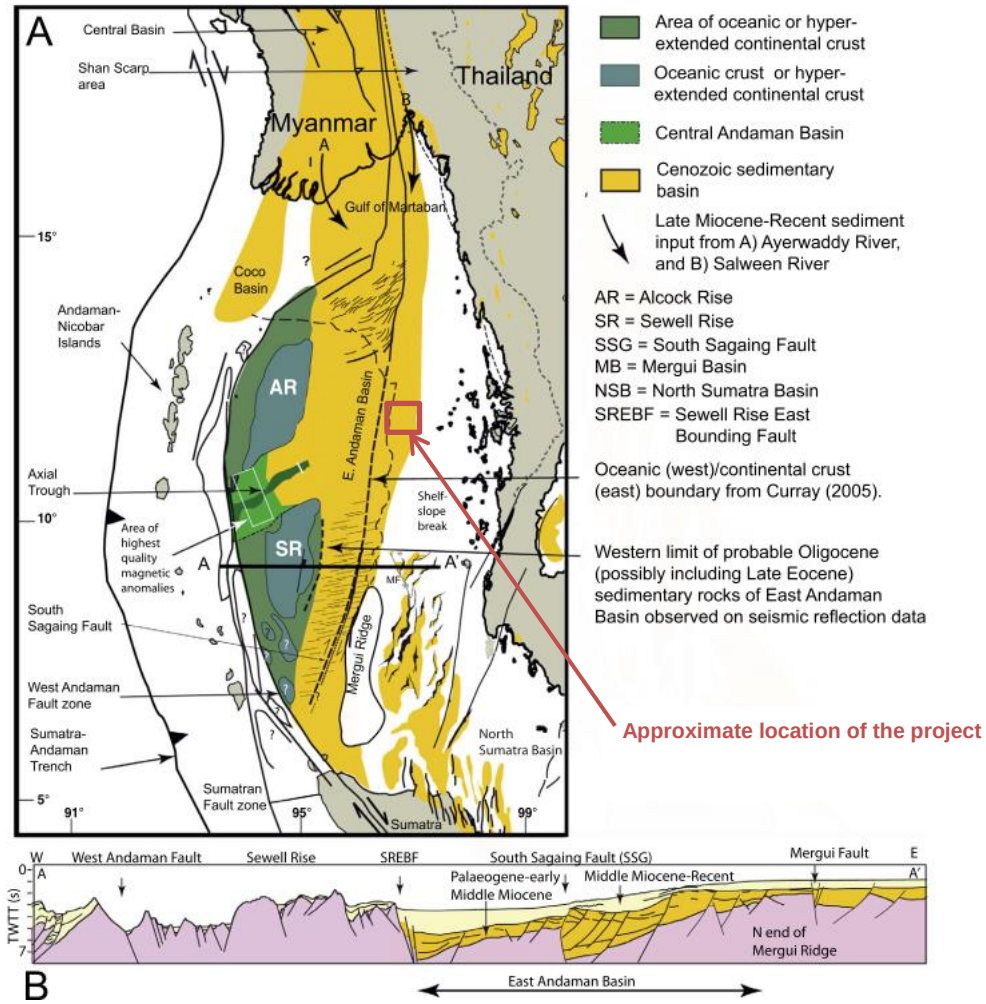


Figure 5-18: Regional map of the Andaman sea region and surrounding areas

Source: "CK Morley, A Alvey, 2014, journal of Asian Earth Sciences, Is spreading prolonged, episodic or incipient in the Andaman sea? Evidence from deepwater sedimentation"

5.1.5. Seawater

5.1.5.1. Seasonal variations of temperature and salinity

The temperature of the surface waters in the Andaman Sea fluctuates mildly from a monthly average of about 30° C in the summer months to one of about 27.5 °C in the winter months. The Andaman Sea also exhibits strong seasonal variations of salinity due to an extremely large freshwater influx from the Irrawaddy and Salween Rivers during the monsoon season. In the northern part, the salinity ranges from about 20 in June-November to about 32 in December-May – tabulated values of the World Ocean Atlas 2009 do not capture the the full range of the coastal areas but show a similar trend. The salinity of surface seawater in the southwest end is fairly constant at about 33.5 (cf. Figure 5-19). The salinity reaches a maximum of 35 almost at 1,500m depth.

Figure 5-19 shows the seasonal variations of temperature and salinity around block M15: compared to other parts of the Andaman Sea, the block is affected both by two influences. (i) The freshwater input from the rivers, particularly during the end of the SW monsoon (July – September), just about reaches M15. (ii) In the

height of the hot season, M15 lies at the edge of a patch of particularly warm water that develops off Mergui – possibly due to poor mixing of the waters in that archipelago with the rest of the Andaman sea.

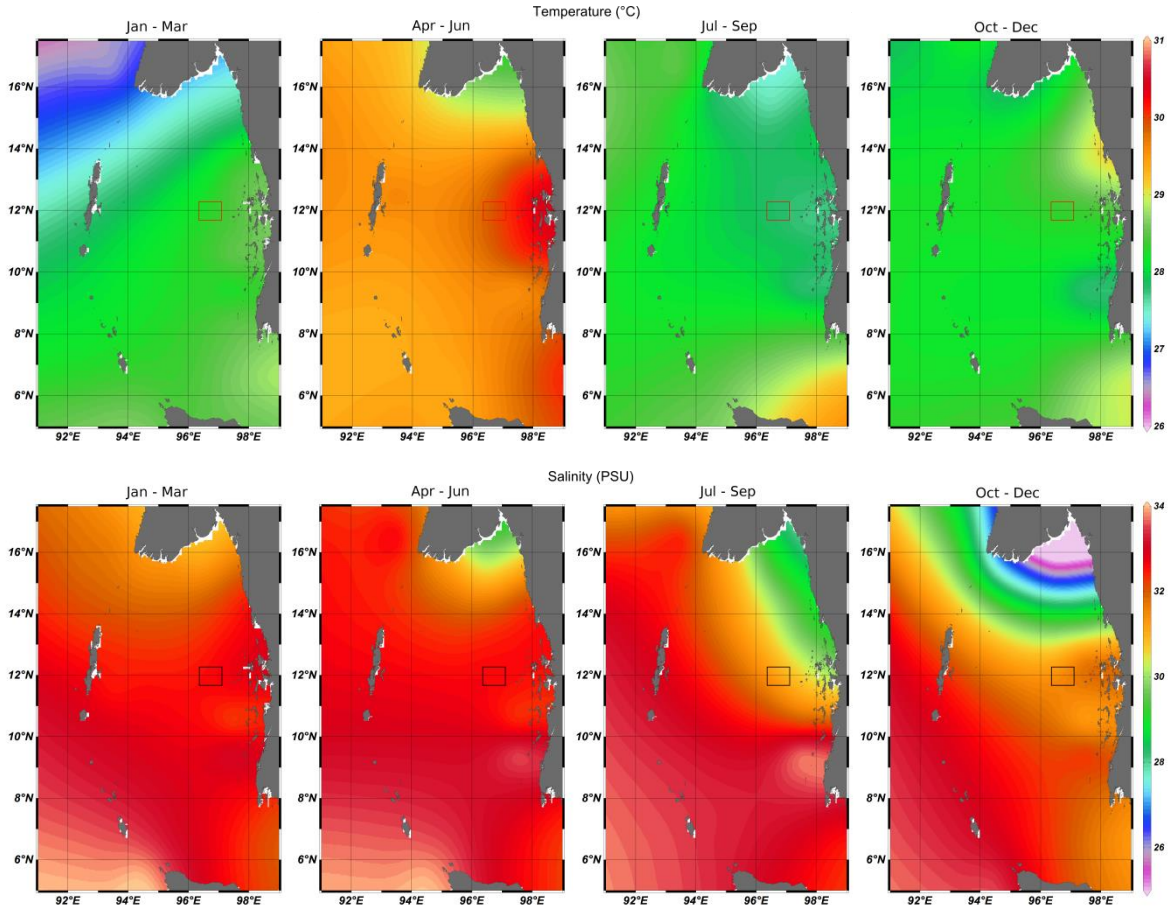


Figure 5-19: Surface temperature and salinity of the Andaman Sea

SOURCE: WORLD OCEAN ATLAS 2009

5.1.5.2. Nutrients

Figure 5-20 shows the location of block M15 with respect to seasonal variations in key nutrients. The same tendencies as for seasonal variations in temperature and salinity are observed once again: i.e. (i) M15 is located at the southern tip of the seasonal influx from the rivers (this shows particularly well on the silicate data), and (ii) M15 is also located at the western edge of a nutrient poor area close to the coastline at 12°N (Mergui archipelago), presumably because of a combination of poor blending with the rest of the water mass and/or biological activity.

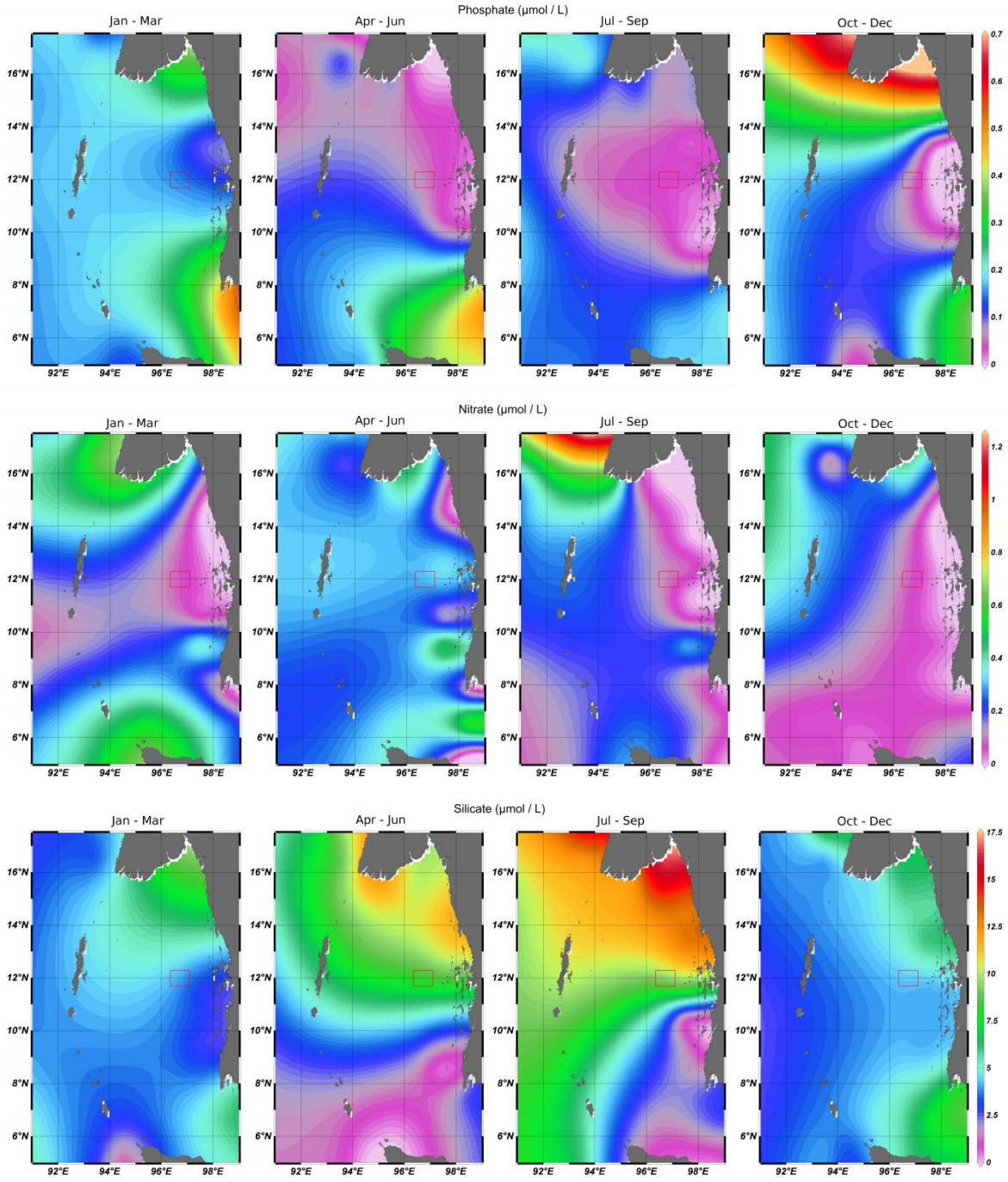


Figure 5-20: Surface nutrients in the Andaman Sea (February to April 2007)

SOURCE: WORLD OCEAN ATLAS 2009

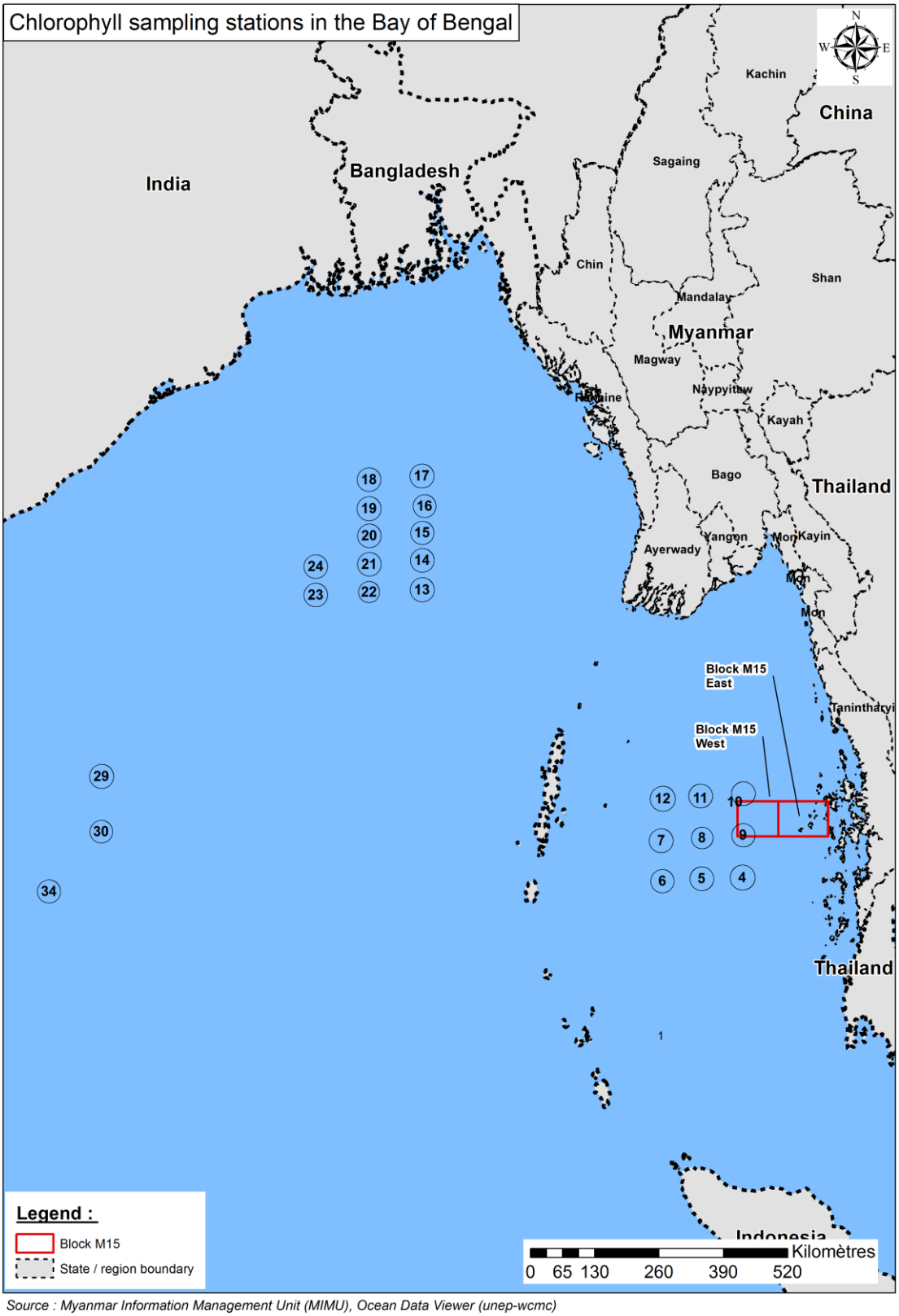
5.1.5.3. Chlorophyll-a

Phytoplankton is a primary producer which converts inorganic matter into organic compounds through photosynthesis, enabling the transfer of energy and nutrients to the zooplankton. Considering that planktonic organisms have short life cycles and can quickly respond to changing environments, such as in the case of water pollution, some phytoplankton species can thus be used as index for monitoring water quality. Chlorophyll is a principal pigment which phytoplankton use in photosynthesis to convert nutrients and carbon

dioxide, which are dissolved in sea water into plant materials. Chlorophyll-a,b,c and phaeophytin are the most commonly occurring pigments in seawater.

Chlorophyll-a is the major photosynthetic pigment of marine phytoplankton that has been used as an indicator of biomass or primary productivity in the oceans (Beebe, 2008).

The distribution of chlorophyll in the Bay of Bengal was determined from the 25th October to the 21st December 2007, during a joint research survey on the Ecosystem-Based Fishery Management in the Bay of Bengal by the M/V SEAFDEC. Among the 25 stations included in this field survey, the closest ones to the M15 Block are stations 9 and 10 (Figure 5-21).



Source : Myanmar Information Management Unit (MIMU), Ocean Data Viewer (unep-wcmc)

Figure 5-21: Chlorophyll sampling stations in the Bay of Bengal

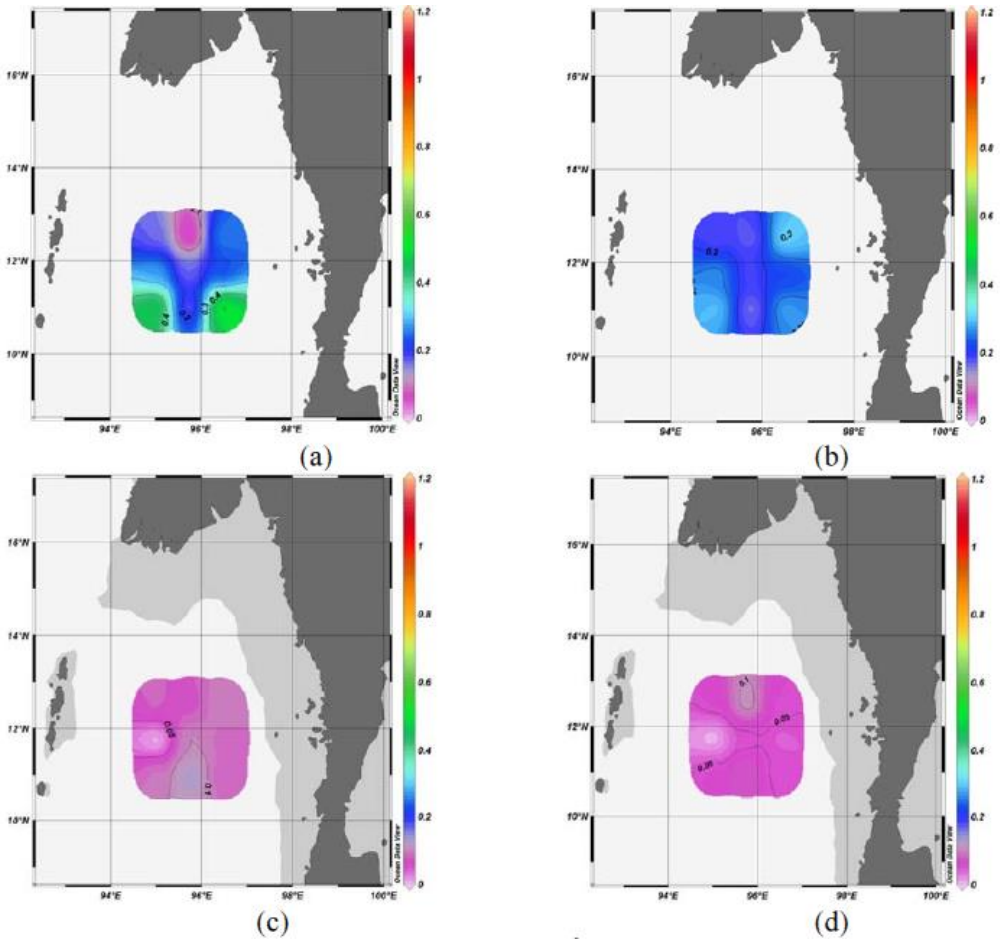
Water samples have been taken at four different depths (2m [a], 10m [b], 125m [c], 200/ 250m [d] below the surface) and at the seafloor.

The results for Area C (which is the closest to the M15 Block) are given in Figure 5-19.

The chlorophyll-a concentration at 2m and 10m ranged from 0.04-0.5mg.m^{-3} and 0.15- 0.32 mg.m^{-3}, respectively. The distributions of chlorophyll-a at 2m and 10m have the same pattern.

It was also observed that low latitude stations had higher chlorophyll-a than the high latitude stations in stations belonging to area C. Distribution of chlorophyll-a had also a similar pattern to the salinity**.**

Deeper than 100m, chlorophyll-a concentrations were lower than above and homogeneous. It should be noted that in the study area, the chlorophyll-a concentration is dependant of the input of freshwater coming from Irrawaddy river and its turbidity. It also depends on the season and the salinity of the seawater. Maximum concentrations of chlorophyll-a are obtained at 10m below the sea level.



Source: (Prommas, R.; Naimee, P.; Laongmanee, P.; Sukramongkol, N.; Khumthong, N., 2007)

Figure 5-22: Concentration of chlorophyll-a (mg/m³) in Area C of the Bay of Bengal: (a) 2m (b) 10m (c) 125m (d) 200/250m

5.2. BIOLOGICAL ENVIRONMENT

In this section, marine species have been assessed as of particular interest considering the IUCN red List classification.

The IUCN Red List of Threatened Species, founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species. The International Union for the Conservation of Nature (IUCN) is the world's main authority on the conservation status of species. The IUCN Red List is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies. These criteria are relevant to all species and all regions of the world. The aim is to convey the urgency of conservation issues to the public and policy makers, as well as help the international community to try to reduce species extinction. Species are classified by the IUCN Red List into nine groups, set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation.

- **Extinct (EX)** – No known individuals remaining.
- **Extinct in the Wild (EW)** – Known only to survive in captivity, or as a naturalized population outside its historic range.
- **Critically Endangered (CR)** – Extremely high risk of extinction in the wild.
- **Endangered (EN)** – High risk of extinction in the wild.
- **Vulnerable (VU)** – High risk of endangerment in the wild.
- **Near Threatened (NT)** – Likely to become endangered in the near future.
- **Least Concern (LC)** – Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
- **Data Deficient (DD)** – Not enough data to make an assessment of its risk of extinction.
- **Not Evaluated (NE)** – Has not yet been evaluated against the criteria.

SOURCE: WIKIPEDIA

Figure 5-23: IUCN Red List categories

5.2.1. Offshore Environment

The M15 Block is located ~160km west of Tanintharyi region coastal area (~40km Great Western Torres Island). In the M15 Block the water depth ranges from ~200m to ~2,000m. The project area is thus situated in the slope between neritic and oceanic realm, composed by the following water column stratification: epipelagic, mesopelagic and bathypelagic zones (Figure 5-24).

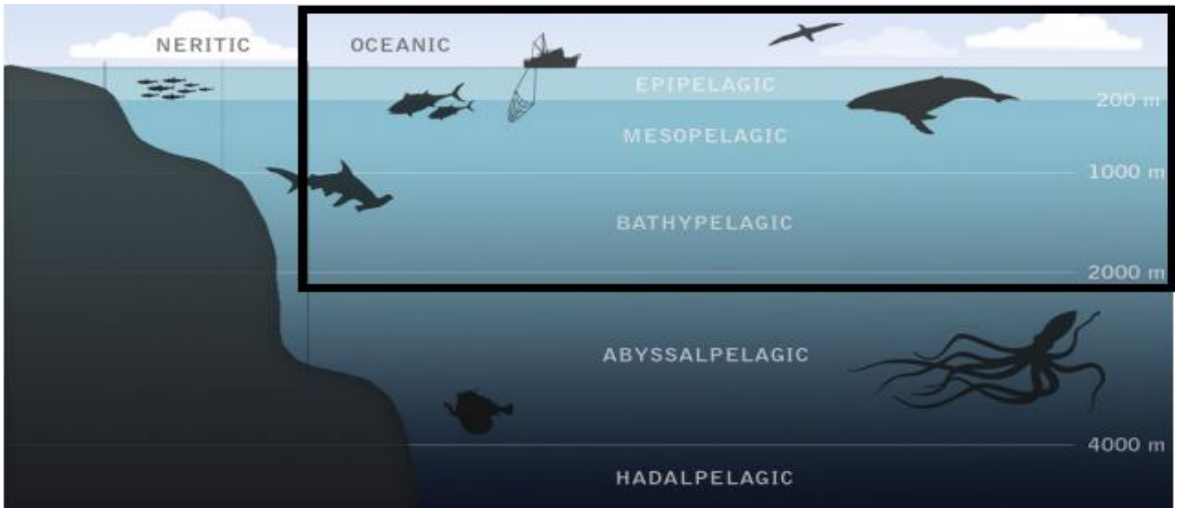


Figure 5-24[10]: Oceanic stratification of the study area

Pelagic species display a great diversity of ecological and life-history traits. For instance, many oceanic pelagic species (those species inhabiting offshore waters) exploit widely distributed resources over very large spatial scales (e.g. tunas; Block et al., 2005, 2011). In contrast, the mobility of small oceanic pelagic species, while far less documented, may be relatively limited with certain species associating with floating objects (Dagorn et al., 2007) or offshore seamounts (Klimley et al., 2003; Morato et al., 2010) for lengthy periods, potentially leading to comparatively sedentary lives[13].
The epipelagic zone is the one closest to the surface and is the best lit. It extends to 200 meters and contains both phytoplankton and zooplankton that can support larger organisms like marine mammals and some types of fish.

The mesopelagic zone is the part of the pelagic zone that extends from a depth of 200 to 700 metres. Although some light penetrates as deep as this zone, it is insufficient for photosynthesis. Therefore, the general types of life forms found are daytime visiting herbivores, detritivores feeding on dead organisms and fecal pellets, and carnivores feeding on the former types. Examples of animals living in this zone include the swordfish, squids, wolf eels, cuttlefish and other deepsea creatures.

The Bathypelagic zone is the part of the pelagic zone that extends from 700 to 2000m and where the temperature rounds the 4°C. It is less densily populated as the above zones and since no sunlight reaches this depth, there is also no primary production. It is known as the midnight zone because of this feature. Because of the lack of light, some species do not have eyes; however those possessing eyes in this zone include the viperfish and the frill shark. Sponges, brachiopods, sea stars, and echinoids are also common. The fish in this zone have become very energy efficient, since it is especially hard to find nutrients. Many have slow metabolic rates to conserve energy. There are no plants because of the lack of light necessary for photosynthesis. In the bathyal some of the world's largest whales feed.

The following section identifies the main group of marine species that may potentially occur within the surveyed area and their main characteristics (IUCN status, population trend, habitat, habits, feeding regime, sensitivity, etc).

5.2.1.1. Offshore Flora - phytoplankton

This section is based on the results presented in the Andaman Sea Fisheries Research and Development Centre on Ecosystem-Based Fishery Management in the Bay of Bengal. A 58-day collaborative survey was conducted in 2007 by the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) to determine the fertility of the area as a new fishery ground.

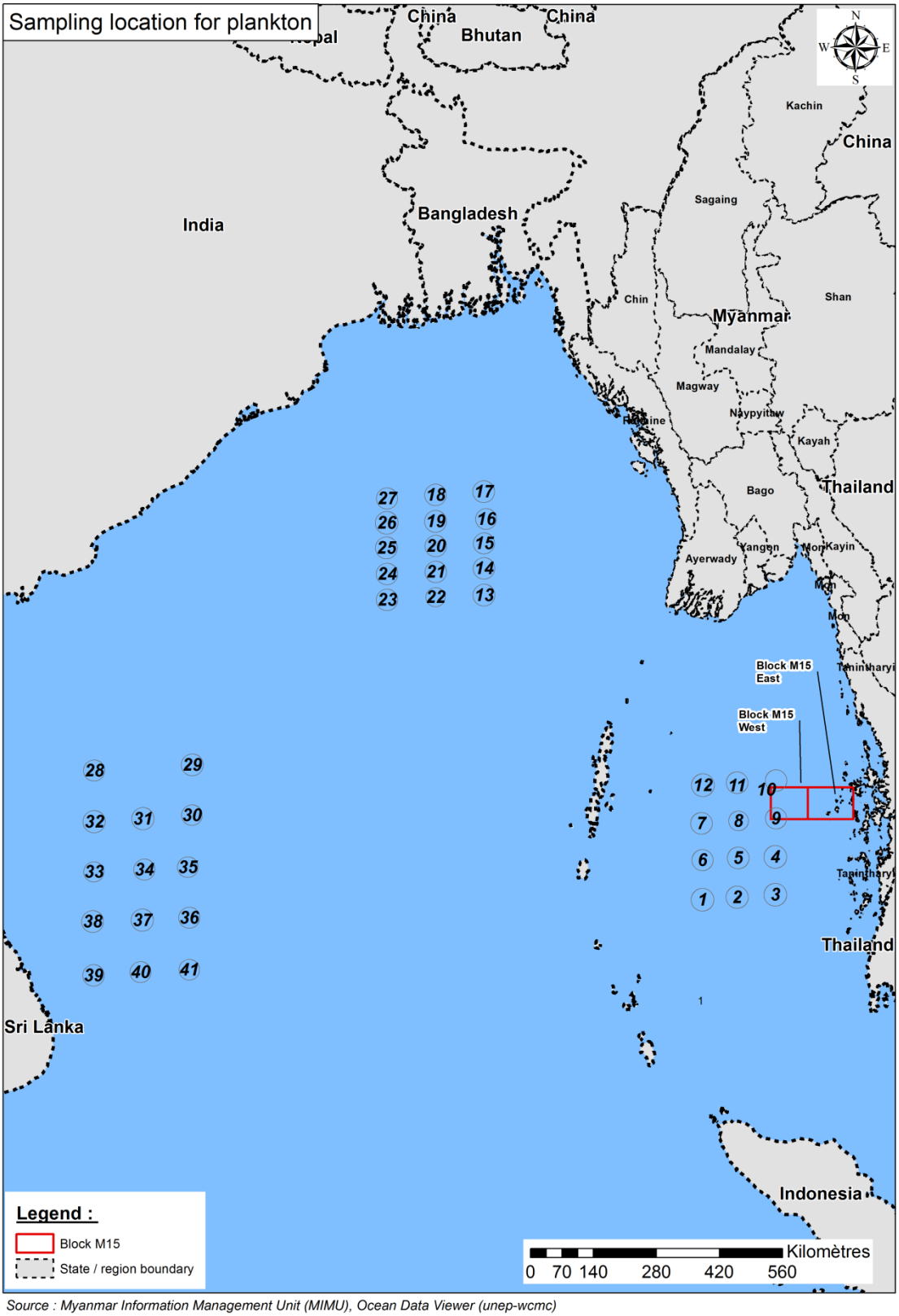
[10] A Review Of The Conservation Benefits Of Marine Protected Areas For Pelagic Species Associated With Fisheries, ISSF Technical Report 2012-02

The purpose of this study was to determine the composition, abundance and distribution of zooplankton in 3 areas of the Bay of Bengal (Area A to the north; Area B to the west; Area C to the east).

The eastern area (Area C) is the closest to the M15 Block (Figure 5-25). Stations 10 and 9 are the closest from project area.

All samples were collected by oblique towing with a Bongo net of 330 µm mesh size. Sampling points are located on the map in figure below.

A total of 58 genera with 135 species were identified from the samples collected in the surface layer during this survey. The identified phytoplankton consisted of two genera with two species of cyanobacteria, 36 genera with 78 species of diatoms, 19 genera with 53 species of dinoflagellates and one genus with one species of silicoflagellate. There were 48 genera with 95 species observed in Area C.



Source : Myanmar Information Management Unit (MIMU), Ocean Data Viewer (unep-wcmc)

Figure 5-25: Sampling locations during the M/V SEAFDEC field survey

The cell densities in the area C (the closest to the M15 block) were in the range of 171-11,178 cells/L. The maximum cell count was found in the north-western part of the Bay of Bengal (area A).

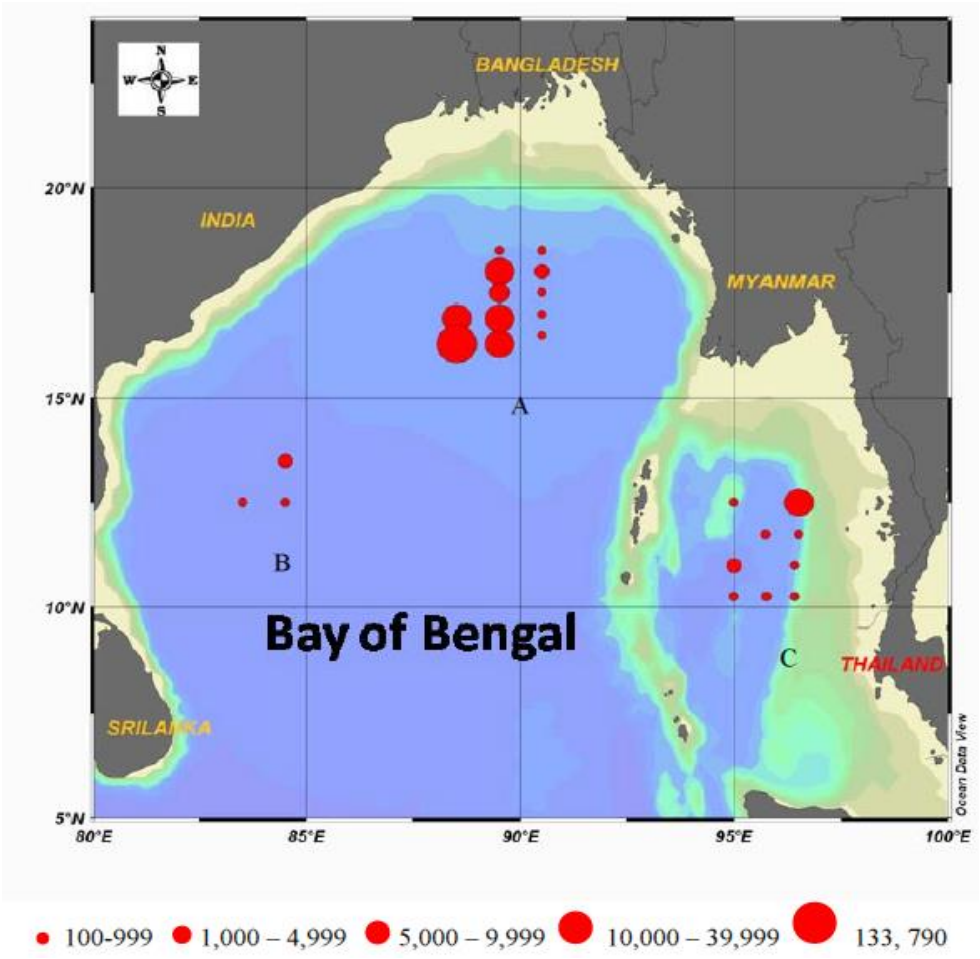


Figure 5-26: Phytoplankton density (cells/litres) in the surface layer

Source: BIMSTEC, 2008

One species of cyanobacteria and five species of diatoms dominated phytoplankton population in the surface layer during the survey period in the Bay of Bengal. *Oscillatoria erythraea* and *Proboscia alata* occurred as dominant species distributed in all areas (Areas A, B and C).

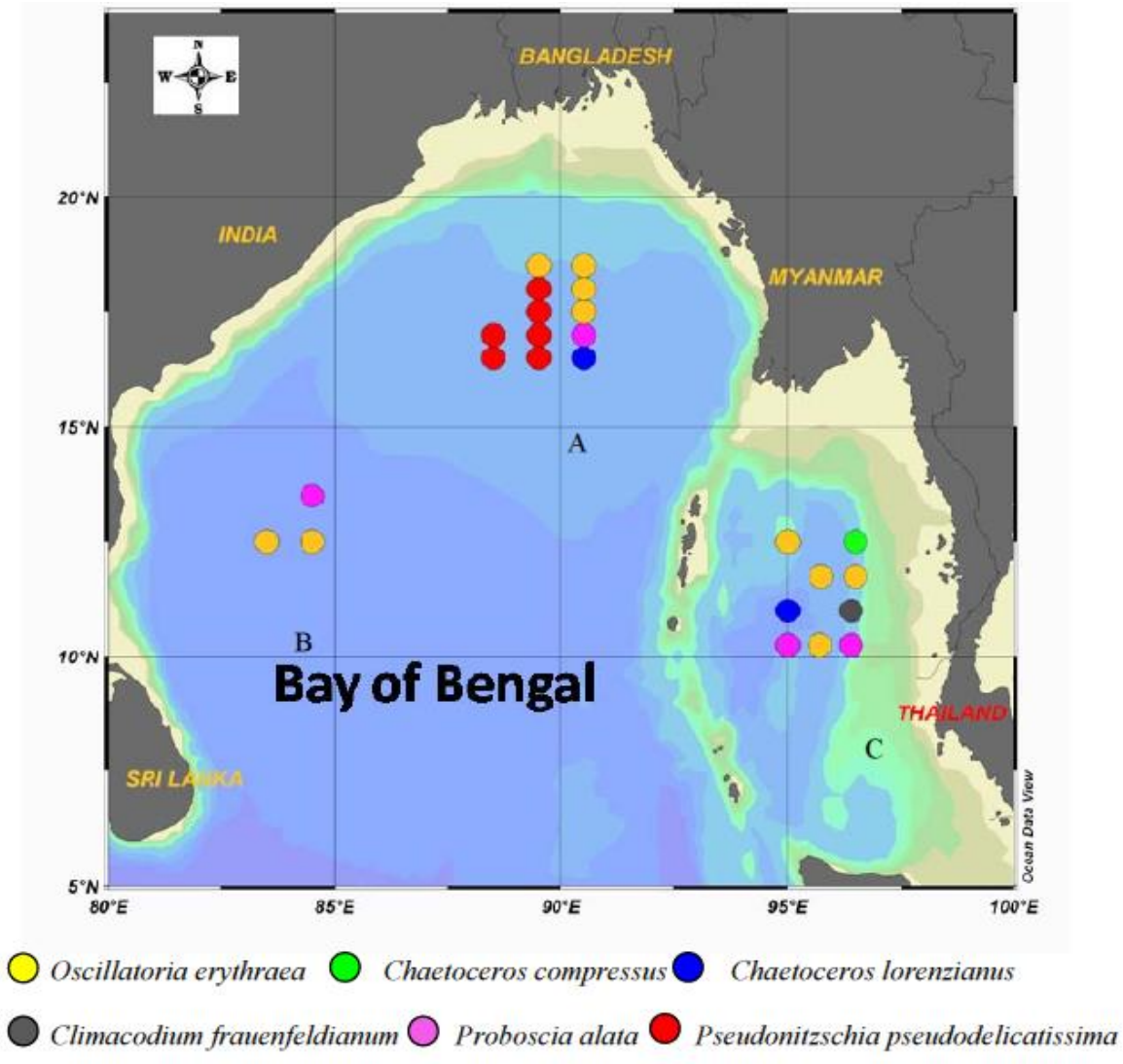


Figure 5-27: Dominant phytoplankton species in the Bay of Bengal

Source: BIMSTEC, 2008

Dominant species found at the closest station of the M15 block are *Chaetoceros compressus* (12%) and associated species is *Detonula pumila* (10%), (Cf. Figure 5-27).

It has been shown during this study that the Andaman sea is very productive with high phytoplankton densities during the Northeast monsoon (November). However, Paul *et al.* (2007) collected sample during southwest monsoon and revealed that micro-phytoplankton were abundant in the Northern Bay.

According to this study, density and richness of phytoplankton in the surface layer at the vicinity of M15 block are important.

5.2.1.2. Offshore Fauna

A. Zooplankton

Zooplankton includes both planktonic or microscopic invertebrates and larval stages of some marine fishes that rely on water currents to move any great distance. Zooplankton is a broad categorization spanning a range of organism sizes that includes both small protozoans and large metazoans. Zooplankton includes holoplanktonic organisms whose complete life cycle lies within the plankton, and meroplanktonic organisms

that spend part of their life cycle in the plankton before metamorphosis to either nekton or sessile, benthic existence. Through its consumption and processing of phytoplankton (and other food sources), zooplankton plays an important role in aquatic food webs as a resource for consumers on higher trophic levels.

An assessment of the zooplankton quality in Bay of Bengal was performed during the same M/V SEAFDEC field survey when the phytoplankton sampling occurred. Therefore, the sampling stations were the same as those described above (Figure 5-25).

Zooplankton communities in the Bay of Bengal consisted of 205 species, 119 genera and 44 taxa. Copepods were the most diverse group containing the highest number of species (98), followed by Cnidaria (32) and Protozoa (25). The taxa that were not identified to generic or species levels included Polychaeta, mollusc larvae, Mysidacea, decapod larvae, larval stages of Copepoda, Cyphonautes larvae, Echinodermata larvae and fish larvae.

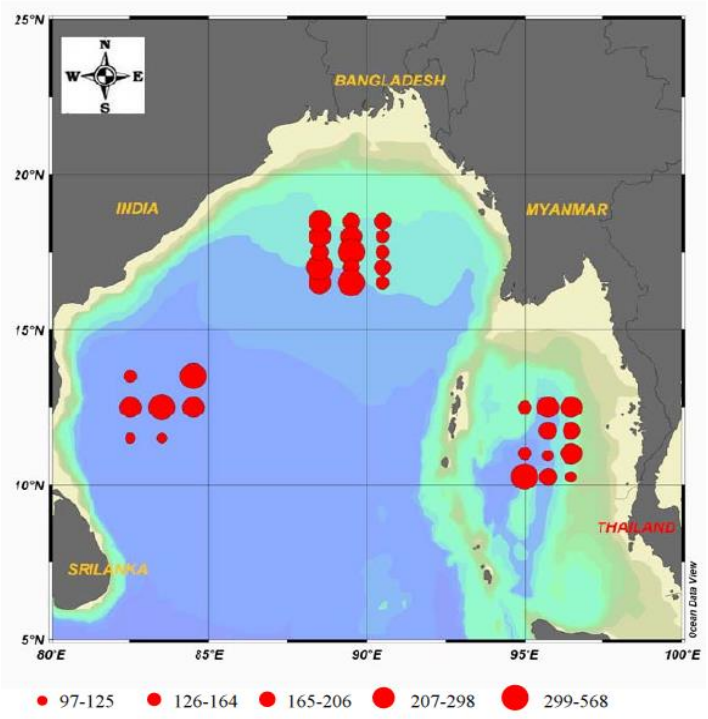


Figure 5-28: Zooplankton distribution and abundance (individuals/m³) in the Bay of Bengal

Source: BIMSTEC, 2008

There was no significant difference in the diversity and the abundance of zooplankton from three studied areas (A, B, C). Area A had the most diverse zooplankton community with 150 species (119 genera).

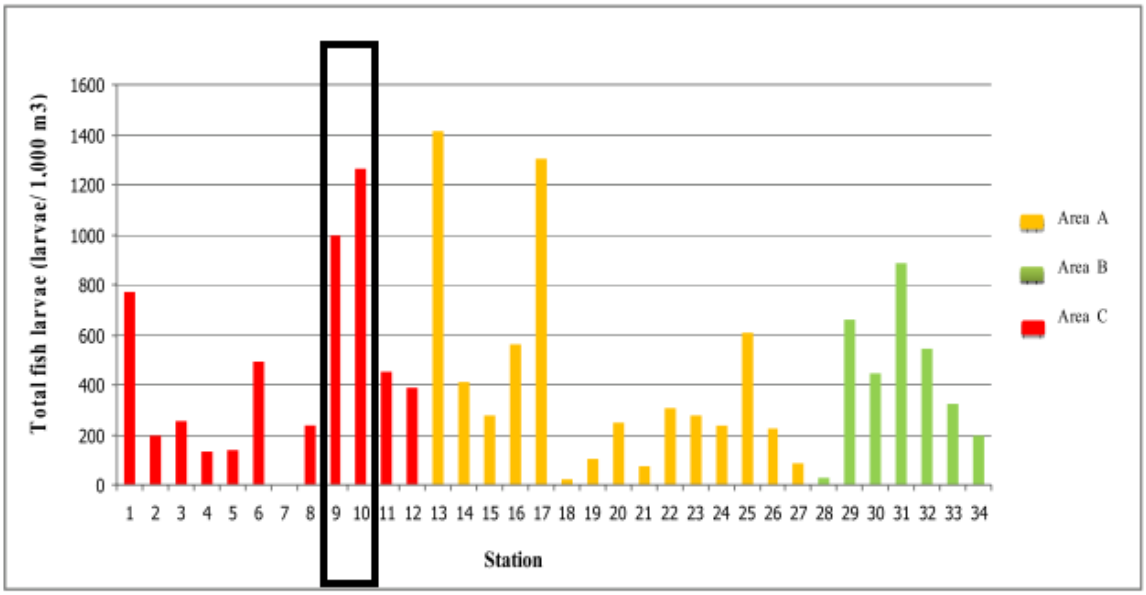
A distribution pattern of the major constituents of the zooplankton community indicated that area A was the most productive area for zooplankton populations. Results for the sampling station located in the southern part of Myanmar waters (that is to say, the closest to the study area) indicated a rich abundance of zooplankton goups, including calanoid copepods, poecilostomatoid copepods and arrow worms, whereas the region presented a lower abundance of crab larvae, planktonic shrimps and larvae.

In addition, numerous species of hydromedusae occur in the region, including ubiquitous species such as *Liriope tetraphylla*, species shared with the Arabian Sea such as *Pandeopsis sutigera*, as well as deep water and even Antarctic species. Mid-ocean species were excluded due to the reduced salinity (Rao, 1979).

B. Fish Larvae

An assessment of the fish larvae distribution and abundance in Bay of Bengal was performed during the same M/V SEAFDEC field survey when the phytoplankton and zooplankton sampling occurred.

Fish larvae were collected by bongo net 45 cm in diameter with mesh size 500 µm at the mouth and 330 µm at the cod end. The sampling depth was from 150 m to the surface.



Source: BIMSTEC, 2008

Figure 5-29: Spatial pattern variation in abundance of total fish larvae in the three areas

In Area C (the closest to the project area), 5,321 specimens were collected. They belonged to 51 families of which 24 families belong to economic important family. All of these contributed to ~14% of the total fish larvae. The most dominant family was Bothidae followed by Hemirhamphidae and Carangidae. The average number of fish larvae per station in Area C was 485 larvae/1,000 m^3.

Stations 9 and 10 (the closest ones from the M15 Block) have the highest density of zone C. The high percentage of stations from 6 to 12 is mainly due to Myctophidae (44.1%), Bregmacerotidae (8%), Photichtyidae (6%), Gonostomatidae (4.8%) and Callionymidae (4.5%). They constituted 67.4% of the total fish larvae. Myctophidae, also called lanternfish, are small bioluminescent mesopelagic fish. Family Myctophidae is the largest family of oceanic fish with 500 species found around the world, they are an important constituent in the food chain of many local system being heavily preyed upon by cetaceans including whales and dolphins as well as large pelagic fish such as tuna and sharks (Nellen , 1973; Fish Base, 2004).

Referring to the type of habitats of the adult fish, 22 families were inshore-reef fish and 16 families represented oceanic fish.

C. Pelagic Fish Community

The pelagic system of the Andaman Sea and the Bay of Bengal in general is related to the considerable seasonal variations imposed by the monsoon systems. This seasonal variability, combined with reduced salinity (compared to oceanic water) due to riverine inputs, gives a distinctive character to the pelagic community.

Strong correlations are observed between temperature, phosphate concentration, primary production, copepod density and fish larvae density during both monsoons in the pelagic community of the Bay of Bengal as a whole, including the Andaman Sea (Rao, 1979).

The pelagic fish community is widespread and relatively eclectic in its distribution. A wide variety of jacks, tunnys, barracudas, flying fish, sharks and rays are included in this community that extends across the entire Indian Ocean. Some predacious species may also be associated with reefs from time to time (e.g. barracudas

and certain shark species), where food fish are most abundant. This community contains some noteworthy species such as the rare whale shark (*Rhyncodon typus* – vulnerable).

The pelagic fish community is represented by the following classes of vertebrates:

- Agnatha (jawless, finless fish), e.g. hagfish, lamprey;
- Chondrichthyes (cartilaginous fish), e.g. sharks, rays;
- Osteichthyes (bony fish), i.e herring, cod, halibut, tuna, salmon.

The list of threatened pelagic fish species living in Myanmar waters is presented in Table 5-6 with the applicable IUCN status and population trend, when available.

A total of 37 pelagic fish species were identified by the IUCN as threatened with different levels of vulnerability:

- 3 species are critically endangered (CR), facing an extremely high risk of extinction in the wild.
- 5 species are endangered (EN), facing very high risk of extinction in the wild;
- 29 are classified as vulnerable (VU), facing high risk of extinction in the wild.

All these species may potentially be found in the M15 Block area.

Table 5-6: Pelagic fish present in Myanmar waters

Source: IUCN, 2014

Order	Family	Genus	Species	Common names	IUCN status	Population trend
RAJIFORMES	*MYLIOBATIDAE*	*Aetomylaeus*	*nichofii*	Banded Eagle Ray	VU	decreasing
LAMNIFORMES	*ALOPIIDAE*	*Alopias*	*pelagicus*	Pelagic Thresher, Thresher Shark, Whiptail Shark	VU	decreasing
LAMNIFORMES	*ALOPIIDAE*	*Alopias*	*vulpinus*	Common Thresher Shark	VU	decreasing
RAJIFORMES	*PRISTIDAE*	*Anoxypristis*	*cuspidata*	Knifetooth Sawfish, Narrow Sawfish, Pointed Sawfish	CR	decreasing
PERCIFORMES	*SERRANIDAE*	*Epinephelus*	*lanceolatus*	Brindle Bass, Brindled Grouper, Giant Grouper, Queensland Groper	VU	decreasing
RAJIFORMES	*RHINOBATIDAE*	*Glaucostegus*	*granulatus*	Sharpnose Guitarfish	VU	decreasing
RAJIFORMES	*RHINOBATIDAE*	*Glaucostegus*	*typus*	Common Shovelnose Ray, Giant Shovelnose Ray	VU	decreasing
CARCHARHINIFORMES	*CARCHARHINIDAE*	*Glyphis*	*siamensis*	Irrawaddy River Shark	CR	unknown
CARCHARHINIFORMES	*HEMIGALEIDAE*	*Hemipristis*	*elongata*	Fossil Shark, Snaggletooth Shark	VU	decreasing
RAJIFORMES	*DASYATIDAE*	*Himantura*	*polylepis*		EN	decreasing
RAJIFORMES	*DASYATIDAE*	*Himantura*	*uarnacoides*	Bleeker's Whipray	VU	decreasing
RAJIFORMES	*DASYATIDAE*	*Himantura*	*uarnak*	Reticulate Whipray, Honeycomb Stingray, Leopard Stingray, Marbled Stingray	VU	decreasing

Order	Family	Genus	Species	Common names	IUCN status	Population trend
RAJIFORMES	*DASYATIDAE*	*Himantura*	*undulata*	Bleeker's Variegated Whipray	VU	decreasing
SYNGNATHIFORMES	*SYNGNATHIDAE*	*Hippocampus*	*trimaculatus*	Flat-faced Seahorse, Low-crowned Seahorse, Three-spot Seahorse	VU	decreasing
LAMNIFORMES	*LAMNIDAE*	*Isurus*	*paucus*	Longfin Mako	VU	decreasing
CARCHARHINIFORMES	*CARCHARHINIDAE*	*Lamiopsis*	*temmincki*	Broadfin Shark	EN	decreasing
PERCIFORMES	*ISTIOPHORIDAE*	*Makaira*	*nigricans*	Blue Marlin	VU	decreasing
RAJIFORMES	*MOBULIDAE*	*Manta*	*alfredi*	Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray	VU	decreasing
RAJIFORMES	*MOBULIDAE*	*Manta*	*birostris*	Giant Manta Ray, Chevron Manta Ray, Oceanic Manta Ray, Pacific Manta Ray, Pelagic Manta Ray	VU	decreasing
CARCHARHINIFORMES	*CARCHARHINIDAE*	*Negaprion*	*acutidens*	Sharptooth Lemon Shark	VU	decreasing
RAJIFORMES	*RHINIDAE*	*Rhina*	*ancylostoma*	Bowmouth Guitarfish, Mud Skate, Shark Ray	VU	decreasing
ORECTOLOBIFORMES	*RHINCODONTIDAE*	*Rhincodon*	*typus*	Whale Shark	VU	decreasing
RAJIFORMES	*RHINOBATIDAE*	*Rhinobatos*	*obtusus*	Widenose Guitarfish	VU	decreasing
RAJIFORMES	*RHINOPTERIDAE*	*Rhinoptera*	*javanica*	Flapnose Ray, Javanese Cownose Ray	VU	unknown
CARCHARHINIFORMES	*SPHYRNIDAE*	*Sphyrna*	*lewini*	Scalloped Hammerhead	EN	unknown
CARCHARHINIFORMES	*SPHYRNIDAE*	*Sphyrna*	*mokarran*	Great Hammerhead, Hammerhead Shark, Squat-headed Hammerhead Shark	EN	decreasing
RAJIFORMES	*DASYATIDAE*	*Taeniurops*	*meyeni*	Black-blotched Stingray, Black-spotted Stingray, Blotched Fantail Ray, Fantail Stingray, Giant Reef Ray, Round Ribbontail Ray, Speckled Stingray	VU	unknown
PERCIFORMES	*SCOMBRIDAE*	*Thunnus*	*obesus*	Bigeye Tuna	VU	decreasing

An ecosystem survey was conducted during one month in November / December 2013 in Myanmar. This survey was conducted by Dr. Fridtjof Nansen after a request from department of Fisheries. Two of the purposes of this survey were to obtain information on demersal fish abundance and biodiversity and to determin the abundance of small pelagic fish. The following paragraph presents the results of this survey on the Taninthary region between 200 an 1000m of depth.

In Tanintharyi region, an area of 8,600nm² was surveyed (between 200m and 1000m depth) by an acoustic survey method. The estimate biomass of pelagic fish during the survey was 71 000 MT: 20 000MT of clupeid and Engraulid species, and 51 000 MT of carangid, scombrid, shyraenid and trichiurid species. The table below presents the pelagic species surveyed.

Table 5-7: Pelagic fish surveyed in Myanmar water (november / december 2013)

Source: Institute Marine Reserch – Ecosystem survey Mayanmar – cruise report "Dr.FRIDTJOF NANSEN" – IMR Norway and DOF Myanmar, 2013

Pelagic species		Biomass (mT)
Clupeidae	Dussumieria acuta	20 000MT
	Ilisha spp.	
	Sardinella gibbosa	
Engraulididae	Stolephorus spp.	
	Thryssa spp.	
Carangidae	Alectis spp.	51 000 MT
	Atule mate	
	Atropus atropos	
	Caranx spp.	
	Carangoides spp.	
	Decapterus spp.	
	Scomberoides spp.	
	Megalaspis cordyla	
Scombridae	Scomberoides spp.	
	Rastrelliger spp.	
	Scomberomorus spp.	
Sphyraenidae	Sphyraena spp.	
Trichluridae	Lepturacanthus savala	

A total of 46 stations were surveyed with a trawl in the Tanintharyi region. The results of demersal fish fund between 200 to 1,000 m during the survey are presented below. A total of 43,014 t of demersal fish were caught between 200 to 500m depth and 7,086 T between 500 to 1,000m.

Table 5-8: Demersal fish surveyed in Myanmar water (November / December 2013)

Source: Institute Marine Reserch – Ecosystem survey Mayanmar – cruise report "Dr.Fridtjof Nansen" – IMR Norway and DOF Myanmar, 2013

Demersal fish	Depth range (200-500m)		Depth range (500-1,000m)	
	Density (t/nm²)	Biomass (t)	Density (t/nm²)	Biomass (t)
Brotula	0.05	310	0.1	239
Sharks	0.26	1,614	0.93	2,226
Rays	1.12	6,952	-	-

Demersal fish	Depth range (200-500m)		Depth range (500-1,000m)	
Soles	0.03	186	-	-
Shrimps	1.3	8,069	0.48	1,149
Lobsters	0.14	2,483	0.05	120
Cephalopods	0.22	1,366	0.02	48
Others	3.55	22,035	1.38	3,303
total	6.93	43,014	2.96	7,086

D. Commercially important fish

The marine capture fishery comprises coastal or inshore fisheries and offshore or deep-sea fisheries. Table 5-9below presents the main fish species caught in Myanmar waters.

Table 5-9: Commercially important fish in Myanmar

Fishing gear	Location of fishermen	Common names
Trawl fisheries	Offshore/coastal	Demersal finfish
	Inshore/coastal/offshore	Penaied prawns
Purse seine fishery	Offshore	Small pelagic species: small mackerels and sardine species such as *Rastelliger spp.* and *Sardinella spp*.
	Coastal	Anchovies (genus *Stolephorus*)
Driftnet and gillnet fishery	Coastal	Demersal fish species like marine catfish and jewfish
	Coastal	Shrimp like *Peneaus merguiensis*
Long-lining	Offshore	Yellowfin tuna primarily others: swordfish, marlin and sharks

SOURCES: FAO & MYANMAR DEPARTMENT OF FISHERIES

Species in blue in the table are likely to be encountered within the project area.

Previous surveys for the Department of Fisheries used to determine the relative abundance and size composition of commercially important species indicated that some commercially important species inhabit Myanmar offshore waters such as the Swordfish (*Xiphiasgladius*), YellowfinTuna (*Thunnusalbacares*), Striped marlin (*Tetrapturusaudax*) and Sailfish (*Istiophorusplatypus*).

Aditionally, the BigeyeThresher (*Alopiaspelagicus*), Whit-tipped shark (*Carcharhinuslongimanus*), Escolar (*Lepidocybium flavobrunneum*), Pelagic stingray (*Dasyatissp*) and Snake mackerel (*Gympylussurpens*) can also be found as by-catch.

M15 Block is located in a one of the Tuna fishing grounds of Myanmar.

E. Marine Mammals

The present review is based on IUCN Red List data and the results of De Boer's study (2002) on cetaceans in the Indian Ocean Sanctuary, which lists the cetacean species thought to occur in Myanmar waters.

Two major groups of marine mammals occur in the waters of Myanmar: the sirenians and the cetaceans. The sirenians are represented by a single species, the dugong (*Dugong dugon*) while a wide variety of both large and small cetaceans are found.

Cetaceans are organized into two groups - the ondotocetes or toothed whales, and the mysticetes, or the baleen whales. To date there are 88-89 recognized species of cetaceans:

- Toothed whales (ondotocetes) include all whales that have teeth such as the killer whale, sperm whale and pilot whale and all dolphins and porpoises. In total, there are 73 species.
- Baleen whales (mysticetes) do not have teeth but have baleen plates which are made from a substance similar to keratin. These plates hang from the upper jaw and have frayed edges which the whale uses to sieve out plankton and fish after it has taken a mouthful of water.

The most significant cetaceans in Myanmar are the finless porpoise (*Neophocaena phocaenoides*) and the Irrawaddy dolphin (*Orcaella brevirostris*). The former is found in the coastal waters of Southeast Asia, while the latter is also found in the Mekong, Ganges, Brahmaputra and Irrawaddy rivers. Both these species are thought to be vulnerable (Northridge 1991, Groombridge 1993, Sylvestre 1993).

All the species that may occur in Myanmar marine waters are listed in Table 5-10 with their IUCN Red List category.

A total of 29 marine mammal species have been recorded in Myanmar, of which seven are listed as endangered, vulnerable or near threatened on the IUCN Red List:

- two species are listed as endangered (EN) facing very high risk of extinction in the wild: the blue whale (*Balaenoptera musculus*) and the fin whale (*Balaenoptera physalus*);
- four species are listed as vulnerable (VU) facing high risk of extinction in the wild: the Indo-Pacific finless porpoise (*Neophocaena phocaenoides*), the Irrawaddy dolphin (*Orcaella brevirostris*), the sperm whale (*Physeter macrocephalus*) and the dugong (*Dugong dugon*). Dugongs are rare and are mostly found west of the Irrawaddy delta and further north along the mainland coastline; and
- one specie is listed as near threatened (NT): the Indo-Pacific hump-backed dolphin (*Sousa chinensis*).

Amongst these species, the majority can be found in estuaries, coastal waters, shallow waters and deep waters. Most of the whales, including the Blue Whale and Sperm Whale are primarily found in offshore deep waters. However some species may also occur in shallow waters.

There is a lack of information on the distribution of marine mammal's species in the Andaman Sea. Few studies have been performed to assess the presence of marine mammals in offshore Myanmar, including the period of migration to South-Asian waters and the location of habitats.

The present review is based on IUCN data and the results de Boer' study (2002) on cetaceans in the Indian Ocean Sanctuary listing the main cetaceans suspected to occur in Myanmar waters.

Table 5-10 lists the main habitats and sensitivities of marine mammals living and/or regularly occurring in Myanmar waters. Some pictures of the most sensitive marine species potentially present in the study area are presented in the Figure 5-30.

According to the habitats indicated by the IUCN in Table 5-10, the marine mammals' occuring offshore of the coast of Myanmar that may be encountered during the M15 Block seismic survey are listed below (21 species identified):

Table 5-10: Marine mammals occurring in Myanmar waters

Order	Family	Genus	Species	Common names	IUCN status	Likely encountered in project area
CETARTIODACTYLA	BALAENOPTERIDAE	*Balaenoptera*	*acutorostrata*	Common Minke Whale	LC	✓
CETARTIODACTYLA	BALAENOPTERIDAE	*Balaenoptera*	*edeni*	Bryde's Whale	DD	✓
CETARTIODACTYLA	BALAENOPTERIDAE	*Balaenoptera*	*musculus*	Blue Whale	EN	✓
CETARTIODACTYLA	BALAENOPTERIDAE	*Balaenoptera*	*physalus*	Fin Whale	EN	✓
CETARTIODACTYLA	DELPHINIDAE	*Feresa*	*attenuata*	Pygmy Killer Whale	DD	✓
CETARTIODACTYLA	DELPHINIDAE	*Globicephala*	*macrorhynchus*	Short-finned Pilot Whale	DD	✓
CETARTIODACTYLA	DELPHINIDAE	*Grampus*	*griseus*	Risso's Dolphin	LC	✓
CETARTIODACTYLA	ZIPHIIDAE	*Indopacetus*	*pacificus*	Indo-pacific Beaked Whale	DD	✓
CETARTIODACTYLA	PHYSETERIDAE	*Kogia*	*breviceps*	Pygmy Sperm Whale	DD	✓
CETARTIODACTYLA	PHYSETERIDAE	*Kogia*	*sima*	Dwarf Sperm Whale	DD	✓
CETARTIODACTYLA	DELPHINIDAE	*Lagenodelphis*	*hosei*	Fraser's Dolphin	LC	✓
CETARTIODACTYLA	BALAENOPTERIDAE	*Megaptera*	*novaeangliae*	Humpback Whale	LC	✓
CETARTIODACTYLA	ZIPHIIDAE	*Mesoplodon*	*densirostris*	Blainville's Beaked Whale	DD	✓
CETARTIODACTYLA	ZIPHIIDAE	*Mesoplodon*	*ginkgodens*	Ginkgo-toothed Beaked Whale	DD	✓
CETARTIODACTYLA	PHOCOENIDAE	*Neophocaena*	*phocaenoides*	Indo-Pacific Finless Porpoise	VU	Unlikely found in water depths <200m
CETARTIODACTYLA	DELPHINIDAE	*Orcaella*	*brevirostris*	Irrawaddy Dolphin	VU	Unlikely found in water depths <200m
CETARTIODACTYLA	DELPHINIDAE	*Orcinus*	*orca*	Killer Whale, Orca	DD	✓
CETARTIODACTYLA	DELPHINIDAE	*Peponocephala*	*electra*	Melon-headed Whale	LC	✓
CETARTIODACTYLA	PHYSETERIDAE	*Physeter*	*macrocephalus*	Sperm Whale	VU	✓
CETARTIODACTYLA	DELPHINIDAE	*Pseudorca*	*crassidens*	False Killer Whale	DD	✓
CETARTIODACTYLA	DELPHINIDAE	*Sousa*	*chinensis*	Indo-pacific Hump-backed Dolphin	NT	Unlikely found in water depths <200m

Order	Family	Genus	Species	Common names	IUCN status	Likely encountered in project area
CETARTIODACTYLA	DELPHINIDAE	*Stenella*	*attenuata*	Pantropical Spotted Dolphin	LC	Unlikely found in water depths <200m
CETARTIODACTYLA	DELPHINIDAE	*Stenella*	*coeruleoalba*	Striped Dolphin, Euphrosyne Dolphin	LC	Unlikely found in water depths <200m
CETARTIODACTYLA	DELPHINIDAE	*Stenella*	*longirostris*	Spinner Dolphin, Long-beaked Dolphin	DD	Unlikely found in water depths <200m
CETARTIODACTYLA	DELPHINIDAE	*Steno*	*bredanensis*	Rough-toothed Dolphin	LC	✓
CETARTIODACTYLA	DELPHINIDAE	*Tursiops*	*aduncus*	Indo-pacific Bottlenose Dolphin	DD	Unlikely found in water depths <200m
CETARTIODACTYLA	DELPHINIDAE	*Tursiops*	*truncatus*	Common Bottlenose Dolphin	LC	✓
CETARTIODACTYLA	ZIPHIIDAE	*Ziphius*	*cavirostris*	Cuvier's Beaked Whale	LC	✓
SIRENIA	DUGONGIDAE	*Dugong*	*dugon*	Dugong	VU	Unlikely found in water depths <200m

Note: IUCN Red List - Category: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD)

BLUE WHALE (SOURCE: HTTP://US.WHALES.ORG/SPECIES-GUIDE, 2014)

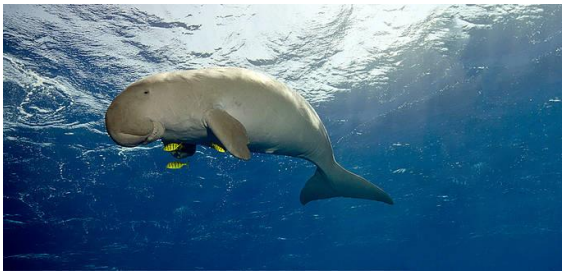
FIN WHALE (SOURCE: WWF GLOBAL, 2014)

INDO-PACIFIC FINLESS PORPOISE (SOURCE://US.WHALES.ORG/SPECIES-GUIDE, 2014)

IRRAWADDY DOLPHIN (SOURCE://US.WHALES.ORG/SPECIES-GUIDE, 2014)

SPERM WHALE (SOURCE : US.WHALES.ORG, 2015)

INDO-PACIFIC HUMPBACK DOLPHIN (SOURCE://US.WHALES.ORG/SPECIES-GUIDE, 2014)



DUGONG (SOURCE: SOSSPECIES.ORG, 2015)

Figure 5-30: Sensitive marine mammals in Myanmar

F. Seabirds

Seabirds are commonly seen over the open ocean thousands of kilometres from the nearest land, but all birds must come ashore to raise their young. Many seabirds are excellent swimmers and divers, including such distantly related types of birds as grebes, loons, ducks, auks, cormorants, penguins, and diving petrels. Most of these seabirds have webbed or lobed toes that act as paddles, which they use to propel themselves underwater. Others, including auks and penguins, use their wings to propel themselves through the water. Swimming seabirds have broad, raft like bodies that provide stability. They have dense feather coverings that

hold pockets of air for warmth, but they can compress the air out of these pockets to reduce buoyancy when diving.

All the seabird species typically found in Myanmar marine waters are listed in Table 5-11 with their IUCN Red protection status.

A total of 20 seabird species are currently identified as occurring in Myanmar waters. Amongst these species, four species are listed as near threatened (NT) and 16 species are listed as least concern (LC).

Table 5-11: Seabird species recorded in Myanmar

Order	Family	Genus	Species	Common name	IUCN Red List category	Typical habitat
PELECANIFORMES	ANHINGIDAE	*Anhinga*	*melanogaster*	African Darter, Darter, Oriental Darter	NT	Common in south Myanmar/ wetlands/marine
CORACIIFORMES	ALCEDINIDAE	*Pelargopsis*	*amauroptera*	Brown-winged Kingfisher	NT	Coast/ fairly common to locally common resident in the south-west and Tenasserim
GRUIFORMES	RALLIDAE	*Fulica*	*atra*	Common Coot, Coot, Eurasian Coot, European Coot	LC	Marine/coastal
ANSERIFORMES	ANATIDAE	*Anas*	*querquedula*	Garganey	LC	Highly migratory/coastal saltmarshes
ANSERIFORMES	ANATIDAE	*Anser*	*albifrons*	Greater White-fronted Goose, White-fronted Goose	LC	Fully migratory/shrubby tundra on the coast
CHARADRIIFORMES	LARIDAE	*Larus*	*ichthyaetus*	Great Black-headed Gull, Pallas's Gull	LC	Fully migratory/coastal
CHARADRIIFORMES	CHARADRIIDAE	*Charadrius*	*leschenaultii*	Greater Sand Plover, Greater Sand-Plover, Large Sand Dotterel	LC	Fully migratory/near the coast
CHARADRIIFORMES	BURHINIDAE	*Esacus*	*giganteus*	Beach Stone-curlew, Beach Thick-knee	NT	Islands off peninsular/ coastal
CHARADRIIFORMES	SCOLOPACIDAE	*Limosa*	*limosa*	Black-tailed Godwit	NT	Marine
CHARADRIIFORMES	SCOLOPACIDAE	*Tringa*	*nebularia*	Common Greenshank, Greenshank	LC	Marine wetlands/estuaries
CHARADRIIFORMES	SCOLOPACIDAE	*Actitis*	*hypoleucos*	Common Sandpiper	LC	Full migrant/coastal shores/ estuaries
CHARADRIIFORMES	SCOLOPACIDAE	*Calidris*	*ferruginea*	Curlew Sandpiper	LC	Full migrant /estuaries
CHARADRIIFORMES	CHARADRIIDAE	*Charadrius*	*alexandrinus*	Kentish Plover, Snowy Plover	LC	Fully migratory /predominantly coastal
CHARADRIIFORMES	SCOLOPACIDAE	*Calidris*	*ruficollis*	Red-necked Stint, Rufous-necked Stint	LC	Terrestrial/marine
CHARADRIIFORMES	SCOLOPACIDAE	*Arenaria*	*interpres*	Ruddy Turnstone,	LC	Fully migratory/species

Order	Family	Genus	Species	Common name	IUCN Red List category	Typical habitat
				Turnstone		is mainly coastal/ estuaries
CHARADRIIFORMES	SCOLOPACIDAE	*Calidris*	*temminckii*	Temminck's Stint	LC	Full migrant/coastal inlets/avoids extremely cold conditions and exposed coasts
CHARADRIIFORMES	SCOLOPACIDAE	*Xenus*	*cinereus*	Terek Sandpiper	LC	Full migrant/inhabits tropical coasts, especially open intertidal estuaries
CICONIIFORMES	CICONIIDAE	*Ciconia*	*episcopus*	Woolly-necked Stork	LC	Frequents coastal mudflats or coral reefs, mangrove swamps and estuaries
CICONIIFORMES	ARDEIDAE	*Mesophoyx*	*intermedia*	Intermediate Egret, Yellow-billed Egret	LC	Marine/coastal
CICONIIFORMES	ARDEIDAE	*Ardea*	*cinerea*	Gray Heron, Grey Heron	LC	Fully migratory/shallow water/ coastal areas

Note: IUCN Red List - Status: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD)

Taking into account the typical habitat of these seabirds, six species could potentially occur within the M15 Block (in purple in Table 5-9): four of these are listed as Least Concern species and two are listed as Near Threatened. However, it is important to note that these are considered mainly coastal species.

Benthic communities

No specific field survey has been performed in M15 Block. Nevertheless, this chapter presents a study concerning benthic macro-invertebrate community structure and distribution in the Ayeyarwady continental shelf of the Andaman Sea that has been performed (Ansari, June 2012) during April and May 2002. The figure below presents the field survey location.

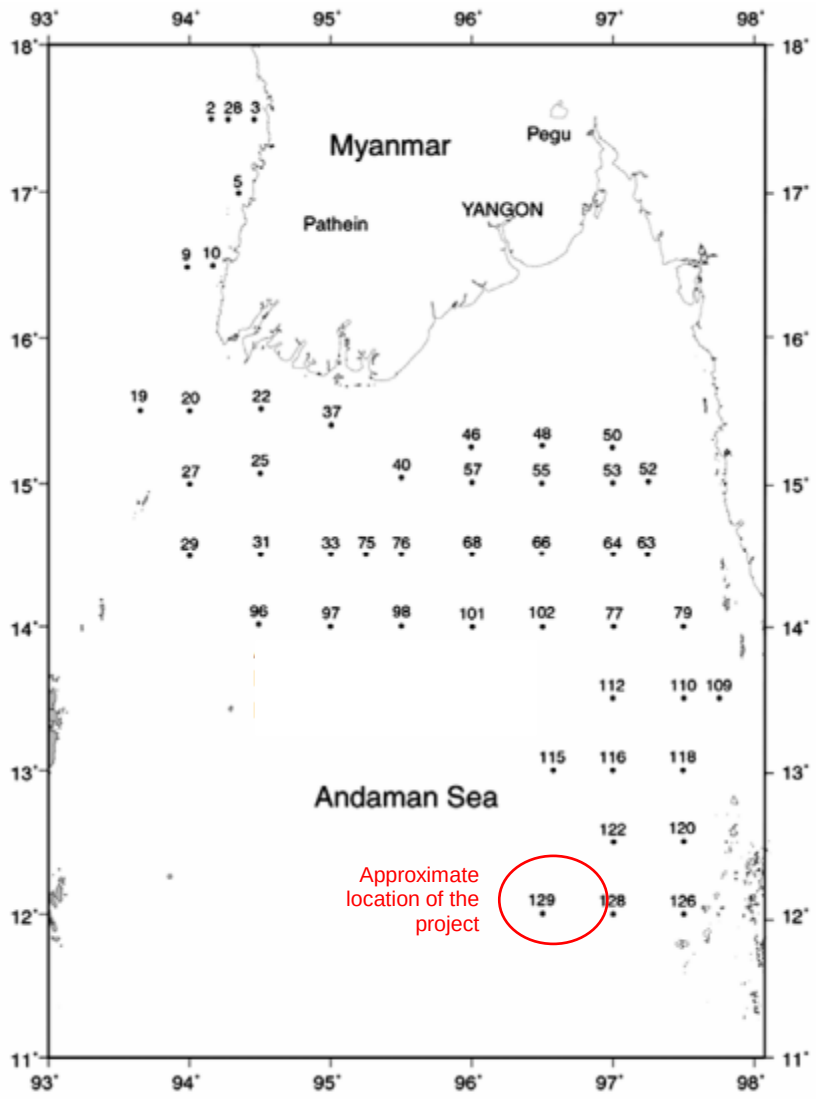


Figure 5-31: Location of benthic stations

SOURCE: ANSARI, JUNE 2012

Fauna composition differed in different depth. Forams were abundant in the shallow region (20-50m) while the polychaete showed no preference to water depth and were recorded regularly with high prevalence from all stations. Among crustaceans the amphipods, copepods, ostracods and macruran crabs were represented at different depth. About 24 taxa were recorded from 20-50m depth while the intermediate depth of 51-100m had the maximum taxa (27) and in the deepest zone 201-1000m there were only 11 taxa recorded. Between 500m and 1000m depth (which is the maximum depth of this field survey, and at the same time the depth range of the project), Polychaeta represented 52.7%, Crustacea 27.8%, Mollusca 6.9%, Echinodermata 0% and others 12.6%. The trends in the abundance of fauna reported in this scientific survey support the hypothesis that the quantity and species diversity of macrobenthos are higher in near shore than in offshore area with exception of specialized ecosystems.

Taking into account this information, and the water depth of the M15 Block project area (200-2000 m), the benthic community is expected to be not very abundant or diversified.

5.2.2. Coastal Environment

The following section describes Myanmar's coastal environment adjacent to the project area, i.e., between the Ayeyarwady district and Tanintharyi but also Mergui archipelago (situated at 60 km of the project area).

5.2.2.1. Coastal Habitats and Flora

The land pattern in coastal areas in Myanmar consists of mangroves, coral reefs, sea-grass beds, evergreen forest, wetlands and various types of agricultural land.

A. Mangroves

With the exception of agriculture, mangrove ecosystems contribute to maintain biological resources which are not only significant for the conservation of biological diversity but also of direct economic significance to Myanmar. Mangroves are found in all regions.

The delta formation is the most extensive of Myanmar, which is situated at the southernmost portions in the Irrawaddy Delta. The other two formations are found along the sheltered coasts in the Rakhine and **Tanintharyi region (the closest to the project area, situated at 160km far from the project location)**. The original surface area covered of mangrove forest in Myanmar was 320,106 ha in early 1900.

The Rakhine mangroves are made up primarily of *Rhizophora mucronata*, *R. candelria, Sonneratia* spp., *Kandelia rheedeii*, *Bruguiera* spp*., Xylocarpus granatum, X. moluccensis, Nipa fruticans,* and *Phoenix paludosa*. The Irrawaddy mangroves consist of *Rhizophora mucronata, R. conjugata, Bruguiera parviflora, B. gymnorhiza, B. cylindrica, Heritiera formes, Sonneratia apetala, S. griffithii, S. caseolaris, Xylocarpus granatum, X. molluccensis, Ceiops roxburghiana, C. mimosoides, Avicennia officinalis, Kanddelia rheedii* and *Excoecaria agallocha*.

The map in Figure 5-30 shows the different locations of mangrove habitats in Myanmar.

Figure 5-32: Location of mangroves and coral reefs

Source: ENCYCLOPAEDIA OF EARTH

Table 5-10 lists the different mangrove habitats in Myanmar and their principal characteristics.

Table 5-12[11]: Characteristics of Myanmar's mangroves

Region	Area (km^2)	Status	Condition
Rakhine	229	Nominally Protected	Threatened
Ayeyarwady	275	Nominally Protected	10.6% reserved forest, remainder threatened
Tanintharyi	224	Nominally Protected	Threatened. Rate of decrease 2.4% per annum.

[11] Bay of Bengal LME, Transboundary Diagnostic Analysis Volume 2

B. Seagrass

Seagrasses are submerged flowering plants found mostly along the coastline. Healthy seagrasses protect the shore, promote biodiversity, store carbon, cycle nutrients and help support numerous industries (e.g. fishing, tourism).

Seagrass plays an important role for major Myanmar's species in their life cycle, as for dugongs, seaturtles, etc. Due to the shallow water, seagrasses can develop with photosynthesis, providing food and protecting habitats for several species.

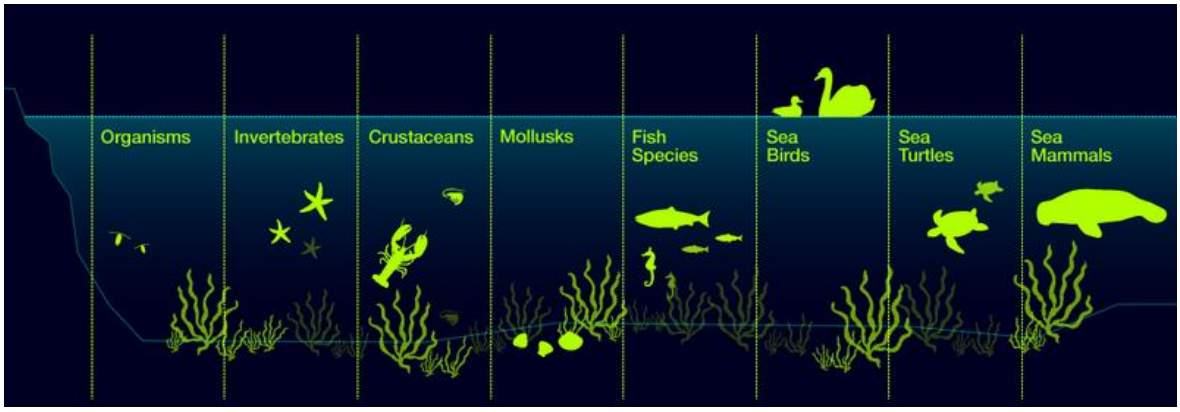


Figure 5-33: Organisms likely to be encountered in the Myanmar's seagrasses (Ocean Health Index)

There is little information on the status of seagrass resources in Myanmar. Based on the data prepared by Soe Htun in 2001, Myanmar has nine species of seagrass belonging to five genera from two families. These are *Cymodocea rotundata, C. serrulata, Halodule pinifolia, H. uninervis, Syringodium isotoefolium, Enhalus acoroides, Halophila beccarii, H. decipiens, H. ovalis*. Among these species, *Cymodocea rotundata*, *C. serrulata* and *Enhalus acoroides* are dominant in the seagrass beds.

The distribution of seagrass along the Myanmar coast is presented in Table 5-13.

Table 5-13: Distribution of seagrass along Myanmar coastal region

Seagrass ((Family/Genus/Species)	Rakhine Coastal Region											Ayeyawady Delta and Gulf of Mottama (Martaban) Coastal Region	Tanintharyi Coastal Region			
	Sittwe	Kyaukphyu	Mazin	Ngapali	Shwewar Gyaing	Kywethauk Gyaing	Maungshwela y Gyaing	Hmawchay Gyaing	Phothaung Gyaing	Wetthay Gyaing	Chaungthar		Kyaikkhami	Maungmagan	South Moscos Island	St.Luke Island
Cymodoceaceae																
Cymodocea rotundata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
C. serrulata	-	-	+	-	+	-	+	-	+	+	-	-	-	-	-	-
Halodule pinifolia	-	-	-	+	+	-	+	-	-	-	-	-	-		-	-
H. uninervis	-	-	+	-	-	-	-	+	-	+	+	-	-	-	-	-
Syringodium isotoefolium	-	-	-	+	+	-	-	-	-	-	+	-	-	-	-	-
Hydrochari-taceae																
Enhalus acoroides	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	+
Halophila beccarii	x	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
H. decipiens	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-
H. ovalis	-	x	-	-	-	+	+	-	+	-	-	-	-	-	+	+
TOTAL	**1**	**1**	**2**	**3**	**3**	**2**	**3**	**1**	**3**	**2**	**2**	-	**1**	**1**	**1**	**3**

Symbols: + Present; - Absence (no information available); x Presence according to C. den Hartog (1970)

SOURCE: NATIONAL REPORT OF MYANMAR, SUTAINABLE MANAGEMENT OF THE BAY OF BENGAL LARGE MARINE ECOSYSTEM,DEPARTMENT OF FISHERIES OF MYANMAR, 2003

The water depth within the project area ranges from 200 to 2000m, at which depth seagrass is not likely to occur; consequently species such as sea horse and dugongs are not likely to be present.

C. Seaweed

Myanmar, located in the tropics, has a rich and varied seaweed flora. Although the Burmese have for many years eaten several seaweeds as vegetables and used them as a source of agar extraction, there is little recognition of their importance as part of the marine environment. Therefore, there is currently not much information available on the subject.

According to the National Report of Myanmar on Sustainable Management of the Bay of Bengal Large Marine Ecosystem (2003), a number of the 122 genera and 307 species of seaweeds from Myanmar have been reported by Kyi Win (1972) and Kyaw Soe and Kyi Win (1975,1977). Seaweed could be considered as a dependable natural resource if sustainably exploited (Kyaw Soe, 1970).

From visual observations and studies, the following seaweed genera have been identified for their economic potential:

- Chlorophyta: *Ulva, Enteromopha, Monostroma, Caulerpa, Codium*.
- Phaeophyta: *Padina, Dictyota, Spathoglossum, Chnoospora, Rosenvingea, Hormophysa, Turbinaria, Sargassum*.
- Rhodophyta: *Porphyra, Gelidiella, Halymenia, Solieria, Catenella, Hypnea, Gracilaria, Laurencia, Acanthophora*.

Among these species, *Sargassum* and *Hypnea* are the most abundant in Myanmar. The standing stock of *Sargassum* is estimated at 2,500 metric tonnes (mt) dry weight and 1,500mtdry weight for *Hypnea*. *Sargassum* beds formed along the Tanintharyi coastal region provide good habitats, refuges and spawning grounds for commercially important fishery resources.

Due to the water depth of the project area, these species will not be found in M15 Block.

D. Myeik Archipelago

Myeik archipelago, situated in the eastern part of the Andaman Sea counts over 800 islands and stretches over 34,340km². Islands and islets are covered by tropical evergreen forests, surrounded by mangroves, extensive coral reefs and seagrass beds. There are hundreds of coves and bays, fringed with white sandy beaches. Most of the islands are uninhabited.

5.2.2.2. Costal Fauna

A. Coral Reefs

Coral reefs are one of the world's most diverse natural ecosystems and provide a wide variety of food and habitat for a great number of species such as plants, fish and other living creatures. Globally, there are about 600,000km^2 of coral reef (0.9% are located in Myanmar); more than half of this area is distributed in the Indian Ocean.

As Myanmar is located in a tropical region, a large number of coral species occur across the coastal waters of the country. The nearest coral reef sites to the project area are in the Myeik archipelago. A description of the coral reefs in Myanmar is provided in Table 5-11.

Table 5-14: Location / characteristics of coral reefs in Myanmar[12]

	Area (km^2)	% live coral cover	Condition
Myeik Archipelago	Fringing	Unknown	Blast fishing
Burma Banks	1,700km^2	Supposed to be in good condition	Tangled nets, blast
Rakhine area	Barrier		Fishing, coastal pollution
Tanintharyi	Fringing	Unknown	Poor fishing practices

B. Marine Mammals

Some species of marine mammals could be encountered in coastal areas (shallow water, delta, rivers) of the Bay of Bengal, although it is unlikely that they will occur within the project area and surrounding offshore waters. These include:

- Irrawaddy dolphin (*Orcaella brevirostris*) (Vulnerable);
- Indo-Pacific humpback dolphin (*Sousa chinensis*) (Near Threatened);
- Striped dolphin (*Stenella coeruleoalba*) (Least Concern); and
- Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) (Data Deficient).

IRRAWADY DOLPHIN

DUGONG

Figure 5-34: Example of shallow water marine mammals in Myanmar

A cetacean survey was conducted in 2005 in the Myeik Archipelago coastal zone, a total of 30 cetacean groups were detected. Following species was observed from the vessel:

[12] Bay of Bengal LME, Transboundary Diagnostic Analysis Volume 2

- Bryde's whale
- Finless porpoise
- Indo-pacific hump-back dolphin
- Indo-Pacific bottlenose dolphin
- Spinner dolphin
- Pantropical spotted dolphin
- Irrawaddy dolphin

Even if these species are known to be resident of the Andaman Sea, the water depth of the M15 Block does not favor their presence, and they are not likely to be present.

C. Coastal birds

There are currently 55 Important Bird Areas (IBAs) recorded in Myanmar by the Birdlife International, which represent a total area of 54,364 km^2: 16 are protected, 3 partially protected and 36 are unprotected.

Myanmar's IBAs cover 8% of the total land area of the country. There are several very large IBAs, reflecting the intact nature of natural habitats in some parts of the country.

According to the BirdLife association, the closest Important Bird Areas are:

- Ayeyarwaddy Delta (approx. 480km far from the project area);
- Lampi Island National Park (approx.140km of the project area).

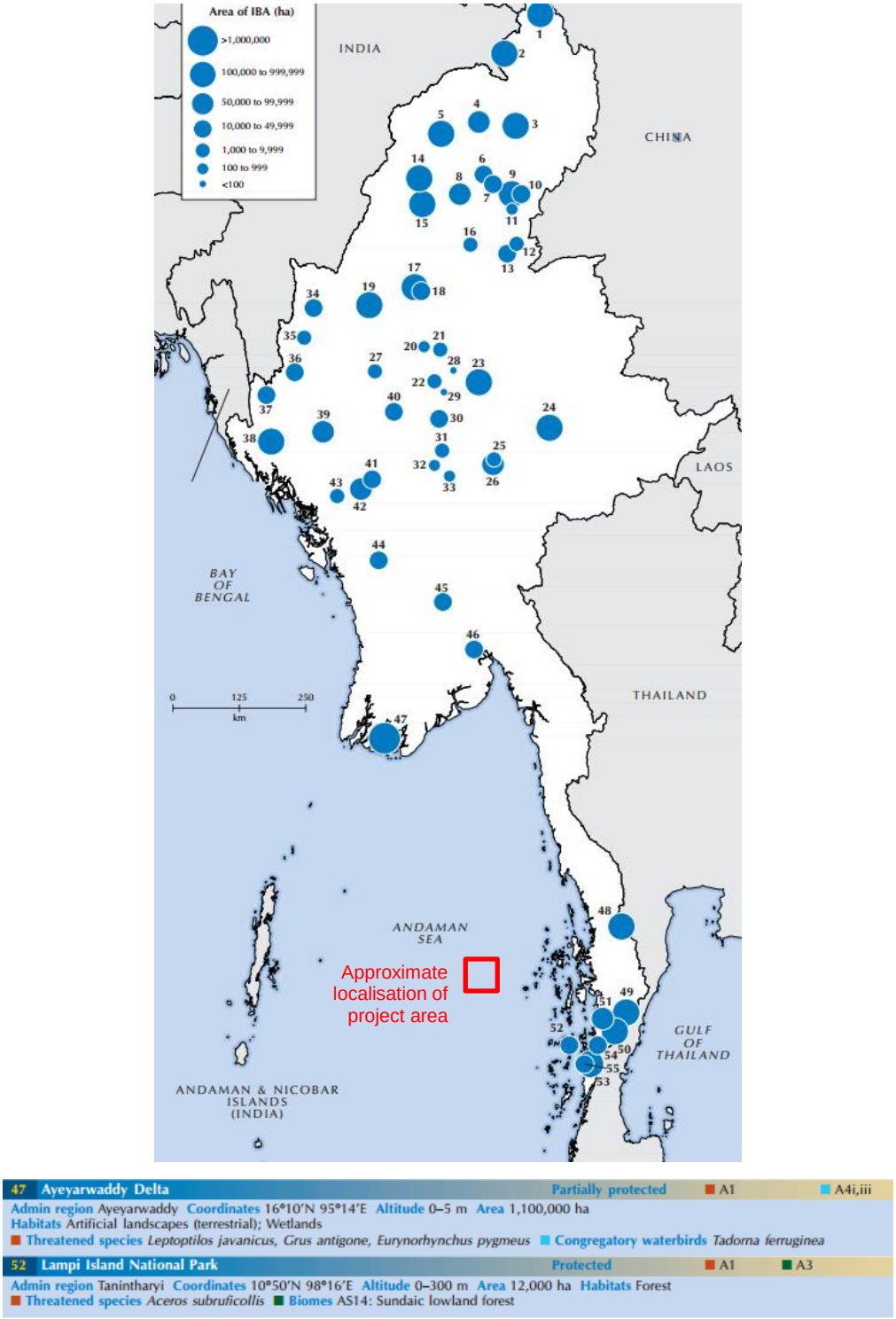


Figure 5-35: Location of closest important Bird Areas (IBAs) of the project area

SOURCE: BIRDLIFE.ORG

D. Coastal marine reptile

A total of 16 marine reptile species have been recorded by the IUCN in Myanmar waters (see Table 5 10).

Table 5-15: Marine reptiles in the coastal waters of Myanmar

Family	Genus	Species	Common names	Red list status	Population trend
ACROCHORDIDAE	Acrochordus	granulatus	Wart Snake	LC	stable
ELAPIDAE	Astrotia	stokesii	Stokes' Sea Snake	LC	unknown
HOMALOPSIDAE	Bitia	hydroides	The Bitia	LC	unknown
HOMALOPSIDAE	Cerberus	rynchops	Asian Bockadam	LC	unknown
DERMOCHELYIDAE	Dermochelys	coriacea	Leatherback	CR	decreasing
ELAPIDAE	Enhydrina	schistosa	Beaked Sea Snake	LC	stable
CHELONIIDAE	Eretmochelys	imbricata	Hawksbill turtle	CR	decreasing
ELAPIDAE	Hydrophis	ornatus	Ornate Reef Sea Snake	LC	unknown
ELAPIDAE	Hydrophis	stricticollis	Collared Sea Snake	DD	unknown
ELAPIDAE	Lapemis	curtus	Shaw's Sea Snake	LC	unknown
CHELONIIDAE	Lepidochelys	olivacea	Olive ridley	VU	decreasing
ELAPIDAE	Pelamis	platura	Pelagic Sea Snake	LC	stable
ELAPIDAE	Thalassophina	viperina	Viperine Sea Snake	LC	unknown
CHELONIIDAE	Caretta	caretta	Loggerhead	EN	
CHELONIIDAE	Chelonia	mydas	Green turtle	EN	decreasing
CROCODYLIDAE	Crocodylus	porosus	Salt-water Crocodile	LC	

SOURCE: IUCN RED LIST, 2014 - STATUS: CRITICALLY ENDANGERED (CR), ENDANGERED (EN), VULNERABLE (VU), LEAST CONCERN (LC), DATA DEFICIENT (DD)

Sea turtles

Sea turtles are one of the internationally listed aquatic endangered species for long term protection and conservation. They present the most threatened group of marine reptiles within Myanmar's coastal areas.

Nesting of turtles is observed around the Andaman Sea, Gulf of Mottama (Gulf of Mattaban), Thameehla Island and Bay of Bengal. Currently in Myanmar, the Department of Fisheries (DoF) has recorded at least 35 nesting sites in areas along the coastal region. Among those, six are closely conserved through monitoring and surveillance of turtle landing sites, clutches and numbers of hatchlings able to return to the sea.

Amongst the turtle species present in Myanmar, 5 species breed regularly on Myanmar's beaches, including the olive ridley turtle *Lepoidochelys olivacea* (vulnerable), the loggerhead *Caretta caretta* (endangered), the green turtle *Chelonia mydas* (endangered), the hawksbill turtle *Eretmochelys imbricata* (critically endangered), and leatherback Turtle *Dermochelys coriacea* (critically endangered).

Most observations of turtles are typically within 15 kilometers of mainland shores in protected, relatively shallow marine waters (22-55m). Each species of turtles live in different type of habitat:

- **Olive ridleys** will occasionally occur in open waters. The multiple habitats and geographical localities used by this species vary throughout its life cycle;
- **Loggerhead sea turtles** spend most of their lives in the open ocean and in shallow coastal waters. They rarely come ashore, with the exception of the females' brief visits to construct nests and deposit eggs. Adults and juveniles live along the continental shelf, as well as in shallow coastal estuaries;

- **Green sea turtles** move across three habitat types, depending on their life stage. They lay eggs on beaches. Mature turtles spend most of their time in shallow, coastal waters with lush seagrass beds. Adults frequent inshore bays, lagoons and shoals with lush seagrass meadows. Turtles spend most of their first five years in convergence zones within the open ocean. Upon leaving the nesting beach, it has been hypothesized for green turtles that hatchlings begin an oceanic phase (Carr 1987), perhaps floating passively in major current systems (gyres) that serve as open-ocean developmental grounds (Carr and Meylan 1980, Witham 1991). After a number of years in the oceanic zone, these turtles recruit to neritic developmental areas rich in seagrass and/or marine algae where they forage and grow until maturity (Musick and Limpus 1997). Upon attaining sexual maturity green turtles commence breeding migrations between foraging grounds and nesting areas that are undertaken every few years (Hirth 1997). Migrations are carried out by both males and females and may traverse oceanic zones, often spanning thousands of kilometers (Carr 1986, Mortimer and Portier 1989). During non-breeding periods adults reside at coastal neritic feeding areas that sometimes coincide with juvenile developmental habitats (e.g., Limpus *et al.* 1994, Seminoff *et al.* 2003).
- **Hawksbill sea turtles** are rare in Myanmar. Adult hawksbill sea turtles are primarily found in tropical coral reefs. They are usually seen resting in caves and ledges in and around these reefs throughout the day. As a highly migratory species, they inhabit a wide range of habitats, from the open ocean to lagoons and even mangrove swamps in estuaries;
- **Leatherback turtles** are also rare in Myanmar and can be found primarily in the open ocean. Its favored breeding beaches are mainland sites facing deep water and they seem to avoid those sites protected by coral reefs.

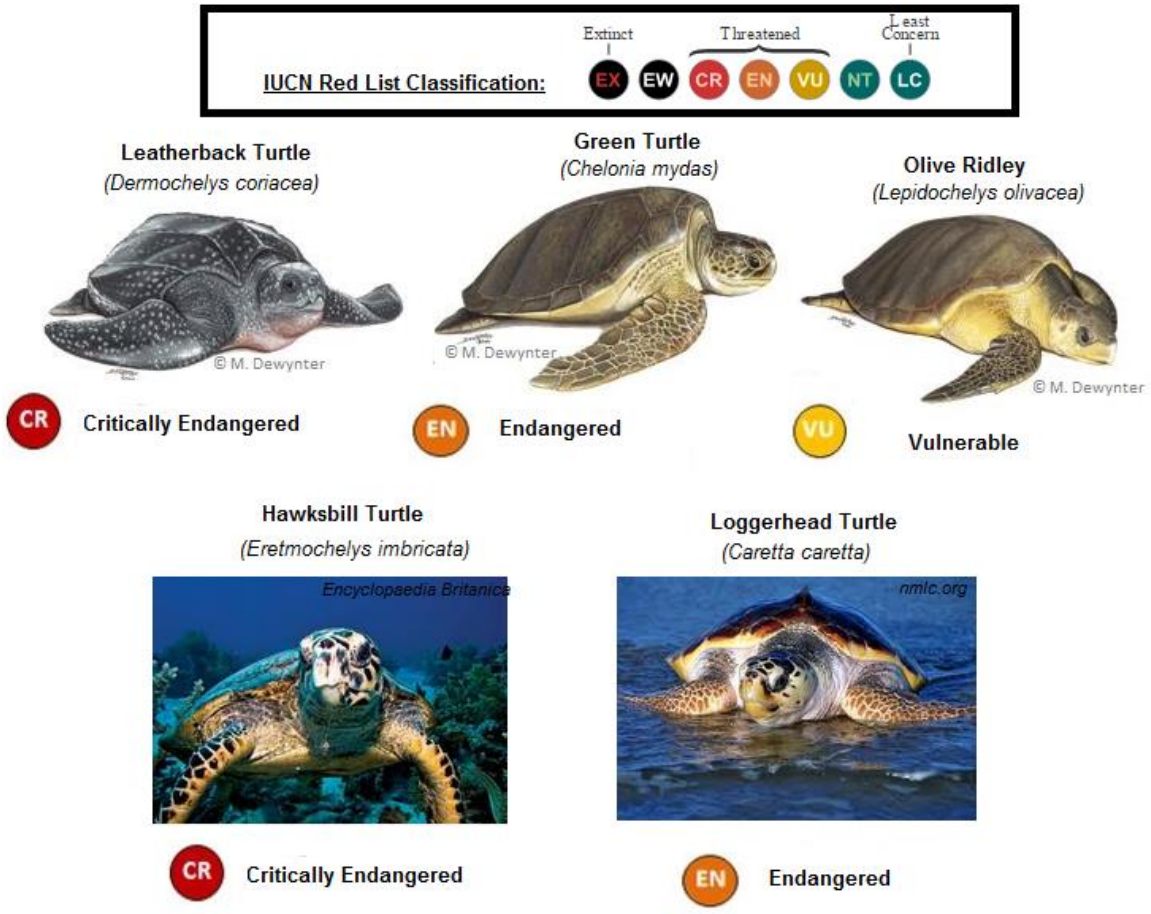


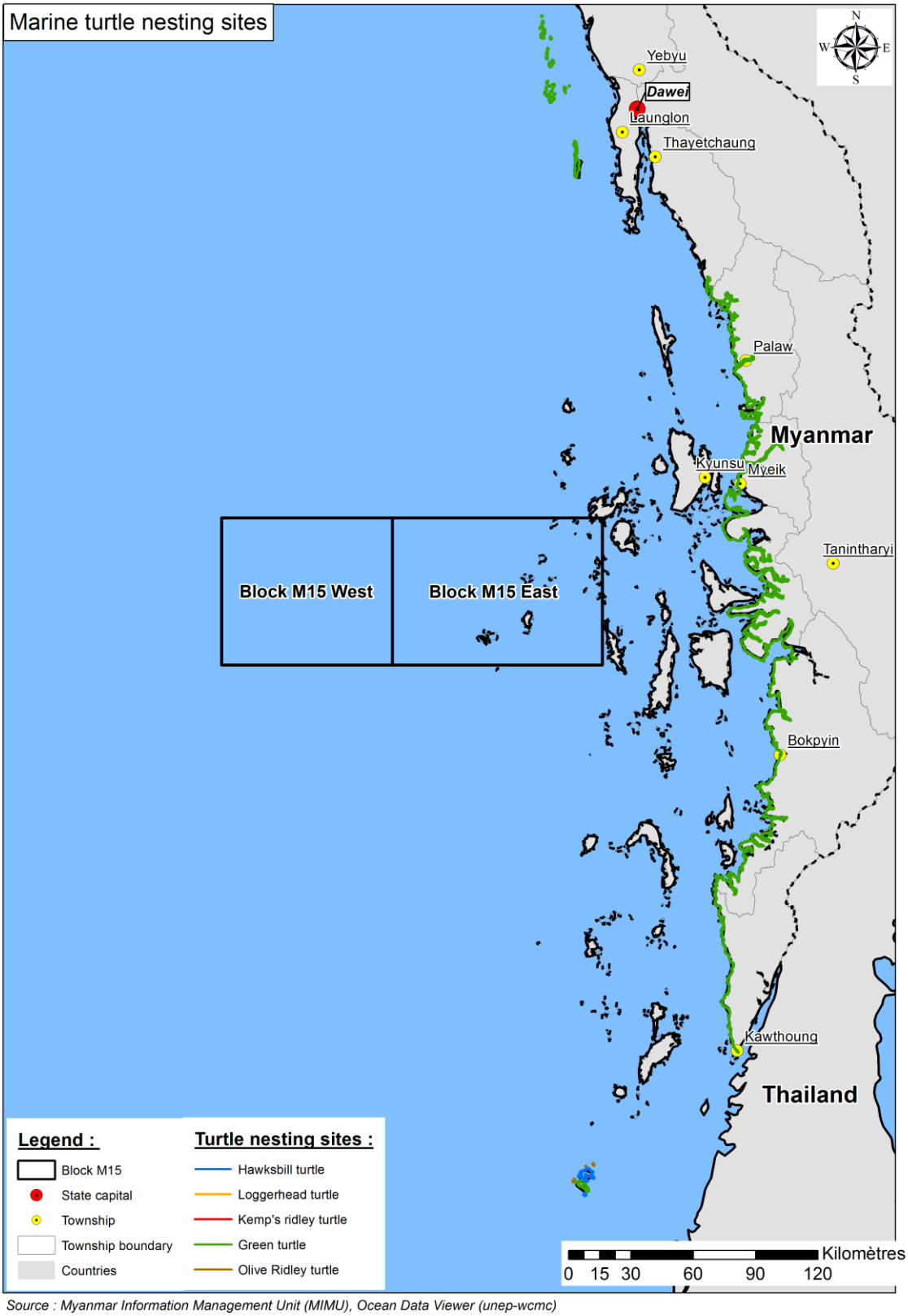
Figure 5-36: Marine turtles presents in Myanmar waters

The hawksbill turtle and leatherback, which were occasionally reported by fishermen in some parts of Tanintharyi Coastal area, have totally disappeared from the Ayeyarwady Delta Coastal areas for example. All species have been abundant in the past.

The beaches of "Tha-mi-hla Kyune" (Diamonds island 15º 51' N 94º 17' E, at **450km** of the Project area), an island at the mouth of the Pathein River, hosts the nesting green turtle and the loggerhead turtle. But "Kaing – Thaung – Kyune" (Kaing-Thaung Island) (15º 44' N 95º 04' E, at **400km** of the project area) and "Taung-Ka-Done-Kyune"(Taung-Ka-Done Island) (15º 43' N 95º 18' E, at **400km of** the project area), two small islands, which situated at the mouths of Ayeyarwady and Bogalay Rivers, respectively host the nesting olive ridley turtle and loggerhead turtle.

Most nesting is by olive ridley turtle (70%), followed by loggerhead turtle (20%) and green turtle (10%). The location of nesting sites of turtles in Myanmar's beaches is presented in Figure 5-37.

Fisheries Department personnel walk the beaches at night during the nesting period (September-March, with a peak in January-February) and mark the location of all nests found. Nests low on the beach, which may be subjected to flooding, are transplanted to higher ground. Sea turtles migration generally occurs from September to March.



Source : Myanmar Information Management Unit (MIMU), Ocean Data Viewer (unep-wcmc)

Figure 5-37: Location of turtles nesting sites on Myanmar's coast

The table below shows the geographical distribution of marine turtle species in Myanmar.

Table 5-16: Distribution of marine turtles in Myanmar[13]

Location/habitat	Leatherback	Loggerhead	Green	Hawksbill	Olive ridley
Location					
Rakhine	*	*	*	*	*
Ayeyarwaddy	*		*	*	*
Yangon	*		*	*	*
Mon			*		*
Tanintharyi	*		*	*	*
Habitat					
Marine	*	*	*	*	*
Coastal	*	*	*	*	*

All turtle species, with the exception of the leatherback, are targeted by fishermen either for food or as a source of tortoise shell scutes. In addition, eggs are extensively collected (around 40,000 a year), which poses a threat to the continued breeding status of turtles in Myanmar.

To promote the protection and conservation of turtles on islands and sandy beaches of Myanmar, the Department of Fisheries is undertaking sea turtle hatcheries and releasing programs in the Irrawaddy Delta areas.

All sea turtles in Myanmar spend part of their life cycle in open sea. Therefore, these species can potentially be met in the M15 Block. Nevertheless, it should be noted that the nearest nesting site is situated at 200km of the study area and most observation of turtles are typically in shallow water.

Sea snakes

Sea snakes are common in the Indo-West Pacific region. **The only species frequently encountered offshore is the yellow sea snake *Pelamis platurus* ('least concern').** It is therefore presumed to be relatively common near the Irrawaddy delta though specific data are lacking.

All the sea snake species identified by the IUCN in Myanmar coastal waters have been identified as 'least concern'.

Saltwater crocodile

In addition to sea turtles and snakes, the saltwater crocodile (*Crocodilus porosus*) has been recorded in swampy coastal areas throughout the region, as well as occasionally being observed in the open sea. **This species is listed by the IUCN as least concern, and is not considered significant in the context of the project.**

5.2.3. Protected Areas

Myanmar defines its Protected Areas for Conservation as follows:

- **National Park.** Maintained for biodiversity conservation and representativeness. Firm management control. No settlement or resource harvesting allowed. Visitors permitted.
- **Marine National Park.** The same as national park but in marine, island and coastal environments.
- **Wildlife Sanctuary.** Species conservation. No settlement or resource harvesting allowed. Visitors permitted.
- **Bird Sanctuary.** As for wildlife sanctuary but birdlife conservation is paramount.

[13] Location: Kyoto University Research Information Repository, 2012 Interaction between Fishing Activities and Marine Turtles in Myanmar, W IN / habitat: IUCN red List 2014

- **Wildlife Park.** Wild animals held in captivity and in the wild but on a fairly small range. For recreation and education. No settlement or resource harvesting allowed. Visitors encouraged.
- **Mountain Park.** Maintained to conserve landscapes, geomorphological features and sites of religious significance. No settlement allowed. Visitors permitted, including pilgrims who are allowed to harvest limited supplies of natural resources – bamboo shoots, mushrooms and edible fruits.
- **Elephant Range.** A means of conserving Asian elephant. Can include villages, and may overlap with other protected areas although the only one that exists at present does not overlap. Covers a range over which elephant herds move.

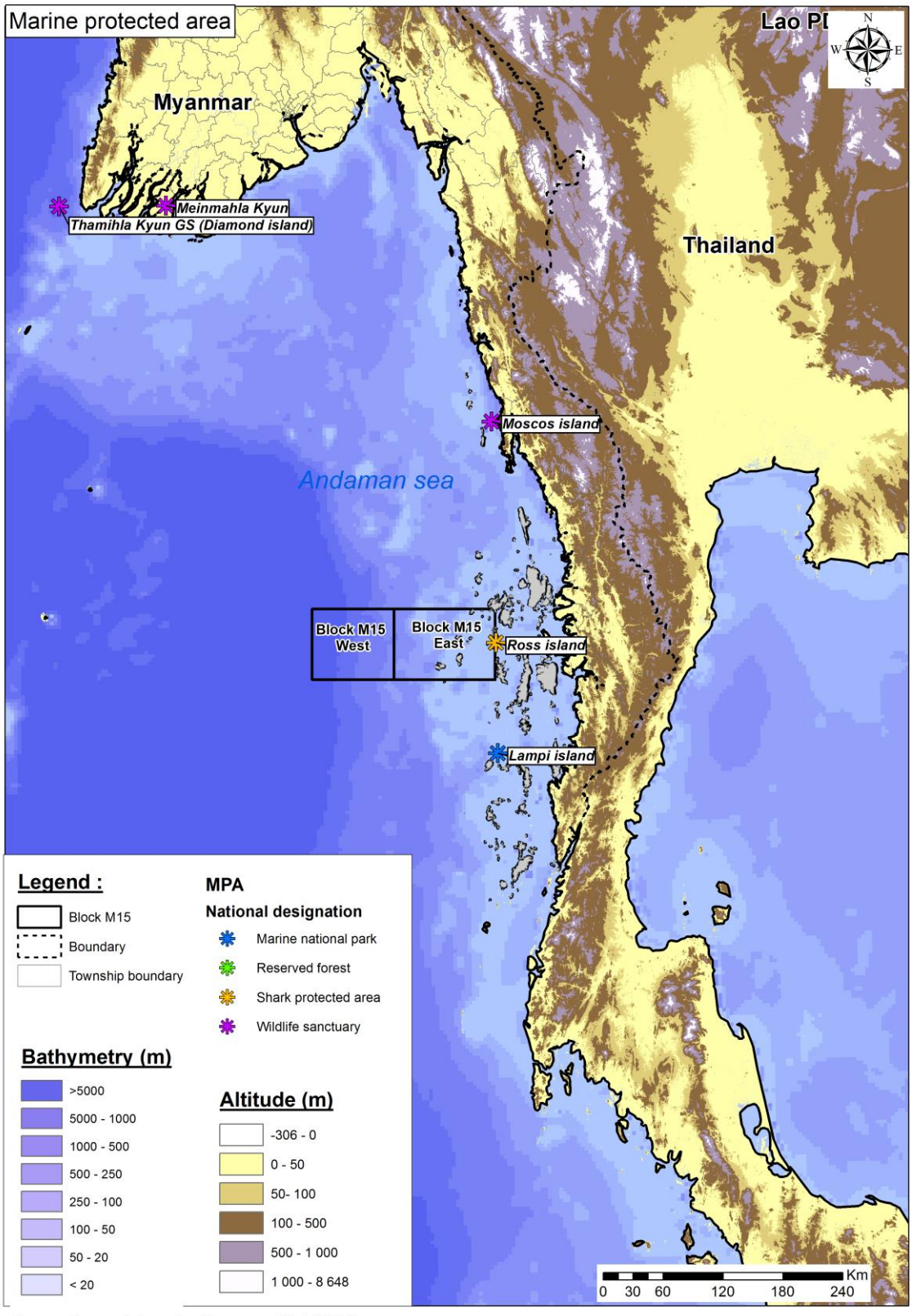
The main sensitive protected areas located in the proximity of the project area are listed in Table 5-12, and more detail is provided in the sub-sections below, based on the Myanmar Protected Areas report from Instituto Oikos and BANCA, 2011.

Table 5-17: Sensitive areas close to the M15 Block[14]

Site Name	Province	National designation	Establish year	IUCN Category	Distance to project area
Lampi Island	Tanintharyi	Marine national park	1996	Ib	140 km
Meinmahla Kyun	Irrawady	Wildlife sanctuary	1993	IV	440 km
Moscos island	Tanintharyi	Wildlife sanctuary	1927	IV	220 km
Ross Island	Tanintharyi	Shark protected area			100 km
Thamihla Kyun GS (Diamond Island)	Irrawady	Wildlife sanctuary	1970	IV	500 km

Additionally, there are currently 55 Important Bird Areas (IBAs) recorded in Myanmar by the Birdlife International, which represent a total area of 54,364 km^2. Of these, 16 are protected; three partially protected and 36 are unprotected. Myanmar's IBAs cover 8% of the total land area of the country. There are several very large IBAs, reflecting the intact nature of natural habitats in some parts of the country. According to Birdlife International data, the closest IBA to the project area is located in the Ayeyarwaddy delta (~440km from the project area).

[14] Analysis performed using the description of BANCA Myanmar Protected area, Context, Current status and Challenges, 2011



Source : Myanmar Information Management Unit (MIMU)

Figure 5-38: Location of marine protected areas

5.2.3.1. Lampi Island

Lampi Island Marine National Park is located in the Myeik archipelago in Tanintharyi Region. It is the southernmost protected area in the country. The protected area was designated in 1996 to include an area extending two miles from the outer islands but there is no demarcation buoy or signal. The park contains not only Lampi Island, but also several adjacent islands and the surrounding seas. Lampi Island is the biggest island and the core of the site. It is 205 km² and is oriented in a north-south direction, with a length of 48 km and a maximum width of about 6 km. It is generally hilly (150–270 m), presenting a rocky coast with presence of sandy beaches, bays and inlets. The sea depth between Island and the mainland is on average 12m and nowhere deeper than 24m. The protection level of the site is total. According to the notification no. 40/96, the boundaries of Lampi Island Marine National Park are as follows:

- *North boundary*: two nautical miles north from the shoreline of Two Hill Island.
- *East Boundary:* two nautical miles east from the shoreline of Pulo Gabon Island, Dolphin Islands (War Kyunn), Marble Island, Gregory Group Islands, Palo Taban Islands.
- *South Boundary*: two nautical miles south from the shoreline of Pulo Tuhan Island which is south east of Lampi Island, Palo Nalo (Bo Cho) Island, Gu Gyi (Kyun) Island, Pulo Lobiaung Island.
- *West Boundary:* two nautical miles west from the shoreline of Kanzagyi Island, Wa Ale Kyun Island, Ko Phawt Island, Pulo Tayu Island, Kular Island, Observation Island, Pulo Tu-ante Island, Pulo Lobiaung (Lin Shu) Island.

Lampi Island is covered by tropical lowland wet evergreen forest in the interior, mangrove forest along rivers and fresh-water sources, and beach and dune forest along the coast. Other important habitat types are coral reefs, seagrass, freshwater streams and swamps. The main island of Lampi has two major perennial rivers and many small seasonal streams. Fresh-water resources are abundant. The variety of habitats supports a high diversity of both terrestrial and marine resources.

The whole area is rich in coral reefs, seaweed and seagrass beds which serve as important habitats for molluscs, crustaceans, echinoderms and fishes, of which many species are of economic importance as food resources for local use and export. The seagrass meadows around Lampi Island also supports threatened species like the green turtle and the dugong that feed on seagrass, and a variety of birds that feed in the intertidal zone and sublittoral zone. Mangrove forests, found in the park in a very good conservation status, also provide an important habitat for many species of molluscs, crustaceans and fishes.

Site ID	17
Locality	Tanintharyi Region (Boke Pyin Township)
Coordinates	N 10° 50', E 98° 12'
Size (km²)	205
Altitude (m. asl)	0 – 455
Myanmar category	National Park
IUCN category	II
Site Governance	Nature and Wildlife Conservation Division
Boundaries	Demarcated
Year gazetted	1996
Protection level	Total
Main purposes	Conservation
Habitat	Evergreen Forest (Typical), Mangrove Forest, Beach and Dune Forest, Sea Grass Beds, Coral Reefs
Key resources	Coral Reefs, Mouse Deer and Salone Ethnic Groups

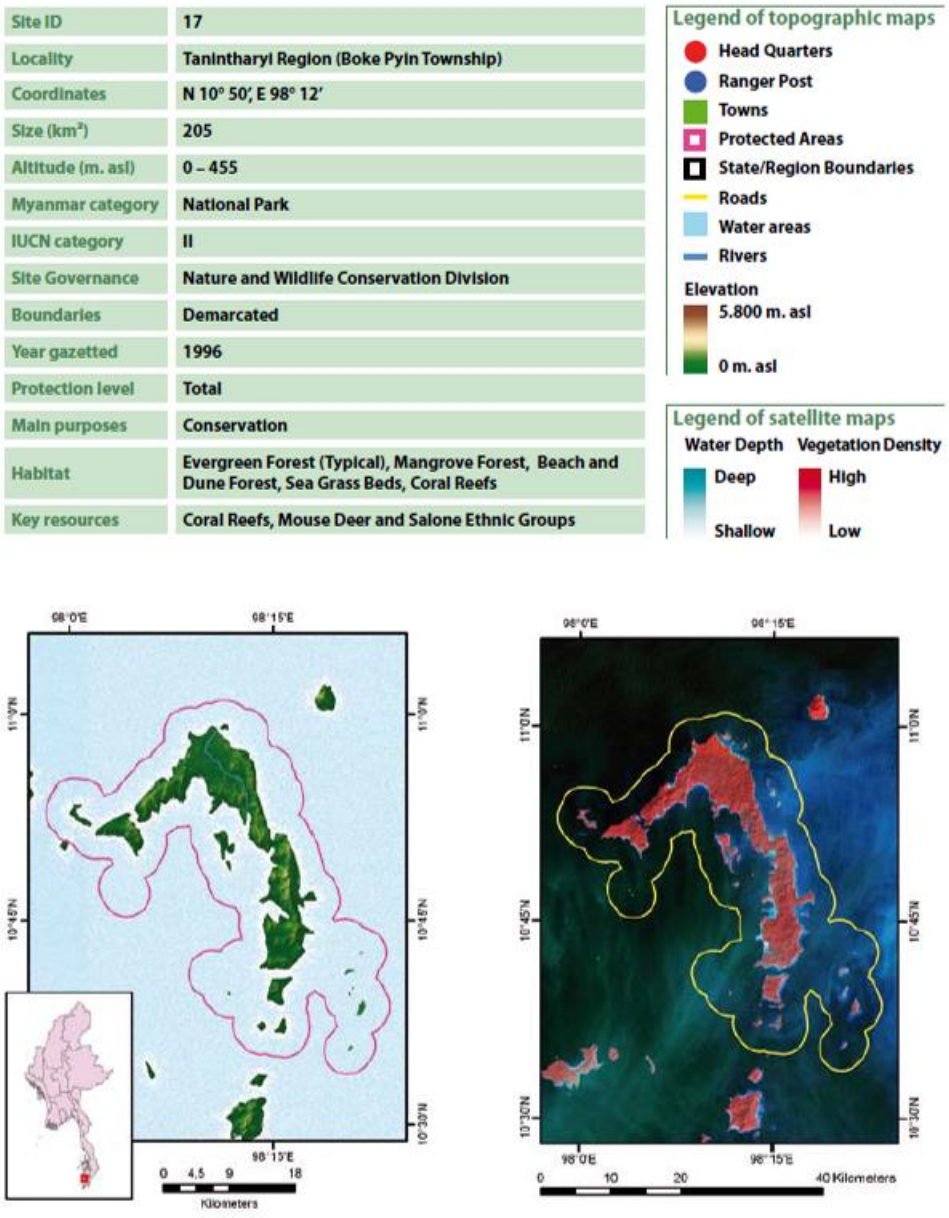


Figure 5-39: Lampi Island National Park

SOURCE: MYANMAR PROTECTED AREAS, ISTITUTO OIKOS AND BANCA, 2011

5.2.3.2. Ross Island

Myanmar designated a Marine Protected Area, where shark fishing cannot be conducted, between Ross Island (12°13'N, 98°05'E) and Lampi Island (10°48'N, 98°16'E). It is illegal to fish, collect, sell or carry all species of shark, in this area.

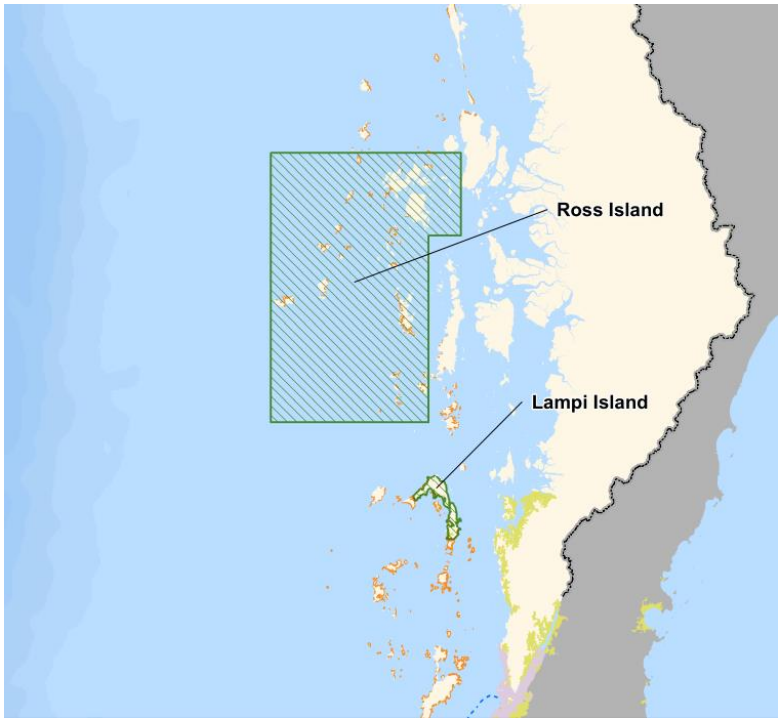


Figure 5-40: Ross Island - Shark protected area

SOURCE: BOLME, REEF BASE, 2014

5.3. SOCIO-ECONOMIC ENVIRONMENT

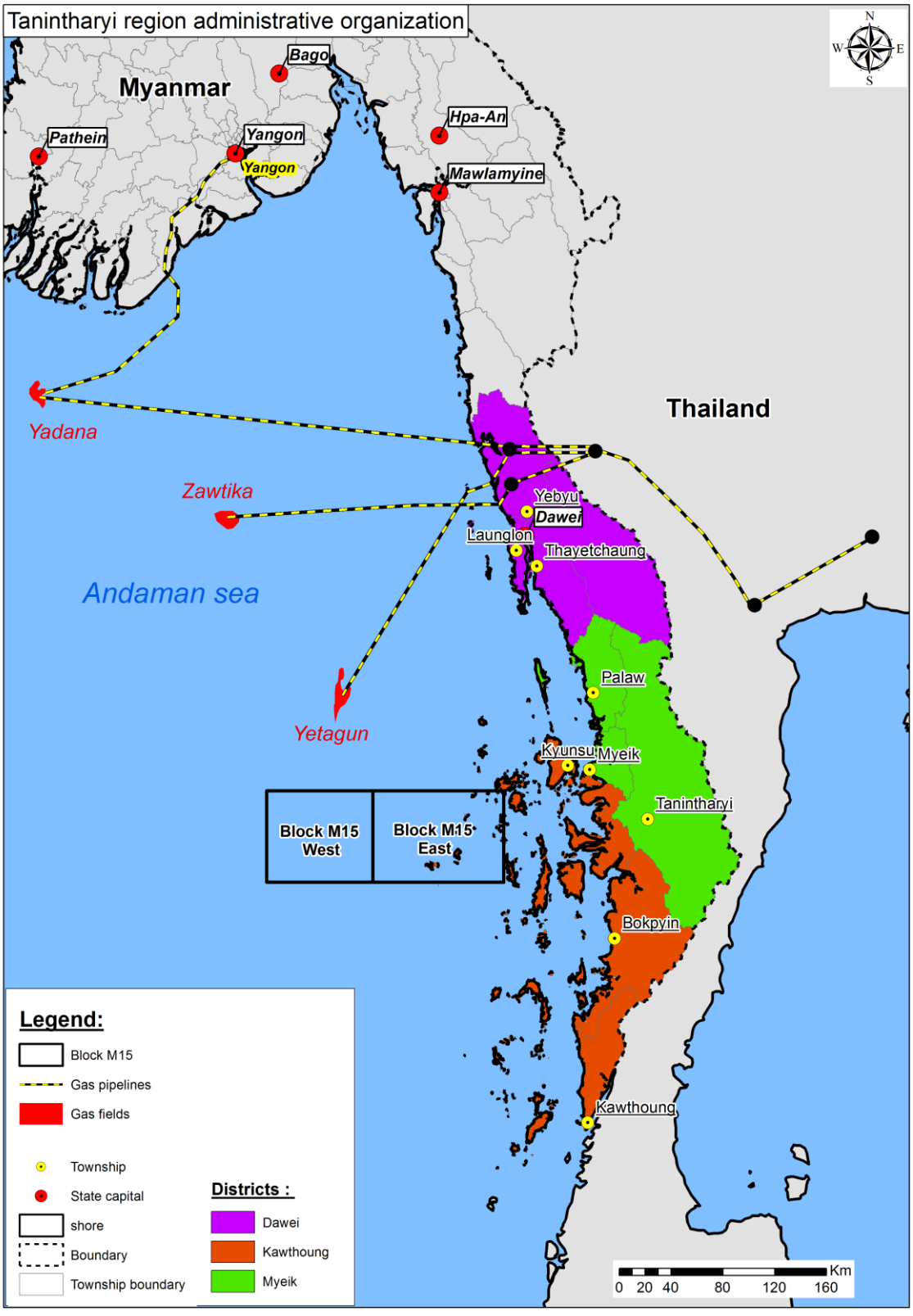
5.3.1. Administrative Organization

The project area is located in the Andaman Sea, offshore of the Mergui Archipelago, at the southernmost tip of Myanmar (Figure 5**.3-41**). The closest shoreline to the project area belongs to the Tanintharyi Region, which borders Thailand to the east and south, and the Mon state to the north.

The Tanintharyi Region composes three districts: Dawei, Myeik and Kawthoung. It is further subdivided into 10 townships and 347 village tracts. Dawei (125 000 inhabitants) is the Region's administrative capital, where all the major government institutions are based. Myeik is the commercial hub of the Region with an active trading port and a large population of over 280,000. At a distance of around 70 km to the north-eastern corner of the block, it is the closest town to the project.

The project area is offshore of a group of islands belonging to the Mergui Archipelago which number 800 islands, most of them uninhabited. This region of the archipelago is part of the Kyunsu township. It is administratively attached to the southern district of Kawthaung, although it is much closer to the town of Myiek than to the town of Kawthaung.

The eastern corners of the Block are located on Daung Kyun Island (north-eastern corner) and Bentink Island (south-eastern corner). The Block's eastern part encompasses a group of a dozen smaller islets. Its western part, the location of the present survey, contains neither islands nor islets.



Source : Myanmar Information Management Unit (MIMU)

Figure 5.3-41: Tanintharyi Region administrative organization

5.3.2. Governance

Prior to 2008, the governmental system in Myanmar was centralized, with limited transfer of authority to sub-national governmental institutions. Central Government held most of political and economic powers and responsibilities, controlling financial resources and budgets.

With the new Constitution of 2008, and changes in national administrative and electoral systems, the Government expressed its will to improve good governance, public services delivery and citizen participation through decentralization reforms and the delegation of resources and responsibilities to local governance systems: state/region, township and village administrations (Nixon et al., 2013). Partially elected local parliaments (State or Region Hluttaw) were established under the 2008 constitution. The government also passed several policies in order to devolve fiscal, political and administrative power to these administrations. It revised the Village Tract Administration Law in 2012, which increased local democracy through the direct election of the village tract administrator by the village inhabitants; in the same year, it introduced the Framework on Economic and Social Reform (FESR), which underlines the development of laws and regulations to organize the decentralization process[15].

The United Nations Development Program (UNDP) partnered with the government and the General Administration Department to support decentralization reforms. In 2013, they initiated a project of local governance mapping aimed at increasing knowledge on the functioning of traditional and formal governance systems at the local level. The project was completed in November 2014 with the publication of reports on all the states and regions of Myanmar. These reports enabled the identification of important local stakeholders and improved understanding of the power relationship mechanisms between them. The Tanintharyi Region UN report[16] informs the description for the Project Region (onshore).

The institutional framework for the Tanintharyi Region follows that of other states and regions of Myanmar. It is prescribed in detail in the 2008 Constitution[17] which afforded regions and states with limited executive, legislative and judicial powers.

The highest authority is the **Chief Minister who heads the Executive Branch of the Region**. The current Chief Minister, Myat Ko (from the government-backed Union Solidarity and Development Party) was appointed by central government in January 2012, following the dismissal of his predecessor on the same month. In addition to the Chief Minister, the Regional Government also comprises 11 ministers and an advocate general.

As in other states and regions, the legislative power is held at the regional level, by the regional parliament (Region Hluttaw). Tanintharyi Region Hluttaw has 21 elected seats (two seats per township and one seat set up for the minority Karen ethnic community) and seven appointed seats reserved for the military. Out of the 21 elected seats, twenty are currently held by the USDP and one by the National Unit Party (NUP).

The UNDP above mentioned report mentions that “the legislative activity of the Tanintharyi Region Hluttaw has been comparatively dynamic, and extended to a number of areas important for the local economy that go beyond what was required as an absolute minimum” (UNDP Myanmar, 2014: 24).

The report further adds that “in addition to its legislative work, the Tanintharyi Region Hluttaw has served as a platform for public debate which made it stand out in comparison with other less active state or region Hluttaws.” The planned special economic zone (SEZ) project in Dawei has been “an obvious focus of the political debate”, raising concerns over the question of land compensation and of corruption schemes that occurred to the detriment of local communities.

[16] The State of Local Governance: Trends in *Tanintharyi* - *UNDP* Myanmar 2014
[17] This document can be consulted online : http://www.burmalibrary.org/docs5/Myanmar_Constitution-2008-en.pdf

5.3.3. Population and Demography

5.3.3.1. Demography

The Ministry of Immigration and Population conducted the latest Myanmar population census in March and April 2014 (for the first time in 30 years): the final results have not been made public at the time of writing the present report. According to published provisional results, the country's total population is 51.4 million people, with an annual population growth rate of 1% as of 2012 (Ministry of Population and Immigration, 2014). Household composition ranges from 4.1 to 5.1 members in the different states of the Union, with an average of 4.4 household members..

With 1.4 million inhabitants, representing 2.7 % of the total population, Tanintharyi is among the least populous state of Myanmar. The Region is sparsely populated with about 32 persons per km². By contrast, the adjacent Mon Stat is estimated to have twice the population of Tanintharyi Region for less than a third of its landmass (UNHCR South-East Myanmar Management Unit, 2014).

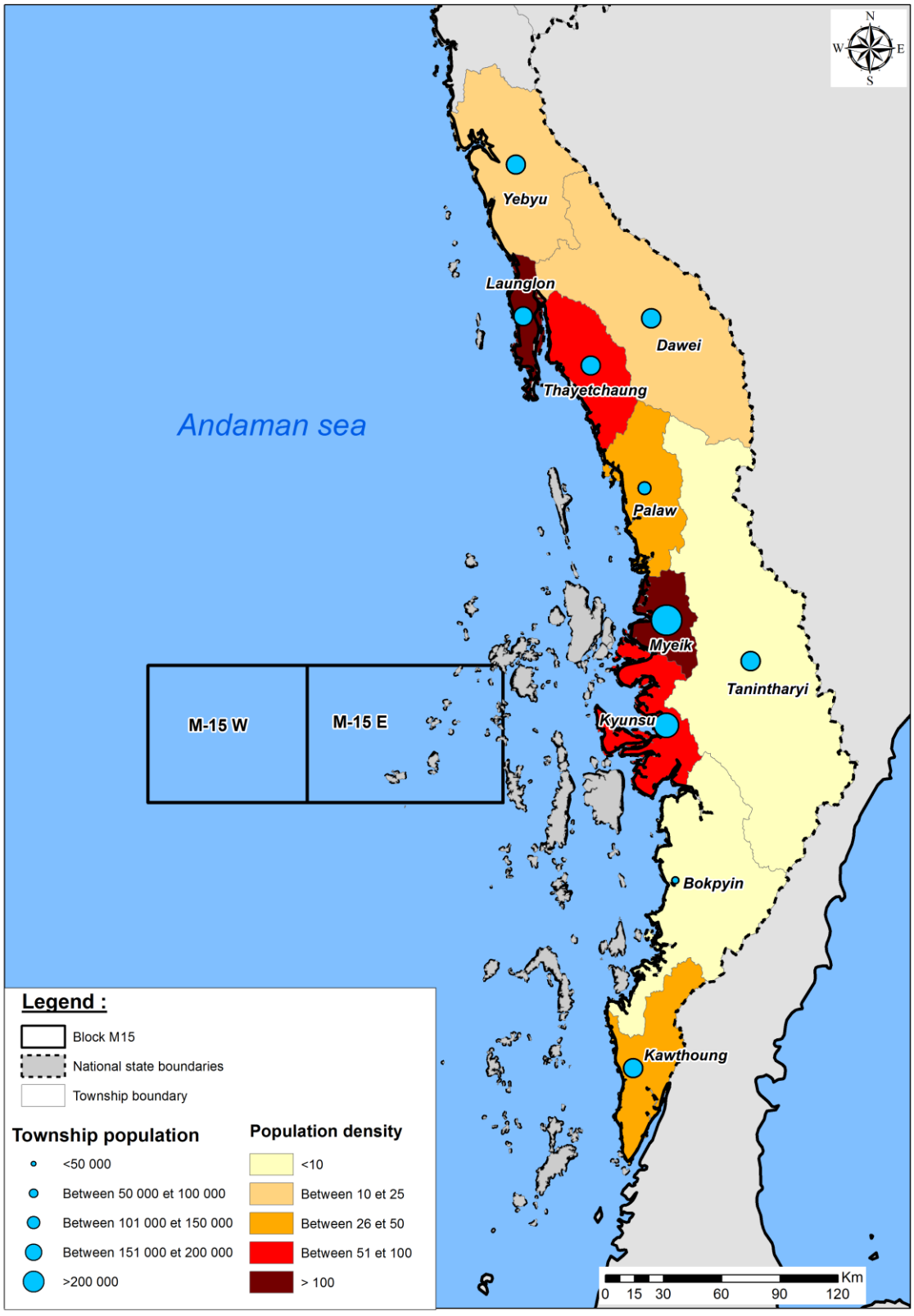
The Region's population is predominantly rural with 24 % as urban population, which is slightly below the country's average of 29.6%. Most of the population live either near the coast or along the rivers and tributaries. It should be noted that the Myanmar State has deployed efforts over the last twenty years to develop this southern peripheral region, namely through the development of the maritime fishery sector. As a consequence, in-migration of Burmese aspiring to economic and social advancements has been particularly important since then (Boutry, 2011).These new fishermen mostly settled along the coasts, and to a lesser extent, in the Mergui Archipelago.

The demographic figures for the districts and townships of the Tanintharyi Region are presented in the Table below. Myeik District is the closest district to the Project area; with approximately 700 000 inhabitants, it is the most populated.

Table 5.3-18: Demographic data in the districts and townships of Tanintharyi Region

District	Population	Township	Population
Dawei	492 277	Dawei	125 239
		Launglon	118 301
		Thayetchaung	105 599
		Yebyu	100 295
		Myitta(ST*)	21 032
		Kaleinaung(ST)	21 811
Myeik	692 880	Myeik	284 037
		Kyunsu	171 514
		Palaw	93 720
		Tanintharyi	106 884
		Palauk (ST)	36 725
Kawthaung	221 277	Kawthaung	116 722
		Bokpyin	46 772
		Khamaukgyi(ST)	23 050
		Pyigyimandaing(ST)	16 491
		Karathuri(ST)	18 242
Total	**1 406 434**		

ST = Sub township



Source : Myanmar Information Management Unit (MIMU)

Figure 5.3 - 2 Population and density in Tanintharyi Region

5.3.3.2. **Ethnicity and Religion**

Myanmar is an ethnically diverse nation with 135 distinct ethnic groups officially recognized by the government, each having a particular history, culture and language.

The Bamar (also called Burman) are the dominant ethnic group in the country. They are 29 million people making about two-thirds of the population (69% of the population according to the 1983 census) and inhabit mostly the central and upper plains of the country. This people from Sino-Tibetan descent migrated from Yunnan in China to settle in central Myanmar, progressively becoming the country's prevailing group. The remaining one-third of the population is composed of the so-called minority "ethnic nationalities". The seven largest ethnic minorities are the Chin, the Kachin, the Karenni (or Kayah), the Karen (or Kayin), the Mon, the Rakhine and the Shan, whose names correspond to the current seven states in Burma.

Unlike its neighbouring states to the north, Tanintharyi's name is not derived from a particular ethnic group. It does not have indeed a dominant ethnic minority, which is the basis for its classification as a Region. The majority of residents are believed to be Bamars, although some self-identify as members of sub-groups such as the Dawei people, also known as "Tavoyans".[18] Although Karen leaders have historically envisioned Tanintharyi as part of the independent Karen Free State, the Karen does not represent an important part of the Tanintharyi population (UNHCR South-East Myanmar Management Unit, 2014).

The Mergui archipelago is also the home of the Moken (locally known as Salone), a group of nomadic seafarers of Austronesian origin whose presence in the waters of Southern Myanmar and Southern Thailand is attested since the 17th century (Boutry, op.cit).

Buddhism is the dominant religion in Tanintharyi. Islam and Christianity are also observed, the latter primarily in Karen communities. Many of the Moken practice animism.

5.3.3.3. **Gender**

In Myanmar, women represent 52% of the population based on the 2014 census. Myanmar used to be a matriarchal society, where women enjoyed independency, political power and rights over economic resources, despite Buddhism stereotypes on gender roles (Chie, 2006). The British rule and the following establishment of a male military state relegated women's rights behind those of men, the society accepting male rights prevalence as the norm.

Today, this heritage still delineates strong social roles between the two sexes. Despite a school enrolment being almost at parity between boys and girls, urban women increasing contribution to the household revenues, and despite sharing the same legal rights as those of men, gender equality is far from being achieved in the country (Nwe, 2003). On the contrary, it varies greatly based on the living environment (urban or rural) and the ethnic group belonging. Women still have a lower adult literacy rate as percentage of men's and lower estimated incomes. Their role in the political sphere remains very limited, with only 5.7% of women holding seats at the Pyithu Hluttaw (lower house) of the national Union Parliament (Global Justice Centre, 2013).

Although their social and political roles are still unequal to those of men, the contribution of women to economic activities in the country is high, with 75% of the total female population being economically active according to the International Labor Office (ILO). Women in the country are mostly engaged in the agricultural sector, especially in rural areas.

5.3.3.4. **Presence of Vulnerable Groups**

Vulnerable groups are commonly described as groups of people who by their age, ethnic group, religion, social status or living conditions are particularly sensitive to changes of their living conditions brought by

[18] While several sources in the literature give an estimate number of 100 000 Tavoyans, it is however difficult to identify them today because of their close ethnic and linguistic affinity to the Bamar majority.

external factors such as industrial projects. They usually encompass elderly, youth, widows or female headed-household, disabled and/or disadvantaged persons, and displaced persons, amongst others.

According to the Reproductive Health Survey (FRHS), 8.7% of the total population was composed of people aged 60 years old and above in 2007. A report from the Ministry of Immigration and Population[19] confirms this ageing process, projecting that 22.2% of the population will be aged 60 and over by 2050. Elderly people are still relatively less vulnerable in Myanmar than in more developed countries, thanks to the active role family plays in their care. However, this might change, given the rapid evolution of the Burmese society. On the other hand, young people (under 18) represented 39% of the total population in 2012 according to the United Nations Children's Fund (UNICEF) figures. Among these, 79% were aged between 5 and 18 years, and 21% below 5.

5.3.4. Human Development and Access to Basic Services

Myanmar indicators on human development and access to basic social services have improved over the last years, but remain low according to international standards. The country Human Development Index of 0.524 ranks it 150 out of 187 countries (2013), and is below the regional average of 0.703. The 25.6% of its population lives below the national poverty line and has limited access to health, education, energy, water, or transportation infrastructures. Myanmar also faces growing inequalities among states/regions, and between urban and rural areas that are differently underserved in basic services and therefore have different levels of human development.

Although poverty incidence (at 33 %) is higher than the national average (26%)[20], on most social development indicators, Tanintharyi fares comparably to the national average.

However, Regional averages mask important disparities at the township and village tracts levels. Accessibility is indeed a major challenge in the delivery of basic services. This is especially the case for the geographical constraints and poor road developments.

5.3.4.1. **Transport infrastructures**

While the region is relatively well served by air transport (with 7 airports), the main highway that runs south through the Mon State, narrows and deteriorates upon entering Tanintharyi.

Road access is therefore problematic everywhere outside Dawei and Myeik, particularly during the rainy season. The construction of a new highway connecting Dawei town to Thailand, is however planned as part of the pending Dawei SEZ project.

5.3.4.2. **Health**

There have been improvements in access to healthcare in the country since its opening to international health organizations and NGOs. For example, 81% of the population now lives within walking distance of a hospital or a health centre, and expenditures by the Ministry of Health have more than doubled between 2007 and 2012.

Recent health indicators show that life expectancy reached 65.7 in 2012, well below regional neighbours, and Myanmar has the highest crude mortality rate (the number of deaths occurring during the year per 1,000 population estimated at midyear) of all Asia-Pacific countries (9 per 1,000 people). Maternal and child health are major issues, along with HIV/AIDS, malaria and tuberculosis, which causes substantial mortality and morbidity. In 2012, HIV/AIDS prevalence rate represented 0.6% of the population. Malaria incidence was

[19] MINISTRY OF IMMIGRATION AND POPULATION, *Ageing Transition in Myanmar*, September 2012

[20] Tanintharyi ranks third in the poorest states/regions of Myanmar, after Rhakine State (44%) and Chin (73%) – UNDP, Myanmar 2014

measured at 2,743 cases for 100,000 people, while tuberculosis prevalence was estimated to 489 cases for 100,000 people (WHO, 2012).

On-going health issues in Myanmar are the major consequence of low government expenditures on health sector (2% of the Gross Domestic Product), low availability of medical care professionals and the poor condition or absence of health facilities. On average, Myanmar has only 1 physician per 2,188 people and 1 hospital bed per 1,667 people.

According to a 2013 UNICEF report, the regional level health indicators in Tanintharyi are not significantly different from the national data. However, township level indicators vary depending on location, level of security, economy, and other factors. Some studies, also document high prevalence of water-borne diseases in Tanintahryi, such as cholera and typhoid, related to poor access to clean water and sanitation systems (TBC, 2012).

As far as healthcare infrastructures are concerned, there are 30 registered hospitals spread throughout Tanintharyi. However, only the general hospitals in Myeik and Dawei offer specialist services. Outside these localities, hospitals' capacity appears to be largely under-sized, with the third largest hospital located in Kawthaung town, having only 100 beds (UNCHR, 2014).

In the field of HIV/AIDS, Health services to fight HIV/AIDS appear to be below national standards, with for example only 56 % of HIV infected mothers receiving antiretroviral treatment in 2012, as opposed to a national average of 84 % (Myanmar National AIDS Programme, 2014).

5.3.4.3. **Education**

The literacy rate of Burma, according to the UNESCO Institute of Statistics, stands at 90 % of adults (for both men and women), although concerns have been raised over the accuracy of the provided rates. According to the same source, net primary school enrolment is of 88 %. However, net secondary school enrolment is low compared to other regional neighbours (53% of the children attend secondary school, against 79% in Thailand and 76% in Indonesia) (UNICEF, 2013).

The primary school enrolment rate in Tanintharyi is comparable to the national average. With 72 per cent of children attending primary school completing their schooling on time, Tanintharyi has the highest primary school completion rate among all states and regions.

While the Region counts seven universities and colleges, all are located within Myeik and Dawei. Tanintharyi is among the states and regions that have the smallest number of women with university education (12.9%).

5.3.4.4. **Water and Sanitation**

Myanmar enjoys abundant water resources, and access to water is good at the national level with 70% of the population having access to a drinkable water source in 2010. Urban populations have higher access (81.4%) than rural ones (65.2%). Strong regional discrepancies are observed.

Access to clean water is still a developmental challenge for some townships of Tanintharyi, especially in the rural areas. Results of a 2010 UNICEF survey[21] indicate that in 2009-10, around 27 % of the population were not using improved water source (which was higher than the national average of 18%). Access to improved sanitation was however in line with the national average (84%).

Lack of access to safe drinking water is a major contributor to water-borne diseases, among which child diarrhoea whose prevalence increased in Tanintharyi from 3 % in 2003 to 9 % in 2009-10 (TBC, 2012).

5.3.4.5. **Energy**

Overall, access to electricity in Myanmar stood at around 48% in 2010, but as in the other sectors, there are significant variations among the states, with Rakhine State and Tanintharyi Region being the most underserved.

[21] The Myanmar Multiple Indicator Cluster Survey 2009-10. UNICEF, 2011

5.3.4.6. Human Development Activities in Tanintharyi State

Because of poor social indicators and high levels of poverty, numerous NGOs and United Nations agencies have developed their operations in Tanintharyi Region since the political opening, with the objective to support the local population in improving their living conditions. They implement development programs in the field of health, support to agricultural and non-agricultural livelihoods, and education (among other sectors).

In April 2015, the Myanmar Information Management System (MIMU) counted over 50 of these organizations in Tanintharyi. Among these were a number of international organizations (UN Habitat, UNICEF, ICUN, UNFPA, WHO) and several international NGOs and foundations (World Wildlife Fund, World Population Foundation Médecins Sans Frontières), some of which like the Thailand Border Consortium (TBC) providing support to IDPs.

5.3.5. Marine Socio-economic activities

Myanmar's economic development has accelerated over the last years, influenced by the democratization process initiated by the regime in 2010. Myanmar authorities have recently refurbished their laws and regulations to improve the ability of its domestic market to welcome foreign investments. They revised the 1988 Foreign Investment Law in 2012 to facilitate international companies' investments in the country. Positive effects were felt rapidly, with an increase of foreign direct investment from USD 1.9 billion in 2012 to USD 2.7 billion in 2013, mostly in the energy, garment industry, information technologies and food and beverages. According to the World Bank, economic growth reached 6.5% in 2013, on the rise from 5.9% in 2012. The government's efforts to improve the business environment and stakeholders' interests in its market has proved to be successful, with numerous foreign companies now willing to invest in the country.

Like for other sectors, Marine economic activities represent a high potential for economic growth. Since they are part of the Myanmar maritime space, these activities are regulated by the United Nations Convention on the Law of the Sea (UNCLOS). This convention rules the governments' rights and responsibilities related to the oceans and establish spatially delineated areas (territorial waters, contiguous zone and Exclusive Economic Zone - EEZ). Each area represents special rights and obligations for the State. For instance, the EEZ status recognizes the right of a State to explore and exploit the ocean's resources, but requires this State to guarantee free passage of foreign ships in its waters (United Nations, 1998). Myanmar signed this convention and translated it in its Territorial Sea and Maritime Zones Law in 1977.

Although not significant on a global scale[22], Myanmar's proven reserves of oil and gas are rendered highly valuable, owing to the physical proximity of important Asian importing countries such as Thailand, China and India (Aung and Toshihiro, 2012). The largest reserves known today are located in the Gulf of Bengal and in the Gulf of Martaban in the Adaman Sea. The country already actively exploits its marine oil and gas resources, offshore Rhakine State in the Shwe field and offshore Tanintharyi Region in Yadana, Yetagun and Zawtika fields.

In parallel, the government sees a large potential for growth in the marine fishery sector. These sectors, along with commercial shipping, use the same environment and their interests will probably overlap over the coming years, creating interactions and potential conflicts among them that need to be anticipated, and whenever possible prevented.

5.3.5.1. Offshore Oil and Gas Operations

Myanmar offshore oil and gas resources represent an important potential for growth for the country's economy, attracting interest from the national and international oil and gas industry. In 2012, 34% of the Foreign Direct Investments in the country were directed at oil and gas exploration and production (Buchanan et al. February 2013).

In a move to boost this sector, the Ministry of Energy recently concluded the "Myanmar Offshore Blocks Bidding Round 2013", awarding 20 offshore blocks to international companies (Offshore Energy Today, March

[22]Myanmar's proven reserves of oil and gas were estimated to account for 0.3% of the World's total reserves in 2007 according to BP's Statistical Review of World Energy.

26th, 2014). Ten deep-water blocks and ten shallow-water blocks located in the Andaman Sea and the Bay of Bengal were attributed to oil majors and independent companies, such as Statoil, Eni, Shell, Total, ConocoPhillips, BG Group and Woodside Energy.

Developments in the Tanintharyi Region

A number of blocks located offshore of the Tanintharyi Region were granted during the 2013 offshore bidding round (including M15 Block awarded to CFG Energy Pte Ltd along with its partners). A list of these blocks and the company to which they were awarded is presented below. The location of these blocks, including the Block M15 where the seismic project will take place, can be seen on Figure .

Shallow-water blocks (from north to south):

M-4 to Oil India Limited, Mercator Petroleum Limited and Oilmax Energy Pvt. Ltd.

M-7 to ROC Oil Co. Ltd. and Tap Oil Ltd.

YEB to Oil India Limited, Mercator Petroleum Limited and Oilmax Energy Pvt. Ltd.

M-15 to CFG Energy Pte Ltd, TRG M15 Pte Ltd (Transcontinental Group), Century Bright Gold Co Ltd.

M-17 to Reliance Industries Ltd.

M- 18 to Reliance Industries Ltd.

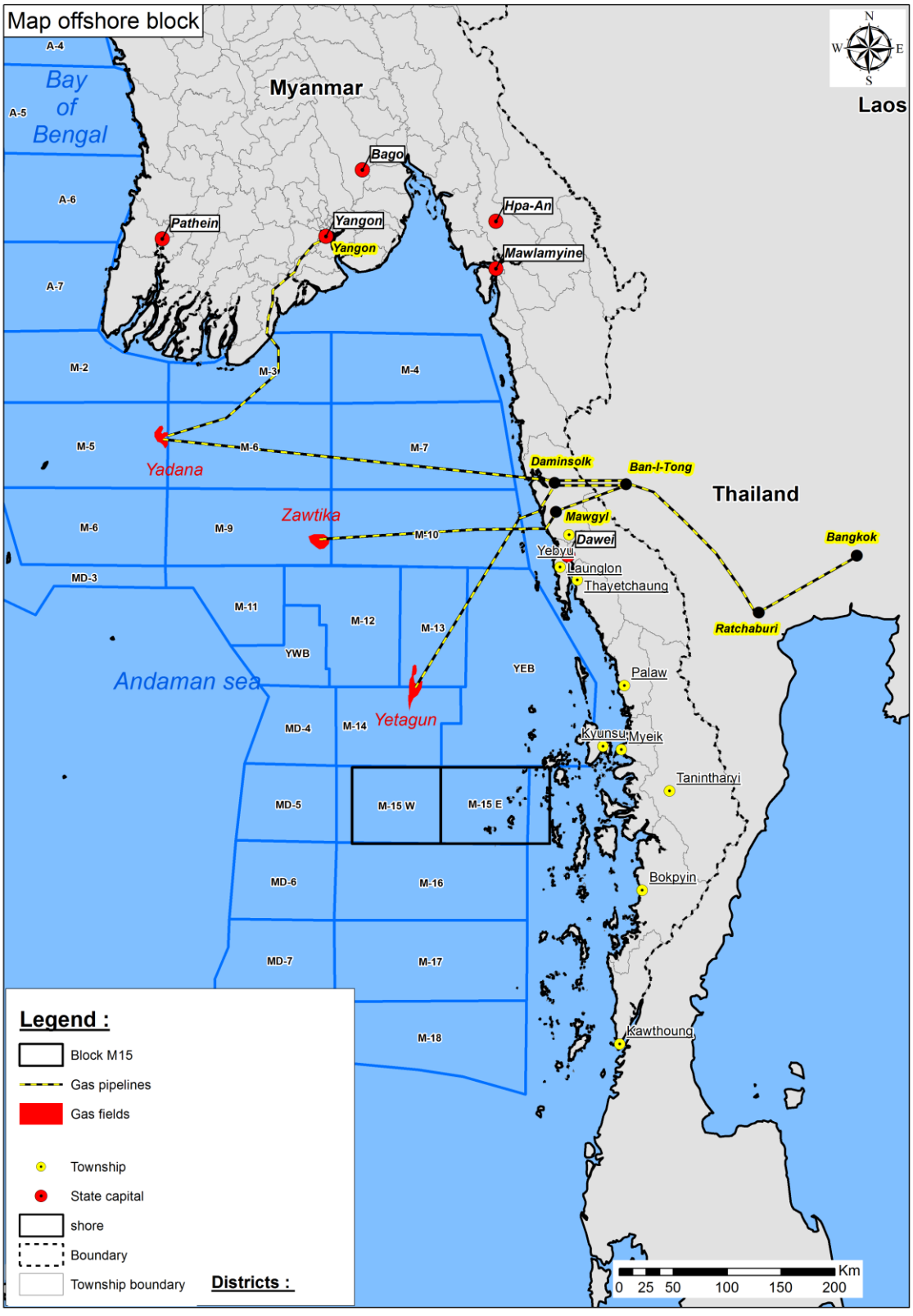
Deep water blocks (from north to south):

YWB to Total E&P Myanmar

MD-4 to Eni Myanmar

MD-5 to Shell Myanmar Energy and MOECO

Since most of them were awarded recently, it is likely that several operators will start their exploration activities at the same time, which would increase significantly the effect of cumulative impacts on the marine ecosystems, commercial traffic and marine fisheries.



Source : Myanmar Information Management Unit (MIMU)

Figure 5.3-3: Offshore oil and gas blocks

Existing producing projects offshore Tanintharyi coast

So far, there are three producing gas projects offshore Tanintharyi coast:

the **Yadana project** (blocks M-5, M-6 and M-8) currently operated by a consortium led by the French Total;

the **Yetagun project** (blocks M-10, M-12, M-13 and M-14) currently operated by a consortium led by the Melanesian firm, Petronas Carigali:

the **Zawtika project** (block M-9 and M-11) currently operated by Thailand state-owned PTTEP.

All three of them, transport gas (reportedly over 1.16 billion cubic feet per day) to Thailand via pipeline.

Yadana and Yetagun gas projects

The Yadana field was discovered in 1982 by the Burma National Oil Company. In 1995, a 30 years joint-venture contract was signed between the Myanmar Oil and Gas Enterprise (MOGE), the French company Total, the American company Unocal (now Chevron Corporation) and a private subsidiary of the Petroleum Authority of Thailand (PTT). They agreed to extract over 525 million cubic feet of natural gas per day, and to export it to the Rachabury power plant in Thailand. The gas is transported along a 649 km long pipeline that emerges offshore Yebyu township and crosses it from east to west.

The Yetagun field, which is directly adjacent (north) to block M-15, was discovered by Texaco (US) in 1992. It was developed by a consortium initially led by Premier oil (UK), which later sold its entire share to the Malaysian company, Petronas Carigali in 2002[23]. Yetagun gas field produces about 500 million cubic feet per day of gas, among which 400 million are exported to Thailand. The project implied the construction of an offshore pipeline that joined the existing onshore pipeline of the Yadana project.

Zawtika Project

The Zawtika project located in block M-9 and M-11 is operated by PTTEP, which holds an 80 % share, with the other 20 % stake held by MOGE. The project began supplying natural gas for domestic use in Myanmar since March 2014, at a rate of approximately 60 million cubic feet per day. In August 2014, PTTEP has started exports of natural gas to Thailand, via a 300 km long pipeline that crosses Tanintharyi over 70 km, to connect to the PTT gas pipeline at Ban-I-Tong on the Thailand–Myanmar border. The production for export is currently ramping up to a rate of 240 million cubic feet/day.

5.3.5.2. **Fishery Sector**

Myanmar has a coastline of 2,280 km, a marine water area of 486,000 km^2 and an inland water area of 124,280 km^2. The potential for development of both inland and marine fisheries is therefore substantial. Fishing is a critical part of both the local diet and the national economy. This sector already represents the fourth largest export earning sector and generate, with livestock 9.9%, of the GDP[24]. Total national fish production doubled in the 15 years to 2000, and may have nearly tripled over the past decade, to a level of 3.2 million tons (UNDP 2004 and FAO/WFP 2009). It employs an estimated number of 8 million persons, among which over 3 million active fishermen (BOBLME, 2012), which represents 15% of the total country population. Like in many Asian countries, fish and other products are an important part of the diet and contribute to reduce food insecurity. In 2002, per capita consumption of fish amounted to 21 kg/year and constituted 60 to 70% of the total protein intake for the population (Ibid.)

Owing to its particularly long coastline of about 1200 km and its 52 designated fishing grounds, Taninthary Region is one of the two largest fish producing areas in Myanmar, alongside Ayewarwady Region.

[23] The consortium currently includes Petronas Carigali Myanmar Inc., PTTEP International Limited, Nippon Oil Exploration (Myanmar) Limited, and the Burmese state owned MOGE (Myanmar Oil and Gas Enterprise).

[24] According to the Institute of Marine Research;
http://www.imr.no/forskning/utviklingssamarbeid/surveys/myanmar_2013/Eng

According to a JICA report of 2013, Tanintharyi produced, 650,000 tons of fish and shrimps during the 2009-10 season. Another source indicates that 40 % of Myanmar's marine fisheries were caught in the Tanintharyi Region in 2011 (Myanmar Times, October 22nd, 2012). The same source indicates that over 42 000 fishermen were, at this time, licensed in Tanintharyi. According to the regional office of the Departement of Fisheries DoF, they are now over 50 000 (approximately 3 % of the Region total population); there are over 10 000 fishing boats licensed to fish in the inshore zone, and 1600 licensed vessels operating in the offshore zone.

Laws, Regulations and Implementing Agencies

Six laws are the basis for inland and marine fishery organization, management and control by the different government agencies in charge of this sector. They are listed below:

Law Relating to the Fishing Rights of Foreign Fishing Vessels - 1989

Law relating to Aquaculture - 1989

Myanmar Marine Fisheries Law - 1990

Freshwater Fisheries Law - 1991

Law Amending the Myanmar Marine Fisheries Law - 1993

Law Amending the Law Relating to the Fishing Rights of Foreign Fishing Vessels - 1993

The Myanmar fishery sector is managed by the Ministry of Livestock, Fisheries and Rural Development, and more particularly by the Department of Fisheries (DoF), which takes care of both inland and marine fisheries. The main mission of the DoF is to develop and implement sectorial policies aiming at promoting sustainable fishing practices and ensuring the preservation of marine resources. The DoF develops conservation efforts, promotes research and surveys on the current condition of marine resources in partnership with intergovernmental agencies, maintains statistics on fisheries, and supervises the fishery sector through delivery of licenses to national fishing vessels.

The DoF has offices at the township level, from where it manages the fishery licensing system and collects taxes from fishermen.

Marine Fisheries

Marine fisheries are organized under the Marine Fisheries Law, which classifies this sector into the inshore and offshore categories. Their main characteristics are detailed below:

Inshore (or coastal) fishery: covers an area up to 10 nautical miles from the shore. Boats entering this category should not be equipped with an engine having more than 12 horsepower and the length of the boat is limited to 30 feet.

Offshore fishery: covers the outer area of the inshore fishery zone up to the EEZ border. Boats should have more than 12 horsepower engine, and can use bottom trawl, purse seine, surrounding nets, drift nets and long lines25.

Figure below represents the borders of the fishery zones as they have been established by the Marine Fisheries. The inshore fishery zone is represented in deep blue and borders the coast, while the offshore zone spans from the inshore borders up to the EEZ borders, at water depths varying from 0 to over 200 meters. For licensing purposes, the Department of Fisheries divided the offshore zone into 140 fishing grounds of 30X30 nautical miles block, using latitude and longitude lines. It also designated four fishing areas: Rakhine (40 blocks), Ayeyarwady (44 blocks), Mon (14 blocks) and Taninthary (52 blocks). Their limits are drawn by blue lines.

As seen on this map, the M-15 block is located in the Tanintharyi offshore fishing zone, in a wide spectrum of water depths from 0 to over 200 meters. The Project's area is however located in the deepest part of the block.

[25] FAO, *The State of World Fisheries and Aquaculture, Opportunities and Challenges*, 2014

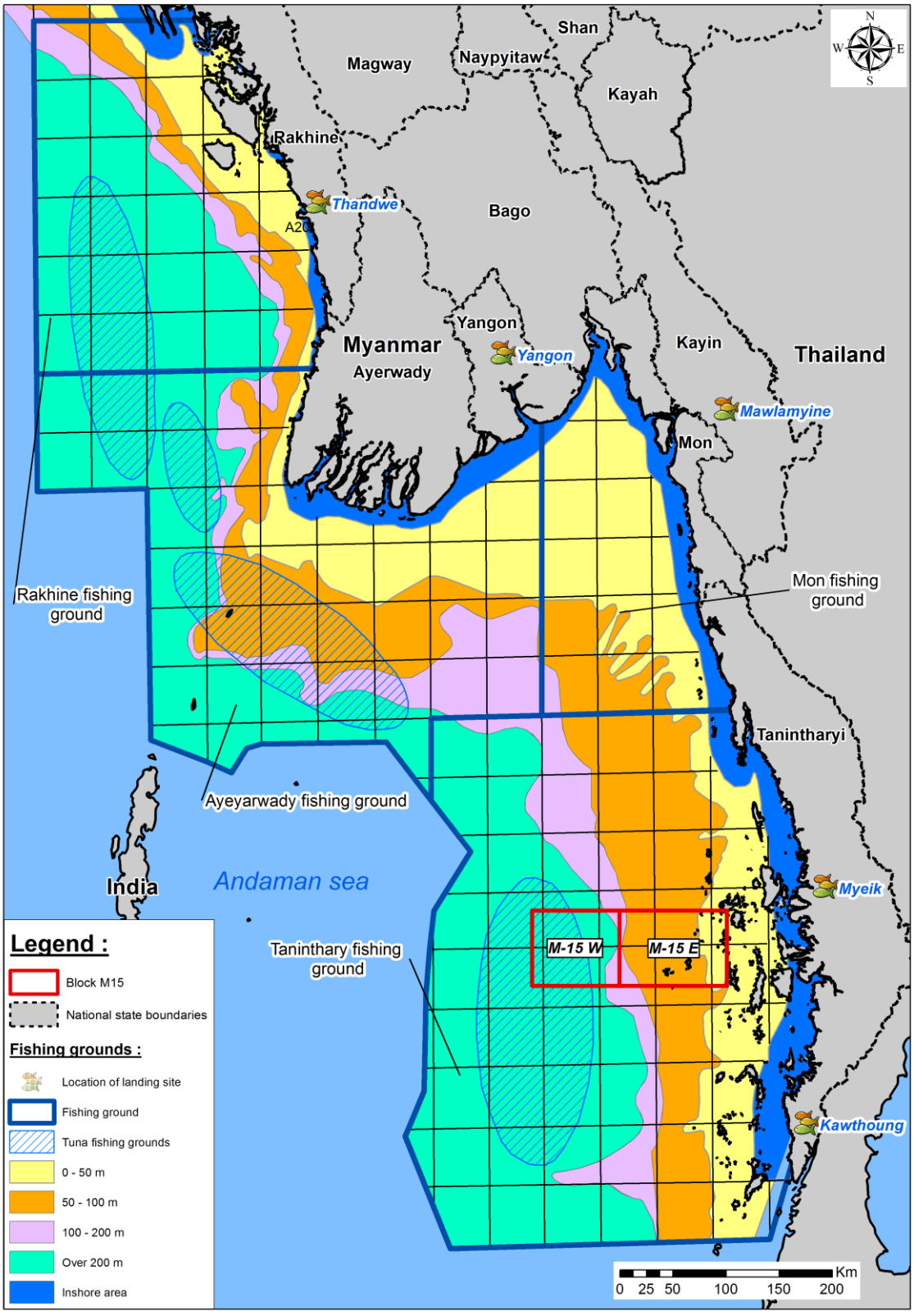
The national fishing license system is divided into two categories based on the fishing zones:

Inshore fishery zone license: the General Administration Department (GAD) is in charge of inshore fishing boats' inspection. The Department of Fisheries proceeds with the issuance of fishing licenses upon recommendation of the GAD.

Offshore fishery zone license: the Department of Marine Administration (DMA) takes care of inspection and registration of the offshore fishing boats. Fishing licenses are delivered by the DoF only when the DMA has issued its approval.

The Myanmar Fisheries Law encourages foreign fishing activity with the granting of fishing rights to foreign companies, but limits their activity to the EEZ and forbids it in the territorial sea. It is only under exceptional circumstances and express agreements of the related government agencies that foreign fishing vessels can conduct fishing activities in the country territorial waters. Foreign fishing companies can acquire licenses to operate in the Burmese waters from the Department of Fisheries, in exchange of a fee and upon approval of the Ministry of Livestock and Fisheries.

In April 2014, the Government of Myanmar decided the suspension of fishing rights and licensing for foreign vessels until further notice. This ban is justified by alleged fish resources depletion, due to overfishing and the use of destructive fishing gears by foreign companies whose activity has intensified over the last five years. It was welcomed by national fishing associations, as it was expected for a long time (The Irrawady, April 3rd, 2014). However, sea fishing activities remain permitted for foreing investors **in joint-venture** with Myanmar partners with the recommendations of the Ministry of Livestock, Fisheries and Rural development.



Source : Myanmar Information Management Unit (MIMU)

Figure 5.3 4: Marine fishery spatial organization

Illegal, Unreported and Unregulated Fishing

Myanmar law is repressive against illegal, unreported and unregulated fishing. It bans all fishing gears that are destructive to the environment and fisheries resources, including pair trawl, electric fishing, fishing using poisons, chemicals, explosives, purse seine net less than 3,5 inches mesh size and trawl net cod-end mesh size less than 2 inches (Kyaw, 2010). Trawl use is also forbidden in the inshore fishery zone. Several institutions are involved in fighting illegal fishing under the coordination of the Myanmar Navy: the Coast guards, the Department of Fisheries, the Myanmar Customs Department and the Myanmar Police Force.

Despite these measures, illegal fishing is commonly practiced in Myanmar waters. That is especially the case in, around the Tanintharyi coastal areas where a number of local and Thai vessels operate illegally, due to DoF limited capacity to control and monitor at sea.

Marine resources: Surveys and Estimates

Myanmar fishery institutions do not have recent and reliable data informing on the dimensions of marine resources stocks, and the current size and composition of marine catches. This lack of knowledge is due to years of isolation and a lack of means (in terms of budget, human resources and competencies) from the government agencies for collecting information and building expertise.

Without these data, the Ministry of Livestock, Fisheries and Rural Development and the Department of Fisheries cannot draft a sustainable fishery policy which would preserve marine resources while allowing for the commercial fishery sector to prosper.

Myanmar is member of several regional inter-governmental organizations specialized in fishery, such as the Southeast Asian Fisheries Development Centre (SEAFDEC), the Asia-Pacific Fisheries Commission (APFIC), and the Bay of Bengal Large Marine Ecosystem Programme (BOBLME). Trying to build knowledge on the state of marine resources and fisheries, these organizations conducted several surveys in Myanmar waters under the leadership of the Food and Agriculture Organization (FAO).

These surveys enabled to draw estimations on fish stocks, but their results vary. According to the Institute of Marine Resources, fish stocks range between 1.3 and 1.8 million metric ton (mmt): 1 mmt for pelagic fish, and 0.8mmt for demersal fish, respectively. But for the government of Myanmar, the potential maximum sustainable yield (MSY) of Myanmar waters is about 1.05 mmt per year (0.5 mmt of pelagic fish and 0.55 mmt of demersal fish) – (Pitcher and Pramod, 2006).

Recently, a large marine ecosystem survey was conducted in the frame of the EAF-Nansen project and the BOBLME[26] in several locations of Myanmar waters including Tanintharyi. Due to large data the project has to process before being able to publish any report, the results are not available yet.

Accordingly, The data used by the government to guide its decisions on fishery management are still out-of-date. Assertions are made by various stakeholders, such as the Myanmar Fishery Federation (Eleven Myanmar, July 27, 2014), on drastic depletion of stocks and overfishing both for the offshore and inshore fisheries. According to IUCN, several surveys indicate that the Mergui archipelago has suffered dramatic declines in fish populations and habitat quality over recent decades. Preliminary results of the recent survey conducted by the EAF-Nansen project estimates that the biomass of pelagic (open ocean) and demersal (which live on or near the ocean bottom) fish have declined by 90% and 60%, respectively, since the previous survey in 1980. This decline is, according to IUCN, “certainly the result of massive overfishing”. Underwater reef surveys also shows that many coral reefs have been severely damaged, mostly by blast fishing.

This concern over reef destruction brought about the project of establishing marine protected area (PMAs) in several locations of the archipelago[27]. This project is currently led by Fauna and Flora International (FFI) in

[26] The EAF-Nansen project, launched in 2006, is a multi-stakeholder project funded by the Norwegian Agency for Development Cooperation and managed by the FAO in partnership with the Institute of Marine Research (IMR). Its objective is to strengthen the knowledge base on fisheries and implement an ecosystem approach to marine fisheries in developing countries. The project conducts activities in the Bay of Bengal and in Myanmar, among other countries. More information at: [http://www.eaf-nansen.org/nansen/organization/17910/en].

[27] A large shark protected area has already been proposed in recent years but it “currently only exists on paper” according to IUCN (2014).

partnership with MLFRD and MOECAF. It includes the establishment of Locally Managed Marine Areas (LMMAs), a type of MPA in which local communities are involved in the preservation of the nearby coral reef and in the management of fishery resources.

Main Characteristics of the Marine Fishery Sector

Fishing Grounds

Several commercially interesting species were identified during previous surveys as having a high potential for the offshore fisheries development. These species are mainly pelagic fishes, such as sword fish (Xiphias gladius), deep-sea lobster and deep-sea shrimp, yellow fin tuna (Thunnus albacares), striped marlin (Tetrapturus audax) and sailfish (Istiophorus platypus) – (Kyaw, 2011). Tuna is in a privileged position for industrial development, and its main fishing grounds were identified by the DoF and appears in Figure , in blue circle filled with blue stripes. As seen on the Figure , the western part of M-15 Block which corresponds to the Project area, is located on one of these fishing grounds. Fishing grounds for other species were not officially identified yet**.**

Fishing fleets and techniques

The latest estimates on the country total fishing fleet set the number of vessels at around 30,800 in 2011, among which half of it are non-motorized boats, and 1,600 trawlers (BOBLME, 2012).

The Myanmar fishery sector is mostly developed in the artisanal, small-scale inshore fishery zone, with 27,751 inshore fishing vessels registered by the DoF in 2012, a decrease compared to the 29,371 vessels the previous year. Among these, 55% are powered vessels, and the rest are non-motorized boats. They usually operate close to the coast, in waters less than 50m depth, due to a lack of technology, suitable fishing gears and equipment to process fisheries resources information (such as GPS or satellite devices).

The offshore fishery zone is the domain of large companies, national and international, and of fishermen having the capital to buy equipment with the capacity to fish in deep waters. Around 2,450 national vessels were engaged in offshore fisheries in 2012. Additionally, 132 foreign vessels were reported having licenses to conduct offshore fishery[28].

Thailand is an important actor of the foreign fishery sector in the country, with several Thai companies having fishing rights. Other companies from countries like Singapore, Japan, China or South Korea also participate in Myanmar fisheries.

Fleets operating offshore (encompassing foreign fishing vessels) mainly use active fishing gears, with trawling, driftnet and purse seine being the most commonly used. Static fishing techniques, fish traps or stow nets, are also used but less commonly in the offshore fishery zone. Dynamite fishing – an illegal practice which raises strong environmental concern, is also currently practiced in the Adaman sea by small and large operators, Thai and Burmese alike.

Fish Catches and Exports

Myanmar is an important contributor to the regional fishery sector along with India. In terms of volume, total catches for all sectors (aquaculture, inland and marine capture fisheries) amounted to 4,464,419 tonnes in 2012. Among these, inland waters fisheries accounted for 1,246,460 tonnes and aquaculture for 0,885 tonnes.

The marine capture fisheries represented half of the total production, with 2,332,790 tonnes of catches in 2012, an increase of 7.5% from the previous year, and from 121% between 2003 and 2012. However, this figure is underestimated as it doesn't take into account the production loss caused by illegal fishing, and by the landing of catches to foreign ports. Indeed, for fishing performed by foreign vessels, landing sites are usually not located in Myanmar but, according to the size of catches, to Phuket in Thailand, Penang in Malaysia or even in Japan. Foreign fleets have the modern equipment and powerful engines enabling them to easily transport their catch to international ports in a short time. These catches are therefore not reported in the country statistics. Furthermore, the general composition of the marine catches landed in the country is also

[28]According to the Institute of Marine Research figures, available online: [http://www.imr.no/forskning/utviklingssamarbeid/surveys/myanmar_2013/en].

not known precisely. This lack of data prevents the country to identify overfishing by species, and therefore to adopt a sustainable fishery policy.

Main landing sites and wholesale fish markets are around Yangon, at Pazuntaung Nyaungdan and Annawa, with a fish market at San Pya in Alone township. Other major landing sites are found along the coast, at Thandwe, Mawlamyine, and at Myeik and Kawthoung cities in Tanintharyi. Capture fishes landing there are sold through an auction system.

The best quality catches are exported to neighbouring countries. A total of 116 fishery processing factories are registered in Myanmar and most of them export fish to the Chinese market. Only 20 of these factories have licenses to export to EU and United States markets. A recent project from the United Nations Industrial Development Organization will help upgrade eight other factories, increasing their standards to allow exports to these high profitability markets (Eleven Myanmar, April 11, 2014). However, exports to Europe and United States markets remain limited for the time being.

Global marine products exports in 2013 amounted to 376,845 tons, generating revenues of USD 650 million. Excluding shrimps, fish products represented 70% of these exports (266,464 tons), and USD 380 million of revenues. During the 2014 fiscal year, a decrease in fishery export was observed with only USD 550 million of revenues against the target set by the Myanmar government for marine products exports of USD 700 million. According to the Myanmar Fishery Products Processors and Exporters Association (MFPPEA), this decrease was mainly caused by a lack of competency in the fishery sector, preventing it to compete on international markets.

In regards to low quality catches, they are processed in Myanmar in the form of fish paste or fish meal for the chicken industry, or used fresh or chilled for direct consumption, with some fish being frozen or cured.

Marine Fishery Sector in Tanintharyi Region

As stated by Boutry (2011) and other authors, the development of the fishing industry in Tanintharyi from the 1970s onwards was closely tied to the willingness of the State to control and colonize the peripheral regions of the country. The Myanmar State also intended to use these regions in its attempt to foster economic development through the exploitation of (then) untapped resources (among which fisheries) and the opening of border trade in the context of the transition to a market-oriented economy that started after 1988.

Parallel to the opening of Tanintharyi's waters to foreign fishing vessels, small-scale marine fisheries developed in in coastal areas and in the Mergui archipelago, where a large number of "new fishermen" Burmese migrants settled, creating new coastal villages. These villages are today highly dependent on fishing and for some of them entirely rely on this activity as a source of livelihoods.

This small-scale fishing is commonly performed at the household level by artisanal fishermen, using small size boats built with traditional methods. Artisanal fishermen use active fishing techniques during the dry season. When weather conditions are good enough to allow fishing far away from the coast, they can venture up to the offshore area. During the rainy season, the offshore area is less accessible because more dangerous, limiting the fishing grounds to the inshore fishery zone. Fishermen tend to use more passive fishing gears such as stow nets, drift nets and gill nets, targeting coastal demersal, shrimp, and small pelagic.

Reef fishing and harvesting of high value species (such as lobsters, sea cucumbers, squid and oysters) in the Mergui archipelago is also commonly practiced by small-scale Burmese fishermen and larger operators. The development of this activity, along with the illegal practice of dynamite fishing, contributes to threaten the lifestyle of the Moken which highly depend on reef harvesting during the dry season. Numerous pearl farms have been developed in the archipelago from the 1970s onwards. This activity, mostly operated by artisanal farmers, has proven to be successful: Myanmar is today one of the leading producers worldwide of *Pinctada maxima* pearls.

The product of artisanal fishing of low commercial value is mostly for the local consumption and/or the retail markets in Myeik, Kawthaung and Dawei. High value commercial species like are destined to outside markets.

As elsewhere in Myanmar, local small-scale fisheries account for a large portion of marine catch. In theory, the DoF gives priority to small-scale fishermen, by forbidding access to the onshore/coastal fishing zones to larger

vessels. However, conflicts between small-scale fishermen and larger operators have been a major issue in Tanintharyi in recent years. Such conflicts reportedly arise due to the failure of larger fishing boats to respect the regulation, partly explained by the sharp increase in demand for quality marine products like shrimps and other demersal.

NGO and local government Support to Artisanal Fishing Activities

Given the context of overexploitation of the fish resource and the environmental pressure on the Myeik archipelago which has also become a small-scale tourism destination, the double challenge of sustaining fishermen livelihoods and preserving the environment has become a major concern. To achieve this goal, Fauna & Floral International (FFI), in partnership with the Forestry and Fisheries departments, has recently initiated a program aiming at the development in Tanintharyi of a network of locally managed marine areas (LMMAs)[29]. This program aims at building the capacity of governmental department, local NGOs and coastal communities so that they are able to design and implement effective marine conservation measures to protect their resource. A workshop gathering government officials, NGOs and local civil society organisations was held in Myeik in November 2014 and further activities are planned.

5.3.5.3. **Interactions between the Fishery Sector and the Project**

The Project area is located in the offshore fishery zone of the Tanintharyi region. The eastern part of the block is located in shallow water (for a large part below 100 meters) relatively close to the mainland shoreline (ca. 70 km). It even encompasses islets belonging to the Myiek archipelago which is commonly exploited by small-scale fisheries the Moken. The Mergui archipelago is also a growing (small-scale) tourism destination due to its yet relatively unspoiled environment.

The western part of the block where the survey will actually take place, is located further away, approximately. 40 km offshore the westernmost islands of the archipelago. In this area, water depths starts at 100 meters but quickly drop off to 2000 meters.

At this distance, there is a probability that fishing fleets operate targeting large pelagic fish species such as tuna, since the block is in the middle of a tuna fishing ground. It is also possible to find small-scale fishermen that occasionally venture far away from the coast depending on the weather condition. However, this cannot be confirmed by evidence: most of the fishing boats operating in Myanmar are not equipped with Automatic Identification Systems (AIS). These fishing operations, although they may occur, should be limited in their scale for two main reasons:

- the small concentration of licensed vessels in the offshore fishery zone when compared to the inshore fishery zone (cf. 1600 versus over 10 000)

-and the ban on foreign fishing (which constituted the largest part of the fishing fleet in the offshore zone) from Myanmar waters since April 2014 for an undetermined duration

Interactions with fishermen during the seismic campaign should therefore, in theory, be limited. However, given the importance of illegal fishing in the Adaman sea (namely by Thai trawlers), the possibility of encounters with fishing fleets is not unlikely.

5.3.5.4. **Port Infrastructures and Marine Traffic**

Port Infrastructures

Port infrastructures in Tanintharyi Region are yet very limited. As shown on Figure, there are only three coastal ports : Dawei, Myeik and Kawthaung. Of these, only the port of Kawthaung can be considered an international port, handling border trade with Thailand. These ports are managed by the Myanmar Port Authority (MPA) and have very limited infrastructures and capacities to welcome a large number of vessels.

[29] A locally managed marine area can be defined as *"an area of nearshore waters and coastal resources that is largely or wholly managed at a local level by the coastal communities, land-owning groups, partner organizations, and/or collaborative government representatives who reside or are based in the immediate area."* (Goven and al. 2009) Under this definition, LMMAs are managed for sustainable use rather than for conservation per se; they constitute an alternative to top-down centralised government interventions, in favour of the involvement of local institutions and communities.

A deep-sea port construction project where 300 000 tons ships could be landed is however pending in Dawei, together with the construction a new highway connecting it to Kanchanaburi in Thailand. It is the main component of the planned Dawei Special Economic Zone (DSEZ) which aims to transform Dawei into a key area as Myanmar's largest industrial and trade zone, contributing further to commercial links with Thailand and China and offering an alternative sea-route to the Malacca Strait (Otsuka, 2013).

Despite some past controversies, Japan, Thailand and Myanmar are in tripartite talks to resume the comprehensive construction of this port. Japan is expected to enter the mega-project fully once the comprehensive plan is completed. Construction of a second Thai-Myanmar friendship bridge and a road is expected to commence in October 2015.

Marine Traffic

As shown on figure Figure, marine traffic off the Tanintharyi coast is limited to regional traffic. Low traffic flows along a shipping lane, passing through the Myeik archipelago and linking Myiek to Kawthaung and Ranong in Thailand. A busier shipping line which corresponds to the main maritime route linking Yangon to the Malacca Strait crosses the area some 100 km offshore Myeik archipelago. The Project is likely to interfere with this major shipping lane (at the national scale) as shown on Figure.

Domestic ship movement from the ports of Dawei does not appear on the map ; it is expected to be very limited due to poor port infrastructure that limit the capacity of these ports to welcome a large number of vessels. However, if completed, the Dawei deep-sea port project (which would have a handling capacity of 100 million metric tons of goods a year) would cause a dramatic increase of maritime traffic, by deporting a part of the traffic currently flowing through the Malacca Straits, to this area.

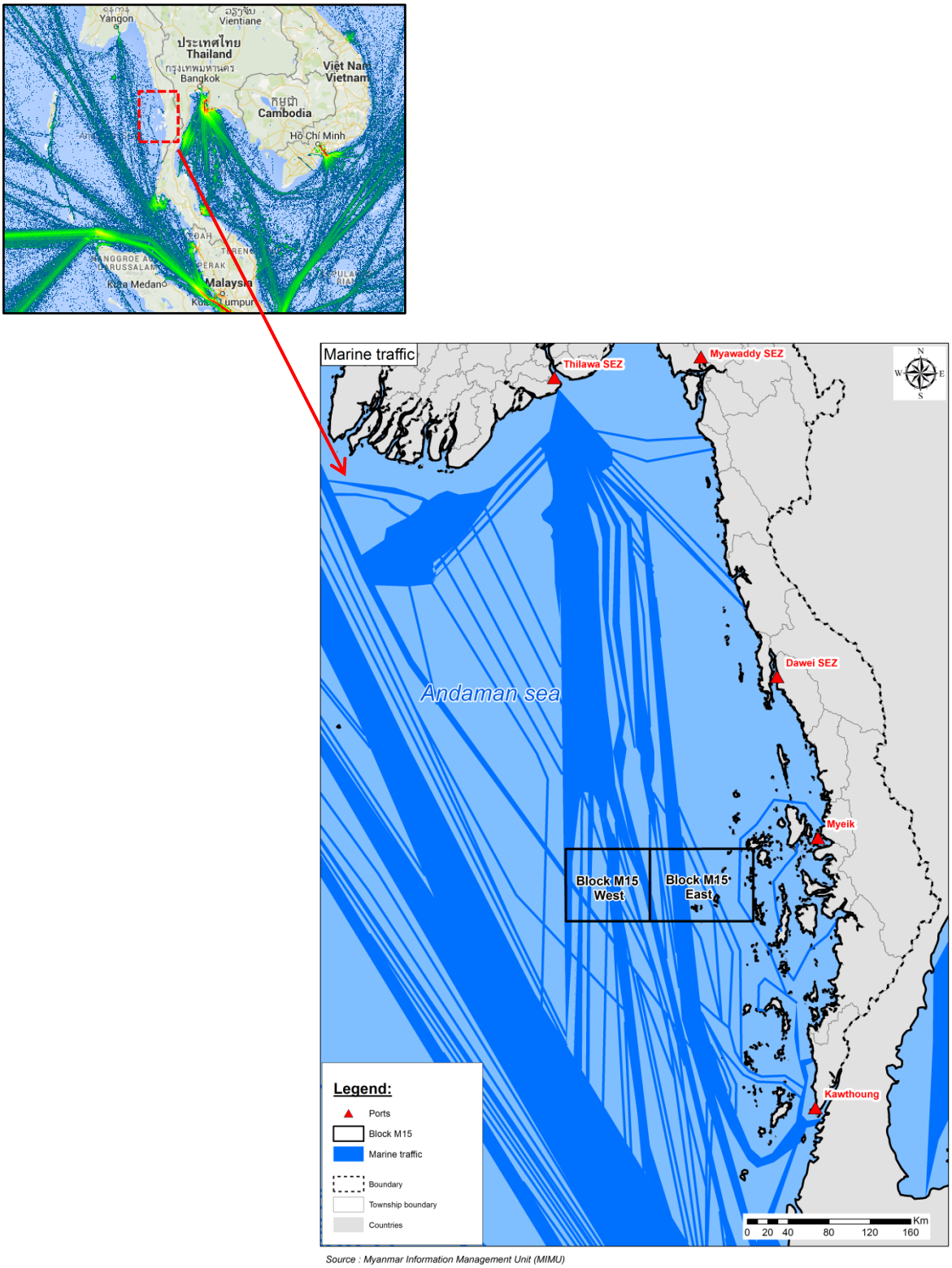


Figure 5.3 5: Marine traffic (ship density) in the Adaman Sea (Source: marinetraffic.com, data collected on 13th April 2015)

5.3.6. Stakeholder Identification

Due to the fast pace of economic development in Myanmar, the use of marine space by multiple actors will increase rapidly, along with pressures on the marine ecosystems and on the individuals and companies that benefit from its resources or are engaged in its protection.

Besides oil and gas operators, other actors having interests in the marine spaces of Myanmar These stakeholders are listed below, covering the public authorities, private sector, and intergovernmental and non-governmental organizations involved in the regulation, use or protection of Myanmar marine areas and their ecosystems. Other actors intervening as a response to the inter-communal conflicts, mainly international organizations and non-governmental organizations are also presented in this document in order to give a broad knowledge of the current crisis and the actors involved in its resolution.

A comprehensive identification of stakeholders will allow to build an efficient stakeholder engagement plan. This plan will determine the appropriate audience for the public consultations, whose objectives are to gather stakeholders' perception on the project's impacts identified and the mitigation measures prepared in this report.

Public Authorities

Public authorities grant the authorizations and permits needed by CFG Energy Pte Ltd. to perform the seismic campaign on Block M-15. They also regulate the use of marine areas between various stakeholders, from commercial vessels to fishermen.

Ministries

Ministry of Energy (MoE): MoE is in charge of developing the oil and gas resources in the country. It provides offshore and onshore blocks through bidding rounds to national and international companies for the purpose of exploration and/or exploitation.

Ministry of Environment Conservation and Forestry (MOECAF): MOECAF is in charge of developing the country environmental policy, in particular in the fields of water and marine resources conservation. It is also responsible for introducing a new environmental permitting system, which is in process of creation.

Ministry of Livestock, Fisheries and Rural Development (MLFRD): MLFRD is in charge of developing, implementing and monitoring the country policies in the field of livestock, fishery and rural development, to ensure that food security is achieved in the country, and prevent infectious diseases development that could endanger the national production.

- Department of Fisheries (DoF): Under the MLFRD, the DoF's main mission is to guarantee the preservation of fish resources in order to ensure the sustainability of the fishery sector. The DoF develops conservation efforts, promotes research and surveys on the current condition of marine resources in partnership with intergovernmental agencies, maintains statistics on fisheries, and supervises the fishery sector through the delivery of licenses to fishing vessels.

DoFDoF has offices at the regional and township levels: these offices are responsible to handle the licensing system and taxes collection at the local level.

Ministry of Transport (MoT): MoT is responsible for the organization of the country's transport infrastructures, from air to marine transportation.

- Department of Marine Administration (DMA): DMA is placed under the management of the Ministry of Transport. It is responsible for the marine traffic safety (conformity of ships to national safety standards, improvement of rescue operations at sea) and human resources development in the maritime sector. It is in charge of the offshore fishing vessels inspection to determine if they meet safety standards, prior to the delivery of fishing licenses by the DoF.

Myanmar Port Authority (MPA): MPA is a government agency under the Ministry of Transport, founded in 1989 and located in Yangon. It is responsible for the regulation and administration of 8 coastal ports, among which Myeik, Dawei and Thawthaung ports in Tanintharyi Region. It is also in charge of developing and improving the port infrastructures, notably through the development Special Economic Zones and their associated ports.

Myanmar Navy: Naval branch of the armed forces of Myanmar with 19,000 staff. The Myanmar Navy currently operates more than 122 vessels, and increased its activities over the last years to improve defence of its territorial waters in particular against illegal fishing. The Navy is also responsible for securing Myanmar waters from illegal fishing activities and human trafficking, which they do through patrolling.

Universities and Research Institutes

University of Mawlamyine (Mon State): this is one of the few universities in the country to offer a specialized degree in marine science, from Bachelor, Master to PhDs. It also has a Marine Science Laboratory in the coastal town of Setse, about 60 km south of Mawlamyine city. A total of 900 students are registered across the various classes available.

Institute of Fisheries Technology: Public institution established in Yangon in 1983 under the management of the Department of Fisheries. It provides training to fishermen on fishing techniques, fishing gears and fish processing, among others. Training courses can vary, from basic fishing technology to fish processing supervision.

Public Enterprises

Myanmar Oil and Gas Enterprise (MOGE): MOGE is Myanmar oil and gas state-owned enterprise. Established in 1983, it is an operator in oil and gas exploration and production as well as domestic gas transport through pipeline networks. It is also partner of joint-ventures with foreign oil and gas companies such as Total, Chevron, etc.

Regional Authorities

The Chief Minister, district and township administrators represent the highest levels of authority in the Tanintharyi Region

Business Associations

Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI): UMFCCI is the largest not-for-profit business federation of the country. Its functions include human resources development and training, commercial courses, management and accounting, providing trade information and participation in international trade fairs. Almost every economic sector has its own federation under the umbrella of the UMFCCI. This is the case for the fishing industry, represented by the MFF.

Myanmar Fishery Federation (MFF): Non-profit association founded in 1989 with the objective to encourage and promote fishing and fishery industries of Myanmar, through cooperation, training and knowledge sharing with other actors of the national fishery sector. The MFF counts 9 functional associations, and 13 regional fisheries associations under its umbrella. It has an important role in advocacy and opinion-making by regularly intervening in Myanmar media on issues of overfishing and depletion of the country marine resources. MFF branch in Tanintharyi is very active in the protection of fishermen's rights and interests in the region.

Myanmar Marine Fisheries Association: Member of the MFF along with 8 other associations such as the Myanmar shrimps association (MSA)

Myanmar Fishery Products Processors and Exporters Association (MFPPEA): Professional association in charge of supporting and promoting the processing and exporting companies in Myanmar.

Oil and Gas Companies

Directly surrounding the project area, several companies were awarded interests in inshore and offshore blocks, and their operations are either at the exploration or exploitation stage. They are presented below.

Shell: international oil and gas major, operator of the deep-water MD-5 block with the Japanese company MOECO (exploration stage)

ENI: Italian multinational Oil and Gas Company, operator of the deep-water block MD-4 (80% participation interest) with the Vietnamese group Petrovietnam for the remaining shares (exploration stage)

TOTAL: French Oil and Gas Company, operator of the YMB deep water block through its local subsidiary Total Exploration & Production Myanmar (exploration stage)

Petronas Carigali: Malaysian Oil and Gas Company (government owned), operator of the Yetagun gas field located in the shallow-water blocks M-12, M-13, M-14, in joint-venture with MOGE, PTTEP limited (Thailand state owned) and Nippon Oil Exploration Myanmar (exploitation stage).

Oil India Limited: Indian state owned company, operator of the shallow-water YEB block with the Indian privately owned Oilmax Energy Pvt Limited (exploration stage)

Reliance Industries Ltd: Indian conglomerate holding company, operator of the deep water blocks M-17 and M-18 (96% participating interest) with United National Resources Development Services (UNRD), a Myanmar company, holding the remaining interest (exploration stage)

International organizations

Food and Agriculture Organization (FAO): FAO has a representation office in Myanmar since 1978, and is involved in a wide range of activities to support sectorial development, in particular fisheries, focusing mostly on aquaculture and coastal fisheries as a support to artisanal fishing communities.

United Nations Refugee Agency (UNHCR): the agency is present in Myanmar and supports the operations of several IDP camps in Tanintharyi Region.

Other international organizations operate in Myanmar, and occasionally in Tanintharyi, such as the United Nations Development Program (UNDP), the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), and the World Food Program (WFP).

Intergovernmental Organizations

Intergovernmental organizations involved in the protection of marine spaces and/or the promotion of sustainable fisheries at the Southeast Asia regional level are numerous. They are particularly active in Myanmar, where the fishery sector is threatened by marine resources depletion.

Asia Pacific Fishery Commission (APFIC): APFIC is a regional fishery body established by the FAO at the request of its members in 1948 during the organization of the Indo-Pacific Fisheries Council. Its Secretariat is provided and supported by the FAO. Its role is to promote full and proper utilization of living aquatic resources, by the development and management of fishing, processing and marketing activities. APFIC also aims at improving knowledge sharing, training and promotion of best practices in the fishery sector to encourage sustainable fisheries, in collaboration with other regional entities and the national fishery institutions of its members.

ASEAN Sectorial Working Group on Fisheries (ASWGFi): Under the leadership of the ASEAN, ASWGFi is a regional working group gathering fisheries specialists during regular consultative forums which address issues such as registration of fishing vessels, census of marine resources, etc. Overall, the working group objective is to provide inputs for the creation of a common sustainable regional fishery policy among the ASEAN countries.

South East Asian Fisheries Development Centre (SEAFDEC): SEAFDEC mission is to develop and manage the fisheries potential of the region, supporting the rational utilization of the resources through transfer of new technologies, research and information dissemination activities. SEAFDEC comprises 11 member countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Its central office is located in Thailand. The Marine Fisheries Research Department and the Marine Fishery Resources Development and Management Department are the

two bodies working on assessing Myanmar marine resources and estimating potential for development of the fishery sector. The organization has also concluded an agreement with the ASEAN leading to the creation of a Fisheries Consultative Group.

Bay of Bengal Large Marine Ecosystem Project (BOBLME): BOBLME is a regional project whose objectives are to develop a coordinated policy on the management and protection of marine resources and environment in the large ecosystem of the Bay of Bengal. Its overall goal is to improve livelihoods of coastal communities depending on the BOB resources. Funded by international donors (Global Environmental Facility, Norway, Swedish Internal Development Agency), the project is piloted by the FAO in cooperation with respective Marine and/or Fisheries Ministries in each member country (Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia and Malaysia).

International Non-Governmental Organizations (INGOs)

The presence of international NGOs in the country has increased over the last 5 years due to the political opening which allows them to open branches and lead projects in various sectors, from community development projects aiming at reducing poverty to environment conservation initiatives targeting inland and marine ecosystems. These INGOs are listed below.

Fauna & Flora International (FFI): FFI works in Myanmar on various biodiversity and conservation projects. It currently leads a capacity-building program for marine conservation which counts among its two priority sites of intervention, the Myeik archipelago in Tanintharyi. Started in 2012, this program aims at identifying marine areas that should be protected, and support the management of already established protected areas, namely through the implementation of locally managed marine areas (LMMAs).In partnership with **Biodiversity and Nature Conservation Association** (BANCA), a Myanmar national NGO, and the Forestry and Fisheries Departments, activities will consist in trainings on marine survey methods, community-based fisheries and marine protected areas establishment and management.

WWF: WWF has been very active in the greater Mekong region over the last decades, and has just recently opened an office in Myanmar. Its aim is to support Myanmar's development ambitions with a focus on spatial planning and biodiversity conservation in parallel with ecosystem services protection and sustainable livelihoods. It has recently announced its plan to focus part of its efforts on green growth development, reforestation and biodiversity conservation in Tanintharyi Region (Myanmar Times, November 10th 2014).

Wildlife Conservation Society: International organization based in the USA, it is involved in the conservation of species with more than 500 projects in 60 countries. It started to operate in Myanmar in 1993, becoming the first international conservation organization to initiate a long-term program in the country. Their activities range from biological surveys, wildlife species population monitoring, to aid in the establishment of protected areas.

Human Rights Watch: Human Rights Watch regularly conduct human rights assessments in oil and gas projects, focusing on the pipelines connecting the offshore fields and the receiving countries than on offshore oil and gas platforms.

National Non-Governmental Organizations (NGOs)

The economic strategy implemented by the government has succeeded in attracting international investors interests in various business sectors. Industrial developments are significant, increasingly threatening ecosystems that were preserved by years of isolation. To face these new environmental challenges, several national NGOs have been created over the last years to preserve and protect the wide range of natural ecosystems.

Myanmar Environmental Rehabilitation-conservation Network (MERN): MERN is a network of 20 local environmental NGOs created in 2009. It works for environmental rehabilitation and conservation activities in support of local communities, to help them improve their sources of livelihoods and food security.

Biodiversity and Nature Conservation Association (BANCA): BANCA is a national NGO registered since 2004 whose objectives are to support conservation of nature, biodiversity through advocacy, research,

networking and capacity-building programmes. It works with the FFI on a marine conservation project. It also worked on projects focusing on inland ecosystems with other international NGOs such as Birdlife International, the Royal Society for the Protection of Birds, Care, Arcona Cambridge, etc.

Marine Science Association, Myanmar (MSAM): MSAM is a national NGO whose objectives are to take part in the sustainable development activities in Myanmar using its marine science expertise to conduct marine and coastal research, conservation and development, and to raise awareness on marine environment preservation.

Community Development Association (CDA): CDA is a registered non-profit, local non-government humanitarian organization established in Myanmar. Its mandates are to implement community developmental elementary interventions with effective involvement of existing support services and technical assistance. The Community Development Association has worked on various humanitarian assistance programs and has already collaborated with Total E&P Myanmar.

Friends of Wildlife Myanmar: Run by a former forestry official and based in Yangon, Friends of Wildlife provides education and technical assistance to help local communities shift from slash-and-burn agriculture, hunting, and illegal logging to sustainable agriculture. It is also involved in sustainable fishery management promotion.

Burma Environmental Working Group (BEWG): BEWG gather Myanmar ethnic environmental and social organizations, providing a forum for member organizations to collaborate on research, reporting, advocacy campaigns, capacity-building initiatives and policy formulation.

Media

Eleven Myanmar: Part of the Eleven Media Group funded in 2000, it has 5 weekly publications among which one is in English, and employs a staff of 250. Number of published copies is 450,000 in 2012.

The Myanmar Times: This newspaper has two versions, one in Burmese and one in English. It counts more than 300 employees and has a circulation of around 25,000 copies.

The Irrawaddy Magazine: Newsmagazine founded in 1992 by Burmese exiles living in Thailand. It is unaffiliated politically but supportive of democratic movements, and publishes news in English.

5.4. SYNTHESIS OF ENVIRONMENTAL SENSITIVITY

The sensitivity of the receiving environment (Se) is integrated into the following impact assessment by determining a sensitivity score. The notion of sensitivity takes into consideration numerous factors including: marine traffic frequencies, biodiversity, presence of protected or rare species, economic importance, capacity to recover and also the percentage of the ecosystem or resource affected compared with regional, national and international ecosystems and resources.

The sensitivity is scored on a scale of 0 to 4; the general principles for determining sensitivity values are provided in the following table (Table 5-19).

Table 5-19: General principles for sensitivity scoring (Se)

Environmental Sensitivity (Se)	Score
High sensitivity: The project area and potential zone that could be affected include a significant number of the local population, sensitive/protected animal or plant species or ecosystems, or include very sensitive areas (national or global resources).	4
Medium sensitivity: The project area and potential zone that could be affected include a significant number of inhabitants, animal or plant species or include sensitive or locally protected ecosystems or resources of regional importance.	3
Low sensitivity: The project area and potential zone that could be affected include a minor or moderate number of inhabitants, animal or plant species or include ecosystems or local resources that are not protected.	2
Very low sensitivity: The project area and potential zone to be affected include a small number of inhabitants, animal or plant species or ecosystems or resources.	1
No sensitivity: The project area and potential zone that could be affected does not include any inhabitants, animal, plant species, ecosystem or resources within the project area	0

According to this methodology, a synthesis of sensitivities for the current project is set out in the table below.

Table 5-20: Synthesis of the description of the environment

	Aspect	Environmental Sensitivity (Se)	Score
Offshore sediments	Sediment Quality	The project area is situated in the slope of the continental shelf and sediment deposits coming from the Ayeyarwady River are expected to be found within the project footprint. The seabed is likely to be covered by silty clays and carbonate sands.	1
Water column	Water Quality (offshore)	The Andaman Sea exhibits strong seasonal variations due to a large freshwater influx from Irrawaddy River. In the study area, the salinity of the surface water is low and the high turbidity may contribute to decrease the chlorophyll-a concentration. Maximum concentration of chlorophyll-a is obtained at 10m below the sea level.	1
Air Quality	Air quality (offshore)	No scientific study has been performed on the air quality within the project area. Nevertheless, taking into account the distance between the project and the coast (approx. 160km), and due to low human activity in the vicinity (excluding marine traffic) the air quality within the M15 Block is expected to be good.	1
Offshore Fauna	Benthic community	Taking into account the water depth (200-2000m) of the project area, the abundance and richness of benthic communities within the M15 block are expected to be low.	1
	Phytoplankton Zooplankton	Results for the sampling station located in the southern part of Myanmar's waters indicated a rich abundance of zooplankton goups, including calanoid copepods,	2

	Aspect	Environmental Sensitivity (Se)	Score
		poecilostomatoid copepods and arrow worms, whereas the region presented a lower abundance of crab larvae, planktonic shrimps and larvaceans.	
	Cetaceans	Among the 29 marine mammal species recorded by the IUCN with different levels of vulnerability in Andaman Sea, 21 may be encountered within the project area: • 2 species are endangered (EN) facing very high risk of extinction in the wild: the blue whale (*Balaenoptera musculus*) and the fin whale (*Balaenoptera physalus*); • 1 species is classified as vulnerable (VU) facing high risk of extinction in the wild: the sperm whale (*Physeter macrocephalus*).	4
	Fish	The pelagic system of the Andaman Sea and the Bay of Bengal in general is related to the considerable seasonal variations imposed by the monsoon systems. The pelagic fish community is widespread and relatively eclectic in its distribution. A wide variety of jacks, tuna, barracudas, flying fish, sharks and rays are included in this community that extends across the entire Indian Ocean. A total of 37 pelagic fish species were identified by the IUCN as threatened with different levels of vulnerability.	3
	Turtles	Amongst the turtle species present in Myanmar, 5 species breed regularly on Myanmar's beaches, including the olive ridley turtle *Lepoidochelys olivacea* (vulnerable), the loggerhead *Caretta caretta* (endangered), the green turtle *Chelonia mydas* (endangered), the hawksbill turtle *Eretmochelys imbricata* (critically endangered), and leatherback turtle *Dermochelys coriacea* (critically endangered). Most observations of turtles are typically within 15km of mainland shores in protected and relatively shallow marine waters (22-55m), i.e. away from the project area. Nevertheless, some species may be encountered as they are migratory.	4
	Birds	A total of 20 seabird species are currently identified by the IUCN in Myanmar waters. Amongst these species, 4 species are identified as near threatened and 16 species are recorded as least concern. Nevertheless, the project area is situated offshore, far from the mainland coastline, with little chance to found these species	2
Coastal Environment	Coastal ecosystem	The land pattern in adjacent coastal areas consist of mangroves, coral reefs, sea-grass beds, evergreen forest, wetlands and various types of agricultural land. The closest coral reef is situated 40km of the project area. The nearest mangroves are at 160km from the project area as are seagrass beds.	3
	Marine protected areas	The closest are situated in Myeik archipelago (Ross Island – 100km, Lampi island 140km). The closest Important Bird Area is Lampi island (~140km distance from the project area).	2

	Aspect	Environmental Sensitivity (Se)	Score
Societal offshore environment	Offshore fishing	The project area is located in the offshore fishery zone. It is also located in the middle of a known tuna fishing ground. The offshore fishing zone is used by a limited number of registered vessels that should only be of Burmese origin since Myanmar banned foreign fishing vessels from its waters in April 2014. Encounter with illegal fishing boats is however possible, illegal Thai trawlers being an “endemic feature” in the Andaman sea, that goes beyond the control capacity of the marine authorities There is also an (assumed very low) degree of probability that the project area could be used by artisanal fishermen, as they sometimes venture out of the inshore fishery zone (10 nm). However the distance separating the project area from the mainland and main inhabited island of the Myiek archipelago makes this occurrence very unlikely. Although the Moken are very unlikely to interact with the project as they do not venture far away from the island coasts, their presence in the waters of the Myeik archipelago should be considered.	3
	Marine traffic	The project area is traversed by a major maritime transportation route linking Myanmar (Yangon) to the Malacca Strait. Although the traffic density along this route is rather low in comparison to other shipping lanes, it is substantial in terms of absolute numbers (it can be expected that all maritime traffic out of Myanmar in direction of Thailand, Singapore and Malaysia – and vice versa - pass along this lane). Piracy is not uncommon in the Andaman sea and could represent a hazard for the project.	3

6. IMPACTS AND MITIGATION MEASURES

An Environmental and Social Risk Assessment (ESRA) of the proposed 3D seismic survey within the M15 Block offshore Myanmar has been undertaken to understand and manage the environmental and social risks associated with the activity to a level that minimises impacts on the environment and meets the objectives of the proposed survey.

6.1. ENVIRONMENTAL/SOCIAL RISK ASSESSMENT METHODOLOGY

The risk assessment has been undertaken to identify the sources of risk (aspects) and potential environmental impacts associated with the activity and to assign a level of significance or risk to each impact. This subsequently assists in prioritising mitigation measures to ensure that the environmental and social impacts are managed to As Low As Reasonably Practicable (ALARP).

The risk has been measured in terms of likelihood and consequence, where consequence is defined as the outcome or impact of an event, and likelihood as a description of the probability or frequency of the identified consequence occurring.

Potential impacts on the receiving environment (physical, biological and socio-economic) within the survey area in the M15 Block, and of the surrounding waters have been identified using a matrix (Table 6-1). Identified activities and key potential sources of impacts (i.e. hazards) have been listed down the vertical column of the matrix, while environmental sensitivities/values or receptors are listed across the horizontal axis. Each square on the scoping matrix represents a potential interaction between an activity and an environmental or social sensitivity/value or receptor (i.e. a potential impact).

Table 6-1: Impact assessment scoping matrix for the M15 Block 3D seismic survey, offshore Myanmar

Environmental sensitivity/value / Operational activity/hazards	Physical					Biological							Socio-economic			
	Marine sediments	Hard substrates / habitats	Water quality	Air quality	Underwater noise levels	Planktonic communities	Benthic communities	Cetaceans	Fish communities	Whale sharks	Turtles	Seabirds	Offshore industrial fisheries	Inshore artisanal fisheries	Shipping	Oil & gas exploration
Vessel presence					■			■	■	■	■	■	■	■	■	■
Seismic array discharges					■	■		■	■	■	■		■			■
Light generation											■	■				
Towed equipment entanglement								■		■	■					
Vessel anchoring*																
Equipment loss	■	■					■						■		■	■

Atmospheric emissions				■												
Invasive marine species							■		■				■	■		
Routine waste discharges			■			■			■				■			
Accidental discharges			■			■		■	■	■	■	■	■	■		■

Note: * Not applicable for this survey given the deep water depths of the survey area.

Key: No Impact ☐ **Potential Impact** ■

The environmental and social risks associated with the proposed seismic survey operations have been assessed by a methodology (see above) that:

- identifies the activities and the environmental/social aspects associated with them;
- identifies the values/attributes at risk within and adjacent to the survey area in the M15 Block;
- defines the potential environmental and social effects of the activities;
- identifies the likelihood of occurrence and potential consequences; and
- determines overall environmental/social risk levels using a likelihood and consequence matrix.

The likelihood of occurrence for the key potential environmental and social impacts from the M15 Block 3D seismic survey has been estimated based on industry incident reporting (see Table 6-2). Table 6-2 also includes a qualitative description of effects assigned to each category of consequence.

Table 6-2: Definitions for qualitative assessment of likelihood and environmental or social effects

Likelihood	Qualitative description of likelihood
Unlikely	Impact has not occurred in the past and there is a low probability that it will occur in exceptional circumstances.
Possible	Impact may have occurred in the past and there is a moderate probability that it will occur at some time.
Likely	Impact has occurred in the past and there is a high probability that it will occur at some time.
Highly Likely	Impact has been a common problem in the past and there is a high probability that it will occur in most circumstances.
Routine	Impact will occur, is currently a problem in the area or is expected to occur in almost all circumstances.
Consequence	**Qualitative description of environmental or social effects**
Slight	Possible incidental impacts to flora and fauna in a locally affected environmental setting. No ecological consequences.
Minor	Reduction of the abundance/biomass of flora and fauna in the affected environmental setting. No changes to biodiversity or ecological system.
Moderate	Reduction of abundance/biomass in the affected environmental setting. Limited impact to local biodiversity without loss of pre-incident conditions.
Severe	Substantial reduction of abundance/biomass in the affected environmental setting. Significant impact to biodiversity and ecological functioning. Eventual recovery of ecological systems possible, but not necessarily to the same pre-incident conditions.
Catastrophic	Irreversible and irrecoverable changes to abundance/biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions.

Table 6-3 shows the overall risk assessment matrix (also referred to as an event potential matrix) that compares the likelihood and consequences of potential environmental or social impacts arising from the M15 Block 3D seismic survey and assigns a level of risk.

Table 6-3: Generic environmental/social risk assessment matrix

	LIKELIHOOD				
CONSEQUENCE	**Unlikely**	**Possible**	**Likely**	**Highly Likely**	**Routine**
Catastrophic	**High**	**High**	**High**	**High**	**High**
Severe	**Medium**	**Medium**	**Medium**	**High**	**High**
Moderate	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Minor	**Low**	**Low**	**Medium**	**Medium**	**Medium**
Slight	**Low**	**Low**	**Low**	**Low**	**Low**

High Risk Level: Apply strict precautionary principle, and industry best practice to reduce to ALARP.

Medium Risk level: Apply standard cost-benefit approach to reduce risk to ALARP.

Low Risk level: Apply normal business management practice to avoid impact.

6.2. IMPACTS AND RISKS IDENTIFICATION AND ASSESSMENT

6.2.1. Environmental/Social risks

A summary of the key sources of environmental/social risks for the proposed activity include:

- discharge of underwater seismic pulses;
- light generation from survey, support and chase vessels;
- Physical presence of vessels on the water,
- loss of streamers and associated equipment;
- emissions to atmosphere from vessels;
- discharge of ballast water and vessel biological fouling (biofouling);
- routine discharge of wastewater and waste to the ocean from survey, support and chase vessels;
- accidental discharge of hydrocarbons and chemicals to the ocean from survey, support and chase vessels; and

6.2.2. Environmental/Social Impacts

A summary of the potential environmental/social impacts associated with the sources of risk listed above include:

- disturbance to marine fauna including cetaceans, whale sharks, turtles and fish because of underwater noise generated;
- disturbance to the seabed and benthic habitats and communities;
- reduced air quality from atmospheric emissions as a result of operation of machinery and use of internal combustion engines;
- introduction of invasive marine species as a result of ballast water discharge and vessel biological fouling;
- marine pollution from routine discharges including sewage water, bilge water and other solid wastes;
- marine pollution from accidental discharges including hydrocarbon spills and hazardous materials; and
- disturbance to fishing industry activities and to marine traffic;
- disturbance to social and community values due to potential interactions with local fishermen and sea nomads;
- interactions with other oil and gas exploration activities;
- collision with marine fauna.

The following section of this EIA provides a detailed assessment of these potential environmental or social impacts that could result from the proposed M15 Block 3D seismic survey, offshore Myanmar.

7. ASSESSMENT OF IMPACTS AND RISKS

This section of the EIA describes and assesses the potential environmental and social impacts identified in Section 6.2.2 above. It also identifies the mitigation and management measures associated with each risk that will be implemented to reduce impacts to an acceptable level.

7.1. DISTURBANCE TO MARINE FAUNA

7.1.1. Discharge of Underwater Seismic Pulses

7.1.1.1. **Background**

The assessment of impacts and risks from discharge of underwater seismic pulses presented in this sub-section is based on information sourced from a number of publications in the scientific literature. It is important to note that this is an active field of research, with new studies being published on a regular basis. It is also sometimes difficult to compare or interpret studies on the effects of underwater sound on marine fauna because research papers may vary on some parameters, including received sound levels, source sound levels, and specific characteristics of the sound.

Underwater sound pressure levels (SPL) are typically reported as dB referenced usually to 1 micro-Pascal (µPa). However, the SPL dB number can represent multiple types of measurements, including zero-to-peak (0-pk), peak-to-peak (pk-pk), or averaged (root mean square - rms). It is not uncommon to find reports and even peer-reviewed papers on the effects of underwater noise sources that fail to specify if the SPL dB values refer to the pk-pk, 0-pk or rms measure of the waveform amplitude, or measured or estimated for the source or the receiver. This can cause further confusion and misconceptions concerning the magnitude and potential impacts of particular noise levels and sources.

Acoustic intensity is a more appropriate measure of sound exposure than SPL (rms) because the former takes into account the overall acoustic energy impinging on the animal per unit area. Sound exposure level (SEL) is the time-integrated squared sound pressure and is expressed as dB re 1 µPa2.s. Because units of SEL take account of pulse duration, they provide the best way to compare source and/or received sound energies from activities such as seismic surveys. Often, it is not possible to determine if received levels quoted in the literature are SPL or SEL. Unless precise measurement types are reported, it can be impossible to directly compare results from two or more independent studies.

The source level of a sound is calculated assuming it arises from an “ideal point source.” An ideal point source assumes all the sound energy is emanating from one focal point. It is important to understand that seismic airgun arrays are not point sources. The sound producing airguns are spread over large areas, so even an animal directly beneath the airgun array would not experience SPL as high as its theoretical source level. For these types of sound sources, the source level is a useful theoretical calculation to help determine likely received SPL at greater distances from the array but it will not accurately describe the level of sound near the array.

Near-field (close to the source) and far-field SEL for airgun arrays relate to a number of parameters, including the overall size (capacity) of the airgun array, water depths in the area, and geo-acoustic properties of the seabed.

The assessment of impacts and risks presented in this sub-section is based on a rigorous and robust interpretation of the currently available science. Whilst every effort has been made to source papers and reports that relate, as far as possible, to the circumstances within the M15 Block and surrounding waters, it is not possible to find examples that directly apply to the specific airgun array parameters and environmental conditions (e.g. water depth range, seabed geo-acoustical properties etc.) that apply in this case.

Studies relating to the environmental effects of marine seismic surveys have largely focused on the potential effects on fish stocks and marine mammals from the sound waves associated with the seismic energy source.

Concerns have included:

- pathological effects (lethal and sub-lethal injuries) – immediate and delayed mortality and physiological effects to nearby marine organisms;
- behavioural change to populations of marine organisms;
- disruptions to feeding, mating, breeding or nursery activities of marine organisms in such a way as to affect the vitality or abundance of populations;
- disruptions to the abundance and behaviour of prey species for marine mammals, seabirds and fish; and
- changed behaviour or breeding patterns of commercially targeted marine species, either directly, or indirectly, in such a way that commercial or recreational fishing activities are compromised.

A. Pathological Effects

Immediate pathological effects are likely to be restricted to very short ranges and high sound intensities and are unlikely to occur for the majority of species, as most free-swimming animals will practice avoidance manoeuvres well before they get within the ranges at which pathological effects may occur. Diving patterns of deep diver mammals (sperm whales, beaked whales, etc.) can be affected. For example, beaked whales when loud sonar is emitted at certain frequency may respond by coming to surface too quickly. Most of these responses are associated with mid-frequency sonar.

Seismic waves should not be confused with high explosives producing shock waves; these produce severe pathological effects at considerable ranges, depending on charge size, and physical or biological factors. Seismic airguns do not give rise to shock waves.

B. Disturbance to Benthic Invertebrates

Benthic organisms that could be affected live permanently in the substrate bottom of the seabed (i.e. located between 200 and 2,000 m depth).

Few marine invertebrates have sensory organs that can perceive sound pressure, but many have organs or elaborate arrays of tactile 'hairs' that are sensitive to hydro-acoustic disturbances (McCauley 1994). These sensory hairs or organs are collectively known as mechanoreceptors, and crustaceans are particularly well endowed with them. Close to a seismic source, the mechano-sensory system of many benthic crustaceans will perceive the 'sound' of airgun pulses, but for most species such stimulation would only occur within the near-field or closer, perhaps within distances of several metres from the source (McCauley 1994).

Decapod crustaceans have a variety of external and internal sensory receptors that are potentially responsive to sound and vibration. Many of these resemble vertebrate receptors that respond to hydrodynamic stimulation, particle motion and possibly pressure. However, the exoskeleton and body plan of aquatic decapods are more capable of responding to particle displacement components of an impinging sound field than pressure changes. The limited acoustic sensitivity of decapods is also related to their lack of any gas-filled spaces such as those associated with pressure detection in fishes. However, many decapods have extensive arrays of hair-like receptors both on and inside their exoskeleton that most probably respond to water- or substrate-borne displacements, and they also have many proprioceptive organs that may perceive vibrations (Christian *et al*. 2003).

In an extensive and thorough review, Moriyasu *et al*. (2004) provide a summary of impacts of seismic airguns on marine invertebrates based on literature reviews. They conclude that "very limited numbers of experiments were scientifically and reasonably conducted" but the results of nine quantitative studies showed five cases of immediate (lethal or physical) impacts of seismic airguns on invertebrate species and four cases of no impacts (see Table 7-1). One study showed physiological impacts and another showed no physiological impact. Three cases showed behavioural impacts and one study showed no impact on behaviour.

Moriyasu *et al*. (2004) conclude that:

"Squid (McCauley et al. 2000a) and crab behaviour (Christian et al. 2003) have been studied by direct observation. Pre- and post- seismic airguns comparisons of catch rates were made by La Bella et al. (1996) and Christian et al. (2003) on various invertebrate species. The quantitative and anecdotal aspects of all other studies were inadequate for assessing the effects of […] seismic airguns on invertebrates. In addition, in-depth analyses on physiological changes in animals exposed to seismic airguns are quasi-absent."

This review (Moriyasu et al. 2004) makes the comment that the papers by La Bella et al. (1996), McCauley et al. (2003) and Christian *et al*. (2003) provided the most detailed and useful information on the possible impacts of seismic airguns on invertebrates among the documents they examined.

Table 7-1: Summary of impacts of seismic airguns on marine invertebrates on literature reviews

	Lethal / physical	Physiological / pathological	Behavioural	Catch rate
Negative impacts observed	*Loligo vulgaris* *Chionoecetes opilio* (eggs) *Chlamys islandicus* Sea urchins *Architeuthis dux*	*Bolinus brandaris*	*Alloteuthis sublata* *Sepioteuthis australs* *Architeuthis dux*	*Bolinus brandaris*
No impacts observed	*Chionoecetes opilio* *Mytilus edulis* *Gammarus locusta* *Crangon crangon*	*Chionoecetes opilio*	*Chionoecetes opilio*	*Crangon crangon* *Penaeus blebejus* *Nephrops norvegicus* *Illes coindetti* *Squilla mantis* *Paphia aurea* *Anadara inaequivalvis*

La Bella *et al*. (1996; as cited in Moriyasu *et al*. 2004) reported that no apparent changes in trawl catches were found in short-finned squid (*Illex coindetti*) nor in Norway lobster (*Nephrops norvegicus*) in the area prospected one day before at sound source levels of 210 dB re 1µPa at 1 m (corresponding to levels of 149 dB re 1µPa at animal location). The same authors reported that no apparent catch reductions in mantis shrimp (*Squilla mantis*) caught by gill nets, and in golden carpet shell (*Paphia aurea*), inaequivalvis ark shell (*Anadara inaequivalvis*), and purple die murex (*Bolinus brandaris*) caught by a hydraulic clam dredge in the area prospected one and two days before exposed to the same sound level mentioned above. However, purple die murex caught by gillnet showed a significant difference in catch rate. Based on the results of catch comparison of this species between hydraulic dredge and gill nets, the author concluded that this is a change in behavioural reaction to seismic guns rather than immediate mortality (La Bella *et al*. 1996; as cited in Moriyasu *et al*. 2004).

Caged squid (*Sepioteuthis australis*) subjected to an individual operating airgun showed behavioural changes and avoidance (McCauley *et al*. 2003; cited in Moriyasu *et al*. 2004 as McCauley *et al*. 2000a). They found an alarm response at 156-161 dB re1µPa rms, and a strong startle response at 174 dB re 1µPa rms involving ink ejection and rapid swimming. The caged squid also moved to the sound shadowed area of the cage. The authors suggested thresholds for affecting squid's behaviour are at 161-166 dB re 1 µPa rms.

Christian *et al*. (2003; as cited in Moriyasu *et al*. 2004) did not detect any effects on the behaviour of snow crab *(Chionoecetes opilio*) placed in cages and put on the ocean bottom at a depth of 50 m after being exposed to sound levels of 197-237 dB from an airgun array. Additionally, this study found no effects on catch rate of snow crab by comparing pre- and post-seismic testing. The catch rates were even higher in post-seismic fishing than pre-seismic fishing. The authors concluded that this was likely due to physical, biological or behavioural factors unrelated to the seismic source. The same study also examined a series of morphological and physiological characteristics i.e. haemolymph, hepatopancreas, heart, heads (statocysts, green glands, and brains), gills and gonads. They did not find significant effects on the physiological

components of tested animals, but they noted that embryonic development of external eggs may be delayed after being exposed to seismic airguns (Christian *et al*. 2003; as cited in Moriyasu *et al*. 2004).

A number of studies have examined the potential effects of seismic surveys on catch levels in fisheries targeting benthic crustaceans such as prawns and rock lobster. Andriguetto-Filho *et al*. (2005) investigated the effect of seismic surveys on prawn fisheries in relatively shallow waters (2-15 m) in Camamu Bay, north-western Brazil. Catch rates of various shrimp species were measured before and after use of a four airgun array with a source peak pressure of 196 dB re 1µPa at 1 m. Catch rates were found to be unaffected. The experiment was carried out over a period of a few days whereby in-migration would not be a confounding factor. It is also noted that the authors carried out histopathological studies on gonadal and hepatopancreatic tissue and reported that there was no damage that could be associated with exposure. This study did not detect any significant deleterious impacts of seismic airgun noise on various penaeid species, suggesting that prawn stocks are resilient to the disturbance by airguns under the experimental conditions applied.

Parry and Gason (2006) investigated the effect of seismic airgun discharges on southern rock lobster (*Jasus edwardsii*) via statistical analysis of the coincidence between seismic surveys and changes in commercial catch rates in western Victoria between 1978 and 2004. There was no evidence that catch rates of rock lobsters in western Victoria were affected by seismic surveys in the weeks or years following the surveys. However, most seismic surveys occurred in deep water, where impacts would be expected to be minimal. The apparent lack of impact of seismic surveys on catch rates of rock lobsters is consistent with the limited information available on the physiological effects of seismic surveys on invertebrates, including rock lobsters (Parry and Gason 2006).

C. Disturbance to Planktonic Organisms

The available data on the effects of seismic noise on plankton species are quite variable and may differ from a species to another. Some research studies on the potential effects on plankton organisms from the extensive seismic activity in the North Sea, have shown no significant harmful effects for experiments with *Gammarus* locusta and shellfish at distances of 0.5m and greater from a single air gun with a chamber volume of 3 litres (DNV, 2007).

Other results from Thomson et al (2000) research studies shown the exposure to acoustic sources located within 5m lead to the deaths of entire populations of phytoplankton and zooplankton (some species), the principle food source for baleen whales.

Other shows that except for planktonic organisms within a few metres of an airgun, no planktonic organisms are likely to be affected significantly by airgun array discharges (McCauley 1994). Calculations show that less than 0.02% of plankton in the area would be affected[30]. Any effect on the planktonic organisms from the seismic discharge is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms. The effects of seismic sound exposure levels depend on the distribution of biomass in the water column. According to research studies, only 1% of this biomass would be lost if uniformly distributed in the first 50m radius of the sound wave (Davies, 1998).

The impact of discharge of underwater seismic pulses on plankton is expected to be localized (surface water, 5-10m) and therefore negligible since maximum of phytoplankton is expected at 10 meters. Even if the Bay of Bengal has a rich abundance of zooplankton groups, natural mortality rates are high and natural annual fluctuations in population densities is large due to oceanographic and climatic variations.

The impact of discharge of underwater seismic pulses on the planktonic community is expected to be negligible.

D. Disturbance to Fish Population

Many fish species are sensitive to sound. They can be scared by the sound of approaching vessels (Olsen, 1971), and their adaptive behaviour my change due to other fish species, vessels, and perceived predators (Misund and Aglen, 1992). Fish can also be attracted by sound (Wahlberg, 1999) and conditioned to sound

[30] This assumes plankton are uniformly distributed, single gun array, 18.75 m shot point interval, maximum range of pathological effect 2 m.

(Bjørnsson, 1999). Some fish are vocal, making sounds themselves. Over 800 species of fishes from 109 families are known to make sounds and this is likely to be an underestimate (Kaatz 2002). Fishes produce sounds when they are feeding, mating, or fighting and they also make noises associated with swimming. Fish sounds vary in structure depending on the mechanism used to produce them, but they are generally composed of low frequencies, with most of their energy lying below 3 kHz. So far, no ultrasonic sounds have been recorded from fish, although marine mammals produce such sounds.

Seismic surveys can have an impact on individual fish, fish populations and fisheries, either directly through harmful physiological effects or behavioural effects. Many fish species display a general 'alarm' response of increased speed at 156 - 161dB re 1µPa (rms), which is included in the disturbance avoidance range of baleen whales. Fish are sensitive to a rather restricted range of frequencies compared with mammals. Even the most sensitive fish have relatively poor hearing above 2-3 kHz. It is well known that fish can be adapted to sound, and, if sound is emitted for a long period, they will ignore it.

Fish are generally most sensitive to low sound frequencies where the wavelength often exceeds the dimensions of the body of water that contains the experiment. It has been possible to demonstrate that some fishes are sensitive to particle motion. Other fishes are sensitive to sound pressure.

- In considering the impact of anthropogenic sounds upon fish it is useful to place fish into different functional categories, depending on their structure and degree of hearing specialisation. Fish may tentatively be separated into:
- Fish with no swim bladder or other gas volume (particle motion detectors)
- Fish with a swim bladder or other gas volume, and therefore susceptible to barotrauma, but where the organ is not involved in hearing (particle motion detectors)
- Fish with a swim bladder or other gas volume, and therefore susceptible to barotrauma, where the organ is also involved in hearing (sound pressure and particle motion detectors).

Physical disturbance

Lethal and direct physical injury from an underwater transient pressure wave are related to the peak pressure level, rise time and duration that the peak pressure acts on the body (usually measured by the impulse of the blast wave).

Fish with swim bladders have not shown mortality (Popper et al., 2007; Hastings et al., 2008; McCauley et al., 2011), and since any damage would be greatest in fish with a swim bladder (as with explosives), mortality of fish without a swim bladder is unlikely.

Examination of the sensory cells of the inner ears after exposure to seismic air guns have shown loss of cells in one species that has a swim bladder distant from the ear (pink snapper – McCauley et al. 2003) but paradoxically not in several other species that have swim bladders closer to the ear (Song et al. 2008; McCauley et al., 2011). Evidently the effects of air guns on the ear differ for different species, and a number of reasons for these differences have been proposed (Popper et al. 2005; Popper and Hastings 2009a, b) including use of different sources, different water depths, and different species. More data are badly needed.

The effects of seismic air guns on hearing were examined by Popper et al. (2005) who showed TTS in a fish that had a connection between the swim bladder and inner ear and in one of two other species that did not have connections. Hastings et al. (2008) examined hearing using AEP in reef fishes exposed to a seismic survey with a full air-gun array in the Indian Ocean. They found no hearing loss following sound exposures up to 190 dB re 1 !Pa2-s cumulative SEL in one species where the swim bladder connected to the ear and in three species where it did not.

Studies with caged fish (Kosheleva 1992; McCauley *et al*. 2003) have shown that some fish species that are caged, and therefore unable to swim away from the noise source, can suffer physiological damage to eyes and hearing. Conditions that could result in fish being trapped and unable to move more than a few metres from the noise source as the survey vessel traverses the area do not exist in the survey area in the M15 Block (indeed it is difficult to conceive of any vessel-based seismic survey causing fish to be trapped within a few metres of the noise source). Therefore, it is considered that the risk of physiological effects on fish is negligible.

For some fish, strong 'startle' responses have been observed at sound levels of 200 to 205 dB re 1µPa, indicating that sounds at or above this level may cause fish to move away from the vessel. Sound levels of this level are likely to occur approximately 100 to 300 m from an airgun array. Based on this an approximate range of 200 m is given as the minimum distance at which fish may move away from an operating array and below which physical effects may occur (McCauley 1994). More recent studies (McCauley *et al*. 2003) have found that active avoidance may occur in some fish species at sound levels of approximately 161–168 dB re 1µPa rms, which corresponds to a distance of approximately 1 km from the survey vessel(s).

Based on existing information, significant impacts on fish populations resulting from seismic survey noise are likely to be restricted to the following:

- short ranges and high sound intensities (i.e. <200 m range from source);
- populations that cannot move away from operating arrays (e.g. site-attached reef species);
- surveys that take place over protracted periods close to areas important for the purposes of feeding, spawning or breeding; and
- surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

Behaviour disturbance

Available evidence suggests that behavioural changes for some fish species may be no more than a nuisance factor. For example, the temporary, short range, displacement of pelagic or migratory fish populations may have insignificant repercussions at a population level (McCauley 1994).

There is a high likelihood that seismic airgun noise could cause the following effects in some finfish:

- avoidance;
- startle/alarm response;
- changes in swimming patterns (including change in swimming speed and direction); and
- changes in vertical distribution.

These effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure, are expected to vary between species and individuals, and be dependent on the properties of received sound (DFO 2004). The ecological significance of such effects is expected to be low, except where they influence reproductive activity.

The threshold received SEL that could result in various behavioural effects in fish outlined above are:

Low level behavioural effects:

- avoidance at >140 dB re 1µPa2.s (pelagic species and the more nomadic demersal species);
- startle/alarm at >160 dB re 1µPa2.s (species with limited home ranges or site-attached and/or territorial strategies).

High level behavioural effects:

- fright/flight at >180 dB re 1µPa2.s (species with limited home ranges or site-attached and/or territorial strategies) (Woodside 2007).

There are no documented cases of fish mortality upon exposure to seismic airgun noise under field operating conditions (DFO 2004).

The threshold received SELs that could result in various sub-lethal and/or physiological effects are:

- onset of short term reversible loss in hearing sensitivity (temporary threshold shift - TTS) at >180 dB re $1\mu Pa^2$.s (site-attached species);
- onset of longer term loss in hearing sensitivity (TTS/permanent threshold shift – PTS) at >187 dB re $1\mu Pa^2$.s (site-attached species); and

- TTS onset but no injury to non-auditory tissues to ~1 kg sized fish at >200 dB re 1µPa^2.s (site-attached species) (Woodside 2007).

The potential effects of marine streamer seismic surveys have been summarised as part of a detailed environmental assessment of geophysical exploration for mineral resources on the Gulf of Mexico outer continental shelf (MMS 2004). This assessment concluded that negligible to potentially adverse effects on fish may occur from seismic surveys. However, these effects were not considered biologically significant due to the following factors:

- seismic survey noise may disturb fish and may produce temporary or permanent hearing impairment in some individuals, but it is unlikely to cause death or life-threatening injury;
- seismic surveys are not expected to cause long term or permanent displacement of any listed species from critical/preferred habitat; and
- seismic surveys are not expected to result in destruction or adverse modification of critical or essential fish habitat.

Fish catch

A number of studies have demonstrated that exposure to seismic surveys has an impact on fish catch, presumably as a result of changes in fish behaviour and distribution (Engås et al. 1996; Engås and Løkkeborg 2002; Slotte et al. 2004, Skalski et al. 1992; Pearson et al. 1992; Løkkeborg et al. 2010).

The effect of seismic shooting on fish catch may depend on the fishing method employed. Thus trawl net and long line catches may decline as a result of fish removing themselves from the area, while gill net catches may increase as a result of the increased activity of fish.

The average measured echo abundance, which represented the quantity of fish, was reduced by 36 % after the shooting, compared with the measured values prior to shooting. Slotte et al. (2004) also observed that fish moved out of an area where seismic shooting occurred or went into deep water (10-50m deeper).

Fish larvae

Studies on the eggs and larvae of several fish species suggest that they are likely to suffer mortality and tissue damage close to air guns (Kostyvchenko (1973; Booman et al., 1996). However, Saetre and Ona (1996) concluded that mortality rates caused by exposure to air gun sounds were so low compared to natural mortality that the impact from seismic surveys must be regarded as insignificant.

Table 7-2: Observed seismic noise pathological effects on fish eggs and larvae

Species	Source	Source level (dB re 1 µPa @ 1 m)	Distance from source (m)	Exposure level (dB re 1 µPa)	Observed effect	Reference
Cod (larvae 5 days)	Single airgun	250	1	250	Delamination of the retina	Matishov (1992)
Cod (larvae 2-10 days)	Single airgun	222	1	222	No injuries detected	Dalen and Knutsen (1986)
			10	202	No injuries detected	
Fish eggs (Anchovy)	Single airgun	230 (estimated)	1	230	7.8% of eggs injured relative to control	Kostyvchenko (1973)
			10	210	No injuries detected	
Fish eggs (Red Mullet)			1	230	No injuries detected	
			10	210	No injuries detected	

Species	Source	Source level (dB re 1 µPa @ 1 m)	Distance from source (m)	Exposure level (dB re 1 µPa)	Observed effect	Reference
Dungeness Crab (larvae)	Seven airgun array	244 (estimated	1	233.5	No significant difference in survival rate relative to controls	Pearson *et al*. (1994)
			3	230.9		
			10	222.5		

E. Disturbance to Marine Turtles

The presence of marine turtle species in the project area is a possibility, though there is a paucity of information on their distribution off Myanmar and on their migration routes. Hence, a precautionary approach was considered when assessing the potential impact of the project on marine turtles.

Electro-physical studies have indicated that the best hearing range for marine turtles is in the range 100 to 700 Hz, which overlaps with the frequency range of maximum energy in the horizontally propagating component of a seismic array 'shot' (McCauley 1994). Studies indicate that marine turtles may begin to show behavioural responses to an approaching seismic array at received sound levels of approximately 166 dB re 1 µPa (rms), and avoidance at around 175 dB re 1 µPa (rms) (McCauley *et al.* 2003). This corresponds to behavioural changes at ~2 km, and avoidance from ~1 km.

Marine turtles may possibly be exposed to noise levels sufficient to cause physical damage if airgun arrays start suddenly with turtles nearby (less than 30 m). In circumstances where arrays are already operating, (i.e. as a vessel moves along an acquisition line), individuals would be expected to implement avoidance measures before entering ranges at which physical damage might take place.

Based on current information, it would appear that significant impacts on marine turtle populations resulting from seismic survey noise are likely to be restricted to:

- short ranges and high sound intensities (perhaps less than 30 m range from source);
- surveys that take place over protracted periods close to areas important for feeding, breeding and nesting; and
- surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

Feeding areas and migratory paths of turtles traverse both shallow and deep-water areas, and therefore individuals of all sizes may be encountered in a seismic survey area. It has been speculated that migrating turtles may use various acoustic cues and that acoustic disturbances might interfere with their navigational ability (McCauley 1994).

Table 7-3: Results of airgun exposure to marine turtles

Species	Received level (dB re 1 µPa rms)	Effect	Source
Loggerhead turtle	175-176	Avoidance response	O'Hara and Wilcox (1990)
One green and one loggerhead turtle	166	Noticeable increase in swimming behaviour, presumed avoidance response	McCauley *et al.* (2003)
One green and one loggerhead turtle	175	Behaviour becomes increasingly erratic, presumed alarm response	McCauley *et al.* (2003)

Source: modified from table in McCauley *et al.* (2003).

There is no evidence implying that turtles actively avoid or are attracted to close range (less than 500 m) encounters with operating airgun arrays. However, Moein *et al.* (1994) tested if hearing sensitivity of caged loggerhead turtles altered after exposure to several hundred pulses within 30-65 m of a single airgun (pulse numbers and received sound levels not stated). Hearing was tested before, within a day, then two weeks after

exposure. Approximately 50% of the exposed individuals indicated altered hearing sensitivity when tested within a day of their exposure, but none provided any sign of altered hearing two weeks later, compared to the pre-exposure tests.

Based on studies that have been conducted to date (DFO, 2004), it is considered unlikely that sea turtles are more sensitive to seismic operations than cetaceans or some fish. Therefore, mitigation measures designed to reduce risk or severity of exposure of cetaceans to seismic sounds may be informative about measures to reduce risk or severity of exposure of sea turtles to seismic sounds. However sea turtles are harder to detect both visually and acoustically than are many species of cetaceans, so mitigation strategies based on sightings or acoustic detection of turtles, are expected to be less effective for turtles than for cetaceans.

Impacts of discharge of underwater seismic pulses on behaviour has been reported for some sea turtles, however, no conclusive evidence of pathological pattern is identified.

The seismic activities for M15 Block are likely to be carried from December to February (i.e. mainly during the nesting season). The operation is not anticipated to have a detectable effect on the turtle migration as the vessel will be operating for a short duration.

High noise level may cause:

- Disturbance to mating and nesting behaviour;
- Disturbance to turtle's mechanism for orientation (navigation) and affecting migration pattern;
- Increased swimming speed;
- Increased activity;
- Change in swimming direction.

F. Disturbance to Marine Mammals

Marine mammals include cetaceans, pinnipeds, and sirenians; pinnipeds are not common in the proposed survey area, dugongs (sirenian family) are present in the Andaman Sea but are unlikely to be found in the survey area due to the topography and water depth. Cetaceans are the group of greatest concern for this study and of these, baleen whales in particular, as their hearing range is optimised for exploiting low frequencies for long-distance communication.

Impacts due to acoustic disturbance can be categorised as by Richardson *et al.* (1995):

- Injury – loss of hearing (permanent threshold shift, PTS) and physical damage
- Temporary hearing impairment (temporary threshold shift,TTS)
- Behavioural response
- Masking
- Audibility

Physical damage to the auditory system of cetaceans may occur at noise levels of about 230 to 240 dB re 1µPa (Gausland 2000), which is equivalent to a distance of about 1-2 m from the energy source. Because of the swimming mobility of marine mammals and their avoidance of either the vessel or the airgun array, it is highly unlikely that any marine mammals will be exposed to levels likely to cause pathological damage (McCauley 1994).

Temporary threshold shift (TTS) affects an individual on a temporary basis but can turn into a permanent shift should the animal be exposed to the source of noise for a prolonged time. For this reason, SEL metrics are adopted to describe noise sources as well as the SPL metrics. Once an individual leaves the area and is no longer subject to the noise exposure, the auditory system will recover; however, the time of recovery is largely unknown and species dependant. Therefore, the impact of multiple exposures to a noise source at levels that can trigger TTS should be considered in and mitigated for.

Noise associated with airguns used during seismic surveys can cause significant behavioural changes in whales (McCauley 1994). Behavioural responses to airgun noise include swimming away from the source, rapid swimming on the surface and breaching (McCauley *et al.* 2003). The level of noise at which response is elicited varies between species and even between individuals within a species (Richardson *et al.* 1995). Stone (2003) suggests that different groups of cetaceans adopt different strategies for responding to acoustic disturbance from seismic surveys. It seems that in UK waters, the tendency of cetacean groups to show a response to noise from seismic airguns does not correlate directly with what might be expected based on their hearing abilities.

JNCC (Joint Nature Conservation Committee, 2015) recently published a review of marine mammal visual and acoustics observations in relation to seismic activity for surveys carried out over the past 16 years mainly around the UK. Key findings confirm that different marine mammal species are impacted to different extents. However, there is no clear split in impacts based on the functional hearing groups; some baleen whales alter their behaviour whilst others don't and the same applies to toothed whales. The main species affected are deep divers, such as beaked whales, sperm whales and blue whales.

The recent JNCC report "*Marine mammal observations during seismic survey from 1994-2010",* indicates that the response of marine mammals to airgun activity is likely to be very complex, involving many variables Based on observations in UK waters over a 16 year period, some responses of marine mammals to seismic surveys were evident; these responses did not correlate directly to their hearing abilities, as small and medium-sized odontocetes showed responses as well as some baleen whales.

It was observed that during surveys with 'large arrays' detection rates were significantly higher when the airguns were not firing for, for example, minke whale, all beaked whales combined or killer whale. Figure 7-1 presents the median closest distance of marine mammals from the airguns while firing or not. For all species, the median closest distances were bigger while firing than not firing. Baleen whales, for example, were observed within a kilometre when airguns were not firing whereas they were spotted at least 1,5km away from the airgun source when firing. Sperm whale did not come close to the airgun source no matter if firing or not - 2km away).

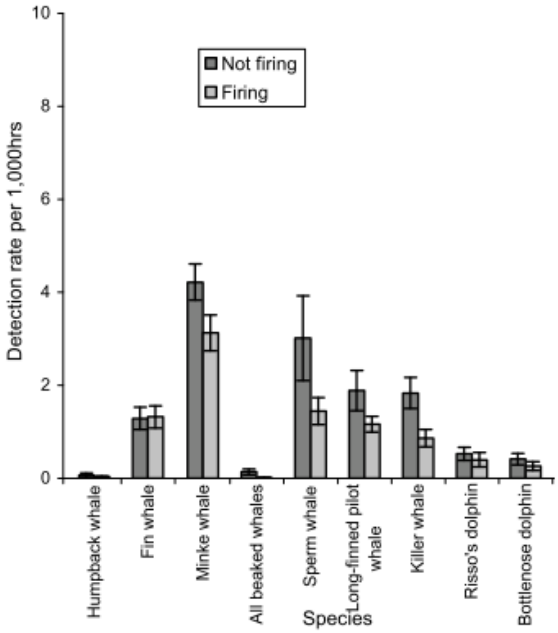


Figure 7-1 : Mean detection rates (and standard error) of marine mammals in relation to airgun activity on surveys with 'large arrays'. – Source: JNCC, 2015.

The JNCC report also notes that firing of 'large arrays' affected the movement of cetaceans around the vessel; significantly more pods avoided or travelled away from the vessel during periods when the airguns were firing compared to when they were not firing.

Some species (minke whales, bottlenose and beaked dolphins) were more often recorded as swimming fast when 'large arrays' were firing. All baleen whales (combined class) were more often recorded as swimming slowly when the airguns were not firing.

Bottlenose dolphins were more likely to breach or jump when the airguns were firing and white-beaked dolphins were more often recorded as splashing when the airguns were firing (often concurrent with fast swimming). There was no apparent effect of firing on the tendency of cetaceans to swim in close groups or more widely spread groups, nor was there any correlation with tail-slapping or spy-hopping.

Other effects on surfacing/ diving behaviours were noted. There were indications that cetaceans may remain close to the water surface (surfacing frequently, logging, apparently resting or milling) when 'large arrays' were active, although this was not a universal response. All cetaceans combined, all baleen whales combined and minke whales were more often recorded as surfacing frequently during periods when 'large arrays' were firing. Barkaszi et al (2012) found that sperm whales in the Gulf of Mexico surfaced more when airguns were at full power than when they were silent.

Most species were recorded as feeding less often when 'large arrays' were firing. Whilst the difference was not statistically significant for individual species, it was when all cetaceans were combined.

Table 7-4: Behaviour of marine mammals in relation to airgun activity (significant species) – source: JNCC, 2015.

Behaviour	Species	% of encounters while firing when behaviour was exhibited	% of encounters while not firing when behaviour was exhibited
Altered course	Minke whale	4.7	1.7
Avoidance or travel away from vessel/ equipment	Fin whales	24.3	14.6
	Minke whale	16.3	8.2
Breaching, jumping, somersaulting	Bottlenose dolphin	69.2	32.1
Diving	All delphinids combined	2.2	1.4
Fast swimming	Minke whale	20.5	8.2
	Bottlenose dolphin	46.2	18.9
Feeding	All cetaceans combined	8.2	10.3
Slow swimming	All baleen whales combined	19.0	24.2
Surfacing frequently	All cetaceans combined	1.6	1.0
	All baleen whales combined	4.8	2.2
	Minke whale	5.1	1.7

In general, cetaceans respond to airgun noise by avoiding the area and the soft-start technique appears to be an effective mitigation tool to elicit this response. Although, it is known that baleen whales will avoid operating seismic vessels, the distance over which the avoidance occurs seems to be highly variable between species and even within species. It is considered that this avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from nursery, resting or feeding areas, at an important period for the species. The M15 Block and adjacent waters are not known critical habitats for any cetacean species, but they could be present in the survey area.

Baleen Whales

Baleen whales are classed as low frequency cetaceans according to the Southall et al (2007). The peak of the noise emitted by air guns during seismic surveys is in the region of 100-200 Hz (low frequency).

Baleen whales produce a range of vocalisations at frequencies between 12 Hz to 8 kHz, depending on the species, but in most cases peak energy is below 1 kHz (McCauley 1994). This combined with studies of their hearing apparatus suggests that their hearing is also best adapted for low frequency sound (McCauley 1994; Richardson *et al.* 1995). All cetaceans exploit acoustics at all stages of their lifetime and use their sound emissions to communicate but also to 'sense' their environment; hearing is a crucial ability for cetaceans allowing them to navigate, find prey and coordinate with conspecifics which is not otherwise possible purely relying on their vision. Therefore, loss of hearing for a cetacean is considered to be lethal. Several mass

stranding of cetaceans have indeed been associated with their exposure to loud noise sources that have impaired their hearing causing them to become disoriented and stranded on beaches.

Baleen whales are estimated to have functional hearing within the range 7Hz to 22 kHz. As many anthropogenic sound sources are of low frequency it has often been assumed that baleen whales would be more vulnerable to disturbance from such sources than odontocetes. Seismic airguns, for example, produce peak energy at low frequencies up to about 200Hz (Gausland 2001; Gulland and Walker 2001). These low frequency sounds can travel long distances; for example, Nieukirk et al (2012) recorded airgun sounds in some cases almost 4,000km away from the source and Hildebrand (2009) noted that seismic sources contributed to low frequency ambient noise across ocean basins.

Table 7-5: Sounds produced by baleen whales that may be encountered during the proposed 3D seismic survey in the M15 Block

Species	Frequency (Hz)	Dominant frequency (Hz)	Estimated source level (dB re 1µPa.m)
Blue	12-31,000	16-25, 6,000–8,000	130–188
Humpback	25–8,200	25–4,000	144–192
Minke	60-20,000	60-12,000	151-175
Bryde's	70–950	700-900	152-174

Source: Richardson *et al*. (1995).

Toothed Whales

Toothed whales produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of toothed whale sounds excluding echo location clicks are mostly <20 kHz with most of the energy typically around 10 kHz, although some calls may be as low as 100 to 900 Hz. Source levels range from 100 to 180 dB re 1 µPa (Richardson *et al.* 1995). The sounds produced other than echo location clicks are very complex in many species and appear to be used for communication between members of a pod in socialising and coordinating feeding activities.

For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran *et al*. 2002). In their review, Gordon *et al.* (2004) considered the potential for TTS and concluded that the threshold for TTS was approximately 195 dB re 1 µPa. This is consistent with the review and calculations contained with Richardson and Moulton (2006) who considered the TTS threshold to be 192 to 202 dB re 1 µPa and reasonably consistent with the value presented by DEWHA (2008b) of 186 dB re 1 µPa. Seismic pulses with received levels of 186 dB re 1 µPa or more are usually restricted to a radius of no more than about 300 m around a seismic airgun array, therefore the potential for TTS is extremely low as it would be necessary for the whale to be <1 km from the airgun array and remain within this range as the vessel traversed a distance of 4-5 km.

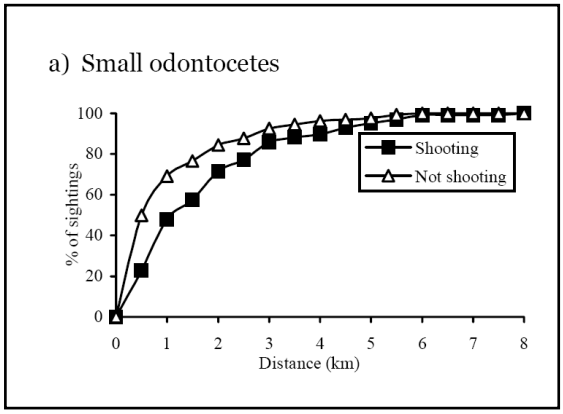
There is little systematic data on the behavioural response of toothed whales to seismic surveys. Richardson *et al*. (1995) reports that sperm whales appeared to react by moving away from surveys and ceasing to call even at great distances from a survey. However, in a 2003 study supported by the US Minerals Management Service (Jochens and Biggs 2003) two controlled exposure experiments were carried out (including one with three simultaneously tagged whales) to monitor the response of sperm whales to seismic source. The whales were exposed to a maximum received level of 148 dB re 1µPa. There was no indication that the whales showed horizontal avoidance of the seismic vessel nor was there any detected change in feeding rates of the tagged sperm whales.

Smaller toothed cetaceans have poor hearing in the low frequency range of airgun array noise (10 to 300 Hz) and seismic operators sometimes report dolphins and other small toothed whales near operating airgun arrays. However, there is a component of seismic pulses in the higher spectrum and in general most toothed whales do show some limited avoidance of operating seismic vessels. Goold (1996) studied the effects of 3D seismic surveys on common dolphins (*Delphinus delphis*) in the Irish Sea. The results indicated that there was

a local displacement of dolphins around the seismic operation. This observation is consistent with data compiled by Stone (2003) from marine mammal observers aboard seismic vessels in the North Sea that shows small toothed whale species tend to move away from operating airguns (see Figure 7-2).

The hearing capability of larger toothed whales (such as the killer whale) is unknown, but it is possible that they can hear better in the lower frequencies than the smaller toothed cetaceans. If this is the case, in lieu of any other information, their reactions to seismic survey vessels may be akin to those of the baleen whales.

It is considered that a potential adverse effect on toothed whales would only occur if the whale is within close range (i.e. less than a few hundred metres).



Source: Stone (2003).

Figure 7-2 : Proportion of marine mammal sighting occurring within specified distances of the airgun during seismic surveys

Mitigation and Management Measures

Due to the predicted or possible presence of marine mammals in the survey area, the following mitigation and management measures are recommended.

Adherence to JNCC guidance for seismic exploration (2010) is recommended because they are commonly adopted in countries that do not have their own guidance for mitigating the environmental impacts on marine mammals during anthropogenic activities. JNCC represents the most comprehensive and most recent guidance, and Artelia's recommendations are to adopt the following measures, which combine JNCC Guidance with our own calculations on distances for applying shut-down and power-down operations should sightings occur during survey.

- **Marine mammal observation** should be conducted starting 30 minutes before shooting until end of activities (or until dark). MMOs should be qualified to JNCC standard accreditation. Two observers should be on-board the survey vessel and each monitor 180 degrees of the field of view.
- **Passive acoustic monitoring (PAM)** should be carried out as a minimum during the night when visual observation is not possible but it is also strongly recommended to use PAM in case of low visibility during daylight hours. Use of PAM is necessary to provide information about presence/absence of marine mammals during the night, when visual surveys cannot be carried out. Even if PAM has its limitations, it is a highly valuable tool that has been shown not to lead to false positive observations of presence, nor to more shut-downs. The recent review conducted by JNCC (2015) showed that the amount of shut-downs based on visual surveys were comparable to those from acoustic surveys. Whilst PAM is not effective for some species that rarely vocalise, it is a useful method to detect sensitive species that could well be encountered in the area, i.e. beaked whales, sperm whales, and dolphin species.

The fact that no data is available on the abundance and distribution of marine mammals in the proposed survey area is in itself a reason why both MMO and PAM should be implemented: no data is available to rule out the chance that species may be present in this area nor evidence that they only utilise the area during a particular time of the day. Therefore, a precautionary approach should be applied to allow the detection of the

presence of marine mammals throughout 24/7 operations. In order to maximise the efficiency and quality of the data collected using acoustic data, the PAM operator should be qualified and have a minimum of 5 years' experience.

- **Soft-start procedure**, i.e. gradual increase of power and frequency of shooting over a 30 minute period, to be implemented as a warning to marine fauna that may be present in the area to allow time to leave the area in the immediate proximity of the survey area. If a whale is sighted within or is about to enter the low power zone, the acoustic source should be powered down to the lowest possible setting (e.g. a single gun). If a whale is sighted within, or enters the shutdown zone, the acoustic source should be shut down completely.
- **A shut down zone of 500 m** will be enforced by the MMO/PAM, meaning that if any marine mammal is observed within a 500m radius from the centre of the airgun array, shooting should be immediately halted. Resuming soft start procedures should only occur after the whale has been observed to move outside the low power zone, or when 30 minutes have lapsed since the last whale sighting.
- MMOs/PAM will observe an area of 3km radius and if within this area an observation occurs, then **the power down procedure** should be implemented as follows:
    - Within 3km: If a whale is sighted within the 3km observation zone the operator of the acoustic source will be placed on stand-by to power down the acoustic source. An additional trained crew member or MMO should also be brought to the bridge to continuously monitor the whale whilst in sight.
    - Within 2km: If a whale is sighted within or is immediately approaching the low power zone the acoustic source should be powered down to the lowest possible setting.
    - Within 500m: If a whale is sighted within or enters the shutdown zone the acoustic source should be shut down completely.
- As a precautionary measure the same procedures will be applied should whale sharks and turtles be observed.
- All cetacean, whale shark and turtle sightings will be recorded by the MMO.
- The MMO will prepare a report on all marine fauna sightings following completion of the survey. Copies of this report will be provided to the Ministry of Environment, Conservation and Forestry (MOECAF), and to other stakeholders, if required.

The implementation of specific whale monitoring and interaction procedures will be used to minimise the potential for any adverse effects to marine mammals. It should be noted that some of these measures, such as soft starts, also mitigate against potential impacts on other fauna such as marine turtles and fish, which will take avoidance behaviour.

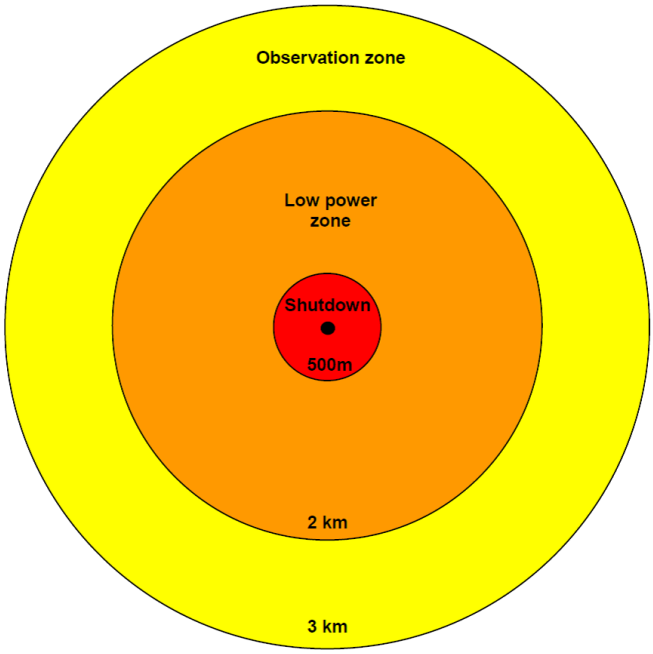


Figure 7-3: Precaution zones surrounding the acoustic source

The key role of the MMOs will be to visually monitor the waters around the survey vessel for the presence of cetaceans, turtles and whale sharks during daylight hours. The lead MMO will be responsible for ensuring that the interaction procedures are implemented and followed correctly during survey activities. The MMOs will also be responsible for recording any cetacean, turtle and whale shark sightings during the survey on the appropriate sightings forms. The MMO will be required to compile a Final Report following completion of the survey. This report will include all marine fauna sighting records, plus records of any whale-instigated delays to commencement of soft start procedures. The MMO Final Report will be provided to the MOECAF, and also to other stakeholders, if required.

Residual risk level

The residual risk ranking for this potential impact is **Medium** (see Table 7-7) after applying mitigation measures.

7.1.1.2. Light Generation

Lighting on the survey, support and chase vessels, is required for safe navigation and work practices at night, and has the potential to create light pollution. This may subsequently affect some marine species, primarily seabirds and turtles.

A. Potential Impacts

Artificial lighting has the potential to affect marine fauna, notably marine turtles. Behavioural responses to light can alter foraging and breeding activity in turtles, seabirds, fish and dolphins, conferring competitive advantage to some species and reducing reproductive success and/or survival in others.

Light pollution reaching nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin 2003). Innate sea finding relies on light cues that include horizon brightness, shape and colour (Salmon *et al*. 1992; Salmon 2003).

Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may ‘entrap’ hatchling swimming behaviour,

reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al*. 1992).

The potential for lighting from the survey vessels to disorientate or attract turtle hatchlings during the M15 Block 3D seismic survey is likely to be negligible. The closest turtle nesting sites to the survey area are located at least 40km away. Additionally, the vessel will be moving continually, albeit at a low speed, and consequently the effects of artificial lighting are likely to be less than for a stationary source, such as a drilling rig, or fixed platform facility.

Owing to their migratory habits, all five species of turtle that occur in Myanmar have the potential to be present in M15 Block and surrounding waters. The density of animals within and in the vicinity of the survey area is likely to be low. Therefore the probability of artificial light impacts on turtles is also low.

It is possible that seabirds may fly over the 3D survey area. However, it is not anticipated that the survey activities will have any impact on any species of seabird, due to their mobility and distance from the survey area to any nesting sites for seabirds (>40km distance away).

The potential impacts to other marine fauna of light emissions from survey vessels is expected to be restricted to localised attraction, temporary disorientation and increased predation and as such, any impacts arising from light emissions are considered to be minor and localised to a small proportion of the population.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks to marine fauna associated with the light generation are reduced:

- External lighting of vessels will be minimised to that required for safe navigation, vessel safety and safety of deck operations, except in the case of an emergency.
- Night time inspections should avoid unnecessary lighting when possible

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.1.3. Vessel and Towed Equipment Interactions with Marine Fauna

The survey, support and chase vessels working within, and travelling to and from, the survey area in the M15 Block may present a potential physical hazard (e.g. animal displacement or vessel strike) to marine fauna including whales, dolphins, whale sharks and turtles. Additionally, there is a potential risk of turtles becoming trapped in the tail buoys that are attached to the end of each seismic streamer.

A. Potential Impacts

The impact from vessel interactions with marine fauna ranges from a minimal impact as behavioural changes to severe impacts such as mortality resulting from vessel strikes. Vessel collisions contribute to the mortality of marine fauna, notably turtles (Lutcavage *et al.* 1997; Hazel and Gyuris 2006; Hazel *et a*l. 2007) and large cetaceans (Knowlton and Kraus 2001; Laist *et al.* 2001; Jensen and Silber 2003). Vessel traffic has severely affected North Atlantic right whales (*Eubalaena glacialis*), for which collisions have been identified as a major source of mortality (Knowlton and Kraus 2001), Stranding records for Queensland, indicate that 14% of dead marine turtles had been struck by vessels (Hazel and Gyuris 2006). These records are largely from populated areas of the state and comprise an unknown proportion of the total mortality.

Marine seismic surveys involve the use of two or more vessels travelling at slow speed (around 4 knots) along defined paths. As described in Section 5.3.1.1, the M15 Block and surrounding waters do not overlap known critical habitat for any cetacean or turtle species. Therefore, it is unlikely that significant numbers of whales, dolphins, turtles or whale sharks will be encountered during the survey.

Turtle entrapments with streamer tail buoys can lead to mortalities (Ketos Ecology 2007, 2009). This has been an issue particularly for marine seismic surveys off the west coast of Africa. In recent years, geophysical

acquisition companies and seismic contractors have been designing and implementing turtle exclusion devices ("turtle guards")—modifications to the tail buoys that minimise the potential for turtle entrapment. The tail buoys used by the survey vessels are fitted with turtle guards.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks to marine fauna associated with vessel and towed equipment interactions are reduced:

- Application of vessel-marine fauna interaction procedures;
- Use of streamer tail buoys fitted with appropriate turtle guards;
- Any vessel or towed equipment interactions with marine fauna (cetaceans, turtles or whale sharks) will be recorded and reported, via the MMO Final Report.

Vessel-marine fauna interaction procedures have been prepared to ensure any interactions between the support and chase vessels and cetaceans, whale sharks and turtles. These procedures, in the form of an action flowchart, are presented as Figure 7-4 below and will be distributed to the Masters of the support and chase vessels, and crews will be made aware of these requirements at induction prior to commencement of the 3D seismic survey in the M15 Block.

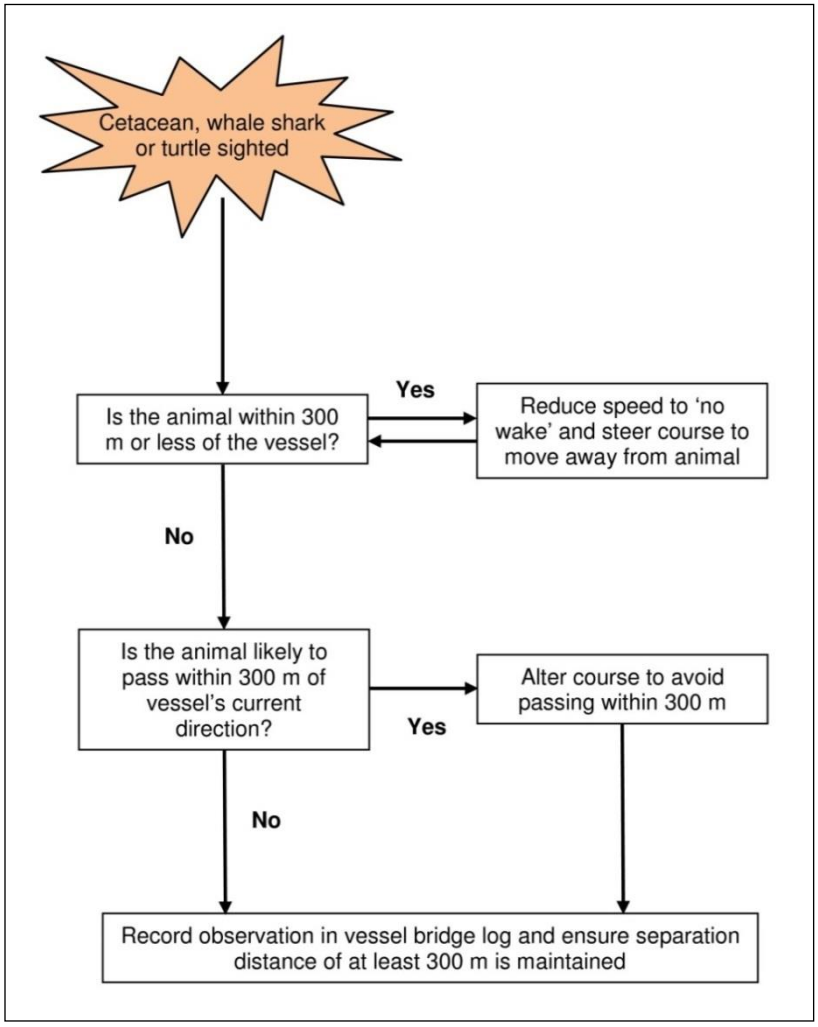


Figure 7-4: Vessel-marine fauna interaction procedures

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7**).**

7.1.2. Disturbance to Benthic Habitats

7.1.2.1. Vessel Anchoring

The potential and significance of impacts caused by anchoring is dependent on the type of receiving environment, the size of the anchor and chain and the frequency of anchoring. Vessel anchoring that takes place in inshore, shallow water areas has the potential to cause physical disturbance and damage to sensitive benthic habitats (e.g. hard and soft corals, fan corals, sponges, calcareous algae, seagrasses etc.).

Water depths in the M15 Block range from ~200m to ~2,000m. Therefore, no anchoring of the survey, support or chase vessels will occur during the survey.

7.1.2.2. Loss of Towed Equipment

A. Potential Impacts

In the unlikely event of loss of a solid seismic streamer, potential environmental effects will be limited to localized physical disturbance of substrates, benthic habitats and communities from the cable and associated equipment sinking to the seabed. Seismic streamers and vanes are fitted with pressure-activated, self-inflating buoys that are designed to bring the equipment to the surface if lost accidentally during a survey. As the equipment sinks it passes a certain water depth at which point the buoys inflate and bring the equipment back to the surface where it can be retrieved by the survey, support or chase vessels.

Lost equipment, such as a streamer and associated birds and tail buoys, could also cause potential impacts on other marine users of the survey area and surrounding waters, such as fishing activities and shipping.

B. Management and Mitigation Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks to benthic habitats and communities from equipment loss are y reduced:

- Experienced operators and crew will be used to minimise the risk of equipment loss.
- Where possible in-water equipment lost will be recovered.
- Detailed records of equipment lost overboard will be maintained.
- Detailed records will be maintained of all incidents involving equipment dragging or loss. If the incident involves loss of a streamer and associated equipment (birds, paravanes, tail buoys) it will be reported to the relevant authorities in Myanmar (e.g. MOECAF, the DMA and the Myanmar Navy).

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.3. Reduced Air Quality from Atmospheric Emissions

Atmospheric emissions from the proposed 3D seismic survey in the M15 Block include greenhouse gas (GHG), NOx (nitrogen oxide), SOx (sulphur oxide), CO (carbon monoxide) and particulate matter (dark smoke) emissions from:

- use of survey, support and chase vessel main engines for propulsion;

- use of survey, support and chase vessel main and emergency power generation equipment;
- use of marine gas oil by the survey vessel's workboat; and
- incineration of oily sludge aboard the survey and support vessel.

7.1.3.1. Potential Impacts

Potential environmental effects from these atmospheric emissions are a contribution to GHG emissions (albeit very minor) that may potentially influence climate change, and a localised reduction in air quality. Atmospheric emissions generated during the survey will result in a localised, temporary reduction in air quality. Incineration of oily sludge and other materials in vessel incinerators is not expected to generate any significant atmospheric emissions, due to the infrequent nature of the activity and the small volumes of material being burnt during each disposal episode.

7.1.3.2. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks from vessel atmospheric emissions are reduced:

- Adherence to MARPOL 73/78 Annex VI requirements:
  - optimisation of fuel use to increase efficiency and minimise emissions;
  - record and monitor fuel resources in order to prevent its excessive consumption;
  - perform regular maintenance of engines and power generation;
  - use of low sulphur fuel when it is available to minimise emissions from combustible sources; and
  - emissions managed by the implementation of a planned maintenance system (PMS).
- Implementation of a Ship Energy Efficiency Management Plan (SEEMP) for the survey vessel (MARPOL 73/78 Annex VI requirement from 1 January 2012).
- There are no sensitive receptors (i.e. concentrated fishing activity, coastal communities, populated areas) within or in the vicinity of the M15 Block and surrounding waters.

7.1.3.3. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.4. Introduction of Invasive Marine Species

Invasive Marine Species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish founder populations. Not all marine species introduced into an area will thrive and therefore have the potential to establish themselves as a pest. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means.

Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities.

IMS have been introduced and translocated in various locations around the world by a variety of natural and human means including for example, discharge of ballast water, biofouling, aquaculture operations and aquarium imports.

In the case of the proposed 3D seismic survey in the M15 Block offshore Myanmar, the key vectors requiring management attention include:

- biofouling on vessel hulls and other external niches (e.g. propulsion units, steering gear and thruster tunnels);
- biofouling of vessel internal niches (e.g. sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces etc.);
- biofouling on equipment that routinely becomes immersed in water; and
- discharge of high risk ballast water taken up at international or domestic sources.

Once introduced IMS can cause serious environmental, social and economic impacts through predation or displacement of native species. These direct or indirect impacts also have the potential to threaten a range of sectors including:

- fisheries and aquaculture;
- tourism industry;
- human health;
- shipping; and
- infrastructure.

Following their establishment eradication of IMS populations is often impossible, limiting management options to ongoing control or impact minimisation. For this reason increased management requirements have been implemented in recent years' regulatory agencies with further legislation currently under development. Reducing the risk of IMS introduction and establishment represents by far the most effective and cost-efficient means of managing the threat of IMS introduction.

7.1.4.1. Ballast Water

A. Potential Impacts

Ballast water which may potentially harbour invasive marine species can be released by survey and support vessels during marine seismic surveys. Once introduced IMS can cause serious environmental, social and economic impacts through predation or displacement of native species. These direct or indirect impacts have the potential to threaten a range of sectors including fisheries and aquaculture, the tourism industry, human health, shipping and infrastructure.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks of IMS associated with ballast water discharge are reduced:

- the survey and support vessel will not routinely discharge ballast water; and
- recording (in vessel engine room log) of any non-routine ballast water discharges.

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.4.2. Biofouling

A. Potential Impacts

Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS.

The potential biofouling risk presented by the survey and support vessel for the 3D seismic survey in the M15 Block will relate to the length of time that these vessels have already been operating in waters of Andaman Sea or, if they have been operating outside the region, the location/s of the surveys they has been

undertaking, the length of time spent at these location/s, and whether the vessels have undergone hull inspections, cleaning and application of new antifoulant coating prior to transiting to Myanmar to conduct the M15 Block 3D seismic survey.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during prior to the 3D seismic survey in the M15 Block to ensure that the impacts and risks of IMS associated with biofouling are reduced:

- the survey and support vessels will have had a recent dry dock, IMS inspection, hull and other niche cleaning and antifoulant application.

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.5. Marine Pollution from Routine Discharges

Risks to marine environmental resources in the M15 Block (and adjacent areas) from routine discharges are considered to be negligible given that all wastes, other than sewage, grey water and putrescible wastes (food scraps), will be incinerated aboard the survey and support vessels or compacted and disposed of onshore.

7.1.5.1. Sewage, Grey Water and Putrescible Wastes

During the 3D seismic survey in the M15 Block, the survey, support and chase vessels will routinely discharge sewage, grey water (comprising laundry, shower and sink water) and putrescible wastes (comprising of food scraps) to the ocean in accordance with the requirements of the MARPOL 73/78 Convention. It is anticipated that the estimated amount of sanitary wastes (including black and grey waters) is 2,097m^3 for the duration of the survey.

A. Potential Impacts

Routine discharge of wastewater to the ocean will cause a negligible and localised increase in nutrient concentrations in water column and sediments. The total nutrient loading from vessel operations during the 3D seismic survey in the M15 Block will be insignificant in comparison to the natural daily nutrient flux that occurs within the region.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks associated with routine discharge of sewage, grey water and putrescible wastes are reduced:

- All sewage and putrescible wastes will be handled and disposed of in accordance with MARPOL 73/78 Annex IV, including:
    - discharge of sewage and putrescible waste will be of short duration with high dispersion and biodegradability;
    - all sewage and putrescible waste treatment systems and holding tanks are to be fully operational prior to survey commencement; and
    - the survey and support vessels will have certified and approved sewage treatment plants that meet relevant International Maritime Organisation (IMO) requirements.
- All effluents must be clearly identified;
- Sewage and putrescible wastes macerated where possible prior to disposal.

- Sewage and putrescible wastes must be passed through a grinder or comminuter and a disinfection system. The final product is small enough to pass through a screen of less than 25 mm diameter prior to disposal to the sea.
- Discharge of sewage which is not comminuted or disinfected will only occur at a distance of more than 12 nautical miles (nm) from the nearest land. Untreated sewage will not be discharged instantaneously, but only when the vessel is en route and proceeding at a speed not less than 4 knots.
- Discharge of sewage which is comminuted or disinfected using a certified and approved sewage treatment plant will only occur at a distance of more than 3 nm from the nearest land.
- If vessels are unable to treat/store grey water (i.e. wastewater from sinks and showers) only biodegradable soaps and detergents will be used, where possible.
- Discharges of sewage and putrescible wastes will be recorded in the survey and support vessel engine room logs.

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.5.2. Bilge Water

The survey and support vessels may need to discharge bilge water during the 3D seismic survey in the M15 Block. The estimated amount of bilge and deck water is 952m^3 for the duration of the survey.

A. Potential Impacts

Bilge tanks receive fluids from many parts of the vessel. Bilge water can contain water, oil, dispersants, detergents, solvents, chemicals, particles and other liquids, solids or chemicals. This can cause a localised reduction in water quality if not treated prior to discharge.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks associated with routine discharge of bilge water are reduced:

Bilge water will be treated and disposed of in accordance with MARPOL 73/78 Annex I.

Blige and deck waters have to be collected through an oily separator on board;

Bilge water contaminated with hydrocarbons must be contained and disposed of onshore, except if the oil content of the effluent without dilution does not exceed 15ppm.

Bilge water contaminated with chemicals must be contained and disposed of onshore, except if the chemical is demonstrated to have a low toxicity (as determined by the relevant Material Safety Data Sheet [MSDS]).

Discharges of bilge water will be recorded in the survey and support vessel engine room logs.

7.1.5.3. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.5.4. Other Wastes

The survey, support and chase vessels will also produce a variety of other solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard.

A. Potential Impacts

These materials could potentially impact the marine environment if accidentally released in significant quantities resulting in a reduction in water quality and physical impacts on marine fauna, for example marine fauna (e.g. fish, turtles and seabirds) can ingest or become entangled in waste plastics.

If food wastes are thrown overboard, it will potentially attract school of fish in surface near the boat. Fish presence involves predator presences or birds.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in M15 Block to ensure that the impacts and risks associated with routine handling and disposal of garbage are continuously reduced:

- Garbage will be disposed of in accordance with MARPOL 73/78 Annex V. Food waste need to be milled on vessels (crushed <25mm and discharged more than 3 miles away of the shore.
- Survey and support vessel Garbage Management Plans in place detailing wastes generated and disposal requirements.
- No discharge of plastics or plastic products of any kind from vessels in accordance with MARPOL requirements.
- No discharge of domestic wastes (i.e. cans, glass, paper or other wastes from living areas) or maintenance wastes (i.e. paint sweepings, rags, deck sweepings, oil soaks, machinery deposits) overboard from vessels.
- All waste receptacles aboard the survey and support vessels will be covered with tightly fitting, secure lids to prevent any solid wastes from blowing overboard. This is a standard operating procedure (SOP) for both vessels.
- Application of Handling and Storage of Dangerous Products Procedures for both the survey and support vessels.
- All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) will be incinerated or compacted (if possible) and stored in designated areas and sent ashore for recycling, disposal or treatment.
- Incinerators used aboard the survey and support vessel will be compliant with MARPOL and IMO requirements.
- Incinerators will be operated in accordance with established operating procedures that align with manufacturers specifications by trained personnel.
- Records will be maintained in the engine room log of incinerator usage.
- Incineration of any oil sludge aboard the survey or support vessels, or disposal of any oil sludge/slops in port, must be recorded in the vessel's Oil Record Book (a requirement under MARPOL 73/78).
- All storage facilities and handling equipment will be in good working order and designed in such a way as to prevent and contain any spillage as far as practicable.
- Vessel Waste Logs will be created and maintained to record quantities of wastes transported to shore.
- Detailed records of waste accidentally discharged will be maintained.

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.6. Marine Pollution from Accidental Discharges

7.1.6.1. Hazardous Materials

The survey, support and chase vessels store and use a variety of hazardous materials such as lubricating oils, cleaning chemicals and lithium batteries.

A. Potential Impacts

These materials have the potential to adversely impact the marine environment if accidentally released in significant quantities. The potential effects include a reduction in water quality and toxic effects on marine flora and fauna. Chemicals e.g. solvents and detergents will typically be stored in small containers of 5-25 litre capacity and stored / used in internal areas where any leak or spill would be retained on board and cleaned up in accordance with the Shipboard Oil Pollution Emergency Plan (SOPEP) and associated spill clean-up procedures. Some spills may occur when small containers of chemicals are being used in open areas, where there is a risk of some entering the sea if spilled. The realistic worst case volume would be 25 litres.

B. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks associated with accidental discharge of hazardous materials are continuously reduced:

- Harmful Packaged Substances will be handled and disposed of in accordance with MARPOL 73/78 Annex III.
- All chemical and hazardous wastes will be segregated into clearly marked containers prior to onshore disposal.
- All storage facilities and handling equipment will be in good working order and designed in such a way as to prevent and contain any spillage as far as practicable.
- The survey and support vessels have implemented and tested SOPEP, and copies are kept aboard both vessels.
- All hazardous substances (as defined in NOHSC:1008 [2004] – Approved Criteria for Classifying Hazardous Substances) will have MSDS in place that is readily available on board.
- Spill response bins/kits will be located in close proximity to hydrocarbon storage areas for prompt response in the event of a spill or leak. The kits will be checked for their adequacy and replenished as necessary prior to the commencement of activities and on a regular basis thereafter. Identified personnel will be trained in use of this equipment.
- Detailed records will be maintained of all accidental releases/discharges of hazardous materials.

C. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.1.6.2. Fuel and Oil Spills

The hazards associated with fuel and oil spills during the 3D seismic survey in the M15 Block (that are considered most credible) are:

- on-deck leak or spill of small quantities (up to 50 litres) of hydraulic oil or lubricating oil;
- loss of up to 125 litres of marine gas oil (diesel) during refuelling operations, as a result of hose failure;
- loss of up to 200m^3 from tank overflow during refuelling; and
- Fluid from damaged streamer in case of collision between seismic boat and another boat or animal.

A. Potential Impacts

The accidental discharge of fuel and oil has the potential to cause toxic effects on marine fauna and flora and a localised reduction in water quality. Potentially affected biota includes seabirds, cetaceans, turtles and whale sharks that may come into contact with a surface hydrocarbon slicks.

B. Assessment of Likelihood

In an ESRA, the likelihood component of the assessment is a function of the event occurring and subsequently affecting a sensitive resource (i.e. having an impact). For a hydrocarbon spill, the likelihood is a combination of:

- the probability of a spill occurring, and the volume of that spill at source (primary risk); and
- the probability of a spill reaching a sensitive part of the environment (secondary risk).

The size of potential hydrocarbon spills on the decks of the survey and support vessels is likely to be less than 50 litres (based on shipping industry leak frequency analyses). This quantity relates primarily to the capacity of storage containers commonly used, plus volumes of hydraulic oil in hoses in equipment. In the case of deck spills, most of the spilt material is likely to be contained with bunds or containment lips installed to prevent discharge to sea. Portable containers used on the vessels for storage of oil range in size from less than a litre up to 200 litre (drums). Some spills may occur when small containers of oil are being used in open areas, where there is a risk of some entering the sea if spilled. Larger containers up to 200 litres may be used for oils such as engine lubricating oil, however, these will always be used and stored in internal and/or bunded areas where any spill or leak would be fully contained aboard.

The realistic worst case volume of diesel spilled during refuelling operations is 125 litres, arising from the total loss of the contents of the transfer hose (e.g. 3” hose of 28 m length) during refuelling. Dry break couplings would prevent any more than the hose volume being spilled in the event of hose failure. In reality, a more likely scenario is a pin hole leak or a large hole in the hose (from abrasion or mechanical damage), resulting in a highly visible sheen on the sea surface enabling action to be taken to stop the leak (by the operation supervisors) before more than a few litres had been spilled.

The volume of a tank overflow spill during refuelling is limited to less than or equal to 200 m^3 – the maximum quantity of diesel which will be transferred during bunkering/refuelling operations.

MGO is a light petroleum distillate that, given the high energy and warm water environment that prevails in the proposed area of operations, is expected to undergo rapid dispersion and evaporation:

- Diesel on the sea surface will spread very rapidly with the slick elongated in the direction of prevailing wind and waves.
- The speed of physical dispersion and evaporation of the surface slick increases with wind speed. Up to 95% of a slick may disperse within about 12 hours of the spill in 15 knot winds, warm air and sea conditions—based on an oil budget graph calculated using the ADIOS2 (Automated Data Inquiry for Oil Spills) oil weathering model.
- Evaporation is likely to account for 25-30% of the loss, will be enhanced due to the warmer prevailing air and sea temperatures

C. Marine Fauna impacts

The potential effects of a hydrocarbon spill on the marine environment varies greatly depending on factors such as the weather and sea state at the time of release, response measures, and the sensitivities of the habitats and species potentially affected. In the open ocean habitat where most survey activities will occur any spilled diesel fuel would be subject to rapid dispersal, weathering, evaporative losses and dissipation throughout the water column. Potentially affected biota includes seabirds, cetaceans, whale sharks and turtles that may come into contact with a surface diesel slick in the period prior to disappearance of these slicks due to natural dispersion and evaporation. Contact with hydrocarbon slicks can have lethal or sub-lethal physical and toxic effects to seabirds, cetaceans, whale sharks and turtles due to external and internal exposure.

The elevated concentrations of dissolved aromatic hydrocarbons associated with surface diesel slicks would likely be acutely toxic to pelagic organisms present in surface waters in the area of a major diesel spill. However, due to the characteristics of diesel and its rapid natural degradation and dispersion in the open ocean, the temporal and spatial extent of any adverse effects is likely to be limited. Air breathing fauna including cetaceans and turtles would be at greater risk through inhalation of hydrocarbons if they surfaced within a fresh slick, although the extent and duration of potential exposure would be limited due to the rapid evaporation rates for volatile components of diesel. Seabirds are particularly vulnerable to hydrocarbon spills owing to the high potential for contact with the sea surface or shoreline where they feed, rest or moult. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour.

Marine turtles are vulnerable to the effects of hydrocarbon spills at all life stages (eggs, post hatchlings, juveniles and adults) whilst in the water or onshore (NOAA 2010). Contact with hydrocarbons can have lethal or sub-lethal physical or toxic effects or impair mobility. Marine turtles are in frequent contact with the sea surface and they may also feed at or below the water surface or rest at the surface. This frequent contact with the sea surface and a lack of avoidance behaviour makes turtles susceptible to coating with spilled hydrocarbons and inhalation of toxic hydrocarbon vapours. On contact with surface slicks, turtles may experience irritation and injury to airways or lungs, eyes and mucous membranes of the mouth and nasal or other cavities (NOAA 2010).

The low viscosity of diesel results in ready dispersion in the water column when winds reach 5-7 knots or with breaking waves and as the diesel is lighter than water, it remains as a slick on the sea surface (NOAA 2012). Cetaceans may come into contact with diesel at the sea surface as they swim through the surface slick and through ingestion, although birds are more susceptible to surface oiling and ingestion through preening their feathers (NOAA 2012).

While surface slicks and entrained diesel have the potential to impact individual seabirds, cetaceans, whale sharks or turtles, significant mortalities are considered unlikely given the low density of seabirds, cetaceans, whale sharks and turtles within the zone of potential impact.

The M15 Block and surrounding waters does not contain critical habitat for any cetacean or turtle species, or for whale sharks.

D. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks associated with accidental discharge of fuel and oil are continuously reduced:

- Adherence to the requirements of the International Regulations for Preventing Collisions at Sea 1972 (COLREGS).
- If at sea refuelling of the survey vessel is required during the survey, it will only take place at a distance of >12 nm from any shore
- Refuelling at sea will follow standard operating procedures, plus the following additional measures:
    - refuelling of the survey vessel will be undertaken under favourable wind and sea conditions as determined by the vessel Masters;
    - refuelling will take place during daylight hours only;
    - Job Hazard Analysis (JHA) or equivalent in place and reviewed before each fuel transfer;
    - all valves and flexible transfer hoses checked for integrity prior to use; and
    - dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses.
- Activation of the survey and support vessel SOPEP in the event of fuel/oil spills.
- SOPEP drills will be conducted aboard the survey and support vessels.

- Response strategy for diesel spills to the ocean will be to allow small spills to disperse and evaporate naturally, and monitor the position and trajectory of any surface slicks. Physical break up (using propwash from the support vessel) by repeated transits through the slick may be considered for larger slicks.
- Hydrocarbons located above deck will be stored with some form of secondary containment to contain leaks or spills e.g. bund, containment pallet, transport packs etc.
- Detailed records will be maintained of all fuel and oil spills. Any spills >80 L will be reported to MOECAF and to other relevant stakeholders in Myanmar.

E. Residual Risk Level

The residual risk ranking for this potential impact is **Medium** (see Table 7-7).

7.1.6.3. Vessel Collisions

A. Potential Impacts

The potential environmental impact as a result of a significant vessel collision could cause localised chronic/acute toxicity effects on marine organisms from a hydrocarbon spill. However, it is highly unlikely that such a collision would occur during the 3D seismic survey in the M15 Block, as the survey and support vessels will be required to adhere to standard maritime safety and navigational procedures, such as use of lights, beacons, etc. and notification of vessel presence via Notice To Mariners (NTM), radio contact and through the use of chase vessels.

The fuel to be used by the survey vessel is marine gas oil (MGO; diesel). Therefore, in the extremely unlikely (improbable) event of a ruptured fuel tank as a result of collision, the maximum spill size possible would be in the order of ~200 m^3 of MGO. However, this could only occur in the event of a rupture of one of the vessels largest MGO tanks and complete loss of all of its contents. The volume of the fuel lost to the marine environment would be expected to be less than the total capacity of the tank due to:

- the MGO tanks are never filled to maximum capacity;
- if the tank was holed below the water line, then it would only leak down to a level equivalent to the water line, and
- emergency procedures would be carried out to transfer the contents of the tank to other MGO tanks aboard the vessel.

B. Assessment of Likelihood

During a seismic campaign, disturbances to commercial marine traffic are caused by the physical presence and movements of the survey vessel and the chase/supply boats. Indeed, their presence can cause collision with all kind of ships, including commercial ships. Unlike for fixed facilities, there are no requirements for a formal safety zone to be established around seismic vessels.

Aside from applying the general maritime rules (in order to avoid collision between vessels), navigation restrictions will have to be implemented. Ships have to be excluded from the operational area of the seismic in order to limit the risks. This exclusion may cause a rerouting of the vessels that usually cross the seismic survey area to reach their port of destination.

The likelihood of a vessel collision resulting in a large diesel spill is low. A collision between the survey vessel and another vessel unconnected with the activity is unlikely, given the comprehensive control and mitigation measures in place to manage the risk of vessel collisions. Vessel collision spill risk levels from the proposed survey are no different from those presented by any other routine shipping operating in the waters offshore Myanmar.

The United-States BSEE statistician (Bureau of Safety and Environmental Enforcement) provides general statistics and summaries of OCS (Outer Continental Shelf) incidents reported by year. Some case of spillage

and collisions were recorded by BSEE between 2007 and 2012 in the Gulf of Mexico Region and the Pacific Region.

Table 7-6: OCS collisions/spillage 2007-2012

Source: BSEE Database as of January 2013

Type	2007	2008	2009	2010	2011	2012
Number of spills > 50 Barrels						
Crude Oil & Natural Gas Condensate	1	19	4	2	1	1
Synthetic-Based Fluids	2	2	4	2	2	3
Chemicals, e.g., Zinc, Bromide, Glycol, Methanol	1	12	3	1	0	4
Total for the year	**4**	**33**	**11**	**5**	**3**	**8**
Collisions						
Total for the year	21	22	29	8	14	7

The various fluid spillages are specific to exploration or production drilling activities and cannot be bound to seismic operation. Between 2007 and 2012, 28 hydrocarbons spillages were recorded by BSEE. They are all recorded during drilling or production activities. **No spills were recorded during seismic activities. Collisions represent less than 2% of the totality of incident**. The main types of incidents reported are injuries (47%) and varied incident (26%).

C. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M15 Block to ensure that the impacts and risks associated with vessel collision are continuously reduced:

- Prohibiting access to the work area for other vessels
- Adherence to the requirements of the COLREGS.
- Shipboard Oil Pollution Emergency Plan (SOPEP) as required by MARPOL
- Use of chase vessels to warn other vessels/shipping of the navigation hazard posed by the survey vessel and towed streamer array.
- The survey, support and chase vessels will use modern and approved navigation systems and experienced bridge crew.
- Adherence to standard maritime safety / navigation procedures—e.g. issuance of NTM.
- Trained team to ensure proper response to spills
- On board antipollution equipment
- Display of appropriate navigational beacons and lights, radar watch, radio contact.
- Detailed records will be maintained of all vessel collision incidents.
- Any vessel collision incidents will be reported to the appropriate authorities in Myanmar (e.g. MOECAF, the DMA and the Myanmar Navy).

D. Residual Risk Level

The residual risk ranking for this potential impact is **Medium** (see Table 7-7).

7.2. SOCIO-ECONOMIC IMPACT ASSESSMENT

As assessed by the analysis of sensitive components, the two social components that could be impacted by the project are the commercial marine traffic and the offshore fishery sector.

7.2.1. Disturbance to fishing activities

7.2.1.1. Potential impacts

As described in Table 6-2, there is likely to be a moderate to high level of activity in the offshore, industrial fishery sector within or adjacent to the M-15 Block, most of which will probably be tuna long-lining conducted by Burmese vessels (as foreign fishing fleets are now prohibited from operating in Myanmar waters).

As discussed in section 7.1.1.1.D, impacts of seismic survey on fish catches are difficult to determine and may vary depending on several factors. As these effects do not extend over the long term, they are unlikely to translate into any significant economic impact for fishermen.

The physical presence of boats and cables is however more likely to cause various disturbances to fishermen such as:

- restriction of access to fishing grounds due to vessel movements and operations;
- seismic equipment loss and subsequent interference with fishing gear (entanglement);
- damage to or loss of fishing gear (e.g. long-lines, buoys, ropes, static fish traps, etc.);
- the risk of collision should not be underestimated. This could result in damages and casualties, especially if the fishing boats are in unseaworthy conditions.

7.2.1.2. Mitigation and Management measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M-15 Block to ensure that the impacts and risks to small-scale fisheries activities are continuously reduced to ALARP:

- Adherence to the requirements of the COLREGS.
- Notification of survey details, as required, to the Department of Fisheries (DoF) and other key fisheries stakeholders such as the local branch of MFF in Tanintharyi State, to inform them about the location of the survey area and timing of operations, and to ascertain if proposed operations overlaps any key fishing grounds or activities.
- Preparation of simple flyers on the seismic campaign in Burmese and Thai language for distribution to fishermen encountered at sea.
- Recruitment of a Fisheries Liaison Officer able to speak Burmese (and if possible Thai). His role will be to participate in the survey and handle encounters with both Burmese fishermen and Thai boats, directly solving any issues that could arise between these fishermen and the project. An alternative solution proposed to recruitment is to add this mission and responsibilities to an already existing position (such as the Party Chief).
- Conduct a preliminary pre-commencement survey of the study area to visually assess any on-going fishing activities (using binoculars identify fishing boats and their activities and determine their port of origin; also identify and count any fish traps installed in the area). This survey can be conducted either before mobilization, at the commencement of operations when vessels are mobilized, or during operations.
- Use of standard maritime safety procedures (e.g. radio contact, display of appropriate navigational beacons and lights, NTM).
- Compliance with relevant marine safety regulations and marine notification requirements.

- Use of chase vessels to manage interactions between the survey vessel and fishing vessels.
- Strict adherence to equipment handling and acquisition procedures.
- Alert Fishermen of presence of survey vessel and extent of towed array.
- Where possible, any in-water equipment lost during the survey will be recovered.
- Detailed records of equipment lost overboard will be maintained.
- Any negative interactions with fishing vessels will be recorded, and reported to the DoF, MOECAF and other relevant stakeholders.

7.2.1.3. Residual risk level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.2.2. Shipping

7.2.2.1. Potential impacts

As described in Section 5.5.5.4, the M-15 Block is located on the main shipping route between Myanmar and the Malacca Strait. Consequently there may be a moderate to high level of shipping activity in the survey area and surrounding waters. The survey vessel and towed array represent a potential navigational hazard and other vessels will need to avoid the seismic vessel to prevent collisions, entanglement of streamers, and other incidents. The survey, support and chase vessels will be required to comply with MARPOL requirements and other applicable maritime laws, and will need to operate strictly in accordance with SOP for marine operations. Any loss of equipment may interfere with shipping activity.

7.2.2.1. Mitigation and Management measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the M-15 Block to ensure that the impacts and risks to shipping activities are continuously reduced to ALARP:

- Adherence to the requirements of the COLREGS.
- Use of chase vessels to warn other vessels/shipping of the navigation hazard posed by the survey vessel and towed streamer array.
- The survey, support and chase vessels will use approved navigation systems and experienced bridge crew.
- Adherence to standard maritime safety / navigation procedures.
- Strict adherence to equipment handling and acquisition procedures.
- Display of appropriate navigational beacons and lights, radar watch, radio contact.
- Where possible in-water equipment lost will be recovered.
- Detailed records of equipment lost overboard will be maintained.
- Any negative interactions with shipping will be recorded and reported to the appropriate authorities in Myanmar (i.e. MOECAF, the DMA, the Myanmar Navy, and other relevant stakeholders).

7.2.2.1. Residual risk level

The residual risk ranking for this potential impact is **Low** (see Table 7-7).

7.3. CUMULATIVE IMPACT ASSESSMENT

7.3.1. General issues

The environmental impacts associated with a project may be accumulated or intensified when considered in the context of existing operations in the area. The cumulative impacts on different environmental indicators may vary depending on the scale, intensity, and proximity of multiple operations, as well as the interactions of environmental ecosystems affected.

This assessment allows the consideration of deviations from baseline environmental conditions as a result of simultaneous marine activities, current and future, and accounts for the seeming insignificance of a single activity which may trigger, aggravate or in some other way worsen the impacts of a project when considered in collaboration with another.

The evaluation of cumulative impacts associated with seismic activities is extremely complex due to the transient nature of airgun fire, the continual displacement of the source and other diverse operational and environmental interactions.

In order to account for the complexity of cumulative impacts, this assessment was conducted in four phases:

- Identification of environmental components which may be significantly adversely affected by the project;
- Identification of projects or activities (mainly future) which may have a negative impact on the environmental components identified above;
- Determination of the sensitivity of environmental components to cumulative impacts (be they over a short- or long-term period) when considered in parallel with other projects or activities identified in the area;
- Determination of significance of cumulative impacts on the environmental components after consideration of proposed mitigation measures.

The potential impacts associated with the marine M15 seismic survey are considered in the context of other existing marine operations in the potentially affected area in the sections below.

7.3.2. Potential environmental impacts associated with seismic activities

The impact assessment indicated that the environmental components susceptible to be the most affected by the M15 seismic activities are the:

- Acoustic environment and response mechanisms of marine mammals;
- Socio-economic environment as a result of disturbance to fishing and shipping traffic routes.

The cumulative effects on marine mammals and fishing/shipping traffic routes may appear if they are affected by other actions at the same time and in the same area.

It is possible that an operator from a nearby block shoots its seismic survey or conducts a drilling program simultaneously with CFG M15 Seismic project.

Environmental cumulative impacts are anticipated due to the significative increase of anthropogenic underwater sound generated by both seismic surveys which could have an impact on the marine fauna in general.

The logarithmic definition of the decibel scale implies that an increase of 10 times in the scale of sound pressure expressed in Pascal corresponds to a 20dB increase in the pressure level. In the case that two nearby projects would occur at the same time, mitigation measures should be reviewed.

The other solution could be to merge its seismic programs with one of its neighbours in order to avoid cumulative impacts. The advantages of this solution are:

- Avoid cumulative impacts of anthropogenic underwater sound generated by both of the projects;
- Share the cost of mobilisation of the seismic vessel and seismic equipment;
- Avoid possible interference of received signals coming from the different airguns used for the two seismic campaigns.

The main issue lies in the organisation of this campaign for the two companies. Nevertheless, even if the footprint of the project is enlarged (which induces a longer duration of seismic acquisition), the cumulative impact is reduced since the airguns will not work at the same time, i.e. the acoustic impact will not be increased but will just last longer.

7.4. SUMMARY OF ENVIRONMENTAL/SOCIAL RISK ASSESSMENT RESULTS

The risk assessment indicates that the potential risks/impacts arising from the 3D seismic survey in the M15 Block can be categorised as having **Low** to **Medium** risk levels. No risks were assessed as **High**. Table 7-7 presents a summary of the assessed level of residual (post-mitigation) environmental and social risk associated with the proposed seismic survey. The environmental/social aspects of the survey that have the potential to cause significant environmental/social effects (**Medium** or **High** risk levels) have been determined through an evaluation of the proposed activity, the surrounding environment including specific sensitivities and values, and legislative requirements. These environmental/social aspects are:

- Disturbance to marine fauna with discharge of underwater seismic pulses
- Vessel collisions resulting in fuel and oil spills.
- Disturbance to fisheries and shipping.

The next section of the IEE describes the Environmental and Social Management Plan (ESMP) for the proposed 3D seismic survey in the M15 Block. A standard cost-benefit approach will be adopted to reduce risk for the medium risks and a normal business management practices will be applied to avoid impact for the low risks.

Table 7-7: Summary of environmental/social risk assessment for the 3D seismic survey in the M15 Block, offshore Myanmar

Hazard	Environmental / social aspect	Potential environmental / social impacts	Risk			
			Consequence of impact	Likelihood of the identified consequence	Residual risk level	Assessment section
Disturbance to marine fauna	Discharge of underwater seismic pulses	Behavioural and physiological effects on cetaceans, whale sharks, turtles and fish	Moderate	Routine	**Medium**	**7.1.1**
		Physiological effects on benthic invertebrates and plankton	Slight	Routine	**Low**	**7.1.1**
	Light generation from vessels	Behavioural effects on turtles, fish and seabirds	Slight	Possible	**Low**	**7.1.2**
	Vessel and towed equipment interactions	Behavioural and physical effects on cetaceans, whale sharks and turtles	Minor	Possible	**Low**	**7.1.3**
Disturbance to benthic habitats	Equipment loss	Localised physical damage to benthic habitats	Slight	Possible	**Low**	**7.2.2**
Atmospheric emissions	Operation of machinery and vessels powered by internal combustion engines	Localised reduction air quality Greenhouse gas emissions	Slight	Routine	**Low**	**7.3**
Invasive marine species	Discharge of ballast water from vessels	Introduction and establishment of IMS and displacement of native marine species	Minor	Possible	**Low**	**7.4.1**
	Biofouling of vessel hulls, other niches and immersible equipment		Minor	Possible	**Low**	**7.4.2**
Marine pollution from routine discharges	Discharge of sewage, grey water and putrescible wastes	Localised reduction in water quality due to nutrient enrichment	Slight	Routine	**Low**	**7.5.1**

Hazard	Environmental / social aspect	Potential environmental / social impacts	Risk			
			Consequence of impact	Likelihood of the identified consequence	Residual risk level	Assessment section
	Discharge of bilge water	Acute toxicity effects on marine fauna and flora Localised reduction in water quality	Minor	Possible	**Low**	**7.5.2**
	Discharge of other wastes i.e. garbage	Localised reduction in water quality Physical impacts on marine fauna i.e. from plastics	Minor	Possible	**Low**	**7.5.3**
Marine pollution from accidental discharges	Hazardous materials	Toxic effects on marine fauna and flora Localised reduction in water quality Indirect effects on offshore fisheries	Minor	Possible	**Low**	**7.6.1**
	Fuel and oil spills		MInor	Possible	**Low**	**7.6.2**
	Vessel collisions		Moderate	Unlikely	**Low**	**7.6.3**
Disturbance to social and community values	Interaction with offshore fisheries	Disruption to fishing vessels Potential direct and indirect noise impacts on target species Restriction of access to fishing grounds, loss/damage to gear Recreational take of finfish species	Moderate	Possible	**Low**	**7.7.1**
	Interaction with shipping	Disruption to shipping activities	Moderate	Possible	**Low**	**7.7.2**

8. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1. INTRODUCTION

The Environmental and Social Management Plan (ESMP) for the proposed 3D seismic survey in the M15 Block offshore Myanmar is essentially a delivery mechanism for the identified environmental and social management and mitigation measures. In the project design, decisions have been made taking account of the need to avoid, minimise and reduce negative environmental and social impacts. In addition, in order to minimise environmental and social impacts, management and mitigation measures have been identified. To ensure that any commitments are fully managed and that mitigation measures with regard to impacts are implemented, an integral part of the IEE for the proposed activity is the development of this ESMP.

The ESMP will be supplemented with additional requirements through regulatory input and consultation procedures.

8.2. PURPOSE AND OBJECTIVES

The ESMP is required to:

- ensure continuing compliance with relevant Myanmar environmental legislation, CFG Energy Pte Ltd Health, Safety and Environmental (HSE) policies, and international best practice;
- provide the initial mechanism for ensuring that identified control and management measures to mitigate potentially adverse impacts are implemented;
- provide a framework for mitigating impacts that may be unforeseen or unidentified until seismic acquisition is underway;
- provide assurance to regulators and stakeholders that their requirements with respect to environmental and social performance will be met;
- undertake monitoring to provide assurance that the control and management measures are being implemented; and
- provide a framework for the compliance auditing and inspection programmes that will enable CFG to be assured that its aims with respect to environmental and social performance are being met and any commitments are implemented in full.

In addition, the ESMP serves as a set of procedures and specifications that define the environmental and social responsibilities of the seismic contractor.

8.3. CONTENT OF THE ESMP

This ESMP consists of:

- a register of environmental and social performance commitments; required management actions and key controls;
- an overview of relevant standards and procedures;

- a statement of roles and responsibilities;
- HSE Policies of CFG; and
- an implementation strategy, comprising:
  - monitoring, audit and review requirements;
  - relevant emergency procedures and plans; and
  - training requirements.

8.4. PERFORMANCE COMMITMENTS, MANAGEMENT ACTIONS AND KEY CONTROLS

A key function of the ESMP is to commitments relating to mitigation, monitoring and management measures into a single concise framework. For each environmental and social performance commitment, the ESMP sets out the following in tabular format:

- a comprehensive listing of the mitigation measures (actions) that CFG and subcontractors will implement according to project phase and activity to ensure that the objectives of mitigation are fully met;
- suggested designation of responsibility for ensuring full implementation of that action;
- the timing for implementation/monitoring of the action; and
- a listing of legal and/or other requirements (e.g. standards/international conventions).

The mitigation measures are set out in Table 8-1. The timing and immediate responsibility for implementing each commitment will be agreed between CFG and subcontractors. Although modifications to some of these measures are possible, there will be one overriding principle: that none of the management measures identified in this ESMP will be omitted or diluted without further assessment and reporting of the potential resultant impacts.

8.5. STANDARDS

International oil and gas industry standards and codes of practice relevant to marine seismic surveys that will be adhered to during the 3D seismic survey in the M15 Block are described below.

- applicable Myanmar environmental legislation (see Section 2.5.2);
- CFG HSE Policy and HSE Management System (HSE-MS);
- relevant international conventions.

Environmental and social issues relevant to all aspects of the 3D seismic survey in the M15 Block are governed or guided by a number of ‘standards’, including:

- those contained in Myanmar environmental legislation;
- those required by CFG and seismic contractor HSE policies and HSE management systems;
- those established by industry codes of practice and guidelines (e.g. IAGC, OGP, IPIECA – see below);
- those within relevant international standards and conventions; and
- commitments made in this ESMP.

Specific international oil and gas industry standards and codes of practice relevant to marine seismic surveys include:

- International Finance Corporation (IFC) Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (2007);
- International Association of Geophysical Contractors (IAGC) Environmental Manual for Worldwide Geophysical Operations (2001);
- International Association of Oil and Gas Producers (OGP) Environmental management in oil and gas exploration and production (1997);
- OGP Waste Management Guidelines (1993);
- International Petroleum Industry Environment and Conservation Association (IPIECA) The Oil and Gas Industry: Operating In Sensitive Environments (2003);
- International Cable Protection Committee (ICPC) Procedure To Be Followed Whilst Offshore Seismic Survey Work Is Undertaken In The Vicinity Of Active Submarine Cable Systems (ICPC Recommendation No. 8);
- Joint OGP/IAGC position paper Seismic Surveys & Marine Mammals (2004);
- UK Joint Nature Conservation Committee (JNCC) Guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys (August 2010, March 2015); and
- IAGC Recommended Mitigation Measures For Cetaceans during Geophysical Operations (June 2011).

8.6. ROLES AND RESPONSIBILITIES

8.6.1. CFG Energy Pte Ltd's role

CFG, as the overall responsible entity for all HSE matters during the 3D seismic survey in the M15 Block, will ensure that seismic acquisition operations are carried out safely and in accordance with their HSE Policy (Table 8-1), the requirements of their HSE Management System and of this ESMP. CFG will ensure that the ESMP and other HSE related requirements are implemented in full.

Relevant details regarding the proposed seismic survey will be submitted to the regulatory authorities in Myanmar (MOECAF, DoF, DMA, Myanmar Navy) in advance of the operations, for their approval. During the seismic survey, CFG will be responsible for the management of medical and health issues and the provision of appropriate care. CFG will ensure there are sufficient plans and resources in place for worker health care and contingency plans to respond to workplace accidents.

As part of their operating and HSE procedures, CFG will undertake environmental, social, safety and health inspections and provide reports that enable the Company to monitor and evaluate performance against the measures and objectives established in this ESMP.

A pre-operational start-up induction for the 3D seismic survey in the M15 Block will be conducted by CFG and subcontractors prior to commencement of operations.

8.6.2. Seismic subcontractor's Role

CFG will ensure their subcontractors will comply with the requirements of this ESMP during the 3D seismic survey in the M15 Block. Subcontractors will need to demonstrate to CFG's satisfaction how compliance with the requirements of this ESMP will be ensured. Subcontractors will also be expected to demonstrate

commitment to the ESMP at all levels in their HSE-MS, and will also be required to identify individual responsibilities for overall HSE matters during the operations.

8.6.3. Project HSE Plan

Prior to the commencement of the 3D seismic survey in the M15, subcontractor will prepare a Project HSE Plan for the survey. The purpose of this Project HSE Plan is to provide a clearly defined interface between the Client (CFG), the Contractor and any other subcontractors during project execution. The Project HSE Plan covers project-specific information and should be used in conjunction with the Crew HSE Plan which covers vessel-specific information. The Project HSE Plan is written to align with the expected format of the OGP Report 432 "*HSE Aspects in a Contracting Environment for Geophysical Operations*" (December 2009) and will accordingly be made up of five sections, together with a sixth section of relevant appendices:

Section 1: Introduction and Purpose

Explains the purpose, scope and structure of the Project HSE Plan.

Section 2: Description of the Project

Describes the project area, what equipment to be used, and the general operation together with the project specific hazards expected.

Section 3: Management System Interfaces

Defines the interfaces between the management systems of all relevant Parties.

Section 4: Contingency and Emergency Response Plans

Summary of emergency response plans and contact numbers for the project.

Section 5: Project Specific Hazard Management

Describes the major hazards encountered in the project that are not already managed by the Crew HSE Plan, listing the mitigations for these hazards.

Section 6: Appendices

Any appendices of relevant project information

Table 8-1: CFG 3D seismic survey, M15 Block, offshore Myanmar – management actions to mitigate potential environmental and social impacts

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
Routine Operations						
Discharge of underwater seismic pulses	Behavioural and physiological effects on cetaceans, whale sharks, turtles and fish	Minimise noise disturbance to marine fauna	• Adherence to Part A Standard Management Procedures of EPBC Act Policy Statement 2.1: - precaution zones (observation zone: 3km+; low power zone: 2km; and shut-down zone: 500m); • 30 minutes pre-firing search • Soft start procedure • Power down procedure • Two dedicated MMO aboard survey vessel for duration of survey • Passive Acoustic Monitoring • Survey personnel provided with pre-survey induction on EPBC Act Policy Statement 2.1. • Part A Standard Management Procedures will be applied to whale sharks as well as to whales for the duration of survey • Recording of all cetacean, turtle and whale shark sightings • Preparation of MMO Final Report	• Party Chief • MMO • PAM operator • Client Site Representative • Vessel Operations Manager • Project Geophysicist	During all acquisition operations	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • HSE Policies • Project HSE Plan • JNCC guidelines, August 2010 and March 2015

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
Light generation from vessels	Behavioural effects on turtles, fish and seabirds	Minimise light disturbance to marine fauna	• External lighting of vessels will be minimised to that required for safe navigation, vessel safety and safety of deck operations, except in case of an emergency	• Vessel Masters • Client Site Representative	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • HSE Policies • Project HSE Plan
Vessel and towed equipment interactions	Behavioural and physical effects on cetaceans, whale sharks and turtles	Minimise likelihood of interactions with marine fauna	• Application of vessel-marine fauna interaction procedures. • Use of streamer tail buoys fitted with appropriate turtle guards • Any vessel or towed equipment interactions with marine fauna recorded and reported	• Support vessel Master • Chase vessel Masters • Party Chief • Client Site Representative • MMO	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • HSE Policies • Project HSE Plan
Equipment loss	Localised physical damage to benthic habitats	Minimise disturbance of seabed habitats and biological communities	• Experienced operators / crew used to minimise risk of equipment loss • Where possible in-water equipment lost will be recovered • Detailed records of equipment lost overboard maintained • Loss of streamer and associated equipment will be reported to appropriate authorities in Myanmar	• Party Chief • Client Site Representative • Vessel Operations Manager • Project Geophysicist	Throughout survey	• *Environmental Conservation Law 2012* • HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
Operation of machinery and vessels powered by internal combustion engines	Localised reduction air quality GHG emissions	Minimise impacts on air quality in vicinity of survey area	• Adherence to MARPOL 73/78 Annex VI requirements: - optimisation of fuel use to increase efficiency and minimise emissions - use of low sulphur fuel if available to - emissions managed by implementation of a planned maintenance system (PMS) • Implementation of a Ship Energy Efficiency Management Plan (SEEMP) for the survey	• Vessel Masters	Throughout survey	• *Environmental Conservation Law 2012* • MARPOL 73/78 Annex VI • HSE Policies • Project HSE Plan
Discharge of ballast water from vessels	Introduction and establishment of IMS and displacement of native marine species	Minimise likelihood of translocation / introduction of IMS	• Survey and support vessel will not routinely discharge ballast water • Recording (in vessel engine room log) of any non-routine ballast water discharges	• Vessel Masters	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • HSE Policies • Project HSE Plan
Biofouling of vessel hulls, other niches and immersible equipment			• Survey and support vessels will have had recent dry dock, IMS inspection, hull and other niche cleaning and antifoulant application	• Vessel Operations Manager	Prior to survey commencement	
Routine Discharges and Emissions						
Sewage, grey water and putrescible waste disposal	Localised reduction in water quality due to nutrient enrichment	Minimise impacts from discharge of sewage, grey water, & putrescible waste on water quality in vicinity of survey area	• All sewage and putrescible wastes handled and disposed of in accordance with MARPOL 73/78 Annex IV • Survey and support vessels will have certified / approved sewage treatment plants • Vessel sewage treatment plants fully operational and includes maceration and disinfection • Maceration of sewage and putrescible wastes to <25 mm prior to discharge	• Vessel Masters • Client Site Representative • Vessel Operations Manager	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • MARPOL 73/78 Annex IV • HSE Policies • Project HSE Plan

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
			• No discharge of treated sewage within 3 nm of land • No discharge of untreated sewage within 12 nm of land • If vessels unable to treat/store grey water only biodegradable soaps / detergents used • Waste log maintained for sewage and ground putrescible waste discharged overboard			• IAGC Environmental Manual for Worldwide Geophysical Operations
Discharge of bilge water	Acute toxicity effects on marine fauna and flora Localised reduction in water quality	Minimise impacts from bilge water discharge on water quality in vicinity of survey area	• Bilge water treated and disposed of in accordance with MARPOL 73/78 Annex I • Bilge water contaminated with hydrocarbons contained and disposed of onshore, except if the oil content of the effluent without dilution does not exceed 15 ppm • Bilge water contaminated with chemicals contained and disposed of onshore, except if chemical is demonstrated to have low toxicity • Discharges of bilge water recorded in vessel engine room logs	• Vessel Masters • Client Site Representative • Vessel Operations Manager	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • MARPOL 73/78 Annex I • HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations
Discharge of other wastes i.e. garbage	Localised reduction in water quality Physical impacts on marine fauna i.e. from plastics	Minimise likelihood of accidental garbage disposal to the ocean	• Garbage disposed of in accordance with MARPOL 73/78 Annex V • Vessel Garbage Management Plans in place • No discharge of plastics or plastic products • No discharge of domestic wastes or maintenance wastes overboard from	• Vessel Masters • Party Chief • Client Site Representative • Vessel Operations Manager	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • MARPOL 73/78 Annex V

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
			vessels • All waste receptacles aboard vessels covered with tightly fitting, secure lids • Application of Handling and Storage of Dangerous Products Procedures for both vessels • All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) incinerated or compacted (if possible), stored in designated areas and sent ashore for recycling, disposal or treatment • Incinerators used aboard the survey and support vessel will be compliant with MARPOL / IMO requirements • Incineration of any oil sludges aboard vessels, or disposal of any oil sludges/slops in port, recorded in the Oil Record Book • All storage facilities and handling equipment in good working order and designed in such a way as to prevent and contain any spillage			• HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations
Non-routine Hazards and Effects						
Accidental discharge of hazardous materials	Toxic effects on marine fauna and flora Localised reduction in water quality Indirect effects on offshore fisheries	Eliminate / minimise potential for accidental discharge of solid or hazardous materials	• Harmful Packaged Substances handled and disposed of in accordance with MARPOL 73/78 Annex III • All chemical and hazardous wastes segregated into clearly marked containers prior to onshore disposal • All storage facilities / handling equipment in good working order and designed to prevent / contain any spillage • Survey and support vessels have	• Vessel Masters • Party Chief • Client Site Representative • Vessel Operations Manager	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • MARPOL 73/78 Annex III • HSE Policies

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
			implemented and tested SOPEP • All hazardous substances MSDS in place • Spill response bins/kits located in close proximity to hydrocarbon storage areas. Kits checked for their adequacy and replenished prior to commencement of survey • Detailed records maintained of all accidental releases/discharges of hazardous materials			• Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations
Fuel and oil spills	Toxic effects on marine fauna and flora Localised reduction in water quality Indirect effects on offshore fisheries	Eliminate / minimise potential for accidental fuel and oil spills	• Adherence to COLREGS • If at sea refuelling of survey vessel is required, it will only take place at a distance of >12 nm from any land, and in accordance with Dolphin Geophysical bunkering operations SOP, plus additional measures specified in **Section 7.6.2** • Activation of survey / support vessel SOPEP in event of fuel/oil spills • SOPEP drills conducted aboard survey and support vessels • Response strategy for diesel spills will be to allow small spills to disperse and evaporate naturally, and monitor position / trajectory of any surface slicks. Physical break up (using propwash) may be considered for larger slicks • Hydrocarbons located above deck stored with some form of secondary containment to contain leaks or spills e.g. bund, containment pallet, transport packs. • Detailed records maintained of all fuel and oil spills • Any spills >80 L reported to appropriate	• Vessel Masters • Party Chief • Client Site Representative • Vessel Operations Manager • Project Geophysicist	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • COLREGS • MARPOL 73/78 Annex I • HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
			authorities in Myanmar			
Vessel collisions	If hydrocarbon spill occurs: toxic effects on marine fauna and flora; localised reduction in water quality Indirect effects on offshore fisheries	Eliminate / minimise potential for vessel collisions	• Adherence to COLREGS • Use of chase vessels to warn other vessels/shipping of navigation hazard posed by survey vessel and towed streamer array • Survey, support and chase vessels use approved navigation systems; experienced bridge crew • Adherence to standard maritime safety / navigation procedures. • Display of appropriate navigational beacons and lights, radar watch, radio contact • Detailed records maintained of all vessel collision incidents • Any vessel collision incidents reported to the appropriate authorities in Myanmar	• Vessel Masters • Party Chief • Client Site Representative • Vessel Operations Manager • Project Geophysicist	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • COLREGS • HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations
Interaction with offshore fisheries	Disruption to fishing vessels Potential direct and indirect noise impacts on target species Restriction of access to fishing grounds, loss/damage to gear	Minimise disturbance to vessels fishing in the offshore fisheries	• Adherence to COLREGS • Notification of survey details to DoF and other relevant stakeholders • Use of chase vessels to manage interactions between survey vessel and fishing vessels • Use of standard maritime safety procedures • Compliance with relevant marine safety regulations and marine notification requirements • Strict adherence to equipment handling and acquisition procedures • Fishermen alerted of presence of survey	• Vessel Masters • Party Chief • Client Site Representative • Vessel Operations Manager • Project Geophysicist	Throughout survey	• *Environmental Conservation Law 2012* • *Protection of Wildlife and Conservation of Natural Areas Law 1994* • *Marine Fisheries Law 1990* • COLREGS • HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
			vessel and extent of towed array • Where possible, any in-water equipment lost will be recovered • Detailed records of equipment lost overboard maintained • Any negative interactions with fishing vessels recorded and reported to DoF, DMA and Myanmar Navy			
Interaction with shipping	Disruption to shipping activities	Minimise disturbance to shipping activities	• Adherence to COLREGS • Use of chase vessels to warn other vessels/shipping of navigation hazard posed by survey vessel and towed streamer array • Survey, support and chase vessels use approved navigation systems; experienced bridge crew • Adherence to standard maritime safety / navigation procedures • Strict adherence to equipment handling and acquisition procedures • Display of appropriate navigational beacons and lights, radar watch, radio contact • Where possible in-water equipment lost will be recovered • Detailed records of equipment lost overboard maintained • Any negative interactions with shipping recorded and reported to DMA and Myanmar Navy	• Vessel Masters • Party Chief • Client Site Representative • Vessel Operations Manager • Project Geophysicist	Throughout survey	• COLREGS • HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations

8.6.4. Key Roles / Responsibilities

Key roles and responsibilities for CFG and contractor personnel in relation to implementation, management and review of this ESMP are described below.

It is the responsibility of all of CFG's employees and contractors to ensure that the requirements of the corporate HSE Policy are applied in their areas of responsibility and that the personnel are suitably trained and competent in their respective roles.

8.6.4.1. Shore-based Personnel

Project Geophysicist (Primary Onshore Contact)

- Ensure the activity is undertaken as per the objectives of this ESMP and the Project HSE Plan.
- Provide sufficient resources to implement management measures to achieve the management objectives.
- Manage change requests for the activity and notifying the Environmental Adviser of any scope changes in a timely manner.
- Review the ESMP as necessary and manage change requests.
- Ensure environmental / social incident reporting meets requirements as outlined in this ESMP, CFG's internal HSE Incident Reporting Procedure, and the Project HSE Plan.
- Monitor and close out corrective actions raised from environmental inspections/audits or incidents.
- Commit necessary resources to facilitate an emergency response strategy in the event of an incident.
- Review results of compliance audit during the program and make recommendations where required.
- Ensure that a full briefing all project personnel is provided, including details of the environmental /social sensitivities of the survey area and management objectives and procedures detailed in this ESMP and the Project HSE Plan.

Vessel Operations Manager

- Vessel HSE performance (qualitative and quantitative) including but not limited to:
  - Leadership by personal example and visible commitment to instil excellent HSE behaviour and culture aboard.
  - Establishing annual HSE plan for the vessel.
  - Ensuring the vessel's compliance with all company standards, policies and procedures.
  - Ensuring major incidents (LTI and/or Hi-Potential or above) are thoroughly investigated, root cause analyses performed, corrective actions completed, logged and closed out.
  - Participation in key audits.
  - Ownership of the vessel's HSE statistics, leading and lagging.
  - Ensuring that all relevant HSE documentation is in place for the vessel, according to the company's HSE-MS requirements.

Environmental Adviser

- Prepare and revise the survey ESIAS and ESMP as necessary.
- Prepare environmental / social induction and vessel inspection information.

- Provide a briefing to project personnel and survey vessel crew members of the environmental / social sensitivities of the survey area, management objectives and procedures detailed in this ESMP as part of the HSE induction process.
- Assist with review, investigation and reporting of environmental incidents.
- Ensure environmental inspections/audits are undertaken as per the requirements of this ESMP and of the Project HSE Plan.

8.6.4.2. Vessel-based Personnel

Master Survey Vessel

- Ensure the safe execution of all operations of the survey vessel.
- Overall responsibility for HSE management aboard the survey vessel.
- Ensure that appropriate control and mitigation measures are implemented to minimise potential environmental / social effects resulting from vessel operations - e.g. waste management/disposal; fuel/oil spill response.
- Immediately notify the Client Site Representative of any incidents/activities arising from vessel operations that are likely to have a negative impact on the management objectives detailed in this ESMP and the Project HSE Plan.
- Support the Client Site Representative in ensuring that all relevant HSE documents are understood and adhered to.
- Ensure compliance with this ESMP, the Project HSE Plan and any relevant statutory regulations – e.g. vessel discharges to sea.
- Report hydrocarbon or other chemical spillage to the Party Chief.
- Establish and maintain radio contact with other vessels in the survey area and adjacent waters.

Party Chief

- Ensure safe execution of all operations carried out by the seismic crew aboard the survey vessel.
- Ensure that the following documents are in place and aboard:
  - Project HSE Plan;
  - Emergency Response Procedures;
  - HSE Management Procedures;
  - Hazard Management Procedures;
  - Environmental Management Procedures; and
  - this ESMP.
- Ensures the seismic operations are consistent with:
  - HSE Policies;
  - Seismic vessel plans, procedures and work instructions;
  - this ESMP and the Project HSE Plan; and
  - relevant environmental legislative requirements or regulatory conditions.
- Provide a daily log of activities and social and environmental incidents to the Client Site Representative.

- Ensure that appropriate control and mitigation measures are implemented to minimise potential environmental impacts resulting from seismic acquisition (e.g. 'soft start' procedures, PAM, whale watch procedures, cetacean, whale shark and turtle sighting records)
- Ensure that potential social risks and impacts (damages to fishing gears, collisions with fishing vessels) are properly mitigated applying recommended mitigation measures.
- Ensure compliance with all aspects of HSE reporting and for investigations of all incidents and near misses.
- Immediately notify the Client Site Representative of any incidents/activities arising from seismic operations that are likely to have a negative impact on the management objectives detailed in this ESMP and in the Project HSE Plan.

Client Site Representative (Primary Offshore Contact)

- Ensure that the following documents are understood and adhered to:
  - Project HSE Plan;
  - Emergency Response Procedures including survey vessel SOPEP;
  - HSE Management Procedures;
  - Hazard Management Procedures;
  - Environmental Management Procedures; and
  - this ESMP.
- Facilitate clear communications between the CFG office, the Vessel Operations Manager, Project Geophysicist and the survey vessel personnel.
- Investigate any hydrocarbon spills >1 L in size.
- Ensure that, during the 3D seismic survey in the M15 Block all sub-contractors perform operations in a manner consistent with the environmental / social management procedures and performance objectives detailed in this ESMP and in the Project HSE Plan.
- Ensure that the survey vessel Master and Party Chief are adhering to the requirements of this ESMP and the Project HSE Plan.
- Ensure that he/she is fully aware of ongoing operations, particularly for environmentally critical activities.
- Immediately alert the Project Geophysicist of any changes in operations that could have a negative impact on environmental / social performance.
- Immediately report any reportable incidents to the Project Geophysicist.
- Maintain records of daily logs, environmental incidents, waste inventory and cetacean, whale shark and turtle sightings provided by the Party Chief and MMOs.
- Conduct a compliance audit during the survey and forward results to the Project Geophysicist.
- Prepare a report of the overall environmental / social performance upon completion of the survey, including the results of audits and any incidents, and forward to the Project Geophysicist.

Marine Mammal Observers

- Maintain watch for cetaceans, whale sharks and turtles during the course of the survey and advise the survey vessel Master, or Party Chief, of the presence of these marine fauna.
- Ensure recording and reporting of cetacean, whale shark and turtle sightings.

- Monitor the implementation of the specific visual monitoring and interaction procedures during acquisition operations.
- Monitor and record any interactions with cetaceans, whale sharks and turtles.
- Prepare the MMO Final Report.

Seismic Operators, Technicians and Vessel Crew

- Apply operating procedures in letter and in spirit.
- Follow good housekeeping procedures and work practices.
- Encourage improvement in environmental / social performance wherever possible.
- Immediately report environmental incidents or spillage of >1 L of hydrocarbons or other chemicals to the survey vessel Master and Party Chief.

8.7. TRAINING AND COMPETENCIES

8.7.1. Environmental/Social Inductions

All personnel required to work on the survey, support and chase vessels will be given a HSE induction prior to the commencement of the survey. The environmental / social component of the induction will include information on the following environmental / social issues:

- a description of the environmental / social sensitivities and conservation values of the survey area and surrounding waters;
- an overview of marine fauna likely to be in the area;
- an overview of fishing and shipping activities (as well as people smuggling activities) likely to occur in the area;
- the importance of following procedures and using Job Hazard Analyses (JHA) (or equivalent) to identify environmental / social risks and mitigation measures; procedures for reporting of any environmental / social incidents or hazards;
- an overview of emergency response and spill management procedures;
- an overview of the waste management requirements;
- roles and environmental responsibilities of each position aboard the survey vessel;
- chemical management requirements;
- procedures for interactions with marine fauna; and
- an outline of all environmental / social management objectives, control/mitigation measures and roles/responsibilities detailed in this ESMP and in the Project HSE Plan.

All personnel who undertake the induction will be required to sign an attendance sheet that will be retained by the Client Site Representative or Project Geophysicist.

8.7.2. Marine Mammal Observers

Only appropriately qualified and experienced MMOs (as determined by a review of their CVs in the project proposal from the provider) will be utilised for the 3D seismic survey in the M15 Block.

8.8. MONITORING AND RECORD KEEPING

Table 8-2 lists the environmental / social performance information that will be monitored and recorded during the 3D seismic survey in the M15 Block.

Table 8-2: Monitoring and recording requirements for the 3D seismic survey in the M15 Block

Activity	Monitoring	Record keeping
Training	Details of crew environmental / social inductions	Induction Record Sheets
Waste management	Quantities of waste discharged or transferred ashore for recycling, treatment or disposal	Vessel Waste Log
Fauna interactions	Cetacean, whale shark and turtle sightings Any interactions between marine fauna and vessels	Sightings report forms Vessel-marine fauna interaction records
Fishery activity interactions	Any interactions between fishermen and vessels	Vessel-fishermen interaction records
Invasive marine species	Management of ballast water and biofouling	Vessel bilge and ballasting records IMS inspection records and antifoulant treatment details for survey and support vessels
At sea refuelling	Records of any refuelling events, quantities transferred, location etc.	Bridge logs
Incident reporting	Number and details of any environmental / social incidents	CFG internal HSE incident reports
Compliance reporting	Compliance with ESMP and Project HSE Plan management objectives	Completed inspection / audit check sheet

A proper Grievance Mechanism should also be developed based on CFG corporate policy and international best practices (such as the IPIECA document: *Operational level grievance mechanisms: good practice survey*, November 2012). This mechanism will serve to record, report grievances expressed by stakeholders related to any impact or incident occurring during the performance of the operations. It will also detail the resolution mechanism in place at CFG (including financial compensation in case of damages to fishing equipment).

8.9. AUDITING

Environmental / social performance of the 3D seismic survey in the M15 Block is reviewed in a number of ways. These reviews are undertaken to:

- ensure all significant environmental / social aspects of the activity are covered in this ESMP and in the Project HSE Plan;
- ensure that environmental / social management measures to achieve management objectives are being implemented, reviewed and where necessary amended;
- identify potential non-conformances and opportunities for continuous improvement; and
- ensure that all environmental / social management objectives have been met before completing the activity.

The following arrangements will be established to review environmental / social performance of the activity:

- An inspection(s) of the vessels will be carried out before or during the survey to ensure that procedures and equipment are in place to enable compliance with this ESMP and with the Project HSE Plan.

- Copies of this EIA document and of the Project HSE Plan will be distributed aboard the vessels, and implementation of the environmental / social management measures will be monitored on a regular basis by the Client Site Representative.

8.10. EMERGENCY RESPONSE

8.10.1. Emergency Response Preparation

Survey specific emergency response (ER) procedures for the 3D seismic survey in the M15 Block are included in the project-specific HSE Plan. The Project HSE Plan contains instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and contact information. In the event of an emergency of any type the survey vessel Master will assume overall onsite command and act as the Emergency Response Coordinator (ERC). All persons aboard the vessel/s will be required to act under the ERC's directions. The survey vessel will maintain communications with the Vessel Operations Manager and Project Geophysicist and/or other emergency services in the event of an emergency. Emergency response support can be provided by CFG if requested by the ERC.

The survey and support vessels have equipment aboard for responding to emergencies, including but not limited to medical equipment, firefighting equipment and oil spill response equipment.

Project-specific contingency and emergency response measures are detailed in Section 4 of the Project HSE Plan.

8.10.2. Fuel, Oil and Other Hazardous Material Spills

Fuel and oil spills will be managed according to the oil spill arrangements and procedures outlined in the survey and support vessel SOPEP and ER procedures described in the Project HSE Plan.

The survey vessel SOPEP functions as the oil spill contingency plan (OSCP) for the 3D seismic survey in the M15 Block, and includes the specific spill contingency procedures that will be implemented in the event of a spill. As listed in the respective SOPEP, the survey and support vessels carry spill containment and recovery kits with sufficient absorbent booms and materials to contain small to medium scale deck spills. The vessel Masters will be responsible for ensuring that these kits are appropriately stocked at all times. Minor spills will be managed through housekeeping practices and the use of absorbent materials. Deck spills will not be discharged into the ocean.

Larger spills associated with structural damage to either vessel will be dealt with in accordance with the relevant ER procedures detailed in the Project HSE Plan. Given the offshore location of the survey area and the nature of the spilled material (diesel fuel), the primary response strategy for any fuel spills will be to monitor and observe any surface slicks, and report the spill to the relevant authorities. Physical break-up of surface slicks using propwash from the support vessel may be considered as a response measure, to aid in dispersion, dilution and evaporation of hydrocarbons, but only after consultation with the Vessel Operations Manager and Project Geophysicist.

Any fuel or oil spills >80 L in size will be reported to MOECAF and to other relevant stakeholders in Myanmar.

8.10.3. ESMP Review

Management of changes to scope (e.g. timing, location or operational details described in this EIA and ESMP) are the responsibility of the Project Geophysicist. A risk assessment will be undertaken for all changes in scopes to assess potential impacts of the change. If the change represents a significant modification a revision of the ESMP will be conducted. The revised ESMP will be submitted to MOECAF and other relevant authorities in Myanmar.

Notification to all Myanmar government authorities, where required, will be undertaken by the CFG Asset Country Manager, Myanmar, who is based in Yangon. Notifications will include details of the change and procedures that will be put in place for managing or mitigating the additional or modified risks.

8.11. ESMP REVIEW

Management of changes to scope (e.g. timing, location or operational details described in this EIA and ESMP) are the responsibility of the Project Geophysicist. A risk assessment will be undertaken for all changes in scopes to assess potential impacts of the change. If the change represents a significant modification a revision of the ESMP will be conducted. The revised ESMP will be submitted to MOECAF and other relevant authorities in Myanmar.

Notification to all Myanmar government authorities, where required, will be undertaken by the CFG Asset Country Manager, Myanmar, who is based in Yangon. Notifications will include details of the change and procedures that will be put in place for managing or mitigating the additional or modified risks.

9. PUBLIC CONSULTATION & INFORMATION DISCLOSURE

As part of the IEE study, Artelia organized a series of consultations with stakeholders in Myeik, which is the closest (harbour) town to the Project area.

These consultations were organized in coordination with CFG Energy Pte Ltd, its local partner Century Bright Gold, Regional and Local authorities, MOGE and MOECAF. The first objective was to collect up-to-date and precise information on the current socio-economic conditions in the Project area, with a focus on marine areas, their natural ecosystems (fauna and flora) as well as economic activities relying on marine space such as fishery and commercial shipping. The second objective was to present the project to the stakeholders, collect their opinions and views, and to discuss the potential environmental and social impacts and possible mitigation measures.

The first public meeting took place on April 26th 2015 in Myiek with residents of both Myeik and Kyunsu townships, representatives of local authorities and representatives of fishermen from both townships. A second public meeting watook place on May 20th 2015 in Kyunsu township, gathering residents of Katan Kyun and neighbouring islands located at and on the margin of Block M-15.

Other meetings convened with key stakeholders to the project are set out in the table below; these meetings formed the basis of a Stakeholder Engagement Plan.

Table 9-1 Stakeholder Engagement Plan

Name of stakeholder	Purpose of Meeting	Date and place convened	Outcome
Environmental Conservation Department (MOECAF) Central level	Presentation of the Project and presentation of CFG Energy Pte Ltd. -Submission of the Project proposal -Validation that the study to be undertaken should be an IEE -Validation of the IEE methodology and planned activities	03/13/2015 Nay Py Thaw	The decision to perform an IEE was officially validated The IEE methodology and the proposed activities to be undertaken as part of the IEE were officially accepted.
Chief Minister in Taninthary	Presentation of the Project and presentation of CFG Energy Pte Ltd	16/03/2015 Dawei	Expressed full support to the project as long as the laws both nationally and locally are followed; adviced us to meet with local government officials advocated public consultation as the way to interact with local citizenry
Environmental Conservation Department (MOECAF) Taninthary level	Presentation of the Project and presentation of CFG Energy Pte Ltd.	16/03/2015 Dawei	Expects to be consulted through the project planning process
Department of Fisheries Tanintharyi	The project being located in the	06/04/2015	Data/ information collected:

Name of stakeholder	Purpose of Meeting	Date and place convened	Outcome
Region	Tanintharyi fishing zone, representatives of the regional office of DoF in Myeik was met during the first round of consultation.	Myeik	-DoF stated that the marine fish resources have been decreasing over the last years due to overfishing -The fishery sector is very important in the Region (1340 metric tons, only for the export). 56 000 fishermen in Taninthary (out of ca. 1.4 million inhabitants). -There are around 10 000 fishing boats (without engines) in the in-shore fishing zone -There are about 1600 licensed vessels for the offshore area (1200 last year), mostly long-line tuna fishing boats. - There is no restricted area within the project area. However fishing is restricted during the Monsoon (breeding season), only 35 to 65% of the boats are allowed to fish (as a result of negotiations between representatives of the fishermen and the government) -DoF reports the existing practice of illegal fishing in Tanintharyi waters, mostly by foreign vessels from Thailand and Bangladesh. -DoF reports the (illegal) practice of blast fishing (small chemical bombs, locally made) from small boats IEE: - The DoF is willing to take on the function of informing the fishermen of the occurrence of the seismic survey.
Myanmar Port Authorities – Tanintharyi Region (Myeik)	The Myanmar Port Authority is in charge of services for the sea ports and providing terminal facilities and services for shipping loading and unloading.	07/04/2015 Myeik	-The Myanmar Port Authority zone is the “port area” which is very close to the shore (in the Inshore zone) -The project area is too far from the shore to concern the Myanmar Port Authority -The MPA representative suggests that we meet with the Department of Marine Administration in Myeik. -The MPA representative stresses out that the people should be informed as much as possible. -Before the seismic survey it will be important to coordinate with the Myanmar Port Authority to review the ships organization (crew list, authorizations, etc.). -The operator will have to contact the MPA in Yangon who will contact the MPA in the Tanintharyi Region
Department of Marine Administration (DMA) – Tanintharyi Region (Myeik)	The DMA is a department under the Ministry of Transport in charge of the maritime sector. It has a wide array of functions from ensuring the general marine traffic safety and marine environmental protection, to conducting surveying and registering vessels. DMA should be invited to bring its expertise on	07/04/2015 Myeik	-No specific concerns for the project in this area. -DMA representative stressed that there is no emergency measures standards in effect in Myanmar: the operator has to be careful and respect international standard -DMA representative stressed the importance of the fishing sector in the region which should be carefully taken into account. -In case of drilling/production, the DMA will coordinate the restriction zone with a safe distance (5km). The operator should contact the DMA through the MOGE and provide at least one month’s notice.

Name of stakeholder	Purpose of Meeting	Date and place convened	Outcome
	potential interactions between the seismic vessels and commercial ships, and provide support to consolidate the mitigation measures proposed in this IEE.		
Environmental Conservation Department (MOECAF) – Tanintharyi Region	The MOECAF is in charge of developing national environmental policy, in particular in the fields of water and marine resources conservation. MOECAF will be consulted to ensure that the IEE is compliant with the national legal framework of EIA.	06/04/2015 Myeik	General information: There was a study performed in 2013 by a Norwegian research team [*cf. "Ecosystem Survey Myanmar", Nancen, F. 2013" preliminary results consulted and referred to in the present report*] and they might have some small studies still going on. Advised to contact and meet Prof. Nan Mya Han from the Myeik University IEE: As planned and discussed with the ECD in Nay Pyi Taw at the earliest stages of the IEE, the guidelines and procedure from the ECD-MOECAF should be followed.
Department of Marine Science, Myeik University	The Department of Marine Science of Myiek University - and particularly Dr. Nang Mya Han has contributed to several environmental surveys in Tanintharyi waters and has a good knowledge of fishing practices in the area.	07/04/2015 Myeik	Observations and suggestions: -The project area is located in a remote area and it is difficult to go there (an authorization from the government is needed in order to conduct research surveys) -Dr. Nang Mya Han is concerned about potential environmental impacts of Oil & Gas projects. She commented on the necessity to perform environmental baseline surveys and offered her help to conduct such surveys. -The Project Team explained that a baseline survey is not needed at this stage; although it will be necessary in the future, prior to the production stage. Data/ information: -Dr. Nang Mya Han reported the presence of several marine species in the area, including porpoise, right whale sperm whale, and six species of dolphins. -A WCS survey report gives information about this [*consulted and referred to in the present IEE*]. -About the 2013 Norwegian study: Not possible to get a copy of the report as she disagreed on its results. In her opinion, the survey has been conducted too close to the shore. A survey will be conducted again from May to June, in order to collect more comprehensive data. -Dr. Nang Mya Han provided a hard copy of a presentation she recently did on her own research work in Myanmar's waters.
Public consultation meeting - local authorities, fishermen	The purpose of this meeting was to introduce CFG & the	26/04/2015 Myeik	- The attendance expressed their concerns on the potential impacts of the survey on fish and fisheries. However, it was also noted that most of the small-

Name of stakeholder	Purpose of Meeting	Date and place convened	Outcome
and residents of Myeik and Kyunsu townships See list of attendees below the table	project and to collect the people's concerns in order to take them into account in the study. An announcement was made for another meeting to be held in about one month to disclose the results of the study.		scale fisheries are located no further than 20km from the shore, well away from the survey area - Questions were asked about the technical aspects of the projects. - Questions were asked about potential impacts on the seabed and benthic species. It was reminded that this area is very sensitive in this respect. -Village representatives (from Myiek and Kyunsu townships) asked about the possibility of compensations of the Project's impacts to the local communities. - Further questions were asked about the potential positive impacts to be expected by local communities, in the event that gas is found. - Indications were made that there might be tuna-fishing in the Project area (and the possibility of illegal fishing in this area). - An official from Myeik district would like to see the IEE, the formulation of a commitment from CFG to compensate local people (in the event that gas is found). -An official from Kyunsu township suggested that such compensations could take the form of improved access to electricity so as to support the needs of Tanintharyi industries (such as fish processing)
Public consultation meeting – over 200 attendees including the Minister of Planning and Economics of Tanintharyi, Tanintharyi Government representatives, village representatives and residents of Katan Kyun and neighbouring islands located at and along the eastern margin of Block M-15) Kyunsu Myo Katan Island (Kyun Yadana Hall) See list of attendeed below the table		20/05/2015, Katan Island (Kyunsu township)	The secretary of the Tanintharyi fishing organization raised concerns over potential disturbance of fish traps, as they can be set in water depths down to 200 m and in areas which can extend up to 150 km offshore. -The project representative and the Minister of Planning and Economics recognized that minor disturbances to fishing activities could occur. However such disturbances, if they occur, would be limited to the specific area of the survey and to a short period of time. The large distance of the Project area (Western part of the block) to the coast makes this impact on fishing activities rather unlikely. -Questions were asked by civil society members about the potential benefits of the Project for fishermen; concerns were expressed that the potential benefits should be directed towards the local communities affected by the Project and not elsewhere. -Issues related to the involvment of foreign workers in the latetr phase of the Project were discussed between the Immigration Officer and the Project representative. -H.E.U Thein Lwin, Minister of Planning and Economics, indicated that if the exploration is successful , the Government is expecting the company to contribute to the development of infrastructures such as health, education and communication in the Project area, as well as to the training of locals so that they can increase their qualifications and skills and then work on any project

Name of stakeholder	Purpose of Meeting	Date and place convened	Outcome
			as equals to foreign labour. -Concerns were expressed about environmental impacts (especially on the fish population) in case of pipeline leaks (in the event that the Project goes further). -The Project representative reminded that the Project is still now on its exploration phase; further consultations and investigations will be made in case the survey is successful and the Project carries on. In any case, safety is a major concern for the company and it will take full responsibility for ensuring it. The project representative added that if the Project goes further, in case of land acquisition, consultations will be held to make sure the compensations will be directed locally, to the rightful people, and that the company will make sure the people benefit..
Environmental Conservation Department (MOECAF) Central level	Disclosure of the ressults of the study	15/06/2015 Nay Pyi Taw	Discussions about the next steps of the IEE's approval procedure.

The following meeting was also organized as part of the Public Consultation, in Yangon:

Name of stakeholder	Purpose of Meeting	Date and place convened	Outcome
Frank MOMBERG – Myanmar Program Director – Fauna & Flora International	FFI is conducting several biodiversity conservation projects on the Tanintharyi Shore. The purpose of this meeting was to discuss the project and collect data on the environmental & social context	27/03//2015 Yangon	-FFI is concerned about the depletion of the fishing resources in the past few years -FFI listed some environmental & social topics that should be taken into account: *Possible seasonal migration lanes for whale sharks, manta rays and other species within the block. (genrally in Spring) *pelagic shrimp fishing *sea gypsies on the Tanintharyi Islands (involved in dynamite fishing) *Turtle nesting sites on the islands 100km to the north *lobsters possibly migrating from breeding areas from the north *coral reefs -There is no protected area in the vicinity of the project, although there may be propositions for new protected areas nearby in the future. -FFI provided some data about coral reefs, mangroves and shark reserve boundaries (not in the project area)

Photos 1, 2 and 3: First Public consultation meeting held in Myeik – April 26th, 2015

Photo 4: First Public Consultation Meeting, Myeik – April 26th, 2015

Photos 5, 6 and 7: Consultations in Myeik.From top to bottom and left to right: Department of Marine Science at Myeik University, Marine Port Authorities and Departement of Fisheries (Tanintharyi Region)

Photos 8, 9, 10 and 11: Second public consultation meeting, Kyunsu Township - May 20th, 2015

Photo 12: Second public consultations meeting, Kyunsu Township – May 20th, 2015

Photo 13: Meeting with Minister Thein Lwin and other government officials, 16/03/2015, Dawei

Photo 14: CFG meeting with Chief Minister Myat Ko, 16/03/2015, Dawei

Table 9 - 2: List of Participants attending the First Public Consultation in Myeik (Pearl Hall), April 6th 2015

NO	Participant's Name	Organization/ Place
1	H. E. U Thein Lwin	Minister for Economic & Planning, Taninthari Government
2	U Aung Kyaw Htun	District Administrator- Myeik Districk
3	U Aung Khaing Soe	Regional MOECAF Officer
4	Daw San Kyu	Township Children and Mother Welfare Organization
5	U Aung Tin Win	Myeik Red Cross
6	U Zayar Moe	Myeik Red Cross
7	U Nyi Nyi Htun	Myeik Red Cross
8	Ayar Win	National Unity Party- Myeik District
9	U Thein Shwe	National Unity Party- Myeik District
10	U Kyaw Soe Moe	National Unity Party - Chairman Kyunsu
11	U Aye Ko	Banda Nei Village
12	U Sa Moe Zaw Oo	Yay Myit Kyi Village
13	U Ohn Thwin	Yay Myit Kyi Village
14	U Htun Win	Yay Myit Kyi Village
15	U Tin Sein	Village Administrator- (1) Quarter- Kyunsu
16	U Zaw Moe	Village Administrator- (2) Quarter- Kyunsu
17	U Maung Maung	Village Administrator- (3) Quarter- Kyunsu
18	U Maung Kin	Village Administrator- (4) Quarter- Kyunsu
19	U Aung Naing	Township Supporting Committee- Kyunsu
20	U Htay Lwin	Quarter Supporting Committee- Kyunsu
21	U Htay Shwin	Quarter Supporting Committee- Kyunsu

NO	Participant's Name	Organization/ Place
22	U Hla Thaung	Quarter Supporting Committee- Kyunsu
23	U Myo Zaw Oo	Quarter Supporting Committee- Kyunsu
24	U Myo Zaw Win	Quarter Supporting Committee- Kyunsu
25	U Than Htun	Village Administrator- Min Gout
26	U Htun Than	Quarter Head- Min Gout
27	U Thee Swe	Chairman- Min Gout Village Supporting Committee
28	U Tin Aye	Member-Min Gout Village Supporting Committee
29	U Aye Po	Member-Min Gout Village Supporting Committee
30	U Saw Moe	Member-Min Gout Village Supporting Committee
31	U Than Myint Htun	NLD- Kyunsu
32	U Khin Soe	Kyunsu Supporting Committee
33	U Soe Win	Wah Louk Village
34	U Than Aung	Kyunsu
35	U Myo Zaw Oo	Kyunsu
36	U Mya Thaung	Kyunsu
37	U Than Zaw Oo	Kyunsu
38	U Thaung Aye	Kyunsu
39	U Kyaw Than	Kyunsu
40	U Htun Win	Kyunsu
41	U Ye Lwin	Kyunsu
42	U Ngwe Tin	Kyunsu
43	U Thet Hlaing	Township Red Cross- Kyunsu
44	U Soe Naing	Planning- Kyunsu
45	U Nyein Chan Soe	Township Fire Department-Kyunsu
46	U Arkar Paing	Township Fire Department-Kyunsu
47	U Zan Bu Di	Township Fire Department-Kyunsu
48	U Naung Lar	Village Administrator
49	U Zaw Naing	Supporting Committee
50	U Kalar Mei	Supporting Committee
51	Daw Tin Tin Oo	Women Affair Committee-Kyunsu
52	Daw Yin Yin Htun	Women Affair Committee-Kyunsu
53	Daw Hla Yee Htway	Women Affair Committee-Kyunsu
54	U Win Naing	Maung Hlaw Village Track
55	U Aung Than	Min Gout Village
56	Daw Moe Moe Cho	Kyunsu Township Children and Mother Welfare Organization
57	Daw Khin Saw Hmwe	Kyunsu Township Children and Mother Welfare Organization
58	Daw Htay Htay Yee	Kyunsu Township Children and Mother Welfare Organization
59	U Htun Hla	Village Administrator- Pa Htet Village

NO	Participant's Name	Organization/ Place
60	U Myint Zaw	Pa Htet- Quarter Head
61	U Myint Wei	Pa Htet- Quarter Head
62	U Chit Ko Ko Oo	Kyunsu
63	U Thaung Htun Lwin	Twonship Police Officer- Kyunsu
64	U Than Htun Oo	Kyay Thet- Kyunsu
65	U Myint Aye	USDP(Pyi Khaing Phyoe- Kyunsu
66	U Aung Thu Soe	USDP(Pyi Khaing Phyoe- Kyunsu
67	U Min Ko	USDP(Pyi Khaing Phyoe- Kyunsu
68	U Paing Soe	USDP(Pyi Khaing Phyoe- Kyunsu
69	U Aung Naing	Village Administrator- Taung Kyar
70	U Tin Htun	Supporting Committee- Taung Kyar
71	U Aye Lwin	Supporting Committee- Taung Kyar
72	U Hlaing Kyu	Supporting Committee- Taung Kyar
73	U Soe Naing	Yay Kan Taung
74	U Nyunt Shein	Yay Kan Taung
75	U Thein Naing	Yay Kan Taung
76	U Soe Paing	Kyunsu
77	U Min Ko	Pa Htaw
78	U Paing Soe	Pa Htet
79	U Than Lwin	Ma Yan Chaung
80	U Kyaw Myo Aung	National Unity Party- Secretary Kyunsu
81	U Hlaing Kyi	National Unity Party - Maung Hlaw
82	U Soe Tin	Village Administrator Pa Ka- Kyunsu
83	U Ko Lay	Kyunsu
84	U Khin Maung Win	Kyunsu
85	U Kyaw Hlaing	Kyunsu
86	U Htun Kho	Kywe Kha Yan- Village Administrator
87	U Soe Lwin	Thandaya Village Track- Kyunsu Township
88	U Tin Aung	Supporting Committee-Kywe Kha Yan
89	U Nyunt Soe	Yaw Nout Lwe- Than Khouk
90	U Kyaw San Oo	Yaw Nout Lwe- Than Khouk
91	U Kyi Shein	Tha Yet Kan
92	U Soe Oo	Zay Ka Mi
93	U Soe Naing	Zay Ka Mi
94	U Thaung Tin	Zay Ka Mi
95	U Shwe Than Maung	Nyaung Bee
96	U Win Myint	Nyaung Bee
96	U Soe Htay	Zay Ka Mi

NO	Participant's Name	Organization/ Place
98	U Aung Moe	Wah Yit Village
99	U Thein Win	Chairman- Township Planning Committee- Myeik
100	Police Major Than Oo	Member- Township Planning Committee-Myeik
101	Daw Estar Kaw	Member- Township Planning Committee-Myeik
102	Daw Mon Mon Naing	Member- Township Planning Committee-Myeik
103	U Ne Lin	Secretary- Township Planning Committee-Myeik
104	U Hla Than	Chairman- Township Supporting Committee-Myeik
105	U Ohn Nyunt	Member- Township Supporting Committee-Myeik
106	U Sein Htun	Member- Township Supporting Committee-Myeik
107	U Thet Soe	Member- Township Supporting Committee-Myeik
108	U Maung Yu	Member- Township Supporting Committee-Myeik
109	U Htway Wei	Member- Township Supporting Committee-Myeik
110	U Htun Htun Win	Secretary- Township Supporting Committee-Myeik
111	U Maung Maung Lay	Chairman- Township Municipal Committee-Myeik
112	U Ba Won	Member- Township Municipal Committee-Myeik
113	U Soe Yi	Member- Township Municipal Committee-Myeik
114	U Soe Thein	Member- Township Municipal Committee-Myeik
115	U Aye Naing	Member- Township Municipal Committee-Myeik
116	U Thet Oo Shein	Secretary- Township Municipal Committee-Myeik
117	U Myat Soe Win	Regional- Myanmar Port Authority Officer
118	U Shein Lin	Assistant Director- District Planning- Myeik
119	U Nyein Htway	Township Administrator- Kyunsu
120	U Thein Nyunt	E.O.M- Kyunsu Municipality
121	U Myo Win	Manager- MPP- Myanmar Oil
122	U Soe Min Htun	Assitant Director- Regional Land Record
123	U Hla Htun	Deputy Director- Districk Law Office
124	U Kyaw Thura	Lecture, Marine University- Myeik
125	U Aung Kyaw Oo	GM- Mining-2, Regional Mining Department
126	U Nanda Lin	AGM-Mining-2, Regional Mining Department
127	U Zaw One	Head- District Fire Department- Myeik
128	U Myo Win	Assistant Director- Forest Department
129	U Myint Oo	Myawaddy News
130	Ma Yoon Mitta Oo	Myawaddy News
131	Capt. Myint Aung	Navy- Myeik
132	Capt. Win Maw	Secretary, Sa Ta Ha- Navy Myeik
133	Coporal Tin Tin Htway	Member, Sa Ta Ha, Navy, Meyik
134	U Tin Myint	Chairman, Kyunsu Sa Ta Ha
135	U Htein Win	Director KyunSu Sa Ta Ha

NO	Participant's Name	Organization/ Place
136	U Aye Maung	Director KyunSu Sa Ta Ha
137	Daw Myint Myint Thi	Member- Mother & Childern Welfare Myeik Township
138	Daw Myo Ma Ma Thaw	Women Affair Committee- Myeik
139	U Than Swe	National Unity Party, Myeik Township
140	Daw San Thi	Mother & Chldren Welfare- Myeik
141	Daw Than Than Swe	Women Affair Committee- Myeik
142	U Win Kyi	Democratic Party(Myanmar)- Chairman- Myeik
143	U Win Maw	Democratic Party(Myanmar)- Member- Myeik
144	U Aung Khaing Oo	Administrator - Tawei Quarter- Myeik
145	U Sein Min	Administrator- Myeik Taung Quarter- Myeik
146	U Win Khaing	Administrator- Ah Lei Kyun Quarter- Myeik
147	U Htun Win Thein	Administrator- Nout Le Yat Quarter- Myeik
148	U Cho Lay	Administrator- Kan Kyi Quarter- Myeik
149	U Ye Naing	Administrator- Kan Pyar Quarter- Myeik
150	U Aung Kyaw Soe	Administrator- Kan Khaung Quarter- Myeik
151	U Khin Maung Yin	Administrator- Seik Nge- Quarter – Myeik
152	U Win Hlaing	Administrator- Say Tan Quarter- Myeik
153	U Soe Lwin	Administrator- Yay Pon Quarter- Myeik
154	U Aung Kyan	Administrator- Myit Nge Quarter- Myeik
155	U Maung Maung Oo	Administrator- Ta Laing Su Quarter- Myeik
156	U Htun Win	Administrator- Myeik Taung Village
157	U Thura Lin	Village Administrator- Ka Lwin Village Track
Operator Company		
1	Ms. Perla Woo	Vice President, CFG Energy Pte. Ltd.,
2	Mr. Wu Min Zhang	Executive Assistant, CFG Energy Pte. Ltd.,
3	Mr. Kyaw Moe	Country Special Representative, CFG Energy Pte. Ltd.,
EIA-SIA Consultant Company		
1	Charles Bouhelier	Environmental Engineer, Artelia
Myanmar Local Partner Company		
1	U Saw Oo	General Manager, Century Bright Gold
2	U Wynn Thein	Director, Century Bright Gold
3	U Myat Ko	Geologist, Century Bright Gold
4	U Aung Myat	Partner, Century Bright Gold
5	U Sai Win Kyaw	AGM, Century Bright Gold

Table 9 - 3 List of Participants attending the Second Public Consultation in Kyunsu (Yadana Hall), May 20th 2015

No	Name	Position/Organization	Address
1	U Ein Sein	No(1) Quarter, Kyunsu	
2	U Zaw Moe	No(2) Quarter, Kyunsu	
3	U Maung Kin	No(3) Quarter, Kyunsu	
4	U Mg Mg Thet Khaing Oo	No(4) Quarter, Kyunsu	
5	U Htun Hla	Ma Ai Village	
6	U Htun Bo	Kan Maw Village	
7	U Soe Lwin	Than Doke Village	
8	U Soe Oo	Zay Ka Mi Village	
9	U Naung Lar	Mei Taw Village	
10	U Soe Naing	Yay Kan Taung Village	
11	U Soe Aung	Kaw Za Yar Village	
12	U Soe Tin	Ka Pa Village	
13	U Sa Moe Zaw Oo	Yay Myit Kyi Village	
14	U Shwe Than Maung	Nyaung Bee Village	
15	U Moe Lwin	Kan Gyi Village	
16	U Saw La Kho	War Yit Village	
17	U Aung Naing	Taw Pyar Village	
18	U Aye Ko	Banda Nei Village	
19	U Than Htun	Min Goke Village	
20	U Htun Soe	Kywei Kha Yit Village	
21	U Kyaw Thant	Katta Lu Village	
22	U Zaw Win	Ka Bin Village	
23	U Saw Win	Sa Khan Thit Village	
24	U Win Naing	Maung Hla Village	
25	Daw Soe Soe Khaing	Kyunsu	
26	Daw San San Oo	Kyunsu	
27	U Aung Kyaw Kyaw	Kyunsu	
28	U Myo Win	Kyunsu	
29	U Aung San Oo	Kyunsu	
30	U Kaung Sett Naing	Kyunsu	
31	U Kyaw Naing Naing	Kyunsu	
32	U Ko Ko Aung	Kyunsu	
33	U Nay Naing Linn	Kyunsu	
34	U Hein Sitt Aung	Kyunsu	
35	U Chit Oo	Kyunsu	
36	U Min Zin Htun	Kyunsu	
37	U Si Thu Aung	Kyunsu	
38	U Nay Myo Kyaw	Kyunsu	
39	U Min Min Oo	Kyunsu	
40	U Zin Moe Kyaw	Kyunsu	
41	U Thura Soe	Kyunsu	
42	U Phyo Kyaw	Kyunsu	
43	U Zaw Ko Latt	Kyunsu	
44	Daw San San Cho	Kyunsu	
45	Daw La Pyae Win	Kyunsu	
46	U Phone Pyae Aung	Kyunsu	
47	U Htet Ko Ko Win	Kyunsu	
48	U Nyi Lwin Soe	Kyunsu	
49	U Min Ko Oo	Kyunsu	
50	U Kyaw Ko Oo	Kyunsu	

No	Name	Position/Organization	Address
52	U Naing Naing Win	Kyunsu	
53	U Nyi Ko Ko	Kyunsu	
54	U Pyi Phyoe Aung	Kyunsu	
55	U Aung Ye Linn	Kyunsu	
56	U San Linn Aung	Kyunsu	
57	U Lin Naing	Kyunsu	
58	Daw Khin San Thi	Kyunsu	
59	U Myo Win	Kyunsu	
60	U Hein Zaw	Kyunsu	
61	U Aung Thu	Kyunsu	
62	Daw Than Hla	Kyunsu	General Administrator-GA
63	Daw Su Myat Noe	Kyunsu	GA Office
64	U Kyaw Min Oo	Kyunsu	
65	Daw Aye Thidar Htun	Kyunsu	
66	U Min Pyae Phyo	Kyunsu	
67	Daw May Tin Zar Win	Kyunsu	
68	U Myat Kyaw Thu	Kyunsu	
69	U Than Naing	Kyunsu	
70	U Kyaw Soe Htun	Twonshipl Head- Kyunsu	Fishery Department
71	U Win Myint Htun	Regional Head-Tawei	Fishery Department
72	U Sein Thaung	District Head-Myeik	Fishery Department
73	U Thaung Myint	Member	Fishery Association- Kyunsu
74	U Thet Soe	Secretary	Fishery Association-Taninthary
75	U Thet Naing Oo	Member	Fishery Association- Myeik
76	U Nay Min Aung	Deputy-DC	GA Office- Kyunsu
77	Daw Ohnmar Swe	Deputy-DC	GA Office- Kyunsu
78	Daw Shwin Lei Yi Phyo	Kyunsu	GA Office
79	Daw Thet Thet Htun	Kyunsu	GA Office
80	U Lin Lin Naing	Kyunsu	GA Office
81	U Myo Paing	Special Beauro-SB	Myeik District- Intellegent Office
82	U Yan Naing Htun	In Charge	Information Department-Kyunsu
83	U Chi Ko Ko Oo	Kyunsu	
84	Daw Ei Ei Win	Kyunsu	
85	Daw Than Nu	Kyunsu	
86	Daw Yin Yin Htun	Kyunsu	
87	Daw Phyo Yati Thet	Kyunsu	
88	Daw Phyo Zar Chi Htway	Kyunsu	
89	Daw NweTin Oo	Kyunsu	
90	Daw Wah Wah Soe	Kyunsu	
91	U Min Hein Htun	Kyunsu	
92	U Zaw Myo	Kyunsu	
93	U Zaw Min Kyaw	Kyunsu	
94	Daw Yi Yi Maw	Kyunsu	Women Affair Organization-NGO
95	Daw Kyi Kyi Htin	Kyunsu	Women Affair Organization-NGO
96	Daw Myint Myint Shein	Kyunsu	Mother & Children Welfare Association

No	Name	Position/Organization	Address
97	Daw Win Win Htun	Kyunsu	Mother & Children Welfare Association
98	U Min We Oo	Kyunsu	Fire Department
99	U Aung Soe Min	Kyunsu	Fire Department
100	U Tin Myint	Kyunsu	Sa Hta Ha
101	U Thein Win	Kyunsu	Sa Hta Ha
102	Dr Kyaw Thura	Kyunsu	MMA Malaria- Health Centre-NGO
103	Daw Ya Min Ei	Kyunsu	
104	Daw Thidar Htay	Kyunsu	
105	Daw Khin May Ci	Kyunsu	
106	U Thiha Moe	Kyunsu	
107	U Myo Chit Naing	Kyunsu	
108	U Htay Aye	Kyunsu	
109	U Sa Phyo Zin Aung	Kyunsu	
110	U Than Tin	Ka De Ka Touk Village	
111	U Tin Win	Lin Ma Lo Kyi Village	
112	U Maung Sein	Lin Ma Lo Kyi Village	
113	U Myint Pe	Lin Ma Lo Kyi Village	
114	U Aung Lin Soe	Ma Yee Kyunt Village	
115	U Myint Naing	Ma Yee Kyunt Village	
116	U Soe Kay Latt	Ma Yee Kyunt Village	
117	U Htin Kyaw Linn	Ma Yee Kyunt Village	
118	U Ye Htun Oo	Ma Yee Kyunt Village	
119	U Kyaw Than	Ma Yee Kyunt Village	
120	U Soe Paing	Kyunsu	
121	U Win Aye	Mi Chaung Aww Village	
122	U Ba Shwe	Mi Chaung Aww Village	
123	U Ohn Thwin	Tar La Paing Village	
124	U Han Soe	Tar La Paing Village	
125	U Mon Shwe Yee	Lei Mit War Village	
126	U Aye Than	Lei Mit War Village	
127	U Win Naing	Sa Lwun Aww Village	
128	U Htun Win	Yay Myit Kyi Village	
129	U Kyin Thaung	Yay Myit Kyi Village	
130	Daw Hla Yee Htway	Yay Myit Kyi Village	
131	Daw Htay Mu	Yay Myit Kyi Village	
132	Daw Htet May	Yay Myit Kyi Village	
133	U Han Moe	Tar Ya Paing Village	
134	U Soe Myint	Thae Tan Kyi Village	
135	U Than Win	Sa Lwun Aww Village	
136	U Thura Haling Oo	Sa Lwun Aww Village	
137	U Myo Min Htun	Sa Lwun Aww Village	
138	U Mya Sein Htun	Tar Ya Paing Village	
139	U San Htun	Sa Lwun Aww Village	
140	Daw Myint Nwee	Kan Gyi Village	
141	Daw Soe Mar Khaing	Kan Gyi Village	
142	U Hla Myo	Kyunsu	Clark
143	U Nyein	No(4) Quarter, Kyunsu	
144	U Lay Myint	No(4) Quarter, Kyunsu	
145	Daw Pan Hmwe	No(4) Quarter, Kyunsu	
146	Daw Myint Htway	No(4) Quarter, Kyunsu	
147	U Than Aung	No(4) Quarter, Kyunsu	

No	Name	Position/Organization	Address
148	U Ko Thein	No(4) Quarter, Kyunsu	
149	U Soe Nge	No(4) Quarter, Kyunsu	
150	U Naing Lin	No(4) Quarter, Kyunsu	
151	U Aung Zaw Oo	No(4) Quarter, Kyunsu	
152	U Than Zaw Oo	No.(3) Quarter, Kyunsu	
153	U Htay Lwin	No(1) Quarter, Kyunsu	
154	U Thein Aung	No(2) Quarter, Kyunsu	
155	U Han Tin	No(4) Quarter, Kyunsu	
156	U Myo Oo	No(4) Quarter, Kyunsu	
157	U Thaung Aye	No(1) Quarter, Kyunsu	
158	U Myo Nyunt	Kan Maw Village	
159	U Myo Nge	Kan Maw Village	
160	U Htay Shin	No(2) Quarter, Kyunsu	
161	Ma Aye Seint Thu	Lin Ma Lo Kyi Village	
162	Ma Hay Mar Htun	Lin Ma Lo Kyi Village	
163	U Kyi Shein	Tha Naing Kan Village	
164	U Than Soe	Mei Yar Village	
165	U Thaung Sein	Kann Kyi Village	
166	U Thiha Soe	Kann Kyi Village	
167	U Win Myint	Nyaung Bee Village	
168	U Zin Mar Myo	Nyaung Bee Village	
169	U Hla Win	Pa Ka Village	
170	U Hlaing Kyi	Maung Kha Hlaw Village	
171	U Tin Shein	Maung Kha Hlaw Village	
172	U Chan Aung	Kyunsu	NLD Party (Opposition Party)
173	U Ko Lay	Kyunsu	NLD Party
174	U Kyaw Hlaing	Kyunsu	NLD Party
175	Daw Maw Maw Htay	Kyunsu	USDP Party(Ruling Party)
176	U Win Htiek	Kyunsu	USDP Party(Ruling Party)
177	U Pho Kyi	Kyunsu	Democrat Party(Opposition)
178	U Myint Aye	Kyunsu	USDP Party(Ruling Party)
179	U Zayar Oo	Kyunsu	USDP Party(Ruling Party)
180	U Zin Myo Htun	Lak Kywei Village	
181	U Myint Thein	Lak Kywei Village	
182	U Htun Htun Win	Htein Chaung Village	
183	U Aung Toe	Htein Chaung Village	
184	U Than Htun Oo	Htein Chaung Village	
185	U Htay Aung	Htein Chaung Village	
186	U Win Naing	Htein Chaung Village	
187	U Inn Htway	Htein Chaung Village	
188	U Si Thura Aung	Htein Chaung Village	
189	U San Htun	Htein Chaung Village	
190	U Htay Tin	Htein Chaung Village	
191	U Htay Win Hlaing Htun	Htein Chaung Village	
192	U Thaung Htun	Htein Chaung Village	
193	U Aung Myo Khaing	Htein Chaung Village	
194	U Min Hein Htun	Htein Chaung Village	
195	U Win Kyaw	War Yit Village	
196	Daw Khin Lay Yee	No(1) Quarter, Kyunsu	
197	Daw Khin Mar Kyi	No(1) Quarter, Kyunsu	
198	Daw Myint Than	No(1) Quarter, Kyunsu	
199	Daw Nu Wei	No(1) Quarter, Kyunsu	

No	Name	Position/Organization	Address
200	Daw Kyin Mya	No(1) Quarter, Kyunsu	
201	U Hla Sein	No(1) Quarter, Kyunsu	
202	U Win Thaing	No(1) Quarter, Kyunsu	
203	U Shwe Htin	No(1) Quarter, Kyunsu	
204	U Kyaw Soe	No(1) Quarter, Kyunsu	
205	U Htun Sein	No(1) Quarter, Kyunsu	
206	U Aung Ko Ko	No(1) Quarter, Kyunsu	
207	Daw Yee Maw	No(2) Quarter, Kyunsu	
208	U Htay Win	No(2) Quarter, Kyunsu	
209	Daw Yu Yu Maw	No(2) Quarter, Kyunsu	
210	Daw Hnin Yee	No(2) Quarter, Kyunsu	
211	Daw Than Mu	No(2) Quarter, Kyunsu	
212	U Ya Nant Paing Lin	No(2) Quarter, Kyunsu	
213	U Kyaw Swar Win	No(2) Quarter, Kyunsu	
214	U Win Kyi	No.(3) Quarter, Kyunsu	
215	U Oh Thaung	No.(3) Quarter, Kyunsu	
216	U Chit Thein	No.(3) Quarter, Kyunsu	
217	U Maung Tin	No.(3) Quarter, Kyunsu	
218	U Kaung Htet Moe Sett	No.(3) Quarter, Kyunsu	
219	H. E. U Thein Lwin	Minister for Eco & Planning	Taninthary Regional Government
220	U Nyein Htway	General Administractor-GA	Kyunsu Township GA Office(DC)
221	Maj Thaung Htun Lwin	Kyunsu Police Station	Police Commander
222	U Win Myat Htut	Kyunsu Township Immigration	In Charge of Immigration Department
223	U Aung Lwin Moe	Agricultural Officer	Agriculture Department- Kyunsu
224	Dr. Thant Zaw Maung	Health Officer	Health Department- Kyunsu
225	U Kyi Swun	Education Officer	Education Department- Kyunsu
226	U San Hmwe	Fishery Officer	Fishery Department- Kyunsu
227	U Aung Soe Min	Lawyer	Legal Department- Kyunsu
228	U Than Naing Oo	Judge	Judicial Departmenr- Kyunsu
229	U Naing Lin Htun	Forest Officer	Forest Department- Kyunsu
230	U Min Aung	Land Record Officer	Land Department-Kyunsu
231	U Soe Myint	Bank Officer	State Bank- Kyunsu
232	Daw War War Khaing	Information Officer	Information Department- Kyunsu
233	U Thein Nyunt	City Councillor	Municipal- Kyunsu
234	U Nay Lin Aung	Tax Officer	Internal Revenue Department-Kyunsu
235	U Aung Zaw Moe	Electrical Officer	Electric Department-Kyunsu
236	U Tin Soe	Co-Op Officer	Co-Op Department-Kyunsu
237	U Saw Win Ko	Agricultural Officer	Agriculture Department- Kyunsu
238	Daw Than Nu	Auditor	Audit Department-Kyunsu
239	U Win Cho	Civil Engineer	Construction Department- Kyunsu
240	U Soe Naing	Tsp Planning Officer	Planning Department- Kyunsu
241	U Aung Zaw Oo	Fire Officer	Fire Department- Kyunsu

No	Name	Position/Organization	Address
242	U Than Htun Oo	Rurual Development Officer	Rural Development Dept.-Kyunsu
243	Dr. Aung Win Myint	Vetarian	Live Stock Department-Kyunsu
244	Daw Nu Nu Hlaing	Communication Officer	MPT Department- Kyunsu
245	U Than Htway	Tsp Sport Officer	Sport Department- Kyunsu
246	U Than Kywe	Member	Township Supporting Committee-Kyunsu
247	U Aung Naing	Member	Township Supporting Committee-Kyunsu
248	U Nyunt Swe	Member	Township Supporting Committee-Kyunsu
249	U Aung Than Win	Member	Township Supporting Committee-Kyunsu
250	U Khin Soe	Member	Township Municipal- Kyunsu
251	U Inn Sein	Member	Township Municipal- Kyunsu
252	U Thant Zin Aung	Election Officer	Election Commission Office-Kyunsu
253	U Myat Lwin	Intellegent Officer	Military Intellent Office-Kyunsu
Operator Company			
1	Ms. Perla Woo	Vice President, CFG Energy Pte. Ltd.,	
2	Mr. Wu Min Zhang	Executive Assistant, CFG Energy Pte. Ltd.,	
3	Mr. Kyaw Moe	Country Special Representative, CFG Energy Pte. Ltd.,	
EIA-SIA Consultant Company			
1	Charles Bouhelier	Environmental Engineer, Artelia	
Myanmar Local Partner Company			
1	U Kyaw Thura	Chairman	Century Bright Gold Company
2	Daw Khin Khin Hla	Director	Century Bright Gold Company
3	U Swe Lynn	Managing Director	Century Bright Gold Company
4	U Saw Oo	General Manager, Century Bright Gold	
5	U Wynn Thein	Director, Century Bright Gold	
6	U Myat Ko	Geologist, Century Bright Gold	
7	U Aung Myat	Partner, Century Bright Gold	
8	U Sai Win Kyaw	AGM, Century Bright Gold	

CSR Statement from CFG Energy Pte. Ltd.,

We are fully committed to fulfill our obligations to Corporate and Social Responsibility (CSR) as a responsible operator in Myanmar and in accordance with the terms of the Production Sharing Contract with the Myanmar Oil and Gas Enterprise (MOGE). In addition to bringing inward investment, we are contributing to job creation as we employ local labour as well as using local facilities and infrastructure. If successful in our exploration program, this will provide more opportunities for jobs and increased revenues at the local and national scale. In this case, the company will be able to contribute to meaningful CSR projects that can improve livelihood and bring improvements to the lives of the people. We will respect and honour Myanmar law in all aspects of our operation in Myanmar. This will encompass land use and the environment whether on land or at sea. We will continue to work with MOECAF at the national and local levels and with other related governmental agencies including the Department of Fisheries and Port Authorities, so that we remain informed on initiatives and directives that will help us comply with and contribute to sustainable and responsible exploration and production of energy reserves.

10. CONCLUSIONS/RECOMMENDATIONS

Oceanic 3D seismic acquisition surveys are attracting increased attention for their environmental (and to a lesser extent, socio-economic) impacts especially in areas where marine life could be affected by the powerful sound pressure waves created by airgun arrays which are used to obtain data from below the seabed. The possible impacts of seismic pressure waves on marine life, especially mammals, are the subject of considerable contemporary research and media attention.

This Initial Environmental Examination (IEE) for the M15 Block has identified a number of environmental and social impacts and risks, all of which can be mitigated to varying extents by the measures recommended. In the case of socio-economic impacts, the exploration and possible development of the gas reserves thought to be present in the Block represents a 'big picture' socio-economic gain for Myanmar and the Tanintharyi Region, though during the three months of continuous seismic survey there is likely to be disturbance to the commercial fishing activities known to take place in the study area, and there may also be disturbance to marine traffic routes traversing the Block. With the adoption of sensitive operational maritime procedures and the implementation of an effective communications strategy, both of these issues can be managed to reduce both operational risks and economic impacts.

In the case of environmental impacts, many of the minor impacts and risks can be avoided or mitigated through the adoption of sensitive operational maritime procedures including compliance with COLREGS and MARPOL, and the adoption of on-board practices governed by the design and implementation of an Environmental and Social Management Plan (ESMP). However, in the case of the possible impacts of seismic pressure waves on marine life and also the possibility of collisions between vessels and cetaceans and/or entanglement of turtles in seismic arrays, a precautionary approach to mitigation is strongly recommended, especially as marine life in the Andaman Sea has to date not been especially well characterized. Our assessment is that it is highly probable that 21 species of marine mammal including IUCN Vulnerable and Endangered Species could be present during the survey period, in addition to adult turtles. In respect of possible serious impacts from seismic waves on cetaceans (in the worst case, irreversible hearing damage likely to lead to fatality), we recommend the adoption of JNCC (2010) guidance, which entails the implementation of Marine Mammal Observation (MMO); Passive Acoustic Monitoring (PAM); soft-start procedures; and concentric shut down and power-down zones; this in our recommendation represents best practice with respect to managing reduced impacts on and risks to, marine life. The correct implementation of a JNCC programme for the M15 survey will very significantly reduce the risk of injury to marine mammals likely to be present. Most (though not all) countries implementing national guidance on this subject have adopted JNCC guidance and our recommendation is that the relevant authorities in Myanmar should consider its adoption.

Similarly, the risk of vessel collisions and equipment entanglements with cetaceans, whale sharks and turtles can be minimised by implementing the recommended mitigation plan based on MMO and sensitive navigation procedures, coupled with preventing and checking for entanglement on streamer tail buoys.

Overall, the environmental and socio-economic impacts and risks identified for this Project can, with responsible implementation and management of the mitigation recommendations set out in this IEE, be reduced to minimal or acceptable levels.

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12. APPENDICES

ANNEX 1 Policy, legal and administrative framework

LEGAL FRAMEWORK

Relevant National Policy, Administrative Framework and Legislation for Myanmar

Institutional Environmental Governance

The National Commission for Environmental Affairs (NCEA) was formed in 1990 by Myanmar's Ministry of Foreign Affairs (MFA) to act as a central management agency for environmental matters. This agency is divided into four sub-committees:

- Conservation of Natural Resources;
- Control of Pollution;
- Research, Information and Education; and
- International Cooperation.

The NCEA has a Chairman, a Secretary and a Joint Secretary. All three representatives are simultaneously senior officials in the MFA, the NCEA Chairman also being the Minister of Foreign Affairs.

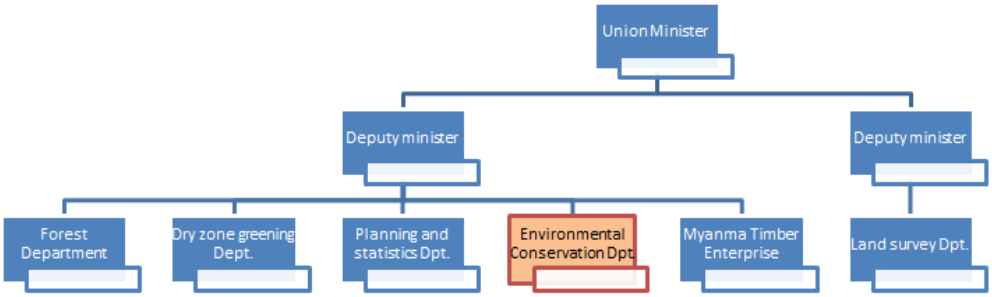
The ministerial departments relevant to the Block M15 project are:

- Ministry of Development and Planning;
- Ministry of Energy;
- Ministry of Industry;
- Ministry of Labour;
- Ministry of Environmental Conservation and Forestry; and
- Ministry of Transport.

In 1994, the NCEA formulated the National Environment Policy (NEP) which represents Myanmar's fundamental policy on environmental protection. The NCEA also assists the ministerial departments in drafting environmental legislation and published the Myanmar Agenda 21 in 1997 which sets out programmes for sustainable consumption and environmental conservation works. The Myanmar Agenda 21 calls for the integrated management of natural resources and provides a blueprint for achieving sustainable development.

The NCEA was replaced in April 2011 by the National Environmental Conservation Committee (NECC) as the central organisation for the national environmental management in Myanmar.

The Ministry of Environmental Conservation and Forestry (MOECAF) replaced the Ministry of Forestry in September 2011 as the focal agency for environmental management. The Environmental Conservation Department (ECD) sits under MOECAF (see Figure below) and is responsible for the implementation of national environmental conservation policy.



Organisational structure of MOECAF

The ECD manages natural resources conservation and sustainable utilization, pollution control of water, air and land for the sustainable environment. It cooperates with other government organizations, civil society, private sector and international organizations concerned with environmental management. ECD is currently engaged in:

- The development of further legislation;
- The coordination of environmental conservation activities;
- Developing plans for climate change mitigation and adaptation; combating desertification; and ozone layer protection;
- Providing national reporting in line with international agreements.

A major recent legislative development is the Myanmar Environmental Conservation Law (30th March, 2012), comprising 14 Chapters and 42 Articles, and implementing the Myanmar National Environmental Policy of 1994.

An Environmental Conservation Committee has been formed with the duty of enacting and guiding further environmental legislation.

Environmental conservation department

The Environmental Conservation Department, one of the six departments under the Ministry of Environmental Conservation and Forestry is responsible for implementing National Environmental Policy, strategy, framework, planning and action plan for the integration of environmental consideration into in the national sustainable development process. ECD also manages natural resources conservation and sustainable utilization, the pollution control on water, air and land for the sustainable environment. It cooperates with other government organizations, civil society, private sectors and international organizations concerning with environmental management.

The main ECD on-going actions are the following:

- To develop legislation related to regulations, guidelines and procedures;
- Coordinate for environmental conservation activities;
- To develop plans of climate change mitigation and adaptation, of combat to desertification and ozone layer protection;
- To do national report in relation with international agreements

ANNEX 2 JNCC Guidelines

JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys

August 2010

To find out more about seismic surveys visit http://www.jncc.gov.uk/page-1534
To learn more about JNCC visit http://www.jncc.gov.uk/page=1729

JNCC, Marine Advice,
Inverdee House, Baxter Street
Aberdeen, AB11 9QA,
United Kingdom
Tel: +44(0)1224 266550
Email: seismic@jncc.gov.uk

JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys

August 2010

Introduction

The guidelines have been written for activities on the United Kingdom Continental Shelf (UKCS) and are aimed at reducing the risk of injury to negligible levels and can also potentially reduce the risk of disturbance from seismic surveys to marine mammals including seals, whales, dolphins and porpoises. Whilst there are no objections to these guidelines being used elsewhere JNCC would encourage all operators to determine if any special or local circumstances pertain, as we would not wish these guidelines to be used where a local management tool has already been adopted (for instance in the Gulf of Mexico OCS Region). In this context, JNCC notes that other protected fauna, for example turtles, will occur in waters where these guidelines may be used, and would suggest that, whilst the appropriate mitigation may require further investigation, the soft-start procedures for marine mammals would also be appropriate for marine turtles and basking sharks[i].

The guidelines require the use of trained Marine Mammal Observers (MMOs) whose role is to advise on the use of the guidelines and to conduct pre-shooting searches for marine mammals before commencement of any seismic activity. A further duty is to ensure that the JNCC reporting forms are completed for inclusion in the MMO report. In addition to the visual mitigation provided by MMOs, if seismic surveys are planned to start during hours of darkness or low visibility it is considered best practice to deploy Passive Acoustic Monitoring (PAM).

The 2010 version of the JNCC seismic guidelines reflects amendments (2007 and 2009 amendments) to the Conservation (Natural Habitats &c.) Regulations 1994 (Habitat Regulations, HR) for England and Wales[ii] and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (Offshore Marine Regulations, OMR**,** as amended in 2009 and 2010). Both regulations have revised the definition of deliberate disturbance of 'European Protected Species' (EPS), which now excludes

[i] Basking sharks are protected from intentional capture or disturbance in British waters (up to 12 miles offshore) under a 1998 listing on the Wildlife and Countryside Act (1981), Schedule 5.
[ii] In 2010 a consolidated version of the regulations came into force: The Conservation of Habitats and Species Regulations 2010.

trivial disturbance from the offence. Both regulations now also include the offence of deliberate injury. European Protected Species include cetaceans and turtles.

It has been recognised that sound generated from seismic sources has the potential to cause injury and possibly also disturbance to marine mammals. Seismic surveys have therefore the potential to cause a deliberate injury offence as defined under regulations 41(1)(a) and 39(1)(a) and a deliberate disturbance offence as in 41(1)(b) and 39(1)(b) of the HR and OMR, respectively. The JNCC seismic guidelines reflect best practice for operators to follow during the planning, operational and reporting stages. **It is considered that compliance with the recommendations in these guidelines will reduce the risk of injury to EPS to negligible levels**.

Please note that the mitigation measures recommended in the existing guidelines are more relevant to the prevention of injury rather than disturbance as defined in regulations 41(2) and 39(1A), of the HR and OMR, respectively. The onus should be on the entity responsible for the activity to assess whether a disturbance offence is likely to occur. Guidance on how to carry out such risk assessment is provided in the JNCC, NE and CCW document 'The protection of marine European Protected Species from injury and disturbance'.

In relation to oil and gas seismic surveys in the UKCS, it is a requirement of the consent issued under regulation 4 of the Petroleum Activities (Conservation of Habitats) Regulations 2001 (& 2007 Amendments) by the Department for Energy Climate Change (DECC), that the JNCC Seismic Guidelines must be followed, and the elements of the guidelines that are relevant to a particular survey are incorporated into the legally-binding condition of consent. It should be noted that it is the responsibility of the company issued consent by DECC[iii], referred to in these guidelines as the 'applicant', to ensure that these guidelines are followed, and it is recommended that a copy of the JNCC guidelines are available onboard all vessels undertaking seismic activities in UK waters. Where relevant, when the survey is completed a MMO report must be submitted to the JNCC.

[iii] Department of Energy and Climate Change was formerly known as Department for Business and Regulatory Reform (BERR)

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Terminology

Marine European Protected Species: These are marine species in Annex IV(a) of the Habitats Directive that occur naturally in the waters of the United Kingdom. These consist of several species of cetaceans (whales, dolphins and porpoises), turtles, and the Atlantic Sturgeon.

Marine Mammal Observer (MMO): Individual responsible for conducting visual watches for marine mammals. For some seismic surveys it may be requested that observers are trained, dedicated and / or experienced. The MMO may also be a PAM operative if trained.

- **Trained MMO**: Has been on a JNCC recognised course
- **Dedicated MMO**: Trained observer whose role on board is to conduct visual watches for marine mammals (although it could double up as a PAM operative)
- **Experienced MMO**: Trained observer with 3 years of field experience observing for marine mammals, and practical experience of implementing the JNCC guidelines
- **PAM Operative**: Person experienced in the use of PAM software and hardware and marine mammal acoustics

Mitigation Zone: The area where a Marine Mammal Observer keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected).

Passive Acoustic Monitoring (PAM): Software system that utilises hydrophones to detect the vocalisations of marine mammals.

Seismic Survey: Any survey that uses airguns, including 2D/3D/4D and OBC (On-Bottom Cabling) surveys and any similar techniques that use airguns. Surveys using multibeam systems and sub-bottom profiling equipment such as boomers, pingers etc are not considered in these guidelines. However, the guidelines can be adapted and applied to the operation of such systems if considered appropriate.

Shot Point Interval (SPI): Interval between firing of the airgun or airguns.

Site Survey: Seismic survey of a limited area proposed for drilling, infrastructure emplacement etc (typically with source size of 180 cubic inches or less).

Soft-Start: Turning on the airguns at low power and gradually and systematically increasing the output until full power is achieved (usually over a period of 20 minutes). The appropriate soft-start method is dependant upon the type of seismic survey and is discussed in section 3.

United Kingdom Waters: Parts of the sea in or adjacent to the United Kingdom from the low water mark up to the limits of the United Kingdom Continental Shelf.

Vertical Seismic Profiling (VSP) or Borehole Seismic: Seismic survey undertaken ‘down hole’ in connection with well operations (typically with a source size of 500 cubic inches).

Section 1 – Assessing and minimising the risk of injury

1.1 The Planning Stage

When a seismic survey is being planned, the applicant should consider the following recommendations and best practice advice:

- Determine what marine mammal species are likely to be present in the survey area and assess if there are any seasonal considerations that need to be taken into account, for example periods of migration, breeding, calving or pupping. For UKCS activities the 'Atlas of cetacean distribution in north-west European waters' (Reid *et al*. 2003) is a useful starting point.
- Consult the latest relevant regulatory guidance notes; in the UK, DECC issues guidance notes for oil and gas seismic activities.
- As part of the environmental impact assessment, assess the likelihood of injuring or disturbing a European Protected Species. In the UK, it will be necessary to assess the likelihood of committing an offence as defined in the HR and in the OMR.
- Consult the JNCC, NE and CCW guidance on 'The protection of marine European Protected Species from injury and disturbance' to assist in the environmental impact assessment. To obtain a copy of the latest draft version of the guidance please contact JNCC.

The operator should whenever possible implement the following best practice measures:

- If marine mammals are likely to be in the area, only commence seismic activities during the hours of daylight when visual mitigation using Marine Mammal Observers (MMOs) is possible.
- Only commence seismic activities during the hours of darkness, or low visibility, or during periods when the sea state is not conducive to visual mitigation, if a Passive Acoustic Monitoring (PAM) system is in use to detect marine mammals likely to be in the area, noting the limitations of available PAM technology (seismic surveys that commence during periods of darkness, or low visibility, or during periods when the observation conditions are not conducive to visual mitigation, could pose a risk of committing an injury offence).
- Plan surveys so that the timing will reduce the likelihood of encounters with marine mammals. For example, this might be an important consideration in certain areas/times, e.g. during seal pupping periods near Special Areas of Conservation for common seals or grey seals.
- Provide trained MMOs to implement the JNCC guidelines.
- Use the lowest practicable power levels to achieve the geophysical objectives of the survey.
- Seek methods to reduce and/or baffle unnecessary high frequency noise produced by the airguns (this would also be relevant for other acoustic energy sources).

Section 2 - Marine Mammal Observers

2.1. Role of an MMO

The primary role of an MMO is to act as an observer for marine mammals and to recommend a delay in the commencement of seismic activity should any marine mammals be detected. In addition, a MMO should be able to advise the crew on the procedures set out in the JNCC guidelines and to provide advice to ensure that the survey programme is undertaken in accordance with the guidelines. Before the survey commences it is important to attend any pre-mobilisation meetings to discuss the working arrangements that will be in place, and to request a copy of the survey consent issued by DECC (if applicable). An MMO may also work closely with Passive Acoustic Monitoring operatives. As the MMO role in relation to the vessel and survey operations is purely advisory, it is important to be aware of the command hierarchy and communication channels that will be in place, and determine who the main MMO / PAM operative contacts should be.

In a typical vessel based seismic survey, the MMO / PAM operative may pass advice to the party chief and client's representative through the navigators or seismic observers, and it is important to establish what the working arrangements are, as this may vary from one survey to the other. The MMOs should consider themselves as part of the crew and respect the chain of command that is in place.

MMOs should make certain that their efforts are concentrated on the pre-shooting search before the soft-start. These guidelines cannot be interpreted to imply that MMOs should keep a watch during all daylight hours, but JNCC would encourage all MMOs to manage their time to ensure that they are available to carry out a watch to the best of their ability during the crucial time - the 30 minutes before commencement of the firing of the seismic source (or 60 minutes if surveying where deep diving marine mammals are likely to be present). Whilst JNCC appreciates the efforts of MMOs to collect data at other times, this should be managed to ensure that those observations are not detrimental to the ability to undertake a watch prior to a soft-start. Where two MMOs are onboard a seismic vessel, JNCC would encourage collaboration to ensure that cetacean monitoring is always undertaken during all daylight hours.

2.2. Training requirements for MMOs

A prerequisite for an MMO to be classified as a 'trained MMO' is that they must have received formal training on a JNCC recognised course. (Further information on MMO course providers is available at: http://www.jncc.gov.uk/page-4703)

2.3. MMO equipment and reporting forms

MMOs should be equipped with binoculars, a copy of the JNCC guidelines and the 'Marine Mammal Recording Form' which is an Excel spreadsheet and has embedded worksheets named: 'Cover Page', 'Operations', 'Effort' and 'Sightings'. A Word document named 'Deckforms' is also available, and MMOs may prefer to use this when observing before transferring the details to the Excel spreadsheets.

The ability to determine range is a key skill for MMOs to have, and a useful tool to perform this function is a range finding stick.

All MMO forms, including a guide to completing the forms, and instructions on how to make and use a range finding stick are available on the JNCC website.

2.4. Reporting requirements – the MMO report

A report, the 'MMO report', should be sent to the JNCC after the survey has been completed. It is the responsibility of the consent holder to ensure that the MMO report is sent to JNCC. Ideally the MMO report should be sent via e-mail to seismic@jncc.gov.uk, or it can be posted to the address on the front page of these guidelines. Reports should include completed JNCC marine mammal recording forms and contain details of the following:

- The seismic survey reference number provided to the applicant by DECC.
- Date and location of survey.
- Total number and volume of the airguns used.
- Nature of airgun array discharge frequency (in Hz), intensity (in dB re. 1µPa or bar metres) and firing interval (seconds), and / or details of any other acoustic energy used.
- Number and types of vessels involved in the survey.
- A record of all occasions when the airguns were used.
- A record of the watches made for marine mammals, including details of any sightings and the seismic activity during the watches.
- Details of any problems encountered during the seismic survey including instances of non-compliance with the JNCC guidelines.

If there are instances of non-compliance with the JNCC guidelines that constitute a breach of the survey consent conditions, JNCC will copy the report, and their comments on the potential breach to DECC. It is therefore essential that MMO reports are completed as soon as possible after the survey has been completed.

Section 3 – Guidance before and during seismic activity

All observations should be undertaken from the source vessel (where the airguns are being deployed from), unless alternative arrangements have been agreed with DECC. The MMO should be positioned on a high platform with a clear unobstructed view of the horizon, and communication channels between the MMO and the crew should be in place before commencement of the pre-shooting search (this may require portable VHF radios). The MMO should be aware of the timings of the proposed operations, so that there is adequate time to conduct the pre-shooting search. Figure 1 illustrates a typical seismic survey with decision making pathways in the event a marine mammal is detected.

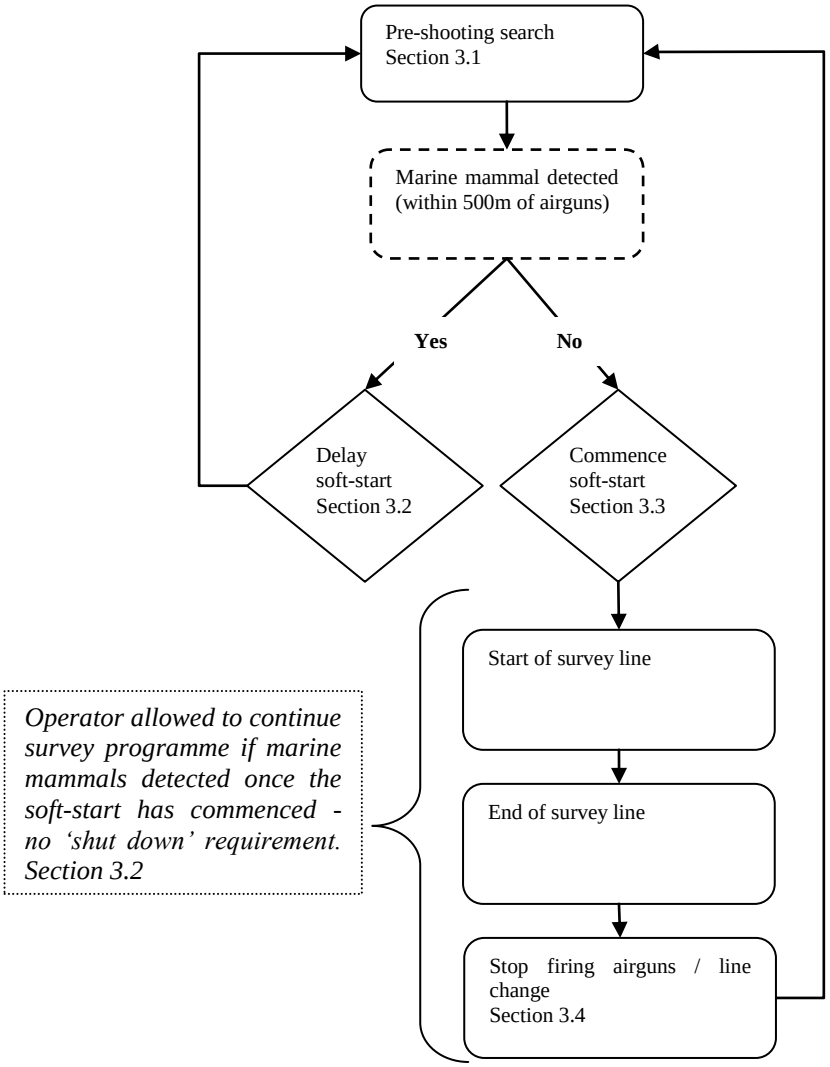

Figure 1. Flowchart illustrating the decision making pathway of a Marine Mammal Observer during a seismic survey.

3.1 Pre-shooting search

The pre-shooting search should normally be conducted over a period of 30 minutes before commencement of any use of the airguns. The MMO should make a visual assessment to determine if any marine mammals are within 500 metres of the centre of the airgun array.

In deep waters (>200m) the pre-shooting search should extend to 60 minutes as deep diving species (e.g. sperm whale and beaked whale) are known to dive for longer than 30 minutes. A longer search time in such areas is likely to lead to a greater detection and tracking of deep diving marine mammals.

To facilitate more effective timing of proposed operations when surveying in deeper waters, the searches for marine mammals can commence before the end of the survey line (whilst the airguns are still firing); this condition may be necessary for surveys which have relatively fast line turn times. If any marine mammals are

detected whilst the airguns are still firing, then no action is required other than for the MMO to monitor and track any marine mammals. The commencement of the soft-start for any subsequent survey lines should be delayed for at least 20 minutes if marine mammals are detected when the airguns have ceased firing.
If PAM is used in conjunction with visual monitoring the PAM operatives should ensure the system is deployed and being monitored for vocalisations during each designated pre-shooting period.

3.2 Delay if marine mammals are detected within the mitigation zone (500 metres)

If marine mammals are detected within 500 metres of the centre of the airgun array during the pre-shooting search, the soft-start of the seismic sources should be delayed until their passage, or the transit of the vessel, results in the marine mammals being more than 500 metres away from the source. In both cases, there should be a 20 minute delay from the time of the last sighting within 500 metres of the source to the commencement of the soft-start, in order to determine whether the animals have left the area. If PAM is used it is the responsibility of the PAM operatives to assess any acoustic detections and determine if there are likely to be marine mammals within 500 metres of the source. If the PAM operatives consider marine mammals are present within that range then the start of the operation should be delayed as outlined above.

If marine mammals are detected within 500 metres of the centre of the airgun array whilst the airguns are firing, either during the soft-start procedure or whilst at full power, there is no requirement to stop firing the airguns.

In situations where seal(s) are congregating around a drilling or production platform that is within the survey area, it is recommended that the soft-start should commence at a location at least 500 metres from the platform.

3.3 The soft-start

The soft-start is defined as the time that airguns commence shooting till the time that full operational power is obtained. Power should be built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the area. This build up of power should occur in uniform stages to provide a constant increase in output. There should be a soft-start every time the airguns are used, the only exceptions being for certain types of airgun testing (section 3.3.2), and the use of a ‘mini-airgun’ (single gun volume less than 10 cubic inches), these are used on site-surveys (section 3.3.1). The duration of the pre-shooting search (at least 30 minutes) and the soft-start procedure (at least 20 minutes) should be factored into the survey design.

General advice to follow for soft-starts:

- To minimise additional noise in the marine environment, a soft-start (from commencement of soft-start to commencement of the line) should not be significantly longer than 20 minutes (for example, soft-starts greater than 40

minutes are considered to be excessive, and an explanation should be provided within the MMO report).

- Where possible, soft-starts should be planned so that they commence within daylight hours.
- Once the soft-start has been performed and the airguns are at full power the survey line should start immediately. Operators should avoid unnecessary firing at full power before commencement of the line.
- If, for any reason, firing of the airguns has stopped and not restarted for at least 10 minutes, then a pre-shooting search and 20 minute soft-start should be carried out (the requirement for a pre-shooting search only applies if there was no MMO on duty and observing at this time, and if the break in firing occurred during the hours of daylight). After any unplanned break in firing for less than 10 minutes the MMO should make a visual assessment for marine mammals (not a pre-shooting search) within 500 metres of the centre of the airgun array. If a marine mammal is detected whilst the airguns are not firing the MMO should advise to delay commencement, as per the pre-shooting search, delay and soft start instructions above. If no marine mammals are present then they can advise to commence firing the airguns.
- When time-sharing, where two or more vessels are operating in adjacent areas and take turns to shoot to avoid causing seismic interference with each other, the soft-start and delay procedures for each vessel should be communicated to, and applied on, all the vessels involved in the surveying.

3.3.1 Soft-start requirements for site survey or Vertical Seismic Profiling (VSP)

Surveys should be planned so that, whenever possible, the soft-start procedures for site surveys and Vertical Seismic Profiles (VSP's) commence during daylight hours. Whilst it is appreciated that high resolution site surveys / VSP operations may produce lower acoustic output than 2D or 3D surveys it is still considered desirable to undertake a soft-start to allow for marine mammals to move away from the seismic source.

For ultra high resolution site surveys that only use a 'mini-airgun' (single airgun with a volume of less than 10 cubic inches) there is no requirement to perform a soft-start, however, a pre-shooting search should still be conducted before its use.

For site surveys and VSPs, a number of options are available to effect a soft-start.

- The standard method, where power is built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the vicinity.
- As the relationship between acoustic output and pressure of the air contained in the airgun is close to linear and most site surveys / VSP operations use only a small number of airguns and a soft-start can be achieved by slowly increasing the air pressure in 500 psi steps. From our understanding, the minimum air pressure which the airgun array can be set to will vary, as this is dependent on the make and model of the airgun being used. The time from initial airgun start up to full power should be at least 20 minutes.

- Over a minimum time period of 20 minutes the airguns should be fired at an increasing frequency (by decreasing the Shot Point Interval (SPI)) until the desired firing frequency is reached.

3.3.2 Soft-starts and airgun testing

Airgun tests may be required before a survey commences, or to test damaged or misfiring guns following repair, or to trial new arrays. Individual airguns, or the whole array may need testing, and the airguns may be tested at varying power levels. The following guidance is provided to clarify when a soft-start is required:

- If the intention is to test all airguns at full power then a 20 minute soft-start is required.
- If the intention is to test a single airgun on low power then a soft-start is not required.
- If the intention is to test a single airgun, or a number of guns on high power, the airgun or airguns should be fired at lower power first, and the power then increased to the level of the required test; this should be carried out over a time period proportional to the number of guns being tested and ideally not exceed 20 minutes in duration.

MMOs should maintain a watch as outlined in the pre-shooting search guidance (section 3.1) before any instances of gun testing.

3.4 Line Change

Seismic data is usually collected along predetermined survey lines. Line change is the term used to describe the activity of turning the vessel at the end of one line prior to commencement of the next line. Depending upon the type of seismic survey being undertaken, the time for a line change can vary. Line changes are not necessary for all types of seismic surveys, for example, in certain regional surveys where there is a significant distance between the lines, and for VSP operations.

The guidance relating to line change depends upon the airgun volume.

3.4.1 Seismic surveys with an airgun volume of 500 cubic inches or more

- If the line change time is expected to be greater than 20 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. A pre-shooting search should also be undertaken during the scheduled line change, and the soft-start delayed if marine mammals are seen within 500 metres of the centre of the airgun array.

3.4.2 Seismic surveys with an airgun volume of 180 cubic inches or less (site surveys)

- If the line change time is expected to be greater than 40 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. The pre-shooting search should also be

undertaken during the scheduled line change, and the soft-start delayed if marine mammals are seen within 500 metres of the centre of the airgun array.

- If the line change time is expected to be less than 40 minutes, airgun firing can continue during the turn, but the Shot Point Interval (SPI) should be increased (longer duration between shots). Ideally, the SPI should not exceed 5 minutes during the turn.

Depending upon the duration of the line turns and the nature of seismic survey it may be necessary to vary the soft-start procedures. If an applicant determines that an effective line change can not be achieved using the above methods please contact JNCC at the earliest possible opportunity to discuss the proposed alternative, and include the details of the agreed procedure and the consultation with the JNCC in the application for survey consent.

3.5 Undershoot operations

During an undershoot operation, one vessel is employed to tow the seismic source and a second vessel used to tow the hydrophone array, although the main vessel will still tow the hydrophone array. This procedure is used to facilitate shooting under platforms or other obstructions. The MMO may be too far away from the airguns to effectively monitor the mitigation zone, and it is therefore recommended to place the MMO on the source vessel. If this is not possible, for example for logistical reasons, or the health and safety implications of transferring personnel from one vessel to another, the application should explain that the recommended procedure cannot be followed in the application for the survey consent, or the application for a variation of that consent. Irrespective of the MMO location agreed with DECC, the pre-shooting search and soft-start procedures should still be followed prior to undertaking an undershoot operation.

Section 4 - Acoustic Monitoring

Visual observation is an ineffective mitigation tool during periods of darkness or poor visibility (such as fog), or during periods when the sea state is not conducive to visual mitigation, as it will not be possible to detect marine mammals in the vicinity of airgun sources. Under such conditions, PAM is considered to be the only currently available mitigation technique that can be used to detect marine mammals. Current PAM systems can be particularly helpful in detecting harbour porpoises within the 500 metre mitigation zone, although the systems have their limitations and can only be used to detect vocalising species of marine mammals.

PAM systems consist of hydrophones that are deployed into the water column, and the detected sounds are processed using specialised software. PAM operatives are needed to set up and deploy the equipment and to interpret the detected sounds.

4.1 Use of PAM as a mitigation tool

PAM can provide a useful supplement to visual observations undertaken by MMOs and JNCC may recommend that it is used as a mitigation tool when commenting on applications for survey consents. However, in many cases it is not as accurate as

visual observation for determining range, and this will mean that the mitigation zone will reflect the range accuracy of the system. For example, if the range accuracy of a system is estimated at +/-300 metres, animals detected and calculated to be within 500 metres from the source could, in reality, be 500 + 300 = 800 metres, but their detection would still lead to a delay in the soft-start. Although, at present it is not possible to express the range accuracy of most PAM systems in numerical terms, this example serves to illustrate that it is in the operator's best interests to use the most accurate system available, and for the PAM operative to factor in a realistic estimate of the range accuracy.

Some PAM systems do not have a reliable range determination facility or can only calculate the range for some species. In such cases, the detection of a confirmed cetacean vocalisation should still be used to initiate postponement of the soft-start if the PAM operator is able to make a judgement about the range of the animals from the airgun source, because of their experience gained in differentiating between distant and close vocalisations. In the absence of PAM systems capable of range determination, this expert judgement will constitute the basis for deciding whether an area is free from cetaceans prior to the soft-start.

In all cases where PAM is employed, a brief description of the system and an explanation of how the applicant intends to deploy PAM to greatest effect should be included in the application for survey consent.

In the last few years, software that processes and analyses cetacean sounds has been developed. An example of this is PAMGuard, an open source software that has been developed as part of the International Association of Oil and Gas Producers Joint Industry Project (JIP). JNCC recognises that PAMGuard is currently in a transition period between use as a research tool and widespread adoption as a monitoring technique. Moreover, JNCC recognises the need to balance proactive implementation of PAM with the need to further develop its capability, for example to include species recognition and baleen whale detection, and therefore encourages users of these systems to actively contribute to their development and refinement.

Section 5 – Requirements for MMOs and PAM

Any survey application or consultation received by JNCC will be considered on a case-by-case basis, and the mitigation measures advised to DECC will reflect the particulars of the survey and the importance of the survey area for marine mammals. The following paragraphs are provided as a guide to the advice applicants are likely to receive following submission of an application with JNCC.

For areas that are currently considered particularly important for marine mammals, for example in the UK this includes areas West of Scotland, the Moray Firth and Cardigan Bay, JNCC may recommend that:

- The MMOs should be experienced MMOs, and that PAM should be used.
- The PAM system should be used to supplement visual observations, or as the main mitigation tool if the seismic survey activity commences during periods of

darkness or poor visibility, or during periods when the sea state is not conducive to visual mitigation.

JNCC will advise that two marine mammal observers should be used when daylight hours exceed approximately 12 hours per day (between 1st April and 1st October north of 57^{O} latitude), or the survey is in an area considered particularly important for marine mammals.

When a non-dedicated MMO is recommended by JNCC (e.g. for VSPs and certain site-surveys), and the recommendation is incorporated into the conditions of the survey consent, a member of the rig's or vessels crew can perform the duties providing the crew member is a trained MMO.

When a dedicated MMO is recommended and this is a condition of the survey consent, the MMO should be employed solely for the purpose of monitoring the implementation of the guidelines and undertaking visual observations to detect marine mammals during periods of seismic activity.

When two dedicated MMOs are requested and this is a condition of the survey consent, both should be employed solely for the purposes of monitoring the implementation of the guidelines and undertaking visual observations, and the use of a crew member with other responsibilities as the second observer is not considered to be an adequate substitute for a dedicated MMO, or to be in compliance with the conditions of the survey consent.

Section 6 - Background Information

These guidelines were originally prepared by a Working Group convened by the Department of the Environment, and were developed from a draft prepared by the Sea Mammal Research Unit (SMRU). The guidelines have subsequently been reviewed three times by the Joint Nature Conservation Committee, following consultation with interested parties.

6.1. Existing protection to cetaceans

Section 9 of the Wildlife and Countryside Act 1981 (CRoW amended) prohibits the intentional or reckless killing, injuring or disturbance of any cetacean. The UK is also a signatory to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and has applied its provisions in all UK waters. Amongst other actions required to conserve and manage populations of small cetaceans, ASCOBANS requires range states to "work towards...the prevention of ...disturbance, especially of an acoustic nature".

Reflecting the requirements of the Convention on the Conservation of European Wildlife and Habitats (the Bern Convention) and Article 12 of the EC Habitats and Species Directive (92/43/EEC), the UK has the following legislation in place:

- The Conservation of Habitats and Species Regulations 2010
- The Conservation (Natural Habitats, &c.) Regulations 1995 (Northern Ireland) (and 2009 amendments)

- The Conservation (Natural Habitats, &c.) Amendment (No. 2) Regulations 2008 (Scotland) (and 2009 amendments)
- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (and 2007 amendments),
- The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (and 2009 and 2010 amendments) (beyond 12 nautical miles UKCS)

Section 7 – References and contacts

Further information on DECC's survey consent procedure can be found at: http://www.og.decc.gov.uk/.

A copy of these guidelines, the standard forms (electronic and hard copy) and further background information is available from the above address, or can be found on the JNCC website at: http://www.jncc.gov.uk/page-1534

Reid, J.B., Evans, P.G.H., & Northridge, S.P. (2003). *'*Atlas of cetacean distribution in north-west European waters*'* (Online). http://www.jncc.gov.uk/page-2713

If you have any comments or questions relating to these guidelines, or suggestions on how they may be improved, please email seismic@jncc.gov.uk